Little Arkansas River Watershed

Watershed Restoration and Protection Strategy

April 9, 2018

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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: Bacteria normally found in gastrointestinal tracts of animals. Some strains cause diarrheal diseases.
Eutrophication (E): Excess of mineral and organic nutrients that promote a proliferation of plant life in lakes and ponds.
Fecal *coli*form bacteria (FCB): Bacteria that originate in the intestines of all warm-blooded animals.
Municipal Water System: Water system that serves at least 25 people or has more than 15 service connections.
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. Contained in 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.
Nutrients: Nitrogen and phosphorus in water source.
Phosphorus (P or TP): Element in water that, in excess, can lead to increased biological activity.
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.
Stakeholder Leadership Team (SLT): Organization of watershed residents, landowners, farmers, ranchers, agency personnel and all persons with an interest in water quality.
Total Suspended Solids (TSS): Measure of the suspended organic and inorganic solids in water. Used as an indicator of sediment or silt.

Watershed Restoration and Protection Strategy for the Little Arkansas River (11030012) Watershed

1. Preface

The purpose of this Watershed Restoration and Protection Strategy (WRAPS) report for the Little Arkansas River watershed is to outline a plan of restoration and protection goals and actions for the surface waters and ground waters of the watershed. Watershed goals are characterized as "restoration" or "protection". Watershed restoration is for waters that do not meet water quality standards, and for areas of the watershed that need improvement in habitat, land management, or other attributes. The ultimate goal of the WRAPS process is to create and implement a plan to restore the health of water bodies that do not meet their water quality standards. Additionally, the WRAPS process will insure that water bodies that currently meet their water quality standards are protected.

The WRAPS development process 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 WRAPS process at the local level. Final goals for the watershed at the end of the WRAPS process are to provide a sustainable water source for drinking and domestic use while preserving food, fiber, and timber 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 goal is watershed restoration and protection that will be "locally led and driven" in conjunction with government agencies in order to better the environment for everyone.

This report 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 WRAPS process, the Stakeholder Leadership Team (SLT) will have the capability, capacity and confidence to make decisions that will restore and protect the water quality and watershed conditions of the Little Arkansas River watershed.

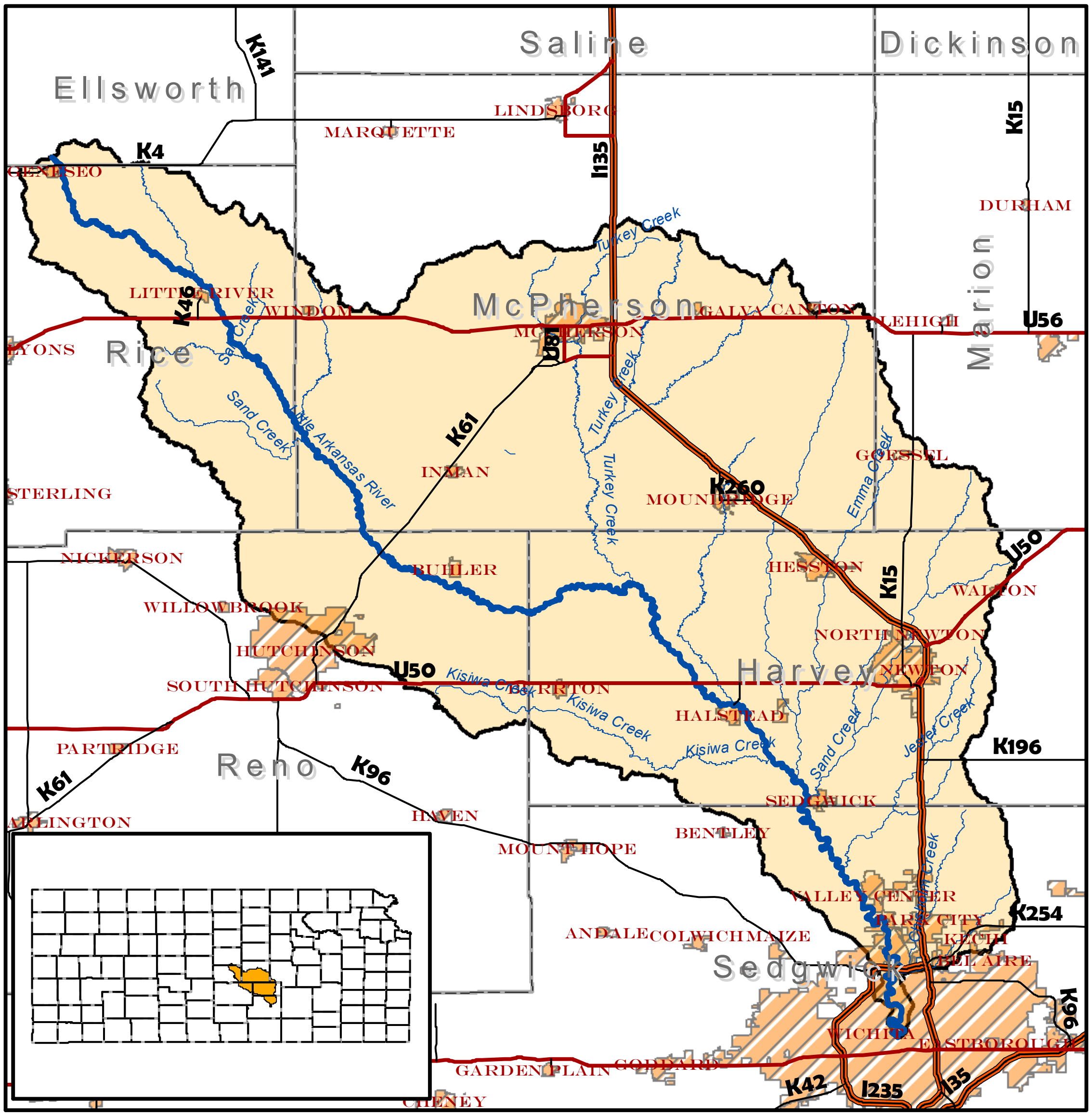


Figure 1 Map of the Little Arkansas River Watershed.

2. Development of the Stakeholder Leadership Team

In 2001, a group of concerned citizens established a proactive, voluntary grass roots Stakeholder Leadership Team (SLT). This volunteer task force consisted of landowners, producers, residents, agency representatives and other stakeholders in the Project Area that were interested in exploring water quality issues and nonpoint source pollution. The SLT was dedicated to developing a WRAPS plan for the preservation and protection of the Little Ark Watershed and the consensus of the SLT was that atrazine load reduction would be the main watershed objective. The written plan was assembled through a series of activities in late 2003 and 2004, the WRAPS plan was submitted to KDHE in October of 2004. A final watershed restoration plan that contained the required EPA 9 Elements of a watershed plan was submitted to and approved by EPA in 2011. This plan, written in 2018, is intended to update the information from 2011 and provide new guidance with revised goals for the SLT to incorporate into decisions that will be made in the future.

The main pollutants of concern for the SLT are:

- Atrazine
- Sediment
- Nutrients and
- E. coli Bacteria.

3. Watershed Goals

1) Stakeholder Leadership Team

The SLT has identified specific goals needed to achieve watershed improvement. Implementation of best management practices (BMPs), as well as financial incentives and cost share programs will, over time, lead to decreases in impairments in surface and ground water resources. Responsibility for restoration and protection of the watershed rests primarily in the hands of local stakeholders. For this reason, federal and state agencies provide technical and financial assistance for education activities and implementation of best management practices.

The SLT has been meeting since 2001 and they have set the following **watershed restoration and protection goals**:

- Protect ground and surface water quality and quantity.
- Protect public drinking water and livestock watering supplies.
- Protect recreational waters and lakes in the watershed.
- Promote wildlife habitat and rural aesthetics while providing for the farming economy and increased population growth.
- Continue sustainability of land conservation.
- Increase public awareness and education about watershed/water quality issues.
- Evaluate and maintain water quality to meet or exceed KDHE standards.
    a. Reduce Atrazine found in surface waters
    b. Reduce Sediment from entering stream and lake waters
    c. Reduce Nutrients in stream and lake waters
    d. Reduce e coli Bacteria in surface waters

2) Regional Advisory Committee

In 2013, the Governor of Kansas issued a call to action to develop a 50-Year Vision Plan to be incorporated into the Kansas Water Plan. Regional Advisory Committees (RACs) were developed in 2015. The Little Ark Watershed is contained in the Equus-Walnut RAC. The Equus-Walnut RAC has developed seven goals for the future of the Lower Arkansas basin. They are closely aligned with the WRAPS process. The seven goals are as follows:

1. Maintain a sustainable balance of groundwater withdrawals to annual groundwater recharge in the Equus Beds Aquifer.
2. Each public water supply will develop a long term water supply plan.
3. To implement and maintain watershed protection activities to maintain regional reservoir storage capacity.
4. Maintain or reduce the rate of sedimentation and nutrient loading through use of best management practices on 50% of high priority acres above water supply reservoirs.
5. Allocate necessary resources to identify and prioritize current contamination issues impacting the Equus Beds Aquifer and develop a plan to manage and mitigate the contamination.
6. Promote less water and nutrient intensive crops; provide incentives for agricultural operators to implement irrigation efficiency; and increase implementation of water conserving agricultural production practices.

7. Encourage municipal, commercial and industrial users to increase the efficiency of net water use by reducing the volume of water used per unit of measure by 5% per decade.

In order to meet the goals, the RAC has developed Action Steps. These steps will include working in cooperation and coordination with local WRAPS groups, conservation districts, producers and municipalities. Partnerships will implement the goals by finding new and leveraging existing funding sources, implementing new conservation practices and providing education and awareness of water quality and quantity issues in the watershed.

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. BMPs are implemented to achieve a specific goal and are placed in an optimal location to achieve that goal. Common agricultural BMPs are buffer strips, terraces, grassed waterways, utilizing no-till or minimum tillage, conservation crop rotation and nutrient management plans. Definitions of each of these BMPs are found in the appendix of this report.

3) Partnerships with the City of Wichita

3.3.1 Atrazine

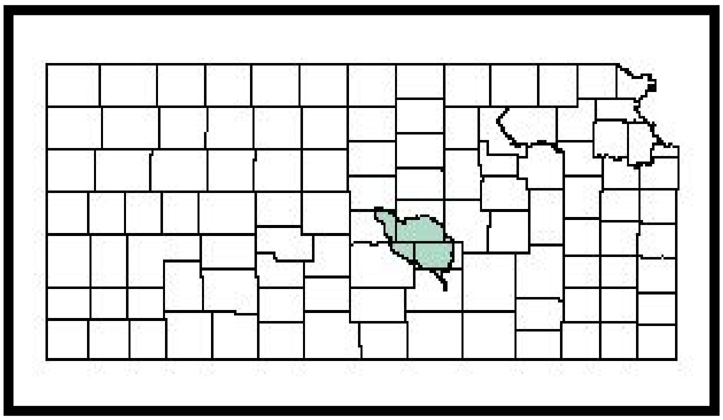
In order to protect their drinking water source, the City of Wichita implemented a program in which they inject water from the Little Arkansas River into the Equus Beds aquifer for storage. This withdrawal from the river can only happen during periods of high flow and the injectable water must be treated to drinking water standards. Since it is to meet the drinking water standards, any atrazine above the limit of 3ppb must be removed prior to injection. Atrazine is a herbicide used by farmers to control emergence of weeds. The City of Wichita determined that it was more efficient and cost effective to encourage farmers to limit or not apply atrazine instead of removal at the time of injection. They partnered with the WRAPS SLT and implemented a new program to provide incentive payments to farmers to encourage them to apply atrazine in responsible approved methods, or to not apply atrazine at all. In 2006, the total cash amount provided by the City of Wichita that was made available for farmer incentives was $10,000. The program was so successful that by 2017, the incentive payment fund for atrazine BMPs had grown to $50,000. In addition to the atrazine farmer payments, the City of Wichita provides all water analysis at no cost to the Little Ark WRAPS. Results of the highly successful atrazine program will be more fully explored in later sections of this document.

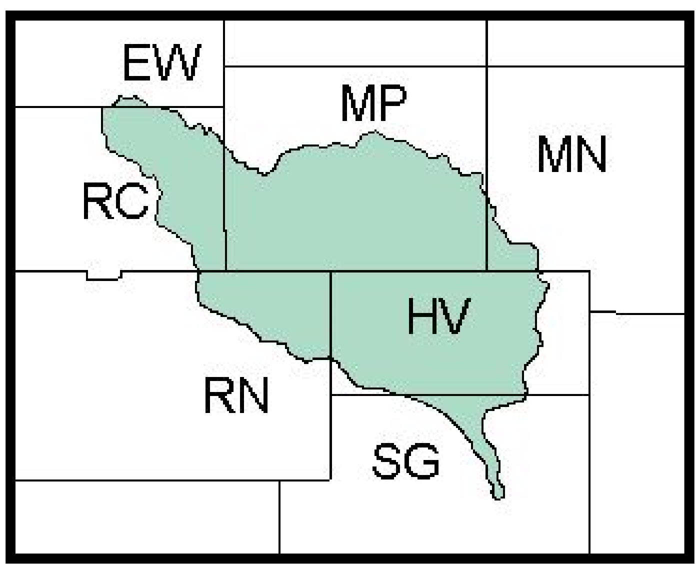
3.3.2 Off-Site Stormwater BMP Implementation

The City of Wichita has a MS4 permit through the Kansas Department of Health and Environment to control suspended solids originating from activities in the city such as development and new construction projects. Because of this permit, the city regulates developers. Remediation costs from post construction control sites is substantial. Therefore, the city and the WRAPS SLT joined forces and decided that rural projects were much more cost effective and if done properly, the effect on the river sediment load would be equal. A sediment credit program was developed where farmers would be paid to implement BMPs that control sediment and be paid incentive payments from a sediment credit fee paid by the developing company. This program has been highly successful for both the farmers and the development companies and helping to prevent sediment in the river.

4. Watershed Review

There are twelve river basins located in Kansas. The scope of this Watershed Restoration and Protection Strategy (WRAPS) is the Little Arkansas River Watershed. The Little Arkansas River watershed is located in south central Kansas within Reno, Harvey, Sedgwick, McPherson, Rice, Marion and Ellsworth counties. The headwaters of the Little Arkansas River originate near the town of Geneseo, and the river travels southeast approximately 80 miles draining numerous tributaries before emptying into the Arkansas River at Wichita.





Counties:
EW=Ellsworth County
RC=Rice County
RN=Reno County
MP=McPherson County
HV=Harvey County
SG=Sedgwick County
MN=Marion County

A watershed is an area of land that catches precipitation and funnels it to a particular creek, stream, 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.

HUC is an acronym for **H**ydrologic **U**nit **C**odes. 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. The Little Arkansas River Watershed is classified as a HUC 8, meaning it has an 8 digit identifying code, **11030012**. HUC 8s can further be split into smaller watersheds that are given HUC 10 numbers and HUC 10 watersheds can be further divided even smaller HUC 12s. The Project Area contains 33 HUC 12 delineations.

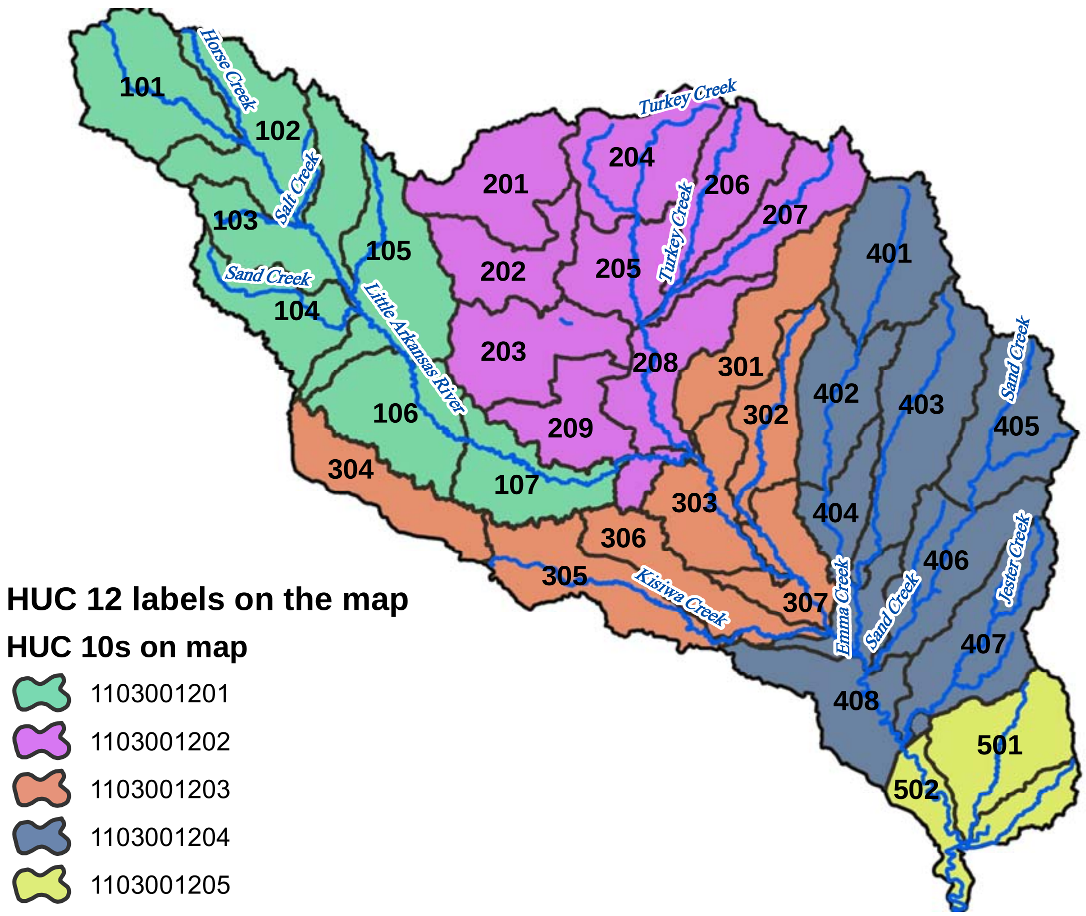


Figure 2 HUC 12 Delineations in the Little Arkansas River Watershed.

The Little Arkansas River Watershed is designated as a Category I watershed indicating it is in need of restoration as defined by the *Kansas Unified Watershed Assessment 1999* submitted by the Kansas Department of Health and Environment (KDHE) and the United States Department of Agriculture (USDA) in 1999. [1] A Category I watershed does not meet state water quality standards or fails to achieve aquatic system goals related to habitat and ecosystem health. Category I watersheds are also assigned a priority for restoration. The Little Arkansas River Watershed is ranked 14th in priority out of 92 watersheds in the state.

1) Description of the Watershed

The watershed is comprised of 913,430[2] acres that is primarily contained in McPherson and Harvey counties with small coverage in Ellsworth, Rice, Reno, Marion and Sedgwick counties in central Kansas.

The major city in the watershed is Wichita, located at the base of the watershed with a population of 389,902. Although there are several smaller communities in the watershed there are a few additional larger municipalities that should be noted: McPherson, population of 13,164, Hutchinson population of 41,310 and Newton with a population of 19,105. These numbers are provided by the US Census Bureau's 2016 estimate. Approximately 667,203 people live in the seven counties that cover the watershed; however, this number includes a few larger cities within the counties that are not contained within the Project Area. According to the US Census Bureau, the average population density (in the seven counties covering the Project Area) is above the Kansas state average. Population increased in the Project Area counties of the watershed by an average of 4.6 percent from 2009 to 2016 (US Census Bureau).

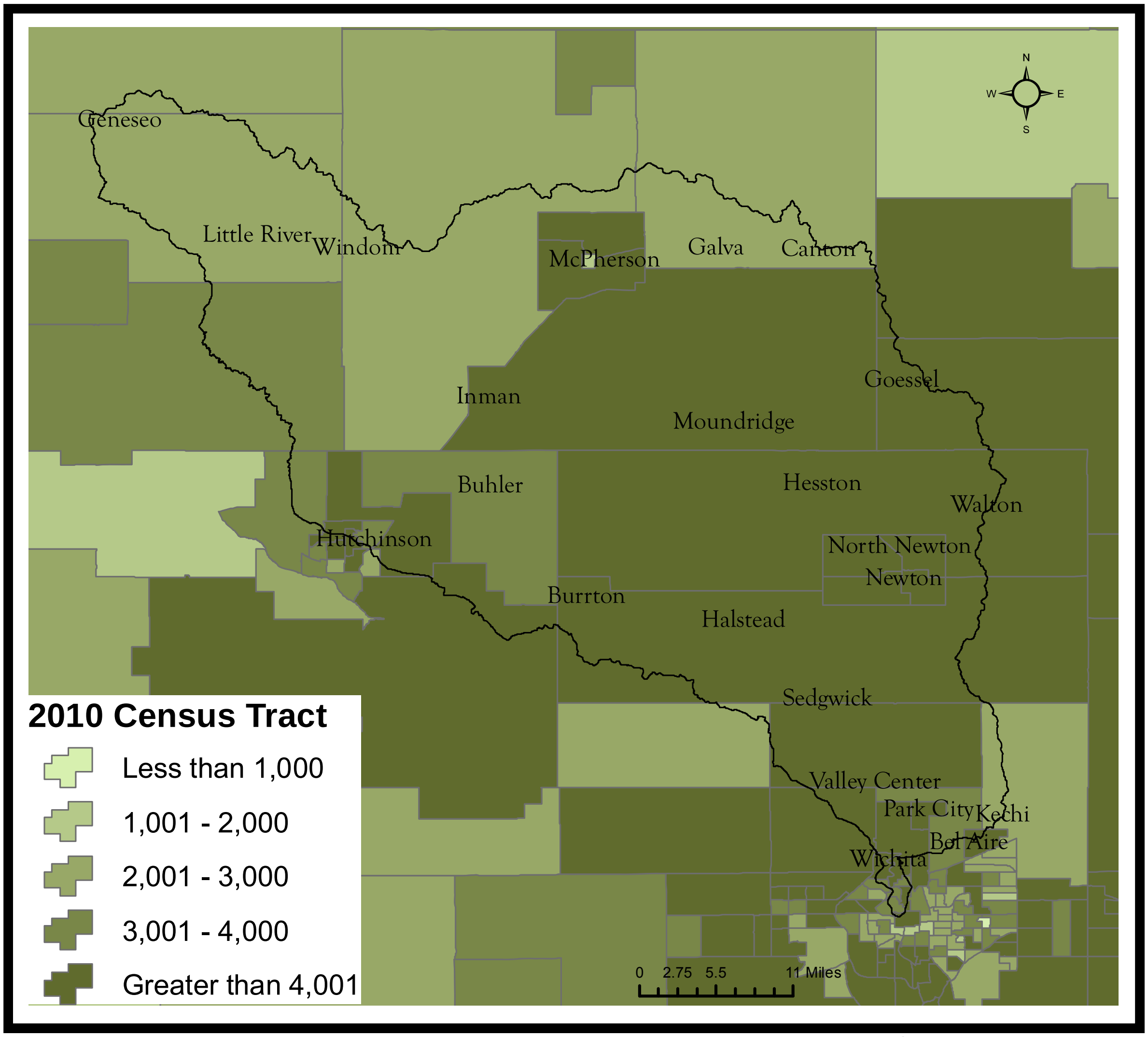


Figure 3 Population Distribution Map in the Little Arkansas Watershed. [3]

2) Public Waters Supply and NPDES

The table below lists the public water supplies in the Little Arkansas River Watershed. There are no surface water sources in the Little Arkansas River Basin WRAPS Service Area.

Table 1 PWS in the Little Arkansas River Watershed.

Public Water Supplier	Population Served
BEL AIRE, CITY OF	7661
BUHLER, CITY OF	1,317
BURRTON, CITY OF	887
CAMP HAWK	25
CANTON, CITY OF	720
CHISHOLM CREEK UTILITY AUTHORITY	1

COUNTRYVIEW MOBILE HOME PARK	48
ELYRIA CHRISTIAN SCHOOL	250
GALVA, CITY OF	873
GARDEN VIEW CHRISTIAN SCHOOL	30
GOESSEL, CITY OF	508
HALSTEAD, CITY OF	2,081
HARVEY CO RWD 1	3,000
HARVEY CO WEST PARK EAST WELL 2	26
HARVEY CO WEST PARK WEST WELL 1	26
HESSTON, CITY OF	3,803
HUTCHINSON, CITY OF	41,310
INMAN, CITY OF	1,353
LITTLE RIVER, CITY OF	536
MCPHERSON, CITY OF	13,164
MOUNDRIDGE, CITY OF	1,737
NEWTON, CITY OF	19,105
NORTH NEWTON, CITY OF	1,797
NORTH STAR RV PARK AND MOBILE HOME COMM	25
PARK CITY, CITY OF	7,632
PUBLIC WHOLESALE WSD 17	1
RENO CO RWD 1	123
RENO CO WATER DISTRICT 8	260
SEDGWICK, CITY OF	1,695
SPRING LAKE RESORT	340
VALLEY CENTER, CITY OF	7,222
WICHITA, CITY OF	389,902
Total population served by PWS in Little Ark WRAPS	**507,458**

Wastewater treatment facilities are permitted and regulated through KDHE. They are considered point sources of pollutants. National Pollutant Discharge Elimination System (NPDES) permits specify the maximum amount of pollutants allowed to be discharged to surface waters. Having theses point sources located on streams or rivers may 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. Waste water will be treated to remove solids and organic materials, disinfected to kill bacteria and viruses, and discharged to surface water. Treatment of municipal waste water is similar across the country.[4] Any pollutant discharge from point sources that is allowed by the state is considered to be Wasteload Allocation. The watershed has forty-three permitted NPDES facilities.

Table 2 NPDES Facilities. [5]

NPDES NO	Facility Name	Treatment Description	Waterway

KS0080951	AGCO CORPORATION	PHYSICAL/CHEMICAL TREATMENT	Little Arkansas River via Middle Emma Creek; Little Arkansas River Basin
KS0001082	BNSF RAILWAY CO - NEWTON	PHYSICAL/CHEMICAL TREATMENT	Little Arkansas River via Sand Creek
KS0093602	BPU-(MCPHERSON) POWER PLANT #3	REVERSE OSMOSIS (OTHER)	Little Arkansas River via Dry Turkey Creek via Unnamed Tributary
KS0088625	BPU-(MCPHERSON) WT AIR STRIPPER	GROUNDWATER REMEDIATION W/STRIPPER	Little Arkansas River via Dry Turkey Creek via Bull Creek via Concrete Storm Sewer
KS0079758	BPU-MCPHERSON #2	REVERSE OSMOSIS (OTHER)	Little Arkansas River via Dry Turkey Creek via Bull Creek
KS0027553	BUHLER, CITY OF	OXIDATION DITCH	LITTLE ARKANSAS RIVER
KS0049786	BURRTON, CITY OF	WASTE STABILIZATION POND; OVERFLOWING	Kisiwa Creek via North Branch Kisiwa Creek
KS0089176	CHISHOLM CREEK UTILITY AUTHORITY	SEQUENCING BATCH REACTOR	Little Arkansas River via Chisholm Creek
KS0000337	CHS - MCPHERSON REFINERY	SEQUENCING BATCH REACTOR	Turkey Creek via Dry Turkey Creek via Bull Creek
KSP000104	FULL VISION, INC	PHYSICAL/CHEMICAL TREATMENT	CITY OF NEWTON MWWTP
KS0022560	GALVA, CITY OF	WASTE STABILIZATION POND; OVERFLOWING	Turkey Creek via Unnamed Tributary; Little Arkansas River Basin
KS0098175	GENESEO, CITY OF	WASTE STABILIZATION POND; OVERFLOWING	LITTLE ARKANSAS RIVER
KS0081060	GOESSEL, CITY OF	WASTE STABILIZATION POND; OVERFLOWING	EMMA CREEK VIA MIDDLE EMMA CREEK
KS0026263	HALSTEAD, CITY OF	OXIDATION DITCH	Little Arkansas River
KS0022799	HESSTON, CITY OF	OXIDATION DITCH	Middle Emma Creek
KS0080292	INMAN, CITY OF	WASTE STABILIZATION POND; OVERFLOWING	Blaze Fork Creek
KSP000101	KICE INDUSTRIES, INC.	PHYSICAL/CHEMICAL TREATMENT	PARK CITY MWWTP
KS0085758	LITTLE RIVER, CITY OF	WASTE STABILIZATION POND; OVERFLOWING	LITTLE ARKANSAS RIVER
KS0036196	MCPHERSON, CITY OF	SEQUENCING BATCH REACTOR	Dry Turkey Creek via Bull Creek
KS0021008	MOUNDRIDGE, CITY OF	WASTE STABILIZATION POND; OVERFLOWING	BLACK KETTLE CREEK
KS0100528	NEWTON, CITY OF (NEW)	ACTIVATED SLUDGE EXTEND. AERATION	SAND CREEK VIA SLATE CREEK
KS0081108	SEDGWICK, CITY OF	OXIDATION DITCH	LITTLE ARKANSAS RIVER VIA SAND CREEK
KS0099074	VALLEY CENTER, CITY OF	ACTIVATED SLUDGE EXTEND. AERATION	LITTLE ARKANSAS RIVER
KS0026140	WALTON, CITY OF	WASTE STABILIZATION POND; OVERFLOWING	SAND CREEK VIA BEAVER CREEK VIA UNNAMED TRIBUTARY
KS0099392	WICHITA ASR PHASE I TREATMENT PLANT	WASTE STBL-POND, OVERFLOWING	Lagoon Outfall 001A1: Kisiwa Creek Sludge Return Outfall 002A1: Little Arkansas River
KS0099694	WICHITA ASR PHASE II TREATMENT PLANT	WASTE STBL-POND, OVERFLOWING	LITTLE ARKANSAS RIVER

KS0051721	WINDOM, CITY OF	WASTE STABILIZATION POND; OVERFLOWING	Little Arkansas River via Unnamed Tributary

The municipal and industrial wastewater treatment facilities in the watershed are located in the figure below. Thousands of onsite wastewater systems (non-NPDES permit) exist in the basin. The functional condition of these systems is generally unknown. All counties in the watershed have sanitary codes.

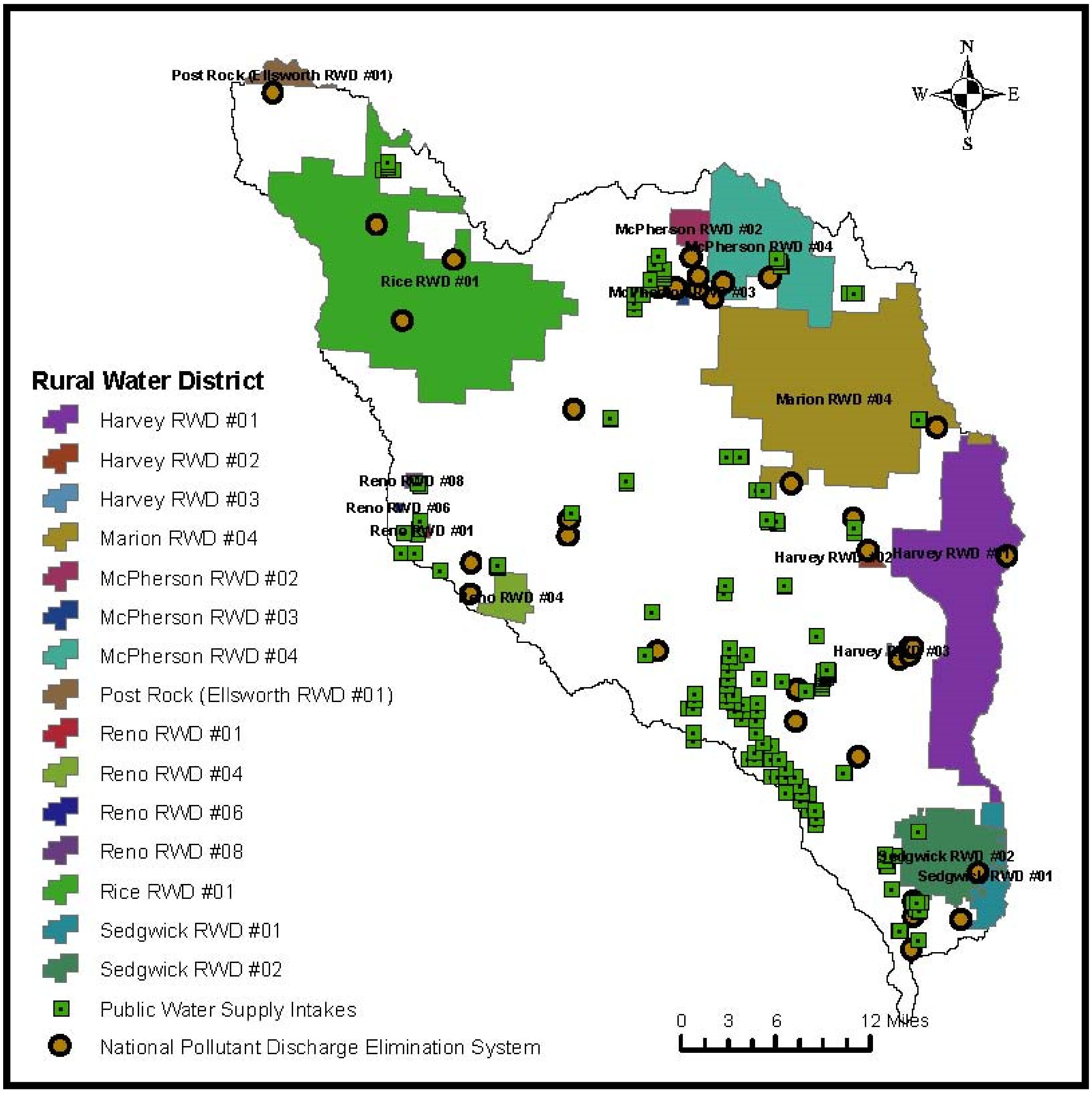


Figure 4 Rural Water Districts, Public Water Supply Intakes, and NPDES Sites in the Little Arkansas Watershed. [6]

3) Water Resources and Uses

Predominant rivers and streams in this watershed are the Little Arkansas River and Emma, Sand, and Turkey Creeks. The Little Arkansas Watershed covers 1,407 square miles and includes 478 stream miles and 88 acres of lakes. Designated resources include aquatic life (fish habitat), recreation (fishing and swimming), domestic water supply and ground water recharge as well as irrigation, livestock and industrial water sources. In addition to the rivers and streams, the watershed contains five major lakes (Newton City Park Lake, Mingenback Lake, Harvey County West Lake, Harvey County Camp Hawk Lake, and Lake Inman), and one wetland area (McPherson Wetlands).

The lakes support aquatic life and provide access to fishing, boating and swimming. Lake Inman (the largest natural lake in Kansas) is part of the McPherson Wetlands network, which consists of 3,000 acres, and is an important site for viewing waterfowl and migratory birds.

Annual rainfall averages range from 27 to 33 inches. Precipitation in the watershed averages 30 inches per year.

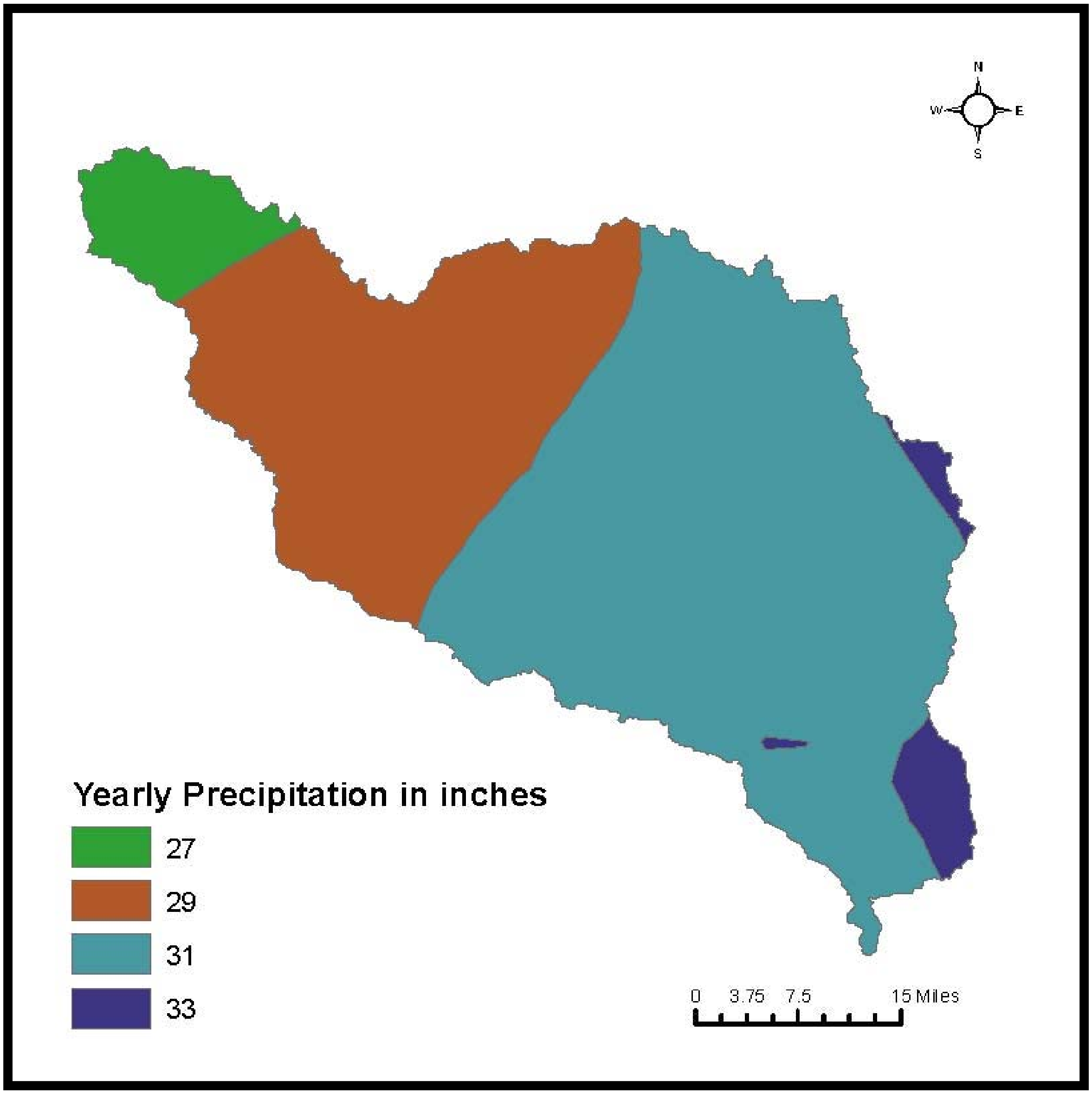


Figure 5 Precipitation in the Little Arkansas Watershed.

The watershed lies above portions of the Little Arkansas River Alluvial Aquifer, the Dakota Aquifer, High Plains Aquifer and the Equus beds.

- Alluvial Aquifer - The alluvial aquifer is a part of and connected to a river system and consists of sediments deposited by rivers in the stream valleys. The Alluvial Aquifers follow the path of the Little Arkansas River and its tributaries and are interconnected to the surface water in the river.
- Dakota Aquifer - The Dakota aquifer extends from southwestern Kansas to the Arctic Circle. In recent years, the Dakota aquifer has been used for irrigation purposes in southwest and in north-central Kansas (Cloud, Republic and Washington counties) and continues to present time. The Dakota aquifer also provides water for municipal, industrial, and stock water supplies. A one-mile distance between wells is the current stipulation for drilling in the Dakota.

- High Plains Aquifer – The High Plains Aquifer is a primary source of groundwater in western Kansas. Drawdown or depletion of the aquifer has greatly surpassed the rate of natural recharge. Responses of future aquifer withdrawals are predicted to cause continued aquifer declines, a reduction in the number of functional wells, and an increase of saline water intrusion into the aquifer.
- Equus beds - In 1995, the *Equus* Beds Groundwater Recharge Demonstration Project began evaluation of artificial recharge techniques and their effects on water quality in the aquifer. The demonstration project was a cooperative effort among the city of Wichita, Bureau of Reclamation (U.S. Department of the Interior), and the U.S. Geological Survey (USGS). Water from the Little Arkansas River was diverted for artificial recharge when flow in the river exceeded base flow in accordance with the Kansas Department of Agriculture, Division of Water Resources, permit conditions (Burns and McDonnell, 1998). Water was artificially recharged to the *Equus* Beds aquifer, which is part of the High Plains aquifer and consists of alluvial (river-deposited) sediments of sand and gravel interbedded with clay and silt.[7] Atrazine is of particular concern during ground water recharge because all waters that are reintroduced to the aquifers must be free of pollutants. The water from the Little Arkansas River requires filtration through charcoal to remove atrazine prior to being reintroduced into the aquifer. This process is a financial burden for the city of Wichita.

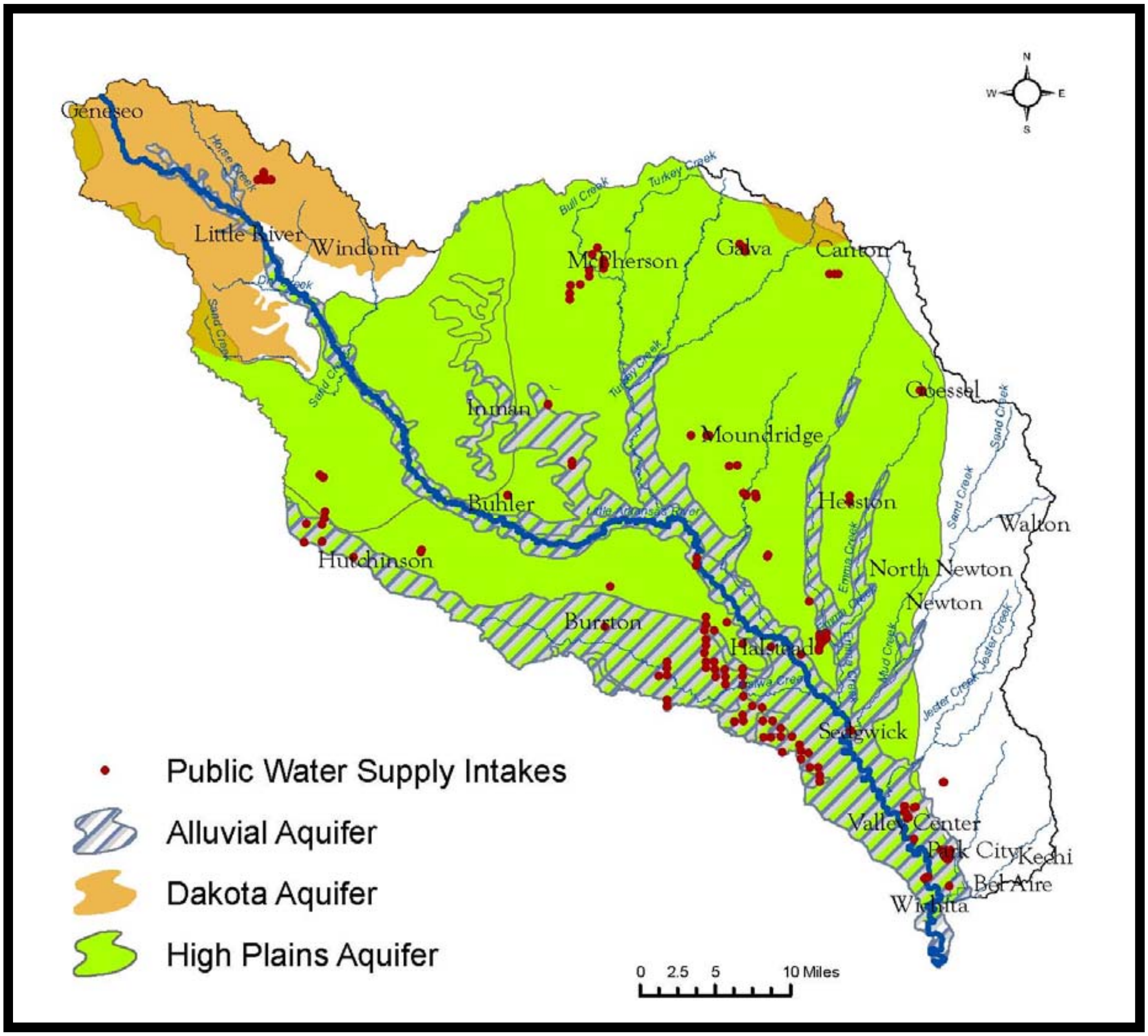


Figure 6 Aquifers in the Little Arkansas River Watershed.

There are approximately 7,406 registered groundwater wells in the project area that draw water from these aquifers. Water from these wells is used for domestic use, monitoring, irrigation, livestock watering, lawn and gardening, and public water supply.

Surface waters in this watershed are generally used for aquatic life support (fish), human health purposes, domestic water supply, recreation (fishing, boating, swimming), groundwater recharge, industrial water supply, irrigation and livestock watering. These are commonly referred to as "designated uses" as stated in the Kansas Surface Water Register, issued by KDHE.

Table 3 Designated Water Uses. [8]

Designated Uses Table

Stream Name	AL	CR	DS	FP	GR	IW	IR	LW
Beaver Creek	E	b	X	X	X	X	X	X
Black Kettle Creek	E	B	X	X	X	X	X	X
Bull Creek	E	C	X	X	X	X	X	X
Chisholm Creek	E	a	X	X	X	X	X	X
Chisholm Creek, Middle Fork	E	b	O	O	O	O	X	X
Dry Creek	E	b	O	X	X	O	O	X
Dry Turkey Creek	E	B	X	X	X	X	X	X
Emma Creek	E	b	X	X	X	X	X	X
Emma Creek, Middle	E	B	X	X	X	X	X	X
Emma Creek, West	E	C	X	X	X	X	X	X
Gooseberry Creek	E	b	O	X	O	X	O	O
Horse Creek	E	B	X	X	X	X	X	X
Jester Creek	E	C	X	X	X	X	X	X
Jester Creek, East Fork	E	C	X	X	X	X	X	X
Jester Creek, West Fork	E	C	O	X	O	O	O	X
Kisiwa Creek	E	B	X	X	X	X	X	X
Little Arkansas River, segments 1 and 14	E	B	X	X	X	X	X	X
Little Arkansas River, segments 3, 5, 9, 10	E	C	X	X	X	X	X	X
Lone Tree Creek	E	b	O	X	X	O	X	X
Mud Creek	E	b	O	X	O	O	O	X
Running Turkey Creek	E	b	X	O	X	X	X	X
Salt Creek	E	b	O	X	O	O	O	O
Sand Creek, segment 4	E	B	X	X	X	X	X	X
Sand Creek, segment 23	E	B	O	X	X	O	X	X
Turkey Creek, segment 11	E	C	O	X	X	O	X	X
Turkey Creek, segment 12	E	b	O	O	O	O	X	X
Lake Name								
Buhler City Lake	E	B	X	X	O	X	X	X
Dillon Park Lakes, Reno County	E	B	X	X	X	X	X	X
Camp Hawk Lake, Harvey County	E	A	X	X	X	X	X	X
West Park Lake, Harvey County	E	A	X	X	X	X	X	X
Inman Lake, McPherson County	E	B	X	X	X	X	X	X
McPherson Wetlands, McPherson County	E	a	X	X	O	X	X	X
Mingenback Lake, McPherson County	E	B	X	X	O	X	X	X
Newton City Park Lake, Harvey County	E	B	X	X	O	X	X	X

4) Land Cover/Uses

Land use activities have a significant impact on the types and quantity of nonpoint source pollutants in the watershed. Urban sprawl or the conversion of agricultural land to suburban homes and small acreages farms can have an impact on water quality. In addition, agricultural activities and lack of maintenance of agricultural structures can have cumulative effects on land transformation.

The major land use in the watershed is **cropland,** covering **69%** of the watershed. The majority of these crops are corn, soybeans, and sorghum. Sources of sediment originating from cropland can originate from overland flow across conventional tilled crop fields and ephemeral gullies that are plowed through each year. Cropland bacteria can originate from application of manure prior to a rainfall event or on frozen ground.

Grazing land or **grassland** comprises **21%** of the watershed. Grassland can be a major contributor of sediment and E. *coli* bacteria pollution. Gullies in rangeland are a major source of erosion and sedimentation. E. *coli* can originate from grasslands through overgrazing and allowing livestock access to streams and creeks.

The remaining land uses in the watershed are **urban areas**, occupying **4%** of the watershed, and over 4**%** of the total land mass is **woodlands** with the other 1% coming from water and other uses.

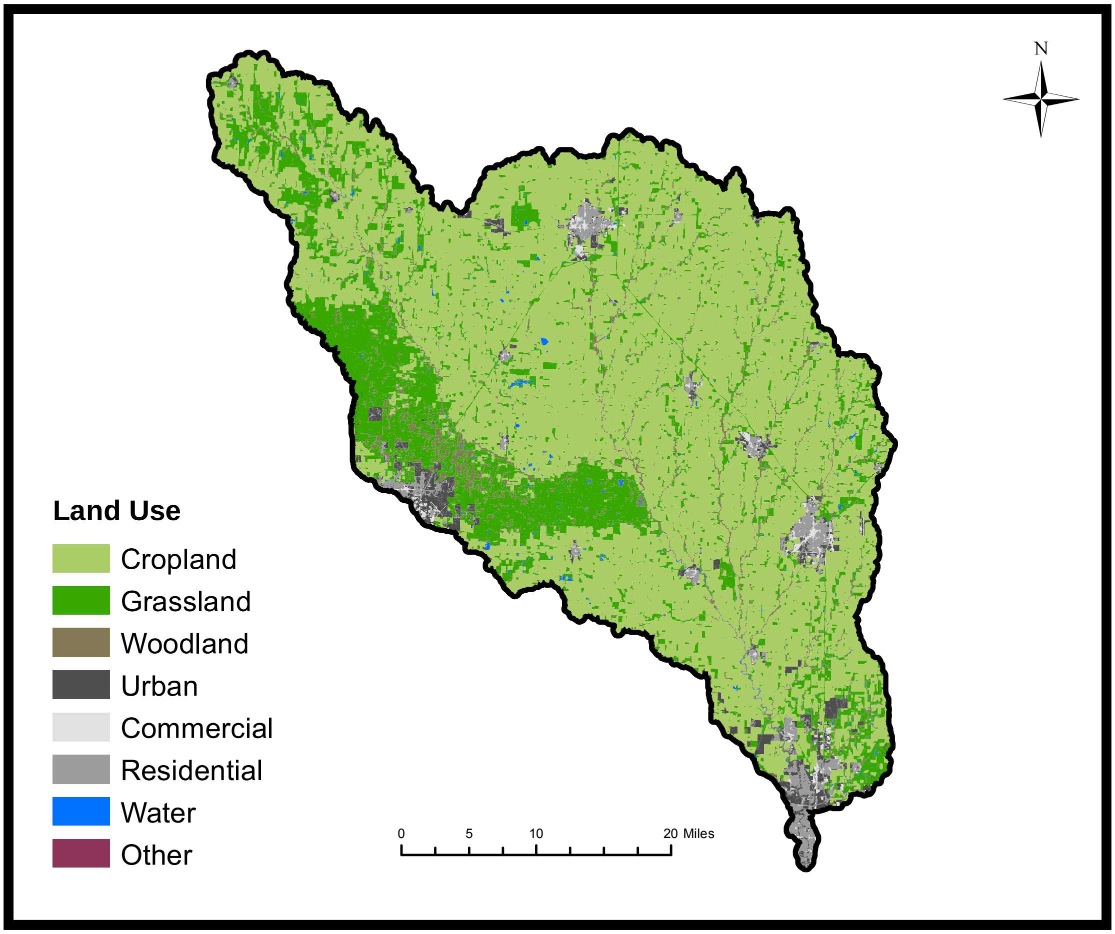


Figure 7 Land use in the Little Arkansas River Watershed. [9]

Table 4 Land Use Distribution. [10]

Land Use	Acres	Percentage of Watershed
Cropland	624,407	68.58
Grassland	189,358	20.80
Woodland	37,554	4.12
Urban	25,481	2.80
Residential	22,046	2.42
Commercial	5,899	0.65
Water	5,700	0.63
Other	6	< 1
Total	**910,450**	**100.00**

Table 5 Land Cover/Land Use Definitions.

Land Cover/Land Use	Definition
Water	All areas of open water, generally with less than 25% cover of vegetation or soil.
Urban/Developed	Includes developed open spaces with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses such as large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes. Also included are lands of low, medium, and high intensity with a mixture of constructed materials and vegetation, such as single-family housing units, multifamily housing units, and areas of retail, commercial, and industrial uses.
Forest/Woodland	Areas dominated by trees generally taller than 5 meters, and greater than 20% of total vegetation cover. Includes deciduous forest, evergreen forest, and mixed forest.
Grassland/Herbaceous	Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
Cropland	Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.
Source: www.mrlc.gov/nlcd_definitions.php & www.mrlc.gov/changeproduct_definitions.php	

According to the National Agricultural Statistics Service (2012 Census), there are a total of 6,381 farms in the counties of the watershed. The average size of a farm is 546 acres. Crops grown are primarily wheat, grain sorghum, corn and soybeans.

4.4.1 Confined Livestock

Any livestock facility with an animal unit capacity of 300 or more or a facility with a daily discharge regardless of size must register with the Kansas Department of Health and Environment (KDHE). Any facility, no matter what animal capacity, is required to register if KDHE's investigates them due to a complaint and the facility is found to pose a significant pollution potential. Facilities which register with KDHE will be site inspected for significant pollution potential, **if deemed not a significant pollution potential by KDHE, they can be certified if they follow BMPs as recommended by the technical service provider and approved by KDHE. These include but are not limited to: regular cleaning of stalls, managing manure storage areas, etc.** Facilities with 300 animal units up to 999 (known as Confined Feeding Facilities (CFFs) identified to have a significant pollution potential must obtain a State of Kansas Livestock Waste Management Permit. Facilities 1,000 or more must obtain an NPDES Livestock Waste Management Permit (Federal) known as Confined Animal Feeding Operations (CAFOs). Operations with a daily discharge, such as a dairy operation that generates an outflow from the milking barn on a daily basis, are required to have a permit. (see www.kdheks.gov/feedlots) for more information.

4.4.2 Unconfined Concentrated Animal Areas

Unconfined areas of animal concentration – e.g. watering areas, loafing areas or feeding areas can also pose a pollution potential if not managed properly. These are potential sources of nutrients, sediment, bacteria and aquatic impacts from manure and leftover feed. Best Management Practices for these areas can include proper manure application from a cleaning of these areas. This would be especially important when addressing cropland target areas. Other practices such as alternative water supplies, rotational grazing are for grazing type of activities, alternative watering or loafing areas, mineral and feed location rotation etc. will not likely address any type of “regulated” livestock pollution control need.

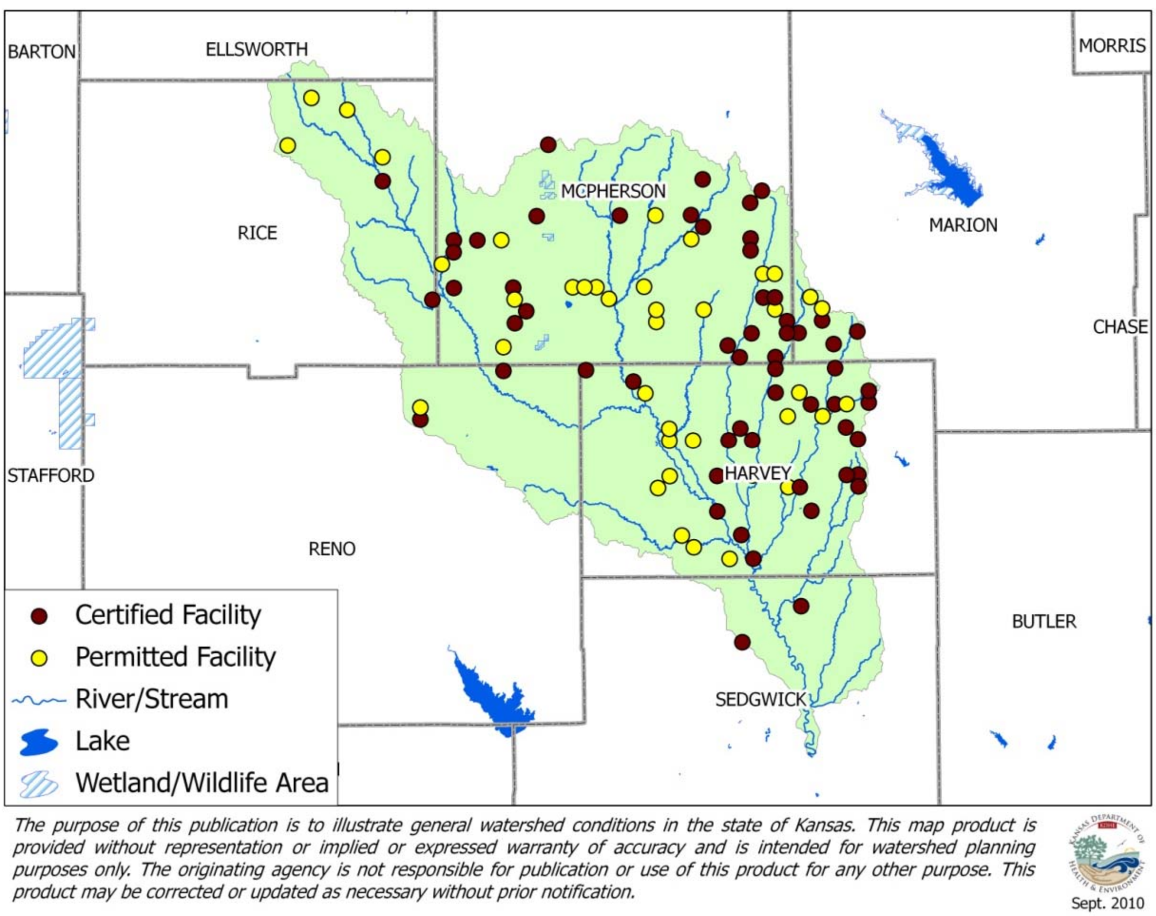


Figure 8 Animal Feeding Facilities in the Little Arkansas River Watershed.

Permit Type

1. *Permitted Facility* – A CAFO that requires on site animal waste management system based upon its pollution potential. A state permit is issued for facilities between 300 and 999 animal units (A.U.); in addition, a federal permit is issued to facilities in excess of 1000 A.U. based upon federal (EPA) animal count procedures.
2. *Certified Facility* – A facility that does not pose a significant pollution potential as determined by KDHE investigation. Certified facilities can be up to 999 animal units and cannot have pollution control structures in place.

Kansas Animal Unit Multipliers

An Animal Unit (AU) is a unit of measurement intended to make comparable the waste generated by different species. As determined by Kansas's law (KSA 65-171d):

- The number of beef cattle weighing more than 700 pounds multiplied by 1.0
- The number of cattle weighing less than 700 pounds multiplied by 0.5
- The number of mature dairy cattle multiplied by 1.4
- The number of swine weighing more than 55 pounds multiplied by 0.4
- The number of swine weighing 55 pounds or less multiplied by 0.1
- The number of sheep or lambs multiplied by 0.1
- The number of horses multiplied by 2.0
- The number of turkeys multiplied by 0.018
- The number of laying hens or broilers, if the facility has continuous overflow watering, multiplied by 0.01
- The number of laying hens or broilers, if the facility has a liquid manure system, multiplied by 0.033
- The number of ducks multiplied by 0.2

5) Special Aquatic Life Use Waters

Special aquatic life use waters are defined as "surface waters that contain combinations of habitat types and indigenous biota not found commonly in the state, or surface waters that contain representative populations of threatened or endangered species." The Little Arkansas River Watershed has NO special aquatic life use waters.

5. Overview of Water Quality

1) 303(d) Listings in the Watershed

Water quality in the project area is monitored at eight sites on the rivers and six sites on the lakes.

Table 6 Little Arkansas River Watershed Monitoring Sites.

Stream Chemistry No.	Monitoring Site
SC533	Turkey Creek near Alta Mills - rotational
SC246	Little Ark River at Alta Mills - permanent
SC705	Black Kettle Creek near Halstead - rotational
SC703	Kisiwa Creek near Halstead - rotational
SC534	Emma Creek near Sedgwick - rotational
SC535	Sand Creek near Sedgwick - rotational
SC282	Little Ark River at Valley Center - permanent
SC728	Little Ark River at Wichita - permanent
Information Provided by KDHE in 2009	
Lake Monitoring No.	**Monitoring Site**
LM064701	Mingenback Lake
LM050301	Inman Lake
LM063101	Dillon Parks Lake
LM049001	Harvey Co West Park Lake
LM064201	Newton City Park Lake
LM064201	Harvey Co Camp Hawk Lake
Information Provided by the Kansas Nonpoint Source Pollution Management Plan 2000 Update, KDHE	

As part of the federal *Clean Water Action Plan* completed by KDHE and Natural Resource Conservation Service (NRCS), the Little Arkansas River Watershed was classified as a "Category I – Watershed in Need of Restoration" for water quality and natural resource degradation. It is ranked 14th out of ninety-two watersheds in Kansas in need of restoration.

The Little Ark Watershed has numerous new listings on the 2016 "303(d) list". A 303(d) list of impaired waters is developed biennially and submitted by KDHE to EPA. To be included on the 303(d) list, samples taken during the KDHE monitoring program must show that water quality standards are not being met. This in turn means that designated uses are not met. TMDLs will be developed over the subsequent two years for "high" priority impairments. Priorities are set by work schedule and TMDL development timeframe rather than severity of pollutant. If it will be greater than two years until the pollutant can be assessed, the priority will be listed as "low". Water bodies are assigned "categories" based on impairment status:

- Category 5 – Waters needing TMDLs
- Category 4a – Waters that have TMDLs developed for them and remain impaired
- Category *4b* – NPDES permits addressed impairment or watershed planning is addressing atrazine problem

- Category 4c – Pollution (typically insufficient hydrology) is causing impairment
- Category 3 – Waters that are indeterminate and need more data or information
- Category 2 – Waters that are now compliant with certain water quality standards

Category 1 – All designated uses are supported, no use is threatened

Implemented strategies for addressing current TMDLs as determined by the SLT and outlined in his report will have an additional benefit by proactively addressing the impairments on the 303(d) list. The ultimate goal will be to eliminate the need for TMDL development of these impairments.

According to the *Unified Watershed Assessment*, approximately 67% of the total miles of water in this watershed do not meet their designated uses.

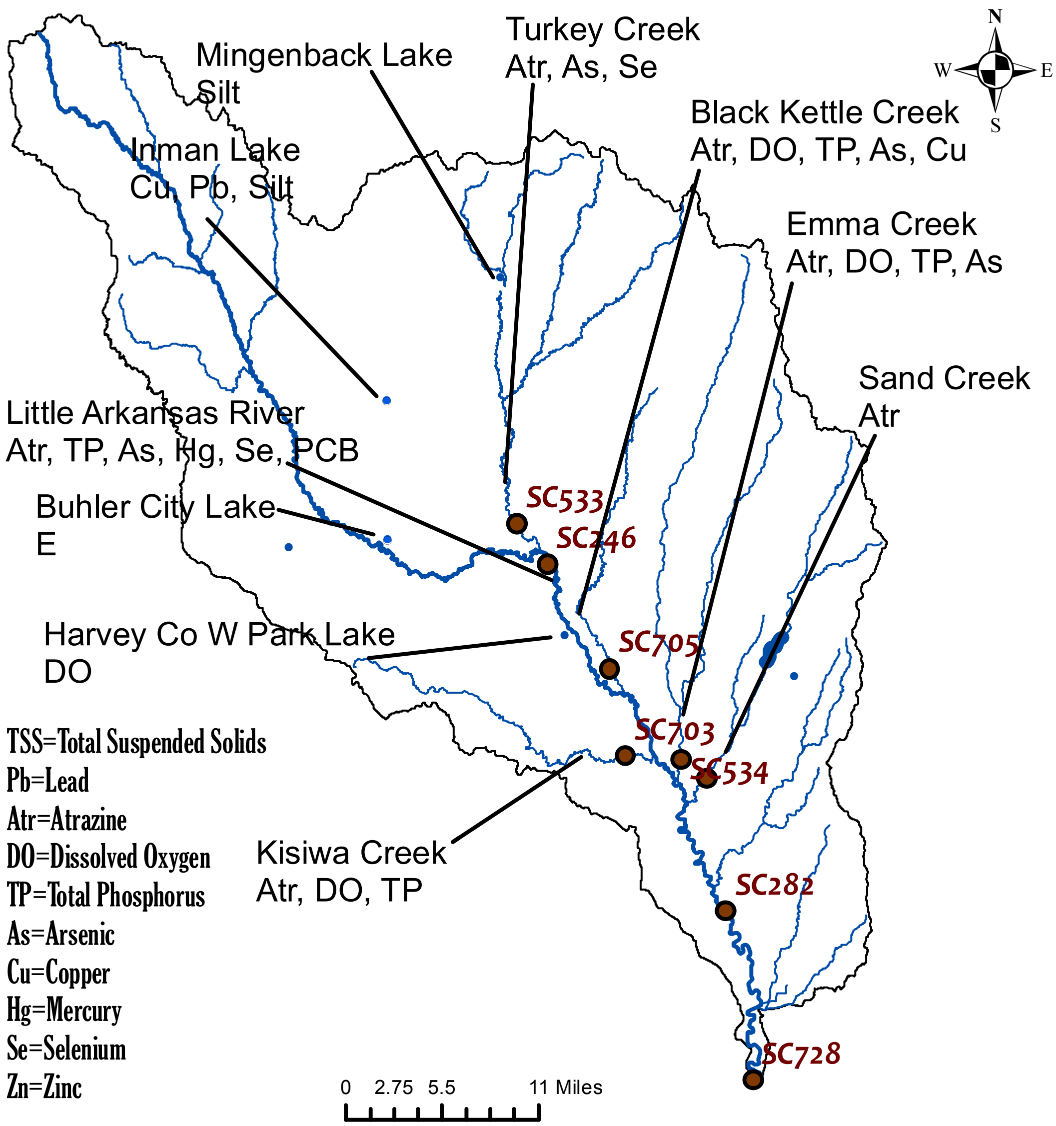


Figure 9 303(d) Listings in the Little Arkansas River Watershed.

Water Quality Impairments on the 303(d) List in the Little Arkansas River Watershed are listed in the table below. **Those TMDL's high-lighted in green are not directly targeted by this WRAPS Plan but the TMDL will subsequently be met by addressing the areas in yellow.**

Table 7 303(d) Listings in the Little Arkansas River Watershed.

TMDL Pollutant	Water Segment	Priority	Sampling Station
Category 5 – TMDL is needed (303(d) List)			
Atrazine (Atr)	Black Kettle Creek	2023	SC705
	Kisiwa Creek		SC703
	Little Arkansas River		SC246, SC282, SC728
Dissolved Oxygen (DO)	Black Kettle Creek	2022	SC705
	Kisiwa Creek		SC703
	Emma Creek		SC534
Total Phosphorus (TP)	Black Kettle Creek	2020	SC705
	Emma Creek		SC534
	Kisiwa Creek		SC703
	Little Arkansas River		SC246, SC282, SC728
Arsenic (As)	Emma Creek	2023	SC534
	Black Kettle		SC705
	Little Arkansas River		SC246
	Turkey Creek		SC533
Copper (Cu)	Black Kettle Creek	2023	SC705
Mercury (Hg)	Little Arkansas River	2023	SC728
Selenium (Se)	Little Arkansas River	2023	SC246
	Turkey Creek		SC533
Eutrophication (E)	Buhler City Lake	2023	LM50701
PCB	Little Arkansas River	2023	SC728
Category 3 – Waters that are indeterminate and need more data or information			
Copper (Cu)	Inman Lake		LM050301
Dissolved Oxygen (DO)	Harvey Co. West Park Lake		LM49001
Lead (Pb)	Inman Lake		LM050301
Siltation (Silt)	Inman Lake		LM050301
	Mingenback Lake		LM064701

2) TMDLs in the Watershed

A TMDL designation sets the maximum amount of pollutant that a specific body of water can receive without violating the surface water-quality standards, resulting in failure to support their designated uses. TMDLs established by Kansas 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 to EPA for approval. 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 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.

KDHE reviews TMDLs assigned in each of the twelve basins of Kansas every five years on a rotational schedule. The table below includes the review schedule for the Little Arkansas River Basin.

Table 8 TMDL Review Schedule for the Watershed. [11]

Year Ending in September	Implementation Period	Possible TMDLs to Revise	TMDLs to Evaluate
2011	2012-2021	2000, 2001	2000, 2001, 2006
2016	2017-2026	2000, 2001, 2007	2000, 2001, 2006, 2007

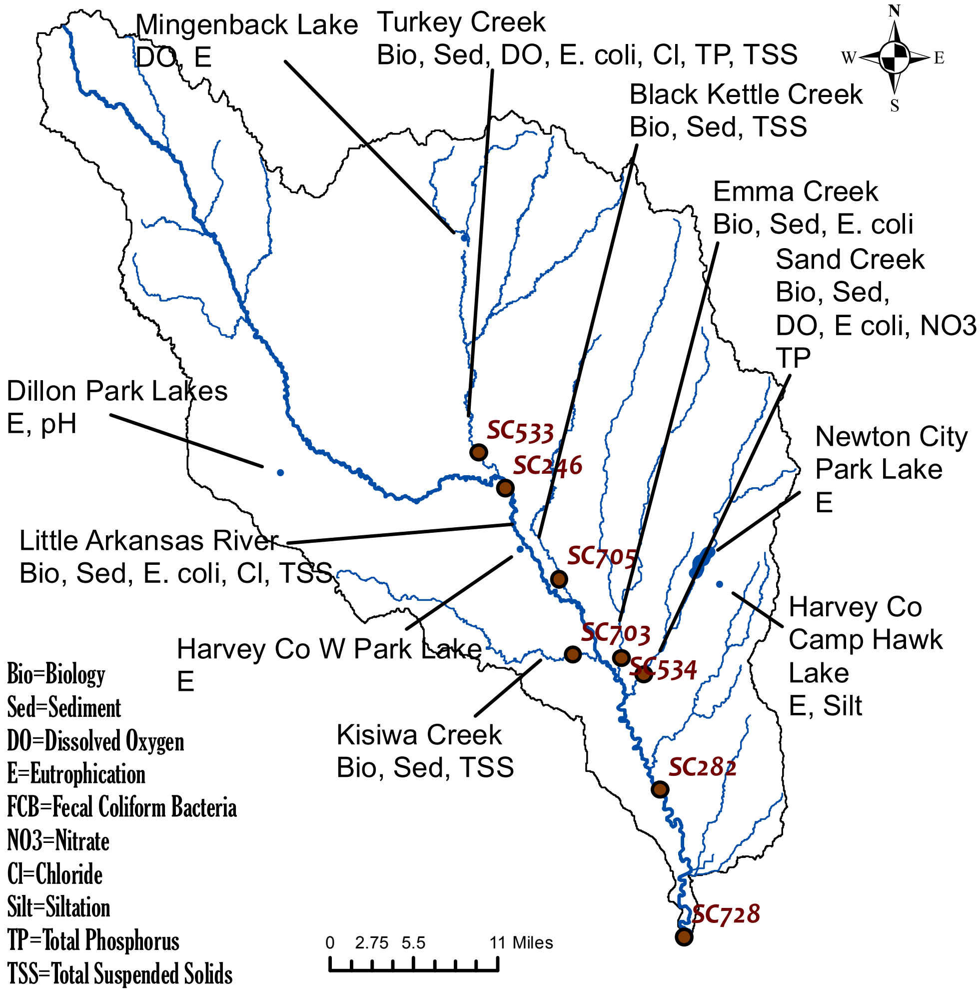


Figure 10 TMDLs in the Little Arkansas River Watershed.

Water Quality Impairments and TMDL(s) in the Little Arkansas River Watershed are listed in the table below. **Those high-lighted in yellow are the impairments and areas in which the SLT has chosen to target in this WRAPS Plan. Those TMDL's high-lighted in green are not directly targeted by this WRAPS Plan but the TMDL will subsequently be met by addressing the areas in yellow.**

TMDL Pollutant	Water Segment	Endgoal of TMDL	Priority	Sampling Station
Category *4b* – Watershed planning is addressing atrazine problem				
Atrazine (Atr)	Emma Creek	3 µg/l	Low	SC534
	Sand Creek			SC535
	Turkey Creek			SC533
Category 4a – TMDL has been developed for water				
Biology (Bio)	Black Kettle Creek	Average MBI (Macroinvertebrate	High	SC705
	Emma Creek			SC534

	Kisiwa Creek	Biotic Index)of 4.5 or less		SC703
	Little Ark River			SC246, SC282, SC728
	Sand Creek			SC535
	Turkey Creek			SC533
Biology/Sediment (Bio/Sed)	Black Kettle Creek	Average % composition of EPT (Ephemeroptera, Plecoptera and Trichoptera)) taxa of 40% or more	High	SC705
	Emma Creek			SC534
	Kisiwa Creek			SC703
	Little Ark River			SC246, SC282, SC728
	Sand Creek			SC535
	Turkey Creek			SC533
Dissolved Oxygen (DO)	Turkey Creek	BPD <4mg/l and dissolved oxygen >5 mg/l	High	SC533
	Sand Creek	Dissolved oxygen >5mg/l	Medium	SC535
	Mingenback Lake	Chlorophyll a ≤12.8 µg/l and dissolved oxygen >5mg/l	Medium	LM064701
Eutrophication (E)	Newton City Park Lake	Chlorophyll a ≤20µg/l	High	LM064201
	Dillon Park Lakes	Chlorophyll a ≤20µg/l, pH ≥6.5 and ≤8.5	Medium	LM063101
	Mingenback Lake	Chlorophyll a ≤12.8 µg/l and dissolved oxygen >5mg/l	Medium	LM064701
	Harvey Co. Camp Hawk Lake	Chlorophyll a ≤9.5µg/l	Low	LM063401
	Harvey Co. West Park Lake	Chlorophyll a ≤12µg/l	Low	LM049001
E. *coli* bacteria (E. *coli*)	Emma Creek	Achieve Water Quality Standards fully supporting Primary Contact Recreation and Secondary Contact Recreation	High	SC534
	Little Arkansas River			SC246, SC282, SC728
	Sand Creek			SC535
	Turkey Creek			SC533
Nitrate (NO3)	Sand Creek	Nitrate concentration ≤10mg/l	High	SC535
pH	Dillon Park Lakes		Medium	LM063101

Chloride (Cl)	Little Arkansas River	Chloride concentration <250mg/l	Medium	SC246
	Turkey Creek			SC533
Siltation (Silt)	Harvey Co. Camp Hawk Lake	Secchi disk depth >30cm	Low	LM063401
Total Phosphorus (TP)	Sand Creek	MBI < 4.5, EPT > 50%, chlorophyll a < 150 mg/sq meter, sestonic chlorophyll < 5 ug/l	High	SC535
	Turkey Creek			SC533
Total Suspended Solids (TSS)	Black Kettle Creek	MBI < 4.5, EPT > 48%	High	SC705
	Kisiwa Creek			SC703
	Turkey Creek			SC533
	Little Arkansas River			SC246, SC282, SC728

Some stream and river segments have been removed from the 2016 303(d) list. The delisted streams are contained in the table below.

Table 9 Delisted Pollutants in the Little Arkansas River Watershed.

TMDL Pollutant	Water Segment	Priority	Sampling Station
Category 2 – Waters that are now compliant			
Ammonia	Little Arkansas River		SC246
Chlordane	Little Arkansas River		SC286
			SC728
Copper	Emma Creek		SC534
	Kisiwa Creek		SC703
	Little Arkansas River		SC246, SC282, SC728
Lead (Pb)	Emma Creek		SC534
	Black Kettle		SC705
	Little Arkansas River		SC246, SC282, SC728
	Kisiwa Creek		SC703
	Turkey Creek		SC533
Fluoride (Fl)	Little Arkansas River		SC246
	Turkey Creek		SC533
Eutrophication (E)	Inman Lake		LM50301
Zinc (Zn)	Turkey Creek		SC533

3) Water Quality Impairments

5.3.1 *Atrazine*

Atrazine is a relatively inexpensive and effective herbicide that is widely used in corn and sorghum production. The watershed average for atrazine exceeds the statewide average. Atrazine is of importance to the City of Wichita due to the expense and inconvenience of filtering river water in order to remove all atrazine prior to recharge of the river water into the aquifer. The City of Wichita cost shares on Atrazine BMP placement within the watershed.

The SLT team is addressing **Atrazine** on Emma, Sand and Turkey Creeks, which are currently listed on the 2016 TMDL list but have been granted “Category *4b*” status, as described below. Black Kettle Creek, Kisiwa Creek and the Little Arkansas River at Alta Mills, Valley Center and Wichita are in need of consideration of a TMDL for Atrazine by the year 2023.

Section 303(d) of the Clean Water Act and the US Environmental Protection Agency’s (USEPA) supporting regulations require states to develop lists of waterbodies impaired by a pollutant and needing a TMDL. USEPA’s regulations also recognize that other pollution control requirements may obviate the need for a TMDL. These alternatives to TMDLs are commonly referred to as “Category *4b*” waters. For the 2008 reporting cycle, the Kansas Department of Health and Environment assigned 11 nonpoint source atrazine impaired stream segments in the Little Arkansas River subbasin to Category *4b*. In August 2010, KDHE and EPA approved the Category *4b* designation. Emma, Sand and Turkey Creeks have been included on the 2016 303(d) list of waters that are being addressed by watershed plans. KDHE will be reviewing data to evaluate success in maintaining water quality standard compliant atrazine levels in the stream data to keep them on the 303(d) list under a Category *4b*.

Atrazine is also listed on the 303(d) list for the Little Arkansas River, Black Kettle Creek and Kisiwa Creek. The segments not listed on the 303(d) list within the watershed all have samples that have exceeded the water quality criteria for Drinking Water Supply and Chronic Aquatic Life, with the exception of Station 705 on Black Kettle Creek. However, the sampling stations associated with the segments that are not listed are primarily rotational sampling stations, and therefore lack the sufficient number of samples over the water quality criteria to actually list these segments under Category 5 on the prior 303(d) lists. Since agricultural land uses throughout the watershed are subject to atrazine application practices, this Category *4b* alternative will be applicable to the entire watershed of the Little Arkansas River and will benefit the downstream reach of the Arkansas River from Wichita to Derby.

5.3.2 *Sediment and Nutrients*

Total Suspended Solids (TSS) is on the 303(d) list as a high priority for the Little Arkansas River, Black Kettle, Kisiwa and Turkey Creeks. TSS is made up of particles such as soil, algae, and finely divided plant material suspended in water. These pollutants may attach to sediment particles on the land and be carried into water bodies with storm water. In the water, the pollutants may be released from the sediment or travel farther downstream. These particles can come from cropland, stream banks, construction sites, as well as municipal and industrial wastewater. High TSS can block light from reaching submerged vegetation, slowing down photosynthesis. High TSS can also cause an increase in surface water temperature as the suspended particles absorb heat from sunlight, also harming aquatic life. Suspended sediment can clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larval development. When suspended solids settle to the bottom of a water body, they can smother the eggs of fish and aquatic insects, as well as suffocate newly hatched insect larvae. Settled sediments can fill in spaces between rocks which could have been used by aquatic organisms for homes. High TSS can also cause problems for industrial use as solids may clog or scour pipes and machinery.

Siltation and/or Sedimentation is listed as a low priority TMDL in this watershed at Harvey County Camp Hawk Lake. Sediment is listed as a high priority TMDL for Black Kettle, Emma, Kisiwa, Sand, and Turkey Creeks as well as the Little Arkansas River. The SLT considers sedimentation to be an area of concern throughout the Little Arkansas River Watershed and will target all these high priority areas.

Silt and sediment accumulation in the lakes are caused by soil erosion into the waterways. Silt decreases water clarity and reduces water storage capacity. Phosphorus attached to soil particles can be introduced into the lake by sediment accumulation, thus accelerating the eutrophication problem. Sedimentation can be caused by overland erosion from cropland, degraded pastureland, streambank sloughing, or improperly contained construction projects.

Eutrophication (E) is a natural process that occurs when a water body receives excess nutrients. These excess nutrients, primarily **nitrogen** and **phosphorus**, create optimum conditions that are favorable for algal blooms and plant growth. Some species of blue-green algae produce chemicals that are harmful to both animals and humans. These algal blooms have been linked to health problems ranging from skin irritation to liver damage to death, depending on type and duration of exposure. The livelihood of many fish, shellfish, and livestock has also been endangered through contact with this toxin. Proliferation of algae and subsequent decomposition can also deplete available dissolved oxygen in the water profile.

Excess nutrient loading from the watershed creates accelerated rates of eutrophication followed by decreasing amounts of **dissolved oxygen** (DO) in the water. This results in unfavorable habitat for aquatic life. These excess nutrients can originate from failing septic systems and manure and fertilizer runoff in rural and urban areas. DO is ranked a medium to high priority TMDL for Turkey and Sand Creeks as well as Mingenback Lake. The SLT will not target for DO impairments specifically but will address Phosphorus and sediment and will subsequently meet the TMDLs for Turkey and Sand Creeks and the 303(d) listed Emma and Black Kettle Creeks.

Total Phosphorus (TP) is 303(d) Category 5 listed currently for Black Kettle, Emma and Kisiwa as well as the Little Arkansas River. A TMDL has been developed for Turkey and Sand Creeks. TP will be targeted on cropland and livestock areas in these sub watersheds.

5.3.3 E. coli Bacteria

The Project Area has a high priority TMDL for **E. *coli* bacteria** (E. *coli*) on Emma, Sand and Turkey Creeks as well as the Little Arkansas River. The SLT will target these areas to meet TMDL needs. The approved TMDLs associated within the watershed were written for Fecal *Coli*form Bacteria (FCB). EPA required the adoption of the E. *coli* standard in 2003 since E. *coli* correlates better between illness and concentrations than FCB.

FCB are present in human and animal waste and is 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. FCB is not itself harmful to humans, but its presence indicates that disease causing organisms, or pathogens, may also be present. A few of these are Giardia, Hepatitis, and Cryptosporidium. Presence of FCB in waterways can originate from failing septic systems, runoff from livestock production areas, close proximity of animals to water sources, and manure application to land if it is applied before a rainfall event or on frozen ground. TMDLs for fecal *coli*form bacteria have an upper limit of 200 cfu (colony forming units)/100ml of water for primary contact recreation, such as swimming, and an upper limit of 2,000cfu/ml of water for secondary, non-contact recreation, such as boating and fishing. The Little Arkansas River and many of its tributaries are impacted by FCB.

Kansas House Bill 2219 established the E. *coli* criteria which is based on a geometric mean for 5-samples collected in a 30-day period with numeric standards based on the designated recreational use of the stream. The bacteria endpoints tied to water quality standards will be maintaining geometric means of bacteria samples collected within 30-day periods during April-October below 262cfu/100ml on these streams. Reductions in frequency and magnitude of high bacteria will serve as the necessary allocations to reduce "loading" and achieve the water quality standard.

Throughout the remainder of this WRAPS Plan, the term "Bacteria" will be used and will indicate both FCB and E. *coli* Bacteria as required by the 2003 Water Quality Standard for E. *coli* Bacteria, House Bill 2219.

5.3.4 Other Pollutants in the Watershed

The Project Area has a high priority TMDL for **biology** impairment for support of aquatic life with an end goal Macroinvertebrate Biotic Index (MBI) of 4.5 or less. Organic material from agricultural and urban nonpoint sources may contribute to the biological impairment downstream. These sources tend to become dominant under higher flow conditions. Additional biological measures are necessary to assure indications of good aquatic community health.

The SLT is not directly addressing the Biology TMDL but in addressing the Biology/Sediment TMDLs for Black Kettle, Emma, Kisiwa, Sand and Turkey Creeks as well as the Little Arkansas River, the Biology TMDLs for these water bodies will be met.

Nitrate (NO3) has been listed as a high priority TMDL for Sand Creek. Water naturally contains less than 1 milligram of nitrate-nitrogen per liter and is not a major source of exposure. Higher levels indicate that the water has been contaminated. Common sources of nitrate contamination include fertilizers, animal wastes, septic tanks, municipal sewage treatment systems, and decaying plant debris. High nitrate concentrations can cause health problems. For example, infants who are fed water or formula made with water that is high in nitrate can develop a condition that doctors call methemoglobinemia, also called "blue baby syndrome" because the skin appears blue-gray or lavender in color. This color change is caused by a lack of oxygen in the blood.

Dillon Park Lakes are on the 2010 TMDL list for having a medium priority pH, with an average pH of 9.28. The pH of water determines the solubility and biological availability of chemical constituents such as nutrients and heavy metals.

The Little Arkansas River and Turkey Creek are listed as medium priority TMDL for **Chloride**. Chloride is a chemical of concern because of its large and variable concentrations in the Little Arkansas River that can exceed drinking-water standards. Chloride concentrations need to be less than 250 mg/l. Chloride increases the electrical conductivity of water and thus increases its ability to corrode. The corrosion of piping systems could increase levels of metals in drinking-water.

More data is needed to determine if TMDLs are needed in the watershed for Lead, copper and siltation in Inman Lake, dissolved oxygen in Harvey County West Park Lake, and siltation in Mingenback Lake as these pollutants are currently a Category 3 on the 303(d) list. These pollutants may become of higher priority to the SLT but at this time, the Little Arkansas River Watershed's SLT wishes to begin addressing the priority issues of atrazine, E. *coli*, and sediment and nutrient pollutants that are listed as TMDLs in the watershed.

4) TMDL Load Allocations [12]

TMDL loading is based on several factors. A total load is derived from the TMDL. Part of this total load is wasteload allocation. This portion comes from point sources in the watershed: NPDES facilities, CAFOs or other regulated sites. Some TMDLs will have a natural or background load allocation, which might be atmospheric deposition or natural mineral content in the waters. After removing all the point source and natural contributions, the amount of load left is the TMDL Load Allocation that originates from nonpoint sources (pollutants originating from diffuse areas, such as agricultural or urban areas that have no specific point of discharge) and is the amount that this WRAPS project is directed to address. All Best Management Practices (BMPs) derived by the SLT will be directed at this Load Allocation by nonpoint sources.

5.4.1 Atrazine

Atrazine comes from field runoff. Streamflows within the Little Arkansas River increase when moving downstream. The high flows associated with these streams are of particular interest when interpreting atrazine impairments because atrazine impairments and exceedances within the stream are primarily caused by runoff from heavy rainfall after the herbicide application. High flows transport atrazine from the upland fields downstream to the on-stream monitoring stations. Atrazine concentrations are significantly higher during the runoff period months of April, May, June, and July due to the prevalent use of atrazine during this time period and because of the susceptibility to heavier rainfall events that contribute runoff. The TMDL has a load reduction target of 50% for atrazine and 3ug/L. Averages will not exceed an average of 3 ppb at sampling stations within the watershed during the runoff period using the *4b Alternative*[13] and the WRAPS Plan.

5.4.2 Sediment

Sedimentation comes predominantly from nonpoint sources. Based on the soil characteristics of the watershed, overland runoff can easily carry sediment to stream segments. Total Suspended Solids (TSS) which are particles such as soil, algae, and finely divided plant material suspended in water. Sources of TSS are soil erosion from cropland, stream banks, or construction sites, and municipal and industrial waste.

The pollutant load reduction responsibility will be to decrease the average condition of sediment over the range of flows encountered on the Little Arkansas River. KDHE cross referenced their monitoring data with K-State's water monitoring data [*Little Arkansas Water Quality Monitoring Quality Assurance Project Plan (QAPP),* Appendix 15.2]; see Figure 12 for monitoring site information. KDHE then added K-State tillage survey results and land usage in the watershed to the monitoring date results and was then able to determine target areas for sediment reductions. KDHE also made an adjustment to the flow on Turkey Creek to better calibrate the mass balance scenario and removed the loads coming in on the Little Arkansas River above Highway 61 based on K-State's data.

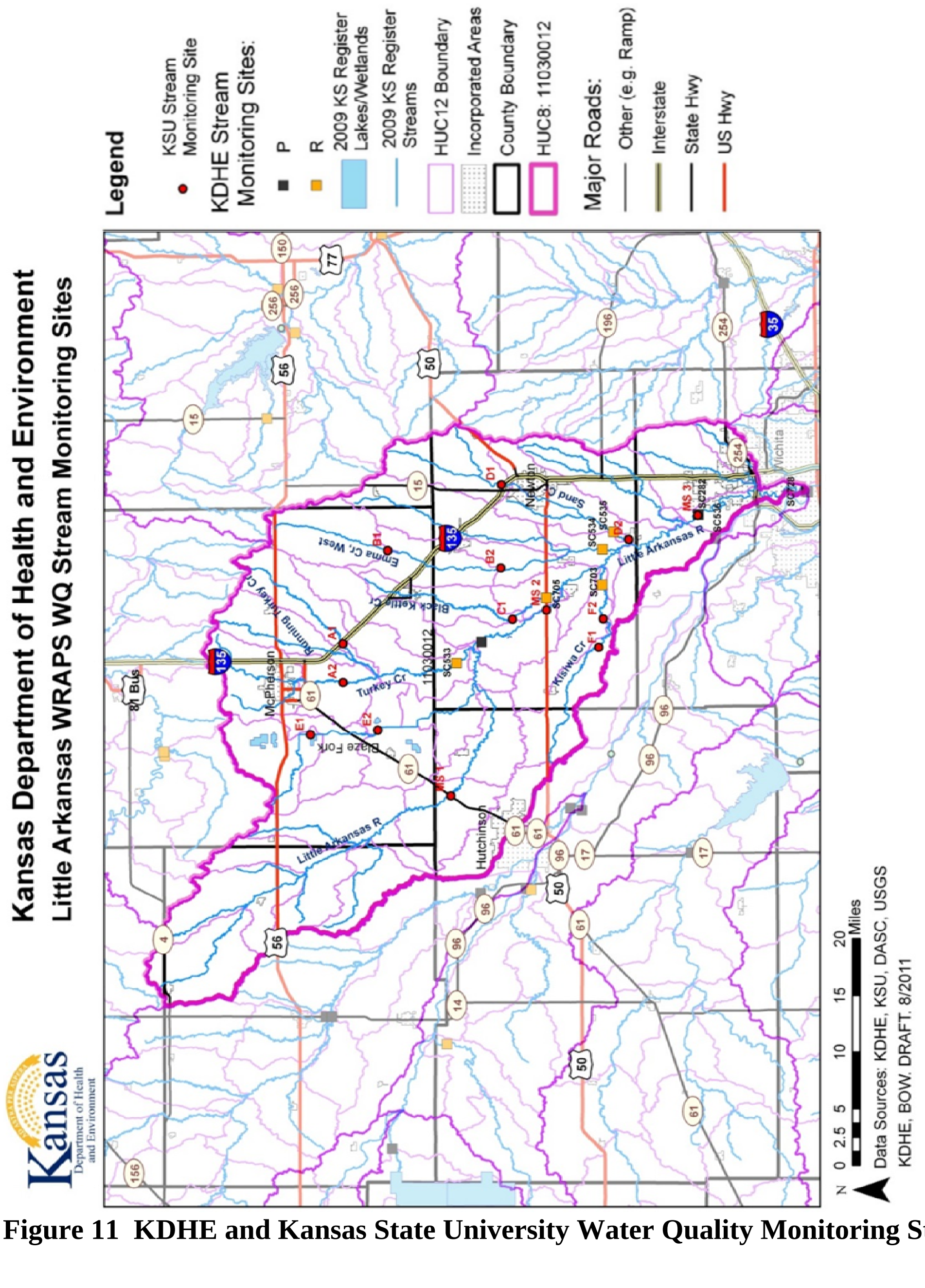


Figure 11 KDHE and Kansas State University Water Quality Monitoring Stations.

In their analysis, KDHE determined that the Load Allocation will be a reduction of sediment loadings such that average TSS concentrations are below 100ppm in stream a majority of the time. Therefore, the nonpoint source TSS load reduction needed is 204 tons/day to meet the TMDL at the average flow condition based on an in stream average concentration of 100 ppm of TSS. BMPs implemented on targeted areas in the watershed will accomplish the TMDL goal over several years.

Table 10 Estimated TSS Loads. [14]

Sub Watershed	Average Flow	TSS Load lbs/day	TSS Target Load lbs/day	TSS % Reduction	TSS Load Red Tons/year
Turkey Creek	62.37	51667.2	24840	51.92	4895.96
Lower W. Emma Cr	41.6	35268.48	22464	36.31	2336.82
Lower Blazefork	34.4	28978.56	18576	35.9	1898.47
Lower Sand Cr	54.3	59230.44	29322	50.5	5458.29
Lower Kisiwa	25.76	29490.048	13910.4	52.83	2843.29
Black Kettle	17.26	11370.888	9320.4	18.03	374.21
LA Valley Center (Less loads from above Hwy 61)	658	659955.6	251100	61.95	74616.15

5.4.3 Nutrients

Nutrient concentrations in the Little Arkansas River are derived primarily of nitrogen and phosphorus from in-field runoff. The Nitrate TMDL for Sand Creek is a point source TMDL; therefore Nitrates will not be targeted in this WRAPS Plan as WRAPS funds can not be used to address point source pollutants. The City of Newton is a contributor to the point source Nitrate pollution along Sand Creek. This WRAPS plan would like to approach the City of Newton and collaborate to achieve a reduction in N pollution using outside funding. The possibility for collaboration with the City of Newton will be discussed in more detail in Section 13.

KDHE cross referenced their monitoring data with K-State's water monitoring data [*Little Arkansas Water Quality Monitoring Quality Assurance Project Plan (QAPP),* Appendix 15.2], see Figure 12 above for monitoring site information. KDHE then added K-State tillage survey results and land usage in the watershed to the monitoring data results and was then able to determine target areas for phosphorus reductions. KDHE also made an adjustment to the flow on Turkey Creek to better calibrate the mass balance scenario and removed the loads coming in on the Little Arkansas River above Highway 61 based on K-State's data.

Table 11 Estimated Total Phosphorus Loads. [14]

Sub Watershed	Average Flow	TP Load lbs/day	TP Target Load lbs/day	TP % Reduction	TP Load Reductions lbs/year
Turkey Creek	62.37	184.42	49.68	73.06	49181.56
Lower W. Emma Cr	41.6	103.33	44.93	56.52	21318.34
Lower Blazefork	34.4	109.6	37.15	66.1	26442.94

Lower Sand Cr	54.3	106.17	58.64	44.76	17346.11
Lower Kisiwa	25.76	72.33	27.82	61.54	16247.35
Black Kettle	17.26	31.69	18.64	41.18	4762.72
LA Valley Center (Less loads from above Hwy 61)	658	1236	502.2	59.35	267837

BMPs implemented on targeted areas in the watershed will accomplish this TMDL goal over several years.

5.4.4 E. coli Bacteria [15]

Bacteria Load Reductions should result in less frequent exceedance of the nominal E. *coli* Bacteria (ECB) criterion (262 Colony Forming Units (CFUs)/100ml) for the sampling stations above Wichita in the Little Arkansas River watershed; and in lowered magnitude of those exceedances.

Data trends presented in Table 11 below, prepared by KDHE Watershed Planning, 2011, indicate Lower Sand Creek needs the most attention in terms of addressing bacteria impairment in the sub-watersheds below. This site is below Newton, which has urban contributions such as a concentrated geese population on the creek, pet waste and other sources associated with urban living.

Table 12 Data Trends for Bacteria. [14]

Data Trends for Bacteria, KDHE 2011						
Location	**Geomean**	**Index 90%**	**Geomean Rank**	**90% Index Rank**	**Index 50%**	**50% Index Rank**
Lower Sand Cr	77	1.12	1	1	0.78	1
Lower West Emma Cr	45	1.05	2	2	0.7	3
Lower Blazefork Cr	41	1.05	3	3	0.71	2
Lower Kissiwa Cr	27	1.03	5	4	0.45	7
Upper West Emma Cr	26	1	6	5	0.57	5
Upper Sand Cr	28	0.99	4	6	0.59	4
Upper Blazefork Cr	23	0.96	7	7	0.49	6
Upper Kissiwa Cr	18	0.92	8	8	0.45	7
Black Kettle	14.5	0.92	9	9	0.32	8
Running Turkey	14.4	0.84	10	10	0.42	9
Dry Turkey	13.4	0.82	11	11	0.36	10

In order to assess the impact of BMPs addressing bacteria impairments the relative frequency and magnitude of bacteria concentrations seen in the receiving streams, monitored by KDHE on a routine or rotational basis, must be measured to determine if water quality improvements are being achieved. The bacteria index is utilized by KDHE to assess the relative frequency and magnitude of the bacteria concentrations at KDHE monitoring sites.

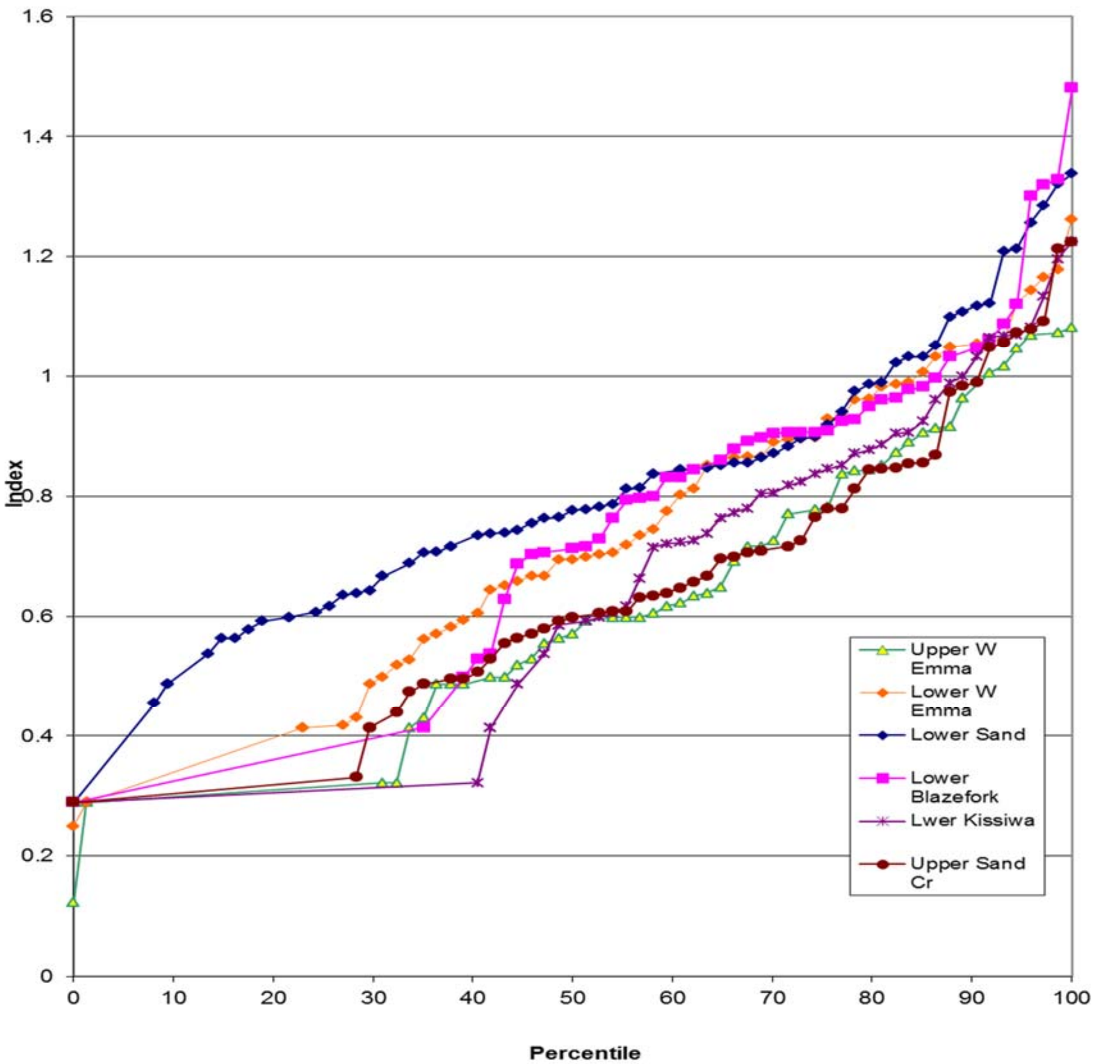


Figure 12 Bacteria Index for Sub watersheds. [14]

The calculated bacteria index for the Little Arkansas River sampling stations SC246, SC282, and SC728 are the natural logarithm of each sample value taken during the April-October Primary Recreation season, divided by the natural logarithm of the bacteria criteria for Primary Recreation Class B [ln(262)]. The bacteria indices for the tributaries of Sand and Emma Creek are also based on the Primary Recreation Class B criterion, whereas Turkey Creek is based on the Primary Recreation Class C criterion (427 CFUs/100ml).

Index = ln(ECB Count) / ln(262)

The indicator will be the Upper Decile of those index values; with the target being that the index is below 1.0 at the upper decile (90th percentile).

Ultimately, compliance with water quality standards will require sampling 5 times within 30 days during several periods during the primary recreation season, and calculating the geometric mean of those samplings. Meeting that test, will be justification for delisting the stream impairment.

Sampling station SC282 on the Little Arkansas River at Valley Center, station SC534 on Emma Creek, and station SC535 on Sand Creek were sampled in accordance with the Water Quality Standard in 2009. The geometric mean for the five samples collected over a 30-day period was 1528 CFUs/100ml for SC282, 1190 CFUs/100ml for SC534 and 2093 CFUs/100ml for SC535. The intensive sampling geometric mean results for these stations are well above the Water Quality Standard.   BMPs implemented on targeted areas in the watershed will decrease bacteria counts in the Little Arkansas River.

6. Critical Targeted Areas

In the Little Arkansas 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 303(d) 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.[16] Four areas have been identified as Critical Areas in this WRAPS:

1. Sub watersheds that have been identified by Water Monitoring Data
2. Sub watersheds with high priority TMDLs or are 303(d) listed
3. Sub watersheds that have a Category *4b* designation
4. Sub watersheds that the City of Wichita has special interest in protecting due to their proximity to the recharge project.

Based on the information available, the Sub watersheds that are considered “Critical Areas” are as follows:

- Black Kettle for TSS, Sediment/Biology
- Emma Creek for Atrazine, E. coli bacteria, Sediment/Biology
- Sand Creek for Atrazine, Sediment/Biology, TP, E. coli bacteria
- Turkey Creek for Atrazine, Sediment/Biology, TP, TSS
- Kisiwa Creek for Sediment/Biology, TSS

This WRAPS Plan will target specific land within these critical areas and in doing so will meet TMDL needs in all areas mentioned above. While targeting within these critical areas and meeting the previously mentioned TMDLs, this Plan will subsequently serve to meet the TMDLs and 303(d) listed areas mentioned below:

- Black Kettle for Biology, Total Suspended Solids (TSS) and Dissolved Oxygen (DO)
- Emma Creek for Atrazine, E. coli bacteria, TP, Biology and DO
- Sand Creek for Atrazine, TP, E. coli bacteria, Biology and DO
- Turkey Creek for Atrazine, E. coli bacteria, TP, Biology, TSS and DO
- Kisiwa Creek for Biology, TSS and DO
- Little Arkansas River – E. coli bacteria, TP, Biology and TSS

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 Best Management Practices (BMPs) in these areas; pollutants can be reduced at a more efficient rate. These areas are called targeted areas. “Targeted Areas” are those specific areas within the Critical Areas that require BMP placement in order to meet load reductions.

Therefore, the SLT has targeted areas within the sub watersheds listed above to focus BMP placement for atrazine, sediment, nutrients and E. coli bacteria. Areas and impairments targeted for these sub watersheds:

- Cropland areas will be targeted for Atrazine, Sediment and Phosphorus.
- Livestock areas will be targeted for Phosphorus and E. coli bacteria.
- Streambanks and Riparian areas will be targeted for Sediment and Nutrients.

1) Methodology for Identifying and Prioritizing Watersheds for BMP Implementatin Targeting for Sediment and Nutrient TMDLs

Utilization of the TMDL as the method for identifying and prioritizing critical watersheds for BMP implementation targeting was discussed between the project management team and KDHE. It was determined the TMDL was dated (to be revisited in fall of 2011) and KDHE monitoring sites may not be conducive to the goals of the wathershed plan.

Utilizing Existing KSU data: The decision was then made to utilize all of the information gathered in the process. The Black Kettle Creek watershed had been modeled for sediment and had been a focus for atrazine BMPs under a USDA Conservation Innovation Grant. Recent water quality and flow data (2006-2010 for atrazine and 2008 to 2010 for TSS, TP, TN and bacteria) more reflective of the goals of targeting BMP implementation was collected by KSU. Water quality trends did show some areas to focus on as described previously, however, since the modeling was limited to Black Kettle Creek watershed, land use, cropping systems and BMP adoption tendencies were also evaluated. For example, KDHE prepared a landuse map to quantify acres of cropland per sub-watershed where water quality data was available. An estimate of cropping systems for each sub-watershed was also prepared resulting in a numerical illustration of where the greatest opportunity for effective BMPs would be located in the HUC8.

The next step was to analyze data collected by KSU through the Section 319 funded Tillage Survey (Project # NPS 2005-0013). The survey was completed by local extension agents or other local resources for selected counties. The Little Arkansas WRAPS Coordinator foresaw the need to collect this data in the service area (mainly McPherson and Harvey Counties) for the WRAPS 9 element planning process. Additionally, there is discussion about making another round of surveys in the area as there is some evidence no-till practices are only being implemented for double cropping or other purposes not necessarily for long term resource protection and sustainability. This is dependent upon the grant status and circumstances. This information was determined to be more useful to assure BMP implementation schedule prepared by KSU was consistent with BMP needs.

Another factor was the City of Wichita contributing to cost share to enhance incentives for adoption of atrazine BMPs. Their interest is minimizing watershed pollutant contributions thus reducing their treatment costs for the aquifer recharge project.

The Watershed Planning Section evaluated the median (50^{th} % meaning 50% of the samples collected exceeded the surface water quality standard, upper quartile (75^{th} % meaning 75% exceeded the surface water quality standard) and upper decile (90^{th} % meaning 90% exceeded the surface water quality standard) from the samples collected by KSU. An index and the upper decile statistical method for E. *Coli* Bacteria, (see water quality summary) to prioritize the HUC 12 critical watersheds for livestock, was utilized. For TSS, the upper decile statistical method was used. The average for TP concentrations was used as it seemed better suited for prioritization. Total nitrogen concentration averages from only KDHE monitoring data was used.

Ultimately, KSU and KDHE concurred that the water quality data collected by KSU and the data at the KDHE Turkey Creek station and KSU would identify and prioritize critical watershed for BMP implementation targeting.

2) Targeting Cropland

Runoff from crop fields is undoubtedly a large source of the atrazine, sediment and P pollution entering the Little Arkansas River. In-field erosion, carrying these pollutants to tributaries, is also a contributor to the project area's nonpoint source pollution.

6.2.1 Targeting Cropland for Atrazine

Atrazine priority areas were defined by the Little Arkansas River Watershed stakeholder leadership team, KDHE and Kansas State University. The initial watersheds were selected by size, similar farming, rainfall patterns and proximity to each other. In 2005, these five sub-watersheds (Dry Turkey, Running Turkey, Upper West Emma, Lower West Emma and Black Kettle Creek) were assessed to determine daily atrazine contaminant loadings. Three of the sub-watersheds used atrazine BMPs while the remaining two sub-watersheds maintained existing farm practices. The three watersheds using atrazine BMPs in the "Paired Watershed Study" were:

- Turkey Creek, 23,536 acres
- Emma Creek, 30,615 acres
- Black Kettle Creek, 19,983 acres

These sites were monitored in 2006 and 2007 and results showed that by implementing atrazine BMPs, the concentration of atrazine was decreased by greater than 40% in 2006 when compared to the atrazine concentration from those sub-watersheds without BMPs.

Dry Turkey Creek, Upper West Emma Creek and Sand Creek will be the targeted areas for the Little Arkansas River Watershed WRAPS. Black Kettle, while Category 5/303(d) listed, will NOT be the main focus of the SLT; however, BMP implementation may take place in this sub watershed since it was part of the paired watershed study back in 2005 and is close in proximity to the Wichita Recharge Project. Landowners may continue to have interest in implementing atrazine BMPs since they were proven to work.

Specific crop fields will be identified based on proximity to streams, vulnerability of slope and soil type. The figure below shows Category *4b* and Category 5 Atrazine Areas in the Little Arkansas River Watershed.

As mentioned, only Category *4b* designated areas will be largely targeted to include Emma, Sand and Turkey Creeks.

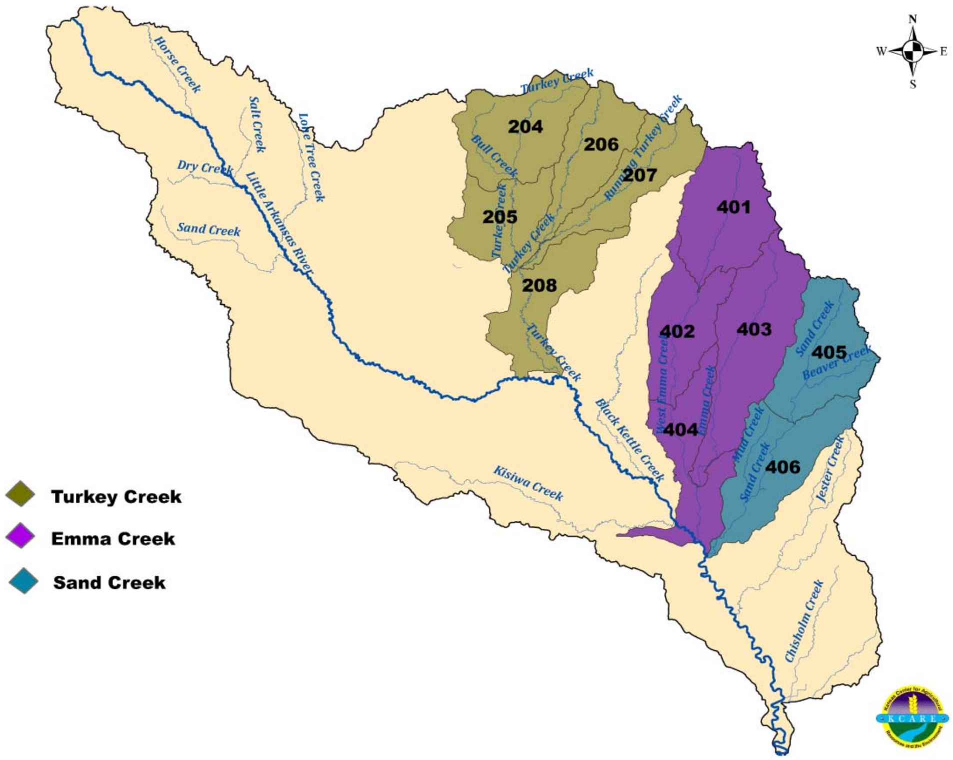


Figure 13 HUC 12 Targeted Areas for Atrazine.

6.2.2 Targeting Cropland for Sediment

Using the KDHE and K-State water monitoring data, tillage survey, and land use comparison table *(Appendix Tables, Section 14)* put together in July 2011 by KDHE, it was determined by the SLT, K-State and KDHE to target the following areas for sediment runoff on cropland. There are two tiers to this plan. Tier 1 will be the BMP implementation priority for plan years 6-15. Tier 2 will resume BMP implementation in plan year 16.

Tier 1 – This WRAPS Plan will first target the following areas for sediment BMP implementations:

- **Turkey Creek**
- **Black Kettle**
- **Kisiwa Creek**

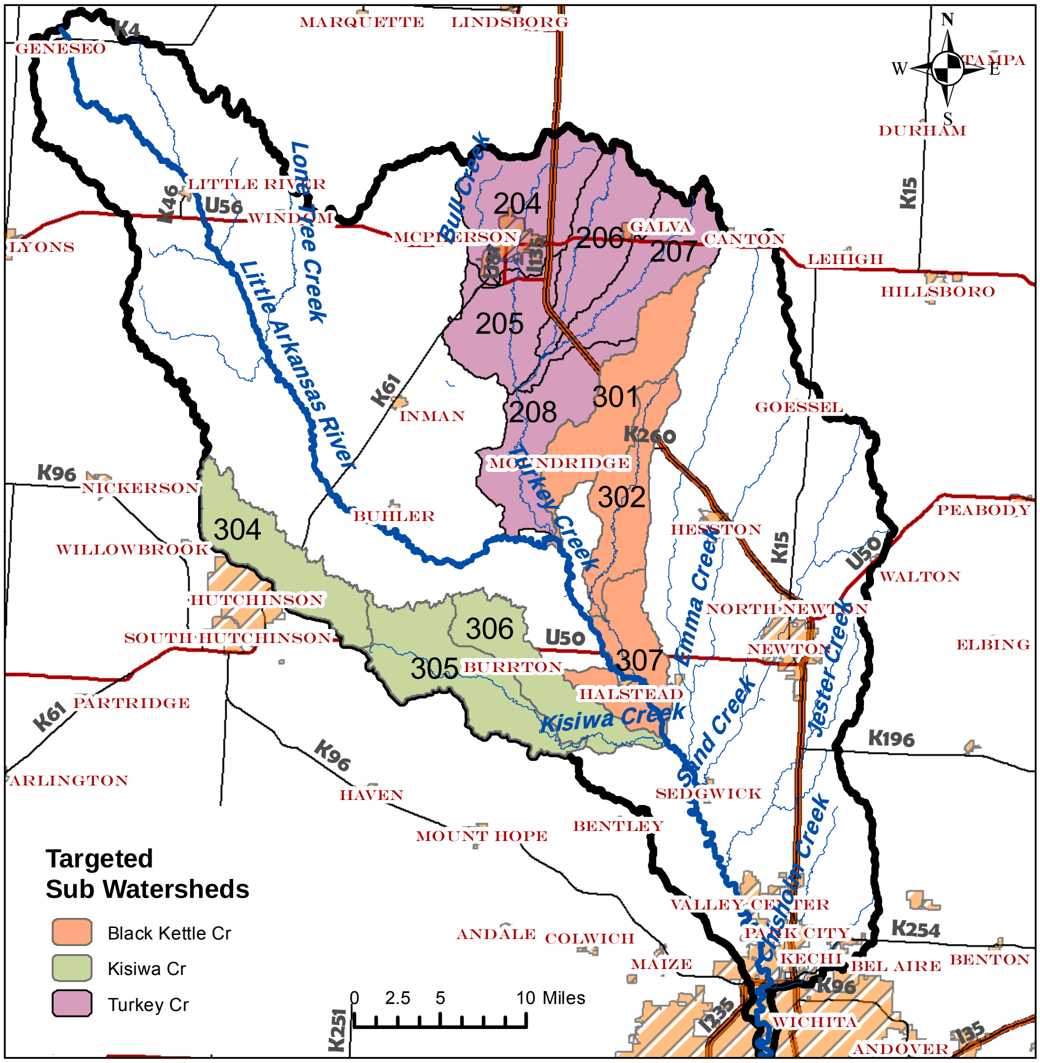


Figure 14 Tier 1 HUC 12 Targeted Areas.

Tier 2 – The WRAPS Plan will focus on these targeted areas if unable to achieve implementation and required load reductions in Tier 1 targeted areas:

- **Sand Creek**
- **Emma Creek**
- **Blazefork Creek**

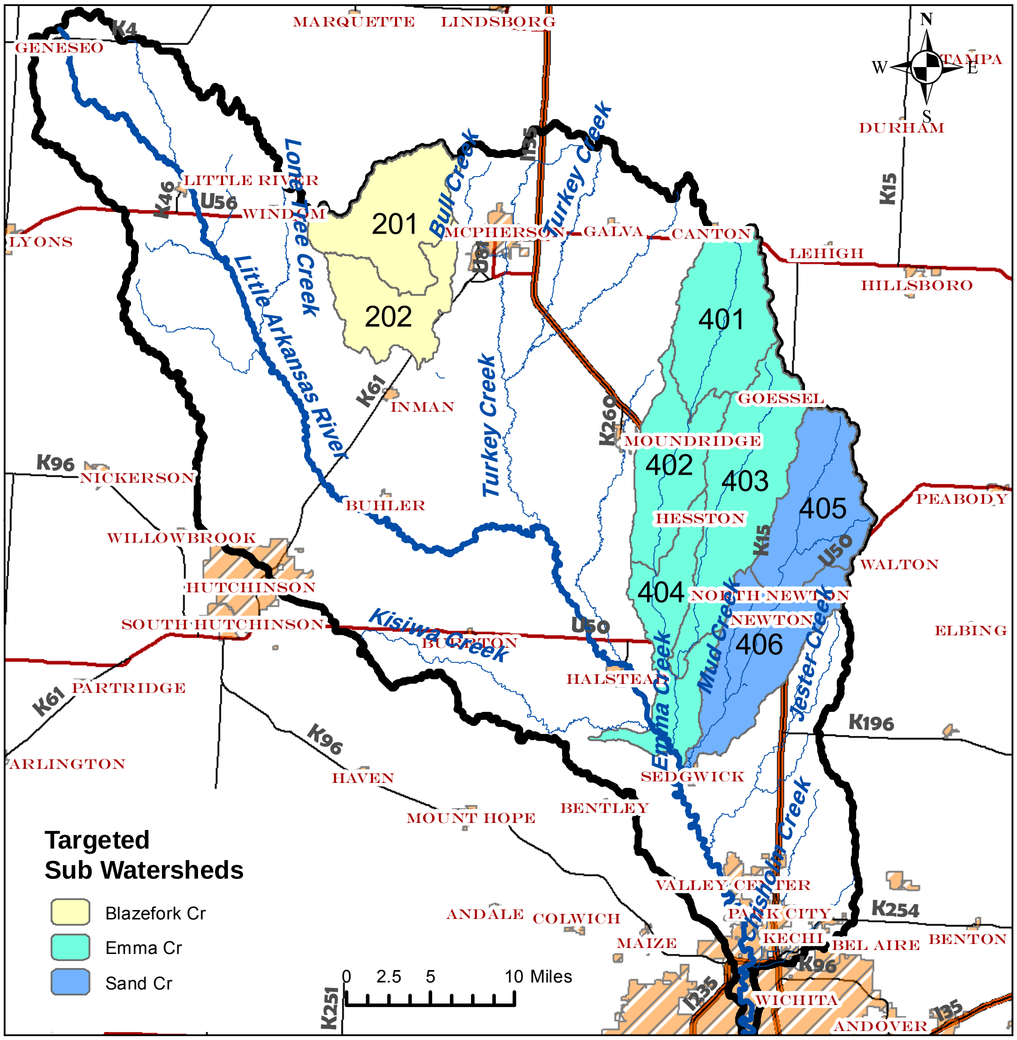


Figure 15 Tier 2 HUC 12 Targeted Areas.

* Black Kettle Creek sub watershed, even though it is showing the least need for load reductions is in close proximity to recharge intake sites, which is of interest to the City of Wichita. Therefore, crop fields along Black Kettle Creek will be targeted for sediment runoff. A Conservation Innovation Grant was received in 2009 to focus on sediment reduction. The first year of the project was spent on mapping and using ArcSWAT to determine high priority areas in the sub-watershed. 677 fields were identified with an estimated 13,000 tons of erosion annually from crop fields. The top 10 and 20 percent of crop fields having high potential for sediment delivery were assessed and then ground-truthed, see figure 18. Targeted fields will be those determined by the ArcSWAT model.

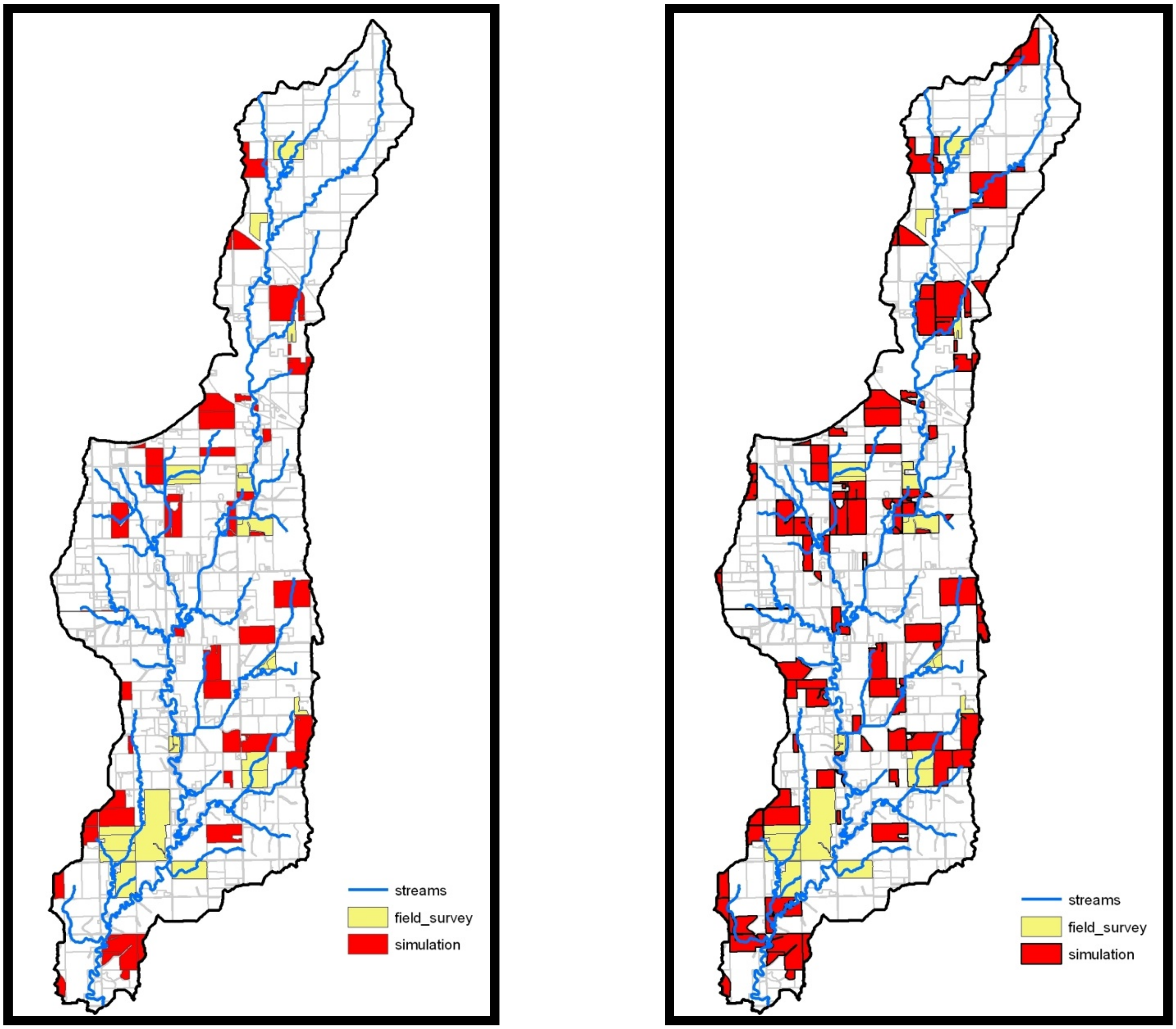


Figure 16 Black Kettle Creek, Sediment Loss.

Left figure = 10% of fields with most sediment loss
Right figure = 20% of fields with most sediment loss

In targeting Tier 1 and Tier 2 areas for sediment BMP implementation, the Sediment/Biology TMDL will be met. Subsequently, this plan will also meet the high priority Biology TMDL for Emma, Sand, Turkey, Black Kettle and Kisiwa Creeks and the Little Arkansas River. Also, the TSS TMDLs in Turkey, Black Kettle, Kisiwa Creeks and the Little Arkansas River will be directly affected by targeting the watersheds through this plan.

6.1.3 Targeting Cropland for Nutrients

Cropland will be targeted for P runoff along those same sub watersheds listed for sediment; Tier 1: Turkey Creek, Black Kettle Creek and Kisiwa Creek. Tier 2 targeted sub watersheds are Emma Creek, Sand Creek and Blazefork Creek.

Nutrient runoff and sediment runoff often occur together due to nutrients leaching to the sediment when exiting the crop field. Therefore, targeting similar sites for both pollutants will have faster and more economical results. BMPs used to target sediment will be effective in reducing P runoff as well. The SLT believes targeting sediment on cropland will also achieve any P load reduction goals set by KDHE and the 303(d) list.

Although this plan is NOT working directly to reduce dissolved oxygen (DO), P is the main contributor to DO issues in the sub watersheds. Therefore, this WRAPS Plan will meet the TMDL for DO in both Turkey and Sand Creeks as well as improve DO for the 303(d) listed Emma, Kisiwa and Black Kettle Creeks by targeting sediment and phosphorus in those sub watersheds.

3) Targeting Livestock Areas

Livestock, like any animal, contributes nutrients and bacteria to nearby water sources by directly depositing the pollutants or by runoff events in close proximity to water sources. It is difficult to target wild animal contributions but livestock nutrient and bacteria contributions can be targeted with BMPs that will undoubtedly improve water quality for the animals and will protect tributaries that will ultimately deliver the polluted waters to drinking water sources. BMPs used to target livestock nutrients will serve to improve bacteria loading and vice versa.

6.2.1 Targeting Livestock for Nutrients

Livestock can be targeted for the nutrient phosphorus. Phosphorus TMDLs are included in Turkey and Sand Creek sub watersheds, and phosphorus listings on the 303(d) list are in Kisiwa, Emma Creeks and the Little Ark River. Manure contains phosphorus and therefore, restricting livestock near creeks and ponds will have a positive effect on phosphorus levels.

The SLT conducted windshield surveys in the Fall 2011 and Winter 2012 and used additional assessment activities to determine which livestock locations are in need of remediation. Any water monitoring that should take place for bacteria will also show spikes in nutrient levels which will assist in pinpointing what livestock areas should be addressed in those sub watersheds that are being targeted. Livestock areas that have received referrals by the Kansas Department of Health and Environment will also be targeted for BMP implementation. **Figure 19 below shows that Sand, Emma, Turkey, Blazefork, and Kisiwa Creeks will all be targeted with Livestock BMPs for nutrients.**

6.2.2 Targeting Livestock Areas for Bacteria

Given that the Little Arkansas River along with Emma, Sand and Turkey Creeks along with the Little Ark River have been listed with a high priority TMDL for BACTERIA, this area's livestock facilities will be targeted for bacteria and nutrient loss. Water monitoring sites along stream segments will be monitored for any spikes in bacteria and/or nutrients that can be acknowledged and addressed. Livestock areas that have received referrals by KDHE will also be targeted for BMP implementation.

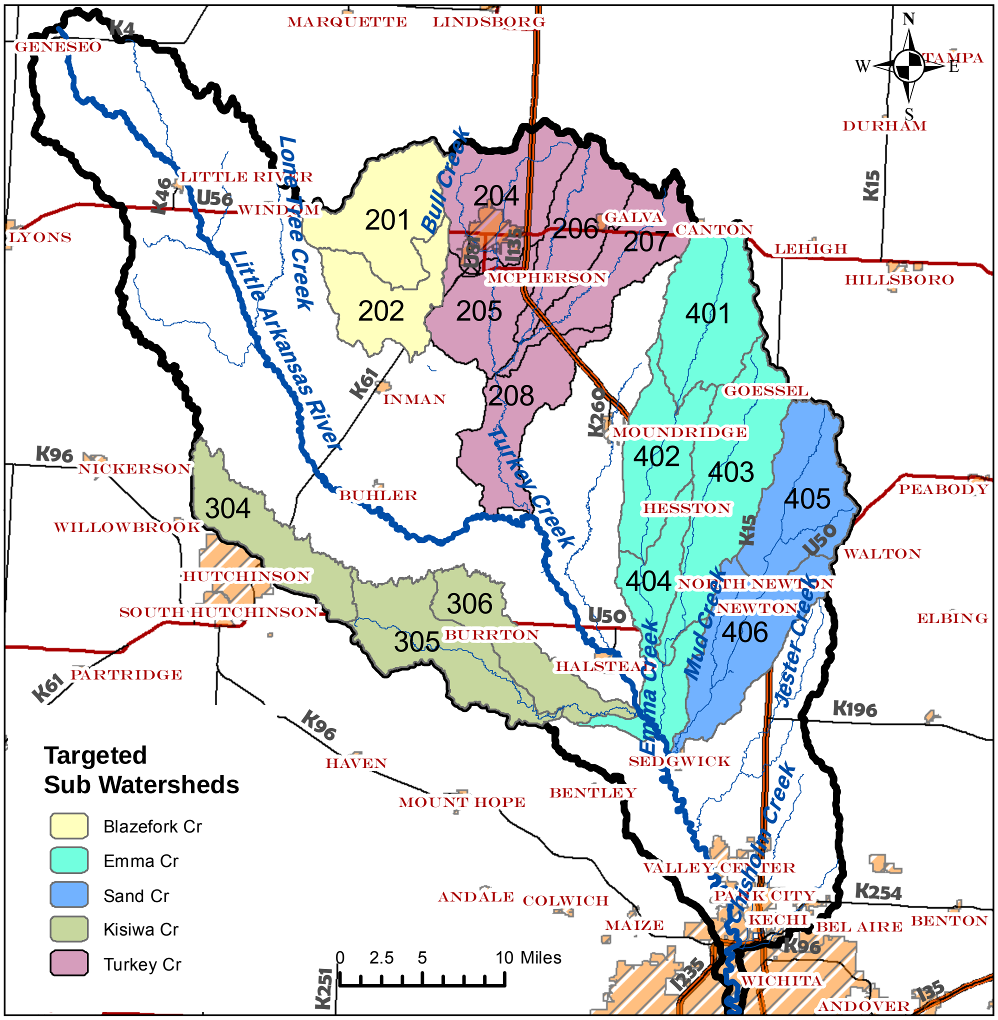


Figure 17 HUC 12 Targeted Areas for Livestock

4) Targeting Streambank Riparian Buffer Sites for Sediment and Nutrients.

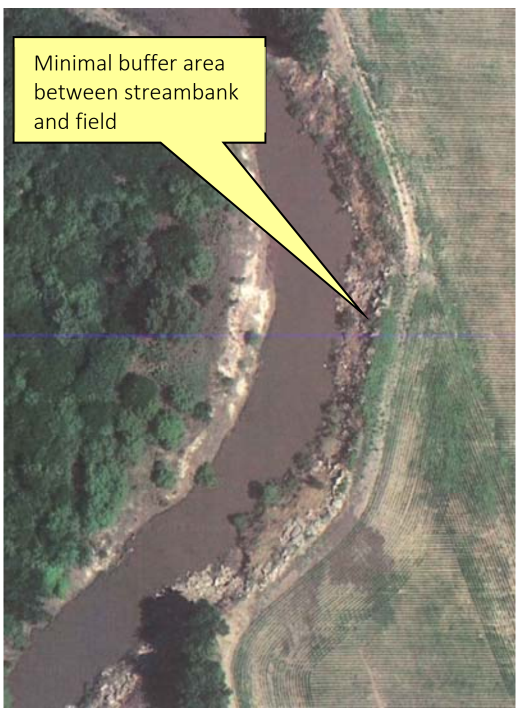
As part of the BMP needs inventory for the Little Arkansas plan, KDHE and the Project Management Team (PMT) discussed the possible need for streambank restoration and gully stabilization projects, as well as riparian buffers. The BMP implementation schedule that has been developed to meet the TMDLs addressed by the plan includes buffers as a conservation practice. While streambank restoration and gully stabilization projects have not been specifically included in the implementation schedule, KDHE and the PMT determined that, if implemented in critical areas, these projects could benefit the watershed by providing load reductions that would contribute to the achievement of the goals set forth in this plan. For this reason, KDHE has completed a preliminary assessment to identify areas along the Little Arkansas River, Lower Sand Creek, Lower Emma Creek and Lower Kisiwa Creek that might be potential sites for streambank restoration and gully stabilization projects, as well as sites in need of riparian buffers.

Due to the size of the watershed, the assessment was targeted to specific areas of the watershed based on three main factors: (1) land use, (2) soil types, and (3) the available water quality monitoring data. Based on this information, as well as discussions with the PMT, the assessment focused on the following areas:

- Lower Little Arkansas River from north of the Wichita city limits upstream to monitoring station SC246 near Alta Mills
- Lower Sand Creek from the Little Arkansas River upstream to the City of Newton
- Lower Emma Creek and a portion of West Emma Creek from the Little Arkansas River upstream to NW 48th Street
- Lower Kisiwa Creek from the Little Arkansas River upstream to S. Spring Lake Road

The preliminary assessment was performed by utilizing ArcMap® software to compare aerial photos from 2002, 2006, 2008 and 2010 to determine areas of streambank changes that might indicate sources of streambank instability. Areas of minimal to no riparian buffers were also noted, as well as potential streambank gully erosion areas. It is important to note that the areas identified have not been ground-truthed, and need to be further investigated and evaluated for project feasibility and effectiveness. Also, the method used for this assessment does not identify all areas in need of restoration. There may be other areas within the watershed in need of restoration not identified as part of this preliminary assessment.

The following aerial photos taken from Google Maps© show some of the areas identified by the assessment in need of riparian buffer restoration or gully stabilization. The locations of these photos have been indicated on the maps included herein.



The aerial photos above show examples of potential buffer sites and gully erosion sites that were identified by the streambank assessment.

The above images show the changes in the streambank area from 2008 to 2011. This site, labeled SB 1, is located along the Little Arkansas River southeast of Halstead on the north side of 36th Street. This site has been identified in the field by the Little Arkansas WRAPS SLT as an area for potential streambank restoration.

As a result of the aerial assessment, several sites were identified as potential sites for various conservation practices. The map below shows the sites that were identified along the Lower Little Arkansas River.

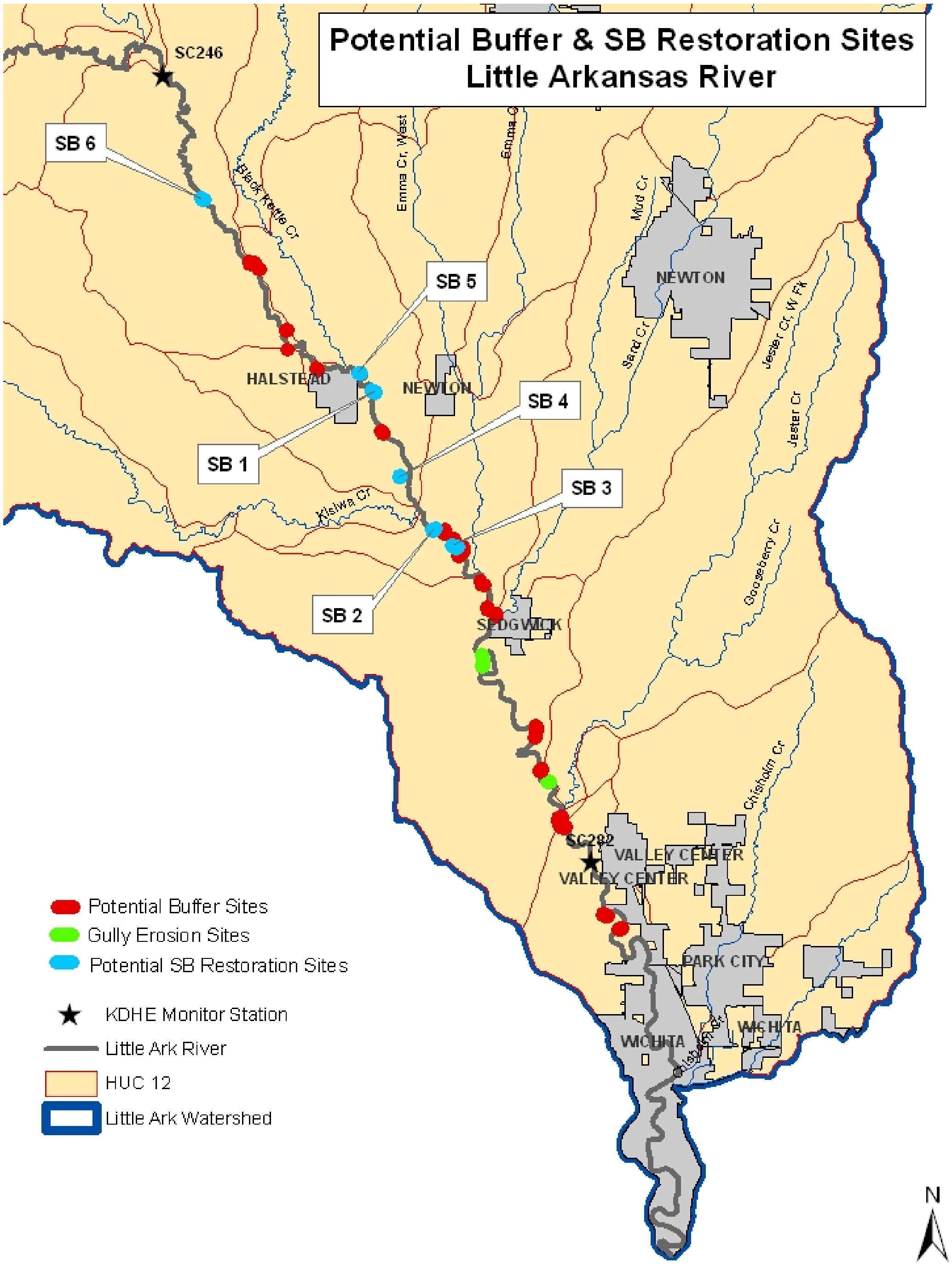


Figure 18 Potential Buffer and Streambank Sites. [14]

The map below shows the gully erosion sites and potential buffer restoration sites and that were identified along Lower Sand Creek, Lower Emma Creek and Lower Kisiwa Creek .

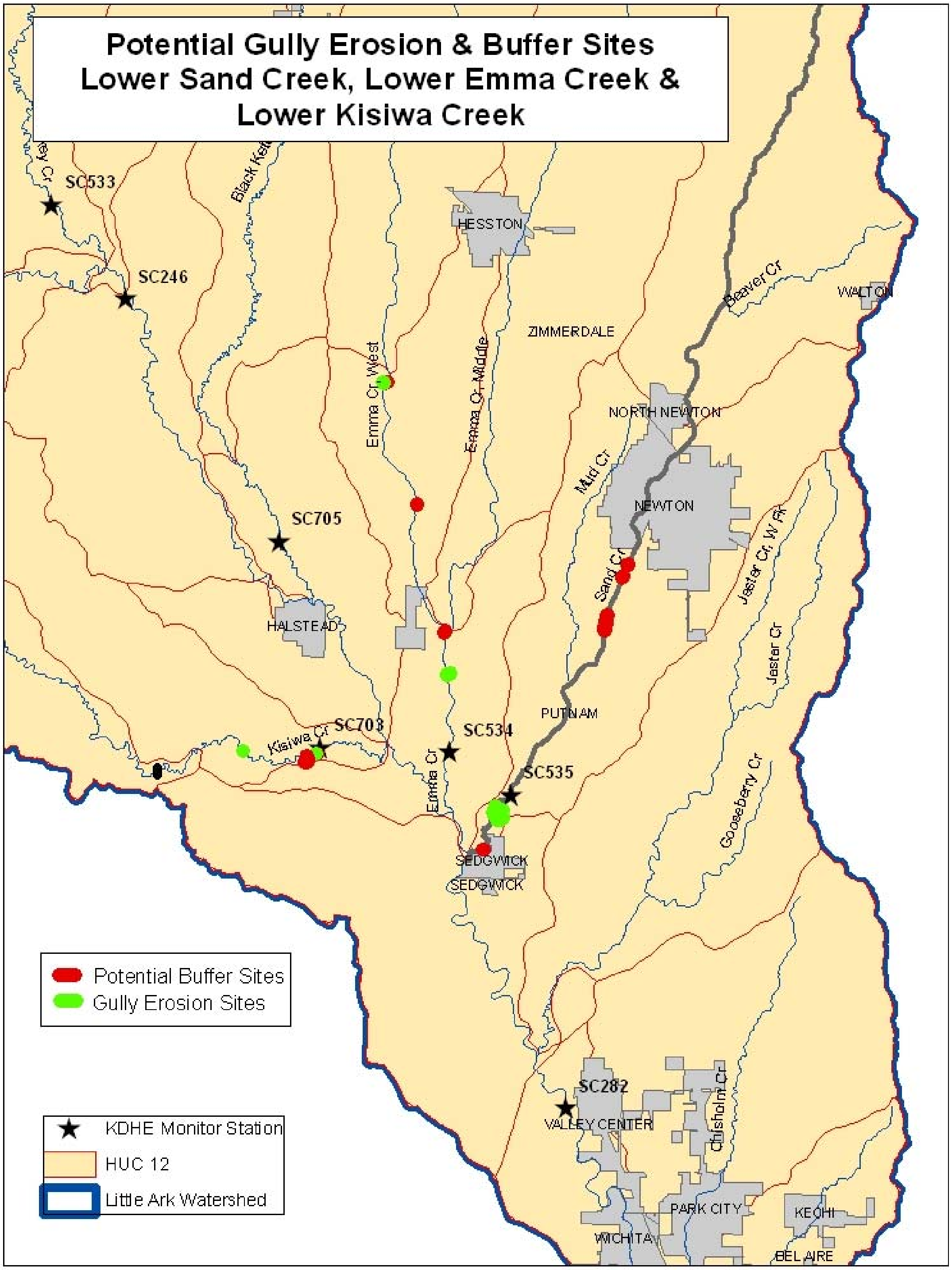


Figure 19 Potential Gully Erosion and Buffer Sites. [14]

5) Load Reduction Methodology

6.4.1 Cropland

Best management practice (BMP) load reduction efficiencies are derived from K-State Research and Extension Publication MF-2572.[17] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies. BMPs specific to atrazine and the Little Arkansas River Watershed are located in MF-2768.[18]

6.4.2 Livestock

Baseline nutrient loadings per animal unit are calculated using the Livestock Waste Facilities Handbook.[19] Livestock management practice load reduction efficiencies are derived from numerous sources including K-State Research and Extension Publication MF-2737[20] and MF-2454.[21] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

The SLT of the Little Arkansas River Watershed has determined that the focus of the WRAPS process will be on five key concerns of the watershed listed in order of importance:

1. Atrazine from Cropland
2. Sediment from Cropland
3. Nutrients from Cropland and Livestock
4. E. coli Bacteria from Livestock
5. Sediment and Nutrients from Streambank and Riparian Areas

All goals and best management practices (BMPs) will be aimed at restoring water quality or protecting the watershed from further degradation. The following sections in this report will address these concerns. BMP descriptions are available in the Appendix, Section 15.3.

7. Impairments with Adoption Rates and Load Reductions Addressed by the SLT

1) Atrazine

Atrazine is one of the most widely used herbicides in Kansas. It is used to selectively control broadleaf weeds with little to no effect to corn and sorghum crops. Atrazine is popular because if can be applied either pre- or postemergence. When atrazine is applied to the soil surface or to the plant surface, it can be taken up through the root system or through the foliage. 302,022 acres of cropland in the project area use atrazine. Atrazine has been listed on the 2010 TMDL list for three of the project area's tributaries and has also been added to the 303(d) list for two creeks and the Little Arkansas River. Water samples in the watershed taken from 1996-2003 show atrazine levels ranging from 4.6 to 10.0 µg/l, exceeding the drinking water limit of 3 µg/l set by EPA. The SLT wishes to reduce the amount of atrazine entering water supplies, reaching the drinking water goal of 3 µg/l with no seasonal spikes. The SLT will incorporate BMPs to achieve this goal.

BMPs such as splitting the application of the herbicide, incorporating the herbicide into the soil rather than just putting it on the plants and surface soil, creating a buffer zone around the field, as well as other BMPs would reduce the amount of the herbicide leaving the field and entering waterways. Atrazine BMPs have the ability to reduce losses in runoff to 1 to 3 percent of the total atrazine applied. BMPs have been selected by the SLT (and will be discussed later in this section) based on acceptability by the landowners, cost effectiveness and pollutant load reduction effectiveness.

Studies show that atrazine is weakly adsorbed and therefore leaves the field mostly with runoff water and not with eroding soil particles. Researchers in the project area found that approximately 90 percent of atrazine loss occurs in the water portion of runoff and only 10 percent by erosion. When atrazine runoff occurs, it begins in the top ½ inch of soil.[22] The movement of atrazine from crop fields is determined by the chemical properties of atrazine; soil type and site characteristics such as slope; and tillage practices. Increased or intense rainfall events and timing relative to atrazine application can result in larger amounts of in-stream herbicide. If a proper buffer is not installed, atrazine, along with sediment and nutrients, can wash from the field downstream. Increased or intense rainfall events and timing relative to atrazine application can result in larger amounts of in-stream herbicide.

7.1.1 Atrazine BMP Adoption Rates and Load Reductions

The SLT has laid out specific BMPs that they have determined will be acceptable to watershed residents as listed below. **These BMPs will be implemented in cropland targeted areas to address SLT goals and objectives.**

K-State Economists had to make a few assumptions for atrazine to develop a BMP implementation schedule together. Assumptions were deduced using *"Reducing Atrazine Runoff in the Little Arkansas River Watershed, 2006-2010 Summary of Progress"* publication.

- Average atrazine application rate 1.5 pounds/acre.
- Average atrazine runoff, 5%, or 0.075 pounds/acre.

Unlike BMPs for reducing soil erosion and nutrient runoff, atrazine BMP efficiencies are additive, therefore acres treated may be less than the adoption rates displayed. For example, split application, reduce application, and vegetative buffer may be applied on the same acreage, but in the adoption tables they appear to be separate acreages.

In the atrazine scenario the cost for implementing and/or repairing buffers, waterways, and terraces was assumed to be $0 since alternative cost-share is available for these practices and is not reimbursed under the *I.A.M.S. Atrazine Management* program.

The following sub watersheds will be targeted with Atrazine BMPs to meet Category *4b* standards: Emma Creek, Turkey Creek and Sand Creek. Black Kettle Creek will not be "targeted". However, if there is interest or need for Atrazine BMP implementation and load reductions are being met or exceeded in those areas mentioned above that are Category *4b* designated, the SLT may choose to implement BMPs in the Black Kettle sub watershed.

Table 13 Atrazine BMPs, Costs and Effectiveness.

Little Ark WRAPS Atrazine BMPs, Costs, and Reduction Efficiencies						
BMP	Adoption Rate	Cost ($/acre)	Acres Adopted	Reduction Effectiveness	Reduction (lbs)	% of TMDL
Use Alternative Herbicide	10%	$6.00	3,709	100%	278	47%
Vegetative Buffers	5%	$0.00	1,236	40%	37	6%
Split Application	5%	$1.50	618	25%	12	2%
Incorporate Atrazine	5%	$4.20	3,090	70%	162	27%
Use Post Emergence	5%	$3.00	3,090	50%	116	20%

Terraces and Waterways	10%	$0.00	618	30%	14	2%
Reduce Application	5%	$1.80	618	30%	14	2%
				Total	**633**	**107%**
Length of Plan (years)	20					
		Required TMDL Reduction (4b)	*591*	*pounds*		

Table 14 Atrazine Adoption Rates.

Total Annual Atrazine BMP Adoption Rate, Acres								
Year	Use Alternative Herbicide	Vegetative Buffers	Split Application	Incorporate Atrazine	Use Post Emergence	Terraces and Waterways	Reduce Application	Total Adoption
1	3,709	618	247	247	618	618	3,709	9,766
2	3,709	618	247	247	618	618	3,709	9,766
3	3,709	618	247	247	618	618	3,709	9,766
4	3,709	618	247	247	618	618	3,709	9,766
5	3,709	618	247	247	618	618	3,709	9,766
6	3,709	618	247	247	618	618	3,709	9,766
7	3,709	618	247	247	618	618	3,709	9,766
8	3,709	618	247	247	618	618	3,709	9,766
9	3,709	618	247	247	618	618	3,709	9,766
10	3,709	618	247	247	618	618	3,709	9,766
11	3,709	618	247	247	618	618	3,709	9,766
12	3,709	618	247	247	618	618	3,709	9,766
13	3,709	618	247	247	618	618	3,709	9,766
14	3,709	618	247	247	618	618	3,709	9,766
15	3,709	618	247	247	618	618	3,709	9,766
16	3,709	618	247	247	618	618	3,709	9,766
17	3,709	618	247	247	618	618	3,709	9,766
18	3,709	618	247	247	618	618	3,709	9,766
19	3,709	618	247	247	618	618	3,709	9,766
20	3,709	618	247	247	618	618	3,709	9,766

Table 15 Atrazine BMP Annual Load Reduction.

Total Annual Atrazine BMP Load Reduction, lbs								
Year	Use Alternative Herbicide	Vegetative Buffers	Split Application	Incorporate Atrazine	Use Post Emergence	Terraces and Waterways	Reduce Application	Total Load Reduction
1	278.14	18.54	4.64	12.98	23.18	13.91	83.44	434.83
2	278.14	37.09	4.64	12.98	23.18	27.81	83.44	467.28
3	278.14	55.63	4.64	12.98	23.18	41.72	83.44	499.73
4	278.14	74.17	4.64	12.98	23.18	55.63	83.44	532.18
5	278.14	92.71	4.64	12.98	23.18	69.54	83.44	564.63
6	278.14	111.26	4.64	12.98	23.18	83.44	83.44	597.08
7	278.14	129.8	4.64	12.98	23.18	97.35	83.44	629.53
8	278.14	148.34	4.64	12.98	23.18	111.26	83.44	661.98
9	278.14	166.89	4.64	12.98	23.18	125.17	83.44	694.43
10	278.14	185.43	4.64	12.98	23.18	139.07	83.44	726.88
11	278.14	203.97	4.64	12.98	23.18	152.98	83.44	759.34
12	278.14	222.52	4.64	12.98	23.18	166.89	83.44	791.79
13	278.14	241.06	4.64	12.98	23.18	180.79	83.44	824.24
14	278.14	259.6	4.64	12.98	23.18	194.7	83.44	856.69
15	278.14	278.14	4.64	12.98	23.18	208.61	83.44	889.14
16	278.14	296.69	4.64	12.98	23.18	222.52	83.44	921.59
17	278.14	315.23	4.64	12.98	23.18	236.42	83.44	954.04
18	278.14	333.77	4.64	12.98	23.18	250.33	83.44	986.49
19	278.14	352.32	4.64	12.98	23.18	264.24	83.44	1,018.94
20	278.14	370.86	4.64	12.98	23.18	278.14	83.44	1,051.39

Table 16 Atrazine Reduction in Emma Creek Watershed.

Emma Creek Atrazine Reduction		
Year	Total Annual Reduction, lbs	% of TMDL
1	177	69%
2	190	74%
3	204	79%
4	217	84%
5	230	89%
6	243	95%
7	256	100%
8	270	105%

9	283	110%
10	296	115%
11	309	120%
12	323	125%
13	336	130%
14	349	136%
15	362	141%
16	375	146%
17	389	151%
18	402	156%
19	415	161%
20	428	166%
Required Load Reduction (lbs)		*257.325*

Table 17 Atrazine Reduction in Turkey Creek Watershed.

Turkey Creek Meeting the Atrazine TMDL		
Year	**Total Annual Reduction, lbs**	**% of TMDL**
1	183.91	96%
2	197.63	103%
3	211.36	110%
4	225.08	117%
5	238.81	125%
6	252.53	132%
7	266.26	139%
8	279.98	146%
9	293.71	153%
10	307.43	160%
11	321.16	168%
12	334.88	175%
13	348.61	182%
14	362.33	189%
15	376.06	196%
16	389.78	203%
17	403.5	211%
18	417.23	218%
19	430.95	225%
20	444.68	232%
Required Load Reduction (lbs)		*191.625*

Table 18 Atrazine Reduction in Sand Creek Watershed.

Sand Creek Meeting the Atrazine TMDL		
Year	**Total Annual Reduction**	**% of TMDL**
1	73.79	52%
2	79.29	56%
3	84.8	60%
4	90.31	63%
5	95.81	67%
6	101.32	71%
7	106.82	75%
8	112.33	79%
9	117.84	83%
10	123.34	87%
11	128.85	91%
12	134.36	94%
13	139.86	98%
14	145.37	102%
15	150.88	106%
16	156.38	110%
17	161.89	114%
18	167.4	118%
19	172.9	121%
20	178.41	125%
Required Load Reduction (lbs)		*142.35*

Table 19 Atrazine BMP Implementation - Cropland Acreage Inventory.

Atrazine BMP Implementation - Cropland Inventory										
	Use Alternative Herbicide	**Vegetative Buffers**	**Split Application**	**Incorporate Atrazine**	**Use Post Emergence**	**Terraces and Waterways**	**Reduce Application**	**Total Adoption**	**Acres Required for BMP Adoption**	**Available Acres in Sub-Watersheds**
Turkey Creek									**4,130**	**17,478**
204	333	56	22	22	56	56	333	877		
205	268	45	18	18	45	45	268	705		
206	297	49	20	20	49	49	297	781		

207	327	55	22	22	55	55	327	861		
208	344	57	23	23	57	57	344	906		
Total	**1,569**	**262**	**105**	**105**	**262**	**262**	**1,569**	**4,130**		
Emma Creek									**3,978**	**20,799**
401	390	65	26	26	65	65	390	1,026		
402	310	52	21	21	52	52	310	815		
403	493	82	33	33	82	82	493	1,297		
404	319	53	21	21	53	53	319	840		
Total	**1,512**	**252**	**101**	**101**	**252**	**252**	**1,512**	**3,978**		
Sand Creek									**1,657**	**24,206**
405	327	55	22	22	55	55	327	862		
406	302	50	20	20	50	50	302	795		
Total	**629**	**105**	**42**	**42**	**105**	**105**	**629**	**1,657**		
Acres Needed/Available for Atrazine BMP Implementation in Little Ark Watershed									***9,765***	***62,484***

The table above indicates that there are 62,484 acres of available cropland in the atrazine targeted sub-watersheds. To achieve plan goals and meet Category *4b* standards, this plan requires 9,765 acres. Therefore, it can be assumed that there are ample acres to implement this WRAPS plan as written.

In 2006, incentive payments were made available to farmers for applying atrazine BMPs on their cropland. The amount available to the program was $10,000. This was provided by the City of Wichita. In 2017, the incentive payment for atrazine BMPs had grown to $50,000. Results of the highly successful atrazine program are demonstrated in the charts below.

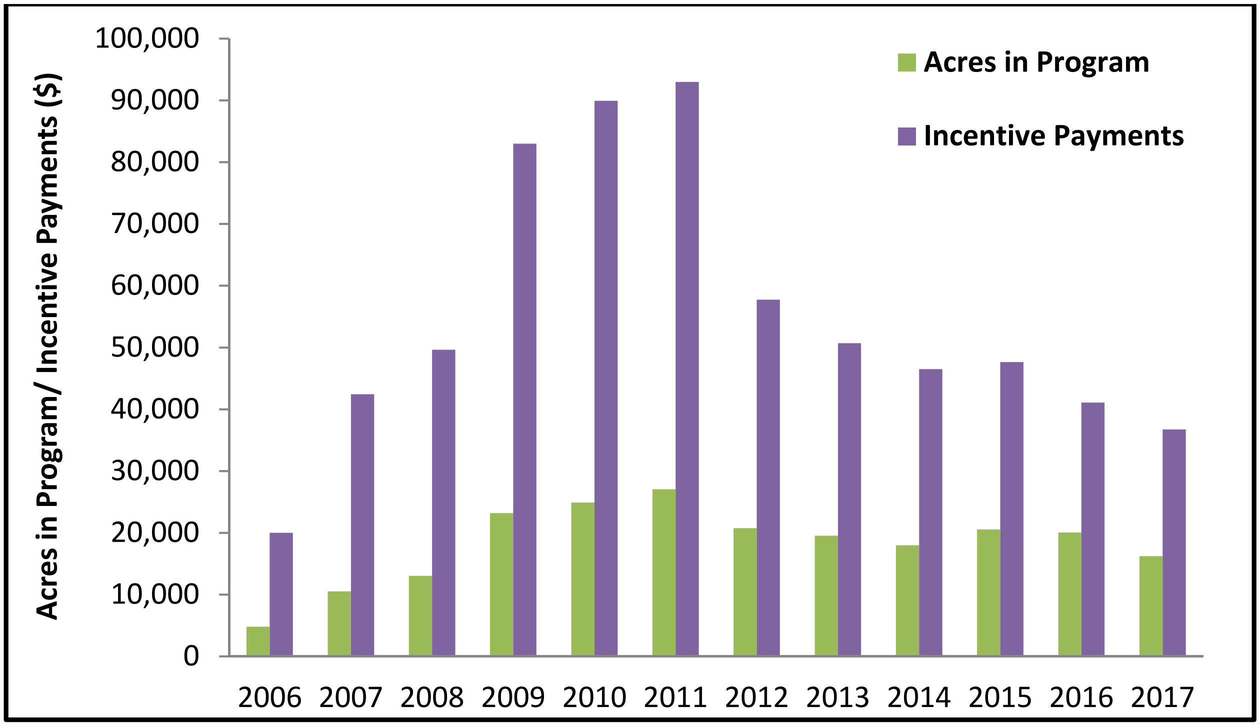


Figure 20 Atrazine BMPs Implemented in 2006-2017 by Acres of BMPs Implemented and Incentive Payments Utilized.

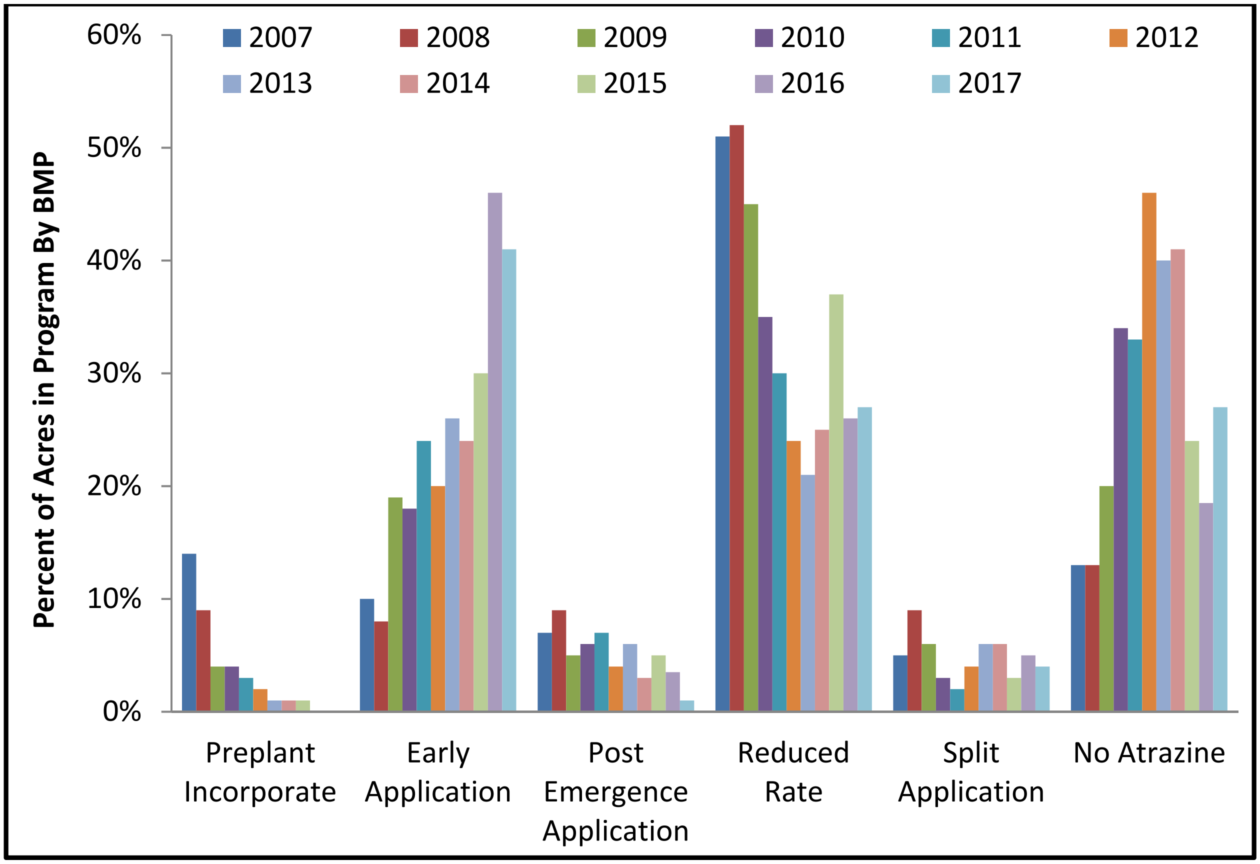


Figure 21 Atrazine BMPs Implemented by BMP and Year.

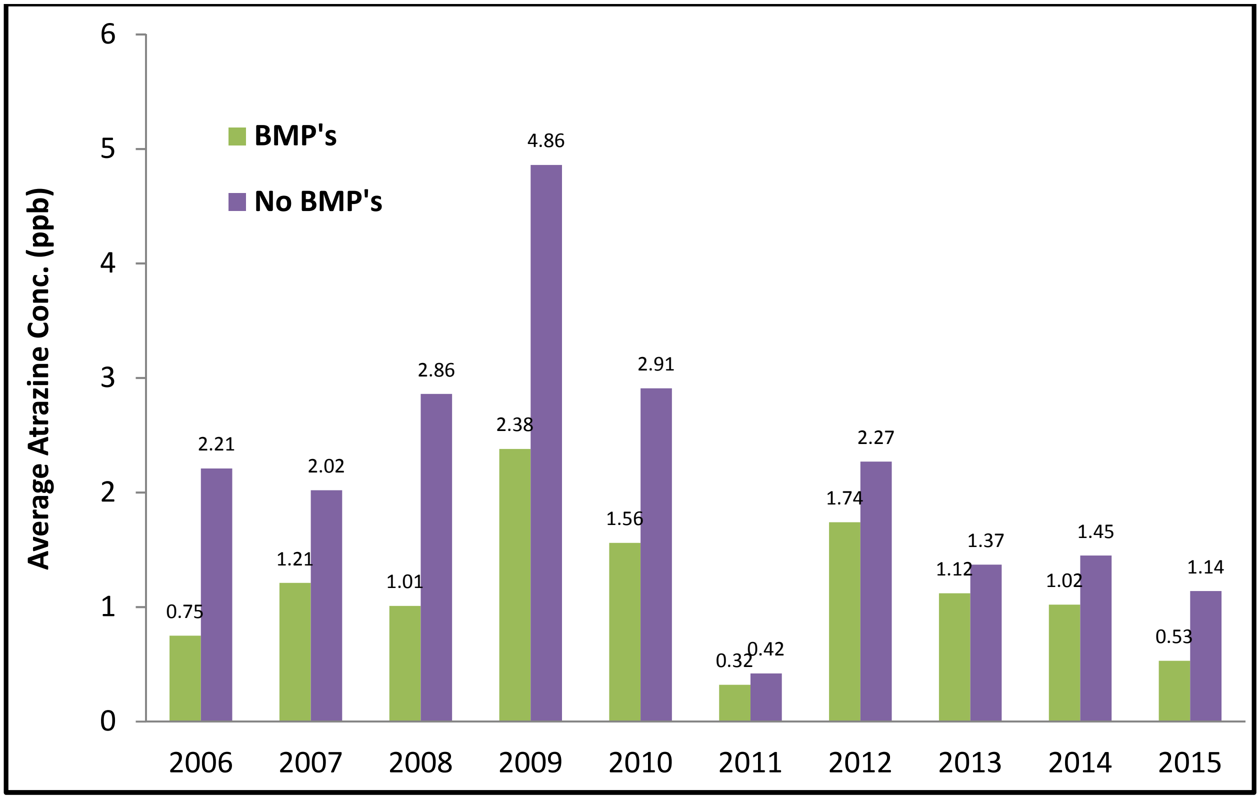


Figure 22 Atrazine concentrations 2006-2015 in streams in watersheds in which atrazine BMPs were implemented compared to atrazine concentrations in streams in watersheds in which atrazine BMPs had not been implemented. Monitoring data collected during April through August 2006-2011, and March through November 2012-2015.

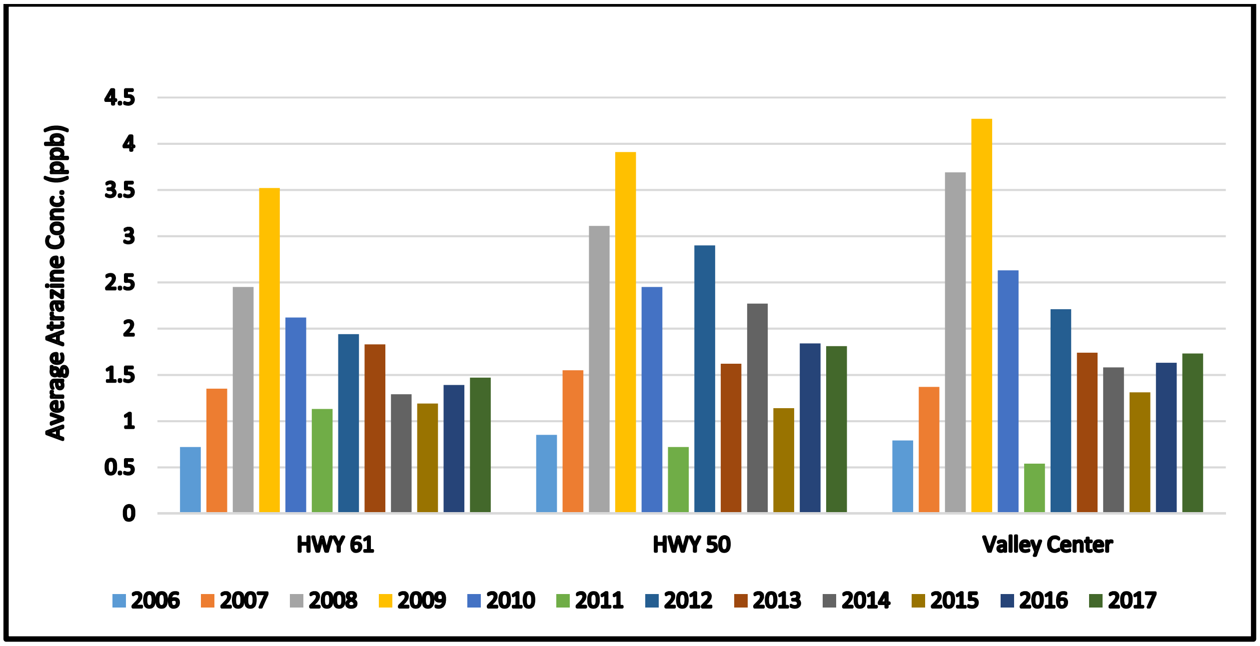


Figure 23 Atrazine concentrations in the Little Arkansas River at various locations in the watershed. Monitoring data collected during April through August 2006-2011, and March through November 2012-2017.

2) Sediment

Sediment is a common nonpoint source pollutant. Sediment has been listed as a TMDL for five of the project area's creeks (Emma, Sand, Black Kettle, Turkey and Kisiwa) and the Little Arkansas River. Sediment carries other nutrients off the field, primarily nitrogen and phosphorus; increased nutrients can produce eutrophication. Nitrogen reductions of 9 to 66 percent and phosphorus reductions of 20 to 90 percent, are required to improve conditions in project area lakes. 702,377 acres of cropland in the project area could use additional BMPs to aid in the overall reduction of sediment pollution. Agricultural best management practices (BMPs) such as continuous no-till, conservation tillage, grass buffer strips around cropland, terraces, grassed waterways and reducing activities within the riparian areas will reduce erosion and improve water quality. BMPs have been selected by the SLT (and will be discussed later in this section) based on acceptability by the landowners, cost effectiveness and pollutant load reduction effectiveness.

The primary source of this impairment in the Little Arkansas River Watershed is cropland runoff. Activities performed on the land affects sediment that is transported downstream to the lakes. Physical components of the terrain are important in sediment movement. The slope of the land, propensity to generate runoff and soil type are important. Although not a predominant factor in the project area, sediment can also come from 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. Animal movement, such as livestock that regularly cross the stream, can cause pathways that will erode. Another source of sediment is silt that is present in the stream from past activities and is gradually moving downstream with each high intensity rainfall event.

Rainfall amounts and subsequent runoff can affect sediment runoff from agricultural areas and urban areas into streams. High rainfall events can cause in-field runoff, cropland erosion, rangeland gully erosion and sloughing of streambanks, which add sediment to tributary streams and ultimately the Little Arkansas River. High intensity rainfall events usually occur in late spring and early summer.

The SLT has chosen to focus on runoff since it is the major contributor to the project areas nonpoint source pollution in the stream.

An adequately functioning and healthy riparian area will stop the sediment flow from cropland. Cropland lying adjacent to the stream without buffer protection can cause erosion along the streambank. In the targeted area, the predominant land use in the watershed is cropland at 68 percent and grassland at 21 percent. However, the riparian areas in the project area are comprised of 55 percent cropland and cropland/tree mix and 26 percent of pasture and pasture/tree mix.

Riparian areas are also vulnerable to runoff and erosion from livestock induced activities. Buffers and filter strips along with forested riparian areas can be used to impede erosion and streambank sloughing. Livestock restriction along the stream will prevent livestock from entering the stream and degrading the banks.

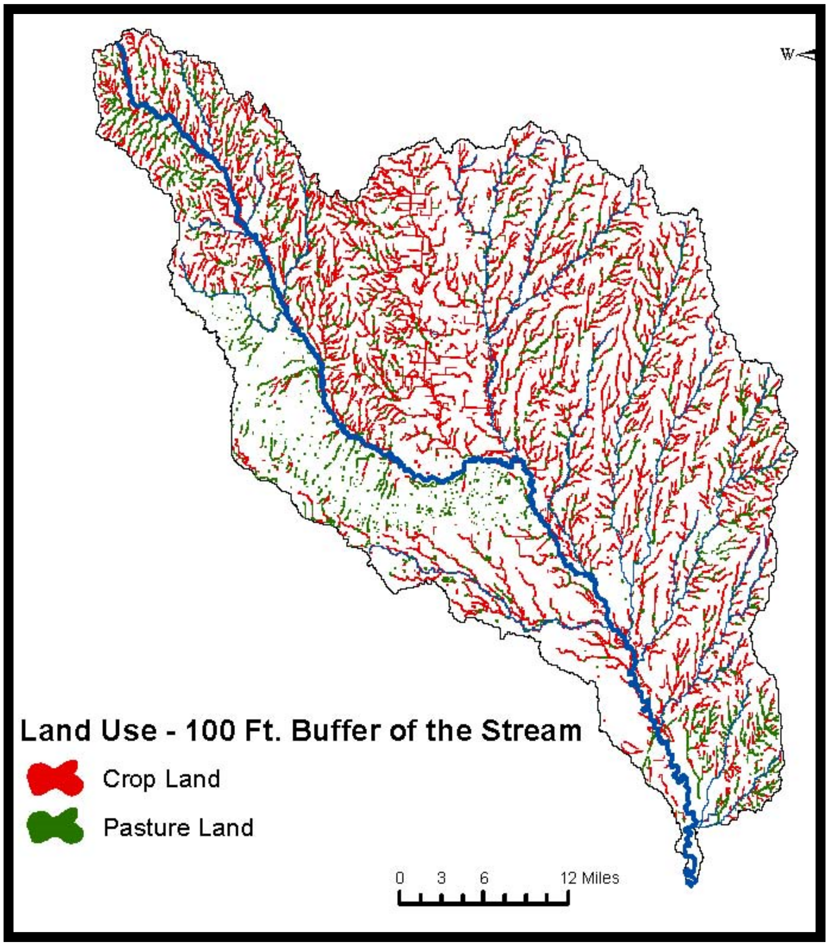


Figure 24 Riparian Inventory of the Streambank Targeted Area.

Table 20 Riparian Land Use.

Land Use	Acres	Percent
Barren Land	58	0.08
Crop Land	35,123	47.61
Crop/Tree Mix	5,264	7.14
Forest Land	9,274	12.57
Pasture	10,764	14.59
Pasture/Tree Mix	8,354	11.32
Shrub/Scrub Land	136	0.18
Urban Land	1,625	2.20
Urban/Tree Mix	840	1.14
Water	2,332	3.16
Total	**73,770**	**100.00**

KEY:

Crop Land - Areas adjacent to a stream where no trees area present and in which 51% of the 100 foot buffer is planted or was planted during the previous growing season for the production of adapted crops for harvest, including row crops, small-grain crops, legume, hay crops, nursery crops, and other specialty crops. Includes **Crop/Tree Mix** - Cropland land use areas that contain a tree canopy cover of less than 50% of the 100 foot buffer zone.
Pasture- Areas adjacent to a stream in which 51% or more of the 100 foot buffer contains pastureland, native pasture, or range land. Includes **Pasture/Tree Mix** - Grassland land use areas that contain a tree canopy cover of less than 50% of the 100 foot buffer zone.

7.2.4 Sediment Pollutant Loads and Load Reductions

To meet the TSS TMDL in the watershed, the sediment reduction goal is 4,671 **tons of sediment per year needs to be reduced.** This is the amount of sediment reduction that will have to be met by implemented BMPs in the watershed on a 40 year implementation schedule.

As mentioned in Section 6, the SLT will target Tier 1 areas first in this plan but if sufficient load reductions can not be made annually in those areas, they will continue in to Tier 2 areas with BMP implementation. Based on numbers provided by KDHE in July 2011, the following load reductions need to be made in the sub watersheds listed:
Tier 1 – This WRAPS Plan will first target the following areas for sediment BMP implementations:

- Kisiwa Creek – 770 tons/year
- Black Kettle Creek – 1,786 tons/year
- Turkey Creek – 990 tons/year

Tier 2 – The WRAPS Plan will focus on these targeted areas if unable to achieve implementation and required load reductions in Tier 1 targeted areas:

- Blazefork – 315 tons/year
- Emma Creek – 612 tons/year
- Sand Creek – 198tons/year

In focusing in the sub watersheds mentioned above for forty years, the Little Arkansas River at Valley Center will show a load reduction as well. The Little Arkansas River at Valley Center needs to show a 4,671 tons/year reduction to be removed from the TMDL list and this plan should over-exceed that amount. Therefore, sediment/biology TMDLs will be met for Emma, Turkey, Sand, Kisiwa, Black Kettle, and Blazefork Creeks as well as the Little Arkansas River. In meeting these TMDLs for sediment, these areas (Little Arkansas River, Black Kettle, Kisiwa and Turkey Creeks) should be removed from the TMDL for TSS.

The BMPs delineated by the SLT for sediment reductions will also serve to reduce the amount of phosphorus, nitrates and other nutrients entering the river. Increases in these nutrients can lead to dissolved oxygen and eutrophication, causing problems for aquatic plants and animals. Nitrates, dissolved oxygen, eutrophication, total phosphorus and biology are all listed on the project area's TMDL list. By implementing sediment BMPs, reductions in nutrient load levels are inevitable.

7.2.5 Sediment Goal and BMPs

The SLT has laid out specific BMPs that they have determined will be acceptable to watershed residents as listed below. **These BMPs will be implemented in cropland targeted areas to address SLT goals and objectives for forty years.**

Table 21 Sediment BMPs and Costs of Effectiveness.

Little Ark WRAPS Cropland BMPs, Costs, and Reduction Efficiencies							
Best Management Practice	Cost per Treated Acre	Available Cost Share	Erosion Reduction Efficiency	Phosphorous Reduction Efficiency	Nitrogen Reduction Efficiency	Cost per Unit	
No-Till	$78	39%	75%	40%	25%	$78	acre
Conservation Tillage	$39	0%	38%	20%	13%	$39	acre
Grassed Waterways	$160	50%	40%	40%	40%	$1,600	acre
Vegetative Buffers	$67	90%	50%	50%	25%	$1,000	acre
Nutrient Mgmt Plans	$57	50%	25%	25%	25%	$39	acre
Terraces	$102	50%	30%	30%	30%	$1.25	foot
Incorporate Manure	$6.33	0%	0%	20%	50%	$6.33	acre
Conservation Crop Rotations	$39	0%	25%	25%	25%	$39	acre
Water Retention	$125	0%	50%	50%	50%	$5,000	acre

Table 22 Achieving the Little Arkansas River TSS TMDL.

Achieving the Little Ark TSS TMDL		
Creek	Total Erosion Reduction	% of Little Ark TMDL
Turkey Creek	26,827	52%
Emma Cr.	12,804	36%
Blazefork	10,403	36%
Sand Cr.	29,908	51%
Kisiwa	15,580	53%
Black Kettle	2,050	18%

Table 23 Sediment BMP Adoption Rates for the Little Arkansas River Watershed.

Annual Adoption (treated acres), Cropland BMPs										
Year	No-Till	Cons. Tillage	Water-ways	Buffers	Nutrient Mgmt Plans	Terraces	Incorp-orate Manure	Cons. Crop Rotations	Water Retention	Total Adoption
1	548	1,095	822	548	274	822	274	274	110	4,765
2	548	1,095	822	548	274	822	274	274	110	4,765
3	548	1,095	822	548	274	822	274	274	110	4,765
4	548	1,095	822	548	274	822	274	274	110	4,765

5	548	1,095	822	548	274	822	274	274	110	4,765
6	548	1,095	822	548	274	822	274	274	110	4,765
7	548	1,095	822	548	274	822	274	274	110	4,765
8	548	1,095	822	548	274	822	274	274	110	4,765
9	548	1,095	822	548	274	822	274	274	110	4,765
10	548	1,095	822	548	274	822	274	274	110	4,765
11	548	1,095	822	548	274	822	274	274	110	4,765
12	548	1,095	822	548	274	822	274	274	110	4,765
13	548	1,095	822	548	274	822	274	274	110	4,765
14	548	1,095	822	548	274	822	274	274	110	4,765
15	548	1,095	822	548	274	822	274	274	110	4,765
16	548	1,095	822	548	274	822	274	274	110	4,765
17	548	1,095	822	548	274	822	274	274	110	4,765
18	548	1,095	822	548	274	822	274	274	110	4,765
19	548	1,095	822	548	274	822	274	274	110	4,765
20	548	1,095	822	548	274	822	274	274	110	4,765
21	548	1,095	822	548	274	822	274	274	110	4,765
22	548	1,095	822	548	274	822	274	274	110	4,765
23	548	1,095	822	548	274	822	274	274	110	4,765
24	548	1,095	822	548	274	822	274	274	110	4,765
25	548	1,095	822	548	274	822	274	274	110	4,765
26	548	1,095	822	548	274	822	274	274	110	4,765
27	548	1,095	822	548	274	822	274	274	110	4,765
28	548	1,095	822	548	274	822	274	274	110	4,765
29	548	1,095	822	548	274	822	274	274	110	4,765
30	548	1,095	822	548	274	822	274	274	110	4,765
31	548	1,095	822	548	274	822	274	274	110	4,765
32	548	1,095	822	548	274	822	274	274	110	4,765
33	548	1,095	822	548	274	822	274	274	110	4,765
34	548	1,095	822	548	274	822	274	274	110	4,765
35	548	1,095	822	548	274	822	274	274	110	4,765
36	548	1,095	822	548	274	822	274	274	110	4,765
37	548	1,095	822	548	274	822	274	274	110	4,765
38	548	1,095	822	548	274	822	274	274	110	4,765
39	548	1,095	822	548	274	822	274	274	110	4,765
40	548	1,095	822	548	274	822	274	274	110	4,765

Table 24 Sediment BMP Annual Load Reductions for the Little Arkansas River Watershed.

Total Annual Soil Erosion Reduction, Cropland BMPs (tons)

Year	No-Till	Cons. Tillage	Water-ways	Buffers	Nutrient Mgmt Plans	Terraces	Incorporate Manure	Cons. Crop Rotations	Water Retention	Total Load Reduction
1	1,610	1,610	1,288	1,073	268	966	0	268	215	7,299
2	3,220	3,220	2,576	2,147	537	1,932	0	537	429	14,599
3	4,830	4,830	3,864	3,220	805	2,898	0	805	644	21,898
4	6,441	6,441	5,153	4,294	1,073	3,864	0	1,073	859	29,198
5	8,051	8,051	6,441	5,367	1,342	4,830	0	1,342	1,073	36,497
6	9,661	9,661	7,729	6,441	1,610	5,797	0	1,610	1,288	43,796
7	11,271	11,271	9,017	7,514	1,879	6,763	0	1,879	1,503	51,096
8	12,881	12,881	10,305	8,588	2,147	7,729	0	2,147	1,718	58,395
9	14,491	14,491	11,593	9,661	2,415	8,695	0	2,415	1,932	65,694
10	16,102	16,102	12,881	10,734	2,684	9,661	0	2,684	2,147	72,994
11	17,712	17,712	14,169	11,808	2,952	10,627	0	2,952	2,362	80,293
12	19,322	19,322	15,458	12,881	3,220	11,593	0	3,220	2,576	87,593
13	20,932	20,932	16,746	13,955	3,489	12,559	0	3,489	2,791	94,892
14	22,542	22,542	18,034	15,028	3,757	13,525	0	3,757	3,006	102,191
15	24,152	24,152	19,322	16,102	4,025	14,491	0	4,025	3,220	109,491
16	25,763	25,763	20,610	17,175	4,294	15,458	0	4,294	3,435	116,790
17	27,373	27,373	21,898	18,248	4,562	16,424	0	4,562	3,650	124,090
18	28,983	28,983	23,186	19,322	4,830	17,390	0	4,830	3,864	131,389
19	30,593	30,593	24,474	20,395	5,099	18,356	0	5,099	4,079	138,688
20	32,203	32,203	25,763	21,469	5,367	19,322	0	5,367	4,294	145,988
21	33,813	33,813	27,051	22,542	5,636	20,288	0	5,636	4,508	153,287
22	35,424	35,424	28,339	23,616	5,904	21,254	0	5,904	4,723	160,587
23	37,034	37,034	29,627	24,689	6,172	22,220	0	6,172	4,938	167,886
24	38,644	38,644	30,915	25,763	6,441	23,186	0	6,441	5,153	175,185
25	40,254	40,254	32,203	26,836	6,709	24,152	0	6,709	5,367	182,485
26	41,864	41,864	33,491	27,909	6,977	25,118	0	6,977	5,582	189,784
27	43,474	43,474	34,779	28,983	7,246	26,085	0	7,246	5,797	197,083
28	45,084	45,084	36,068	30,056	7,514	27,051	0	7,514	6,011	204,383
29	46,695	46,695	37,356	31,130	7,782	28,017	0	7,782	6,226	211,682
30	48,305	48,305	38,644	32,203	8,051	28,983	0	8,051	6,441	218,982
31	49,915	49,915	39,932	33,277	8,319	29,949	0	8,319	6,655	226,281
32	51,525	51,525	41,220	34,350	8,588	30,915	0	8,588	6,870	233,580
33	53,135	53,135	42,508	35,424	8,856	31,881	0	8,856	7,085	240,880
34	54,745	54,745	43,796	36,497	9,124	32,847	0	9,124	7,299	248,179
35	56,356	56,356	45,084	37,570	9,393	33,813	0	9,393	7,514	255,479
36	57,966	57,966	46,373	38,644	9,661	34,779	0	9,661	7,729	262,778

37	59,576	59,576	47,661	39,717	9,929	35,746	0	9,929	7,943	270,077
38	61,186	61,186	48,949	40,791	10,198	36,712	0	10,198	8,158	277,377
39	62,796	62,796	50,237	41,864	10,466	37,678	0	10,466	8,373	284,676
40	64,406	64,406	51,525	42,938	10,734	38,644	0	10,734	8,588	291,976

Table 25 Meeting the TSS TMDL for the Little Arkansas River Watershed.

Year	Load Reduction tons/yr	% of TMDL
1	7,299	156%
2	14,599	313%
3	21,898	469%
4	29,198	625%
5	36,497	781%
6	40,469	866%
7	44,442	951%
8	48,414	1,036%
9	52,387	1,122%
10	56,359	1,207%
11	60,331	1,292%
12	64,304	1,377%
13	68,276	1,462%
14	72,249	1,547%
15	76,221	1,632%
16	83,439	1,786%
17	90,914	1,946%
18	98,390	2,106%
19	105,865	2,266%
20	113,341	2,426%
21	120,816	2,587%
22	128,291	2,747%
23	135,767	2,907%
24	143,242	3,067%
25	150,718	3,227%
26	158,193	3,387%
27	165,669	3,547%
28	173,144	3,707%

29	180,619	3,867%
30	188,095	4,027%
31	195,570	4,187%
32	203,046	4,347%
33	210,521	4,507%
34	217,997	4,667%
35	225,472	4,827%
36	232,948	4,987%
37	240,423	5,147%
38	247,898	5,307%
39	255,374	5,467%
40	262,849	5,627%

Table 26 Achieving the Little Arkansas River TSS TMDL by Sub Watershed.

Sub Watershed	Total Erosion Reduction	% of Little Ark TMDL
Blazefork	34,200	732%
Turkey Creek	103,080	2,207%
Kettle Creek	26,136	560%
Kisiwa Creek	29,680	635%
Emma Creek	69,803	1,494%
Sand Creek	29,076	622%
Total	**291,976**	**6,251%**

The sections of this plan that are contained in the text below represent total reductions for sediment and phosphorus using cropland BMP implementation for each targeted sub watershed. The row high-lighted in yellow demonstrates the year in which that particular sub watershed is projected to meet its TMDL. The last line of each table shows what reduction was required to meet the TSS TMDL in that sub watershed. After 40 years of BMP implementation, this plan will far exceed the load reductions required to meet the Tier 1 and Tier 2 sub watershed's individual TSS TMDLs. In exceeding load reduction goals in each sub watershed, TSS load reduction goals for the, Little Arkansas River will also be met.

3) Nutrients

Nutrients are a common nonpoint source pollutant. A TMDL or 303d listing for Total Phosphorus (TP) is listed for four of the project area's creeks (Emma, Sand, Turkey, Kisiwa) and the Little Arkansas River. The SLT wishes to address nutrients in the watershed with an emphasis on phosphorus carried to water bodies by crop field runoff and livestock areas. Nutrients contribute heavily to the eutrophication that is taking place in five of the watershed lakes. Phosphorus reductions of 20 to 90 percent and nitrogen reductions of 9 to 66 percent are required to improve conditions in project area lakes.

Nitrates are TMDL listed as a high priority for Sand Creek but it has been determined that this is a result of point source pollution and will not be addressed by this WRAPS plan. However, while addressing sediment and phosphorus runoff, nitrates will be also be impacted by BMP implementation, resulting in improvements in Biology and DO TMDLs and 303(d) listed areas.

Reducing crop field runoff and erosion is necessary for a reduction in sediment loss and nutrient loading. 702,377 acres of cropland in the project area could use additional BMPs to aid in the overall reduction of nutrient pollution. BMPs such as continuous no-till, conservation tillage, grass buffer strips around cropland, terraces, grassed waterways and reducing activities within the riparian areas will reduce erosion and improve water quality.

Nutrients, primarily phosphorus, are present in manure. Soluble phosphorus can easily be transported in runoff from fields where livestock gather. Nitrogen and phosphorus can originate from fertilizer runoff caused by either excess application or a rainfall event immediately after application. Not all phosphorus and nitrogen contributions can be attributed to agricultural practices. Excess fertilization of lawns, golf courses and urban areas can easily transport nitrogen and phosphorus downstream.

7.3.1 Nutrient Pollutant Loads and Load Reductions

The current estimated nutrient loading, including total phosphorus (P) entering the Little Arkansas River Watershed are above acceptable numbers. Currently, 557,355 pounds of P are entering the watershed annually. P loading needs to be reduced by 267,837 pounds per year.

The SLT will target Tier 1 areas first in this plan but if sufficient load reductions can not be made annually in those areas, they will continue in to Tier 2 areas with BMP implementation. Based on numbers provided by KDHE in July 2011, the following load reductions for TP need to be made in the sub watersheds listed below:

Tier 1 – This WRAPS Plan will first target the following areas for TP BMP implementations:

- **Kisiwa Creek – 16,247 lbs/year**
- **Black Kettle Creek – 4,763 lbs/year**
- **Turkey Creek – 49,182 lbs/year**

Tier 2 – The WRAPS Plan will focus on these targeted areas if unable to achieve implementation and required load reductions in Tier 1 targeted areas:

- **Blazefork – 26,443 lbs/year**
- **Emma Creek – 21,318 lbs/year**
- **Sand Creek – 17,346 lbs/year**

In focusing in the sub watersheds mentioned above, the Little Arkansas River at Valley Center will show a load reduction. The Little Arkansas River at Valley Center needs to show a 267,837 lbs/year reduction to be removed from the TMDL list and this plan should exceed that amount. Therefore, TP TMDLs will be met for Turkey and Sand Creeks as well as the Little Arkansas River. In meeting these TMDLs for TP and Sediment/Biology, those areas will also meet

Biology TMDLs. DO TMDLs for Turkey and Sand Creeks will also be met since TP issues will be resolved.

7.3.2 Nutrient Goal and BMPs

The SLT has laid out specific BMPs that they have determined will be acceptable to watershed residents as listed below. **These BMPs will be implemented in cropland targeted areas to address SLT goals and objectives.** The BMPs delineated by the SLT for nutrient reductions will also serve to reduce sediment and bacteria.

7.3.2.a Cropland BMPs Implemented for Nutrients

Table 27 Phosphorus Load Reduction for the Little Arkansas River Watershed.

Total Annual Phosphorous Reduction, Cropland BMPs (pounds)										
Year	No-Till	Cons. Tillage	Waterways	Buffers	Nutrient Mgmt Plans	Terraces	Incorporate Manure	Cons. Crop Rotations	Water Retention	Total Load Reduction
1	657	657	986	822	205	739	164	205	164	4,600
2	1,314	1,314	1,972	1,643	411	1,479	329	411	329	9,201
3	1,972	1,972	2,957	2,465	616	2,218	493	616	493	13,801
4	2,629	2,629	3,943	3,286	822	2,957	657	822	657	18,402
5	3,286	3,286	4,929	4,108	1,027	3,697	822	1,027	822	23,002
6	3,943	3,943	5,915	4,929	1,232	4,436	986	1,232	986	27,603
7	4,600	4,600	6,901	5,751	1,438	5,176	1,150	1,438	1,150	32,203
8	5,258	5,258	7,886	6,572	1,643	5,915	1,314	1,643	1,314	36,804
9	5,915	5,915	8,872	7,394	1,848	6,654	1,479	1,848	1,479	41,404
10	6,572	6,572	9,858	8,215	2,054	7,394	1,643	2,054	1,643	46,005
11	7,229	7,229	10,844	9,037	2,259	8,133	1,807	2,259	1,807	50,605
12	7,886	7,886	11,830	9,858	2,465	8,872	1,972	2,465	1,972	55,205
13	8,544	8,544	12,816	10,680	2,670	9,612	2,136	2,670	2,136	59,806
14	9,201	9,201	13,801	11,501	2,875	10,351	2,300	2,875	2,300	64,406
15	9,858	9,858	14,787	12,323	3,081	11,090	2,465	3,081	2,465	69,007
16	10,515	10,515	15,773	13,144	3,286	11,830	2,629	3,286	2,629	73,607
17	11,173	11,173	16,759	13,966	3,491	12,569	2,793	3,491	2,793	78,208
18	11,830	11,830	17,745	14,787	3,697	13,308	2,957	3,697	2,957	82,808
19	12,487	12,487	18,730	15,609	3,902	14,048	3,122	3,902	3,122	87,409
20	13,144	13,144	19,716	16,430	4,108	14,787	3,286	4,108	3,286	92,009
21	13,801	13,801	20,702	17,252	4,313	15,527	3,450	4,313	3,450	96,610
22	14,459	14,459	21,688	18,073	4,518	16,266	3,615	4,518	3,615	101,210
23	15,116	15,116	22,674	18,895	4,724	17,005	3,779	4,724	3,779	105,810
24	15,773	15,773	23,659	19,716	4,929	17,745	3,943	4,929	3,943	110,411

25	16,430	16,430	24,645	20,538	5,134	18,484	4,108	5,134	4,108	115,011
26	17,087	17,087	25,631	21,359	5,340	19,223	4,272	5,340	4,272	119,612
27	17,745	17,745	26,617	22,181	5,545	19,963	4,436	5,545	4,436	124,212
28	18,402	18,402	27,603	23,002	5,751	20,702	4,600	5,751	4,600	128,813
29	19,059	19,059	28,589	23,824	5,956	21,441	4,765	5,956	4,765	133,413
30	19,716	19,716	29,574	24,645	6,161	22,181	4,929	6,161	4,929	138,014
31	20,373	20,373	30,560	25,467	6,367	22,920	5,093	6,367	5,093	142,614
32	21,031	21,031	31,546	26,288	6,572	23,659	5,258	6,572	5,258	147,215
33	21,688	21,688	32,532	27,110	6,777	24,399	5,422	6,777	5,422	151,815
34	22,345	22,345	33,518	27,931	6,983	25,138	5,586	6,983	5,586	156,415
35	23,002	23,002	34,503	28,753	7,188	25,878	5,751	7,188	5,751	161,016
36	23,659	23,659	35,489	29,574	7,394	26,617	5,915	7,394	5,915	165,616
37	24,317	24,317	36,475	30,396	7,599	27,356	6,079	7,599	6,079	170,217
38	24,974	24,974	37,461	31,217	7,804	28,096	6,243	7,804	6,243	174,817
39	25,631	25,631	38,447	32,039	8,010	28,835	6,408	8,010	6,408	179,418
40	26,288	26,288	39,432	32,860	8,215	29,574	6,572	8,215	6,572	184,018

Although nitrogen is not a targeted impairment, as previously mentioned, cropland BMPs addressing sediment and phosphorus will subsequently remove nitrogen as well. The table below exemplifies nitrogen load reductions based on BMPs that will already be implemented for sediment and TP targeted areas. These reductions in nitrogen and phosphorus will aid in the DO TMDLs being met for Turkey and Sand Creeks. As well as the Biology TMDLs for Black Kettle, Emma, Sand, Turkey, Kisiwa Creeks as well as the Little Arkansas River.

Table 28 Nitrogen BMP Annual Load Reductions.

Total Annual Nitrogen Reduction, Cropland BMPs (pounds)										
Year	**No-Till**	**Cons. Tillage**	**Waterways**	**Buffers**	**Nutrient Mgmt Plans**	**Terraces**	**Incorporate Manure**	**Cons. Crop Rotations**	**Water Retention**	**Total Load Reduction**
1	1,506	1,506	3,615	1,506	753	2,711	1,506	753	602	14,459
2	3,012	3,012	7,229	3,012	1,506	5,422	3,012	1,506	1,205	28,917
3	4,518	4,518	10,844	4,518	2,259	8,133	4,518	2,259	1,807	43,376
4	6,024	6,024	14,459	6,024	3,012	10,844	6,024	3,012	2,410	57,834
5	7,531	7,531	18,073	7,531	3,765	13,555	7,531	3,765	3,012	72,293
6	9,037	9,037	21,688	9,037	4,518	16,266	9,037	4,518	3,615	86,751
7	10,543	10,543	25,303	10,543	5,271	18,977	10,543	5,271	4,217	101,210
8	12,049	12,049	28,917	12,049	6,024	21,688	12,049	6,024	4,820	115,669
9	13,555	13,555	32,532	13,555	6,777	24,399	13,555	6,777	5,422	130,127
10	15,061	15,061	36,146	15,061	7,531	27,110	15,061	7,531	6,024	144,586
11	16,567	16,567	39,761	16,567	8,284	29,821	16,567	8,284	6,627	159,044

12	18,073	18,073	43,376	18,073	9,037	32,532	18,073	9,037	7,229	173,503
13	19,579	19,579	46,990	19,579	9,790	35,243	19,579	9,790	7,832	187,961
14	21,085	21,085	50,605	21,085	10,543	37,954	21,085	10,543	8,434	202,420
15	22,592	22,592	54,220	22,592	11,296	40,665	22,592	11,296	9,037	216,879
16	24,098	24,098	57,834	24,098	12,049	43,376	24,098	12,049	9,639	231,337
17	25,604	25,604	61,449	25,604	12,802	46,087	25,604	12,802	10,241	245,796
18	27,110	27,110	65,064	27,110	13,555	48,798	27,110	13,555	10,844	260,254
19	28,616	28,616	68,678	28,616	14,308	51,509	28,616	14,308	11,446	274,713
20	30,122	30,122	72,293	30,122	15,061	54,220	30,122	15,061	12,049	289,171
21	31,628	31,628	75,908	31,628	15,814	56,931	31,628	15,814	12,651	303,630
22	33,134	33,134	79,522	33,134	16,567	59,642	33,134	16,567	13,254	318,089
23	34,640	34,640	83,137	34,640	17,320	62,353	34,640	17,320	13,856	332,547
24	36,146	36,146	86,751	36,146	18,073	65,064	36,146	18,073	14,459	347,006
25	37,653	37,653	90,366	37,653	18,826	67,775	37,653	18,826	15,061	361,464
26	39,159	39,159	93,981	39,159	19,579	70,486	39,159	19,579	15,663	375,923
27	40,665	40,665	97,595	40,665	20,332	73,197	40,665	20,332	16,266	390,381
28	42,171	42,171	101,210	42,171	21,085	75,908	42,171	21,085	16,868	404,840
29	43,677	43,677	104,825	43,677	21,838	78,618	43,677	21,838	17,471	419,299
30	45,183	45,183	108,439	45,183	22,592	81,329	45,183	22,592	18,073	433,757
31	46,689	46,689	112,054	46,689	23,345	84,040	46,689	23,345	18,676	448,216
32	48,195	48,195	115,669	48,195	24,098	86,751	48,195	24,098	19,278	462,674
33	49,701	49,701	119,283	49,701	24,851	89,462	49,701	24,851	19,881	477,133
34	51,207	51,207	122,898	51,207	25,604	92,173	51,207	25,604	20,483	491,591
35	52,714	52,714	126,513	52,714	26,357	94,884	52,714	26,357	21,085	506,050
36	54,220	54,220	130,127	54,220	27,110	97,595	54,220	27,110	21,688	520,509
37	55,726	55,726	133,742	55,726	27,863	100,306	55,726	27,863	22,290	534,967
38	57,232	57,232	137,356	57,232	28,616	103,017	57,232	28,616	22,893	549,426
39	58,738	58,738	140,971	58,738	29,369	105,728	58,738	29,369	23,495	563,884
40	60,244	60,244	144,586	60,244	30,122	108,439	60,244	30,122	24,098	578,343

7.3.2.b Livestock BMPs Implemented for Nutrients

Livestock BMPs have been selected by the SLT based on acceptability by the landowners, cost effectiveness and pollutant load reduction effectiveness. Tables below reflect TP load reductions with livestock BMP implementation over a 40 year span.

Table 29 Livestock BMP Adoption Rates.

Annual Livestock BMP Adoption				
Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System

1	1	1	1	0
2	1	1	0	1
3	1	1	1	0
4	1	1	0	1
5	1	1	1	0
6	1	1	0	1
7	1	1	1	0
8	1	1	0	1
9	1	1	1	0
10	1	1	0	1
11	1	1	1	0
12	1	1	0	1
13	1	1	1	0
14	1	1	0	1
15	1	1	1	0
16	1	1	0	1
17	1	1	1	0
18	1	1	0	1
19	1	1	1	0
20	1	1	0	1
21	1	1	1	0
22	1	1	0	1
23	1	1	1	0
24	1	1	0	1
25	1	1	1	0
26	1	1	0	1
27	1	1	1	0
28	1	1	0	1
29	1	1	1	0
30	1	1	0	1
31	1	1	1	0
32	1	1	0	1
33	1	1	1	0
34	1	1	0	1
35	1	1	1	0
36	1	1	0	1
37	1	1	1	0
38	1	1	0	1
39	1	1	1	0
40	1	1	0	1

Total	*40*	*40*	*20*	*20*

Table 30 Phosphorus Reductions for Livestock BMPs.

Annual Phosphorous Load Reductions (lbs) using Livestock BMPs					
Year	**Vegetative Filter Strip**	**Relocate Feeding Pens**	**Relocate Pasture Feeding Site**	**Off Stream Watering System**	**Annual Load Reduction**
1	1,276	1,595	63	0	**2,933**
2	2,552	3,189	63	63	**5,867**
3	3,827	4,784	126	63	**8,800**
4	5,103	6,379	126	126	**11,734**
5	6,379	7,973	189	126	**14,667**
6	7,655	9,568	189	189	**17,601**
7	8,930	11,163	252	189	**20,534**
8	10,206	12,758	252	252	**23,468**
9	11,482	14,352	315	252	**26,401**
10	12,758	15,947	315	315	**29,335**
11	14,033	17,542	378	315	**32,268**
12	15,309	19,136	378	378	**35,202**
13	16,585	20,731	441	378	**38,135**
14	17,861	22,326	441	441	**41,069**
15	19,136	23,920	504	441	**44,002**
16	20,412	25,515	504	504	**46,936**
17	21,688	27,110	568	504	**49,869**
18	22,964	28,704	568	568	**52,803**
19	24,239	30,299	631	568	**55,736**
20	25,515	31,894	631	631	**58,670**
21	26,791	33,488	694	631	**61,603**
22	28,067	35,083	694	694	**64,537**
23	29,342	36,678	757	694	**67,470**
24	30,618	38,273	757	757	**70,404**
25	31,894	39,867	820	757	**73,337**
26	33,170	41,462	820	820	**76,271**
27	34,445	43,057	883	820	**79,204**
28	35,721	44,651	883	883	**82,138**
29	36,997	46,246	946	883	**85,071**
30	38,273	47,841	946	946	**88,005**
31	39,548	49,435	1,009	946	**90,938**
32	40,824	51,030	1,009	1,009	**93,872**
33	42,100	52,625	1,072	1,009	**96,805**

34	43,376	54,219	1,072	1,072	**99,739**
35	44,651	55,814	1,135	1,072	**102,672**
36	45,927	57,409	1,135	1,135	**105,606**
37	47,203	59,003	1,198	1,135	**108,539**
38	48,479	60,598	1,198	1,198	**111,473**
39	49,754	62,193	1,261	1,198	**114,406**
40	51,030	63,788	1,261	1,261	**117,340**

Table 31 Livestock BMP Adoption Rates by Sub Watershed.

Livestock BMP Adoption by Sub Watershed					
Subwatershed	**Vegetative Filter Strip**	**Relocate Feeding Site**	**Relocate Pasture Feeding Site**	**Off-Stream Watering System**	**Total Adoption**
Sand Creek	5	5	2	2	14
Emma Creek	8	8	4	4	24
Blazefork	6	6	3	3	18
Kisiwa	8	8	4	4	24
Turkey Creek	13	13	7	7	40
Total	40	40	20	20	120

Table 32 Phosphorus Reductions from Livestock BMPs by Sub Watershed.

Livestock BMP Phosphorous Load Reduction by Sub Watershed (pounds)					
Subwatershed	**Vegetative Filter Strip**	**Relocate Feeding Site**	**Relocate Pasture Feeding Site**	**Off-Stream Watering System**	**Total Load Reduction**
Sand Creek	6,379	7,973	126	126	14,604
Emma Creek	10,206	12,758	252	252	23,468
Blazefork	7,655	9,568	189	189	17,601
Kisiwa	10,206	12,758	252	252	23,468
Turkey Creek	16,585	20,731	441	441	38,199
Total	51,030	63,788	1,261	1,261	117,340

Table 33 Nitrogen Load Reductions from Livestock BMPs.

Annual Nitrogen Load Reductions (lbs) using Livestock BMPs					
Year	**Vegetative Filter Strip**	**Relocate Feeding Pens**	**Relocate Pasture Feeding Site**	**Off Stream Watering System**	**Annual Load Reduction**
1	2,403	3,004	119	0	**5,525**

2	4,806	6,007	119	119	**11,050**
3	7,209	9,011	238	119	**16,576**
4	9,612	12,014	238	238	**22,101**
5	12,014	15,018	356	238	**27,626**
6	14,417	18,022	356	356	**33,151**
7	16,820	21,025	475	356	**38,677**
8	19,223	24,029	475	475	**44,202**
9	21,626	27,032	594	475	**49,727**
10	24,029	30,036	594	594	**55,252**
11	26,432	33,040	713	594	**60,778**
12	28,835	36,043	713	713	**66,303**
13	31,237	39,047	831	713	**71,828**
14	33,640	42,050	831	831	**77,353**
15	36,043	45,054	950	831	**82,879**
16	38,446	48,058	950	950	**88,404**
17	40,849	51,061	1,069	950	**93,929**
18	43,252	54,065	1,069	1,069	**99,454**
19	45,655	57,068	1,188	1,069	**104,980**
20	48,058	60,072	1,188	1,188	**110,505**
21	50,460	63,075	1,307	1,188	**116,030**
22	52,863	66,079	1,307	1,307	**121,555**
23	55,266	69,083	1,425	1,307	**127,081**
24	57,669	72,086	1,425	1,425	**132,606**
25	60,072	75,090	1,544	1,425	**138,131**
26	62,475	78,093	1,544	1,544	**143,656**
27	64,878	81,097	1,663	1,544	**149,182**
28	67,281	84,101	1,663	1,663	**154,707**
29	69,683	87,104	1,782	1,663	**160,232**
30	72,086	90,108	1,782	1,782	**165,757**
31	74,489	93,111	1,900	1,782	**171,283**
32	76,892	96,115	1,900	1,900	**176,808**
33	79,295	99,119	2,019	1,900	**182,333**
34	81,698	102,122	2,019	2,019	**187,858**
35	84,101	105,126	2,138	2,019	**193,384**
36	86,504	108,129	2,138	2,138	**198,909**
37	88,906	111,133	2,257	2,138	**204,434**
38	91,309	114,137	2,257	2,257	**209,959**
39	93,712	117,140	2,375	2,257	**215,485**
40	96,115	120,144	2,375	2,375	**221,010**

Table 34 Nitrogen Load Reductions from Livestock BMPs by Sub Watershed.

Livestock BMP Nitrogen Load Reduction by Sub Watershed (pounds)					
Subwatershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Total Load Reduction
Sand Creek	12,014	15,018	238	238	27,507
Emma Creek	19,223	24,029	475	475	44,202
Blazefork	14,417	18,022	356	356	33,151
Kisiwa	19,223	24,029	475	475	44,202
Turkey Creek	31,237	39,047	831	831	71,947
Total	96,115	120,144	2,375	2,375	221,010

Table 35 Achieving the Littler Arkansas River TP TMDL.

Sub Watershed	Total Phosphorous Reduction	% of Little Ark TMDL
Blazefork	33,767	128%
Turkey Creek	90,901	185%
Black Kettle Creek	28,736	603%
Kisiwa Creek	42,174	260%
Emma Creek	56,463	265%
Sand Creek	28,348	163%
Total	**280,389**	**105%**

Table 36 Phosphorus Reduction to Meet the TP TMDL in the Little Arkansas River Watershed.

Meeting the TP TMDL for Little Ark				
Year	Cropland Reduction (lbs)	Livestock Reduction (lbs)	Total Reduction (lbs)	% of TMDL
1	4,600	2934	7,534	3%
2	9,201	5867	15,068	6%
3	13,801	8801	22,602	8%
4	18,402	11734	30,136	11%
5	23,002	14668	37,670	14%
6	25,506	17601	43,107	16%
7	28,010	20535	48,544	18%
8	30,513	23468	53,981	20%
9	33,017	26402	59,418	22%
10	35,520	29335	64,855	24%
11	38,024	32269	70,292	26%
12	40,528	35202	75,730	28%

13	43,031	38136	81,167	30%
14	45,535	41069	86,604	32%
15	48,038	44003	92,041	34%
16	52,639	46936	99,575	37%
17	57,239	49870	107,109	40%
18	61,840	52803	114,643	43%
19	66,440	55737	122,177	46%
20	71,041	58670	129,711	48%
21	75,641	61604	137,245	51%
22	80,242	64537	144,779	54%
23	84,842	67471	152,313	57%
24	89,443	70404	159,847	60%
25	94,043	73338	167,381	62%
26	98,643	76271	174,914	65%
27	103,244	79205	182,448	68%
28	107,844	82138	189,982	71%
29	112,445	85072	197,516	74%
30	117,045	88005	205,050	77%
31	121,646	90939	212,584	79%
32	126,246	93872	220,118	82%
33	130,847	96806	227,652	85%
34	135,447	99739	235,186	88%
35	140,048	102673	242,720	91%
36	144,648	105606	250,254	93%
37	149,248	108540	257,788	96%
38	153,849	111473	265,322	99%
39	158,449	114407	272,856	102%
40	163,050	117340	280,390	105%
Load Reduction to meet TP TMDL:				**267,837**

4) Bacteria

Emma, Sand and Turkey Creeks as well as the Little Arkansas River are listed for having E. coli bacteria TMDLs of high priority. E. coli bacteria are a part of a broad spectrum of fecal coliform bacteria (FCB) species. FCB's presence in water indicates that the water has been in contact with human or animal waste. FCB is not itself harmful to humans, but its presence indicates that disease causing organisms, or pathogens, may also be present. E. coli bacteria can be detrimental to human health.

Presence of bacteria in waterways can originate from runoff from livestock production areas, close proximity of any mammals to water sources, and manure application to agricultural fields. Bacteria is present in livestock manure and can be transported into waterways if livestock have access to streams. Bacteria can originate in both rural and urban areas. It can can originate from 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 as well. In addition, failing septic systems can be a source of bacteria from humans.

7.4.1 Manure Application on Fields from Livestock Operations

In Kansas, animal feeding operations (AFOs) with greater than 300 animal units must register with KDHE. Confined 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 several CAFOs. (This data is derived from KDHE, 2003. It may be dated and subject to change). CAFOs are not allowed to release manure from the operation. However, they are allowed to spread manure on cropland fields for distribution. If this application is followed by a rainfall event or the manure is applied on frozen ground, it can run off into the stream. Smaller operations are not regulated by the state. Many of these operations are located along streams because of historic preferences by early settlers. Movement of feeding sites away from the streams and providing alternate watering sites is logistically important to prevention of bacteria entering the stream. Grazing density is an important factor in manure runoff due to the common practice of cattle loafing in ponds and streams during the hot summer months and frequently defecating directly into the water source.

7.4.2 Land Use and Manure Transport

Livestock production areas are a source of bacteria. Livestock that are housed in close proximity to a stream or allowed to loaf in the water source can shed bacteria into the water sources. Wild animals are also contributors in streams and lakes. However, the wild animal population is not as easily controlled as limiting livestock from water sources. Alternative water supplies allow the livestock to have access to fresh water while limiting the time they spend in surrounding areas. This not only reduces bacteria, but provides a clean drinking water source. Manure runoff from grasslands close to waterways can add to bacteria in the waterways. The SLT has chosen to target high livestock areas for manure BMPs near those creeks TMDL listed for E.coli bacteria (Kisiwa, Emma, Sand, Turkey and the Little Arkansas River).

7.4.3 Rainfall and Runoff

Rainfall amounts and subsequent runoff along with flooding outside the stream channel can affect bacteria concentrations in the Little Arkansas River and its tributaries. Manure runoff from livestock that are allowed access to stream or manure applied before a rainfall or on frozen ground is washed into the stream.

7.4.4 Pollutant Load and Load Reductions

The current estimated pollutant load for bacteria is difficult to model. Environmental factors affect the viability of the bacteria since it is a living organism. The fate of the bacteria is affected by variations in its initial loading, ambient temperature, amount of sunlight or UV rays, and a decrease in survivability over time are all factors that affect the viability of bacteria.

The SLT will first target livestock areas in those areas listed as having a TMDL for Bacteria: the Little Arkansas River along Emma, Sand and Turkey Creeks. By meeting TMDLs for Emma, Sand and Turkey Creeks, the bacteria TMDL for the Little Arkansas River will subsequently be met.

7.4.5 Bacteria Goal and BMPs

The SLT has laid out specific BMPs that they have determined will be acceptable to watershed residents as listed below. **These BMPs will address SLT goals and objectives and will be implemented in livestock areas. Nutrient BMPs as listed in the previous section will also serve to reduce bacteria loading in the watershed.**

Table 37 Bacteria Goals and BMPs.

Goal: Reduce Bacteria entering the Little Arkansas River.				
TMDL Water Quality Goals: To achieve ECB water quality standards and maintain geometric means of bacteria samples collected within 30-day periods from April – October below 262 cfus/100 ml on the stream.				
Protection Measures	***BMPs and Other Actions***	***Bacteria Load Reduction***	***Timeframe***	***Acres/Projects to be Implemented***
Prohibit Bacteria from entering streams by addressing livestock areas.	Establish vegetative buffer strips along streams	TBD	2010-2050	171,091 acres of grassland and livestock areas could use additional BMPs. Acres implemented and time frame may need adjusted to meet the necessary load reductions.
	Relocate small feedlots away from streams	TBD	2010-2050	
	Relocate pasture feeding sites away from streams	TBD	2010-2050	
	Promote alternative watering sites away from streams	TBD	2010-2050	
Reduce runoff from manure used as fertilizer	Manure application - incorporate with tillage	20% reduction in P, 50% reduction in N, % Bacteria - unknown	2010-2050	

Develop Nutrient Management Plans	Soil tests will be issued to determine nutrient needs. Nutrients, including manure applications, will then be applied at agronomic rates based on test results.	0-25% P, 0-25% N	2010-2050	on-going

5) Streambank and Riparian Buffer Restoration Sites

Several gully erosion sites and riparian buffer restoration sites were identified through aerial analysis. The following table indicates the number of gully stabilization areas (in linear feet) that were identified in each area, as well as the estimated load reductions that would be achieved with gully stabilization.

Table 38 Gully Stabilization Projects for Sediment, P{hosphorus and Nitrogen Load Reductions.

Water Body	Gully Stabilization Areas Identified (L.F.)	Estimated Potential Load Reductions*		
		Sediment (ton/yr)	Phosphorus (lb/yr)	Nitrogen (lb/yr)
Lower Little Ark River	1,810	121	121	242
Sand Creek	4,200	281	281	562
Emma Creek	835	56	56	112
Kisiwa	175	12	12	23

*Assumed gullies with average Top Width = 12 ft., Bottom Width = 2 ft., Depth = 1.5 ft., Soil Weight = 85 lb/ft^3, Soil P
Concentration (lb/lb soil) = 0.0005, and Soil N Concentration (lb/lb soil) = 0.001

As previously stated, the BMP implementation schedule includes buffers as one of the practices to be implemented in order to achieve the load reduction goals of the plan. As a result of this assessment, the following areas needing buffer restoration/establishment have been identified as shown on the previous maps.

Table 39 Riparian Buffer Projects in the Little Arkansas River Watershed.

Water Body	Riparian Buffers Identified (Acres)
Little Arkansas River	23.7
Sand Creek	4.2
Emma Creek	1.4
Kisiwa	1.8
Total Acreage	**31.1**

The potential load reductions associated with the above riparian buffer areas are 19 tons/yr of sediment, 31 lbs/yr of phosphorus, and 42 lbs/yr of nitrogen. It should be noted that this preliminary assessment of the hot spots for riparian areas is not extensive, and could be expanded in the future to identify more potential riparian restoration areas.

Approximately 6 sites for potential streambank restoration/stabilization projects have been identified along the Lower Little Arkansas River. The locations of these sites are shown on the map provided in Section 6, and they have been identified as SB 1 through SB 6. The following table indicates the estimated length of each potential streambank project (in linear feet) and the estimated load reductions that would be achieved with each project implementation.

Table 40 Streambank Restoration Projects for Sediment, Phosphorus and Nitrogen Load Reductions.

Streambank Site	Length of Streambank Restoration Site (L.F.)	Estimated Potential Load Reductions*		
		Sediment (ton/yr)	Phosphorus (lb/yr)	Nitrogen (lb/yr)
SB 1	750	143	143	287
SB 2	625	120	120	239
SB 3	880	168	168	337
SB 4	160	31	31	61
SB 5	330	63	63	126
SB 6	540	103	103	207
Totals	**3,285**	**628**	**628**	**1257**

*Assumed averages for Streambank Stabilization Projects as follows: Height = 15 ft.; Lateral Recession Rate (ft/yr) = 0.4, Soil Weight = 85 lb/ft^3, Soil P Concentration (lb/lb soil) = 0.0005, and Soil N Concentration (lb/lb soil) = 0.001

The estimated load reductions for the potential streambank restoration areas are based on the site lengths estimated from the aerial photos, as well as the assumptions noted. In particular, a lateral recession rate of 0.4 ft/yr was used for the load reduction calculations; however, this rate, as well as the other soil data assumptions utilized in the calculations will vary depending on the individual site investigation. Depending on site-specific conditions, some of these projects, if implemented, may achieve greater or less load reductions than those noted.

The following table summarizes the potential streambank projects, gully stabilization project and riparian buffer acres by HUC 12 as identified through this preliminary assessment.

Table 41 Streambank and Riparian Area Project Sites by HUC 12.

HUC 12	Streambank Projects (L.F.)	Gully Stabilization (L.F.)	Riparian Buffers (Acres)	Streambank Sites Included
303	540	-	2.63	SB 6
306	-	175	1.79	

307	1,240	-	3.19	SB 1, SB 4, SB 5
404	1,505	835	8.44	SB 2, SB 3
406	-	4,200	4.75	
408	-	1,810	8.74	
502	-	-	1.45	
Totals	**3,285**	**7,020**	**31**	

8. Sub Watersheds Addressed by BMPs

The table below indicates that there are 112,279 acres of available cropland in the Sediment and Nutrient targeted Tier 1 and Tier 2 sub-watersheds. To achieve plan goals and meet TMDL requirements, this plan requires 4,768 acres. Therefore, it can be assumed that there are ample acres to implement this WRAPS plan as written.

Table 42 BMP Adoption Rates by Sub Watershed.

	No-Till	Conservation Tillage	Waterways	Buffers	Nutrient Mgt. Plans	Terraces	Incorporate Manure	Cons. Crop Rotations	Water Retention	Total Adoption Acres	Acres Required for BMP Adoption	Available Acres in Sub-Watersheds
Turkey Creek											**1,365**	**17,478**
204	33	67	50	33	17	50	17	17	7	290		
205	27	54	40	27	13	40	13	13	5	233		
206	30	59	44	30	15	44	15	15	6	258		
207	33	65	49	33	16	49	16	16	7	285		
208	34	69	52	34	17	52	17	17	7	299		
Total	**157**	**314**	**235**	**157**	**78**	**235**	**78**	**78**	***32***	**1,365**		
Emma Creek											**1,139**	**20,799**
401	34	68	51	34	17	51	17	17	7	294		
402	27	54	40	27	13	40	13	13	5	233		
403	43	85	64	43	21	64	21	21	9	371		
404	28	55	41	28	14	41	14	14	6	241		
Total	**132**	**262**	**196**	**132**	**65**	**196**	**65**	**65**	***27***	**1,139**		
Sand Creek											**475**	**24,206**
405	28	57	43	28	14	43	14	14	6	247		
406	26	52	39	26	13	39	13	13	5	228		
Total	**54**	**109**	**82**	**54**	**27**	**82**	**27**	**27**	***11***	**475**		
Blaze-fork Creek											**559**	**19,126**
201	35	69	52	35	17	52	17	17	7	302		
202	29	59	44	29	15	44	15	15	6	257		

Total	**64**	**128**	**96**	**64**	**32**	**96**	**32**	**32**	***13***	**559**		
Black Kettle Creek											**745**	**17,152**
301	36	73	55	36	18	55	18	18	7	318		
302	25	50	37	25	12	37	12	12	5	216		
307	24	48	36	24	12	36	12	12	5	211		
Total	**85**	**171**	**128**	**85**	**42**	**128**	**42**	**42**	***17***	**745**		
Kisiwa Creek											**485**	**13,517**
304	6	13	9	6	3	9	3	3	1	55		
305	29	58	43	29	14	43	14	14	6	252		
306	20	41	31	20	10	31	10	10	4	178		
Total	**55**	**112**	**83**	**55**	**27**	**83**	**27**	**27**	***11***	**485**		
Acres Needed/Available for Cropland BMP Implementation in Little Ark Watershed											**4,768**	**112,279**

1) Tier 1 Sub Watersheds

Tier 1 sub watersheds were determined by current TMDLs, water monitoring data, tillage surveys and land use comparison tables. Tier 1 sub watersheds are Turkey Creek, Black Kettle Creek and Kisiwa Creek. Implementation plans, adoption rates, and reduction rates are contained below. The numbers highlighted in yellow indicate that the TMDL has been met.

7.1.1 Turkey Creek Watershed

Table 43 Impairments in Turkey Creek.

High Priority TMDL	Medium Priority TMDL	303(d) Listing
E. coli bacteria	Chloride	Arsenic
Total Suspended Solids	Atrazine Category 4b	Selenium
Total Phosphorus		
Dissolved Oxygen		
Biology Sediment		
Biology		

BMP implementation will be aimed at

Cropland	Livestock	Atrazine
✓	✓	✓

BMPs implemented will meet the TMDL reduction goals for sediment and phosphorus.

Sediment Reduction Goal
- 990 tons/year

Phosphorus Reduction Goal
- 49,182 pounds/year

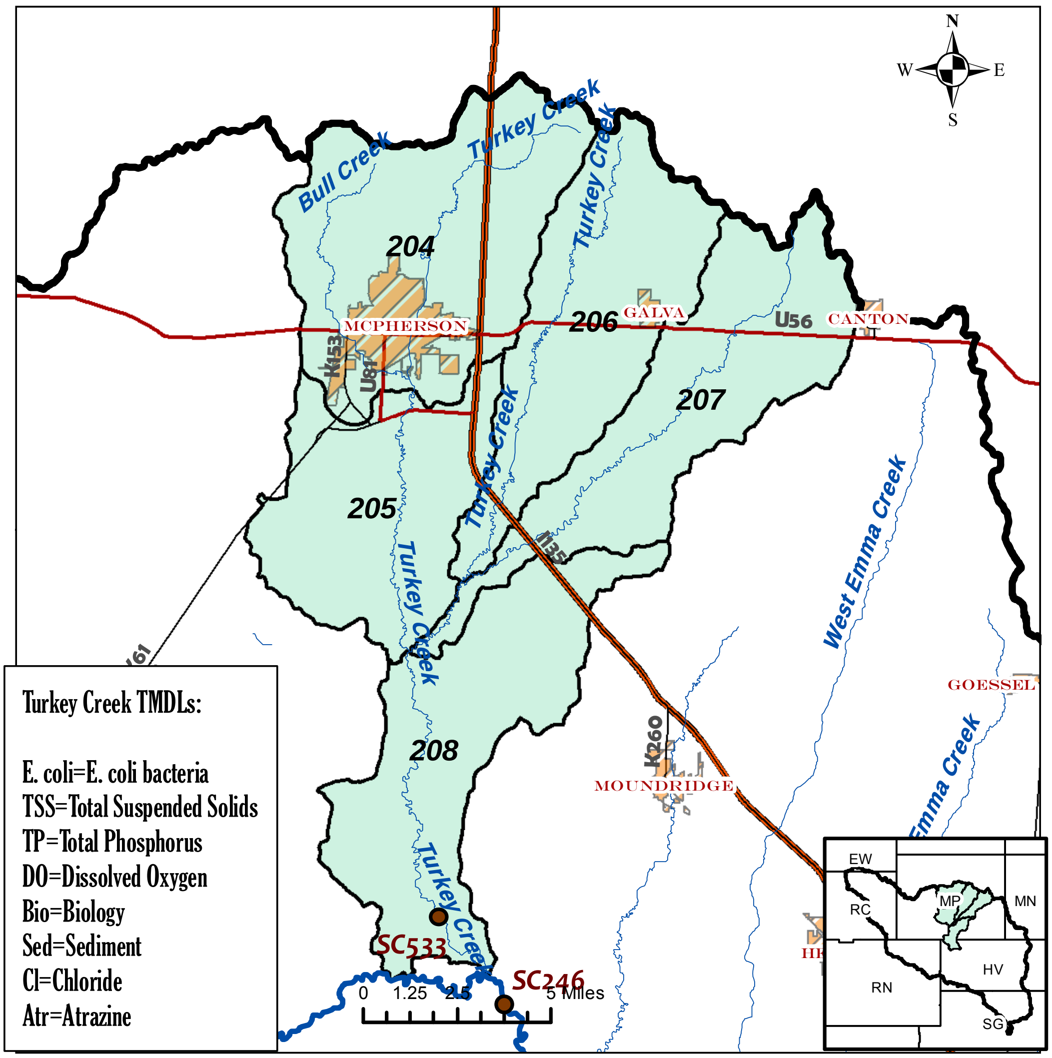


Figure 25 Map of the Turkey Creek Watershed.

Table 44 40 Year Adoption Rate for Cropland BMPs in Turkey Creek.

BMP	Treated Acres
No-Till	157
Conservation Tillage	314
Waterways	235
Buffers	157

Nutrient Management Plan	78
Terraces	235
Incorporate Manure	78
Conservation Crop Rotation	78
Water Retention	31
Total Adoption	**1,365**

Table 45 40 Year Adoption Rate for Livestock BMPs in Turkey Creek.

Practice	Number Installed
Vegetative Filter Strip	13
Relocate Feeding Site	13
Relocate Pasture Feeding Site	7
Off-Stream Watering System	7

Table 46 Sediment Reduction from Implemented Cropland BMPs in Turkey Creek Watershed. (Highlighted number indicates that the sediment goad of the TSS TMDL has been met.)

Year	Cropland Reduction (tons) for Sediment	% of TMDL
1	2,091	211%
2	4,181	422%
3	6,272	633%
4	8,362	845%
5	10,453	1056%
6	12,543	1267%
7	14,634	1478%
8	16,724	1689%
9	18,815	1900%
10	20,905	2112%
11	22,996	2323%
12	25,086	2534%
13	27,177	2745%
14	29,268	2956%
15	31,358	3167%
16	33,449	3379%
17	35,539	3590%
18	37,630	3801%
19	39,720	4012%
20	41,811	4223%
21	43,901	4434%
22	45,992	4646%
23	48,082	4857%

24	50,173	5068%
25	52,263	5279%
26	54,354	5490%
27	56,444	5701%
28	58,535	5913%
29	60,626	6124%
30	62,716	6335%
31	64,807	6546%
32	66,897	6757%
33	68,988	6968%
34	71,078	7180%
35	73,169	7391%
36	75,259	7602%
37	77,350	7813%
38	79,440	8024%
39	81,531	8235%
40	83,621	8447%
Load Reduction to meet TSS TMDL:		990 tons

Table 47 Phosphorus Reduction from Implemented Cropland and Livestock BMPs in Turkey Creek. (Highlighted numbers indicate that the TP TMDL has been met.)

Year	Cropland Reduction (lbs) for Phosphorus	Livestock Reduction (lbs) for Phosphorus	Total Reduction (lbs) for Phosphorus	% of Phosphorus TMDL
1	1,318	955	2,273	5%
2	2,635	1,910	4,545	9%
3	3,953	2,865	6,818	14%
4	5,270	3,820	9,090	18%
5	6,588	4,775	11,363	23%
6	7,905	5,730	13,635	28%
7	9,223	6,685	15,908	32%
8	10,541	7,640	18,180	37%
9	11,858	8,595	20,453	42%
10	13,176	9,550	22,725	46%
11	14,493	10,505	24,998	51%
12	15,811	11,460	27,270	55%
13	17,128	12,415	29,543	60%
14	18,446	13,369	31,815	65%
15	19,763	14,324	34,088	69%

16	21,081	15,279	36,360	74%
17	22,399	16,234	38,633	79%
18	23,716	17,189	40,906	83%
19	25,034	18,144	43,178	88%
20	26,351	19,099	45,451	92%
21	27,669	20,054	47,723	97%
22	28,986	21,009	49,996	102%
23	30,304	21,964	52,268	106%
24	31,622	22,919	54,541	111%
25	32,939	23,874	56,813	116%
26	34,257	24,829	59,086	120%
27	35,574	25,784	61,358	125%
28	36,892	26,739	63,631	129%
29	38,209	27,694	65,903	134%
30	39,527	28,649	68,176	139%
31	40,845	29,604	70,448	143%
32	42,162	30,559	72,721	148%
33	43,480	31,514	74,993	152%
34	44,797	32,469	77,266	157%
35	46,115	33,424	79,539	162%
36	47,432	34,379	81,811	166%
37	48,750	35,334	84,084	171%
38	50,067	36,289	86,356	176%
39	51,385	37,244	88,629	180%
40	52,703	38,199	90,901	185%
Load Reduction to meet TP TMDL:				49,182 pounds

Table 48 Nitrogen Reduction from Implemented Cropland BMPs in Turkey Creek

Year	Cropland Reduction (lbs) for Nitrogen
1	4,141
2	8,282
3	12,423
4	16,564
5	20,705
6	24,846
7	28,986
8	33,127

9	37,268
10	41,409
11	45,550
12	49,691
13	53,832
14	57,973
15	62,114
16	66,255
17	70,396
18	74,537
19	78,677
20	82,818
21	86,959
22	91,100
23	95,241
24	99,382
25	103,523
26	107,664
27	111,805
28	115,946
29	120,087
30	124,228
31	128,368
32	132,509
33	136,650
34	140,791
35	144,932
36	149,073
37	153,214
38	157,355
39	161,496
40	165,637

7.1.2 Black Kettle Creek Watershed

Table 49 Impairments in Black Kettle Creek Watershed

High Priority TMDL	Medium Priority TMDL	303(d) Listing
Total Suspended Solids		Copper
Biology Sediment		Dissolved Oxygen
Biology		Atrazine

BMP implementation will be aimed at

Cropland	Livestock	Atrazine
✓		

BMPs implemented will meet the TMDL reduction goals for sediment and phosphorus.

Sediment Reduction Goal	• 1,786 tons/year
Phosphorus Reduction Goal	• 4,763 pounds/year

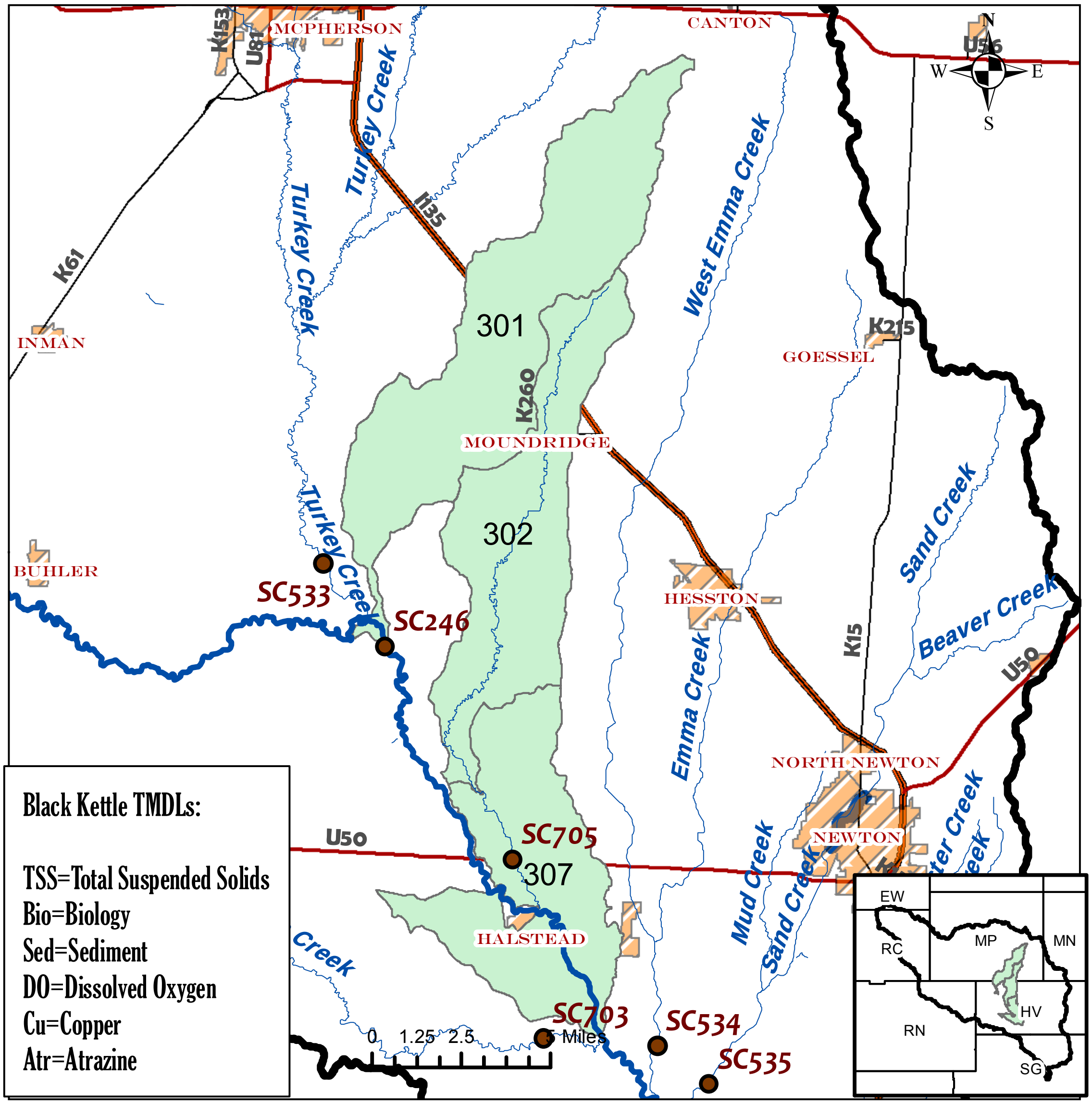


Figure 26 Map of Black Kettle Creek Watershed.

Table 50 40 Year Adoption Rate for Cropland BMPs in Black Kettle Creek.

BMP	Treated Acres
No-Till	86
Conservation Tillage	171
Waterways	128
Buffers	86
Nutrient Management Plan	43
Terraces	128
Incorporate Manure	43
Conservation Crop Rotation	43

Water Retention	17
Total Adoption	**744**

Table 51 Sediment Reduction from Implemented Cropland BMPs in Black Kettle Creek Watershed. (Highlighted number indicates that the sediment goad of the TSS TMDL has been met.)

Year	Cropland Reduction (tons) for Sediment	% of TMDL
1	1,140	64%
2	2,280	128%
3	3,420	191%
4	4,559	255%
5	5,699	319%
6	6,839	383%
7	7,979	447%
8	9,119	511%
9	10,259	574%
10	11,399	638%
11	12,539	702%
12	13,678	766%
13	14,818	830%
14	15,958	894%
15	17,098	957%
16	18,238	1021%
17	19,378	1085%
18	20,518	1149%
19	21,658	1213%
20	22,797	1276%
21	23,937	1340%
22	25,077	1404%
23	26,217	1468%
24	27,357	1532%
25	28,497	1596%
26	29,637	1659%
27	30,776	1723%
28	31,916	1787%
29	33,056	1851%
30	34,196	1915%
31	35,336	1978%
32	36,476	2042%
33	37,616	2106%

34	38,756	2170%
35	39,895	2234%
36	41,035	2298%
37	42,175	2361%
38	43,315	2425%
39	44,455	2489%
40	45,595	2553%
Load Reduction to meet TSS TMDL:		1,786 tons

Table 52 Phosphorus Reduction from Implemented Cropland BMPs in Black Kettle Creek. (Highlighted numbers indicate that the TP TMDL has been met.)

Year	Cropland Reduction (lbs) for Phosphorus	% of Phosphorus TMDL
1	718	15%
2	1,437	30%
3	2,155	45%
4	2,874	60%
5	3,592	75%
6	4,310	90%
7	5,029	106%
8	5,747	121%
9	6,466	136%
10	7,184	151%
11	7,902	166%
12	8,621	181%
13	9,339	196%
14	10,058	211%
15	10,776	226%
16	11,494	241%
17	12,213	256%
18	12,931	271%
19	13,650	287%
20	14,368	302%
21	15,086	317%
22	15,805	332%
23	16,523	347%
24	17,242	362%
25	17,960	377%
26	18,679	392%

27	19,397	407%
28	20,115	422%
29	20,834	437%
30	21,552	452%
31	22,271	468%
32	22,989	483%
33	23,707	498%
34	24,426	513%
35	25,144	528%
36	25,863	543%
37	26,581	558%
38	27,299	573%
39	28,018	588%
40	28,736	603%
Load Reduction to meet Phosphorus TMDL: 4,763 pounds		

Table 53 Nitrogen Reduction from Implemented Cropland BMPs in Black Kettle Creek

Year	Cropland Reduction (lbs) for Nitrogen
1	2,258
2	4,516
3	6,774
4	9,031
5	11,289
6	13,547
7	15,805
8	18,063
9	20,321
10	22,578
11	24,836
12	27,094
13	29,352
14	31,610
15	33,868
16	36,125
17	38,383
18	40,641
19	42,899
20	45,157

21	47,415
22	49,673
23	51,930
24	54,188
25	56,446
26	58,704
27	60,962
28	63,220
29	65,477
30	67,735
31	69,993
32	72,251
33	74,509
34	76,767
35	79,025
36	81,282
37	83,540
38	85,798
39	88,056
40	90,314

7.1.3 Kisiwa Creek Watershed

Table 54 Impairments in the Kisiwa Creek Watershed.

High Priority TMDL	Medium Priority TMDL	303(d) Listing
Total Suspended Solids		Total Phosphorus
Biology Sediment		Dissolved Oxygen
Biology		Atrazine

BMP implementation will be aimed at

Cropland	Livestock	Atrazine
✓	✓	

Sediment Reduction Goal
- 770 tons/year

Phosphorus Reduction Goal
- 16,247 pounds/year

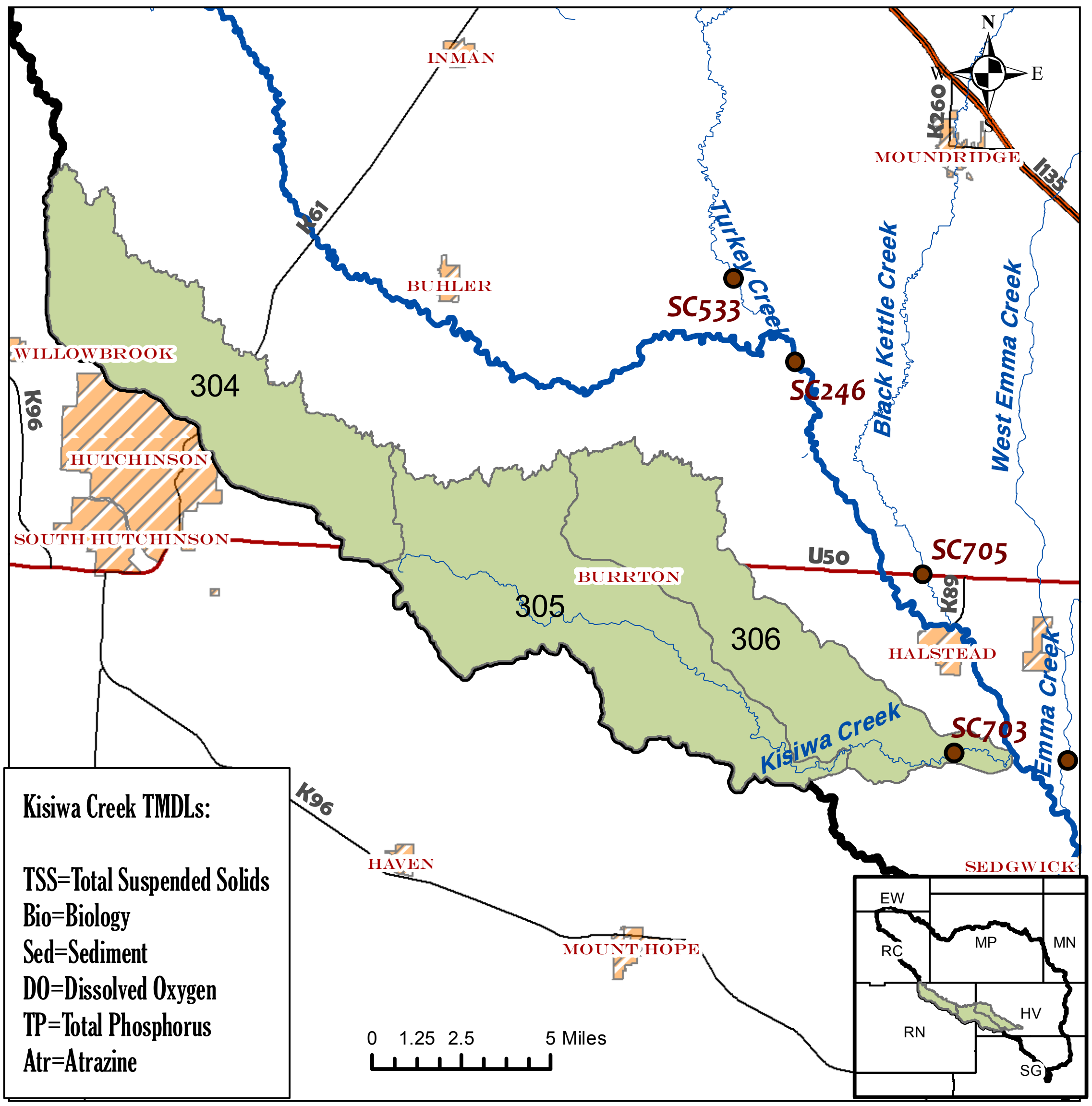


Figure 27 Map of the Kisiwa Creek Wateshed.

Table 55 40 Year Adoption Rate for Cropland BMPs in Kisiwa Creek.

BMP	Acres
No-Till	56
Conservation Tillage	111

Waterways	84
Buffers	56
Nutrient Management Plan	28
Terraces	84
Incorporate Manure	28
Conservation Crop Rotation	28
Water Retention	11
Total Adoption	**484**

Table 56 40 Year Adoption Rate for Livestock BMPs in Kisiwa Creek.

Practice	Number Installed
Vegetative Filter Strip	8
Relocate Feeding Site	8
Relocate Pasture Feeding Site	4
Off-Stream Watering System	4

Table 57 Sediment Reduction from Implemented Cropland BMPs in Kisiwa Creek Watershed. (Highlighted number indicates that the sediment goad of the TSS TMDL has been met.)

Year	Cropland Reduction (tons) for Sediment	% of TMDL
1	742	96%
2	1,484	193%
3	2,226	289%
4	2,968	385%
5	3,710	482%
6	4,452	578%
7	5,194	675%
8	5,936	771%
9	6,678	867%
10	7,420	964%
11	8,162	1060%
12	8,904	1156%
13	9,646	1253%
14	10,388	1349%
15	11,130	1445%
16	11,872	1542%
17	12,614	1638%
18	13,356	1735%
19	14,098	1831%
20	14,840	1927%
21	15,582	2024%

22	16,324	2120%
23	17,066	2216%
24	17,808	2313%
25	18,550	2409%
26	19,292	2505%
27	20,034	2602%
28	20,776	2698%
29	21,518	2795%
30	22,260	2891%
31	23,002	2987%
32	23,744	3084%
33	24,486	3180%
34	25,228	3276%
35	25,970	3373%
36	26,712	3469%
37	27,454	3565%
38	28,196	3662%
39	28,938	3758%
40	29,680	3855%
Load Reduction to meet TSS TMDL:		770 tons

Table 58 Phosphorus Reduction from Implemented Cropland and Livestock BMPs in Kisiwa Creek. (Highlighted numbers indicate that the TP TMDL has been met.)

Year	Cropland Reduction (lbs) for Phosphorus	Livestock Reduction (lbs) for Phosphorus	Total Reduction (lbs) for Phosphorus	% of Phosphorus TMDL
1	468	587	1,054	6%
2	935	1,173	2,109	13%
3	1,403	1,760	3,163	19%
4	1,871	2,347	4,217	26%
5	2,338	2,934	5,272	32%
6	2,806	3,520	6,326	39%
7	3,274	4,107	7,380	45%
8	3,741	4,694	8,435	52%
9	4,209	5,280	9,489	58%
10	4,676	5,867	10,543	65%
11	5,144	6,454	11,598	71%
12	5,612	7,040	12,652	78%
13	6,079	7,627	13,707	84%

14	6,547	8,214	14,761	91%
15	7,015	8,801	15,815	97%
16	7,482	9,387	16,870	104%
17	7,950	9,974	17,924	110%
18	8,418	10,561	18,978	117%
19	8,885	11,147	20,033	123%
20	9,353	11,734	21,087	130%
21	9,821	12,321	22,141	136%
22	10,288	12,907	23,196	143%
23	10,756	13,494	24,250	149%
24	11,224	14,081	25,304	156%
25	11,691	14,668	26,359	162%
26	12,159	15,254	27,413	169%
27	12,627	15,841	28,467	175%
28	13,094	16,428	29,522	182%
29	13,562	17,014	30,576	188%
30	14,029	17,601	31,630	195%
31	14,497	18,188	32,685	201%
32	14,965	18,774	33,739	208%
33	15,432	19,361	34,794	214%
34	15,900	19,948	35,848	221%
35	16,368	20,535	36,902	227%
36	16,835	21,121	37,957	234%
37	17,303	21,708	39,011	240%
38	17,771	22,295	40,065	247%
39	18,238	22,881	41,120	253%
40	18,706	23,468	42,174	260%
Load Reduction to meet TP TMDL:				16,247 pounds

Table 59 Nitrogen Reduction from Implemented Cropland BMPs in Kisiwa Creek

Year	Cropland Reduction (lbs) for Nitrogen
1	1,470
2	2,940
3	4,409
4	5,879
5	7,349
6	8,819

7	10,288
8	11,758
9	13,228
10	14,698
11	16,167
12	17,637
13	19,107
14	20,577
15	22,046
16	23,516
17	24,986
18	26,456
19	27,925
20	29,395
21	30,865
22	32,335
23	33,804
24	35,274
25	36,744
26	38,214
27	39,683
28	41,153
29	42,623
30	44,093
31	45,562
32	47,032
33	48,502
34	49,972
35	51,441
36	52,911
37	54,381
38	55,851
39	57,321
40	58,790

2) Tier 2 Sub Watersheds

7.2.1 Emma Creek Watershed

Table 60 Impairments in the Emma Creek Watershed

High Priority TMDL	Medium Priority TMDL	303(d) Listing
E. coli bacteria		Total Phosphorus
Biology Sediment		Dissolved Oxygen
Biology		Arsenic
Atrazine		

BMP implementation will be aimed at

Cropland	Livestock	Atrazine
✓	✓	✓

Sediment Reduction Goal
- **612 tons/year**

Phosphorus Reduction Goal
- 21,318 **pounds/year**

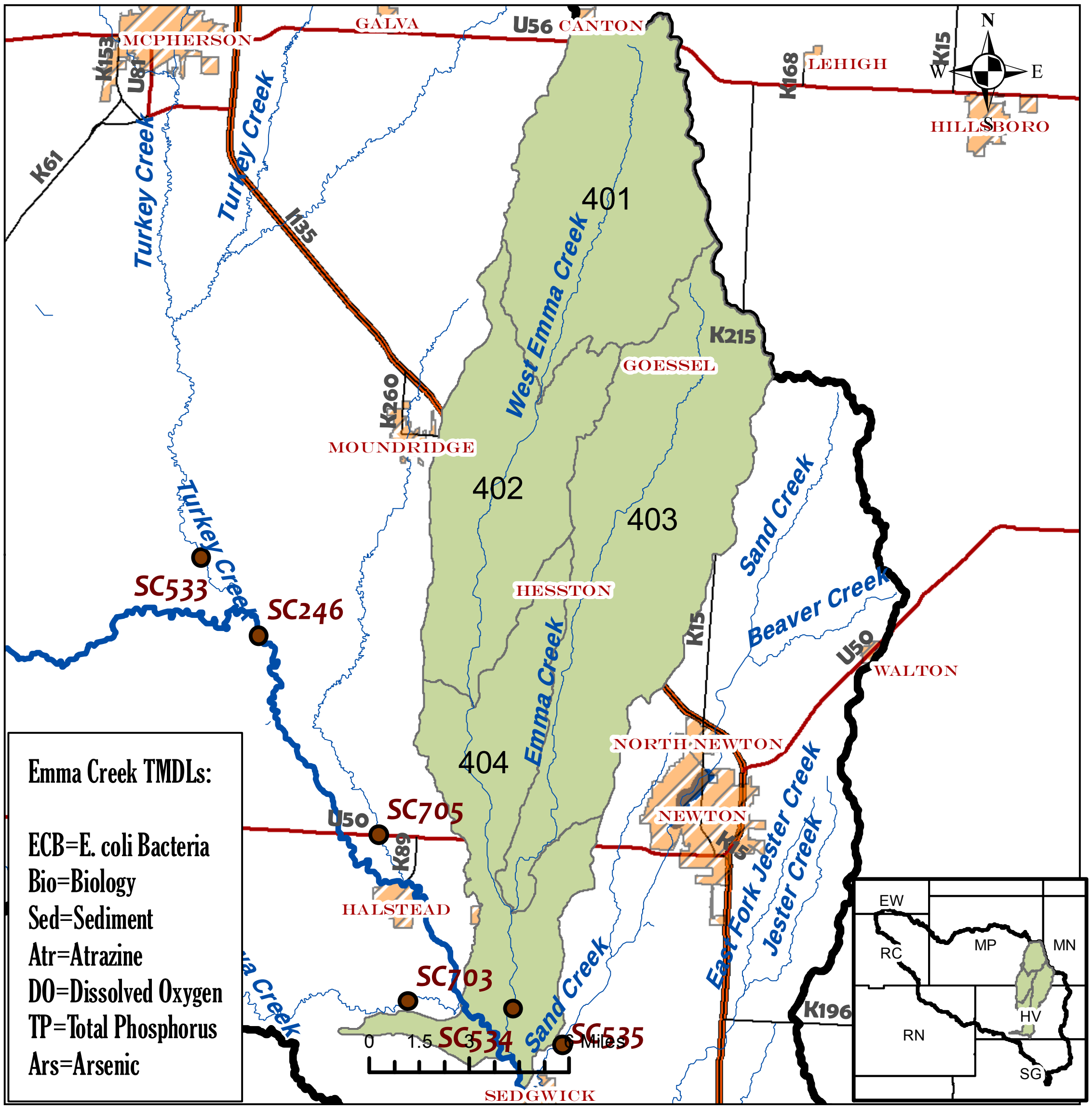


Figure 28 Map of the Emma Creek Watershed.

Table 61 40 Year Adoption Rates for Cropland BMPs in Emma Creek.

BMP	Acres
No-Till	131
Conservation Tillage	262
Waterways	196
Buffers	131
Nutrient Management Plan	65
Terraces	196
Incorporate Manure	65
Conservation Crop Rotation	65

Water Retention	26
Total Adoption	**1,139**

Table 62 40 Year Adoption Rates for Livestock BMPs in Emma Creek.

Practice	Number Installed
Vegetative Filter Strip	8
Relocate Feeding Site	8
Relocate Pasture Feeding Site	4
Off-Stream Watering System	4

Table 63 Sediment Reduction from Implemented Cropland BMPs in Emma Creek Watershed. (Highlighted number indicates that the sediment goad of the TSS TMDL has been met.)

Year	Cropland Reduction (tons) for Sediment	% of TMDL
1	1,745	285%
2	3,490	570%
3	5,235	855%
4	6,980	1141%
5	8,725	1426%
6	8,725	1426%
7	8,725	1426%
8	8,725	1426%
9	8,725	1426%
10	8,725	1426%
11	8,725	1426%
12	8,725	1426%
13	8,725	1426%
14	8,725	1426%
15	8,725	1426%
16	10,470	1711%
17	12,215	1996%
18	13,961	2281%
19	15,706	2566%
20	17,451	2851%
21	19,196	3137%
22	20,941	3422%
23	22,686	3707%
24	24,431	3992%
25	26,176	4277%
26	27,921	4562%
27	29,666	4847%

28	31,411	5133%
29	33,156	5418%
30	34,901	5703%
31	36,646	5988%
32	38,392	6273%
33	40,137	6558%
34	41,882	6843%
35	43,627	7129%
36	45,372	7414%
37	47,117	7699%
38	48,862	7984%
39	50,607	8269%
40	52,352	8554%
Load Reduction to meet TSS TMDL:		612 tons

Table 64 Phosphorus Reduction from Implemented Cropland and Livestock BMPs in Emma Creek. (Highlighted numbers indicate that the TP TMDL has been met.)

Year	Cropland Reduction (lbs) for Phosphorus	Livestock Reduction (lbs) for Phosphorus	Total Reduction (lbs) for Phosphorus	% of Phosphorus TMDL
1	1,100	587	1,687	8%
2	2,200	1,173	3,373	16%
3	3,299	1,760	5,060	24%
4	4,399	2,347	6,746	32%
5	5,499	2,934	8,433	40%
6	6,599	3,520	10,119	47%
7	7,699	4,107	11,806	55%
8	8,799	4,694	13,492	63%
9	9,898	5,280	15,179	71%
10	10,998	5,867	16,865	79%
11	12,098	6,454	18,552	87%
12	13,198	7,040	20,238	95%
13	14,298	7,627	21,925	103%
14	15,398	8,214	23,611	111%
15	16,497	8,801	25,298	119%
16	17,597	9,387	26,985	127%
17	18,697	9,974	28,671	134%
18	19,797	10,561	30,358	142%
19	20,897	11,147	32,044	150%

20	21,997	11,734	33,731	158%
21	23,096	12,321	35,417	166%
22	24,196	12,907	37,104	174%
23	25,296	13,494	38,790	182%
24	26,396	14,081	40,477	190%
25	27,496	14,668	42,163	198%
26	28,596	15,254	43,850	206%
27	29,695	15,841	45,536	214%
28	30,795	16,428	47,223	222%
29	31,895	17,014	48,909	229%
30	32,995	17,601	50,596	237%
31	34,095	18,188	52,283	245%
32	35,195	18,774	53,969	253%
33	36,294	19,361	55,656	261%
34	37,394	19,948	57,342	269%
35	38,494	20,535	59,029	277%
36	39,594	21,121	60,715	285%
37	40,694	21,708	62,402	293%
38	41,794	22,295	64,088	301%
39	42,893	22,881	65,775	309%
40	43,993	23,468	67,461	316%
Load Reduction to meet TP TMDL:				21,318 pounds

Table 65 Nitrogen Reduction from Implemented Cropland BMPs in Emma Creek

Year	Cropland Reduction (lbs) for Nitrogen
1	3,457
2	6,913
3	10,370
4	13,826
5	17,283
6	20,740
7	24,196
8	27,653
9	31,110
10	34,566
11	38,023
12	41,479
13	44,936

14	48,393
15	51,849
16	55,306
17	58,763
18	62,219
19	65,676
20	69,132
21	72,589
22	76,046
23	79,502
24	82,959
25	86,415
26	89,872
27	93,329
28	96,785
29	100,242
30	103,699
31	107,155
32	110,612
33	114,068
34	117,525
35	120,982
36	124,438
37	127,895
38	131,351
39	134,808
40	138,265

7.2.2 Sand Creek

Table 66 Impairments in the Sand Creek Watershed.

High Priority TMDL	Medium Priority TMDL	303(d) Listing
E. coli bacteria	Dissolved Oxygen	
Total Phosphorus	Atrazine Category 4b	
Biology Sediment		
Biology		
Nitrate		

BMP implementation will be aimed at

Cropland	Livestock	Atrazine
✓	✓	✓

Sediment Reduction Goal	• 198 **tons/year**
Phosphorus Reduction Goal	• 17,346 **pounds/year**

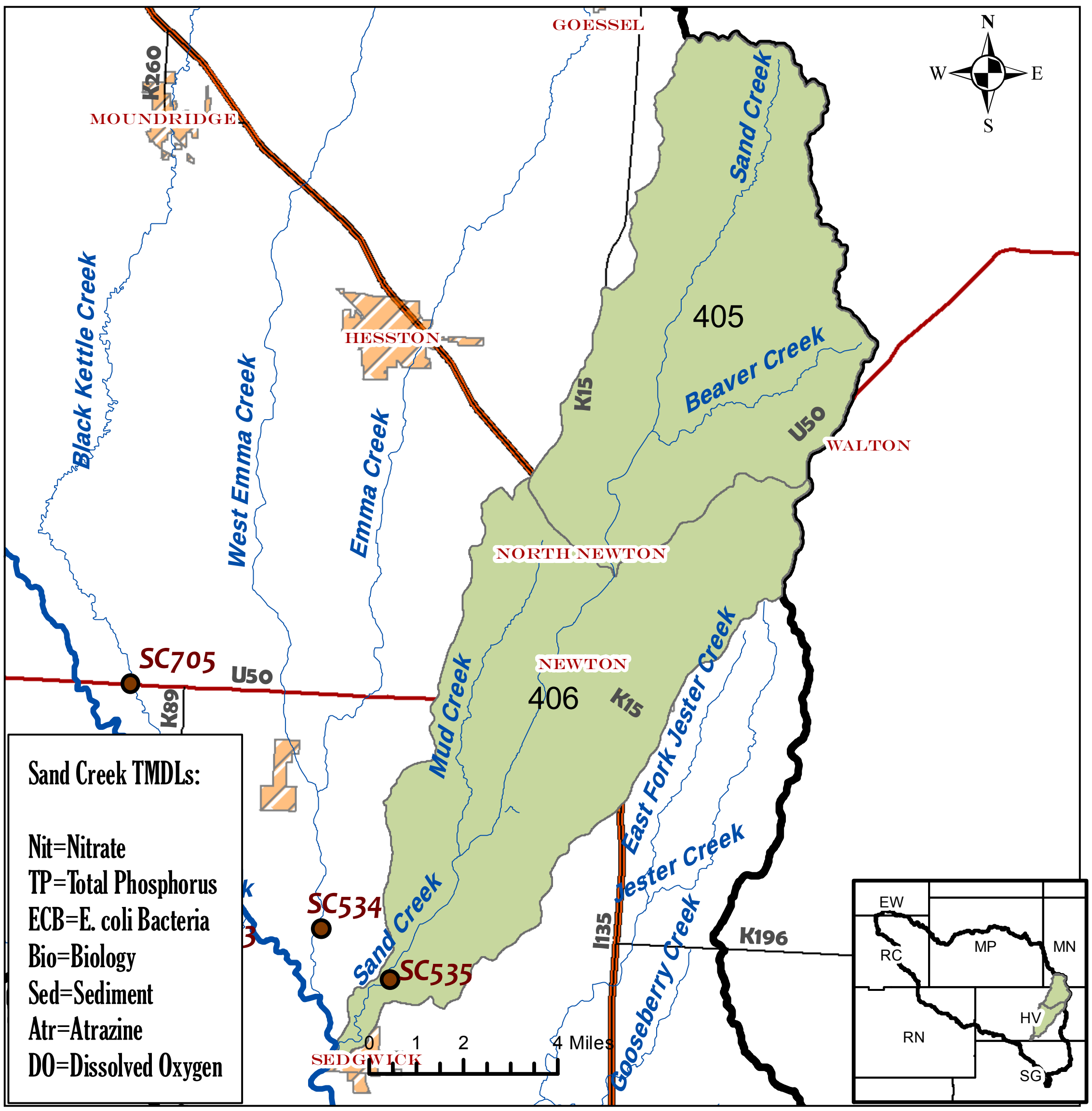


Figure 29 Map of the Sand Creek Watershed.

Table 67 40 Year Adoption Rate for Cropland BMPs in Sand Creek.

BMP	Acres
No-Till	28
Conservation Tillage	57
Waterways	43
Buffers	28
Nutrient Management Plan	14
Terraces	43
Incorporate Manure	14
Conservation Crop Rotation	14
Water Retention	6
Total Adoption	**247**

Table 68 40 Year Adoption Rate for Livestock BMPs in Sand Creek.

Practice	Number Installed
Vegetative Filter Strip	5
Relocate Feeding Site	5
Relocate Pasture Feeding Site	2
Off-Stream Watering System	2

Table 69 Sediment Reduction from Implemented Cropland BMPs in Sand Creek Watershed. (Highlighted number indicates that the sediment goad of the TSS TMDL has been met.)

Year	Cropland Reduction (tons) for Sediment	% of TMDL
1	727	367%
2	1,454	734%
3	2,181	1101%
4	2,908	1469%
5	3,635	1836%
6	3,635	1836%
7	3,635	1836%
8	3,635	1836%
9	3,635	1836%
10	3,635	1836%
11	3,635	1836%
12	3,635	1836%
13	3,635	1836%
14	3,635	1836%
15	3,635	1836%
16	4,361	2203%
17	5,088	2570%

18	5,815	2937%
19	6,542	3304%
20	7,269	3671%
21	7,996	4038%
22	8,723	4406%
23	9,450	4773%
24	10,177	5140%
25	10,904	5507%
26	11,631	5874%
27	12,358	6241%
28	13,084	6608%
29	13,811	6975%
30	14,538	7343%
31	15,265	7710%
32	15,992	8077%
33	16,719	8444%
34	17,446	8811%
35	18,173	9178%
36	18,900	9545%
37	19,627	9912%
38	20,354	10280%
39	21,080	10647%
40	21,807	11014%
Load Reduction to meet TSS TMDL:		198 tons

Table 70 Phosphorus Reduction from Implemented Cropland and Livestock BMPs in Sand Creek. (Highlighted numbers indicate that the TP TMDL has been met.)

Year	Cropland Reduction (lbs) for Phosphorus	Livestock Reduction (lbs) for Phosphorus	Total Reduction (lbs) for Phosphorus	% of Phosphorus TMDL
1	458	365	823	5%
2	916	730	1,646	9%
3	1,374	1095	2,470	14%
4	1,833	1460	3,293	19%
5	2,291	1826	4,116	24%
6	2,749	2191	4,939	28%
7	3,207	2556	5,763	33%
8	3,665	2921	6,586	38%
9	4,123	3286	7,409	43%

10	4,581	3651	8,232	47%
11	5,040	4016	9,056	52%
12	5,498	4381	9,879	57%
13	5,956	4746	10,702	62%
14	6,414	5111	11,525	66%
15	6,872	5477	12,349	71%
16	7,330	5842	13,172	76%
17	7,788	6207	13,995	81%
18	8,246	6572	14,818	85%
19	8,705	6937	15,642	90%
20	9,163	7302	16,465	95%
21	9,621	7667	17,288	100%
22	10,079	8032	18,111	104%
23	10,537	8397	18,935	109%
24	10,995	8762	19,758	114%
25	11,453	9128	20,581	119%
26	11,912	9493	21,404	123%
27	12,370	9858	22,228	128%
28	12,828	10223	23,051	133%
29	13,286	10588	23,874	138%
30	13,744	10953	24,697	142%
31	14,202	11318	25,521	147%
32	14,660	11683	26,344	152%
33	15,119	12048	27,167	157%
34	15,577	12413	27,990	161%
35	16,035	12779	28,814	166%
36	16,493	13144	29,637	171%
37	16,951	13509	30,460	176%
38	17,409	13874	31,283	180%
39	17,867	14239	32,107	185%
40	18,326	14604	32,930	190%
Load Reduction to meet TP TMDL:				17,346 pounds

Table 71 Nitrogen Reduction from Implemented Cropland BMPs in Sand Creek

Year	Cropland Reduction (lbs) for Nitrogen
1	1,440
2	2,880

3	4,320
4	5,759
5	7,199
6	8,639
7	10,079
8	11,519
9	12,959
10	14,399
11	15,838
12	17,278
13	18,718
14	20,158
15	21,598
16	23,038
17	24,478
18	25,918
19	27,357
20	28,797
21	30,237
22	31,677
23	33,117
24	34,557
25	35,997
26	37,436
27	38,876
28	40,316
29	41,756
30	43,196
31	44,636
32	46,076
33	47,515
34	48,955
35	50,395
36	51,835
37	53,275
38	54,715
39	56,155
40	57,594

7.2.3 Blazefork Creek Wateshed

The Blazefork Creek Watershed has no TMDLs however, BMP implementation will be aimed at protection of the watershed.

BMP implementation will be aimed at

Cropland	Livestock	Atrazine
✓	✓	

Sediment Reduction Goal
- 315 **tons/year**

Phosphorus Reduction Goal
- 26,443 **pounds/year**

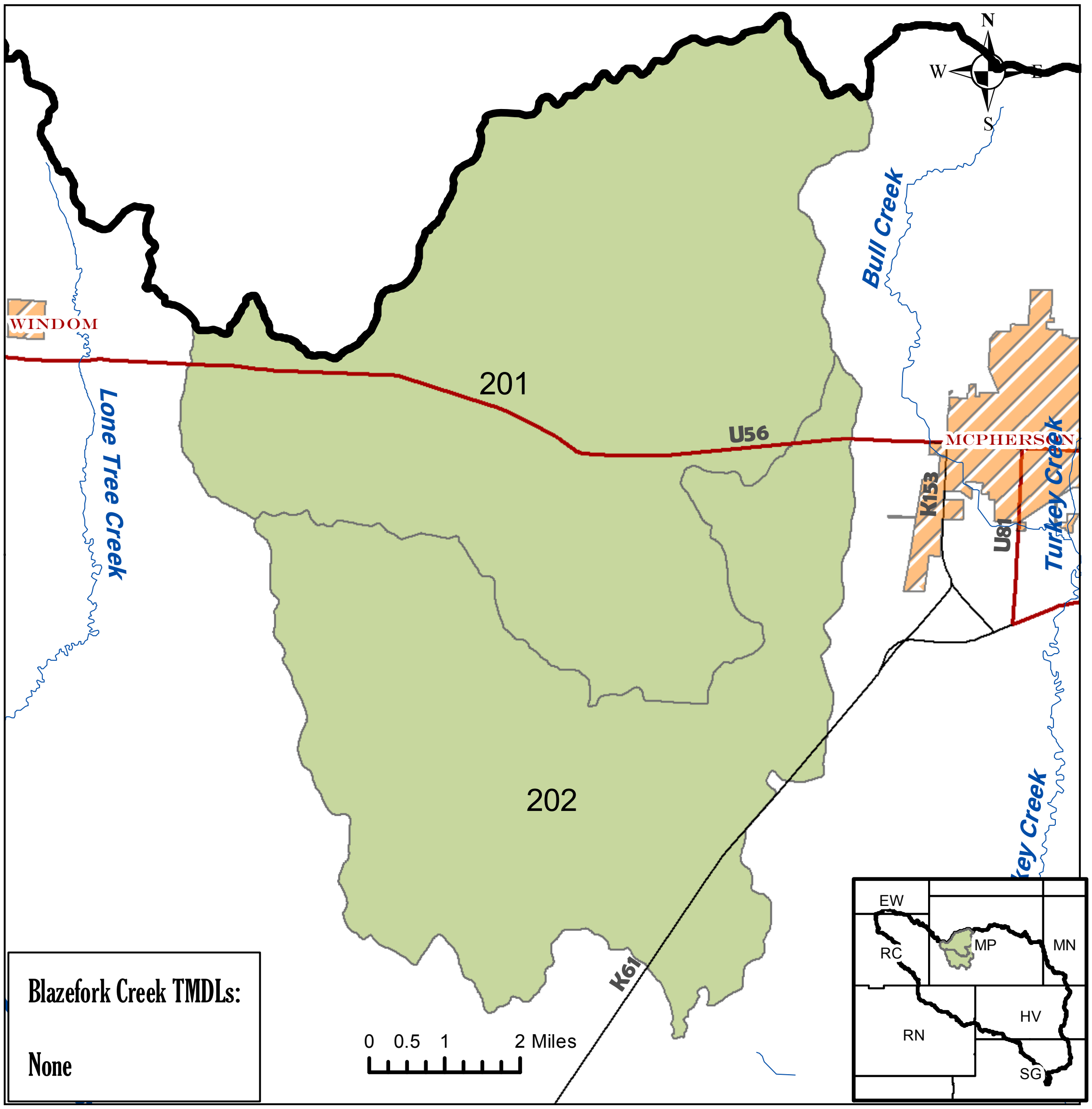


Figure 30 Map of the Blazefork Creek Watershed.

Table 72 40 Year Adoption Rate for Cropland BMPs in Blazefork Creek.

BMP	Acres
No-Till	64
Conservation Tillage	128
Waterways	96
Buffers	64
Nutrient Management Plan	32
Terraces	96
Incorporate Manure	32
Conservation Crop Rotation	32

Water Retention	13
Total Adoption	**558**

Table 73 40 Year Adoption Rate for Livestock BMPs in Blazefork Creek.

Practice	Number Installed
Vegetative Filter Strip	6
Relocate Feeding Site	6
Relocate Pasture Feeding Site	3
Off-Stream Watering System	3

Table 74 Sediment Reduction from Implemented Cropland BMPs in Blazefork Creek Watershed. (Highlighted number indicates that the sediment goad of the TSS goal has been met.)

Year	Cropland Reduction (tons) for Sediment	% of TMDL
1	855	271%
2	1,710	543%
3	2,565	814%
4	3,420	1086%
5	4,275	1357%
6	4,275	1357%
7	4,275	1357%
8	4,275	1357%
9	4,275	1357%
10	4,275	1357%
11	4,275	1357%
12	4,275	1357%
13	4,275	1357%
14	4,275	1357%
15	4,275	1357%
16	5,048	1603%
17	6,079	1930%
18	7,110	2257%
19	8,141	2585%
20	9,173	2912%
21	10,204	3239%
22	11,235	3567%
23	12,266	3894%
24	13,297	4221%
25	14,328	4548%
26	15,359	4876%
27	16,390	5203%

28	17,421	5530%
29	18,452	5858%
30	19,483	6185%
31	20,514	6512%
32	21,545	6840%
33	22,576	7167%
34	23,607	7494%
35	24,638	7822%
36	25,669	8149%
37	26,700	8476%
38	27,731	8804%
39	28,762	9131%
40	29,794	9458%
Load Reduction to meet TSS TMDL:		315 tons

Table 75 Phosphorus Reduction from Implemented Cropland and Livestock BMPs in Blazefork Creek. (Highlighted numbers indicate that the TP goal has been met.)

Year	Cropland Reduction (lbs) for Phosphorus	Livestock Reduction (lbs) for Phosphorus	Total Reduction (lbs) for Phosphorus	% of Phosphorus TMDL
1	539	440	979	4%
2	1,078	880	1,958	7%
3	1,617	1320	2,937	11%
4	2,155	1760	3,916	15%
5	2,694	2200	4,894	19%
6	3,233	2640	5,873	22%
7	3,772	3080	6,852	26%
8	4,311	3520	7,831	30%
9	4,850	3960	8,810	33%
10	5,389	4400	9,789	37%
11	5,928	4840	10,768	41%
12	6,466	5280	11,747	44%
13	7,005	5720	12,726	48%
14	7,544	6160	13,704	52%
15	8,083	6600	14,683	56%
16	8,622	7040	15,662	59%
17	9,161	7480	16,641	63%
18	9,700	7920	17,620	67%
19	10,238	8360	18,599	70%

20	10,777	8801	19,578	74%
21	11,316	9241	20,557	78%
22	11,855	9681	21,536	81%
23	12,394	10121	22,514	85%
24	12,933	10561	23,493	89%
25	13,472	11001	24,472	93%
26	14,010	11441	25,451	96%
27	14,549	11881	26,430	100%
28	15,088	12321	27,409	104%
29	15,627	12761	28,388	107%
30	16,166	13201	29,367	111%
31	16,705	13641	30,346	115%
32	17,244	14081	31,324	118%
33	17,783	14521	32,303	122%
34	18,321	14961	33,282	126%
35	18,860	15401	34,261	130%
36	19,399	15841	35,240	133%
37	19,938	16281	36,219	137%
38	20,477	16721	37,198	141%
39	21,016	17161	38,177	144%
40	21,555	17601	39,156	148%
Load Reduction to meet TP TMDL:				26,443 pounds

Table 76 Nitrogen Reduction from Implemented Cropland BMPs in Blazefork Creek

Year	Cropland Reduction (lbs) for Nitrogen
1	1,694
2	3,387
3	5,081
4	6,774
5	8,468
6	10,161
7	11,855
8	13,549
9	15,242
10	16,936
11	18,629
12	20,323

13	22,016
14	23,710
15	25,404
16	27,097
17	28,791
18	30,484
19	32,178
20	33,871
21	35,565
22	37,259
23	38,952
24	40,646
25	42,339
26	44,033
27	45,727
28	47,420
29	49,114
30	50,807
31	52,501
32	54,194
33	55,888
34	57,582
35	59,275
36	60,969
37	62,662
38	64,356
39	66,049
40	67,743

9. Information and Education in Support of BMPs

The SLT has determined which information and education activities will be needed in the watershed. These activities are important in providing the residents of the watershed with a higher awareness of watershed issues. This will lead to an increase in adoption rates of BMPs. Listed below are the activities and events along with their costs and possible sponsoring agencies.

Table 77 Information and Education Activities and Events.

BMP	Target Audience	Information / Education Activity / Event	Time Frame	Estimated Costs	Sponsor/ Responsible Agency
Atrazine BMP Implementation					
Split Applications of Herbicide	Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	K-State Extension Watershed Specialists, BMP coordinators, K-State Extension County Offices, Conservation Districts
		Seasonal Information Meetings	Ongoing	$1,000 per year for all Atrazine BMPs combined	
		Crop Schools to cover weed control and atrazine use - multi-county	Winter / Spring	$200 ($100 per event)	
Incorporate Herbicide into Top 2" of Soil	Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	
		Seasonal Information Meetings	Ongoing	Combined with Split Application of Herbicide BMP	
		Crop Schools to cover weed control and atrazine use - multi-county	Winter/ Spring	Combined with Split Application of Herbicide BMP	
Vegetative Buffer Zones	Landowners and Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	K-State Extension Watershed Specialists, BMP coordinators, K-State Extension County

		Seasonal Information Meetings	Ongoing	Combined with Split Application of Herbicide BMP	Offices, Conservation Districts
		Crop Schools to cover weed control and atrazine use - multi-county	Annual - Winter/ Spring	Combined with Split Application of Herbicide BMP	
Use Post-emergence Herbicide	Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	
		Seasonal Information Meetings	Ongoing	Combined with Split Application of Herbicide BMP	
		Crop Schools to cover weed control and atrazine use - multi-county	Winter/ Spring	Combined with Split Application of Herbicide BMP	
Use Alternative Herbicides	Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	
		Seasonal Information Meetings	Ongoing	Combined with Split Application of Herbicide BMP	
		Crop Schools to cover weed control and atrazine use - multi-county	Winter/ Spring	Combined with Split Application of Herbicide BMP	
Terraces and Grass Waterways	Landowners and Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	
		Seasonal Information Meetings	Ongoing	$1,000 per year for all cropland pollutants in plan	
Reduce Application Rate	Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	K-State Extension Watershed Specialists, BMP coordinators, K-State Extension County

		Seasonal Information Meetings	Ongoing	Combined with Split Application of Herbicide BMP	Offices, Conservation Districts
		Crop Schools to cover weed control and atrazine use - multi-county	Winter/ Spring	Combined with Split Application of Herbicide BMP	
Conservation Crop Rotation	Farmers and Rental Operators	Seasonal Information Meetings	Ongoing	Combined with informational meeting mentioned above for terraces	
Cropland BMP Implementation for Sediment					
No-till	Farmers and Rental Operators	Field Day and/or Tour	Biennial	$2,500 per year	K-State Extension Watershed Specialists, K-State Extension County Offices, Conservation Districts, NRCS
		No-till Meetings	Winter	$500 per year	
		Harvey County Discussion Group	Monthly during the Winter	$500 for the Winter	Conservation Districts and Kansas State Research and Extension
Conservation Crop Rotation	Farmers and Rental Operators	Seasonal Information Meeting	Ongoing	Combined with informational meeting mentioned above for terraces	K-State Extension Watershed Specialists, K-State Extension County Offices, Conservation Districts, NRCS
Vegetative Buffers along Streams	Landowners and Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	K-State Extension Water Specialists, BMP coordinators, K-State Extension County Offices,

		Seasonal Information Meetings	Ongoing	Combined with informational meeting mentioned above for buffers	Conservation Districts
Terraces and Waterways	Landowners and Farmers	One-on-One Technical Assistance	Ongoing	Cost included with Technical Assistance for Watershed Specialist	K-State Extension Watershed Specialists, BMP coordinators, K-State Extension County Offices, Conservation Districts
		Seasonal Information Meetings	Ongoing	Combined with informational meeting mentioned above for terraces	
Water Retention Structure	Landowners and Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	K-State Extension Watershed Specialists, BMP coordinators, K-State Extension County Offices, Conservation Districts
		Seasonal Information Meetings	Ongoing	Combined with informational meeting mentioned above for terraces	
Cropland BMP Implementation for Nutrients					
No-till	Farmers and Rental Operators	Field Day and/or Tour	Biennial	Combined with that listed under Sediment	K-State Extension Watershed Specialists, K-State Extension County Offices, State Conservation Districts, NRCS
		No-till Meetings	Winter		
		Harvey County Discussion Group	Monthly during the Winter	Combined with that listed under Sediment	Conservation Districts and Kansas State Research and Extension

Conservation Crop Rotation	Farmers and Rental Operators	Seasonal Information Meeting	Ongoing	Combined with informational meeting mentioned above for terraces	K-State Extension Watershed Specialists, K-State Extension County Offices, Conservation Districts, NRCS
Vegetative Buffers along Streams	Landowners and Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	K-State Extension Watershed Specialists, BMP Coordinators, K-State Extension County Offices, Conservation Districts
		Seasonal Information Meetings	Ongoing	Combined with informational meeting mentioned above for buffers	
Terraces and Waterways	Landowners and Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	
		Seasonal Information Meetings	Ongoing	Combined with informational meeting mentioned above for terraces	
Incorporate Manure with Tillage	Farmers and Rental Operators	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	K-State Extension Watershed Specialists, BMP Coordinators, K-State Extension County Offices, Conservation Districts
		Informational Meeting	Fall/Winter	$500 per event to cover all Livestock BMPs	
Water Retention Structure	Landowners and Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	K-State Extension Watershed Specialists, BMP coordinators, K-State Extension County

		Seasonal Information Meetings	Ongoing	Combined with informational meeting mentioned above for terraces	Offices, Conservation Districts
Nutrient Management Plans	Landowners and Farmers	Information Meetings	Ongoing	Cost included with Technical Assistance for Watershed Specialist	Kansas State Research and Extension
		One on One Meetings with Producers	Ongoing	Cost included with Technical Assistance for Watershed Specialist	
Livestock BMP Implementation for Nutrients and Bacteria					
Vegetative Buffer Strips along streams	Landowners and Ranchers	Field Day and/or Tour	Ongoing	$500 per year	K-State Extension Watershed Specialists, BMP coordinators, K-State Extension County Offices, Conservation Districts
		One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	
		Seasonal Information Meetings	Ongoing	Combined with informational meeting mentioned above for buffers	
Relocate Small Feedlots away from Streams	Landowners and Ranchers	Field Day and/or Tour	Ongoing	Combined with that of Vegetative Filter Strips listed above	
		Informational Meeting	Fall/Winter	Combined with Meeting on Manure Incorporation for Nutrients	
Relocate Pasture Feeding Sites away from Streams	Landowners and Ranchers	Field Day and/or Tour	Ongoing	Combined with that of Vegetative Filter Strips listed above	

		Informational Meeting	Fall/Winter	Combined with Meeting on Manure Incorporation for Nutrients	
Promote Alternative Watering Sites away from Streams	Landowners and Ranchers	Field Day and/or Tour	Ongoing	Combined with that of Vegetative Filter Strips listed above	
		Informational Meeting	Fall/Winter	Combined with Meeting on Manure Incorporation for Nutrients	
Manure Application-Incorporate with Tillage	Landowners and Farmer	Field Day and/or Tour	Ongoing	Combined with that of Vegetative Filter Strips listed above	K-State Extension Watershed Specialists, BMP coordinators, K-State Extension County Offices, Conservation Districts
		Informational Meeting	Fall/Winter	Combined with Meeting on Manure Incorporation for Nutrients	
Nutrient Management Plans	Landowners and Farmers	Information Meetings	Ongoing	Cost included with Technical Assistance for Watershed Specialist	Kansas State Research and Extension
		One on One Meetings with Producers	Ongoing	Cost included with Technical Assistance for Watershed Specialist	
General / Watershed Wide Information and Education					

Educational Activities Targeting Youth	3rd-4th Grade Students	Ag in the Classroom ~ 400 kids per year	Annual - Winter/ Spring	$5,000 per year	Conservation Districts, County Extension Offices, K-State Research and Extension
	Educators, K-12 Students	Day on the Farm	Annual – Spring	$500 per event	Conservation Districts, County Extension Offices, K-State Research and Extension
		Environmental education	Ongoing	$500 per year	Kansas FFA Organization, Conservation Districts
	10-12 Grade Students	Range Youth Camp - 4 kids per year	Annual - Summer	$880 ($220 per student)	Farm Bureau, Conservation District
	5th-7th Grade Students and Educators	Water Festival (Harvey County)	Annual - Spring	$1,250 per event	Conservation Districts and Kansas State Research and Extension
	5th Grade Students and Educators	EARTH Day	Annual - Spring	$1,200	Farm Buearu, Consevation District, K-State Research and Extension, Master Gardners, NRCS, Harvey County Parks and Recreation, and 4-H
	4th Grade Students and Educators	Water Festival (McPherson County)	Annual - Fall	$15,200 per event	Conservation Districts, Kansas State Research and Extension and Cargill

Educational Activities Targeting Adults	Watershed Residents	Budget Hearings with County Commissioners	Annual - Spring	No charge	Conservation Districts
		Bankers Awards (No-Till, Soil and Water Conservation, Water Quality, Pasture Management and Wildlife Habitat) - Publicity and Tour	Annual - Winter	No charge	Kansas State Research and Extension and Conservation Districts
		Conservation District Annual Meetings (Harvey and McPherson)	Annual - Winter	$2,000 per event	Conservation Districts
Total annual cost for Information and Education if all events are implemented				**$31,980**	

** One-on-One Technical Assistance includes on-farm assessments and consultations to encourage BMP implementation, proper operation and maintenance techniques for BMP longevity.*

10. Costs of Implementing BMPs and Possible Funding Sources

The SLT has reviewed all the recommended BMPs listed in Section 7 of this report for each individual impairment. It has been determined by the SLT that specific BMPs will be the target of implementation funding for both cropland and livestock. Most of the BMPs that are targeted will be advantageous to more than one impairment, thus being more efficient.

1) Cropland Costs

Summarized Derivation of Cropland BMP Cost Estimates

Atrazine BMPs: Estimated costs were determined by Josh Roe of Kansas State University. Roe figured costs estimates by taking into account the payment that the producer/landowner would be eligible to receive through the Little Arkansas WRAPS atrazine program, therefore dollar amounts listed are not the full dollar amount of the practice.

Split Applications of Herbicide: Using split applications of herbicide, e.g., 1⁄2 to 2/3 prior to May 1 and 1⁄2 to 2.3 at planting would cost about $1.50 per acre. *$6.02 per acre without Atrazine Program Assistance (Water Quality Best Management Practices, Effectiveness and Cost for Reducing Contaminant Losses from Cropland, MF-2572)*

Incorporate Herbicide into Top 2" of Soil: $4.20 per acre. *$7.15 per acre without Atrazine Program Assistance (Water Quality Best Management Practices, Effectiveness and Cost for Reducing Contaminant Losses from Cropland, MF-2572)*

Use Post-emergence Herbicide: $3.00 per acre for conventional and no-till fields. *$6.02 per acre without Atrazine Program Assistance (Water Quality Best Management Practices, Effectiveness and Cost for Reducing Contaminant Losses from Cropland, MF-2572)*

Use Alternative Herbicides: $6.00 per acre for conventional and no-till fields. *$10.12 per acre without Atrazine Program Assistance (Water Quality Best Management Practices, Effectiveness and Cost for Reducing Contaminant Losses from Cropland, MF-2572)*

Reduce Application Rate: Use reduced soil-applied herbicide application rates followed by a post-emergence application would cost roughly $1.80 per acre. *$6.02 per acre without Atrazine Program Assistance (Water Quality Best Management Practices, Effectiveness and Cost for Reducing Contaminant Losses from Cropland, MF-2572)*

Summarized Derivation of Cropland BMP Cost Estimates – Continued

Other Cropland BMPs not associated with Atrazine specifically:

No-Till: After being presented with information from K-State Research and Extension (Craig Smith and Josh Roe) on the costs and benefits of no-till, the SLT decided that a fair price to entice a producer to adopt no-till would be to pay them $10 per acre for 10 years, or a net present value of $78.00 per acre upfront assuming the NRCS discount rate of 4.75%.

Conservation Tillage: $3.91 per acre based contour farming numbers. *$6.80 per acre without Atrazine Program Assistance* (Water Quality Best Management Practices, Effectiveness and Cost for Reducing Contaminant Losses from Cropland, MF-2572)*

Vegetative Buffer: 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 developed by Craig Smith. It has been determined that for every acre of a vegetative buffer installed, 15 acres have been treated, this cuts the cost down to $93.00 per acre affected.

Conservation Crop Rotations: $39.00 per acre. Estimate provided by Josh Roe in July 2011.

Terraces: In consulting with numerous conservation districts it was determined by Josh Roe that the average cost of building a terrace at this point in time is $102 per acre.

Grassed Waterway: $2,200 per acre installed was arrived at using average cost of installation figures from the conservation districts within the watershed and updated costs of brome grass seeding from Josh Roe.

Nutrient Management Plan: After being presented with information from K-State Research and Extension (Craig Smith and Josh Roe) on the costs and benefits of nutrient management plans, the SLT decided that a fair price to entice a producer to adopt nutrient management plans would be to pay them $7.30 per acre for 10 years, or a net present value of $57 per acre upfront assuming the NRCS discount rate of 4.75%.

Incorporate Manure with Tillage: It has been determined that it costs about $6.33 per acre to incorporate manure with tillage. This estimate was provided by Josh Roe of Kansas State University in July 2011.

Water Retention Structure: Approximately $5,000 per structure, treats 40 acres, $125 per treated acre. This estimate was provided by Josh Roe of Kansas State University in September 2011.

Prices below reflect current prices (2018) for implementation and also include technical assistance costs.

Atrazine: Josh Roe, K-State, calculated costs estimates by taking into account the payment that the producer/landowner would be eligible to receive through the Little Arkansas WRAPS atrazine program, therefore dollar amounts listed are not the full dollar amount of the practice. The cost for implementing and/or repairing buffers, waterways, and terraces was assumed to be $0 since alternative cost-share is available for these practices and is not reimbursed under the *I.A.M.S. Atrazine Management* program.

Table 78 Estimated Costs for Cropland Implemented BMPs for Atrazine

Total Annual Atrazine BMP Cost								
Year	Use Alternative Herbicide	Vegetative Buffers	Split Application	Incorporate Atrazine	Use Post Emergence	Terraces and Waterways	Reduce Application	Total Cost
1	$22,252	$0	$371	$1,038	$1,854	$0	$6,675	$32,191
2	$22,920	$0	$382	$1,069	$1,910	$0	$6,875	$33,156
3	$23,607	$0	$394	$1,101	$1,967	$0	$7,082	$34,150
4	$24,315	$0	$405	$1,134	$2,026	$0	$7,294	$35,175
5	$25,045	$0	$418	$1,168	$2,087	$0	$7,513	$36,230
6	$25,796	$0	$430	$1,203	$2,149	$0	$7,738	$37,317
7	$26,570	$0	$443	$1,239	$2,214	$0	$7,970	$38,437
8	$27,367	$0	$456	$1,277	$2,280	$0	$8,209	$39,590
9	$28,188	$0	$470	$1,315	$2,349	$0	$8,456	$40,777
10	$29,034	$0	$484	$1,354	$2,419	$0	$8,709	$42,001
11	$29,905	$0	$499	$1,395	$2,492	$0	$8,971	$43,261
12	$30,802	$0	$514	$1,437	$2,566	$0	$9,240	$44,558
13	$31,726	$0	$529	$1,480	$2,643	$0	$9,517	$45,895
14	$32,678	$0	$545	$1,524	$2,723	$0	$9,802	$47,272
15	$33,658	$0	$561	$1,570	$2,804	$0	$10,097	$48,690
16	$34,668	$0	$578	$1,617	$2,888	$0	$10,399	$50,151
17	$35,708	$0	$595	$1,666	$2,975	$0	$10,711	$51,656
18	$36,779	$0	$613	$1,716	$3,064	$0	$11,033	$53,205
19	$37,883	$0	$632	$1,767	$3,156	$0	$11,364	$54,801
20	$39,019	$0	$651	$1,820	$3,251	$0	$11,705	$56,445

Assumes 3% Inflation

Table 79 Estimated Annual Costs Before Cost Share for Cropland Implemented BMPs for Sediment and Nutrients.

Total Annual Cost* Before Cost-Share, Cropland BMPs										
Year	No-Till	Cons. Tillage	Waterways	Buffers	Nutrient Mgmt Plans	Terraces	Incorporate Manure	Cons. Crop Rotations	Water Retention	Total Cost

1	$42,549	$42,549	$131,442	$50,934	$15,529	$83,794	$1,733	$10,680	$8,215	$387,424
2	$43,825	$43,825	$135,385	$52,462	$15,995	$86,308	$1,785	$11,000	$8,462	$399,047
3	$45,140	$45,140	$139,446	$54,035	$16,475	$88,897	$1,839	$11,330	$8,715	$411,018
4	$46,494	$46,494	$143,630	$55,657	$16,969	$91,564	$1,894	$11,670	$8,977	$423,349
5	$47,889	$47,889	$147,939	$57,326	$17,478	$94,311	$1,951	$12,020	$9,246	$436,049
6	$49,326	$49,326	$152,377	$59,046	$18,003	$97,140	$2,009	$12,381	$9,524	$449,131
7	$50,805	$50,805	$156,948	$60,817	$18,543	$100,054	$2,070	$12,752	$9,809	$462,605
8	$52,330	$52,330	$161,657	$62,642	$19,099	$103,056	$2,132	$13,135	$10,104	$476,483
9	$53,899	$53,899	$166,506	$64,521	$19,672	$106,148	$2,196	$13,529	$10,407	$490,777
10	$55,516	$55,516	$171,501	$66,457	$20,262	$109,332	$2,262	$13,934	$10,719	$505,500
11	$57,182	$57,182	$176,646	$68,451	$20,870	$112,612	$2,330	$14,353	$11,040	$520,666
12	$58,897	$58,897	$181,946	$70,504	$21,496	$115,990	$2,399	$14,783	$11,372	$536,285
13	$60,664	$60,664	$187,404	$72,619	$22,141	$119,470	$2,471	$15,227	$11,713	$552,374
14	$62,484	$62,484	$193,026	$74,798	$22,805	$123,054	$2,546	$15,683	$12,064	$568,945
15	$64,359	$64,359	$198,817	$77,042	$23,489	$126,746	$2,622	$16,154	$12,426	$586,014
16	$66,290	$66,290	$204,782	$79,353	$24,194	$130,548	$2,701	$16,639	$12,799	$603,594
17	$68,278	$68,278	$210,925	$81,733	$24,920	$134,465	$2,782	$17,138	$13,183	$621,702
18	$70,327	$70,327	$217,253	$84,185	$25,668	$138,499	$2,865	$17,652	$13,578	$640,353
19	$72,436	$72,436	$223,770	$86,711	$26,438	$142,654	$2,951	$18,181	$13,986	$659,563
20	$74,609	$74,609	$230,484	$89,312	$27,231	$146,933	$3,040	$18,727	$14,405	$679,350
21	$76,848	$76,848	$237,398	$91,992	$28,048	$151,341	$3,131	$19,289	$14,837	$699,731
22	$79,153	$79,153	$244,520	$94,752	$28,889	$155,882	$3,225	$19,867	$15,283	$720,723
23	$81,528	$81,528	$251,856	$97,594	$29,756	$160,558	$3,321	$20,463	$15,741	$742,345
24	$83,974	$83,974	$259,411	$100,522	$30,648	$165,375	$3,421	$21,077	$16,213	$764,615
25	$86,493	$86,493	$267,194	$103,538	$31,568	$170,336	$3,524	$21,709	$16,700	$787,553
26	$89,088	$89,088	$275,209	$106,644	$32,515	$175,446	$3,629	$22,361	$17,201	$811,180
27	$91,760	$91,760	$283,466	$109,843	$33,490	$180,709	$3,738	$23,032	$17,717	$835,515
28	$94,513	$94,513	$291,970	$113,138	$34,495	$186,131	$3,850	$23,723	$18,248	$860,581
29	$97,348	$97,348	$300,729	$116,532	$35,530	$191,715	$3,966	$24,434	$18,796	$886,398
30	$100,269	$100,269	$309,751	$120,028	$36,596	$197,466	$4,085	$25,167	$19,359	$912,990
31	$103,277	$103,277	$319,043	$123,629	$37,694	$203,390	$4,207	$25,922	$19,940	$940,380
32	$106,375	$106,375	$328,614	$127,338	$38,824	$209,492	$4,334	$26,700	$20,538	$968,591
33	$109,567	$109,567	$338,473	$131,158	$39,989	$215,776	$4,464	$27,501	$21,155	$997,649
34	$112,854	$112,854	$348,627	$135,093	$41,189	$222,250	$4,598	$28,326	$21,789	$1,027,578
35	$116,239	$116,239	$359,086	$139,146	$42,425	$228,917	$4,735	$29,176	$22,443	$1,058,406
36	$119,726	$119,726	$369,859	$143,320	$43,697	$235,785	$4,878	$30,051	$23,116	$1,090,158
37	$123,318	$123,318	$380,954	$147,620	$45,008	$242,858	$5,024	$30,953	$23,810	$1,122,863
38	$127,018	$127,018	$392,383	$152,048	$46,358	$250,144	$5,175	$31,881	$24,524	$1,156,549
39	$130,828	$130,828	$404,154	$156,610	$47,749	$257,648	$5,330	$32,838	$25,260	$1,191,245
40	$134,753	$134,753	$416,279	$161,308	$49,182	$265,378	$5,490	$33,823	$26,017	$1,226,982
***3% Inflation**										

Table 80 Estimated Annual Costs After Cost Share for Cropland Implemented BMPs for Sediment and Nutrients.

Total Annual Cost* After Cost-Share, Cropland BMPs										
Year	No-Till	Cons. Tillage	Waterways	Buffers	Nutrient Mgmt Plans	Terraces	Incorporate Manure	Cons. Crop Rotations	Water Retention	Total Cost
1	$25,529	$25,529	$65,721	$5,093	$7,765	$41,897	$1,733	$10,680	$4,108	$188,055
2	$26,295	$26,295	$67,692	$5,246	$7,998	$43,154	$1,785	$11,000	$4,231	$193,696
3	$27,084	$27,084	$69,723	$5,404	$8,238	$44,449	$1,839	$11,330	$4,358	$199,507
4	$27,896	$27,896	$71,815	$5,566	$8,485	$45,782	$1,894	$11,670	$4,488	$205,493
5	$28,733	$28,733	$73,969	$5,733	$8,739	$47,155	$1,951	$12,020	$4,623	$211,657
6	$29,595	$29,595	$76,188	$5,905	$9,001	$48,570	$2,009	$12,381	$4,762	$218,007
7	$30,483	$30,483	$78,474	$6,082	$9,271	$50,027	$2,070	$12,752	$4,905	$224,547
8	$31,398	$31,398	$80,828	$6,264	$9,550	$51,528	$2,132	$13,135	$5,052	$231,284
9	$32,340	$32,340	$83,253	$6,452	$9,836	$53,074	$2,196	$13,529	$5,203	$238,222
10	$33,310	$33,310	$85,751	$6,646	$10,131	$54,666	$2,262	$13,934	$5,359	$245,369
11	$34,309	$34,309	$88,323	$6,845	$10,435	$56,306	$2,330	$14,353	$5,520	$252,730
12	$35,338	$35,338	$90,973	$7,050	$10,748	$57,995	$2,399	$14,783	$5,686	$260,312
13	$36,399	$36,399	$93,702	$7,262	$11,071	$59,735	$2,471	$15,227	$5,856	$268,121
14	$37,491	$37,491	$96,513	$7,480	$11,403	$61,527	$2,546	$15,683	$6,032	$276,165
15	$38,615	$38,615	$99,409	$7,704	$11,745	$63,373	$2,622	$16,154	$6,213	$284,450
16	$39,774	$39,774	$102,391	$7,935	$12,097	$65,274	$2,701	$16,639	$6,399	$292,983
17	$40,967	$40,967	$105,463	$8,173	$12,460	$67,232	$2,782	$17,138	$6,591	$301,773
18	$42,196	$42,196	$108,626	$8,419	$12,834	$69,249	$2,865	$17,652	$6,789	$310,826
19	$43,462	$43,462	$111,885	$8,671	$13,219	$71,327	$2,951	$18,181	$6,993	$320,151
20	$44,766	$44,766	$115,242	$8,931	$13,615	$73,467	$3,040	$18,727	$7,203	$329,755
21	$46,109	$46,109	$118,699	$9,199	$14,024	$75,671	$3,131	$19,289	$7,419	$339,648
22	$47,492	$47,492	$122,260	$9,475	$14,445	$77,941	$3,225	$19,867	$7,641	$349,837
23	$48,917	$48,917	$125,928	$9,759	$14,878	$80,279	$3,321	$20,463	$7,870	$360,332
24	$50,384	$50,384	$129,706	$10,052	$15,324	$82,687	$3,421	$21,077	$8,107	$371,142
25	$51,896	$51,896	$133,597	$10,354	$15,784	$85,168	$3,524	$21,709	$8,350	$382,277
26	$53,453	$53,453	$137,605	$10,664	$16,257	$87,723	$3,629	$22,361	$8,600	$393,745
27	$55,056	$55,056	$141,733	$10,984	$16,745	$90,355	$3,738	$23,032	$8,858	$405,557
28	$56,708	$56,708	$145,985	$11,314	$17,248	$93,065	$3,850	$23,723	$9,124	$417,724
29	$58,409	$58,409	$150,364	$11,653	$17,765	$95,857	$3,966	$24,434	$9,398	$430,256
30	$60,161	$60,161	$154,875	$12,003	$18,298	$98,733	$4,085	$25,167	$9,680	$443,164
31	$61,966	$61,966	$159,522	$12,363	$18,847	$101,695	$4,207	$25,922	$9,970	$456,458
32	$63,825	$63,825	$164,307	$12,734	$19,412	$104,746	$4,334	$26,700	$10,269	$470,152
33	$65,740	$65,740	$169,236	$13,116	$19,995	$107,888	$4,464	$27,501	$10,577	$484,257

34	$67,712	$67,712	$174,314	$13,509	$20,594	$111,125	$4,598	$28,326	$10,895	$498,784
35	$69,743	$69,743	$179,543	$13,915	$21,212	$114,459	$4,735	$29,176	$11,221	$513,748
36	$71,836	$71,836	$184,929	$14,332	$21,849	$117,892	$4,878	$30,051	$11,558	$529,160
37	$73,991	$73,991	$190,477	$14,762	$22,504	$121,429	$5,024	$30,953	$11,905	$545,035
38	$76,211	$76,211	$196,191	$15,205	$23,179	$125,072	$5,175	$31,881	$12,262	$561,386
39	$78,497	$78,497	$202,077	$15,661	$23,875	$128,824	$5,330	$32,838	$12,630	$578,228
40	$80,852	$80,852	$208,140	$16,131	$24,591	$132,689	$5,490	$33,823	$13,009	$595,575
3% Inflation										

2) Livestock Costs

Summarized Derivation of Livestock BMP Cost Estimates

Vegetative Filter Strip: The cost of $714 an acre was calculated by Josh Roe and Mike Christian figuring 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 estimated by Josh Roe.

Relocate Small Feedlots: The cost of moving a one acre feedlot of $6,621 was calculated by Josh Roe figuring the cost of fencing, a new watering system, concrete, and labor.

Relocated Pasture Feeding Site: The cost of moving a pasture feeding site of $2,203 was calculated by Josh Roe figuring the cost of building ¼ mile of fence, a permeable surface, and labor.

Alternative Watering Sites: The average cost of installing an alternative watering system of $3,795 was estimated by Herschel George, Marais des Cygnes Watershed Specialist who has installed numerous systems and has detailed average cost estimates.

Table 81 Annual Estimated Costs for Implementing Livestock BMPs Before Cost Share.

Annual Cost* Before Cost-Share of Implementing Livestock BMPs					
Year	**Vegetative Filter Strip**	**Relocate Feeding Pens**	**Relocate Pasture Feeding Site**	**Off Stream Watering System**	**Annual Cost**
1	$714	$6,621	$2,203	$0	$9,538
2	$735	$6,820	$0	$3,909	$11,464
3	$757	$7,024	$2,337	$0	$10,119
4	$780	$7,235	$0	$4,147	$12,162

5	$804	$7,452	$2,479	$0	$10,735
6	$828	$7,676	$0	$4,399	$12,903
7	$853	$7,906	$2,630	$0	$11,389
8	$878	$8,143	$0	$4,667	$13,688
9	$904	$8,387	$2,791	$0	$12,082
10	$932	$8,639	$0	$4,952	$14,522
11	$960	$8,898	$2,961	$0	$12,818
12	$988	$9,165	$0	$5,253	$15,407
13	$1,018	$9,440	$3,141	$0	$13,599
14	$1,049	$9,723	$0	$5,573	$16,345
15	$1,080	$10,015	$3,332	$0	$14,427
16	$1,112	$10,315	$0	$5,912	$17,340
17	$1,146	$10,625	$3,535	$0	$15,306
18	$1,180	$10,944	$0	$6,273	$18,396
19	$1,216	$11,272	$3,750	$0	$16,238
20	$1,252	$11,610	$0	$6,655	$19,517
21	$1,290	$11,958	$3,979	$0	$17,227
22	$1,328	$12,317	$0	$7,060	$20,705
23	$1,368	$12,687	$4,221	$0	$18,276
24	$1,409	$13,067	$0	$7,490	$21,966
25	$1,451	$13,459	$4,478	$0	$19,389
26	$1,495	$13,863	$0	$7,946	$23,304
27	$1,540	$14,279	$4,751	$0	$20,570
28	$1,586	$14,707	$0	$8,430	$24,723
29	$1,634	$15,148	$5,040	$0	$21,822
30	$1,683	$15,603	$0	$8,943	$26,229
31	$1,733	$16,071	$5,347	$0	$23,151
32	$1,785	$16,553	$0	$9,488	$27,826
33	$1,839	$17,050	$5,673	$0	$24,561
34	$1,894	$17,561	$0	$10,066	$29,520
35	$1,951	$18,088	$6,018	$0	$26,057
36	$2,009	$18,631	$0	$10,679	$31,318
37	$2,069	$19,190	$6,385	$0	$27,644
38	$2,131	$19,765	$0	$11,329	$33,226
39	$2,195	$20,358	$6,774	$0	$29,327
40	$2,261	$20,969	$0	$12,019	$35,249
**3% Annual Cost Inflation*					

Table 82 Annual Estimated Costs for Implementing Livestock BMPs After Cost Share.

Annual Cost* After Cost-Share of Implementing Livestock BMPs

Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Annual Cost
1	$357	$3,311	$1,102	$0	**$4,769**
2	$368	$3,410	$0	$1,954	**$5,732**
3	$379	$3,512	$1,169	$0	**$5,059**
4	$390	$3,617	$0	$2,073	**$6,081**
5	$402	$3,726	$1,240	$0	**$5,368**
6	$414	$3,838	$0	$2,200	**$6,451**
7	$426	$3,953	$1,315	$0	**$5,694**
8	$439	$4,071	$0	$2,334	**$6,844**
9	$452	$4,194	$1,395	$0	**$6,041**
10	$466	$4,319	$0	$2,476	**$7,261**
11	$480	$4,449	$1,480	$0	**$6,409**
12	$494	$4,583	$0	$2,627	**$7,703**
13	$509	$4,720	$1,570	$0	**$6,799**
14	$524	$4,862	$0	$2,787	**$8,172**
15	$540	$5,007	$1,666	$0	**$7,214**
16	$556	$5,158	$0	$2,956	**$8,670**
17	$573	$5,312	$1,768	$0	**$7,653**
18	$590	$5,472	$0	$3,136	**$9,198**
19	$608	$5,636	$1,875	$0	**$8,119**
20	$626	$5,805	$0	$3,327	**$9,758**
21	$645	$5,979	$1,989	$0	**$8,613**
22	$664	$6,159	$0	$3,530	**$10,353**
23	$684	$6,343	$2,111	$0	**$9,138**
24	$705	$6,534	$0	$3,745	**$10,983**
25	$726	$6,730	$2,239	$0	**$9,694**
26	$747	$6,931	$0	$3,973	**$11,652**
27	$770	$7,139	$2,375	$0	**$10,285**
28	$793	$7,354	$0	$4,215	**$12,361**
29	$817	$7,574	$2,520	$0	**$10,911**
30	$841	$7,801	$0	$4,472	**$13,114**
31	$867	$8,035	$2,674	$0	**$11,576**
32	$893	$8,277	$0	$4,744	**$13,913**
33	$919	$8,525	$2,836	$0	**$12,281**
34	$947	$8,781	$0	$5,033	**$14,760**
35	$975	$9,044	$3,009	$0	**$13,028**
36	$1,005	$9,315	$0	$5,339	**$15,659**
37	$1,035	$9,595	$3,192	$0	**$13,822**

38	$1,066	$9,883	$0	$5,664	**$16,613**
39	$1,098	$10,179	$3,387	$0	**$14,664**
40	$1,131	$10,484	$0	$6,009	**$17,625**
**3% Annual Cost Inflation*					

Table 83 40 Year Livestock BMP Costs Before Cost Share by Sub Watershed.

Livestock BMP Cost Before Cost-Share by Sub Watershed					
Sub watershed	**Vegetative Filter Strip**	**Relocate Feeding Site**	**Relocate Pasture Feeding Site**	**Off-Stream Watering System**	**Total Cost**
Sand Creek	$3,570	$33,105	$4,406	$7,590	$48,671
Emma Creek	$5,712	$52,968	$8,812	$15,180	$82,672
Blazefork	$4,284	$39,726	$6,609	$11,385	$62,004
Kisiwa	$5,712	$52,968	$8,812	$15,180	$82,672
Turkey Creek	$9,282	$86,073	$15,421	$26,565	$137,341
Total	$28,560	$264,840	$44,060	$75,900	$413,360

Table 84 40 Year Livestock BMP Costs After Cost Share by Sub Watershed.

Livestock BMP Cost After Cost-Share by Sub Watershed					
Sub watershed	**Vegetative Filter Strip**	**Relocate Feeding Site**	**Relocate Pasture Feeding Site**	**Off-Stream Watering System**	**Total Cost**
Sand Creek	$1,785	$16,553	$2,203	$3,795	$24,336
Emma Creek	$2,856	$26,484	$4,406	$7,590	$41,336
Blazefork	$2,142	$19,863	$3,305	$5,693	$31,002
Kisiwa	$2,856	$26,484	$4,406	$7,590	$41,336
Turkey Creek	$4,641	$43,037	$7,711	$13,283	$68,671
Total	$14,280	$132,420	$22,030	$37,950	$206,680

3) Streambank Costs

Approximately 6 sites for potential streambank restoration/stabilization projects have been identified along the Lower Little Arkansas River. The stabilization costs were estimated utilizing an average of $71.50 per linear foot, based on an assessment conducted by The Watershed Institute, Inc. (TWI).

Table 85 Riparian and Streambank Restoration Costs.

Streambank Site		**Estimated Costs****

	Length of Streambank Restoration Site (L.F.)	
SB 1	750	$53,625
SB 2	625	$44,687
SB 3	880	$62,920
SB 4	160	$11,440
SB 5	330	$23,595
SB 6	540	$38,610
Totals	**3,285**	**$234,877**

It should be noted that the estimated costs shown in the table above for the sites identified for streambank restoration projects may vary depending on the size of the project. The length of the projects may also vary, depending on the site investigation and feasible design of the potential project. Depending on the ground-truthed streambank conditions and adjacent land use, some of the sites identified for streambank restoration may require only vegetative establishment and/or buffers. Some projects may not require structural elements be incorporated into the project, thus varying the overall cost of the project.

4) Technical Assistance Costs

Table 86 Technical Assistance Needed to Implement BMPs.

BMP		Technical Assistance	Projected Annual Cost
Atrazine	Split applications of herbicide	WRAPS Coordinator, BMP Coordinator	Extension Agronomist $36,000 WRAPS Coordinator $73,630r
	Incorporate herbicide into top 2" of soil	WRAPS Coordinator, BMP Coordinator	
	Use post emergence herbicide	WRAPS Coordinator, BMP Coordinator	
	Use alternative herbicides	WRAPS Coordinator, BMP Coordinator	
	Reduce application rates	WRAPS Coordinator, BMP Coordinator	
Cropland	No-till	WRAPS Coordinator, BMP Coordinator	
	Conservation Tillage	WRAPS Coordinator, BMP Coordinator	

	Conservation Crop Rotation	WRAPS Coordinator, BMP Coordinator	
	Vegetative Buffers	WRAPS Coordinator, BMP Coordinator	
	Terraces	WRAPS Coordinator, BMP Coordinator	
	Waterways	WRAPS Coordinator, BMP Coordinator	
	Nutrient Management Plans	WRAPS Coordinator, BMP Coordinator	
Livestock	Incorporate manure with tillage	WRAPS Coordinator, BMP Coordinator	
	Vegetative Buffers	WRAPS Coordinator, r	
	Relocate small feedlots	WRAPS Coordinator	
	Relocate pasture feeding sites	WRAPS Coordinator	
	Promote alternative water sites	WRAPS Coordinator	
	Nutrient Management Plans	WRAPS Coordinator	
Total			**$109,630**

5) Information and Education Costs

Table 87 Information and Education Costs.

Year	I&E Costs
1	$31,980
2	$32,939
3	$33,928

4	$34,945
5	$35,994
6	$37,074
7	$38,186
8	$39,331
9	$40,511
10	$41,727
11	$42,978
12	$44,268
13	$45,596
14	$46,964
15	$48,373
16	$49,824
17	$51,319
18	$52,858
19	$54,444
20	$56,077
21	$57,759
22	$59,492
23	$61,277
24	$63,115
25	$65,009
26	$66,959
27	$68,968
28	$71,037
29	$73,168
30	$75,363
31	$77,624
32	$79,953
33	$82,351
34	$84,822
35	$87,366
36	$89,987
37	$92,687
38	$95,468
39	$98,332
40	$101,282

6) Total Costs

Table 88 Total Costs After Cost Share of Implementing Cropland, Atrazine and Livestock BMPs In Addition to Information and Education and Technical Assistance

Year	BMP Implementation			I&E and Technical Assistance		Total
	Cropland	Atrazine	Livestock	I&E	Technical	
1	$188,055	$32,191	$4,769	$31,980	$109,630	$366,625
2	$193,697	$33,157	$5,732	$32,939	$112,919	$378,444
3	$199,508	$34,151	$5,059	$33,928	$116,306	$388,952
4	$205,493	$35,176	$6,081	$34,945	$119,796	$401,491
5	$211,658	$36,231	$5,368	$35,994	$123,390	$412,640
6	$218,007	$37,318	$6,451	$37,074	$127,091	$425,941
7	$224,548	$38,438	$5,694	$38,186	$130,904	$437,769
8	$231,284	$39,591	$6,844	$39,331	$134,831	$451,881
9	$238,222	$40,779	$6,041	$40,511	$138,876	$464,429
10	$245,369	$42,002	$7,261	$41,727	$143,042	$479,401
11	$252,730	$43,262	$6,409	$42,978	$147,334	$492,713
12	$260,312	$44,560	$7,703	$44,268	$151,754	$508,596
13	$268,121	$45,897	$6,799	$45,596	$156,306	$522,719
14	$276,165	$47,274	$8,172	$46,964	$160,995	$539,570
15	$284,450	$48,692	$7,214	$48,373	$165,825	$554,554
16	$292,984	$50,153	$8,670	$49,824	$170,800	$572,430
17	$301,773	$51,657	$7,653	$51,319	$175,924	$588,326
18	$310,826	$53,207	$9,198	$52,858	$181,202	$607,291
19	$320,151	$54,803	$8,119	$54,444	$186,638	$624,155
20	$329,756	$56,447	$9,758	$56,077	$192,237	$644,275
21	$339,648		$8,613	$57,759	$198,004	$604,025
22	$349,838		$10,353	$59,492	$203,944	$623,627
23	$360,333		$9,138	$61,277	$210,062	$640,810
24	$371,143		$10,983	$63,115	$216,364	$661,605
25	$382,277		$9,694	$65,009	$222,855	$679,835
26	$393,745		$11,652	$66,959	$229,541	$701,897
27	$405,558		$10,285	$68,968	$236,427	$721,238
28	$417,725		$12,361	$71,037	$243,520	$744,642
29	$430,256		$10,911	$73,168	$250,826	$765,161
30	$443,164		$13,114	$75,363	$258,350	$789,991
31	$456,459		$11,576	$77,624	$266,101	$811,759
32	$470,153		$13,913	$79,953	$274,084	$838,102
33	$484,257		$12,281	$82,351	$282,306	$861,196
34	$498,785		$14,760	$84,822	$290,776	$889,142
35	$513,748		$13,028	$87,366	$299,499	$913,642
36	$529,161		$15,659	$89,987	$308,484	$943,291

37	$545,036		$13,822	$92,687	$317,738	$969,283
38	$561,387		$16,613	$95,468	$327,270	$1,000,738
39	$578,228		$14,664	$98,332	$337,089	$1,028,312
40	$595,575		$17,625	$101,282	$347,201	$1,061,683
	$14,179,584	**$864,984**	**$390,040**	**$2,411,332**	**$8,266,240**	**$26,112,181**

Potential funding sources for these BMPs are (but not limited to) the following organizations:

Table 89 Potential Funding Sources.

Potential Funding Sources	Potential Funding Programs
Natural Resources Conservation Service	Environmental Quality Incentives Program (EQIP)
	Wetland Reserve Program (WRP)
	Conservation Reserve Program (CRP)
	Wildlife Habitat Incentive Program (WHIP)
	Forestland Enhancement Program (FLEP)
	State Acres for Wildlife Enhancement (SAFE)
	Grassland Reserve Program (GRP)
	Farmable Wetlands Program (FWP)
EPA/KDHE	319 Funding Grants
	State Water Plan Funds
	KDHE WRAPS Funding
	Clean Water Neighbor Grants
Kansas Department of Wildlife and Parks	
Kansas Alliance for Wetlands and Streams	
State Conservation Commission	Nonpoint Source Pollution Cost Share Program
Conservation Districts	
Kansas Forest Service	
U.S. Fish and Wildlife	

City of Wichita	
Rural Water Center	

Table 90 Potential Service Providers for BMP Implementation.

BMP		Services Needed to Implement BMP		Service Provider *
		Technical Assistance	*Information and Education*	
Atrazine	Split applications of herbicide	Design, cost share and maintenance	Seasonal BMP information meetings, and crop schools	KSRE NRCS DOC CD
	Incorporate herbicide into top 2" of soil	Design, cost share and maintenance	Seasonal BMP information meetings, and crop schools	
	Use post emergence herbicide	Design, cost share and maintenance	Seasonal BMP information meetings, and crop schools	
	Use alternative herbicides	Design, cost share and maintenance	Seasonal BMP information meetings, and crop schools	
	Reduce application rates	Design, cost share and maintenance	Seasonal BMP information meetings, and crop schools	
Cropland	No-till	Design, cost share and maintenance	Field Day and/or Tours, No-toll meetings, discussion groups	KSRE NRCS DOC KRC CD KDWP
	Conservation Tillage	Design, cost share and maintenance	Residue Alliance	
	Conservation Crop Rotation	Design, cost share and maintenance	BMP Information Meetings	
	Vegetative Buffers	Design, cost share and maintenance	BMP Information Meetings	
	Terraces	Design, cost share and maintenance	BMP Information Meetings	
	Waterways	Design, cost share and maintenance	BMP Information Meetings	
	Nutrient Management Plans	Writing	One on One Meetings with Producers	
Livestock	Incorporate manure with tillage	Design, cost share and maintenance	BMP Information Meetings	KSRE NRCS DOC KRC CD KDWP
	Vegetative Buffers	Design, cost share and maintenance	BMP Information Meetings	
	Relocate small feedlots	Design, cost share and maintenance	BMP Information Meetings	

	Relocate pasture feeding sites	Design, cost share and maintenance	BMP Information Meetings	
	Promote alternative water sites	Design, cost share and maintenance	BMP Information Meetings	
	Nutrient Management Plans	Writing	One on One Meetings with Producers	
See Appendix for Service Provider Directory				

11. Timeframe

The plan will be reviewed every five years starting in 2021. The timeframe of this document for BMP implementation to meet the Category *4b* Atrazine impairments will be twenty years; sediment and phosphorus TMDLs will be met in forty years and bacteria is to be determined. They will examine BMP placement and implementation in 2021 and every subsequent five years after.

Table 91 Review Schedule for Pollutants and BMP Implementation.

Review Year	Atrazine	Sediment	Phosphorus	BMP Placement
2021	X	X	X	X
2026	X	X	X	X
2031	X	X	X	X
2036		X	X	X
2041		X	X	X
2046		X	X	X
2051		X	X	X

Targeting and BMP implementation might shift over time in order to achieve TMDLs.

- The timeframe for meeting the **atrazine** Category *4b* impairment is 20 years. After the atrazine Category *4b* designation provisions are met, the BMPs directed at atrazine will be considered "protection measures" instead of "restoration measures". At this point, the SLT may decide to redirect their funding to additional sediment, phosphorus and bacteria BMPs.
- The **sediment TMDL** will be met in year one if all BMPs are implemented in the watershed. After the sediment TMDL is met, the BMPs directed at sediment will be considered "protection measures" instead of "restoration measures". At this point, the SLT may decide to redirect their funding to impairments and areas in need at that time.
- The timeframe for meeting the **phosphorus TMDL** will be thirty-eight years if all BMPs are implemented in the watershed. After the sediment TMDL is met, the BMPs directed at sediment will be considered "protection measures" instead of "restoration measures". At this point, the SLT may decide to redirect their funding to impairments and areas in need at that time.
- The timeframe for meeting the **Bacteria TMD**L is to be determined by additional monitoring and guidance from KDHE on desired bacteria parameters.

12. Measurable Milestones

1) Adoption Rates

Milestones will be determined by number of acres treated, projects installed, contacts made to residents of the watershed or load reductions at the end of five, ten and twenty years for atrazine BMPs on cropland. The SLT will examine the number of acres treated or the load reduction to determine if adequate progress has been made from the current BMP implementations.

Table 92 Short, Medium and Long Term Goals for Atrazine BMPs.

Total Short, Medium, and Long Term Atrazine BMP Adoption									
	Year	Use Alt. Herbicide	Veg. Buffers	Split App.	Incorp. Atrazine	Use Post Emergence	Terraces and Waterways	Reduce App.	Total Load Reduction
fShort-Term	1	3,709	618	247	247	618	618	3,709	9,766
	2	3,709	618	247	247	618	618	3,709	9,766
	3	3,709	618	247	247	618	618	3,709	9,766
	4	3,709	618	247	247	618	618	3,709	9,766
	5	3,709	618	247	247	618	618	3,709	9,766
	Total	***18,543***	***3,090***	***1,236***	***1,236***	***3,090***	***3,090***	***18,543***	***48,830***
Medium-Term	6	3,709	618	247	247	618	618	3,709	9,766
	7	3,709	618	247	247	618	618	3,709	9,766
	8	3,709	618	247	247	618	618	3,709	9,766
	9	3,709	618	247	247	618	618	3,709	9,766
	10	3,709	618	247	247	618	618	3,709	9,766
	Total	***37,086***	***6,181***	***2,472***	***2,472***	***6,181***	***6,181***	***37,086***	***97,660***
Long-Term	11	3,709	618	247	247	618	618	3,709	9,766
	12	3,709	618	247	247	618	618	3,709	9,766
	13	3,709	618	247	247	618	618	3,709	9,766
	14	3,709	618	247	247	618	618	3,709	9,766
	15	3,709	618	247	247	618	618	3,709	9,766
	16	3,709	618	247	247	618	618	3,709	9,766
	17	3,709	618	247	247	618	618	3,709	9,766
	18	3,709	618	247	247	618	618	3,709	9,766
	19	3,709	618	247	247	618	618	3,709	9,766
	20	3,709	618	247	247	618	618	3,709	9,766
	Total	***74,172***	***12,362***	***4,945***	***4,945***	***12,362***	***12,362***	***74,172***	***195,319***

Table 93 Short, Medium and Long Term Goals for Cropland BMPs.

Cropland BMP Adoption Milestones										
	Year	No-Till	Cons. Tillage	Water-ways	Buffers	Nutrient Mgmt Plans	Terraces	Incorporate Manure	Cons. Crop Rotations	Water Retention
Short-Term	1	548	1,095	822	548	274	822	274	274	110
	2	548	1,095	822	548	274	822	274	274	110
	3	548	1,095	822	548	274	822	274	274	110
	4	548	1,095	822	548	274	822	274	274	110
	5	548	1,095	822	548	274	822	274	274	110
	Total	***2,738***	***5,477***	***4,108***	***2,738***	***1,369***	***4,108***	***1,369***	***1,369***	***548***
Medium-Term	6	298	596	447	298	149	447	149	149	60
	7	298	596	447	298	149	447	149	149	60
	8	298	596	447	298	149	447	149	149	60
	9	298	596	447	298	149	447	149	149	60
	10	298	596	447	298	149	447	149	149	60
	Total	***4,228***	***8,457***	***6,343***	***4,228***	***2,114***	***6,343***	***2,114***	***2,114***	***848***
Long-Term	11	298	596	447	298	149	447	149	149	60
	12	298	596	447	298	149	447	149	149	60
	13	298	596	447	298	149	447	149	149	60
	14	298	596	447	298	149	447	149	149	60
	15	298	596	447	298	149	447	149	149	60
	16	298	596	447	298	149	447	149	149	60
	17	298	596	447	298	149	447	149	149	60
	18	298	596	447	298	149	447	149	149	60
	19	298	596	447	298	149	447	149	149	60
	20	298	596	447	298	149	447	149	149	60
	21	298	596	447	298	149	447	149	149	60
	22	298	596	447	298	149	447	149	149	60
	23	298	596	447	298	149	447	149	149	60
	24	298	596	447	298	149	447	149	149	60
	25	298	596	447	298	149	447	149	149	60
	26	298	596	447	298	149	447	149	149	60
	27	298	596	447	298	149	447	149	149	60
	28	298	596	447	298	149	447	149	149	60
	29	298	596	447	298	149	447	149	149	60
	30	298	596	447	298	149	447	149	149	60
	31	298	596	447	298	149	447	149	149	60

	32	298	596	447	298	149	447	149	149	60
	33	298	596	447	298	149	447	149	149	60
	34	298	596	447	298	149	447	149	149	60
	35	298	596	447	298	149	447	149	149	60
	36	298	596	447	298	149	447	149	149	60
	37	298	596	447	298	149	447	149	149	60
	38	298	596	447	298	149	447	149	149	60
	39	298	596	447	298	149	447	149	149	60
	40	298	596	447	298	149	447	149	149	60
	Total	***13,168***	***26,337***	***19,753***	***13,168***	***6,584***	***19,753***	***6,584***	***6,584***	***2,648***

Table 94 Short, Medium and Long Term Goals for Livestock BMPs.

Livestock BMP Adoption Milestones					
	Year	**Vegetative Filter Strip**	**Relocate Feeding Pens**	**Relocate Pasture Feeding Site**	**Off Stream Watering System**
Short-Term	1	1	1	1	0
	2	1	1	0	1
	3	1	1	1	0
	4	1	1	0	1
	5	1	1	1	0
	Total	**5**	**5**	**3**	**2**
Medium-Term	6	1	1	0	1
	7	1	1	1	0
	8	1	1	0	1
	9	1	1	1	0
	10	1	1	0	1
	Total	**10**	**10**	**5**	**5**
Long-Term	11	1	1	1	0
	12	1	1	0	1
	13	1	1	1	0
	14	1	1	0	1
	15	1	1	1	0
	16	1	1	0	1
	17	1	1	1	0
	18	1	1	0	1
	19	1	1	1	0
	20	1	1	0	1
	21	1	1	1	0
	22	1	1	0	1

	23	1	1	1	0
	24	1	1	0	1
	25	1	1	1	0
	26	1	1	0	1
	27	1	1	1	0
	28	1	1	0	1
	29	1	1	1	0
	30	1	1	0	1
	31	1	1	1	0
	32	1	1	0	1
	33	1	1	1	0
	34	1	1	0	1
	35	1	1	1	0
	36	1	1	0	1
	37	1	1	1	0
	38	1	1	0	1
	39	1	1	1	0
	40	1	1	0	1
	Total	**40**	**40**	**20**	**20**

2) Monitoring in the Watershed

Water quality milestones contained in this section are tied to the sampling stations that KDHE continues to monitor for water quality in each of the water bodies that will be positively affected by the BMP implementation schedule included in this plan. KDHE has several monitoring stations located with the Little Arkansas River watershed. The stations listed below will be utilized to measure water quality improvements throughout the implementation of the plan.

Station ID	Water Body	Type of Station
SC533	Turkey Creek Near Alta Mills	Rotational
SC705	Black Kettle Creek Near Halstead	Rotational
SC703	Kisiwa Creek Near Halstead	Rotational
SC534	Emma Creek Near Sedgwick	Rotational
SC535	Sand Creek Near Sedgwick	Rotational
SC246	Little Ark River at Alta Mills	Permanent
SC282	Little Ark River at Valley Center	Permanent

The map shows both the permanent and rotational KDHE monitoring stations located within the Little Arkansas River Watershed. The permanent monitoring sites are continuously sampled, while the rotational sites are typically sampled every four years. The sites are sampled for nutrients, *E. Coli* bacteria, chemicals, turbidity, alkalinity, dissolved oxygen, pH, ammonia and metals. The pollutant indicators tested for at each site may vary depending on the season at collection time and other factors.

In addition to the KDHE monitoring stations, the Little Arkansas River Watershed has several USGS gaging stations located within the watershed that provide real-time flow information. With two of these stations located in the Little Arkansas River, one located at Hwy 50 near Halstead, and one located near Sedgwick (as shown on the map on the following page), the USGS is currently collecting continuous real-time water quality data for several parameters, including total phosphorus, pH, dissolved oxygen, TSS, and others. This information is available for viewing online at the USGS website.

The map below shows the locations of the monitoring sites located within the Little Arkansas watershed, as well as the targeted areas for implementation that have been identified and discussed in previous sections of this plan.

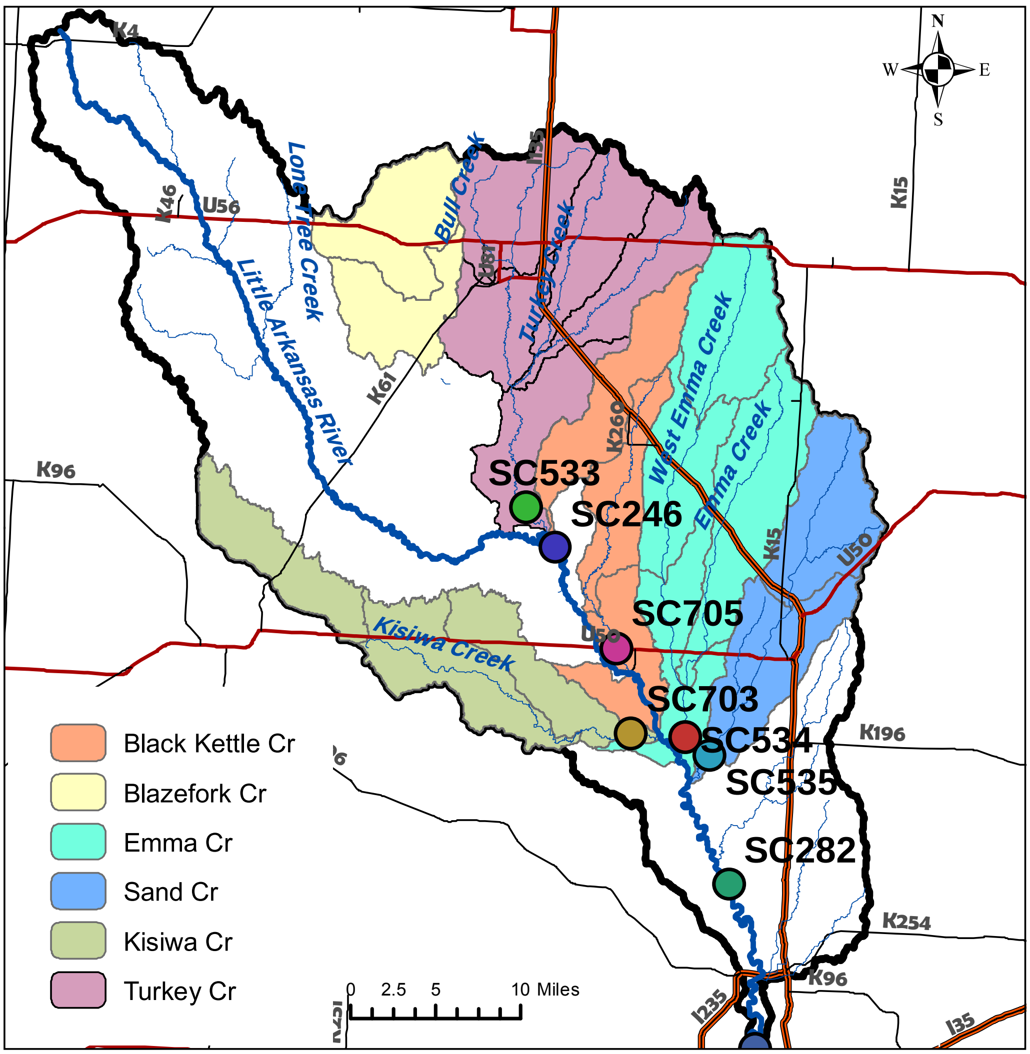


Figure 31 Monitoring Sites in the Watershed.

3) Water Quality Milestones for the Little Arkansas River Watershed

As previously stated, this plan estimates that it will take 40 years to implement the planned BMPs necessary to meet the load reduction goals for the impairments being addressed in the Little Arkansas River watershed. Several water quality milestones and indicators have been developed, as included herein. The sub watershed tables below include short term, mid-term, and long term water quality goals for various parameters monitored in the watershed.

12.3.1 Turkey Creek

Water quality trends (although rotational sampling has a limited amount of new data for assessment) for Turkey Creek at SC 533 are:

- TP = Declined
- TN = Declined
- TSS = Improved
- DO = Improved

Turkey Cr Nr Alta Mills	# of Samples	TP (ug/L)	TP (ug/L)	Midterm Goal Median TP (ug/L)	Longterm Goal Median TP (ug/L)	Total Reduction Needed - Percent
POR	N	Avg	Median			
1990-2009	30	850	680			
2010-2014	9	1000	720			
1990-2014	39	890	690	348	154	77.68

Turkey Cr Nr Alta Mills	# of Samples	TN (mg/L)	TN (mg/L)	Midterm Goal Median TN (mg/L)	Longterm Goal Median TN (mg/L)	Total Reduction Needed - Percent
POR	N	Avg	Median			
1990-2009	12	1.91	1.83			
2010-2014	9	2.06	2.06			
1990-2014	21	1.98	2	2	1	50.00

Turkey Cr Nr Alta Mills	mber of Samp	TSS (mg/L)	TSS (mg/L)	Midterm Goal Median TSS (mg/L)	Longterm Goal Median TSS (mg/L)	Total Reduction Needed - Percent
POR	N	Avg	Median			
1990-2009	30	99	80			
2010-2014	9	81	40			
1990-2014	39	95	64	50	36	43.75

Turkey Cr Nr Alta Mills	# of Samples	DO	DO	Midterm Goal - Percent of Samples < 5mg/L	Longterm Goal - Percent of Samples < 5 mg/L
POR	N	Samples < 5mg/L	Percent < 5 mg/L		
1990-2009	30	13	43%		
2010-2014	8	2	25%		
1990-2014	38	15	40%	15%	0%

12.3.2 Black Kettle Creek

Water quality trends (although rotational sampling has a limited amount of new data for assessment) for Turkey Creek at SC 705 are:

- TP = Declined
- TN = Improved
- TSS = Improved
- DO = Declined

Black Kettle Cr Nr Halstead	# of Samples	TP (ug/L)	TP (ug/L)	Midterm Goal Median TP (ug/L)	Longterm Goal Median TP (ug/L)	Total Reduction Needed - Percent
POR	N	Avg	Median			
1990-2009	12	720	740			
2010-2014	3	1280	1550			
1990-2014	15	830	780	350	200	74.36

Black Kettle Cr Nr Halstead	# of Samples	TN (mg/L)	TN (mg/L)	Midterm Goal Median TN (mg/L)	Longterm Goal Median TN (mg/L)	Total Reduction Needed - Percent
POR	N	Avg	Median			
1990-2009	3	5.49	4.2			
2010-2014	3	2.45	2.84			
1990-2014	6	3.97	2.9	2	1	65.52

Black Kettle Cr Nr Halstead	# of Samples	TSS (mg/L)	TSS (mg/L)	Midterm Goal Median TSS (mg/L)	Longterm Goal Median TSS (mg/L)	Total Reduction Needed - Percent
POR	N	Avg	Median			
1990-2009	12	254	134			
2010-2014	3	29	26			
1990-2014	15	209	78	50	36	53.85

Black Kettle Cr Nr Halstead	# of Samples	DO	DO	Midterm Goal - Percent of Samples < 5mg/L	Longterm Goal - Percent of Samples < 5 mg/L
POR	N	Samples < 5mg/L	Percent < 5 mg/L		
1990-2009	12	3	25%		
2010-2014	3	1	33%		
1990-2014	15	4	27%	15%	0%

12.3.3 *Kisiwa Creek*

Water quality trends (although rotational sampling has a limited amount of new data for assessment) for Turkey Creek at SC 703 are:

- TP = Declined
- TN = Declined
- TSS = Declined
- DO = Declined

Kisiwa Cr Nr Halstead	# of Samples	TP (ug/L)	TP (ug/L)	Midterm Goal Median TP (ug/L)	Longterm Goal Median TP (ug/L)	Total Reduction Needed - Percent
POR	N	Avg	Median			
1990-2009	6	750	690			
2010-2014	2	1865	1865			
1990-2014	8	1068	880	350	200	77.27

Kisiwa Cr Nr Halstead	# of Samples	TN (mg/L)	TN (mg/L)	Midterm Goal Median TN (mg/L)	Longterm Goal Median TN (mg/L)	Total Reduction Needed - Percent
POR	N	Avg	Median			
1990-2009	1	2.12	2.12			
2010-2014	1	3.79	3.79			
1990-2014	2	2.96	2.96	2	1	66.22

Kisiwa Cr Nr Halstead	# of Samples	TSS (mg/L)	TSS (mg/L)	Midterm Goal Median TSS (mg/L)	Longterm Goal Median TSS (mg/L)	Total Reduction Needed - Percent
POR	N	Avg	Median			
1990-2009	6	84	57			
2010-2014	2	79	79			
1990-2014	8	83	57	50	36	36.84

Kisiwa Cr Nr Halstead	# of Samples	DO	DO	Midterm Goal - Percent of Samples < 5mg/L	Longterm Goal - Percent of Samples < 5 mg/L
POR	N	Samples < 5mg/L	Percent < 5 mg/L		
1990-2009	6	1	17%		
2010-2014	2	2	100%		
1990-2014	8	3	38%	15%	0%

12.3.4 Emma Creek

Water quality trends (rotational sampling has a limited amount of new data for assessment) for Turkey Creek at SC 534 are:

- TP = Stable
- TN = Declined
- TSS = Improved
- DO = Stable

Emma Cr nr Sedgwick	# of Samples	TP (ug/L)	TP (ug/L)	Midterm Goal Median TP (ug/L)	Longterm Goal Median TP (ug/L)	Total Reduction Needed - Percent
POR	N	Avg	Median			
1990-2009	27	791	720			
2010-2014	8	727	717			
1990-2014	35	776	720	350	200	72.22

Emma Cr nr Sedgwick	# of Samples	TN (mg/L)	TN (mg/L)	Midterm Goal Median TN (mg/L)	Longterm Goal Median TN (mg/L)	Total Reduction Needed - Percent
POR	N	Avg	Median			
1990-2009	10	1.65	1.68			
2010-2014	8	2.75	2.27			
1990-2014	18	2.14	2	2	1	50.00

Emma Cr nr Sedgwick	# of Samples	TSS (mg/L)	TSS (mg/L)	Midterm Goal Median TSS (mg/L)	Longterm Goal Median TSS (mg/L)	Total Reduction Needed - Percent
POR	N	Avg	Median			
1990-2009	27	66	41			
2010-2014	8	26	12			
1990-2014	35	57	35	50	36	0.00

Emma Cr nr Sedgwick	# of Samples	DO	DO	Midterm Goal - Percent of Samples < 5mg/L	Longterm Goal - Percent of Samples < 5 mg/L
POR	N	Samples < 5mg/L	Percent < 5 mg/L		
1990-2009	27	2	7%		
2010-2014	8	1	13%		
1990-2014	35	3	9%	4%	0%

12.3.5 Sand Creek

Sand Creek is predominately influenced by the City of Newton and their wastewater discharge.Water quality trends (rotational sampling has a limited amount of new data for assessment) for Turkey Creek at SC 535 are:

- TP = Improved
- TN = Improved
- TSS = Improved
- DO = Improved

Sand Cr nr Sedgwick	# of Samples	TP (ug/L)	TP (ug/L)	Midterm Goal Median TP (ug/L)	Longterm Goal Median TP (ug/L)	Total Reduction Needed - Percent
POR	N	Avg	Median			
1990-2009	30	2140	2060			
2010-2014	10	1220	1040			
1990-2014	40	1910	1820	348	154	91.54

Sand Cr nr Sedgwick	# of Samples	TN (mg/L)	TN (mg/L)	Midterm Goal Median TN (mg/L)	Longterm Goal Median TN (mg/L)	Total Reduction Needed - Percent
POR	N	Avg	Median			
1990-2009	13	8.6	9.47			
2010-2014	10	5.66	4.86			
1990-2014	23	7.32	7.64	2	1	86.91

Sand Cr nr Sedgwick	# of Samples	TSS (mg/L)	TSS (mg/L)	Midterm Goal Median TSS (mg/L)	Longterm Goal Median TSS (mg/L)	Total Reduction Needed - Percent
POR	N	Avg	Median			
1990-2009	30	50	40			
2010-2014	10	35	32			
1990-2014	40	46	39	50	36	7.69

Sand Cr nr Sedgwick	# of Samples	DO	DO	Midterm Goal - Percent of Samples < 5mg/L	Longterm Goal - Percent of Samples < 5 mg/L
POR	N	Samples < 5mg/L	Percent < 5 mg/L		
1990-2009	30	6	20%		
2010-2014	10	0	0%		
1990-2014	40	6	15%	5%	0%

12.3.5 *Little Arkansas River at Alta Mills*

Water quality trends for the Little Arkansas River at Alta Mills at SC 246 are:

- TP = Stable
- TN = Stable
- TSS = Stable
- DO = Stable

Little Ark R at Alta Mills	# of Samples	TP (ug/L)	TP (ug/L)	Midterm Goal Median (ug/L)	Long Term Goal Median (ug/L)	Total Reduction Needed - Percent
POR	N	**Avg.**	Median			
1990-2009	113	630	520			
1990-1994	30	804	595			
1995-1999	31	499	427			
2000-2004	30	546	426			
2005-2009	26	650	560			
2010-2014	18	637	560			
1990-2014	135	620	530	350	150	71.70

Little Ark R at Alta Mills	# of Samples	TN (mg/L)	TN (mg/L)	Midterm Goal Median (mg/L)	Long Term Goal Median (mg/L)	Total Reduction Needed - Percent
POR	N	**Avg.**	Median			
1990-2009	52	2.16	1.51			
1990-1994	0	no data	no data			
1995-1999	0	no data	no data			
2000-2004	30	2.02	1.41			
2005-2009	26	2.28	1.68			
2010-2014	18	1.98	1.81			
1990-2014	74	2.1	1.59	1.5	1	37.11

Little Ark R at Alta Mills	# of Samples	TSS (mg/L)	TSS (mg/L)	Midterm Goal Median (mg/L)	Long Term Goal Median (mg/L)	Total Reduction Needed - Percent
POR	N	Avg.	Median			
1990-2009	113	149	52			
1990-1994	30	89	66			
1995-1999	31	146	48			
2000-2004	30	189	42			
2005-2009	26	216	68			
2010-2014	18	60	45			
1990-2014	135	145	49	50	36	26.53

Little Ark R at Alta Mills	# of Samples	DO	DO	Midterm Goal % of Samples < 5mg/L	Long Term Goal % of Samples < 5 mg/L (mg/L)
POR	N	Samples < 5 mg/L	% < 5 mg/L		
1990-2009	113	5	4%		
1990-1994	30	4	13%		
1995-1999	31	1	3%		
2000-2004	30	0	0%		
2005-2009	26	0	0%		
2010-2014	18	3	17%		
1990-2014	135	8	6%	3%	0%

12.3.6 Little Arkansas River at Valley Center

Water quality trends for the Little Arkansas River at Valley Center at SC 282 are:

- TP = Improved
- TN = Improved
- TSS = Improved
- DO = Improved

Little Ark R at Valley Center	# of Samples	TP (ug/L)	TP (ug/L)	Midterm Goal Median (ug/L)	Long Term Goal Median (ug/L)	Total Reduction Needed - Percent
POR	N	Avg.	Median			
1990-2009	115	672	597			
1990-1994	30	892	780			
1995-1999	30	568	521			
2000-2004	29	595	514			
2005-2009	26	623	617			
2010-2014	21	553	551			
1990-2014	136	654	582	350	150	74.23

Little Ark R at Valley Center	# of Samples	TN (mg/L)	TN (mg/L)	Midterm Goal Median (mg/L)	Long Term Goal Median (mg/L)	Total Reduction Needed - Percent
POR	N	Avg.	Median			
1990-2009	55	2.35	1.95			
1990-1994	0	no data				
1995-1999	0	no data				
2000-2004	29	2.41	2.06			
2005-2009	26	2.29	1.9			
2010-2014	21	1.87	1.71			
1990-2014	76	2.22	1.92	1.5	1	47.92

Little Ark R at Valley Center	# of Samples	TSS (mg/L)	TSS (mg/L)	Midterm Goal Median (mg/L)	Long Term Goal Median (mg/L)	Total Reduction Needed - Percent
POR	N	**Avg.**	Median			
1990-2009	115	118	51			
1990-1994	30	72	44			
1995-1999	30	123	49			
2000-2004	29	162	50			
2005-2009	26	115	62			
2010-2014	21	50	24			
1990-2014	136	107	47	50	36	23.40

Little Ark R at Valley Center	# of Samples	DO	DO	Midterm Goal % of Samples < 5mg/L	Long Term Goal % of Samples < 5 mg/L (mg/L)
POR	N	**Samples < 5 mg/L**	% < 5 mg/L		
1990-2009	115	1	<1%		
1990-1994	30	1	3%		
1995-1999	30	0	0%		
2000-2004	29	0	0%		
2005-2009	26	0	0%		
2010-2014	21	0	0%		
1990-2014	136	1	<1%	0%	0%

4) Atrazine

Milestones remain unchanged as difference between older data sets and newer data sets remain similar.

Station	Location	Period of Record	Months	# of Samples	# of Samples > 3 ppb	% of Samples > 3 ppb	Average Atrazine (ppb)	Max Atrazine (ppb)
SC246	Little Ark @ Alta Mills	1986-2006	April-July	19	5	26%	2.2	11
			August-March	33	2	6%	0.68	5.1
			All	52	7	13%	1.2	11
		2007-2014	April-July	7	2	29%	3.3	13
			August-March	10	0	0%	0.65	2.3
			All	17	2	12%	1.7	13
		1986-2014	April-July	26	7	27%	2.5	13
			August-March	43	2	5%	0.67	5.1
			All	69	9	13%	1.3	13
7143672	Little Ark @ Hwy 50 nr Halstead	1995-2004	April-July	417	140	34%	3.8	50
			August-March	267	1	0%	0.65	4
			All	684	141	21%	2.6	50
		2005-2014	April-July	293	115	39%	3.6	37
			August-March	312	15	5%	0.77	13
			All	605	130	21%	2.1	37
		1986-2014	April-July	710	255	36%	3.7	50
			August-March	579	16	3%	0.72	13
			All	1289	271	21%	2.4	50

7144100	Little Ark nr Sedgwick	1995-2004	April-July	1602	739	46%	5.3	40
			August-March	739	16	2%	0.90	8
			All	2341	755	32%	3.9	40
		2005-2014	April-July	477	214	45%	4.6	30
			August-March	386	16	4%	0.79	20
			All	863	230	27%	2.9	30
		1986-2014	April-July	2079	953	46%	5.1	40
			August-March	1125	32	3%	0.86	20
			All	3204	985	31%	3.6	40
SC282	Little Ark @ Valley Center	1985-2006	April-July	21	9	43%	3.6	17
			August-March	34	1	3%	0.63	6.5
			All	55	10	18%	1.8	17
		2007-2014	April-July	8	4	50%	4.3	13
			August-March	12	0	0%	0.49	1.5
			All	20	4	20%	2.0	13
		1986-2014	April-July	29	13	45%	3.8	17
			August-March	46	1	2%	0.57	6.5
			All	75	14	19%	1.8	17

KDHE Station	Stream	Estimated Mean Daily Flow (cfs)	Period of Record	May-July Avg. Atrazine (ppb)	May-July Max Atr (ppb)	Est. Avg. Load (lbs/day)	Est. Max Load (lbs/day)	Load Reduction Achieved (lbs/day)	Desired Avg. Load Reduction (lbs/day)
			1990-2002	***3.11***	***7***	***1.05***	***2.36***		
SC533	Turkey Creek	62.4	2006-2014	1.83	5.8	0.62	1.95	17-42%	**15%**
			1990-2002	***2.30***	***2.8***	***0.22***	***0.26***		
SC705	Black Kettle Cr	17.4	2006-2014	8.20	14	0.77	1.32	0%	**80%**
			1990-2002	***4.72***	***13***	***0.81***	***2.23***		
SC703	Kisiwa Cr	31.7	2006-2014	6.70	11	1.15	1.88	0-15%	**64%**
			1990-2002	***6.05***	***9.2***	***1.41***	***2.14***		
SC534	Emma Cr	43.1	2006-2014	7.18	17	1.67	3.96	0%	**58%**
			1990-2002	***4.95***	***7.6***	***0.77***	***1.19***		
SC535	Sand Cr	29	2006-2014	3.12	6.4	0.49	1.00	16-37%	**21%**

5) E. coli Bacteria

Water quality trends for the Little Arkansas River at Valley Center at SC 282 are:

- Slight improvement on Turkey, Emma, Sand and the Little Ark River at Wichita
- Milestones will remain the same

	Turkey Cr-SC533		Emma Cr-SC534		Sand Cr-SC535	
Period of Record	Plan (4/19/06-10/18/06)	2015 Review (4/19/06-10/14/14)	Plan (4/19/06-10/18/06)	2015 Review (4/19/06-10/14/14)	Plan (4/19/06-10/18/06)	2015 Review (4/19/06-10/14/14)
Percent of Samples below Bacterial Index of 1	33%	50%	33%	42%	22%	35%
# of Samples	4	9	7	32	10	41
	Little Ark R @ Alta Mills-SC246		**Little Ark R at Valley Center-SC282**		**Little Ark R at Wichita-SC728**	
Period of Record	Plan (4/19/06-10/18/06)	2015 Review (4/19/06-10/14/14)	Plan (4/19/06-10/18/06)	2015 Review (4/19/06-10/14/14)	Plan (4/19/06-10/18/06)	2015 Review (4/19/06-10/14/14)
Percent of Samples below Bacterial Index of 1	50%	45%	54%	54%	35%	52%
# of Samples	21	32	25	51	21	32

Table 95 Water Quality Milestones for the WRAPS Plan.

Water Quality Milestones for Little Arkansas River Watershed										
	Current Condition 1990 - 2010 Average TP	Short Term Goal	Mid Term Goal	Long Term Goal		Current Condition 1990 - 2010	Short Term Goal	Mid Term Goal	Long Term Goal	
		Improved Condition (2011 - 2015) Average TP	Improved Condition (2011 - 2031) Average TP	Improved Condition Average TP	Total Reduction Needed	Average TSS	Improved Condition (2011 - 2015) Average TSS	Improved Condition (2011 - 2031) Average TSS	Improved Condition Average TSS	Total Reduction Needed
Sampling Sites	Total Phosphorus (average of data collected during indicated period), ppb					Total Suspended Solids (TSS) (average of data collected during indicated period), ppm				
Turkey Creek Near Alta Mills SC533	850	790	590	200	**77%**	99	Maintain Avg TSS ≤ 100	Maintain Avg TSS ≤ 100	Maintain Avg TSS ≤ 100	**0%**
Black Kettle Cr. Near Halstead	780	720	550	200	**74%**	222	210	170	100	**55%**

SC705										

	Current Condition	***Short Term Goal***	***Mid Term Goal***	***Long Term Goal***		***Current Condition***	***Short Term Goal***	***Mid Term Goal***	***Long Term Goal***	
	1990 - 2010 Average TP					***1990 - 2010***				
		Improved Condition (2011 - 2015) Average TP	***Improved Condition (2011 - 2031) Average TP***	***Improved Condition Average TP***	***Total Reduction Needed***	***Average TSS***	***Improved Condition (2011 - 2015) Average TSS***	***Improved Condition (2011 - 2031) Average TSS***	***Improved Condition Average TSS***	***Total Reduction Needed***
Sampling Sites	***Total Phosphorus (average of data collected during indicated period), ppb***					***Total Suspended Solids (TSS) (average of data collected during indicated period), ppm***				
Kisiwa Creek *Near Halstead SC703*	*750*	*695*	*570*	*200*	***73%***	*89*	*Maintain Avg TSS ≤ 100*	*Maintain Avg TSS ≤ 100*	*Maintain Avg TSS ≤ 100*	***0%***
Emma Creek *Near Sedgwick SC534*	*770*	*710*	*540*	*200*	***74%***	*63*	*Maintain Avg TSS ≤ 100*	*Maintain Avg TSS ≤ 100*	*Maintain Avg TSS ≤ 100*	***0%***
Sand Creek *Near Sedgwick SC535*	*1950*	*1780*	*1250*	*200*	***90%***	*49*	*Maintain Avg TSS ≤ 100*	*Maintain Avg TSS ≤ 100*	*Maintain Avg TSS ≤ 100*	***0%***
Little Ark River At Alta Mills	*620*	*580*	*450*	*200*	***68%***	*155*	*150*	*130*	*100*	***35%***

SC246										
Little Ark River At Valley Center *SC282*	*670*	*620*	*480*	*200*	***70%***	*117*	*115*	*110*	*100*	***15%***

	Current Condition	**Short Term Goal**	**Mid Term Goal**	**Long Term Goal**		**Current Condition 1990 – 2009 *DO < 5 mg/L**	**Short Term Goal**	**Mid Term Goal**	**Long Term Goal**
	2000 - 2010 Average TN	**Improved Condition (2011 - 2015) Average TN**	**Improved Condition (2011 - 2031) Average TN**	**Improved Condition Average TN**	**Total Reduction Needed**		**Improved Condition (2011 - 2015) *DO < 5 mg/L**	**Improved Condition (2011 - 2031) *DO < 5 mg/L**	**Improved Condition**
Sampling Sites	**Total Nitrogen (TN) (average of data collected during indicated period), ppm**					***Percent of Samples DO < 5 mg/L (data collected during indicated period)**			
Turkey Creek Near Alta Mills SC533	2.08	1.88	1.26	1	**52%**	43%	35%	15%	No Samples - DO < 5 mg/L
Black Kettle Cr. Near Halstead SC705	4.22	3.44	1.1	1	**76%**	17%	15%	7%	No Samples - DO < 5 mg/L
Kisiwa Creek Near Halstead SC703	2.97	2.64	1.63	1	**66%**	25%	20%	10%	No Samples - DO < 5 mg/L
Emma Creek Near Sedgwi	2.02	1.93	1.65	1	**50%**	7%	6%	4%	No Samples - DO

ck SC534									< 5 mg/L

	Current Condition	**Short Term Goal**	**Mid Term Goal**	**Long Term Goal**		**Current Condition 1990 – 2009 *DO < 5 mg/L**	**Short Term Goal**	**Mid Term Goal**	**Long Term Goal**
	2000 - 2010 Average TN	**Improved Condition (2011 - 2015) Average TN**	**Improved Condition (2011 - 2031) Average TN**	**Improved Condition Average TN**	**Total Reduction Needed**		**Improved Condition (2011 - 2015) *DO < 5 mg/L**	**Improved Condition (2011 - 2031) *DO < 5 mg/L**	**Improved Condition**
Sampling Sites	**Total Nitrogen (TN) (average of data collected during indicated period), ppm**					***Percent of Samples DO < 5 mg/L (data collected during indicated period)**			
Sand Creek Near Sedgwick SC535	7.53	6.36	2.85	1	**86%**	20%	18%	12%	No Samples - DO < 5 mg/L
Little Ark River At Alta Mills SC246	2.15	1.89	1.11	1	**54%**	4%	3%	0%	No Samples - DO < 5 mg/L
Little Ark River At Valley Center SC282	2.39	2.25	1.34	1	**58%**	0%	0%	0%	No Samples - DO < 5 mg/L

In addition to the water quality milestones listed in the tables above, concurrent biological sampling in the Little Arkansas River should show adequate macroinvertebrate index scores over the same time period. The Macroinvertebrate Biotic Index (MBI) is a biological monitoring metric that can be used to assess compliance with water quality standards.

The MBI values can be used to determine the extent to which the monitored water body can support aquatic life, as follows:

$MBI \leq 4.5$ → fully supporting
$4.5 < MBI < 5.4$ → partially supporting
$MBI \geq 5.4$ → non-supporting

An average of MBI of 4.5 or less is desired for a healthy water body, with no sampled values above 5.

Water Quality Milestones for Bacteria

The water quality goal associated with the bacteria impairments in the Little Arkansas River watershed can be tied to the *E. Coli* Bacteria (ECB) Index values. ECB index values for individual samples are computed as the ratio of the sample count to the contact recreation criterion. The calculated index is the natural logarithm of each sample value taken during the primary recreation season (April through October), divided by the natural logarithm of the bacteria criteria. Plotting the ECB ratio against the percentile rank for each individual sample within the data set for each sampling location illustrates the frequency and magnitude of the bacteria impairment for the sampling location. Higher bacteria frequencies are evident when the ECB ratio is over 1 for a large percentage of samples.

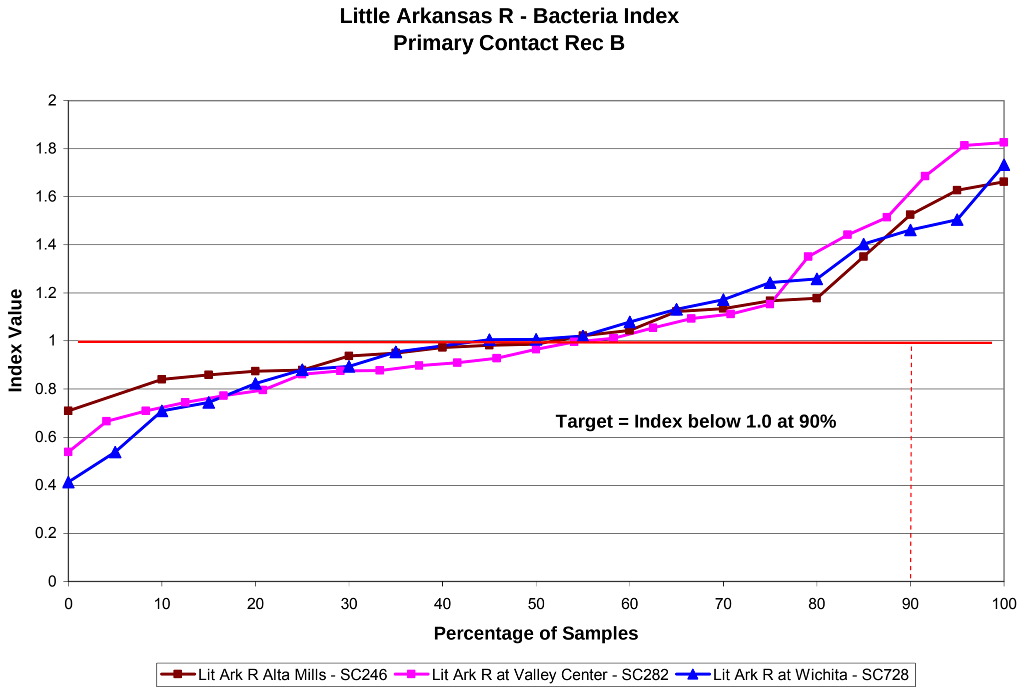
The water quality milestones associated with bacteria are based on the contact recreation designation of the impaired water body, as well as the proximity and designation of the downstream water body. Contact recreation is designated as either primary or secondary. Primary contact recreation designation is assigned to water bodies that have a high likelihood of ingestion based on public access, while secondary contact recreation designation is assigned to waters that are not as likely to be ingested due to restricted public access.

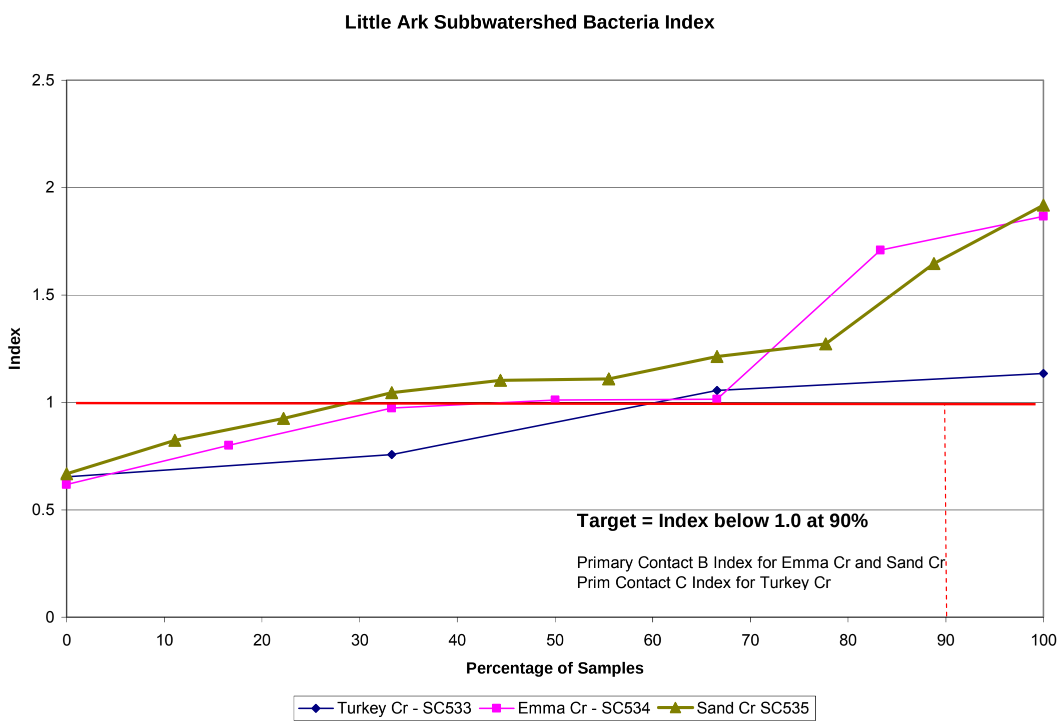
Bacteria load reductions should result in less frequent exceedance of the nominal ECB criterion. For the Little Arkansas River sampling stations SC246 and SC282, the bacteria index is based on the criteria of 262 Colony Forming Units (CFUs)/100ml, Primary Recreation Class B. For are the natural logarithm of each sample value taken during the April-October Primary Recreation season, divided by the natural logarithm of the bacteria criteria for Primary Recreation Class B [ln(262)]. The bacteria indices for the tributaries of Sand and Emma Creek are also based on the Primary Recreation Class B criterion, whereas Turkey Creek is based on the Primary Recreation Class C criterion (427 CFUs/100ml).

$$\textbf{Index} = \ln(\textbf{ECB Count}) / \ln(\textbf{262})$$

The indicator will be the Upper Decile of those index values, with the target being that the index is below 1.0 at the upper decile (90^{th} percentile).

Sampling station SC282 on the Little Arkansas River at Valley Center, station SC534 on Emma Creek, and station SC535 on Sand Creek were sampled in accordance with the Water Quality Standard in 2009. The geometric mean for the five samples collected over a 30-day period was 1528 CFUs/100ml for SC282, 1190 CFUs/100ml for SC534 and 2093 CFUs/100ml for SC535. The intensive sampling geometric mean results for these stations are well above the Water Quality Standard.





Ultimately, compliance with water quality standards will require sampling 5 times within 30 days during several periods during the primary recreation season, and calculating the geometric mean of those samplings. Meeting that test will be justification for delisting the stream impairment.

Water Quality Milestones for Atrazine

As listed earlier in this section, this plan is addressing the Little Arkansas Watershed *4b* Alternative for atrazine. The water quality criterion for domestic water supply (the main stem of the Little Arkansas River) is 3 ppb. The table below is taken from the *4b* document and includes the Little Arkansas River monthly comparisons of atrazine detections. Data from three sampling stations is included in the table, which includes KDHE stations SC246 and SC282, as well as two USGS monitoring stations, one located near Hwy. 50, and the other located near Sedgwick.

Station	Location	Month	# of Samples	# of Samples > 3 ppb	% of samples over 3 ppb	Monthly Atz Avg. in ppb
SC246	Alta Mill	April	4	0	0%	0.70
		May	6	1	17%	3.22
		June	4	2	50%	2.87
		July	4	2	50%	2.16
		Aug-Mar	32	2	6%	0.85
USGS	Hwy 50 Nr Halstead	April	11	5	45%	2.98
07143672		May	34	25	74%	8.99
		June	22	15	68%	8.76
		July	21	14	67%	3.58
		Aug-Mar	29	1	3%	0.75
USGS	Sedgwick	April	44	26	59%	4.72
07144100		May	95	75	79%	9.28
		June	53	42	79%	9.52
		July	66	37	56%	4.07
		Aug-Mar	72	5	7%	0.94
SC282	Valley Center	April	5	1	20%	2.22
		May	6	3	50%	5.51
		June	3	1	33%	3.03
		July	4	3	75%	3.51
		Aug-Mar	32	1	3%	0.83

Due to the lack of data available from the KDHE rotational sampling stations, load reduction estimates were assigned to the respective tributaries and their corresponding sampling stations based on the actual excessive load averages assigned to the corresponding USGS stations along the Little Arkansas River downstream of the tributary.

The first table on the following page illustrates the average and maximum atrazine concentrations at the respective rotational stations during the runoff season and the associated loadings. The second table shows the load contribution and reduction ranges for the average and maximum atrazine concentrations for the respective tributary sampling stations during the runoff period along with the *4b* desired average load reduction.

Table 96 May-July Estimated Average and Maximum Atrazine Loading.

KDHE Station	Stream	Estimated Mean Daily Flow	Runoff Period May-July	Runoff Period May-July	Estimated Avg Load Contribution #s/day	Estimated Max Load Contribution #s/day

			Atz Avg. Conc.	Atz Max Conc.		
SC533	Turkey Cr	62.4	3.11	7	1.05	2.36
SC705	Black Kettle Cr	17.4	2.3	2.8	0.22	0.26
SC703	Kisiwa Cr	31.7	4.72	13	0.81	2.23
SC534	Emma Cr	43.1	6.05	9.2	1.41	2.15
SC535	Sand Cr	29	4.95	7.6	0.78	1.19

Table 97 May – July Load Contributions and 4b Desired Loading Reductions.

KDHE Station	Stream	Estimated Runoff Load Contribution #s/day	% Load Reduction Range during Runoff Period	***4b* % Desired Avg. Load Reduction during Runoff Period**
SC533	Turkey Cr	1.05-2.36	4-57%	**50%**
SC705	Black Kettle Cr	0.22-0.26	0%	**0%**
SC703	Kisiwa Cr	0.81-2.23	37-77%	**50%**
SC534	Emma Cr	1.41-2.15	50-68%	**50%**
SC535	Sand Cr	0.78-1.19	40-61%	**50%**

The *4b* Alternative desired load reduction for all tributary streams within the watershed is 50% on average during May-July, with the exception of Black Kettle Creek. Since Black Kettle Creek does not contribute significant loads and has not had any water quality violations there will be no load reduction applied to this stream. The 50% atrazine load reduction assigned to the tributaries is based on the comparison of the estimated average and maximum load contributions for each stream and consistent with the reduction goals for the Little Arkansas River. While there have been no samples collected during the month of April for any of the tributary sampling stations, April is a month of concern for the lower portion of the watershed, therefore there should be no excursions in April on Kisiwa Creek, Emma Creek, and Sand Creek.

The water quality targets for the *4b* alternative are to meet the Water Quality Standard, achieve lower annual averages and fewer excursions over 3 ppb, and averages will not exceed 3 ppb at the sampling stations within the watershed during the runoff period. Since atrazine application is often performed based on the extended weather forecasts, it is inevitable that overland runoff events will occur on occasion despite careful application planning. When excursions do occur, the goal is to limit these to brief periods in May and June.

Additional Water Quality Indicators

In addition to the monitoring data, other water quality indicators can be utilized by KDHE and the SLT. Such indicators may include anecdotal information from the SLT and other citizen groups within the watershed (skin rash outbreaks, fish kills, nuisance odors), which can be used to assess short-term deviations from water quality standards. These additional indicators can act as trigger-points that might initiate further revisions or modifications to the WRAPS plan by KDHE and the SLT.

- No fish kills on Little Arkansas River or tributaries resulting from poor water quality
- No fish consumption advisories resulting from non-point source pollutants
- City of Wichita does not have to increase treatment and associated treatment costs of raw water from Little Arkansas River for ASR project due to degrading water quality trends

Evaluation of Monitoring Data

Monitoring data in the Little Arkansas River watershed will be used to determine water quality progress, track water quality milestones, and to determine the effectiveness of the implementation of conservation practices outlined in the plan. The schedule of review for the monitoring data will be tied to the water quality milestones that have been developed, as well as the frequency of the sampling data. It should be noted that the current TMDLs for the Little Arkansas Watershed are scheduled to be reviewed by KDHE in 2011. Monitoring data will be utilized at that time to determine necessary modifications to the TMDL.

The implementation schedule and water quality milestones for the Little Arkansas River watershed extend through a 40-year period from 2011 to 2051. Throughout that period, KDHE will continue to analyze and evaluate the monitoring data collected. After the first ten years of monitoring and implementation of conservation practices, KDHE will evaluate the available water quality data to determine whether the water quality milestones have been achieved. If milestones are not achieved, KDHE will assist the Little Arkansas River WRAPS group to analyze and understand the context for non-achievement, as well as the need to review and/or revise the water quality milestones included in the plan. KDHE, the PMT and the SLT can address any necessary modifications or revisions to the plan based on the data analysis. In 2051, at the end of the plan, a determination can be made as to whether the water quality standards have been attained.

In addition to the planned review of the monitoring data and water quality milestones, KDHE, the PMT and the SLT may revisit the plan in shorter increments. This would allow the group to evaluate newer available information, incorporate any revisions to applicable TMDLs, or address any potential water quality indicators that might trigger an immediate review.

13. Monitoring Water Quality Progress

The SLT and WRAPS Coordinator will meet to develop a monitoring plan of action. Monitoring site data that will be generated will be of great benefit to the SLT. Many of the existing monitoring sites will benefit multiple targeted areas and the site in Valley Center will benefit all targeted areas. Due to K-State monitoring personnel changing, someone new will need to be brought in to collect water samples. Out sourcing the actual analysis of the samples is preferable but funding may not make that option feasible. Monitoring sites and equipment may change as well with personnel changes, these are items that will need to be addressed and updated in the plan at a later date as additional information becomes available.

Once monitoring resumes, analysis of the data generated will be used to determine effectiveness of implemented BMPs. If the SLT decides at some point in the future that more data is required, they can discuss this with KDHE. All KDHE monitoring data will be shared with the SLT and can then be passed on to the watershed residents by way of the information and education efforts discussed previously.

Year 1 Monitoring Draft Plan:
At the time in which this WRAPS plan was written, a sample plan for monitoring and analyses for the first year of the plan was formulated using the estimated cost of $10,000 as agreed upon in the SFY12 PIP for Year 1.

The monitoring draft plan below and $10,000 expense is ONLY for Year 1 monitoring activities. Changes in budget and/or monitoring needs will require additional evaluation and may result in monitoring strategy and plan changes.

<u>Monitoring for Atrazine</u>: In the targeted areas of Running Turkey Creek, Lower Emma and Lower Sand Creeks; 6 to 9 atrazine samples from April through June will be collected at the established sample sites. Best professional judgment on when the atrazine application will occur within those 3 months would be used to determine sampling periods. Based on past data analysis, the best information collected would not be sampling on the basis of rainfall amounts, but rather on storm intensity. A quick, intense ½ inch rainfall could yield enough flow to track atrazine control/loss from the field. Three samples would be collected during application times using best professional judgment of non-runoff events. This may indicate application error such as spraying over the edge of the field with no riparian buffer or drift to the surface water rather than runoff associated.

<u>Monitoring for Sediment, Nutrients and Bacteria</u>: The KDHE, the Little Arkansas stakeholder leadership and project management teams are interested in maintaining some of the Atrazine sampling sites for long term data collection for other parameters. Therefore, it would appear the atrazine samples mentioned above could be analyzed for sediment, phosphorus, nitrogen and bacteria as well.

Additional monitoring for sediment, nutrients and bacteria would take place for Tier 2 BMP implementation areas as well. Therefore, sampling sites for Blazefork, Black Kettle and Kisiwa Creeks will be determined at a later date. Samples collected for sediment, nutrients and bacteria would be taken in the Fall prior to November 1 and again in the Spring and Summer using best professional judgment. Judgment will be made considering fertilizer application periods and rainfall events (to include storm intensity and runoff). If there is an unusual runoff event in the Winter months, water samples may also be collected during that timeframe as well.

Monitoring data will be used to direct the SLT in their evaluation of water quality progress. KDHE will be requested to meet with the SLT to review the monitoring data accumulated by their sites on a yearly basis. However, the overall strategy and alterations of the WRAPS plan will be discussed with KDHE immediately after each update of the 303(d) list and subsequent TMDL designation, which will take place in 2011 and 2016. At this time, the plan can be altered or modified in order to meet the water quality goals as assigned by the SLT in the beginning of the WRAPS process.

14. Review of the Watershed Plan

In the year 2021, the plan will be reviewed and revised according to results acquired from monitoring data. At this time, the SLT will review the following criteria in addition to any other concerns that may occur at that time:

1. The SLT will ask KDHE for a report on the milestone achievements in **atrazine** load reductions.
2. The SLT will ask KDHE for a report on the milestone achievements in **sediment** load reductions.
3. The SLT will ask KDHE for a report on the milestone achievements in nutrients, specifically **phosphorus** load reductions.
4. The SLT will request a report from KDHE concerning the revisions of the TMDLs.
5. The SLT will report on progress towards achieving the adoption rates listed in this report.
6. The SLT will report on progress towards achieving the benchmarks listed in this report.
7. The SLT will report on progress towards achieving the BMP implementations in this report.
8. The SLT will discuss the impairments on the 303(d) list and the possibility of addressing these impairments prior to listing as TMDLs.
9. The SLT will discuss the effect of implementing BMPs aimed at specific TMDLs on the impairments listed on the 303(d) list.
10. The SLT will discuss necessary adjustments and revisions needed in the targets listed in this plan.

15. Appendix

1) Service Providers and Contact Information

Table 98 Service Provider List

Organizations	Program	Purpose	Phone	Website address
Kansas Dept. of Agriculture	Watershed structures permitting.	Available for watershed districts and multipurpose small lakes development.	785-296-2933	www.accesskansas.org/kda
Kansas Dept. of Health and Environment	**Nonpoint Source Pollution Program** Municipal and livestock waste Livestock waste Municipal waste State Revolving Loan Fund	Provide funds for projects that will reduce nonpoint source pollution. Compliance monitoring. Makes low interest loans for projects to improve and protect water quality.	785-296-5500	www.kdhe.state.ks.us
Kansas Water Office	Public Information and Education	Provide information and education to the public on Kansas Water Resources	785-296-3185	www.kwo.org
Environmental Protection Agency	Clean Water State Revolving Fund Program Watershed Protection	Provides low cost loans to communities for water pollution control activities. To conduct holistic strategies for restoring and protecting aquatic resources based on hydrology rather than political boundaries.	913-551-7003 913-551-7003	www.epa.gov

Division of Conservation, Kansas Dept. of Agriculture	Water Resources Cost Share Nonpoint Source Pollution Control Fund Riparian and Wetland Protection Program Stream Rehabilitation Program Kansas Water Quality Buffer Initiative Watershed district and multipurpose lakes	Provide cost share assistance to landowners for establishment of water conservation practices. Provides financial assistance for nonpoint pollution control projects which help restore water quality. Funds to assist with wetland and riparian development and enhancement. Assist with streams that have been adversely altered by channel modifications. Compliments Conservation Reserve Program by offering additional financial incentives for grass filters and riparian forest buffers. Programs are available for watershed district and multipurpose small lakes.	785-296-3600	www.accesskansas.org/kDOC

Kansas Alliance for Wetlands and Streams	Streambank Stabilization Wetland Restoration Cost share programs	The Kansas Alliance for Wetlands and Streams (KAWS) organized in 1996 to promote the protection, enhancement, restoration and establishment wetlands and streams in Kansas.	620-241-3636	www.kaws.org

Kansas State Research and Extension	Water Quality Programs, Waste Management Programs Kansas Center for Agricultural Resources and Environment (KCARE) Kansas Environmental Leadership Program (KELP) Kansas Local Government Water Quality Planning and Management Rangeland and Natural Area Services (RNAS) Kansas Pride: Healthy Ecosystems/Healthy Communities Citizen Science	Provide programs, expertise and educational materials that relate to minimizing the impact of rural and urban activities on water quality. Educational program to develop leadership for improved water quality. Provide guidance to local governments on water protection programs. Reduce non-point source pollution emanating from Kansas grasslands. Help citizens appraise their local natural resources and develop short and long term plans and activities to protect,	785-532-7108 785-532-5813 785-532-2643 785-532-0416 785-532-3039 785-532-1443	www.kcare.ksu.edu www.ksu.edu/kelp www.ksu.edu/olg www.kansasprideprogram.ksu.edu/ healthyecosystems/ www.ksu.edu/kswater/

		sustain and restore their resources for the future. Education combined with volunteer soil and water testing for enhanced natural resource stewardship.		

Kansas Forest Service	Conservation Tree Planting Program Riparian and Wetland Protection Program	Provides low cost trees and shrubs for conservation plantings. Work closely with other agencies to promote and assist with establishment of riparian forestland and manage existing stands.	785-532-3312 785-532-3310	www.kansasforests.org

Kansas Department of Wildlife and Parks	Land and Water Conservation Funds Conservation Easements for Riparian and Wetland Areas Wildlife Habitat Improvement Program North American Waterfowl Conservation Act MARSH program	Provides funds to preserve develop and assure access to outdoor recreation. To provide easements to secure and enhance quality areas in the state. To provide limited assistance for development of wildlife habitat. To provide up to 50 percent cost share for the purchase and/or development of wetlands and wildlife habitat. May provide up to 100 percent of funding for small wetland projects.	620-672-5911 785-296-2780 620-672-5911 620-342-0658 620-672-5911	www.kdwp.state.ks.us/about/grants.html

US Army Corps of Engineers	Planning Assistance to States Environmental Restoration	Assistance in development of plans for development, utilization and conservation of water and related land resources of drainage Funding assistance for aquatic ecosystem restoration.	816-983-3157 816-983-3157	www.usace.army.mil
Kansas Rural Center	The Heartland Network Clean Water Farms-River Friendly Farms Sustainable Food Systems Project Cost share programs	The Center is committed to economically viable, environmentally sound and socially sustainable rural culture.	913-873-3431	http://www.kansasruralcenter.org
Kansas Corporation Commission	Online Site Specific Remediation Planner	Remediation of brine scar sites	620-432-2300	http://www.kcc.state.ks.us/conservation/ scar/index.htm
US Fish and Wildlife Service	Fish and Wildlife Enhancement Program Private Lands Program	Supports field operations which include technical assistance on wetland design. Contracts to restore, enhance, or create wetlands.	785-539-3474 785-539-3474	www.fws.gov

USDA-Natural Resources Conservation Service and Farm Service Agency	Conservation Compliance Conservation Operations Watershed Planning and Operations Wetland Reserve Program Wildlife Habitat Incentives Program Grassland Reserve Program, EQIP, and Conservation Reserve Program	Primarily for the technical assistance to develop conservation plans on cropland. To provide technical assistance on private land for development and application of Resource Management Plans. Primarily focused on high priority areas where agricultural improvements will meet water quality objectives. Cost share and easements to restore wetlands. Cost share to establish wildlife habitat which includes wetlands and riparian areas. Improve and protect rangeland resources with cost-sharing practices, rental agreements, and easement purchases.	785-823-4565 785-823-4565 785-823-4565 785-823-4565 785-823-4565	www.ks.nrcs.usda.gov

Table 99 Regional Organizations and Agencies and Contact Information.

Organization	Contact Person	Email Address	Contact Information
Kansas State Research and Extension	Ron Graber Watershed Specialist – Lower Arkansas River Watershed	rgraber@ksu.edu	7001 W. 21st Street N Wichita, KS 67205 316-660-0100 ext.155

Kansas Department of Health and Environment	Scott Satterthwaite Environmental Scientist	ssatterthwaite@kdheks.gov	1000 SW Jackson St Suite 420 Topeka, KS 66612 785-296-5573
Natural Resources Conservation Service	Gay Spencer Harvey County District Conservationist	gay.spencer@ks.usda.gov	1405 South Spencer Road Newton, KS 67114 316-283-0370
	Baron Shively McPherson County District Conservationist	baron.shively@ks.usda.gov	200 S. Centennial Dr. McPherson, KS 67460 785-241-1836
Conservation District	Christy Leewright-Patry Harvey County Conservation District Manager	Christi.leewright@ks.nacdnet.net	1405 South Spencer Road Newton, KS 67114 316.283.0370
	Brenda Peters McPherson County Conservation District Manager	brenda.peters@ks.nacdnet.net	200 S. Centennial Dr. McPherson, KS 67460 785-241-1836
Central Prairie Resource Conservation & Development	Dan Curtis Coordinator	dan.curtis@ks.usda.gov	1817 16th St. Great Bend, KS 67530 620-792-6224

2) BMP Definitions

Atrazine BMPs

Split Applications of Herbicide

- Apply atrazine and tankmixes as split applications. For example, apply one-half to two-thirds of the atrazine before April 15 and one-third to one-half before or immediately following planting. Using split applications reduces the amount of atrazine available for runoff at any one time. In addition, the early application is made at a less vulnerable time for atrazine runoff. This BMP has the potential to reduce atrazine runoff by 25 percent compared to applying all the atrazine at planting time.

Incorporate Herbicide

- Apply preplant atrazine alone or as part of a tankmix and incorporate it into the top 2 inches of soil with a field cultivator, tandem disc, or other appropriate tillage implement. Avoid deep incorporation, which will reduce weed control. Incorporation will reduce the amount of atrazine in the mixing zone of the soil, where it is most vulnerable to runoff. Incorporation will reduce atrazine runoff by 60 to 75 percent compared to a surface application without incorporation. Incorporation will improve weed control if rainfall does not occur within 7 days of herbicide application.

Use Post-emergence Herbicide

- Postemergence herbicide applications that contain low rates of atrazine in mixtures with other herbicides are widely used by Kansas farmers. Postemergence applications typically contain atrazine at rates of ½ pound applied ingredient per acre, approximately 60 to 70 percent lower than typical soil-applied atrazine application rates. In addition, the growing crop foliage helps reduce atrazine runoff potential by intercepting some of the atrazine and reducing the storm impact at the soil surface. Postemergence applications result in 50 to 67 percent less atrazine runoff compared to typical preemergence soil-applied atrazine applications. The herbicide mixture used for postemergence applications can be based on specific weed species and populations present.

Reduce Application Rate

- There is a direct relationship between atrazine application rate and runoff amount. The lower the rate of atrazine applied, the less the potential runoff. Using lower atrazine rates and/or formulations with lower atrazine rates can still provide excellent control of pigweed and other small-seeded broadleaf weeds. Reducing atrazine rates by one-third potentially reduces atrazine runoff by 33 percent.

Cropland BMPs

No-Till

- 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% no-till system.
- 75% erosion reduction efficiency, 40% phosphorous reduction efficiency.

Conservation Tillage

- Involves the planting, growing and harvesting of crops with minimal disturbance to the soil surface through the use of minimum tillage, ridge tillage, or no-till.

Vegetative Buffer

- Area of field 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 for Kansas fields, 1 acre buffer treats 15 acres of cropland.
- 50% erosion reduction efficiency, 50% phosphorous reduction efficiency

Terraces

- Earth embankment and/or channel constructed across the slope to intercept runoff water and trap soil.
- One of the oldest/most common BMPs
- 30% Erosion Reduction Efficiency, 30% phosphorous reduction efficiency

Grassed Waterway

- Grassed strip used as an outlet to prevent silt and gully formation.
- Can also be used as outlets for water from terraces.

- On average for Kansas fields, 1 acre waterway will treat 10 acres of cropland.
- 40% erosion reduction efficiency, 40% phosphorous reduction efficiency.

Conservation Crop Rotation
- Growing various crops on the same piece of land in a planned rotation.
- High residue crops (corn) with low residue crops (wheat, soybeans).
- Low residue crops in succession may encourage erosion.
- 25% Erosion Reduction Efficiency, 25% phosphorous reduction efficiency

Nutrient Management Plan
- Managing the amount, source, placement, form and timing of the application of nutrients and soil amendments.
- Intensive soil testing
- 25% erosion and 25% P reduction efficiency.

Incorporate Manure with Tillage

Incorporating manure with tillage reduces surface residue cover.

Water Retention Structure

-May include sediment basin that is a water impoundment made by constructing an earthen dam.
-May include grade stabilization structures that control runoff and prevent gully erosion.
-Traps sediment and nutrients from leaving edge of field.
-Provides source of water.
-50% soil erosion, nitrogen, and phosphorous reduction efficiency.

Livestock BMPs

Vegetative Filter Strip
- A vegetated area that receives runoff during rainfall from an animal feeding operation.
- Often require a land area equal to or greater than the drainage area (needs to be as large as the feedlot).
- 10 year lifespan, requires periodic mowing or haying, average P reduction: 50%.

Relocate Small Feedlots
- Feedlot- Move feedlot or pens away from a stream, waterway, or body of water to increase filtration and waste removal of manure.

Relocate Pasture Feeding Site
- Pasture- Move feeding site that is in a pasture away from a stream, waterway, or body of water to increase the filtration and waste removal (eg. move bale feeders away from stream).
- Average P reduction: 30-80%

Alternative (Off-Stream) Watering Sites
- Watering system so that livestock do not enter stream or body of water.
- Studies show cattle will drink from tank over a stream or pond 80% of the time.
- 10-25 year lifespan, average P reduction: 30-98% with greater efficiencies for limited stream access.

Pond

- Water impoundment made by constructing an earthen dam.
- Traps sediment and nutrients from leaving edge of pasture.
- Provides source of water.
- 50% P Reduction.

Rotational Grazing
-Rotating livestock within a pasture to spread manure more uniformly and allow grass to regenerate.
-May involve significant cross fencing and additional watering sites.
-50-75% P Reduction.

Stream Fencing
- Fencing out streams and ponds to prevent livestock from entering.
- 95% P Reduction.
- 25 year life expectancy.

16. Bibliography

[1] Kansas Unified Watershed Assessment 1999. Kansas Department of Health and Environment and the United States Department of Agriculture Natural Resources Conservation Service.

[2] Kansas Land Cover Patterns (KLCP)

[3] US Census Bureau, 2010.

[4] Internet source. http://www.pollutionissues.com/Pl-Re/Point-Source.html

[5] Kansas Department of Health and Environment, 2017.

[6] Rural Water Districts, 2015. Public Water Supply and National Discharge Elimation Systems, 1994. Kansas Data Access and Support System.

[7] Internet Source, USGS, Kansas Water Center – http://ks.water.usgs.gov/studies/equus/

[8] Kansas Surface Water Register, 2013.

[9] Kansas Land Cover Patterns, 2015.

[10] Kansas Land Cover Pattern's, 2015.

[11] Kansas Department of Health and Environment. TMDL Development Cycle.

[12] Section provided by Kansas Department of Health and Environment. October, 2009.

[13] Available at: http://www.kdheks.gov/tmdl/la/Lit_Ark_CAT*4b*_10-12-06.pdf

[14] Provided by Kansas Department of Health and Environment, July 2011.

[15] Provided by Kansas Department of Health and Environment. November 2010.

[16] EPA website. http://water.epa.gov/type/watersheds/datait/watershedcentral/goal4.cfm

[17] Water Quality Best Management Practices, Effectiveness, and Cost for Reducing Contaminant Losses from Cropland. Kansas State University Agricultural Experiment Station and Cooperative Extension Service. MF-2572 (Rev.). August 2015.

[18] Atrazine Herbicide Best Management Practices for the Little Arkansas River Watershed. Kansas State University Agricultural Experiment Station and Cooperative Extension Service. MF-2768. January 2007.

[19] Livestock Waste Facilities Handbook. Iowa State University. MWPS-18. 1993.

[20] Alternative Livestock Watering: Covered Concrete Waterer. Kansas State University Agricultural Experiment Station and Cooperative Extension Service. MF-2737. July 2006.

[21] Vegetative Filter Strips for Animal Feeding Operations, Kansas State University Agricultural Experiment Station and Cooperative Extension Service. MF-2454. February 2000.

[22] Atrazine Herbicide Best Management Practices for the Little Arkansas River Watershed. Kansas State University Agricultural Experiment Station and Cooperative Extension Service. MF-2768. January 2007.