Lower Lower Smoky Watershed – 9 Element Watershed Plan Summary

<u>Impairments to be Directly addressed:</u>

Smoky Hills River (Salina to Junction City) (TSS)

Herington Reservoir (EU)

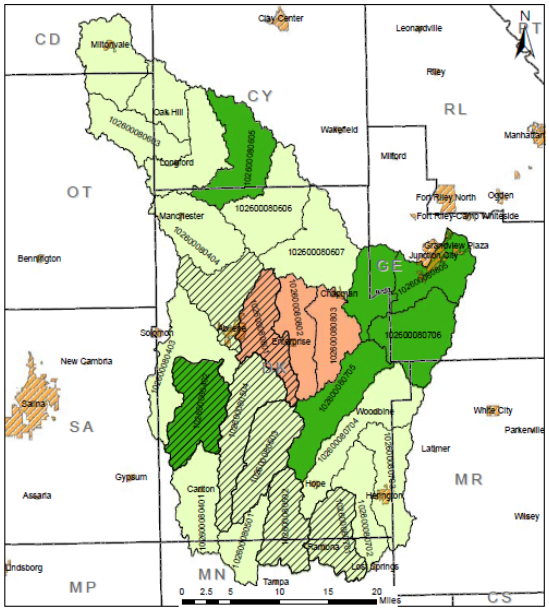
<u>Impairments to be positively affected:</u>

Holland Creek (DO)

Smoky Hill River at Enterprise (Biology)

Herington Reservoir (DO, Atr)

<u>Prioritized Critical Areas for Targeting BMPs</u>

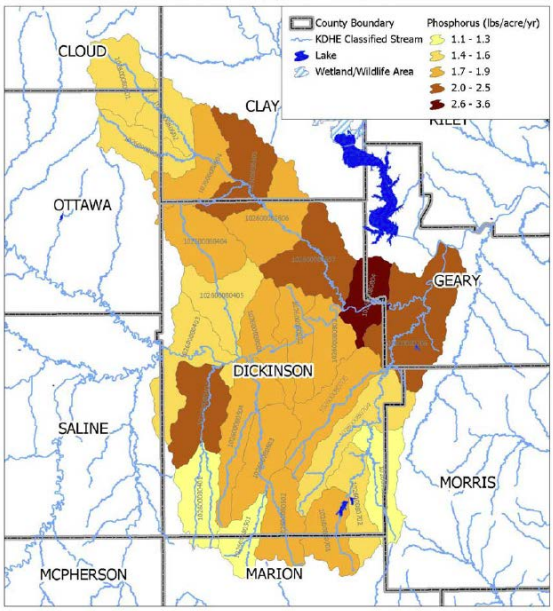


Lower Lower Smoky Watershed
Cropland and Livestock Targeted Areas

Cropland Tier 1 Cropland Tier 2 Livestock

K-STATE Research and Extension

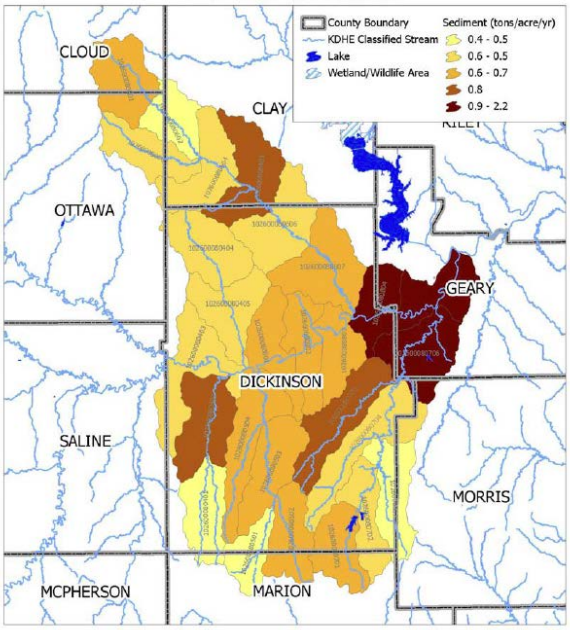
Lower Lower Smoky Hill WRAPS
STEPL Model Results



The purpose of this publication is to illustrate general watershed conditions in the state of Kansas. This map product is provided without representation or implied or expressed warranty of accuracy and is intended for watershed planning purposes only. The originating agency is not responsible for publication or use of this product for any other purpose. This product may be corrected or updated as necessary without prior notification.

February 2011

Lower Lower Smoky Hill WRAPS
STEPL Model Results



The purpose of this publication is to illustrate general watershed conditions in the state of Kansas. This map product is provided without representation or implied or expressed warranty of accuracy and is intended for watershed planning purposes only. The originating agency is not responsible for publication or use of this product for any other purpose. This product may be corrected or updated as necessary without prior notification.

February 2011

Lower Lower Smoky Watershed – 9 Element Watershed Plan Summary

Targeting Considerations:

- Cropland BMP Targeted areas were identified through STEPL modeling to determine where high levels of phosphorous and sediment where coming from within the Lower Lower watershed.
- Livestock Targeted areas were identified by comparing landowner knowledge and examining CAFO maps.
- Streambank Targeted areas were determined with an streambank assessment study completed by The Watershed Institute (TWI).

Best Management Practices and Load Reduction Goals

Best Management Practices (BMPs) to address phosphorus and sediment in the watershed where chosen by the SLT based on local acceptance/adoptability and the amount of load reduction gained per dollar spent.

Phosphorus/Sediment Reducing Cropland BMPs

- Permanent Vegetation
- No-Till cultivation Practice
- Terraces
- Nutrient Management Plans
- Grassed Waterways
- Vegetative Buffers
- Water Retention Structures

Phosphorus/Sediment Reducing Livestock BMPs

- Vegetative Filter Strip
- Relocate Feeding Pens
- Relocate Pasture Feeding Sites
- Alternative (Off-Stream) Watering System
- Rotational Grazing

Sediment reduction needed:

Phosphorus reduction needed:

LOWER LOWER SMOKY WATERSHED

Watershed Restoration and Protection Strategy

Final Draft Plan October 8, 2012

Funding for the development of this plan was provided through an EPA 319 grant from the Kansas Department of Health and Environment.

Lower Lower Smoky Watershed Project Staff

Randy Barten, Director of Environmental Services
Janet Meyer, WRAPS Coordinator
Ann D'Alfonso, Kansas Department of Health and Environment Project Officer

Stakeholder Leadership Team

Iralee Barnard
Ken Barnard
Jack Burwell
Christie Carl
John Gough
Herb Graves
Bevin Law
Jay Leusman
Doug Lindahl
Tom Meek
LaVerne Myers
Dustin Parks
Tim Sanders
Mark Schmidt
Debbie Smart
Mark Struss
Teresa Wilson
Ken Wood

K-State Research and Extension Project Staff

Robert Wilson, Watershed Planner, Office of Local Government
Josh Roe, Watershed Economist, Department of Agricultural Economics
Susan Brown, Kansas Center for Agricultural Resources and the Environment

Table of Contents

List of Figures

List of Tables

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 (ECB): 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 coliform 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.

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

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

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

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

Nutrients: Nitrogen and phosphorus in water source.

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

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

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

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

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

Stakeholder Leadership Team (SLT): Organization of watershed residents, landowners, farmers, ranchers, agency personnel and all persons with an interest in water quality.

Total Maximum Daily Load (TMDL); Maximum amount of pollutant that a specific body of water can receive without violating the surface water-quality standards, resulting in failure to support their designated uses

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

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

1.0 Preface

The purpose of this Watershed Restoration and Protection Strategy (WRAPS) report for the Lower Lower Smoky (LLS) Watershed is to outline a plan of restoration and protection goals and actions for the surface waters of the watershed. Watershed goals are characterized as “restoration” or “protection”.

Watershed restoration is for surface waters that do not meet water quality standards, and for areas of the watershed that need improvement in habitat, land management, or other attributes. Watershed protection is needed for surface waters that currently meet water quality standards, but are in need of protection from future degradation.

The 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 evaluating 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 LLS Watershed.

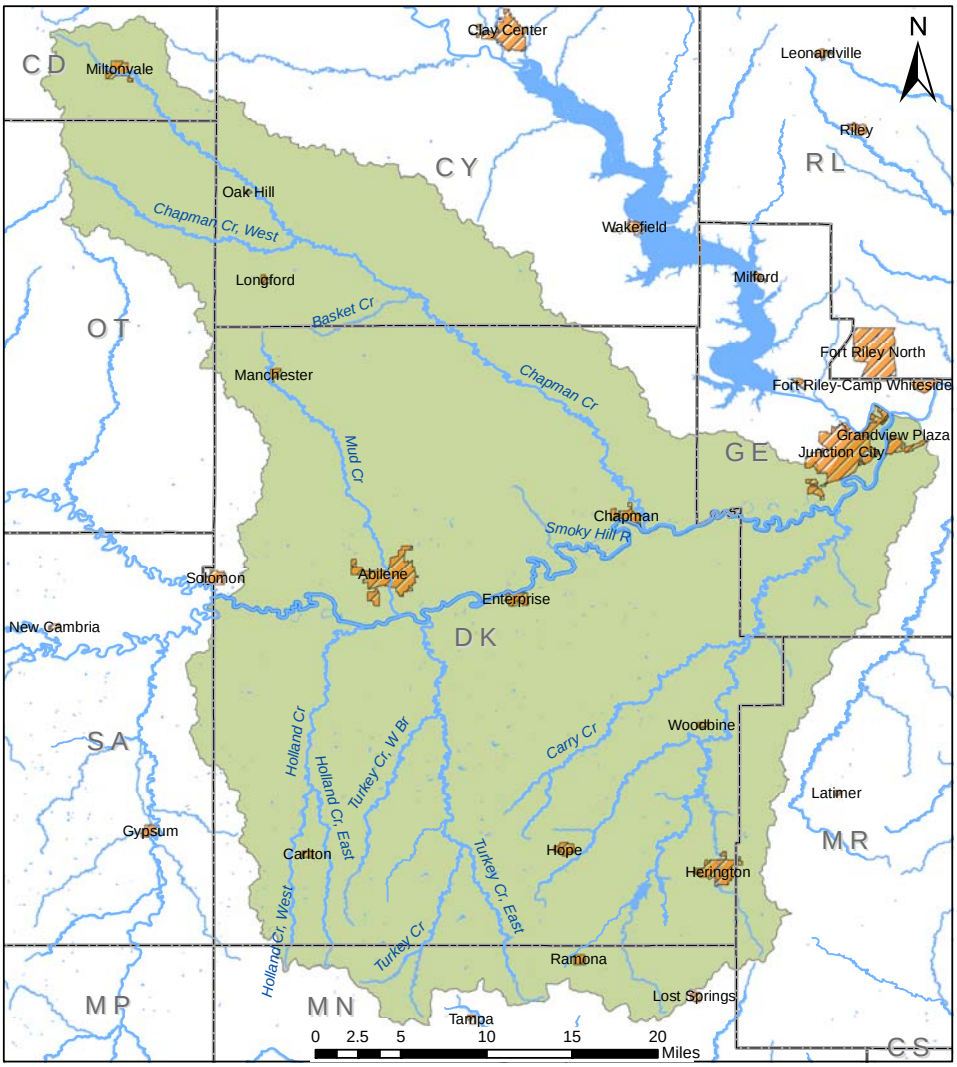
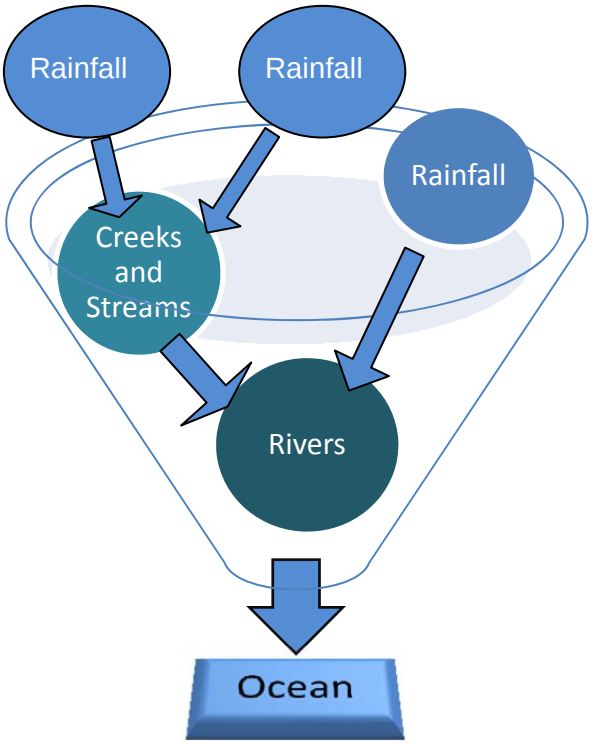


Figure 1. Map of the LLS Watershed

2.0 Background Information of the Lower Lower Smoky (LLS) Watershed

2.1 What is a Watershed?

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



Elevation determines the watershed boundaries. The upper boundary of the LLS Watershed has an elevation of 365 meters (1,198 feet) and the lowest point of the watershed has an elevation of 313 meters (1,030 feet) above sea level.

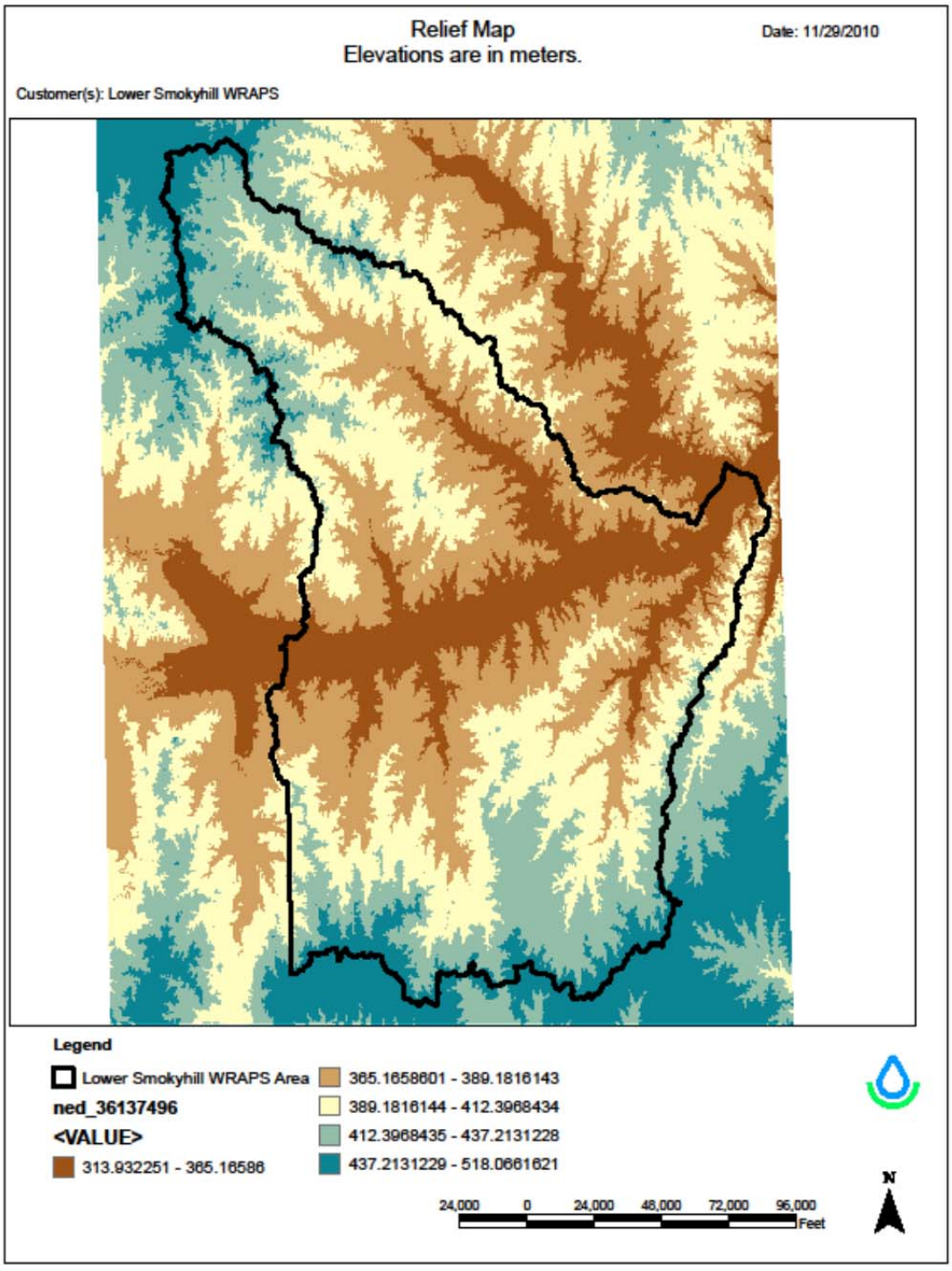
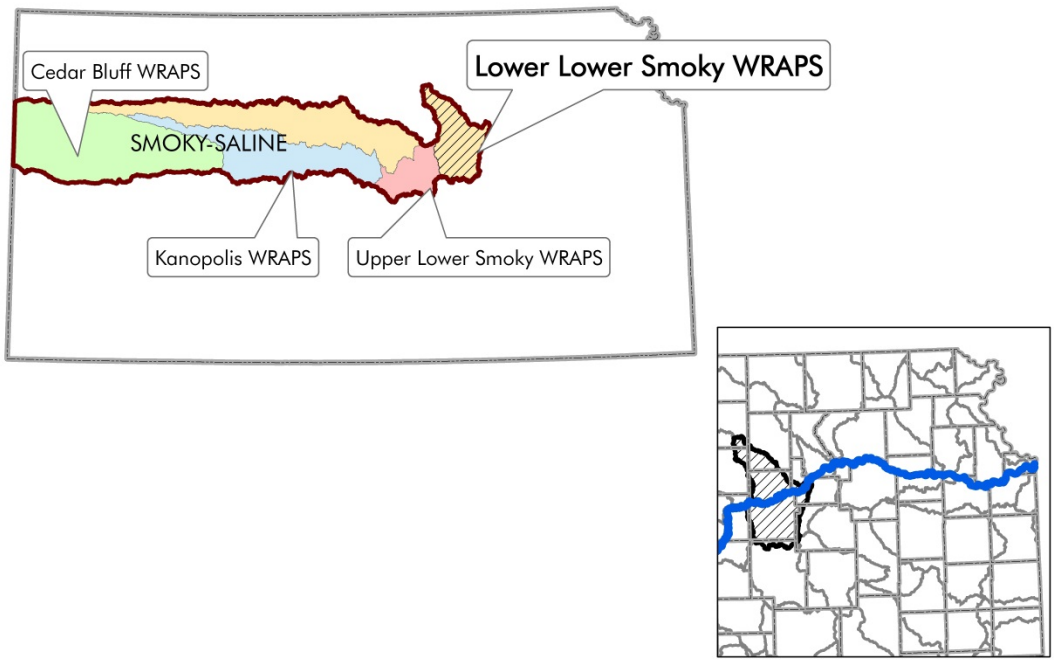


Figure 2 Relief Map of the LLS Watershed. [1]

2.2 Where is the LLS Watershed?

There are twelve river basins located in Kansas. The scope of this WRAPS project is a portion of the Smoky Hill Basin in central Kansas. The entire basin drains the Kansas River and its tributaries into Missouri and eventually empties into the Gulf of Mexico. The extent of the WRAPS area is the confluence of the Solomon River and Smoky Hill River near Solomon and its tributaries with its endpoint being the confluence of the Smoky Hill River and Republican River near Junction City.

Figure 3 Major Rivers of Kansas



The purpose of this publication is to illustrate general watershed conditions in the state of Kansas. This map product is provided without representation or implied or expressed warranty of accuracy and is intended for watershed planning purposes only. The originating agency is not responsible for publication or use of this product for any other purpose. This product may be corrected or updated as necessary without prior notification.

Kansas Department of Health and Environment
June 2011

Figure 4. Location of LLS Watershed

2.3 What is a HUC?

HUC is an acronym for Hydrologic Unit Codes. It is a way of identifying all of the drainage basins in the United States. A watershed (term often used in place of drainage basin) is an area or region of land that catches precipitation that falls within that area, and channels it to a particular creek, stream, river and so, until the water drains into an ocean. Each watershed has a unique HUC number in addition to a common name.

The Lower Smoky Hill Watershed is classified as a HUC 8, meaning it has an 8 digit identifying code. Its HUC number is 10260008. The first 2 numbers in the code refer to the drainage region, the second 2 digits refer to the drainage subregion, the third 2 digits refer to the accounting unit and the fourth set of digits is the cataloging unit. As watersheds become smaller, the HUC number will become larger. HUC 8s are further divided into smaller watersheds with HUC 10 and HUC 12 delineations. The LLS Watershed is divided into twenty-eight HUC 12 delineations.

Lower Lower Smoky Watershed
HUC 12s

Lower Lower Smoky Watershed
Cities/towns
Counties

K-STATE Research and Extension

Figure 5 HUC 12 Delineations in the LLS Watershed

3.0 Watershed History

3.1 Stakeholder Leadership Team (SLT) History

From 1997 to 2003, the EPA 319 funded Sand Springs Aquifer Groundwater Protection Project was conducted by the Dickinson County Water Improvement Program (WIP). The project closeout report was submitted to the Kansas Department of Health and Environment in January, 2004. The report proposed that the remaining FY01 EPA 319 funds of $25,914 be transferred to Dickinson County. A WRAPS coordinator was hired in March of 2006 and the first landowner meeting took place in October of 2006. During this development stage a Stakeholder Leadership Team (SLT) was formed and educational programs were initiated. The assessment and planning phase of the LLS WRAPS started in October of 2008. The first implementation grant for the LLS Watershed will begin in July of 2012.

3.2 Overview

The LLS Watershed is primarily a drainage basin for the Smoky Hill River and its tributaries. It stretches from the Smoky Hill/Solomon River junction to the Smoky Hill/Republican junction, capturing a drainage area of about 1,200 square miles, principally in Dickinson County. Portions of the watershed are also located in Ottawa, Cloud, Saline, Clay, Geary, Morris and Marion counties. Within the LLS Watershed drainage there are 32 registered stream segments with a total stream-length of 470 miles. There are also four registered lakes, three Herington lakes and Geary County State Fishing Lake.

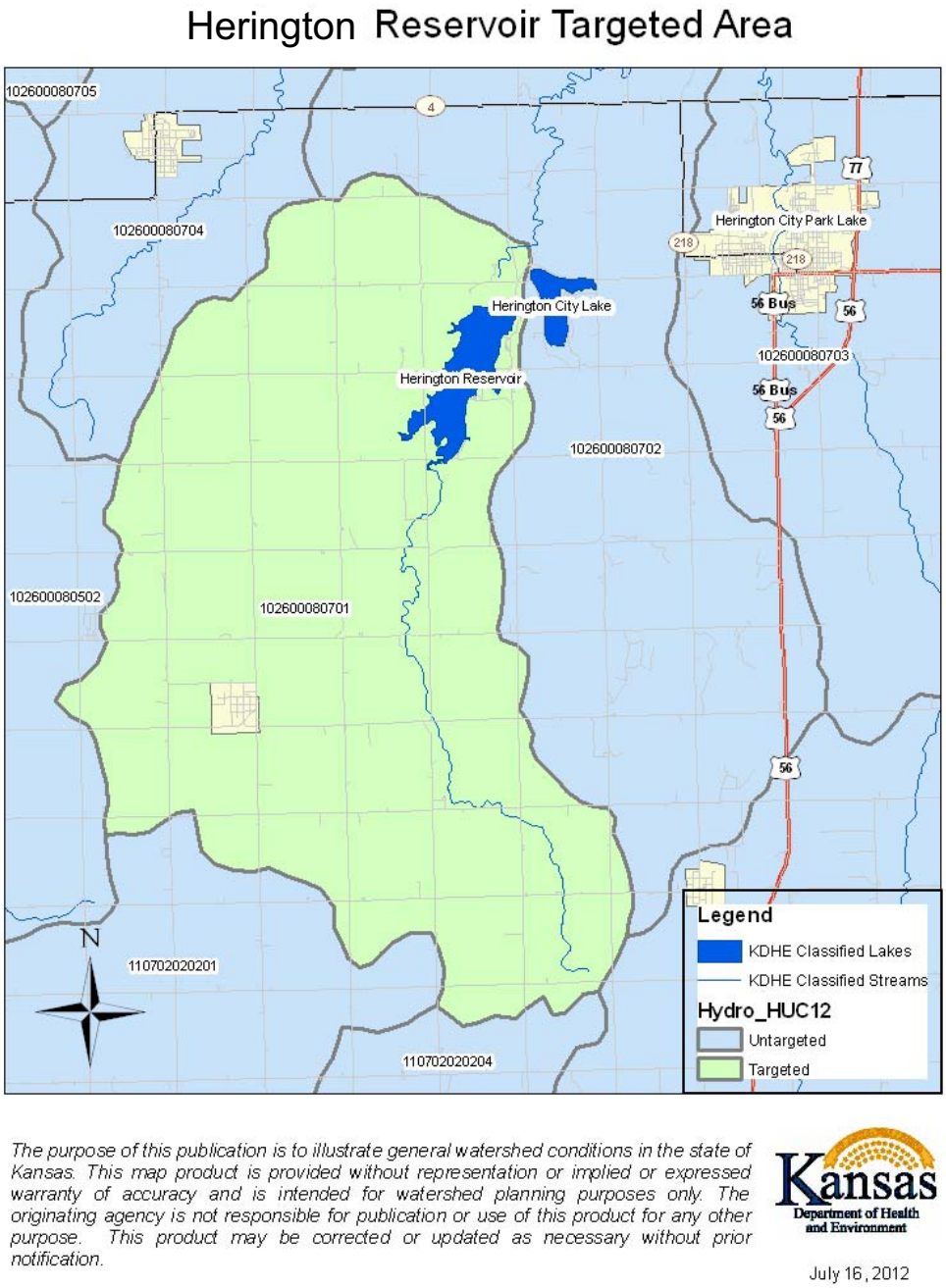


Figure 6. Location of Herington Reservoir in the LLS Watershed.

The majority of the LLS Watershed is located in Dickinson County. The largest water course is the Smoky Hill River, which flows across the county from west to east, a little north of the center. This stream with its tributaries, the most important of which are Chapman's and Turkey creeks, waters all of the county. A few springs exist and good well water is found at a depth of 30 feet. The county is well adapted to agriculture, the principal crops being winter wheat, corn, and

other grains. Tame grasses and prairie hay are also important products and Dickinson ranks high as one of the great stock raising counties.

The Smoky Hill River originates in the High Plains of eastern Colorado and flows east. Both the main course of the river and its north fork rise in northern Cheyenne County, Colorado. The two streams converge roughly 5 miles west of Russell Springs in Logan County, Kansas. From there, the river continues generally eastward through the Smoky Hills region. The Saline River, one of the Smoky Hill's two main tributaries, joins the river in eastern Saline County. The other major tributary, the Solomon River, joins the Smoky Hill in western Dickinson County. The Smoky Hill joins the Republican River at Junction City to form the Kansas River.

The Smoky Hill River directly drains an area of 8,810 square miles. The combined Smoky Hill-Saline Basin drains 12,229 square miles. The entire Smoky Hill drainage basin covers approximately 20,000 square miles, including most of north-central and northwestern Kansas. Via the Kansas and Missouri Rivers, the Smoky Hill is part of the Mississippi River watershed. The LLS Watershed does not drain into a reservoir.

In this report, the term BMP (Best Management Practice) will be used frequently. A BMP is defined as an environmental protection practice used to control pollutants, such as sediment or nutrients, from common agricultural or urban land use activities. Common agricultural BMPs are buffer strips, terraces, grassed waterways, utilizing no-till or minimum tillage, conservation crop rotation and nutrient management plans. Definitions of each of these BMPs are found in the appendix of this report.

3.3 Issues and Goals of the SLT

The charge of the SLT has been to create a plan of restoration and protection measures for the watershed. During the time they have been meeting, they have had speakers and discussions to review and learn about watershed issues and concerns. The LLS Watershed has set the following watershed restoration and protection goals to address their watershed issues.

- Improve water quality in the LLS Watershed
- Educate and assist the LLS Watershed community on water quality

The purpose of this WRAPS plan is to address the issues and concerns of the SLT, to address and mitigate current TMDLs in the watershed and to proactively improve conditions so that the impairments on the current 303d list will not reach the stage of TMDL development.

What is a Total Maximum Daily Load (TMDL)?

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

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

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

TMDLs consist of 3 parts: wasteload allocation (WLA) from point sources, load allocation (LA) from nonpoint sources, and a built in margin of safety (MOS). In this WRAPS report, we will address the LA from nonpoint sources.

4.0 Watershed Review

4.1 Land Cover/Land Uses

Land use activities have a significant impact on the types and quantity of pollutants in the watershed. The major land use for the LLS Watershed is cropland (60% with 308,504 acres). This watershed is a strong agricultural area. Small grains and row crops comprise over half of the watershed. Of the cropland acres involved, 21% or 69,120 acres have no-till covering at least 70% of the ground. Mulch till covering 30% of the land makes up 15% or 50,235 acres. Minimum till, 15-30% coverage of the land, accounts for 19% or 62,485 acres. Conventional farming still makes up the largest percent of cropland with 44% or 143,260 acres. Grazed grasslands, pastures, and hay lands cover much of the rest of the LLS Watershed. The majority of this watershed lies in Dickinson County from which the before mentioned numbers were derived.

Diversity is the key to successful production. Many farmers are also cattlemen who use the grain and hay they raise to feed and finish cattle during the winter months. There are also many cow-calf operations.

The lands directly adjacent to the major rivers generally have both timbered areas and cropland. Timbered lands are expected to be sources of reductions in sediment, and cropland is expected to result in increased sediment delivery, suggesting that these lands near the major rivers are contributors to the elevated TSS concentrations observed in the rivers. Erosion on cropland areas can be expected to be greater. In Table 1 the land use is broken down for the HUC 12 area and in Table 2 the land use is described in a 300 foot area adjacent to the Solomon and Smoky Hill Rivers.

Table 1. Land Use in the TMDL Area by HUC 12 [2]

HUC 8	HUC 12	Grassland	Cropland	Forest	Open Water	Roads/ Developed	Wetlands
10260008	306	24.3	38.5	2.6	2.8	30.5	1.2
	307	22.2	59.9	4.9	8.0	3.3	1.7
	403	40.2	47.3	4.2	2.4	4.7	1.1
	801	40.1	45.3	2.9	2.0	8.3	1.3
	802	46.3	40.7	3.7	1.7	6.1	1.5
	803	45.8	39.3	4.5	2.1	5.6	2.4
	804	40.9	42.5	6.0	2.4	5.4	2.6
	805	40.5	26.2	11.5	3.5	14.4	3.6
10260015	704	33.0	56.8	3.0	1.7	4.8	0.8
	705	33.4	54.0	4.3	1.4	6.1	0.6

Table 2..Land Use in a 300 Foot Area Adjacent to the Solomon and Smoky Hill Rivers. [3]

HUC 8	HUC 12	Grassland	Cropland	Forest	Roads/ Developed	Wetlands
10260008	306	19.9	54.2	9.9	11.4	4.6
	307	15.1	54.1	19.2	4.4	7.1
	403	21.7	42.4	18.2	5.0	12.6
	801	14.5	53.2	10.7	6.4	15.3
	802	11.3	56.8	15.2	4.0	12.8
	803	13.8	45.7	17.2	7.1	16.3
	804	10.3	41.4	20.9	2.6	22.6
	805	18.2	31.6	27.7	7.2	15.3
10260015	704	4.6	59.5	24.7	2.5	7.7
	705	10.7	48.9	27.1	7.1	6.2

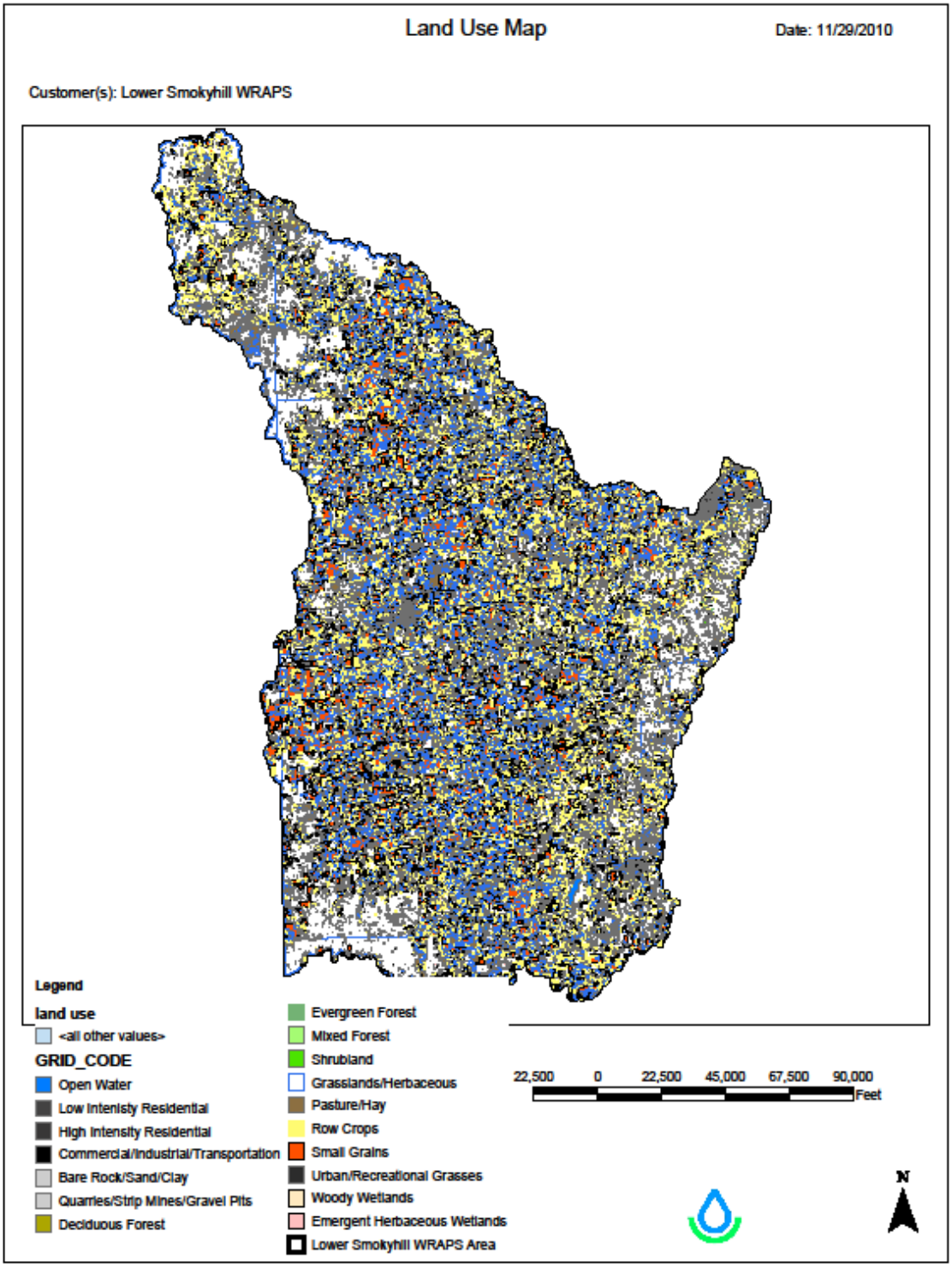


Figure 7 Land Use of the LLS Watershed.

4.2 Designated Uses

All surface waters in this watershed are generally used for aquatic life support (fish), human health purposes, domestic water supply, recreation (fishing, boating, and swimming), groundwater recharge, industrial water supply, irrigation or livestock watering. These are commonly referred to as "designated uses" as stated in the Kansas Surface Water Register, 2010, issued by KDHE.

Each water body in the state has been assigned a set of Designated Uses which the water quality in the watershed must allow. According to the Kansas Surface Water register, 2009, KDHE has determined the following designated uses for the waters of the LLS Watershed.

Table 3 Designated Water Uses for the LLS Watershed, 2010. [4]

Designated Uses Table								
Stream or Lake Name	**AL**	**CR**	**DS**	**FP**	**GR**	**IW**	**IR**	**LW**
Basket Cr, Holland Cr E, Holland Cr W, Middle Br	E	b	O	O	X	O	X	X
Carry Cr, Unnamed St seg 542	S	C	X	O	X	X	X	X
Chapman Cr seg 3, Lime Cr, Smoky Hill R seg 1, 2, 6, 10	E	C	X	X	X	X	X	X
Chapman Cr seg 4	E	B	X	O	X	X	X	X
Chapman Cr W, Lone Tree Cr	E	C	X	O	X	X	X	X
Holland Cr, Turkey Cr W Br	E	C	O	O	X	O	X	X
Lyon Cr	S	C	X	X	X	X	X	X
Mud Cr	E	A	X	O	X	X	X	X
Otter Cr, Unnamed St seg 638	E	b	X	X	X	X	X	X
Turkey Cr, Turkey Cr E	E	C	O	X	X	O	X	X
Unnamed St seg 515, Unnamed St seg 618	S	B	O	X	O	O	O	O
Geary Co SFL, Herington City Park Lake	E	B	X	X	O	X	X	X
Herington City Lake	E	A	X	X	X	X	X	X
Herington Reservoir	S	B	X	X	X	X	X	X

AL = Aquatic Life Support	GR = Groundwater Recharge
CR = Contact Recreation Use	IW = Industrial Water Supply
DS = Domestic Water Supply	IR = Irrigation Water Supply
FP = Food Procurement	LW = Livestock Water Supply

A=Primary contact recreation lakes that have a posted public swimming area
B=Primary contact recreation stream segment is by law or written permission of the landowner open to and accessible by the public
b=Secondary contact recreation stream segment is not open to and accessible by the public under Kansas law
C=Primary contact recreation lakes that are not open to and accessible by the public under Kansas law
S=Special aquatic life use water
E = Expected aquatic life use water
X = Referenced stream segment is assigned the indicated designated use
O = Referenced stream segment does not support the indicated beneficial use
Blank=Capacity of the referenced stream segment to support the indicated designated use has not been determined by use attainability analysis

4.3 Special Aquatic Life Use and Exceptional State Waters [5]

Special Aquatic Life Use (SALU) waters are defined as "surface waters that contain combinations of habitat types and indigenous biota not commonly found in the state, or surface waters that contain representative populations of threatened or endangered species". Carry Creek, Lime Creek, Lyon Creek, Lyon Creek West Branch, and Herington Reservoir are listed as SALU waters.
Exceptional State Waters (ESW) are defined as "any of the surface waters or surface water segments that are of remarkable quality or of significant recreational or ecological value". Lyon Creek is considered an ESW.

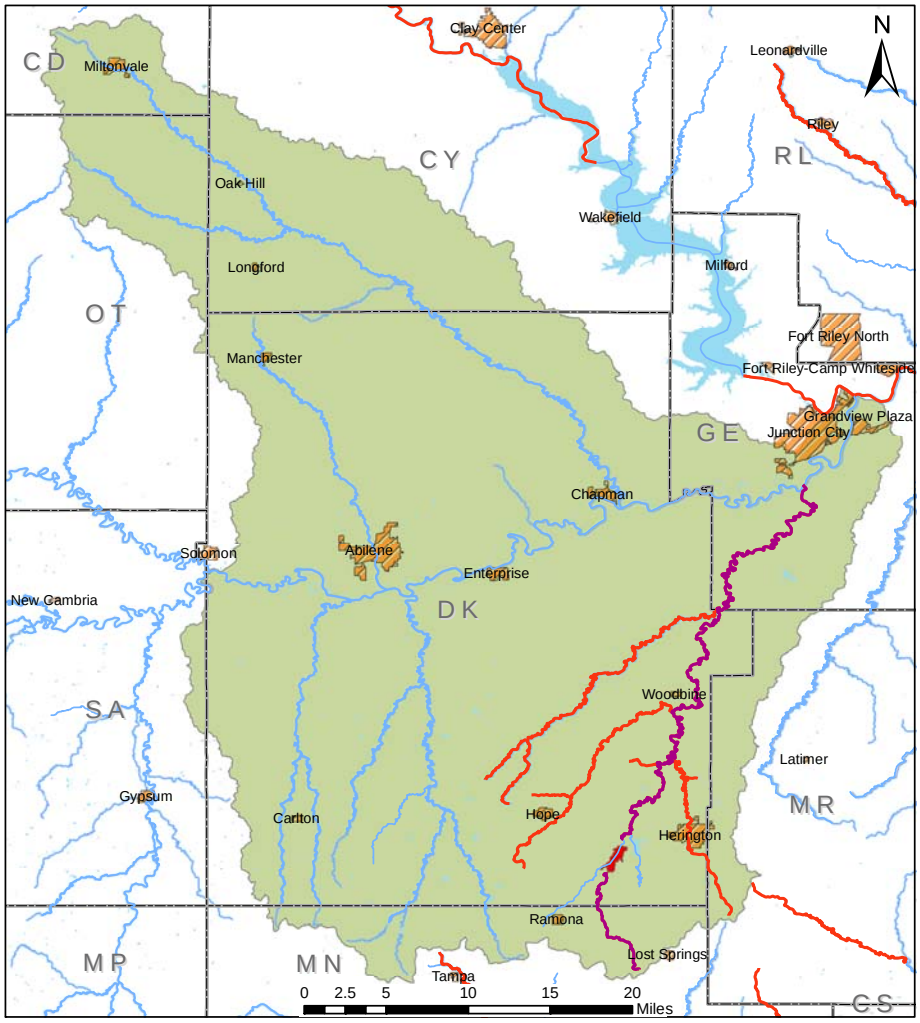


Figure 8. Special Aquatic Life Use and Exceptional State Waters.

4.4 Rainfall and Runoff

Rainfall rates and duration will affect sediment and nutrient runoff during high rainfall events. The LLS Watershed averages 33 inches of rainfall yearly. Most high intensity rainfall events will occur in late spring and early summer. This is

the time when crop ground is either bare or crop biomass is small. Also, grassland is short and does not catch runoff. Both of these situations can lead to pollutants entering the waterways.

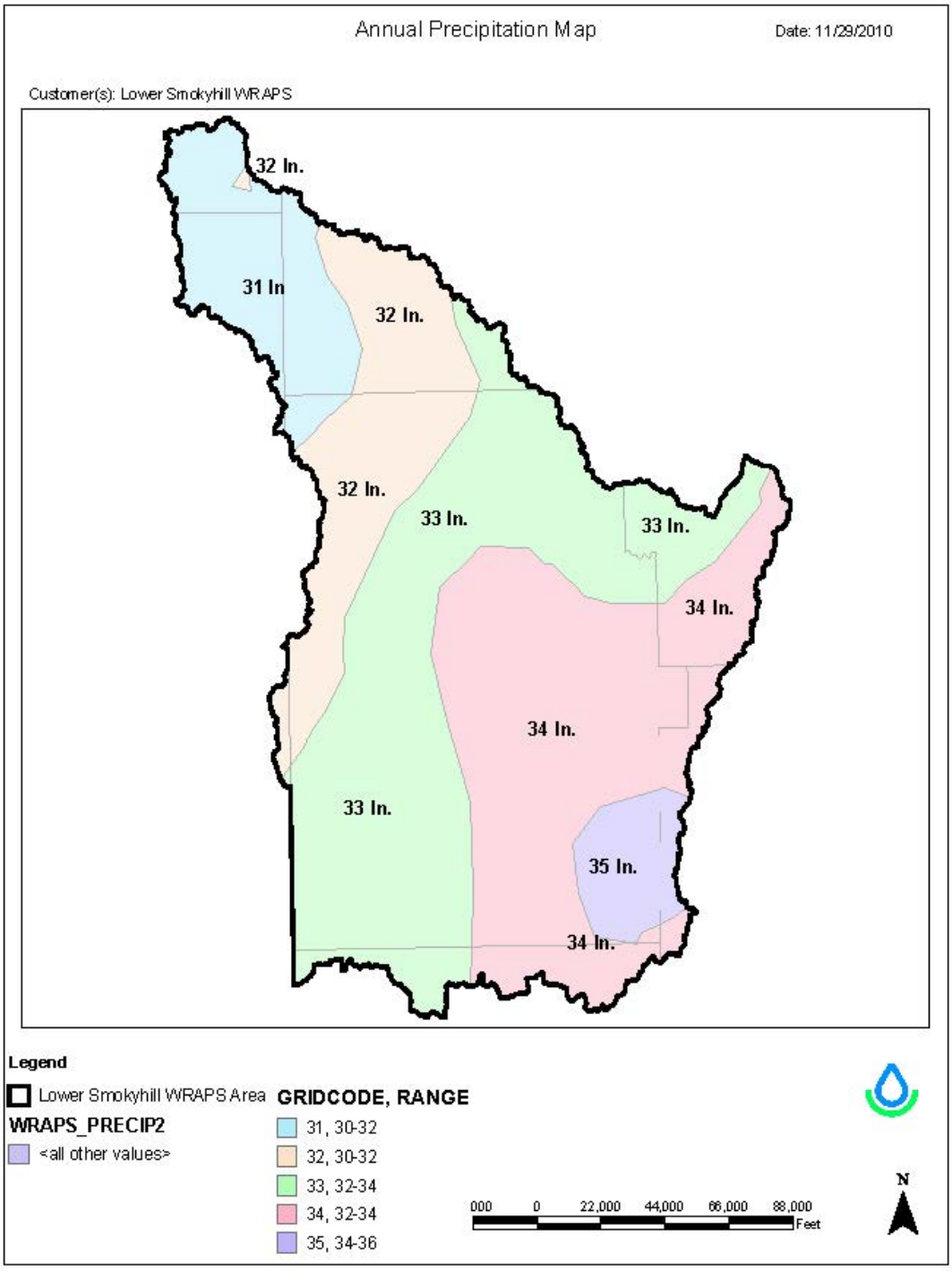


Figure 9 Average Yearly Precipitation in the Watershed. [6]

4.5 Population and Wastewater Systems

The number of wastewater treatment systems is directly tied to population, particularly in rural areas that do not have access to municipal wastewater treatment facilities. Failing, improperly installed or lack of an onsite wastewater system can contribute *E. coli* Bacteria or nutrients to the watershed through leakage or drainage of untreated sewage. There is no way of knowing how many failing or improperly constructed systems exist in the watershed. Thousands of onsite wastewater systems may exist in this watershed and the functional condition of these systems is generally unknown. However, it is estimated that ten percent of wastewater systems in the watershed are failing or insufficient. [7] Therefore, the exact number of systems is directly tied to population.

Most of the watershed would be considered below average population. Abilene and Junction City are urban areas in the watershed.

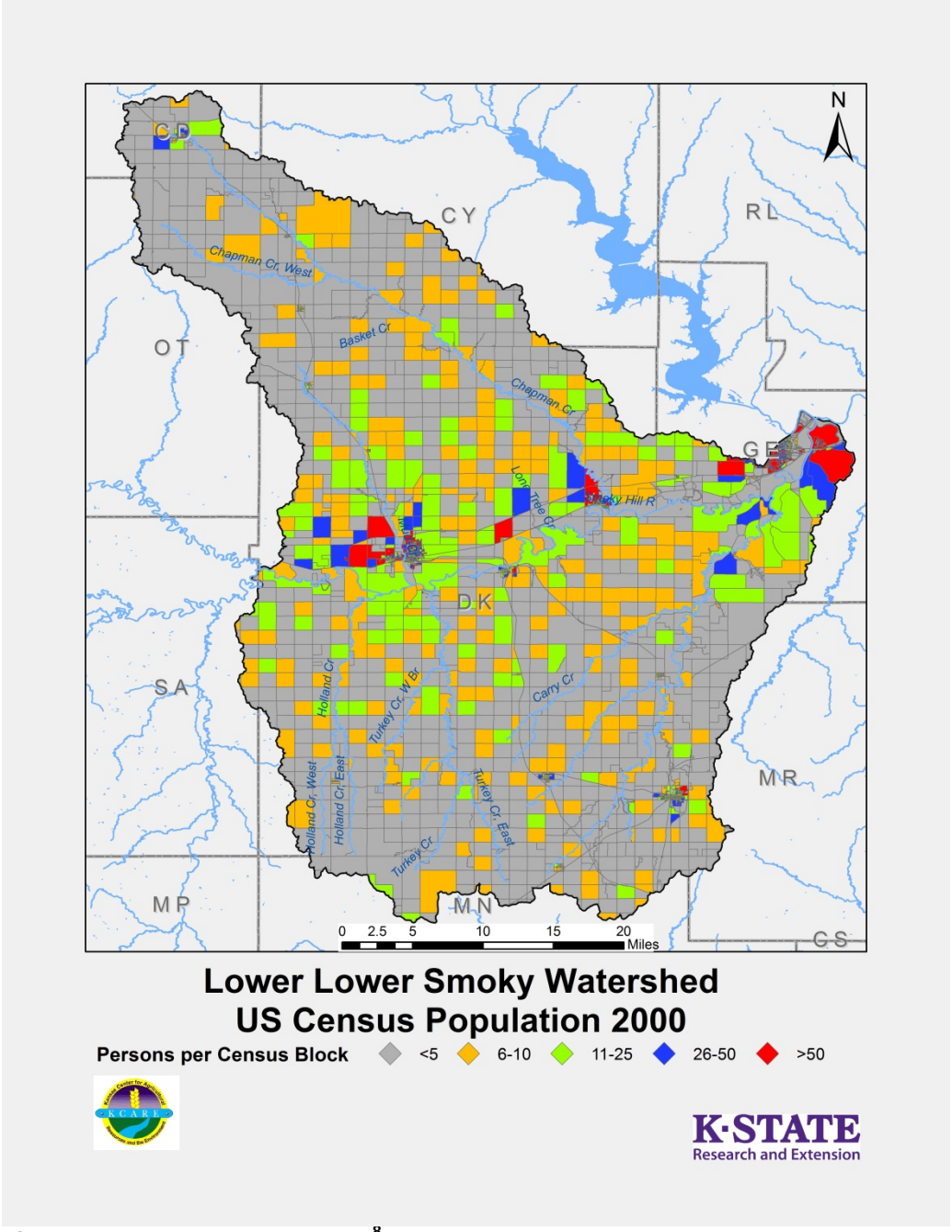


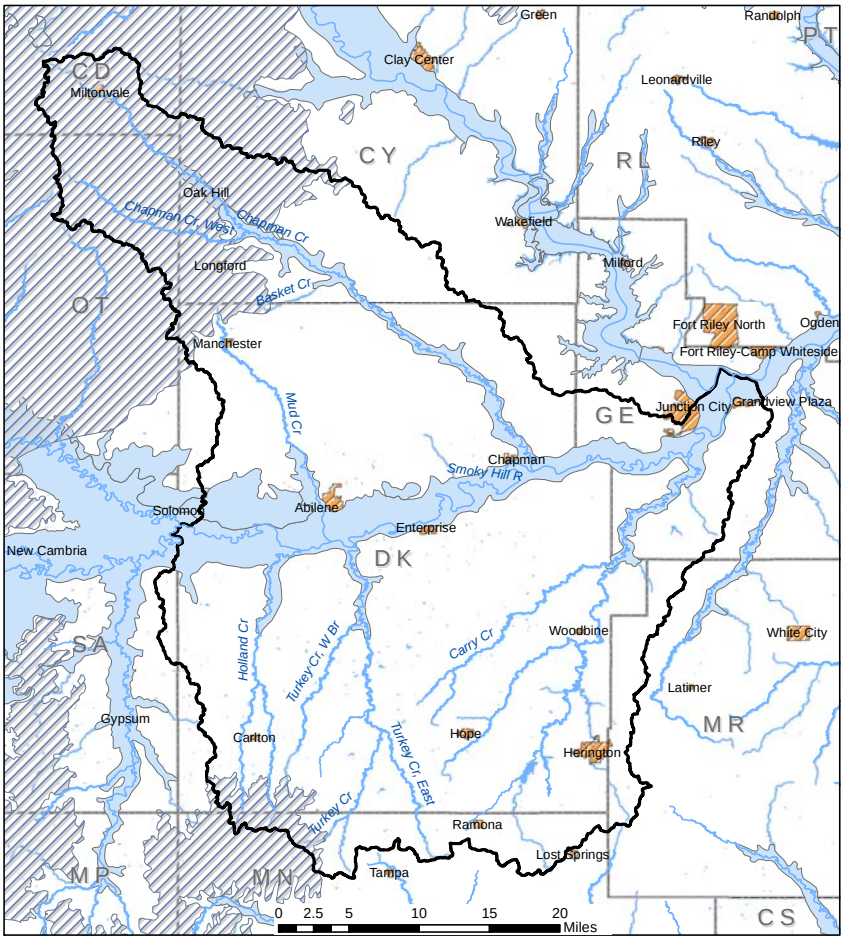
Figure 10 Census Count, 2000. [8]

4.6 Aquifers

Two aquifers underlie the watershed:

- Alluvial Aquifer - An alluvial aquifer is a part of and connected to a river system and consists of sediments deposited by rivers in the stream valleys.

- 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 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.



Lower Lower Smoky Watershed Aquifers

Dakota Aquifer

Alluvial Aquifer

Figure 11 Aquifers in the Watershed. [9]

4.7 Public Water Supply (PWS) and National Pollutant Discharge Elimination System (NPDES)

A Public Water Supply (PWS) that derives its water from a surface water supply can be affected by sediment – either in difficulty at the intake in accessing the water or in treatment of the water prior to consumption. Nutrients and bacteria will also affect surface water supplies causing excess cost in treatment prior to public consumption.

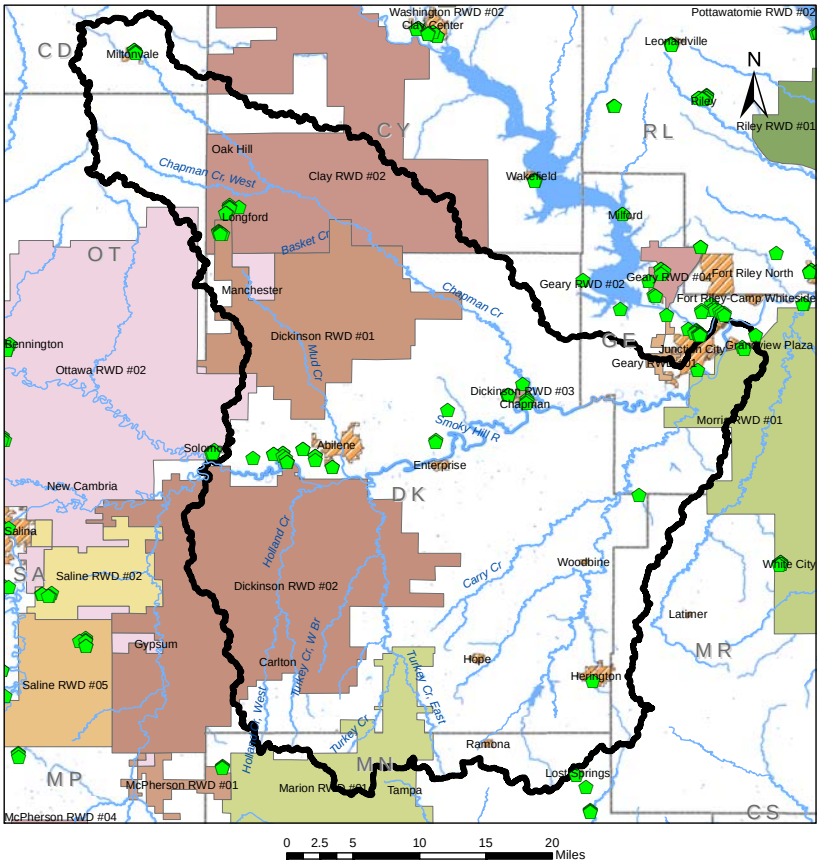
Herington Reservoir is the only surface water intake in the watershed. All other intakes are from ground water aquifers.

Table 4. Public Water Supplies in the Watershed. [10]

System Name	Pop Served	Facility Name	Local Name	Active or Inactive	Water Source
ABILENE, CITY OF	6844	WELL 18	WELL 18	A	GU
ABILENE, CITY OF	6844	WELL 14	WELL 14	A	GU
ABILENE, CITY OF	6844	WELL 03	WELL 03	A	GU
ABILENE, CITY OF	6844	WELL 09 NONPWS		I	GW
ABILENE, CITY OF	6844	WELL 21	WELL 21	A	GW
ABILENE, CITY OF	6844	WELL 15	WELL 15	A	GU
ABILENE, CITY OF	6844	WELL 02	WELL 02	A	GU
ABILENE, CITY OF	6844	WELL 19 NONPWS		I	GW
ABILENE, CITY OF	6844	WELL 17	WELL 17	A	GU
ABILENE, CITY OF	6844	WELL 05	WELL 05	A	GU
ABILENE, CITY OF	6844	WELL 16	WELL 16	A	GU
ABILENE, CITY OF	6844	WELL 06	WELL 06	A	GU
ABILENE, CITY OF	6844	WELL 20	WELL 20	A	GW
ABILENE, CITY OF	6844	WELL 13 ABANDONED	WELL 13	I	GU
ABILENE, CITY OF	6844	WELL 01	WELL 01	A	GU
ABILENE, CITY OF	6844	WELL 08 NONPWS		I	GW
BLUE RIDGE ELEMENTARY SCHOOL	62	WELL 02 SEASONAL	NORTH WELL	A	GW
BLUE RIDGE ELEMENTARY SCHOOL	62	WELL 01 EMERGENCY	SOUTH WELL	I	GW
CHAPMAN, CITY OF	1393	WELL 05	WELL 5	A	GW
CHAPMAN, CITY OF	1393	WELL 02	WELL 2	A	GW
CHAPMAN, CITY OF	1393	WELL 06	WELL 6	A	GW
CLAY CO RWD 2	950	WELL 02	WELL 02	A	GW
CLAY CO RWD 2	950	WELL 04	WELL 04	A	GW
CLAY CO RWD 2	950	WELL 01	WELL 01	A	GW
CLAY CO RWD 2	950	WELL 07	WELL 07	A	GW
CLAY CO RWD 2	950	WELL 05	WELL 05	A	GW

Public Water Supplies, cont.					
System Name	Pop Served	Facility Name	Local Name	Active or Inactive	Water Source
CLAY CO RWD 2	950	WELL 03	WELL 03	A	GW
CLAY CO RWD 2	950	WELL 06	WELL 06	A	GW
DICKINSON CO RWD 1	879	WELL 04		A	GW
DICKINSON CO RWD 1	879	WELL 10		A	GW
DICKINSON CO RWD 1	879	WELL 09		A	GW
DICKINSON CO RWD 1	879	WELL 07		A	GW
DICKINSON CO RWD 1	879	WELL 05		A	GW
DICKINSON CO RWD 1	879	WELL 02		A	GW
DICKINSON CO RWD 1	879	WELL 01		A	GW
DICKINSON CO RWD 1	879	WELL 08		A	GW
DICKINSON CO RWD 1	879	WELL 06		A	GW
DICKINSON CO RWD 2	1560	WELL 02 EMERGENCY		I	GW
DICKINSON CO RWD 2	1560	WELL 01 EMERGENCY		I	GW
ENTERPRISE, CITY OF	855	WELL 06	WELL 6	A	GW
ENTERPRISE, CITY OF	855	WELL 07	WELL 7	A	GW
FOUR SEASONS RV ACRES	25	WELL 02	WELL 02	A	GW
HERINGTON, CITY OF	2526	INTAKE 998 EMERGENCY	HERINTON LAKE INTAKE 998	I	SW
HERINGTON, CITY OF	2526	INTAKE 999	HERINGTON RESERVOIR INTAKE 999	A	SW
JOHNSTON TRAILER COURT	25	WELL 01	WELL 01	A	GW
LONGFORD, CITY OF	79	WELL 01	EAST WELL	A	GW
LONGFORD, CITY OF	79	WELL 03	WEST WELL	A	GW
M AND M MOBILE HOME COURT	46	WELL 01	WELL 01	A	GW
M AND M MOBILE HOME COURT 2	80	WELL 01	WELL 01	A	GW

Public Water Supplies, cont.					
System Name	Pop Served	Facility Name	Local Name	Active or Inactive	Water Source
M AND M MOBILE HOME COURT 2	80	WELL 02	WELL 02	A	GW
MILTONVALE, CITY OF	539	WELL 04	WELL 4	A	GW
MILTONVALE, CITY OF	539	WELL 05 EMERGENCY	WELL 5	I	GW
MILTONVALE, CITY OF	539	WELL 08	WELL 8	A	GW
RED BUD LAKE IMPROVEMENT DIST	56	WELL 01 PLUGGED		I	GW
RED BUD LAKE IMPROVEMENT DIST	56	WELL 02 PLUGGED		I	GW
ROCK SPRINGS 4H CENTER	63	INTAKE 999	INTAKE	A	GU
SOLOMON, CITY OF	1095	WELL 12 ABANDONED		I	GW
SOLOMON, CITY OF	1095	WELL 09 PLUGGED		I	GW



Lower Lower Smoky Watershed
Rural Water Districts and
Public Water Supply Intake Points

Figure 12. PWS in the LLS Watershed. [11]

Wastewater treatment facilities are permitted and regulated through KDHE. National Pollutant Discharge Elimination System (NPDES) permits specify the maximum amount of pollutants allowed to be discharged to surface waters. Having these point sources located on streams or rivers may impact water quality in the waterways. For example, municipal wastewater can contain suspended solids, biological pollutants that reduce oxygen in the water column, inorganic compounds or bacteria. Wastewater will be treated to remove solids and organic materials, disinfected to kill bacteria and viruses, and discharged to surface water. Treatment of municipal wastewater is similar across the country. Industrial point sources can contribute toxic chemicals or heavy metals. Treatment of industrial wastewater is specific to the industry and pollutant discharged. [12] Any pollutant discharge from point sources that is allowed by the state is considered to be Wasteload Allocation.

Table 5 Permitted Point Source Facilities. [13]

Facility City	County	Receiving Stream	Inactive or Active	Feature
CHAPMAN	DK	LOWER SMOKY HILL RIVER	A	LAGOON
CHAPMAN	DK	LWR. SMOKY HILL RIVER	A	LAGOON
CHAPMAN	DK		A	LAGOON
HERINGTON	DK	SMOKY HILL	A	LAGOON
JUNCTION CITY	DK	LWR SMOKY HILL R/LYON CRK	A	MECHANICAL PLANT
ABILENE	DK	SMOKY HILL RIVER/MUD CREEK	A	BUSINESS SITE
ABILENE	DK	MUD CREEK VIA UNNAMED TRIBUTARY	A	LAGOON
ABILENE	DK	MUD CREEK	A	BUSINESS SITE
CHAPMAN	GE	SMOKY HILL RIVER/OLD RIVER OXBOW	A	BUSINESS SITE
CHAPMAN	DK	SMOKY HILL RIVER/TERRAPIN LAKE	A	BUSINESS SITE
CHAPMAN	DK	SMOKY HILL RIVER VIA UNNAMED TRIB	A	FACILITY LATLONG
HERINGTON	DK	LIME CREEK	A	BUSINESS SITE
WOODBINE	DK	LYON CREEK VIA CARRY CREEK	A	BUSINESS SITE
WOODBINE	DK	WEST BRANCH LYON CREEK	A	BUSINESS SITE
JUNCTION CITY	GE	SMOKY HILL RIVER VIA UNNAMED TRIB	A	BUSINESS SITE
JUNCTION CITY	GE	GOOSE CREEK	A	BUSINESS SITE
JUNCTION CITY	GE	REPUBLICAN R	A	MECHANICAL PLANT
ABILENE	DK	SMOKY HILL RIVER	A	MECHANICAL PLANT
CHAPMAN	DK	LWR SMOKY HILL R	A	MECHANICAL PLANT
ENTERPRISE	DK	SMOKY HILL R	A	LAGOON
GRANDVIEW PLAZA	GE	LWR SMOKY HILL RIVER	A	LAGOON
HERINGTON	DK	LWR SMOKY HILL R VIA LIME CR	A	MECHANICAL PLANT
HOPE	DK	LWR SMOKY HILL R VIA WEST BR. LYON CR	A	LAGOON
LONGFORD	CY	CHAPMAN CR	A	LAGOON
MANCHESTER	DK	SMOKY HILL RIVER	A	LAGOON
MILTONVALE	CD	CHAPMAN CR	A	LAGOON
RAMONA	MN	LWR SMOKY HILL R	A	LAGOON
WOODBINE	DK		A	LAGOON
JUNCTION CITY	GE	SMOKY HILL	A	MECHANICAL PLANT
TALMAGE	DK	SMOKY HILL RIVER	A	LAGOON
JUNCTION CITY	GE		A	BUSINESS SITE
ABILENE	DK		A	BUSINESS SITE

Figure 13 NPDES Wastewater Treatment Plants (WTP).

4.8 Total Maximum Daily Loads in the Watershed

A Total Maximum Daily Load (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 provide a tool to target and reduce point and nonpoint pollution sources. 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. [14] In summary, TMDLs provide a tool to target and reduce point and nonpoint pollution sources. The goal of the WRAPS process is to address high priority TMDLs.

The LLS Watershed has several impaired waters that will be directly targeted by BMP implementation of the LLS Watershed 9 Element Plan. The Smoky Hill River from Salina to Junction City has a high priority for TSS. The Herington Reservoir also has a high priority for Eutrophication. A 303d list of impaired waters is developed biennially and submitted by KDHE to EPA. To be included on the 303d 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. TMDL development and revision for waters of the LLS Watershed is scheduled to begin in 2012.

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 Smoky Hill Basin.

Table 6. TMDLs Review Schedule for the Smoky Hill Basin. [15]

Year Ending in September	Implementation Period	Possible TMDLs to Revise	TMDLs to Evaluate
2014	2015-2024	2003, 2004	2003, 2004, 2006

Pollutants are assigned “categories” depending on stage of TMDL development: [16]

- 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 impairment
- 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

TMDLs in the watershed are listed in the table below.

Table 7. TMDLs in the Watershed. [17]

Category	Water Segment	TMDL Pollutant	Priority	Sampling Station
4a - Has TMDL and remains impaired	Holland Creek	Dissolved Oxygen	High	SC642
4a - Has TMDL and remains impaired	Smoky Hill River at Enterprise	Biology	Medium	SC268
4a - Has TMDL and remains impaired	Smoky Hill River (Enterprise)	SO4	Low	SC265
4a - Has TMDL and remains impaired	Smoky Hill River at Junction City	S04	Low	SC264
4a - Has TMDL and remains impaired	Turkey Creek (Abilene)	SO4	Low	SC644
4a - Has TMDL and remains impaired	Smoky Hill River (Salina to Junction City)	TSS	High	SC265, SC264
4a - Has TMDL and remains impaired	Holland Creek	SO4	Low	SC642
4a - Has TMDL and remains impaired	Smoky Hill River (Junction City)	Cl	Low	SC264
4a - Has TMDL and remains impaired	Smoky Hill River (Enterprise)	Cl	Low	SC265
4a - Has TMDL and remains impaired	Carry Creek	SO4	Low	SC708
4a - Has TMDL and remains impaired	Mud Creek (Abilene)	SO4	Low	SC643
4a - Has TMDL and remains impaired	Chapman Creek	SO4	Low	SC515
4a - Has TMDL and remains impaired	Herington Reservoir	EU	High	LM047201
4a - Has TMDL and remains impaired	Herington Reservoir	DO	High	LM047201
4a - Has TMDL and remains impaired	Herington Reservoir	Atr	Medium	LM047201
4a - Has TMDL and remains impaired	Herington City Park Lake	EU	Low	LM072801
4a - Has TMDL and remains impaired	Herington City Lake	EU	Low	LM69701
4a - Has TMDL and remains impaired	Geary CO SFL	EU	Medium	LM043201
Key:		Impaired waters that will be positively affected by BMP implementation		

Key, cont.		Impaired waters that will not be affected by BMP implementation
		Impaired waters that will be directly targeted by BMP implementation of L.L. Smoky 9 element plan

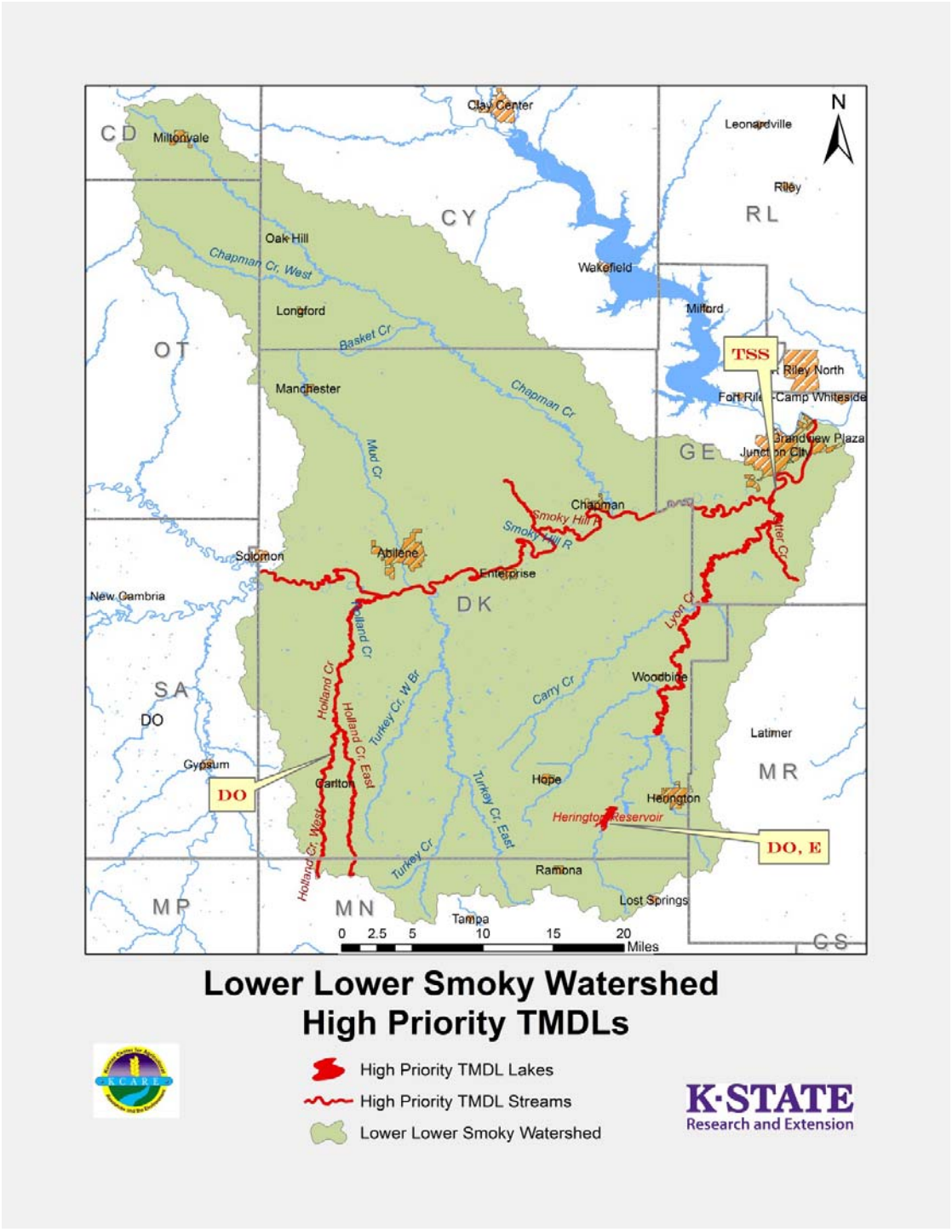


Figure 14 TMDLs in the Watershed. [18]

4.9 303d Listings in the Watershed

The LLS Watershed has new listings on the 2012 "303d list". A 303d list of impaired waters is developed biennially and submitted by KDHE to EPA. To be included on the 303d 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 (refer to page 24) are not met. TMDL development and revision for waters of the LLS Watershed is scheduled for 2012. 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 [19] two years until the pollutant can be assessed, the priority will be listed as "low".

Table 8. 2012 303d List of Impaired Waters in the LLS Watershed. [20]

Category	Water Segment	TMDL Pollutant	Priority	Sampling Station
5 - Waters needing TMDL	Smoky Hill River at Junction City	Biology, Total Phosphorus	Low	SC264
5 - Waters needing TMDL	Holland Creek Near Sand Springs	Selenium	Low	SC642
5 - Waters needing TMDL	Smoky Hill River at Junction City	Lead	Low	SC264
5 - Waters needing TMDL	Smoky Hill River at Enterprise	Total Phosphorus	Low	SC265
5 - Waters needing TMDL	Mud Creek near Abilene	Total Phosphorus	Low	SC644
5 - Waters needing TMDL	Chapman Creek near Sutphen	Total Suspended Solids	Low	SC515
5 - Waters needing TMDL	Herington Reservoir	Siltation	Low	LM047201
Key:		Impaired waters that will be positively affected by BMP implementation		
		Impaired waters that will not be affected by BMP implementation		

Land use composition can have a significant effect on the types and quantity of nonpoint source pollutants in the watershed. NPS pollution occurs as water moves across the land or through the ground and picks up natural and human made pollutants. Non-point pollution sources are the greatest threat to the river and stream's improved water quality in our watershed. The main contaminants in the LLS Watershed include Total Suspended Solids (TSS), nitrogen (N) and phosphorous (P), and eutrophication and dissolved oxygen at the Herington Reservoir. The WRAPS SLT will focus their efforts on the reduction of these NPS pollutants through the reduction of sediment and nutrients.

According to KDHE monitoring station SC265, the Smoky Hill River at Enterprise has among the highest median TSS concentration statewide, and because this river contributes to the publicly accessible recreation resources on the Kansas River downstream, this TMDL is a High Priority for implementation. Water quality with regard to total suspended solids (TSS) in the Smoky Hill River is consistently poor through all seasons. Summary statistics from KDHE monitoring data indicates that in all seasons (except SC265 winter) the TSS median concentration at both stations included in this analysis exceeds 50 mg/L, and the overall median is also greater than 50 mg/L. Substantial areas of bank erosion exist along the major rivers in this area. Banks are typically between 15 and 20 feet high, and sloughing/erosion are likely to contribute substantially to the TSS load at these monitoring stations.

During the late 1960's or early 1970's a significant section of the Smoky Hill River was channelized in and around the community of Salina. While this channelization is immediately monitored by SC268, the full impacts on the river are likely not fully evident until SC265 at Enterprise. The section of river that was channelized was previously 25.3 miles long, and is presently 8.5 miles long. This loss of channel length has likely contributed substantially to the bank instability observed along the Smoky Hill River between Salina and Junction City, primarily by increasing discharge strength due to reduced energy dispersion and increased channel slope.

The Watershed Institute has done an erosion assessment on the Smoky Hill River mainstem from Solomon to Junction City. They completed 21 geomorphology streambank surveys and evaluated an additional 43 sites using historic and current aerial photography. For the 21 surveyed sites, the model estimated an 87-percent average reduction in erosion loss after establishing BMPs. BMPs included the use of rock bendway weirs, longitudinal peaked stone toe protection, excavating the banks to a 3 foot horizontal to 1 foot vertical slope, and planting the banks using native trees, shrubs, and grasses.

The Herington Reservoir also has a high priority ranking for eutrophication and dissolved oxygen. Eutrophication refers to natural or artificial addition of nutrients to bodies of water and to the effects of the added nutrients. When the effects are undesirable, eutrophication may be considered a form of pollution. These nutrients may be the result of human activity such as fertilizer runoff, septics, sewage discharge, etc.

Dissolved oxygen levels in water are impacted by four major factors: water movement, plant life, water temperature and decaying organic matter. Water that is still has very low levels of DO, while a white-water river would have very high levels. Plant life is another source of dissolved oxygen. During photosynthesis plants store the sugar for their own use, but the oxygen is a waste product to the plant. When the plant is in the water, the oxygen is dissolved into the water. Cooler water can also hold more dissolved oxygen than

warm water. DO levels can vary quickly in shallow bodies of water that are fully exposed to the sun. When plants and animals die and fall to the bottom of the lake they decompose. This decomposition process is done by bacteria which consumes dissolved oxygen to do their work. If a body of water has a lot of decaying organic material in it, the bacteria can quickly deplete the oxygen levels.

4.10 Load Reductions [21]

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. This is the amount 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 BMPs derived by the SLT will be directed at this Load Allocation by nonpoint sources.

4.10.1 Load Reductions to Meet the Siltation TMDL in LLS Watershed

KDHE has set a required load reduction goal for sediment in LLS originating from nonpoint sources. It is derived from subtracting the TMDL from the current loading in the watershed. This is the amount that the LLS Watershed will need to remove through BMP installations, conservation practices and streambank and riparian restorations.

Table 9. Load Reductions to Meet Siltation TMDL Smoky Hill River. [22]

	Annual Loading of Sediment (tons)
Current Condition	71,540
Less TMDL	25,477
Required Load Reduction from Nonpoint Sources	**48,545**

Figure 15. Sediment Load Reduction for LLS Watershed. *Above diagram only accounts for TSS loads at median flow, 50% exceedance.

4.10.2 Load Reductions to Meet Eutrophication TMDL for Herington Reservoir

KDHE has set a required load reduction goal for phosphorus for Herington Reservoir originating from nonpoint sources. It is derived from subtracting the TMDL from the current loading in the lake. This is the amount that the LLS Watershed will need to remove through BMP installations and conservation practices.

Table 10. Load Reductions to Meet Eutrophication TMDL for Herington Lake. [23]

	Annual Loading of Phosphorus (pounds)
Current Condition (SWAT calculated)	6,368
Less TMDL	2,087
Required Load Reduction from Nonpoint Sources	**4,281**

Figure 16. Phosphorus Load Reduction for Herington Lake.

5.0 Critical and Targeted Areas, and Load Reduction Methodology

5.1 Critical Areas

In the LLS Watershed, "Critical Areas" have been identified as areas that need to be protected or restored, such as areas that have TMDLs, emerging pollutant threats, on the 303d list or contain a public water supply. Critical areas are defined by EPA as geographic areas that are critical to implement management practices in order to achieve load reductions. [24]

This WRAPS Plan will target specific land within these critical areas and in doing so will meet TMDL and 303d needs in all areas.

5.2 Targeted Areas

"Targeted Areas" are those specific areas in the Critical Areas that require BMP placement in order to meet load reductions. Therefore, the SLT has targeted areas within the sub watersheds to focus BMP placement for Total Suspended Solids (TSS) and Nutrients (primarily phosphorus). Areas and impairments targeted for these sub watersheds are:

1. Cropland areas targeted for sediment and nutrient runoff
2. Livestock areas targeted for nutrient runoff
3. Streambank for sedimentation

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

Table 11. Overlapping Targeted Areas for Cropland, Livestock.

Targeted Areas	Cropland Tier 1	Cropland Tier 2	Livestock
102600080402	X		X
102600080405			X
102600080502			X
102600080503			X
102600080504			X
102600080605	X		
102600080701			X
102600080705	X		
102600080706	X		
102600080801		X	X

Targeted Areas, cont.	Cropland Tier 1	Cropland Tier 2	Livestock
102600080802		X	
102600080803		X	
102600080804	X		
102600080805	X		

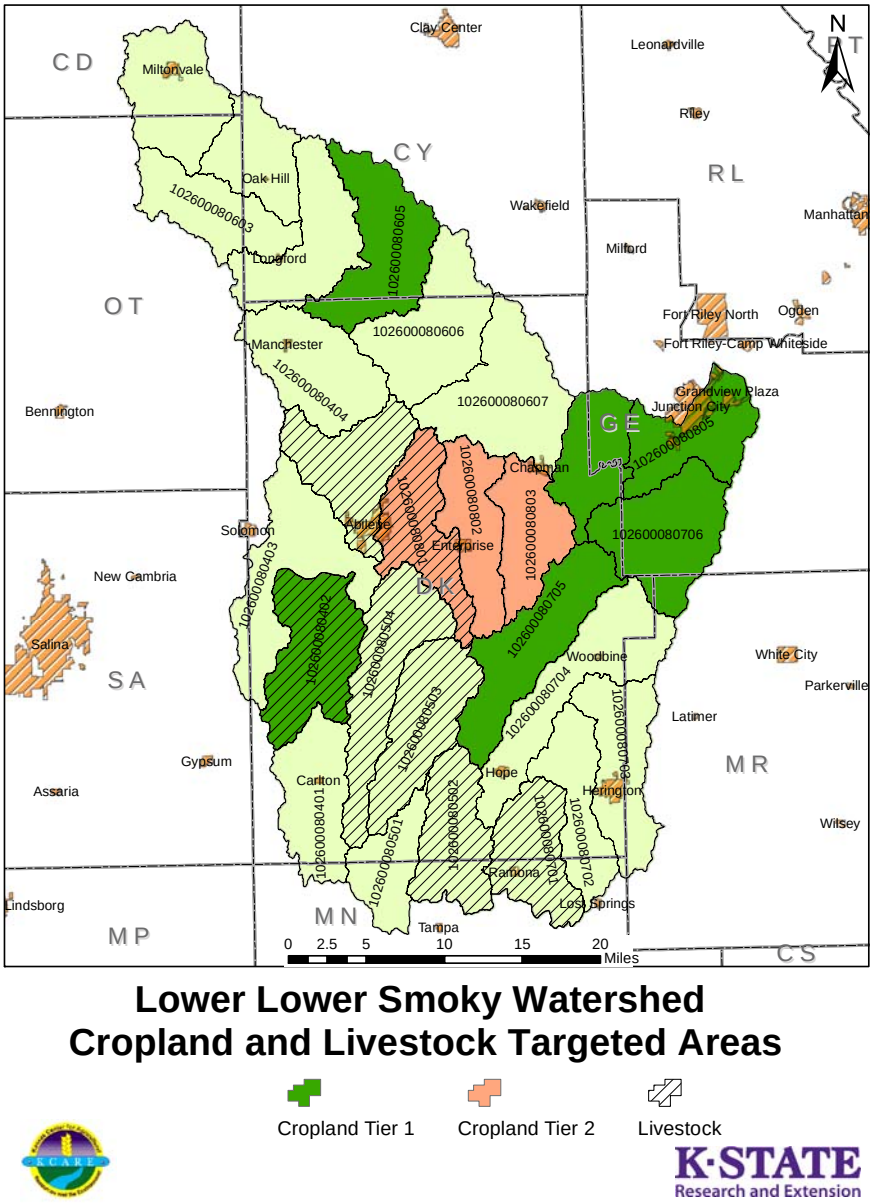


Figure 17. Targeted Areas for Cropland Tier 1, Cropland Tier 2, and Livestock.

5.2.1 Cropland Targeted Areas

Erosion from cropland runoff within the LLS River watershed is thought to be a contributing source of sediment loading which is contributing to the Smoky Hill River High Priority TSS TMDL (still in draft status June 2011) within the WRAPS project area. A variety of tools can be utilized to characterize sediment loading from cropland-related sources. For the LLS WRAPS project area KDHE has developed a STEPL model to characterize nutrient and sediment loading originating from HUC 12 watersheds. STEPL, or Spreadsheet Tool for Estimating Pollutant Loads, is a Microsoft Excel based model which utilizes algorithms to calculate estimated nutrient and sediment loads resulting from differing land uses for selected watersheds. This tool can also be utilized to evaluate estimated load reductions resulting from BMP implementation within modeled watersheds. Results of the STEPL model are shown within this 9 Element Plan. Additional information regarding STEPL can be found at the following website: http://it.tetratech-ffx.com/steplweb/.

In every watershed, there are specific locations that contribute a greater pollutant load due to soil type, proximity to a stream and land use practices. By focusing BMPs in these areas; pollutants can be reduced at a more efficient rate. Through research, it has been shown that there is a “bigger bang for the buck” with streamlining BMP placement in contrast to a “shotgun” approach of applying BMPs in a random nature throughout the watershed. Therefore, the SLT has targeted areas in the watershed to focus BMP placement for sediment and nutrient runoff. Targeting for this watershed will be accomplished in three different areas:

1. Cropland areas will be targeted for sediment and nutrients (phosphorus and nitrogen).
2. Livestock areas will be targeted for nutrients (phosphorus).
3. Streambank areas will be targeted for sediment and nutrients (phosphorus.

The maps produced by the modeling are displayed on the following pages. It is noted that the darker or brighter the color on the map, the higher the pollutant load potential. The model accounts for land use, soil type, slope, and current conservation practices.

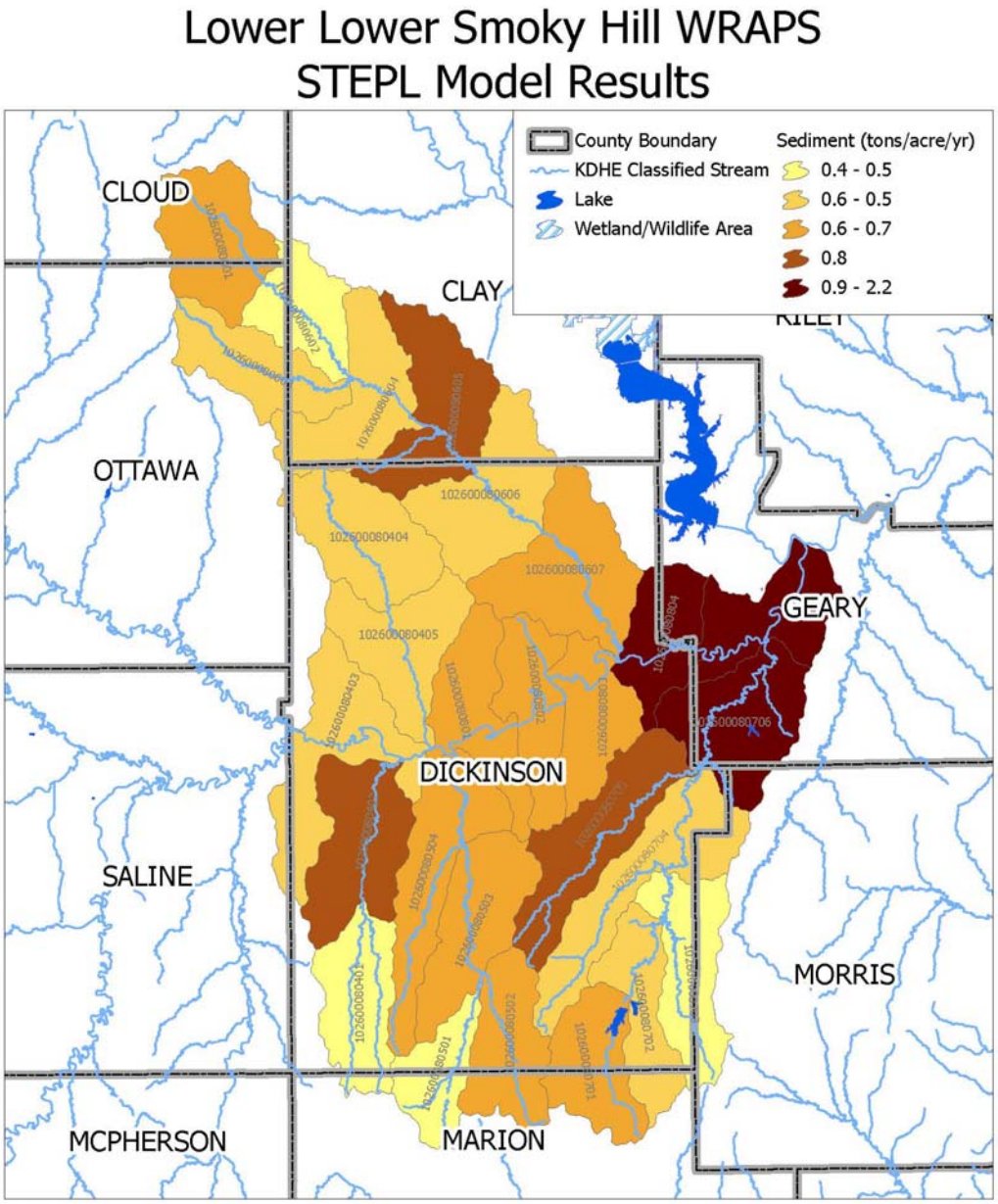


Figure 18. STEPL Sediment Results [25]

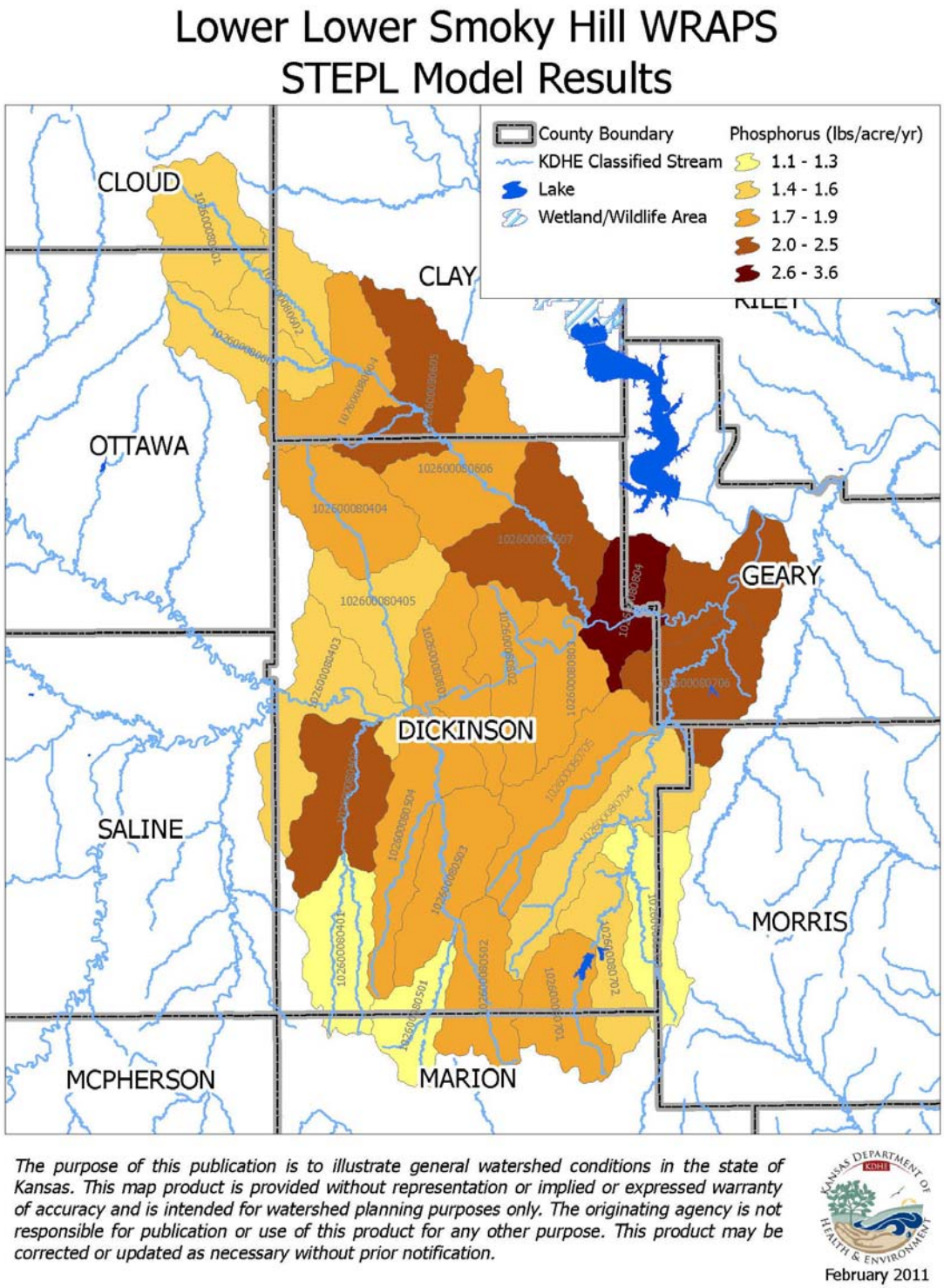


Figure 19. STEPL Phosphorus Results [25]

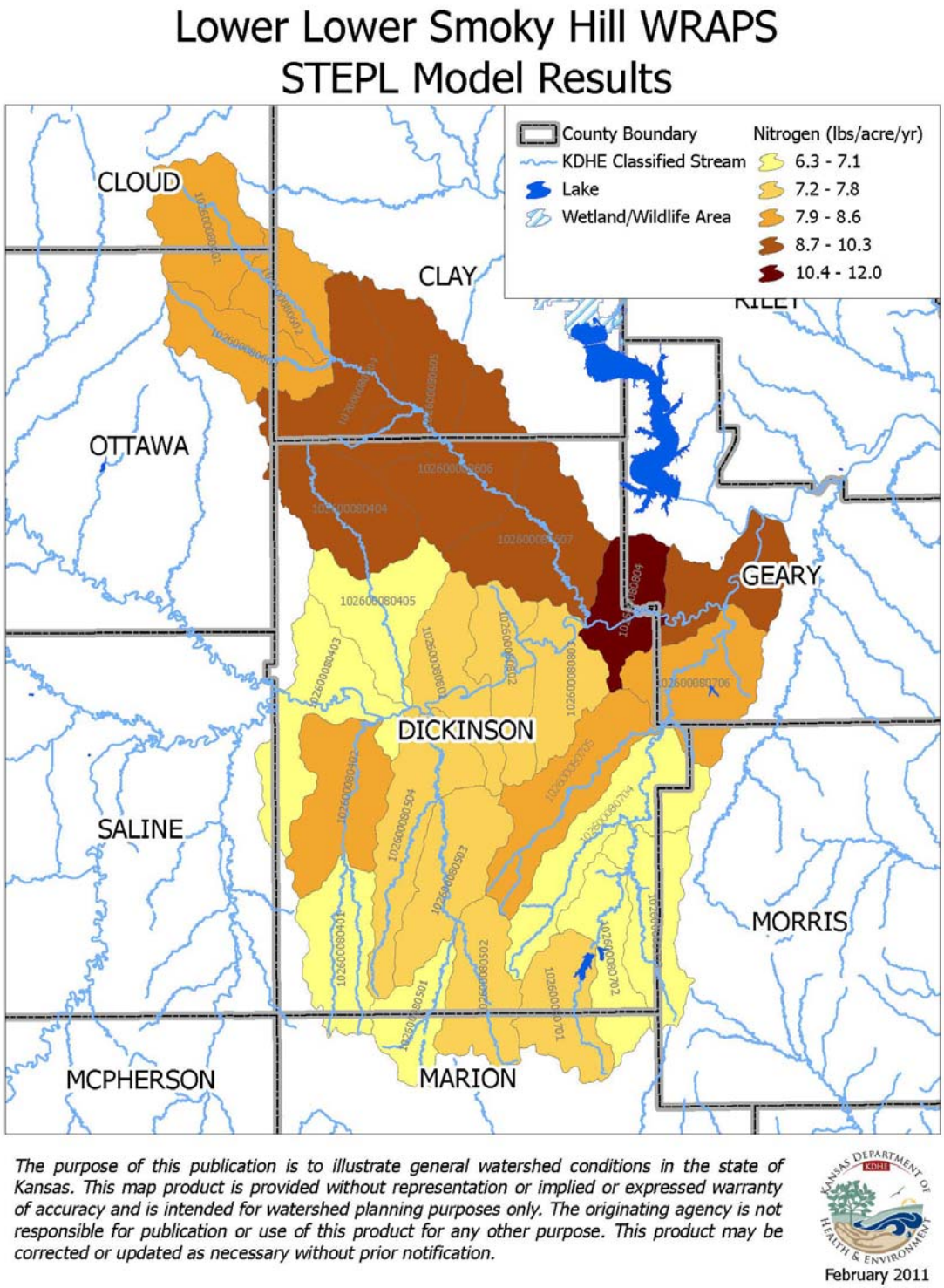


Figure 20. STEPL Nitrogen Results [25]

5.2.1.A Needs Inventory

KDHE surveyed the county conservation districts for land treatment "needs" in 2005. The districts completed a spreadsheet indicating the number of acres for each land use type that were in need of structural and/or nonstructural land treatment.

Table 12. Needs Inventory for Dickinson County. [26]

Kansas NPS Needs Inventory By County		
Dickinson County		
Acres Cropland Needing Treatment (a)	Avg. Treatment Cost (Cropland) (g)	Total County Treatment Cost (Cropland)
110,100	$125	$13,762,500
Acres Pasture/Rangeland Needing Treatment (b)	Avg. Treatment Cost (Range/Pasture) (h)	Total County Treatment Cost (Pasture/Rangeland)
57,933	$25	$1,448,325
Livestock Facilities Requiring Treatment (Cattle) (c)	Avg. Treatment Cost Per Facility (i)	Total County Treatment Cost (Livestock Facilities)
962	$7,500	$7,215,000
Failing Septic Systems (d)	Avg. Cost For Upgrade/Replacement (j)	Total County Septic System Upgrade/Replacement Cost
1337	$4,500	$6,016,500
Hydromodification (Stream Miles Needing Treatment) (e)	Avg. Cost For Stream Bank Stabilization (k)	Total County Hydromodification Cost
48	$79,200	$3,801,600
Active 319 Projects (f)	Cost Per 319 Project (l)	
Sand Springs Aquifer-NPS Pollution Control Project	$96,000	
		Total County 319 Project Cost
		$96,000
Total County NPS Need		**$32,339,925**

The STEPL model results and land owner information were presented to the SLT. After discussion by the SLT, cropland HUC 12 Targeted Areas were decided upon. After determining the Targeted Areas, the SLT decided upon BMPs that they felt would be beneficial to improving water quality and, using their knowledge of the watershed, would be acceptable to producers and landowners. The SLT then examined the Needs Inventory seen in Table 12 to determine if there was a need for all of the necessary types and quantities of BMPs chosen for implementation. The BMPs that will be implemented in the Cropland Targeted Area for this watershed are:

- Implement no-till cropping
- Install grassed waterways

- Install vegetative buffers
- Implement nutrient management plans
- Install terraces
- Establish permanent vegetation
- Install water retention structures

The STEPL model distinguished Tier 1 and Tier 2 for implementation. The SLT will focus BMP installation in Tier 1 first and Tier 2 second.

5.2.2 Livestock Targeted Area

The Livestock Targeted Area was determined by landowner input and examining CAFO maps and the phosphorus TMDL HUC 12s. The area will be targeted for phosphorus.

Based on SLT opinion of landowner and producer acceptability, the BMPs that will be implemented for this watershed are:

- Establish vegetative filter strips
- Relocate feeding pens
- Relocate pasture feeding sites
- Install off stream watering systems
- Rotational grazing

5.2.3 Streambank Targeted Area

The Stakeholder Leadership Team (SLT) identified improving streambank stabilization along the course of the Smoky Hill River as one major objective that would aid in the decrease in sedimentation/siltation. Subsequently, the SLT contacted The Watershed Institute, Inc. (TWI) to analyze streambank erosion potential.

Targeted Areas were identified by *The Watershed Institute's* (TWI) Assessment of the LLS Watershed from Solomon to Junction City in 2011. The following information was provided in the Assessment by TWI.

"Under contract to the Kansas State Research & Extension, TWI completed 21 geomorphology streambank surveys and evaluated an additional 43 sites using historic and current aerial photography in preparation of the report. TWI used aerial photography and photo-revised topography maps to predict streambank erosion rates. The field data TWI collected were used to populate the Rosgen (2006) Bank Erodibility Hazard Index (hereinafter, "BEHI") model in RIVERMorph stream restoration software. TWI used these indices to estimate the reduction in streambank erosion through best management practice implementation.

The 21 sites TWI surveyed and the additional 43 sites TWI evaluated comprised of 108,255 linear feet of streambank. Time-weighted erosion rates varied from 2.2 to 14.6 feet per year. The combined average annual erosion loss estimate was 422,827 cubic yards. Most sites had sparse vegetation at the top of bank with steep banks dominated by sand. The average bank height was 24.5 feet. The average radius of curvature was 693 feet and the average radius of curvature to channel width ratio was 3.4. The greatest amount of erosion occurs at sites with a radius of curvature to channel width ratio between 2 to 5.

BMP scenarios were used in the BEHI model to predict the reduction in streambank erosion using the Bank Assessment for Non-Point Consequences in Sediment (hereinafter, "BANCS") model developed by Rosgen (1996). For the 21 surveyed sites, the model estimated an 87 percent average reduction in erosion loss after establishing BMPs. BMPs included the use of rock bendway weirs, longitudinal peaked stone toe protection, excavating the banks to a 3 foot horizontal to 1 foot vertical slope, and planting the banks using native trees, shrubs, and grasses.

TWI used the data to prioritize sites for streambank stabilization projects. Instead of prioritizing individual sites, TWI combined sites into nine groups. If future streambank stabilization projects were to commence, TWI recommends completing projects in groups. There were 8 sites TWI examined that were not combined into the other nine groups as they were either isolated geographically from other sites, or there were stable meanders upstream and downstream of the site.

Based on the erosion loss by group, TWI gave priority to groups with higher annual erosion loss rates. TWI also identified sites that are not good candidates for streambank stabilization. These included sites that are about to initiate a channel change by cutting off a channel meander. The table below provides the group ranking, bank erosion summary, and cost estimate to implement BMPs for the nine groups. Cost estimates were based on local quarry prices and costs associated with previously completed streambank stabilization projects."

The top 2 sites for erosion reduction were chosen by the SLT for inclusion into this report. They are Sites 87 and 19. Although site 19 is identified as the second worse site with respect to erosion loss, it is not a site that TWI would recommend for streambank stabilization. It is already about to cut through at the meander, therefore a much greater gain in long term use and return would be realized with site 13. Both 13 and 19 are included in group 2. It would also be advantageous to do more than one site within a reach to maximize the benefits of the streambank stabilization.

Site 87 is the site that ranked highest of all for average annual erosion rate (13.4 feet per year), but all of the other sites in that grouping (group 8) were much lower in comparison. The average annual erosion rate for this reach was about

the same as group 7 which had erosion rates much more consistent overall. Therefore, group 7 was given a higher priority to target any streambank stabilization projects. It is hard to predict what the change in dynamics of flow would be within each group, but TWI felt that these two reaches would have the greatest benefit for the Smoky Hill.

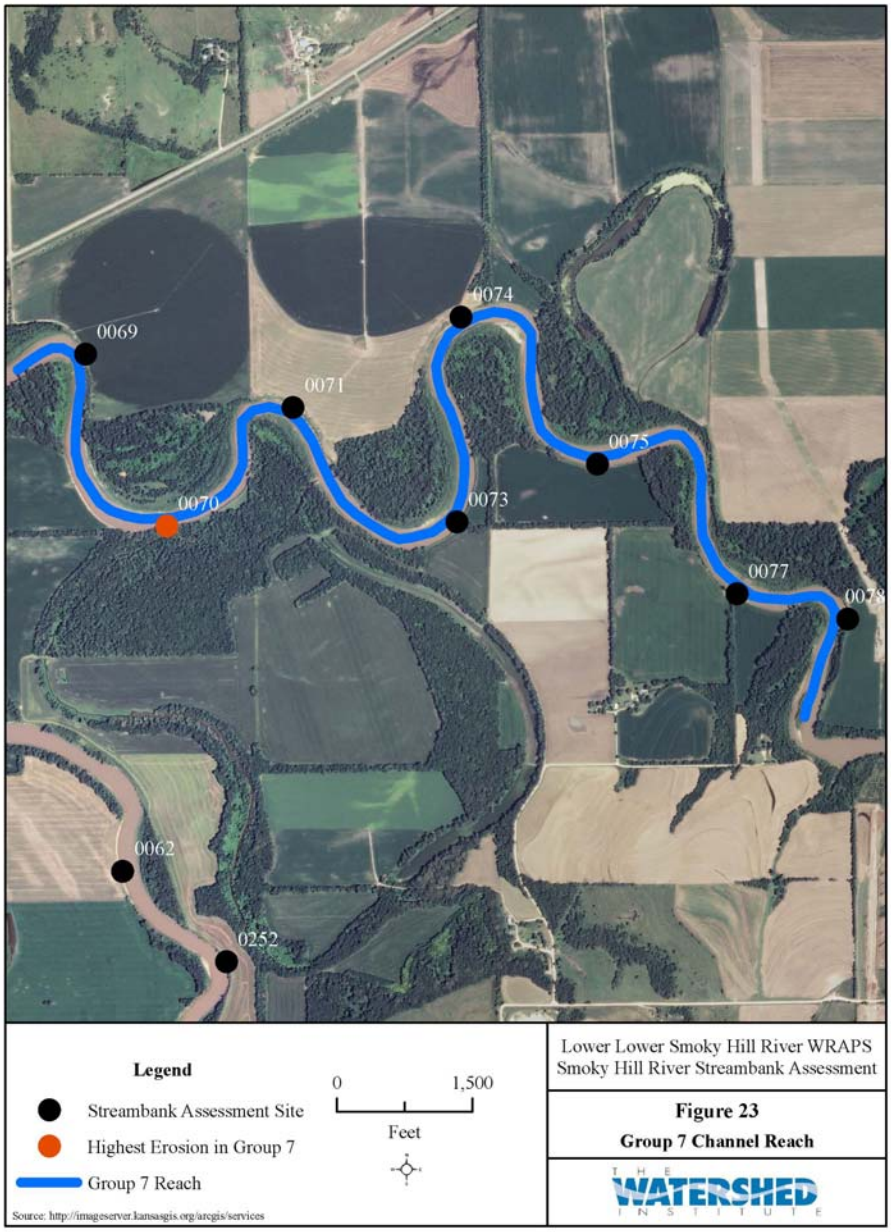
However, the final published report from TWI has not been received as of the date of this WRAPS report; therefore, some of these anticipated sites may be open for revision.

Table 13. Streambank Stabilization Priority Rankings [27]

Rank	Group	Average Annual Erosion Rate (ft/year)	Average Annual Erosion Loss (cubic yards)	Estimated BMP Cost
1	2	8.3	118,548	$1,677,763.55
2	7	7.3	60,317	$933,761.25
3	3	6.0	56,489	$963,521.50
4	1	5.1	51,900	$964,850.77
5	8	7.4	47,035	$679,482.64
6	5	5.7	36,301	$672,296.39
7	9	6.8	31,602	$497,247.82
8	4	11.0	19,389	$237,368.60
9	6	4.7	15,088	$342,774.57

A-14

Figure 21. Group 2 Streambank Stabilization Projects. [27]



A-19

Figure 22. Group 7 Streambank Stabilization Projects. [27]

5.3 Load Reduction Estimate Methodology

5.3.1 Cropland

Baseline loadings are calculated using the AnnAGNPS model delineated to the HUC 12 watershed scale. BMP load reduction efficiencies are derived from K-State Research and Extension Publication MF-2572. [28] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

5.3.2 Livestock

Baseline nutrient loadings per animal unit are calculated using the Livestock Waste Facilities Handbook.[29] Livestock management practice load reduction efficiencies are derived from numerous sources including K-State Research and Extension Publication MF-2737 and MF-2454.[30] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

5.3.3 Streambank

A 2010 study of 21 geomorphology streambank surveys and evaluations of an additional 43 sites using historic and current aerial photography was conducted by The Watershed Institute (TWI) on the Smoky Hill River. TWI used this information to prioritize sites for streambank stabilization projects. Instead of prioritizing individual sites, TWI combined sites into nine groups. If future streambank stabilization projects are to commence, TWI recommends completing projects in the groups identified in the following table. There were eight sites TWI examined that are not combined in the nine groups as they are either isolated geographically from other sites, or there are stable meanders upstream and downstream of the site.

Based on the erosion loss by group, TWI gave priority to groups with higher annual erosion loss rates. TWI also identified sites that are not good candidates for streambank stabilization. These included sites that are about to initiate a channel change by cutting off a channel meander. The table below provides the group ranking and the cost estimate to implement BMPs. Cost estimates were based on local quarry prices and costs associated with previously completed streambank stabilization projects.

Table 14. Rankings and Costs of Targeted Streambank Sites.

RANK	GROUP	ESTIMATED BMP COST
1	2	$1,677,763.55
2	7	$933,761.25

Rankings, cont.		
RANK	**GROUP**	**ESTIMATED BMP COST**
3	3	$963,521.50
4	1	$964,850.77
5	8	$679,482.64
6	5	$672,296.39
7	9	$497,247.82
8	4	$237,368.60
9	6	$342,774.57

NOTE: The SLT of the LLS Watershed has determined that the focus of this WRAPS process will be on two key concerns of the watershed listed in order of importance:

1. **Sedimentation caused by:**
    a. **Cropland erosion**
    b. **Streambank erosion**
2. **Nutrients runoff caused by:**
    a. **Livestock**
    b. **Cropland**
    c. **Streambank**

All goals and best management practices will be aimed at restoring water quality or protecting the watershed from further degradation. The following sections in this report will address these concerns.

6.0 Impairments Addressed by the SLT

6.1 Sediment

LLS Watershed has a high priority TMDL for **siltation**. BMP implementation and load reductions in this report will refer to sediment and sedimentation, the TMDL will refer to siltation. The SLT hopes that the sediment BMPs that will be incorporated in the watershed will reduce excess silt in the Smoky Hill River.

Sediment that originates in this watershed will eventually accumulate in lakes and wetlands downstream. This reduces reservoir volume and therefore, limits public access to the lakes because of inaccessibility to boat ramps, beaches and the water side. Also, a decrease in storage in the lake affects domestic and industrial uses of the lake water. Sediment can originate from streambank erosion and sloughing of the sides of the streams due to erosion and a lack of riparian cover. Sheet and rill erosion from cropping and pasture systems contributes sediment in the ecosystem. Therefore, reducing erosion is necessary for accomplishing a reduction in sediment. Agricultural BMPs such as 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. These are some of the BMPs that will be the focus of this WRAPS plan.

Physical components and activities performed on the land affects sediment movement. Some are:

- Slope of the land, propensity to generate runoff and soil type

- Streambank erosion and sloughing or undercutting of the sides of the stream bank. A lack of riparian cover can cause washing on the banks of streams and enhance erosion.
- Animal movement, such as livestock that regularly cross the stream or follow trails in pastures, can cause pathways that will erode.
- Silt that is present in the stream from past activities and is gradually moving downstream with each high intensity rainfall event.

Agricultural BMPs that will help reduce sediment deposition in waterways are (in no particular order, many other BMPs exist):

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

Cropland BMPs that have been selected by the SLT based on projected acceptability by landowners, cost effectiveness and pollutant load reduction effectiveness are:

- Implement no-till cultivation
- Install grassed waterways
- Establish vegetative buffers
- Implement nutrient management plans
- Install terraces
- Establish permanent vegetation on cropland
- Establish water retention structures

This section will review several potential sources or environmental actions that have the potential of increasing sediment in the waters. They are (in no particular order of importance):

Cropland Erosion

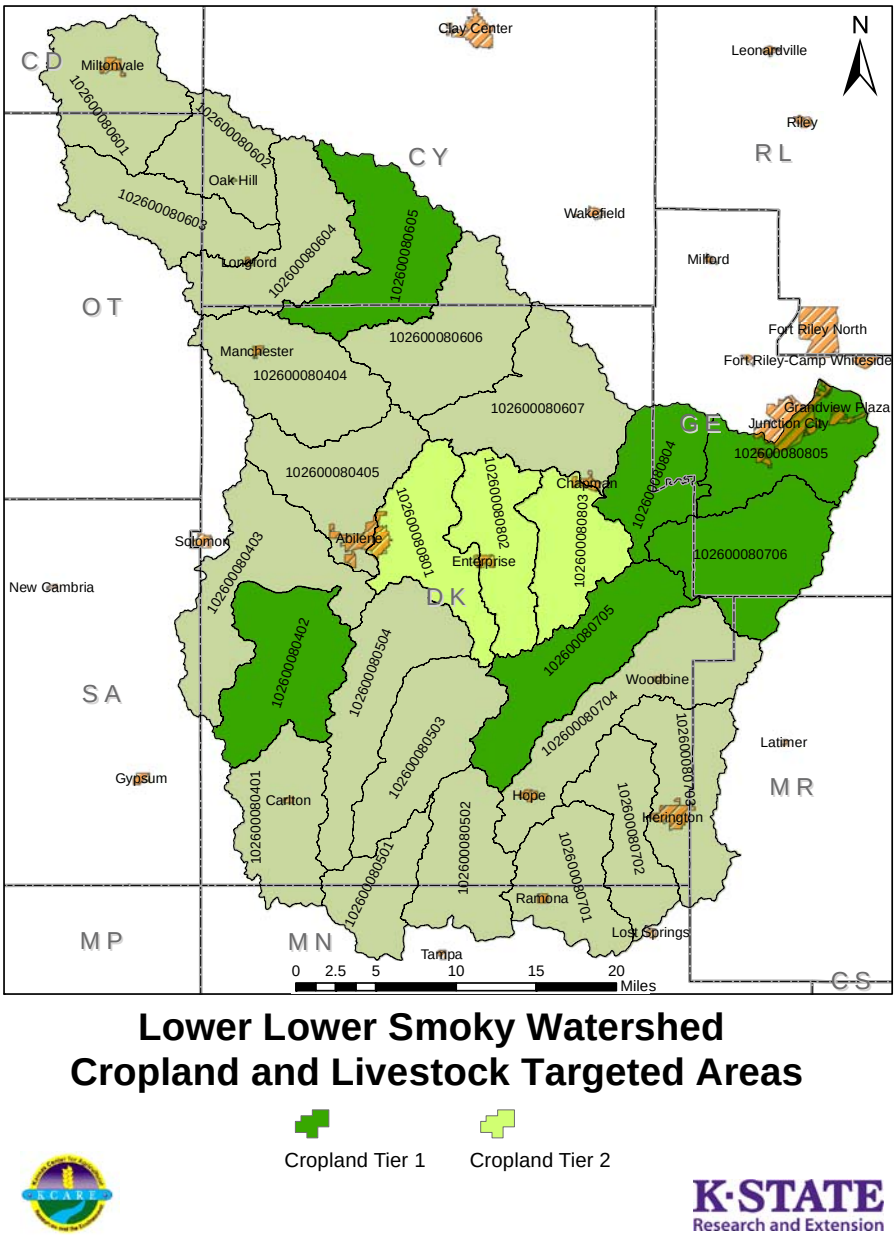
- Land use
- T-factor or soil loss
- Hydrologic soil groups
- Type of crops in the watershed

Streambank and Riparian Degradation

- Riparian quality
- Precipitation distribution

6.1.1 Cropland Erosion

Cropland BMPs have been assigned by the SLT. The Targeted Areas for cropland are prioritized into Tier 1 and Tier 2 areas. These are the areas that contain the most potential for sediment runoff as determined by the SWAT model. Causes of erosion are discussed in more detail in the rest of this section.



Lower Lower Smoky Watershed
Cropland and Livestock Targeted Areas

Cropland Tier 1 Cropland Tier 2

K-STATE Research and Extension

Figure 23. Targeted Area for Cropland as Determined by STEPL.

6.1.1.A Land Use

Land use activities have a significant impact on the types and quantity of sediment transfer in the watershed. Construction projects in the watershed and in communities can leave disturbed areas of soil and unvegetated roadside ditches that can wash in a rainfall event. In addition, agricultural cropland that is under conventional tillage practices as well as a lack of maintenance of agricultural BMP structures can have cumulative effects on land transformation through sheet and rill erosion. The primary land uses in the Cropland Targeted Areas are croplands (approximately 51 percent) and grasslands (approximately 36 percent). Total acreage in the LLS Watershed is 769,322 acres. Size of the Tier 1 Targeted Area is 181,020 acres. Size of the Tier 2 Targeted Area is 71,186 acres.

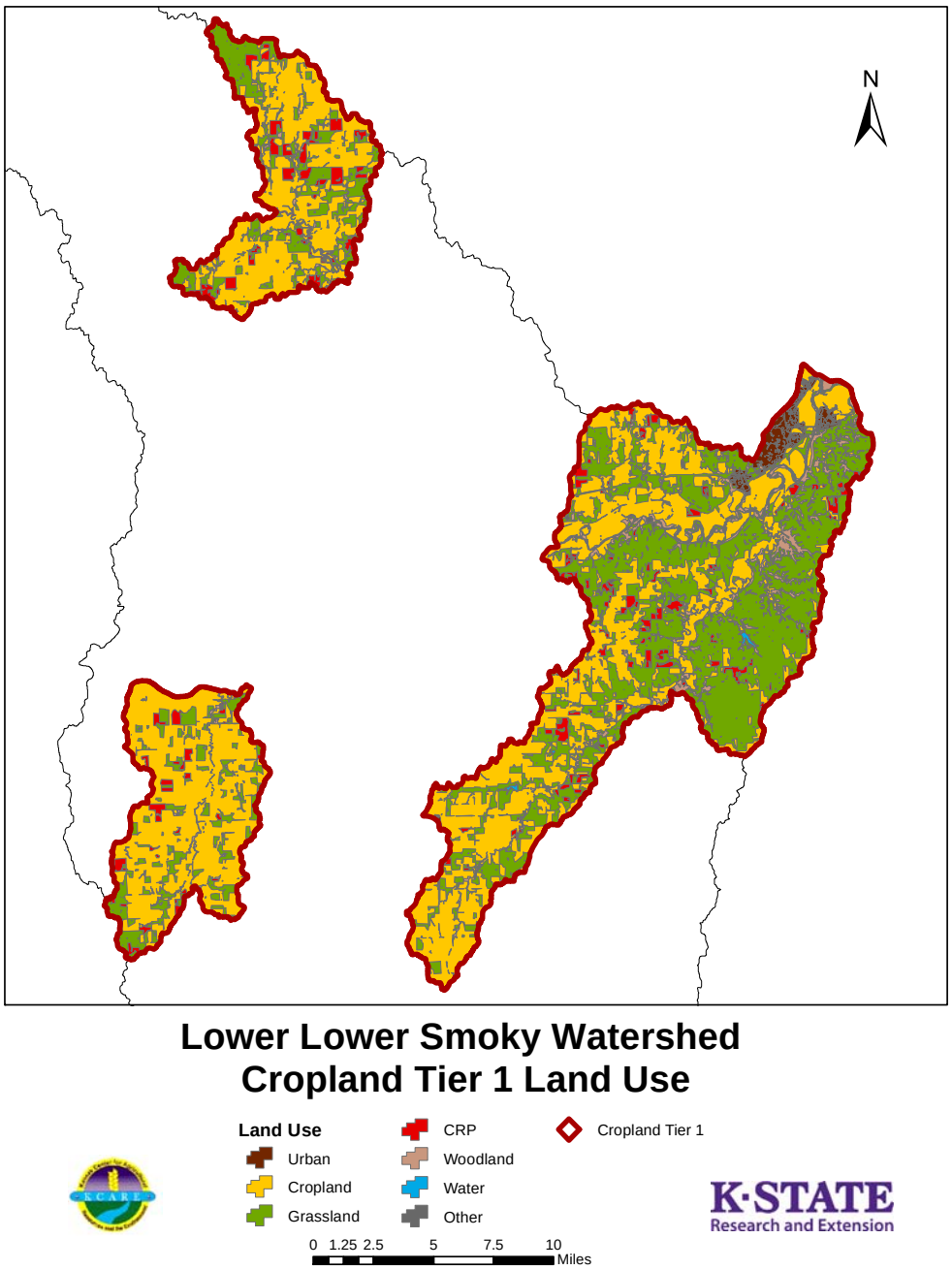


Figure 24. Cropland Tier 1 Targeted Area Land Use. [31]

Table 15. Land Use in the Tier 1 Targeted Area, 2005. [31]

Land Use	*Acres*	*Percentage*
Cropland	93,596	51.7
Grassland	66,398	36.7
CRP	8,489	4.7
Woodland	8,488	4.7
Urban	3,162	1.7
Water	749	0.4

Land Use, cont	*Acres*	*Percentage*
Other	138	0.1
Total	**181,020**	**100.0**

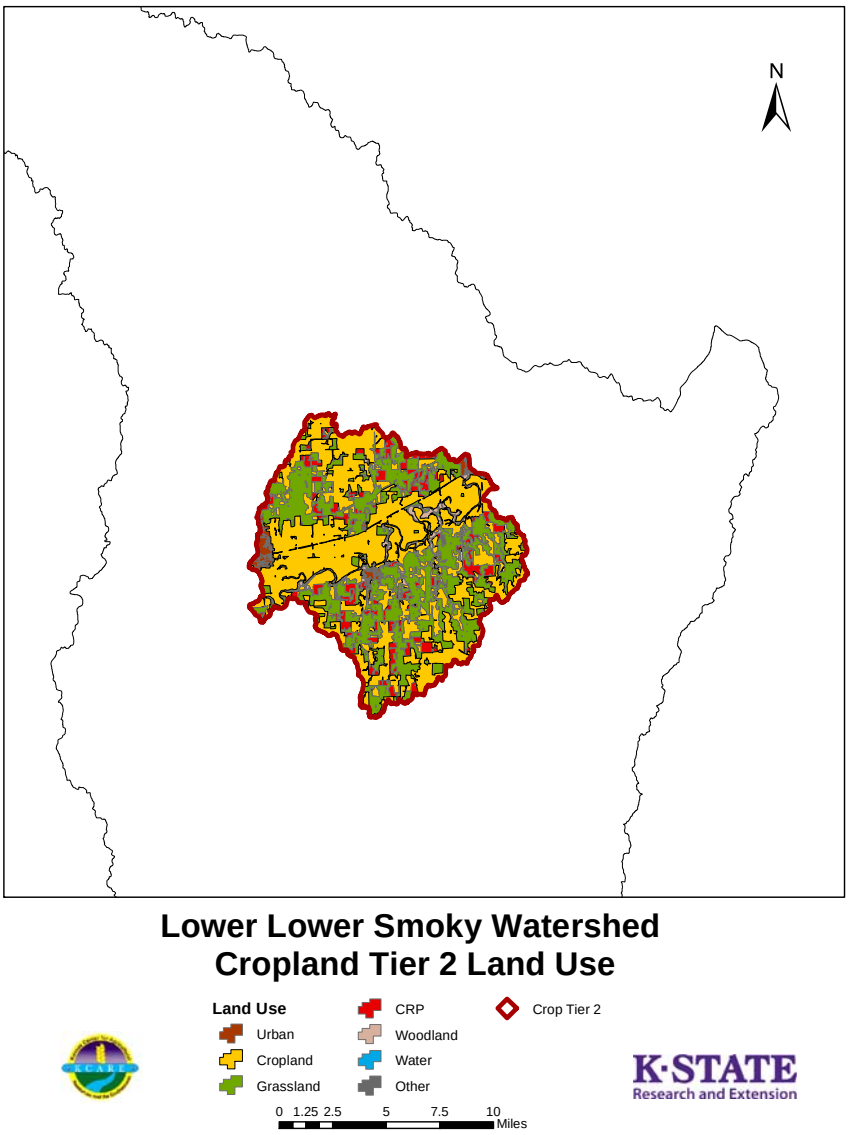


Figure 25. Cropland Tier 2 Targeted Area Land Use. [31]

Table 16. Land Use in the Tier 2 Targeted Area, 2005. [31]

Land Use	*Acres*	*Percentage*
Cropland	35,885	50.4
Grassland	24,973	35.1
CRP	5,907	8.3
Woodland	2,220	3.1
Urban	1,692	2.4
Water	451	0.6

Land Use, cont.	*Acres*	*Percentage*
Other	57	0.1
Total	**71,186**	**100.0**

6.1.1.C Soil Erosion Influenced by Soil Type and Runoff Potential

Soil type has an influence on runoff potential and erosion throughout the watershed. Soils are classified into four hydrologic soil groups (HSG). The soils within each of these groups have the same runoff potential after a rainfall event if the same conditions exist, such as plant cover or storm intensity. Soils are categorized into four groups: A, B, C and D.

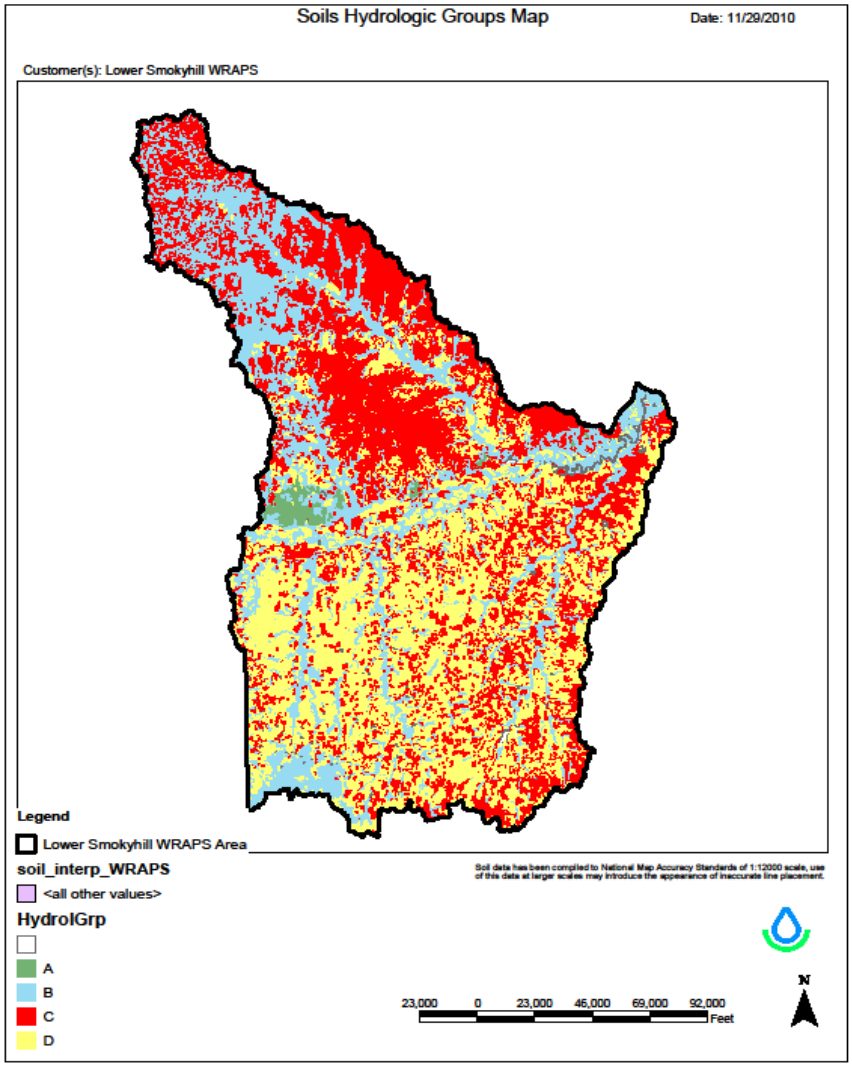


Figure 26. Hydrologic Soil Groups of the Watershed.

Soils are classified into hydrologic soil groups (HSGs) to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting. The infiltration rate is the rate at which water enters the soil at the soil surface. It is controlled by surface conditions. HSG also shows the transmission rate-the rate at which the water moves within the soil. This rate is controlled by the soil profile. The soil scientists at Soil Conservation Service (SCS) have defined four soil groups ~ A, B, C, and D.

Group A ~ Soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sand or gravel and have a high rate of water transmission.

Group B ~ Soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep or deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

Group C ~ Soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes the downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission.

Group D ~ Soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission.

The LLS Watershed consists mainly of Groups C and D soil. The upper portion of our watershed contains quite a bit of soil that obstructs the downward movement of water and soils, thus having a low rate of water transmission. The lower division of the LLS contains mainly soils with a potential for high runoff.

Soil permeability values across the watershed, based on NRCS STATSGO database, indicate the average soil permeability of the watershed is 0.88”/hour, with nearly 88% of the watershed having a soil permeability of less than 1.3”/hour which contributes to runoff during very low to low rainfall intensity events. According to a USGS open-file report (Jaracek, 2000), the threshold soil-permeability values are set at 3.43 inches/hour for very high, 2,86 inches/hour for high, 2.29 inches/hour for moderate, 1.71 inches/hour for low, 1.14 inches/hour for very low, and 0.57 inches/hour for extremely low soil permeability. As the watersheds’ soil profiles become saturated, excess overland flow is produced.

6.1.2 Streambank Erosion

Sediment can originate 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. TWI has determined two areas of need for streambank stabilization projects.

6.1.2.B Rainfall and Runoff

Rainfall amounts and subsequent runoff can affect sediment delivery from agricultural areas and urban areas into Smoky Hill River. High water flows will cause swirling and under cutting of the stream banks with subsequent sloughing. Sloughing of stream and river banks is a major contributor of sediment downstream.

In cropland, high rainfall events can cause sheet and rill erosion and lead to water channel outlets in the riparian areas. High intensity rainfall events (rainfall rates that overwhelm soil adsorptive capacity) usually occur in late spring and early summer. Extended duration of rainfall events that causes soil saturation and subsequent runoff also usually occurs in late spring and early summer. For these reasons it is important to utilize conservation practices such as no-till that provide a “cover” on bare soil during the spring and into the summer.

6.1.3 Sediment BMPs with Acres or Projects Needed

The current estimated sediment load in LLS Watershed is 71,540 tons per year according to the TMDL section of KDHE. **The total annual load reduction in the LLS Watershed needed to meet the siltation TMDL is 48,545 tons of sediment annually**. This is the amount of sediment that needs to be removed from the watershed and is the target of the BMP installations that will be placed in the watershed. Specific acreages or projects that need to be implemented per year have been determined through modeling and economic analysis and approved by the SLT.

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 the Cropland Targeted Area.** An added bonus of implementing cropland BMPs aimed at sediment reduction is a positive effect on nutrient/phosphorus runoff (will be discussed in the next section). Specific acreages or projects that need to be implemented per year have been determined through modeling, cost-effectiveness and producer acceptability and approved by the SLT. Therefore, all buffers and waterways were assumed to go on land that is terraced. All other BMPs are considered independent projects and stand alone in their load reductions.

Table 17. BMPs and Acres or Projects Needed to Reduce Sediment Contribution in the LLS Siltation TMDL.

Protection Measures	Best Management Practices and Other Actions	Annual Treated Acres Needed to be Implemented Annually
Prevention of sediment contribution from **cropland**	1. No-Till	702 acres
	2. Grassed Waterways	1,054 acres
	3. Vegetative Buffers	702 acres
	4. Nutrient Management Plans	351 acres
	5. Terraces	702 acres
	6 Permanent Vegetation	140 acres
	7 Water Retention Structures	351 acres
Prevention of sediment contribution from **streambank erosion**	Streambank stabilization	2,785 feet for the total life of the plan

6.1.4 Sediment Load Reductions

The table below lists the cropland BMPs and acres implemented with the associated load reductions attained by implementing all of these BMPs. The percent of sediment reduction achievement is illustrated in the right column.

Table 18. Estimated Sediment Load Reductions for Implemented BMPs on Cropland Aimed at Meeting the LLS Watershed Siltation TMDL.

Annual Soil Erosion Reduction (tons)								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	455	364	304	76	182	115	152	**1,649**
2	911	729	607	152	364	231	304	**3,297**
3	1,366	1,093	911	228	547	346	455	**4,946**
4	1,822	1,457	1,215	304	729	462	607	**6,595**
5	2,277	1,822	1,518	380	911	577	759	**8,243**
6	2,733	2,186	1,822	455	1,093	692	911	**9,892**
7	3,188	2,550	2,125	531	1,275	808	1,063	**11,541**
8	3,644	2,915	2,429	607	1,457	923	1,215	**13,189**
9	4,099	3,279	2,733	683	1,640	1,038	1,366	**14,838**
10	4,554	3,644	3,036	759	1,822	1,154	1,518	**16,487**
11	5,010	4,008	3,340	835	2,004	1,269	1,670	**18,136**
12	5,465	4,372	3,644	911	2,186	1,385	1,822	**19,784**
13	5,921	4,737	3,947	987	2,368	1,500	1,974	**21,433**
14	6,376	5,101	4,251	1,063	2,550	1,615	2,125	**23,082**
15	6,832	5,465	4,554	1,139	2,733	1,731	2,277	**24,730**
16	7,287	5,830	4,858	1,215	2,915	1,846	2,429	**26,379**

Annual Soil Erosion Reduction (tons), cont.								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
17	7,742	6,194	5,162	1,290	3,097	1,961	2,581	**28,028**
18	8,198	6,558	5,465	1,366	3,279	2,077	2,733	**29,676**
19	8,653	6,923	5,769	1,442	3,461	2,192	2,884	**31,325**
20	9,109	7,287	6,073	1,518	3,644	2,308	3,036	**32,974**

Table 19. Estimated Sediment Load Reductions for Implemented BMPs on Streambanks Aimed at Meeting the LLS Watershed Siltation TMDL.

Site	Streambank Stabilization (feet)	Soil Load Reduction (tons)	Cumulative Erosion Reduction (tons)
87	1,191	17,746	17,746
19	1,594	22,316	40,062

The life of the WRAPS plan is 20 years. After 6 years, the sediment portion of this plan will switch from being "restoration" to "protection" of the watershed.

Table 20. Sediment Load Reductions for Cropland, Streambank and Riparian Area BMPs Aimed at Meeting the LLS Watershed Siltation TMDL.

Sediment Reduction (tons)				
Year	Cropland Reduction	Streambank Stabilization	Total Reduction (tons)	% of TMDL
1	1,649	40,062	**41,711**	85.9%
2	3,297	40,062	**43,359**	89.3%
3	4,946	40,062	**45,008**	92.7%
4	6,595	40,062	**46,657**	96.1%
5	8,243	40,062	**48,305**	99.5%
6	9,892	40,062	**49,954**	**102.9%**
7	11,541	40,062	**51,603**	106.3%
8	13,189	40,062	**53,251**	109.7%
9	14,838	40,062	**54,900**	113.1%
10	16,487	40,062	**56,549**	116.5%
11	18,136	40,062	**58,198**	119.9%
12	19,784	40,062	**59,846**	123.3%
13	21,433	40,062	**61,495**	126.7%
14	23,082	40,062	**63,144**	130.1%
15	24,730	40,062	**64,792**	133.5%
16	26,379	40,062	**66,441**	136.9%
17	28,028	40,062	**68,090**	140.3%
18	29,676	40,062	**69,738**	143.7%

Sediment Reduction (tons), cont.				
Year	Cropland Reduction	Streambank Stabilization	Total Reduction (tons)	% of TMDL
19	31,325	40,062	**71,387**	147.1%
20	32,974	40,062	**73,036**	150.4%

Table 21. Sediment Load Reduction by Category at the End of 20 Years Aimed at Reducing Sediment Contribution in the LLS Watershed Siltation TMDL.

Best Management Practice Category	Total Load Reduction (tons)	% of Siltation TMDL
Cropland	40,062	**83%**
Streambank	32,974	**68%**
Total	**73,036**	**150%**
Sediment Reduction Goal 48,5445 tons		

Refer to Section 8, "Costs of BMP Implementation" for specific BMP costs in order to meet the TMDL.

6.2 Nutrients

An excess of nutrients in water bodies can cause water impairments that are detrimental to aquatic life and water quality. The terminology "nutrients" primarily encompasses phosphorus and nitrogen as the two main contributors. An excess in nutrients can be caused by any land practice that will contribute to nutrients in surface waters. Examples are (but not limited to):

- Fertilizer runoff from agricultural and urban lands,
- Manure runoff from domestic livestock and wildlife in close proximity to streams and rivers,
- Failing septic systems, and
- Phosphorus recycling from lake sediment.

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. However, for this WRAPS process, targeting will be for agricultural practices.

The impairments that are caused by excess nutrients are:

- **Eutrophication (E).** E is a natural process that occurs when a water body receives excess nutrients. These excess nutrients create optimum conditions that are favorable for algal blooms and plant growth. Herington Lake has a high priority TMDL for E.

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

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

6.2.1 Livestock Related Impairments

Livestock will be the main entity targeted for nutrient remediation. However, cropland runoff will be discussed and included in reductions of nitrogen and phosphorus.

Livestock can contribute to nutrients in surface water through manure runoff. Soluble phosphorus can easily be transported in runoff from fields where livestock gather. Preventing manure runoff into streams is important in avoiding elevated phosphorus concentrations. A few BMPs that can assist are restricting cattle access to streams, maintaining adequate buffer areas, providing an alternate watering system and managing optimal grass cover. Other nutrient issues can arise from fertilizers applied to non-native pastures used for livestock grazing. Nitrogen and phosphorus can originate from fertilizer runoff caused by either excess application or a rainfall event immediately after application.

6.2.1.A. Manure Runoff from Fields and Livestock Operations

CAFOs are defined by EPA as agricultural operations where animals are kept and raised in confined situations. CAFOs congregate animals, feed, manure and urine, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures, fields, or on rangeland.

Where there are animals, there is animal waste, and as the growth of industrial farming concentrates thousands of animals on increasingly fewer farms, it produces massive amounts of animal waste on relatively small plots of land. When too much waste is produced in one place, there's no safe, cost-effective way to either use it productively or dispose of it. While government regulation and better waste management practices can make a difference and should be encouraged for existing farms, the problem of livestock waste will never end so long as we rely on concentrated industrial farms to produce our food.

Animal feeding operations annually produce about 100 times more manure than the amount of human sewage sludge processed in US municipal wastewater plants. One dairy farm with 2,500 cows produces as much waste as a city with around 411,000 residents. Unlike human waste, however, in most cases the law does not require that livestock waste be treated.

People often believe that animal manure is harmless, but in truth it can be quite hazardous. Factory livestock facilities pollute the air and release over 400 separate gasses, most due to the large amounts of manure they produce. The principal gases released are hydrogen sulfide, methane, ammonia, and carbon dioxide. Gasses can be dangerous air pollutants that threaten both the environment and human health. Nitric oxides are also released in large quantities from farms through manure application, and are among the leading causes of acid rain.

In Kansas, confined animal feeding operations (CAFOs) with greater than 300 animal units and/or a significant contributor of pollutants must register with

KDHE. The waste disposal practices and waste water discharge quality are closely monitored by KDHE for these registered CAFOs to determine the need for runoff control practices or structure. The monitoring of these registered CAFOs reduces the threat of fecal coliform bacteria and nutrients in the watershed. The smaller unregistered animal operations actually produce a greater threat to the water quality because they are not being regulated by KDHE.

Small beef operations with less than 1,000 head at all times are the largest number of CAFOs within this watershed. Along with the swine, dairy and chicken facilities they are likely to contribute relatively little to the sediment loads observed in the Smoky Hill due to existing pollution prevention and containment requirements.

Twenty three small confined animal feeding operations (CAFOs) exist within the TMDL area, none of which hold a federal discharge permit (NPDES) number. The largest number are small beef operations (18) with less than 1,000 head at all times. According to the USDA National Agricultural Statistics Service, on January 1, 2010 cattle inventories for Saline, Dickinson and Geary counties were 40,000, 49,000 and 15,000 head, respectively. Along with the swine, dairy and chicken facilities the permitted and certified beef CAFO facilities are likely to contribute relatively little to the sediment loads observed in the Smoky Hill River due to existing pollution prevention and containment requirements, which include containing all runoff from a 25 year—24 hour storm.

Smaller livestock operations in the watershed likely consist of range livestock, of which is predominantly cattle in this region. Rangeland cattle are unlikely to contribute to the TSS loads within the watershed since these cattle are ranging on permanent grassland vegetation.

Fifteen facilities with NPDES permits exist within the TMDL area. Seven are industrial facilities, one is an MS4 general (stormwater) permit for Junction City, and the remainder are municipal wastewater treatment facilities. These facilities are unlikely to contribute significantly to the TSS load observed in the Smoky Hill River due to a combination of factors, including limited discharge (quarry and concrete), small discharge volumes (<1 cfs) on lagoon facilities, and highly effective treatment for removal of suspended materials on mechanical plants that typically report TSS effluent concentrations well below their permit limits.

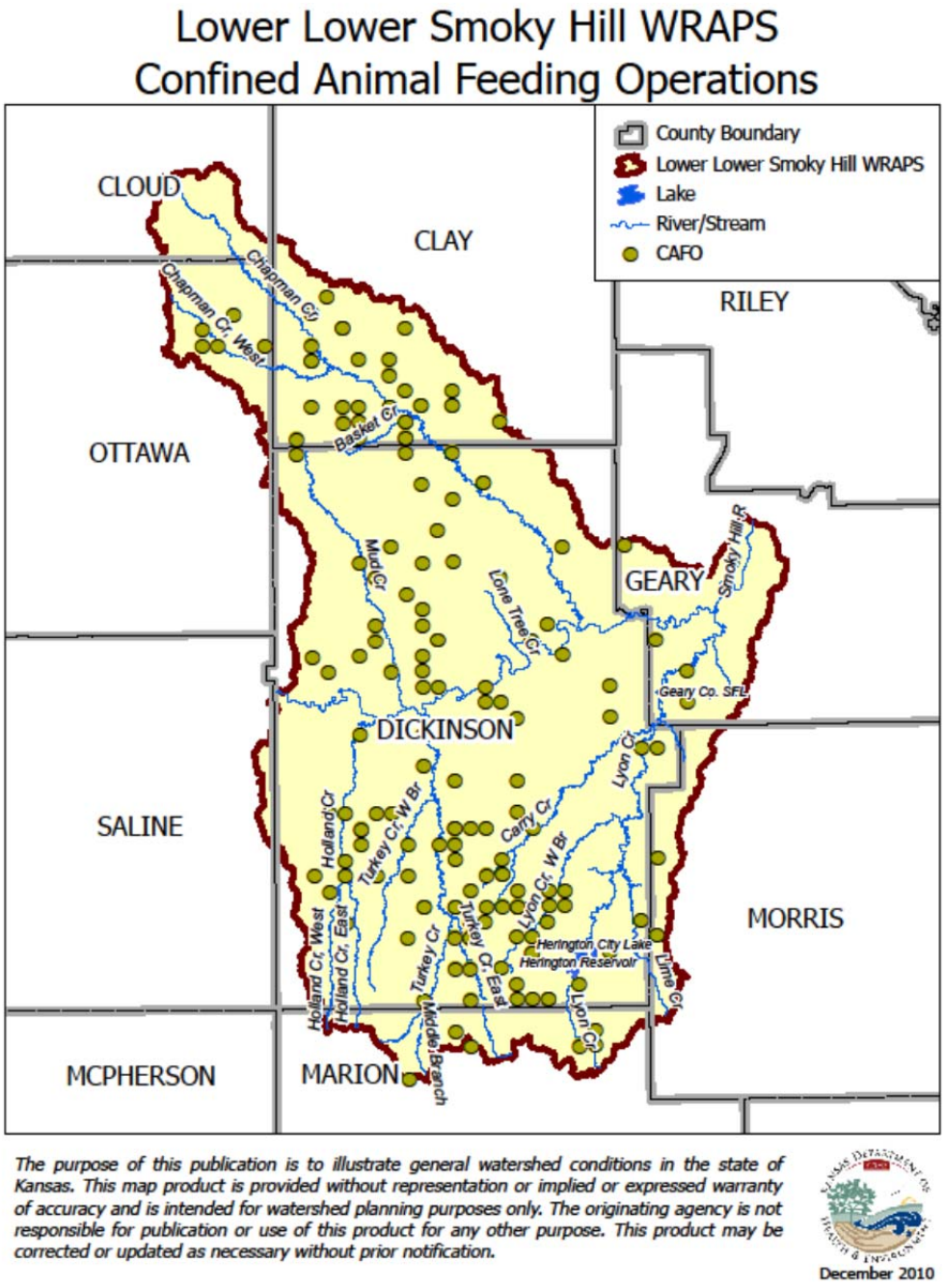


Figure 27. Confined Animal Feeding Operations and Grazing Density in the Watershed. [32]

6.2.1.B Land Use

Land use activities have a significant impact on the types and quantity of livestock related nonpoint source pollutants in the watershed. Agricultural activities and lack of maintenance of agricultural structures can have cumulative effects on land transformation. Manure runoff from grasslands close to

waterways can add to phosphorus in the waterways. The primary land uses in the Livestock Targeted Areas are croplands (approximately 59 percent) and grasslands (approximately 30 percent). Total acreage in the LLS Watershed is 769,322 acres. Size of the Livestock Targeted Area is 199,323 acres.

Table 22. Land Use in the Livestock Targeted Area [31]

Land Use	*Acres*	*Percentage*
Cropland	118,138	59.3
Grassland	60,464	30.3
CRP	12,518	6.3
Woodland	4,324	2.2
Urban	2,690	1.3
Water	1,179	0.6
Other	10	0.0
Total	**199,323**	**100.0**

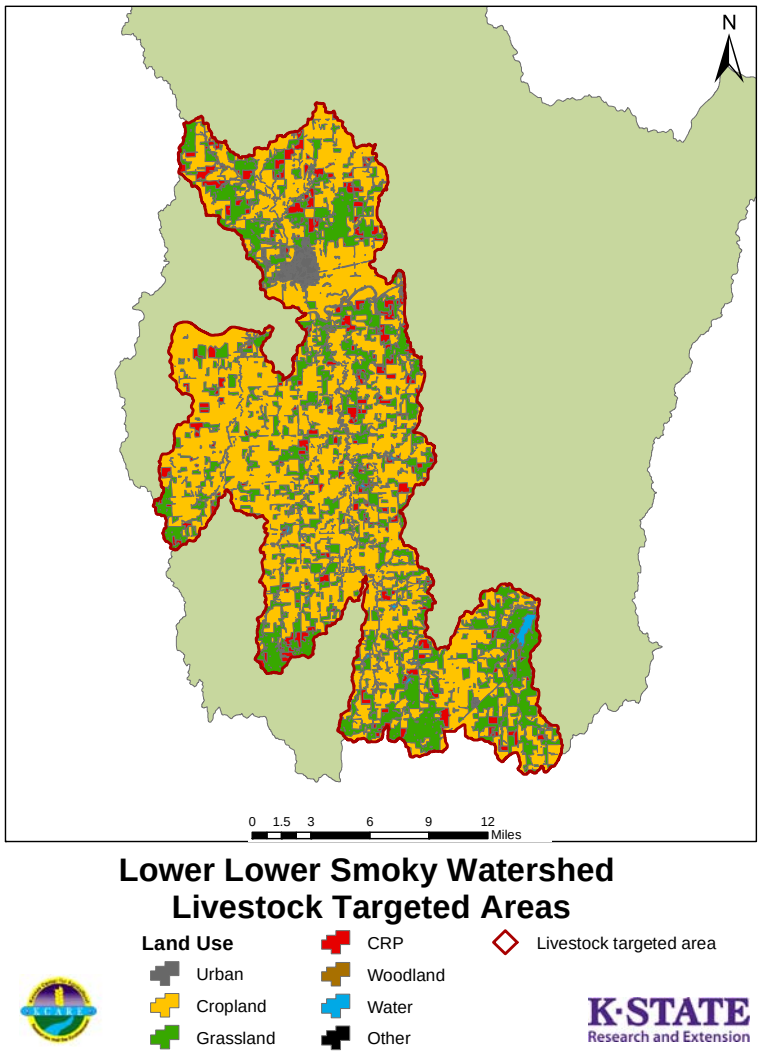


Figure 28. Land Use in the Livestock Targeted Areas. [31]

6.2.1.C Rainfall and Runoff

Rainfall amounts and subsequent runoff along with flooding outside the stream channel can affect nutrient concentrations in the streams. Manure in streams can originate from livestock that are allowed access to wade or loaf directly in the stream. Manure from cropland can originate from fields where the manure that has been applied either before a rainfall event or on frozen ground. Manure and livestock management is important in preventing phosphorus runoff from the targeted area. Rainfall in this watershed occurs primarily in the late spring and early summer. This occurs when grass is short and runoff potential is greatest.

6.2.2 Cropland Related Nutrient Pollutants

6.2.2.A Land Uses

Land use activities have a significant impact on the types and quantity of nutrient runoff in the watershed. Agricultural cropland in the watershed primarily lies along and adjacent to the creeks and their tributaries. If this cropland is under conventional tillage practices and/or lacks maintenance of agricultural BMP structures, there can be an increase in runoff which will carry nitrogen and phosphorus into streams and lakes.

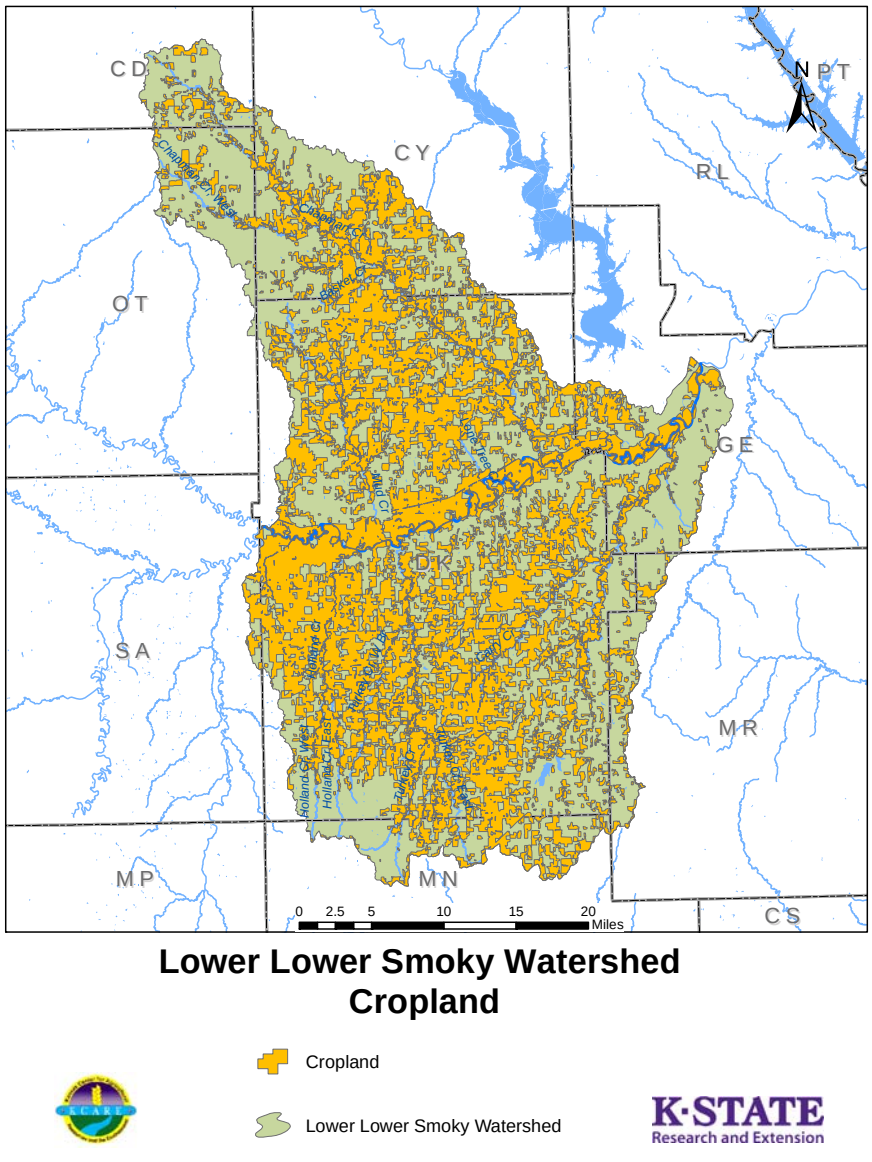


Figure 29. Cropland in the Watershed. [31]

Crop type grown has an effect on possible nutrient runoff due to differing fertilizer requirements for individual crops. According to the National Agricultural Statistics Service, records from 2008 to 2010 indicate that approximately 300,000 acres were planted to crops in Dickinson County. While the exact individual crop acreages grown in the LLS Watershed is not known, it is assumed that the percentage of individual crops is uniform across the counties. The type of crop grown will have an effect on nutrient runoff since different crops have different nutrient requirements. The main crop grown in the watershed was wheat (51 percent). Wheat is a moderate user of nitrogen. Some farms apply nitrogen on wheat fields in the fall as anhydrous ammonia. This is usually dependent on whether the crop will be used for winter grazing of stocker calves. Nitrogen may also be applied in the spring. Soybeans (31 percent) are a legume and as such, do not require nitrogen fertilizer. Sorghum (13 percent) is a moderate user of nitrogen, similar to wheat. Corn (acres planted are 5 percent of total) is a heavy user of nitrogen fertilizer in order to support the large amount of biomass produced. All farm ground should be soil tested for the proper amount of phosphorus available in the soil and phosphorus fertilizer should be applied only when needed. It should be applied at planting time and incorporated into the soil where it will attach to soil particles and prevent runoff.

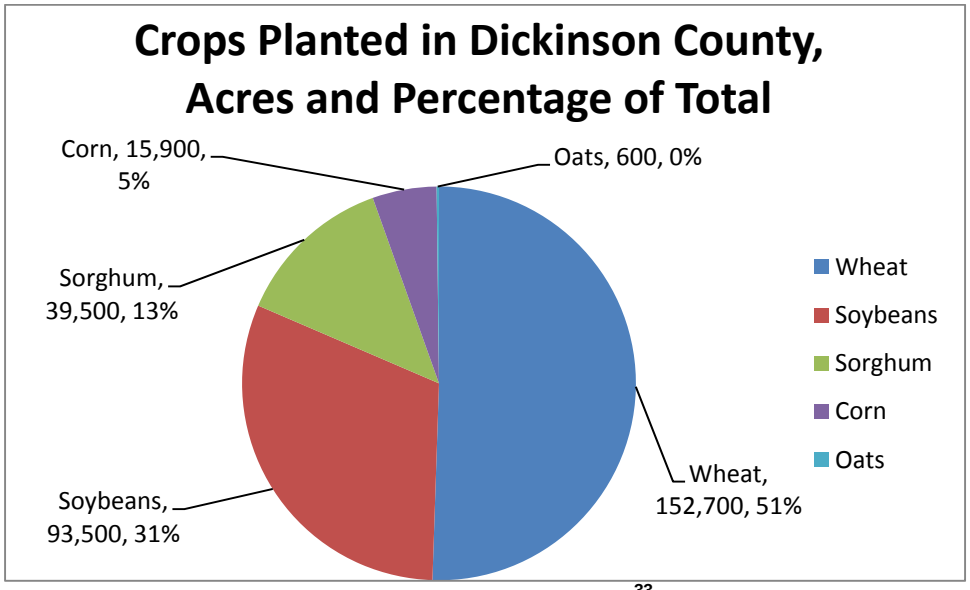


Figure 30. Farm Crops in the Watershed by percentage. [33]

6.2.2.B CRP

CRP (Conservation Reserve Program) land is marginal farm ground that has been removed from production and planted to grass cover. The owner of the land receives a government payment as incentive for allowing the land to be removed from production. This is the best way to stop runoff of nutrients as well as sediment through erosion. CRP lands are scattered throughout the

watershed. CRP comprised approximately six percent of the farmable land in the watershed.

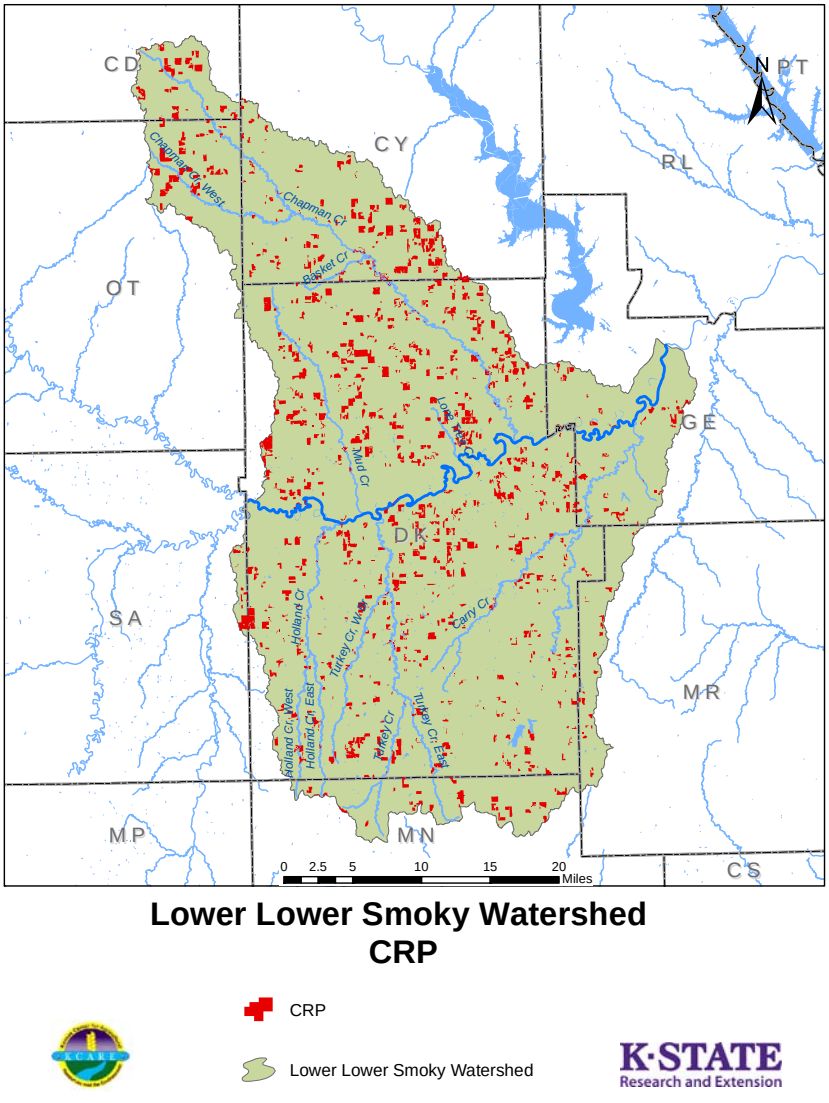


Figure 31. CRP in the Watershed. [31]

6.2.2.C Rainfall and Runoff

Rainfall amounts and subsequent runoff can affect nutrient runoff from agricultural areas. Fertilizer runoff from crop fields if applied prior to a rainfall event or on frozen ground can contribute to elevated phosphorus water concentrations.

6.2.3 Phosphorus BMPs with Projects Needed

The current estimated phosphorus load from nonpoint sources in the LLS Watershed is 6,368 pounds per year according to the TMDL section of KDHE. This has been determined by KDHE as a result of sampling data obtained in the watershed. After subtracting the annual load capacity, t**he total annual load reduction allocated to the LLS Watershed needed to meet the phosphorus reduction goal with implemented BMPs is 4,281 pounds of phosphorus**. This is the amount of phosphorus that needs to be removed from the watershed and is the target of the BMP installations that will be placed in the watershed. These BMPs have been determined as feasible and approved by the SLT.

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 the Cropland, Livestock, and in the Streambank Targeted Area. All these BMPs will simultaneously have a positive effect on reduction of sediment impairments.** Specific acreages or projects that need to be implemented per year have been determined through modeling, cost-effectiveness and producer acceptability and approved by the SLT. Therefore, all buffers and waterways were assumed to go on land that is terraced. All other BMPs are considered independent projects and stand alone in their load reductions.

Table 23. BMPs and Number of Projects to be Installed as Determined by the SLT Aimed at Reducing Nutrients in the Watershed.

Protection Measures	Best Management Practices and Other Actions	Annual Treated Acres Needed to be Implemented Annually
Prevention of phosphorus (TP) contribution from **cropland**	1. No-Till	702 acres
	2. Grassed Waterways	1,054 acres
	3. Vegetative Buffers	702 acres
	4. Nutrient Management Plans	351 acres
	5. Terraces	702 acres
	6 Permanent Vegetation	140 acres
	7 Water Retention Structures	351 acres
2. Prevention of phosphorus (TP) contribution from **livestock**	1. Vegetative Filter Strip	1 acre every other year
	2. Relocate Feeding Pens	1 project every other year
	3. Relocate Pasture Feeding Sites	1 project
	4. Off Stream Watering Systems	2 project
	5.Rotational Grazing	1 project per year

6.2.4 Nutrient Load Reductions

The table below lists the cropland and livestock BMPs installed with the associated phosphorus and nitrogen load reductions.

Table 24. Estimated Phosphorus Load Reductions in the Cropland Targeted Area for All Implemented BMPs Aimed at Reducing Nutrients in the Watershed.

Annual Phosphorus Reduction (pounds)								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	577	865	721	180	433	274	361	3,411
2	1,154	1,731	1,442	361	865	548	721	6,822
3	1,731	2,596	2,163	541	1,298	822	1,082	10,233
4	2,308	3,461	2,885	721	1,731	1,096	1,442	13,644
5	2,885	4,327	3,606	901	2,163	1,370	1,803	17,055
6	3,461	5,192	4,327	1,082	2,596	1,644	2,163	20,466
7	4,038	6,058	5,048	1,262	3,029	1,918	2,524	23,877
8	4,615	6,923	5,769	1,442	3,461	2,192	2,885	27,288
9	5,192	7,788	6,490	1,623	3,894	2,466	3,245	30,699
10	5,769	8,654	7,211	1,803	4,327	2,740	3,606	34,110
11	6,346	9,519	7,933	1,983	4,760	3,014	3,966	37,521
12	6,923	10,384	8,654	2,163	5,192	3,288	4,327	40,932
13	7,500	11,250	9,375	2,344	5,625	3,562	4,687	44,343
14	8,077	12,115	10,096	2,524	6,058	3,836	5,048	47,754
15	8,654	12,980	10,817	2,704	6,490	4,110	5,409	51,165
16	9,231	13,846	11,538	2,885	6,923	4,385	5,769	54,576
17	9,807	14,711	12,259	3,065	7,356	4,659	6,130	57,987
18	10,384	15,577	12,980	3,245	7,788	4,933	6,490	61,398
19	10,961	16,442	13,702	3,425	8,221	5,207	6,851	64,809
20	11,538	17,307	14,423	3,606	8,654	5,481	7,211	68,220

Table 25. Estimated Nitrogen Load Reductions in the Cropland Targeted Area for All Implemented BMPs Aimed at Reducing Nutrients in the Watershed.

Annual Nitrogen Reduction (pounds)								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	1,500	3,601	1,500	750	1,801	1,140	1,500	11,794
2	3,001	7,202	3,001	1,500	3,601	2,281	3,001	23,587
3	4,501	10,803	4,501	2,251	5,402	3,421	4,501	35,381
4	6,002	14,405	6,002	3,001	7,202	4,561	6,002	47,175
5	7,502	18,006	7,502	3,751	9,003	5,702	7,502	58,969
6	9,003	21,607	9,003	4,501	10,803	6,842	9,003	70,762
7	10,503	25,208	10,503	5,252	12,604	7,983	10,503	82,556
8	12,004	28,809	12,004	6,002	14,405	9,123	12,004	94,350
9	13,504	32,410	13,504	6,752	16,205	10,263	13,504	106,144
10	15,005	36,011	15,005	7,502	18,006	11,404	15,005	117,937

Annual Nitrogen Reduction (pounds), cont.								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
11	16,505	39,613	16,505	8,253	19,806	12,544	16,505	129,731
12	18,006	43,214	18,006	9,003	21,607	13,684	18,006	141,525
13	19,506	46,815	19,506	9,753	23,407	14,825	19,506	153,319
14	21,007	50,416	21,007	10,503	25,208	15,965	21,007	165,112
15	22,507	54,017	22,507	11,254	27,009	17,105	22,507	176,906
16	24,008	57,618	24,008	12,004	28,809	18,246	24,008	188,700
17	25,508	61,219	25,508	12,754	30,610	19,386	25,508	200,494
18	27,009	64,821	27,009	13,504	32,410	20,527	27,009	212,287
19	28,509	68,422	28,509	14,255	34,211	21,667	28,509	224,081
20	30,010	72,023	30,010	15,005	36,011	22,807	30,010	235,875

Table 26. Estimated Phosphorus Load Reductions in the Livestock Targeted Area for All Implemented BMPs Aimed at Reducing Nutrients in the Watershed.

Annual Phosphorous Load Reductions (lbs)						
Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Annual Load Reduction
1	638	0	63	126	140	**967**
2	638	797	126	252	280	**2,094**
3	1,276	797	189	378	420	**3,061**
4	1,276	1,595	252	504	560	**4,187**
5	1,914	1,595	315	631	700	**5,154**
6	1,914	2,392	378	757	840	**6,281**
7	2,552	2,392	441	883	980	**7,248**
8	2,552	3,189	504	1,009	1,120	**8,374**
9	3,189	3,189	568	1,135	1,260	**9,341**
10	3,189	3,987	631	1,261	1,400	**10,468**
11	3,827	3,987	694	1,387	1,540	**11,435**
12	3,827	4,784	757	1,513	1,680	**12,561**
13	4,465	4,784	820	1,640	1,820	**13,529**
14	4,465	5,581	883	1,766	1,960	**14,655**
15	5,103	5,581	946	1,892	2,100	**15,622**
16	5,103	6,379	1,009	2,018	2,240	**16,749**
17	5,741	6,379	1,072	2,144	2,380	**17,716**
18	5,741	7,176	1,135	2,270	2,520	**18,842**
19	6,379	7,176	1,198	2,396	2,660	**19,809**
20	6,379	7,973	1,261	2,522	2,800	**20,936**

Table 27. Estimated Nitrogen Load Reductions in the Livestock Targeted Area Aimed at Reducing Nutrients in the Watershed.

Annual Nitrogen Load Reductions (lbs)						
Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Annual Load Reduction
1	1,201	0	119	238	264	**1,821**
2	1,201	1,502	238	475	527	**3,943**
3	2,403	1,502	356	713	791	**5,765**
4	2,403	3,004	475	950	1,055	**7,887**
5	3,604	3,004	594	1,188	1,318	**9,708**
6	3,604	4,505	713	1,425	1,582	**11,830**
7	4,806	4,505	831	1,663	1,846	**13,651**
8	4,806	6,007	950	1,900	2,110	**15,773**
9	6,007	6,007	1,069	2,138	2,373	**17,595**
10	6,007	7,509	1,188	2,375	2,637	**19,716**
11	7,209	7,509	1,307	2,613	2,901	**21,538**
12	7,209	9,011	1,425	2,851	3,164	**23,660**
13	8,410	9,011	1,544	3,088	3,428	**25,481**
14	8,410	10,513	1,663	3,326	3,692	**27,603**
15	9,612	10,513	1,782	3,563	3,955	**29,424**
16	9,612	12,014	1,900	3,801	4,219	**31,546**
17	10,813	12,014	2,019	4,038	4,483	**33,368**
18	10,813	13,516	2,138	4,276	4,746	**35,489**
19	12,014	13,516	2,257	4,513	5,010	**37,311**
20	12,014	15,018	2,375	4,751	5,274	**39,433**

The table below shows the combined load reduction for phosphorus that is attained by implementing all cropland and livestock BMPs annually.

Table 28. Combined Phosphorus Load Reduction Aimed at Reducing Nutrients in the Watershed.

Phosphorous				
Year	Cropland Reduction	Livestock Reduction	Streambank Stabilization	Total Reduction (lbs)
1	3,411	967	2,404	6,782
2	6,822	2,094	2,404	11,319
3	10,233	3,061	2,404	15,697
4	13,644	4,187	2,404	20,235
5	17,055	5,154	2,404	24,613
6	20,466	6,281	2,404	29,150
7	23,877	7,248	2,404	33,528
8	27,288	8,374	2,404	38,066

Phosphorous, cont.				
Year	Cropland Reduction	Livestock Reduction	Streambank Stabilization	Total Reduction (lbs)
9	30,699	9,341	2,404	42,444
10	34,110	10,468	2,404	46,981
11	37,521	11,435	2,404	51,359
12	40,932	12,561	2,404	55,897
13	44,343	13,529	2,404	60,275
14	47,754	14,655	2,404	64,812
15	51,165	15,622	2,404	69,191
16	54,576	16,749	2,404	73,728
17	57,987	17,716	2,404	78,106
18	61,398	18,842	2,404	82,644
19	64,809	19,809	2,404	87,022
20	68,220	20,936	2,404	91,559

In Herington Reservoir, the percent of E TMDL achievement is illustrated in the right column. The timeframe for attaining the TMDL is ten years. The life of the WRAPS plan is twenty years. After ten years, the phosphorus portion of this plan in the Herington Reservoir watershed will switch from being "restoration" to "protection" of the watershed.

Table 29. Phosphorus Load Reduction in Twenty Years by Category Aimed at Meeting the E TMDL in Herington Reservoir.

Herington Reservoir Phosphorous TMDL				
Year	Cropland Reduction	Livestock Reduction	Total Reduction (lbs)	% of TMDL
1	236	215	451	10.5%
2	472	429	901	21.1%
3	708	644	1,352	31.6%
4	944	859	1,803	42.1%
5	1,180	1,073	2,253	52.6%
6	1,416	1,288	2,704	63.2%
7	1,652	1,503	3,154	73.7%
8	1,888	1,717	3,605	84.2%
9	2,124	1,932	4,056	94.7%
10	2,360	2,147	4,506	105.3%
11	2,596	2,361	4,957	115.8%
12	2,832	2,576	5,408	126.3%
13	3,068	2,790	5,858	136.8%
14	3,304	3,005	6,309	147.4%
15	3,540	3,220	6,760	157.9%

Herington Reservoir Phosphorous TMDL, cont.				
Year	Cropland Reduction	Livestock Reduction	Total Reduction (lbs)	% of TMDL
16	3,776	3,434	7,210	168.4%
17	4,012	3,649	7,661	178.9%
18	4,248	3,864	8,111	189.5%
19	4,484	4,078	8,562	200.0%
20	4,720	4,293	9,013	210.5%

Table 30. Phosphorus Load Reduction in Twenty Years by Category Aimed at Reducing Nutrients in the Watershed.

Best Management Practice Category	Total Load Reduction (pounds)	Percent of Phosphorous TMDL
Cropland	4,720	100%
Livestock	4,293	110%
Total	**9,013**	**211%**

Refer to Section 8, "Costs of BMP Implementation" for specific BMP costs in order to meet the TMDL.

7.0 Information and Education (I&E) in Support of BMPs

7.1 I&E Activities and Events

The SLT has determined which I&E 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. I&E projects will be emphasized in the Targeted Areas, but are open to the entire watershed. Even though open to the entire watershed, special attention will be paid to residents of the Targeted Areas with supplemental postcards, mailings and contacts.

Table 32. I&E Activities and Events as Requested by the SLT in Support of Meeting the TMDLs.

Livestock BMP Implementation					
Vegetative Filter Strips	**Small Livestock Producers**	Demonstration Project	Annual-Summer	Combined with buffer	Kansas Rural Center K-State Research and Extension Conservation Districts
	Small Livestock Producers	Tour/Field Day	Annual-Summer	$2,000	Kansas Rural Center K-State Research and Extension Conservation Districts NRCS
	Small Livestock Producers	One-on-one technical assistance for producers to in targeted areas	Annual, Ongoing	No cost	K-State Research and Extension Conservation Districts Watershed Specialists

Livestock BMP Implementation, cont.					
Relocate Pasture Feeding Sites/Pens	**Small Livestock Producers**	Tour/Field Day	Annual-Summer	$2,000	Kansas Rural Center K-State Research and Extension Conservation Districts
	Small Livestock Producers	Demonstration Project	Annual-Summer	$5,000	Kansas Rural Center K-State Research and Extension Conservation Districts
	Small Livestock Producers	One-on-one technical assistance to remove livestock from riparian areas	Annual – Ongoing	$2,500	Kansas Rural Center K-State Research and Extension Conservation Districts Watershed Specialists
Off-stream/ Alternative Watering Systems	**Small Livestock Producers**	Tour/Field Day	Annual-Summer	Included above	Kansas Rural Center K-State Research and Extension Conservation Districts NRCS
	Small Livestock Producers	Demonstration Project	Annual-Summer	$5,000	Kansas Rural Center K-State Research and Extension Conservation Districts
	Small Livestock Producers	One-on-one technical assistance for producers to implement livestock BMPs in targeted areas	Annual, Ongoing	Included above	K-State Research and Extension Watershed Specialists Kansas Rural Center

Livestock BMP Implementation, cont.					
Rotational Grazing	**Small Livestock Producers**	Tour/Field Day/Workshop	Annual-Summer	$2,500	Kansas Rural Center K-State Research and Extension Watershed Specialists
	Small Livestock Producers	One-on-one technical assistance for producers to in targeted areas	Annual, Ongoing	Included above	Kansas Rural Center K-State Research and Extension Conservation Districts Watershed Specialists
Total Annual Cost for Livestock BMPs				**$19,000**	
Cropland and Streambank BMP Implementation					
No-Till	**Farmers/Landowners**	Scholarships for farmers/ landowners to attend No-Till on the Plains Annual Conference	Annual, Winter	5 scholarships per year $1,000	No-Till on the Plains Conservation Districts
	Farmers/Landowners	Workshop/Field Day/Tour	Annual, Spring	$2,500	No-Till on the Plains Conservation Districts K-State Research and Extension Kansas Rural Center
	Farmers/Landowners	One-on-one technical assistance for farmers/ landowners to implement no-till in targeted areas	Annual-Ongoing	$1,000	Conservation Districts Kansas Rural Center K-State Research and Extension Watershed Specialists

Cropland and Streambank BMP Implementation, cont.					
Grassed Waterways And Terraces	**Farmers/Landowners**	One-on-one technical assistance for farmers/landowners to implement waterways/terraces in targeted areas	Annual	No Cost	Conservation Districts NRCS Watershed Specialists Kansas Rural Center
		Workshop/field day/tour	Annual spring	$2,500	K-State Research and Extension Conservation District Watershed Specialist KRC
Vegetative Buffers	**Farmers/Landowners**	Tour/Field Day	Annual, Spring	$2,500	Conservation Districts K-State Research and Extension
	Farmers/Landowners	One-on-one technical assistance for farmers to implement buffers in targeted areas	Annual	No Cost	Conservation Districts K-State Research and Extension NRCS Watershed Specialists Dk. Co. Environmental Serv.
	Farmers/Landowners	Demonstration Project	Annual-Summer	$5,000	K-State Research and Extension Conservation Districts Kansas Rural Center
Nutrient Management Plans	**Farmers/Landowners**	Workshop/Field Day	Annual, Spring	$1,000	Conservation Districts K-State Research and Extension Kansas Rural Center
	Farmers/Landowners	One-on-one technical assistance for farmers to implement BMPs in targeted areas	Annual	No Cost	Conservation Districts K-State Research and Extension NRCS Watershed Specialists Kansas Rural Center

Cropland and Streambank BMP Implementation, cont.					
Permanent Vegetation	**Farmers/Landowners**	Workshop/Field Day/Tour	Annual, Spring	$2,500	K-State Research and Extension Conservation districts NRCS
Water Retention Structures	**Farmers/Landowners**	Tour/Field Day	Annual, Spring	$2,000	Conservation Districts K-State Research and Extension
	Farmers/Landowners	One-on-one technical assistance for farmers to implement structures in targeted areas	Annual	No Cost	Conservation Districts NRCS Watershed Specialists
	Farmers/Landowners	Demonstration Project	Annual-Summer	$5,000	K-State Research and Extension Conservation Districts Dk. Co. Environmental Serv.
Streambank Stabilization	**Landowners**	Tour/Field Day	Annual	$3,000	NRCS, Conservation Districts, K-State Research and Extension Watershed Specialists The Watershed Institute Soil Cons. Commission Kansas Water Office Kansas Forest Service
		One on One Technical Assistance	Annual ongoing	Included with Technical Assistance	Natural Res. Cons. Ser. The Watershed Institute Soil Cons. Commission Kansas Water Office Conservation Districts
		Demonstration Project	Annual ongoing	$5,000	Natural Res. Cons. Ser. The Watershed Institute Soil Cons. Commission Kansas Water Office Conservation Districts

Total Annual Cost for Cropland and Streambank BMPs				**$33,000**	
General / Watershed Wide Information and Education					
Educational Activities Targeting Youth	**Educators, K-12 Students**	Day on the Farm	Annual	No Cost	Conservation Districts Kansas Farm Bureaus Kansas FFA K-State Research And Extension
		Poster, essay, and speech contests	Annual	No Cost	Conservation Districts
		Water Festival	Annual	$3,000	Dickinson County Environmental Services
Educational Activities Targeting Adults	**Watershed residents**	River Friendly Farms Program	Annual	$2,000	Kansas Rural Center
		Newsletter articles & press releases	As needed	$1,000	Dickinson County Environmental Services
		Teacher Education	Annual	$1,000	KACEE
Total Annual Cost for I&E for General Watershed				**$7,000**	
Total Costs for I&E				**$59,000**	
Project Management					
		WRAPS Coordination	Annual	$35,000	Dickinson County Environmental Services
		Grant Administration	Annual	10% of total grant	Dickinson County Environmental Services
Total Annual Project Management Cost				**$35,000**	

7.2 Evaluation of I&E Activities

All service providers conducting I&E activities funded through the LLS WRAPS will be required to include an evaluation component in their project proposals and PIPs. The evaluation methods will vary based on the activity.

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

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

- Feedback forms allowing participants to provide rankings of the content, presenters, useful of information, etc.
- Pre and post surveys to determine amount of knowledge gained, anticipated behavior changes, need for further learning, etc.
- Follow up interviews (one-on-one contacts, phone calls, e-mails) with selected participants to gather more in-depth input regarding the effectiveness of the I&E activity.

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

8.0 Costs of Implementing BMPs and Possible Funding Sources

The SLT has reviewed all the recommended BMPs listed in the Section 6 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 each category (cropland, livestock and high priority TMDLs). Most of the BMPs that are targeted will be advantageous to more than one impairment, thus being more efficient.

Summarized Derivation of Cropland BMP Cost Estimates

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 $77.69 per acre upfront assuming the NRCS discount rate of 4.75%.

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

Vegetative Buffer Strips: The cost of $1,000 per acre was arrived at using average cost of installation figures from the conservation districts within the watershed and cost estimates from the KSU Vegetative Buffer Tool developed by Craig Smith.

Nutrient Management Plans: 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 $56.71 per acre upfront assuming the NRCS discount rate of 4.75 percent.

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 $1.25 per foot.

Establish Permanent Vegetation: The cost of $150 an acre was calculated based on K-State Research and Extension estimates of the cost of planting and maintaining native grass.

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.

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 Feeding Pens:
-Feeding Pens- Move feedlot or pens away from a stream, waterway, or body of water to increase filtration and waste removal of manure. Highly variable in price, average of $6,600 per unit (1 unit equals 1 acre, 100 AU pen).
-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 (e.g. move bale feeders away from stream). Highly variable in price, average of $2,203 per unit (1 unit equals 1 acre, 100 AU pen).
-Average P reduction: 30-80%

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.

Off-Stream Watering System: The average cost of installing an alternative watering system of $3,500 was estimated by Herschel George, Marais des Cygnes Watershed Specialist, who has installed numerous systems and has detailed average cost estimates.

Rotational Grazing: The average cost of implementing a rotational grazing system for $7,000 was estimated by Herschel George, Marais des Cygnes Watershed Specialist who has installed numerous systems and has detailed average cost estimates. More complex systems that require significant cross fencing and buried water lines will come with a much higher price.

8.1 Costs of Implementing BMPs and I&E

Table 31. Estimated Costs Before Cost Share for Cropland Implemented BMPs in the Cropland Targeted Area. Individual sub watershed costs are provided in the Appendix. Expressed in 2012 dollar amounts.

Total Annual Cost Before Cost-Share, Cropland BMPs								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$54,571	$168,580	$46,828	$19,917	$71,646	$21,072	$43,901	**$426,515**
2	$56,208	$173,637	$48,232	$20,514	$73,796	$21,705	$45,218	**$439,310**
3	$57,894	$178,846	$49,679	$21,130	$76,010	$22,356	$46,575	**$452,489**
4	$59,631	$184,211	$51,170	$21,764	$78,290	$23,026	$47,972	**$466,064**
5	$61,420	$189,738	$52,705	$22,417	$80,639	$23,717	$49,411	**$480,046**
6	$63,262	$195,430	$54,286	$23,089	$83,058	$24,429	$50,893	**$494,447**
7	$65,160	$201,293	$55,915	$23,782	$85,549	$25,162	$52,420	**$509,281**

Total Annual Cost Before Cost-Share, Cropland BMPs, cont.								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
8	$67,115	$207,332	$57,592	$24,495	$88,116	$25,916	$53,993	**$524,559**
9	$69,128	$213,552	$59,320	$25,230	$90,759	$26,694	$55,612	**$540,296**
10	$71,202	$219,958	$61,099	$25,987	$93,482	$27,495	$57,281	**$556,505**
11	$73,338	$226,557	$62,932	$26,767	$96,287	$28,320	$58,999	**$573,200**
12	$75,539	$233,354	$64,820	$27,570	$99,175	$29,169	$60,769	**$590,396**
13	$77,805	$240,354	$66,765	$28,397	$102,151	$30,044	$62,592	**$608,108**
14	$80,139	$247,565	$68,768	$29,249	$105,215	$30,946	$64,470	**$626,351**
15	$82,543	$254,992	$70,831	$30,126	$108,372	$31,874	$66,404	**$645,142**
16	$85,019	$262,642	$72,956	$31,030	$111,623	$32,830	$68,396	**$664,496**
17	$87,570	$270,521	$75,145	$31,961	$114,971	$33,815	$70,448	**$684,431**
18	$90,197	$278,636	$77,399	$32,920	$118,420	$34,830	$72,562	**$704,964**
19	$92,903	$286,995	$79,721	$33,907	$121,973	$35,874	$74,738	**$726,113**
20	$95,690	$295,605	$82,113	$34,925	$125,632	$36,951	$76,981	**$747,896**

Table 32. Estimated Costs After Cost Share for Cropland Implemented BMPs in the Cropland Targeted Area. Individual sub watershed costs are provided in the Appendix. Expressed in 2012 dollar amounts.

Total Annual Cost After Cost-Share, Cropland BMPs								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$33,288	$84,290	$4,683	$9,958	$35,823	$10,536	$21,950	**$200,529**
2	$34,287	$86,818	$4,823	$10,257	$36,898	$10,852	$22,609	**$206,545**
3	$35,315	$89,423	$4,968	$10,565	$38,005	$11,178	$23,287	**$212,741**
4	$36,375	$92,106	$5,117	$10,882	$39,145	$11,513	$23,986	**$219,123**
5	$37,466	$94,869	$5,270	$11,208	$40,319	$11,859	$24,705	**$225,697**
6	$38,590	$97,715	$5,429	$11,545	$41,529	$12,214	$25,447	**$232,468**
7	$39,748	$100,646	$5,591	$11,891	$42,775	$12,581	$26,210	**$239,442**
8	$40,940	$103,666	$5,759	$12,248	$44,058	$12,958	$26,996	**$246,625**
9	$42,168	$106,776	$5,932	$12,615	$45,380	$13,347	$27,806	**$254,024**
10	$43,433	$109,979	$6,110	$12,994	$46,741	$13,747	$28,640	**$261,645**
11	$44,736	$113,278	$6,293	$13,383	$48,143	$14,160	$29,500	**$269,494**
12	$46,078	$116,677	$6,482	$13,785	$49,588	$14,585	$30,385	**$277,579**
13	$47,461	$120,177	$6,677	$14,198	$51,075	$15,022	$31,296	**$285,906**
14	$48,885	$123,782	$6,877	$14,624	$52,608	$15,473	$32,235	**$294,484**
15	$50,351	$127,496	$7,083	$15,063	$54,186	$15,937	$33,202	**$303,318**
16	$51,862	$131,321	$7,296	$15,515	$55,811	$16,415	$34,198	**$312,418**
17	$53,418	$135,260	$7,514	$15,980	$57,486	$16,908	$35,224	**$321,790**
18	$55,020	$139,318	$7,740	$16,460	$59,210	$17,415	$36,281	**$331,444**
19	$56,671	$143,498	$7,972	$16,954	$60,987	$17,937	$37,369	**$341,387**

Total Annual Cost After Cost-Share, Cropland BMPs, cont.								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
20	$58,371	$147,803	$8,211	$17,462	$62,816	$18,475	$38,490	**$351,629**

Table 33. Annual Costs for Livestock BMPs Before Cost Share in the Livestock Targeted Area. Expressed in 2012 dollar amounts.

Annual Cost*Before Cost-Share of Implementing Livestock BMPs						
Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Annual Cost
1	$714	$0	$2,203	$7,590	$7,000	**$17,507**
2	$0	$6,820	$2,269	$7,818	$7,210	**$24,116**
3	$757	$0	$2,337	$8,052	$7,426	**$18,573**
4	$0	$7,235	$2,407	$8,294	$7,649	**$25,585**
5	$804	$0	$2,479	$8,543	$7,879	**$19,704**
6	$0	$7,676	$2,554	$8,799	$8,115	**$27,143**
7	$853	$0	$2,630	$9,063	$8,358	**$20,904**
8	$0	$8,143	$2,709	$9,335	$8,609	**$28,796**
9	$904	$0	$2,791	$9,615	$8,867	**$22,177**
10	$0	$8,639	$2,874	$9,903	$9,133	**$30,550**
11	$960	$0	$2,961	$10,200	$9,407	**$23,528**
12	$0	$9,165	$3,049	$10,506	$9,690	**$32,410**
13	$1,018	$0	$3,141	$10,822	$9,980	**$24,961**
14	$0	$9,723	$3,235	$11,146	$10,280	**$34,384**
15	$1,080	$0	$3,332	$11,481	$10,588	**$26,481**
16	$0	$10,315	$3,432	$11,825	$10,906	**$36,478**
17	$1,146	$0	$3,535	$12,180	$11,233	**$28,094**
18	$0	$10,944	$3,641	$12,545	$11,570	**$38,700**
19	$1,216	$0	$3,750	$12,921	$11,917	**$29,804**
20	$0	$11,610	$3,863	$13,309	$12,275	**$41,057**

Table 34. Annual Costs After Cost Share in the Livestock Targeted Area. Expressed in 2012 dollar amounts.

Annual Cost* After Cost-Share of Implementing Livestock BMPs						
Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Annual Cost
1	$357	$0	$1,102	$3,795	$3,500	**$8,754**
2	$0	$3,410	$1,135	$3,909	$3,605	**$12,058**
3	$379	$0	$1,169	$4,026	$3,713	**$9,287**
4	$0	$3,617	$1,204	$4,147	$3,825	**$12,793**
5	$402	$0	$1,240	$4,271	$3,939	**$9,852**

Annual Cost* After Cost-Share of Implementing Livestock BMPs, cont.						
Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Annual Cost
6	$0	$3,838	$1,277	$4,399	$4,057	**$13,572**
7	$426	$0	$1,315	$4,531	$4,179	**$10,452**
8	$0	$4,071	$1,355	$4,667	$4,305	**$14,398**
9	$452	$0	$1,395	$4,807	$4,434	**$11,089**
10	$0	$4,319	$1,437	$4,952	$4,567	**$15,275**
11	$480	$0	$1,480	$5,100	$4,704	**$11,764**
12	$0	$4,583	$1,525	$5,253	$4,845	**$16,205**
13	$509	$0	$1,570	$5,411	$4,990	**$12,480**
14	$0	$4,862	$1,618	$5,573	$5,140	**$17,192**
15	$540	$0	$1,666	$5,740	$5,294	**$13,240**
16	$0	$5,158	$1,716	$5,912	$5,453	**$18,239**
17	$573	$0	$1,768	$6,090	$5,616	**$14,047**
18	$0	$5,472	$1,821	$6,273	$5,785	**$19,350**
19	$608	$0	$1,875	$6,461	$5,959	**$14,902**
20	$0	$5,805	$1,931	$6,655	$6,137	**$20,528**

Table 35. Annual Costs for Implemented Streambank BMPs.

Site	Streambank Stabilization (feet)	Soil Load Reduction (tons)	Cumulative Erosion Reduction (tons)	Cost
87	1,191	17,746	17,746	$115,027
19	1,594	22,316	40,062	$118,478

Table 36. Technical Assistance Needed to Implement BMPs.

BMP		Technical Assistance	Projected Annual Cost
Cropland	1. No-till	No-Till Coordinator WRAPS Coordinator	**No-Till Coordinator $10,000** **WRAPS Coordinator $35,000** **Watershed Specialist $40,000** **WRAPS Technician $30,000**
	2. Grassed waterways	No-Till Coordinator WRAPS Coordinator	
	3. Vegetative buffers	Watershed Specialist WRAPS Coordinator	
	4. Nutrient Management Plans	WRAPS Technician WRAPS Coordinator	
	5. Terraces	WRAPS Technician WRAPS Coordinator	
	6. Permanent Vegetation	WRAPS Technician WRAPS Coordinator	
	7.Water Retention Structures	Watershed Specialist WRAPS Technician WRAPS Coordinator	
Livestock	1. Vegetative filter strips	WRAPS Coordinator	
	2. Relocate feeding pens	Watershed Specialist WRAPS Coordinator	
	3. Relocate pasture feeding sites	Watershed Specialist WRAPS Coordinator	
	4.Off stream watering	Watershed Specialist WRAPS Coordinator	
	5. Rotational grazing	Watershed Specialist WRAPS Technician WRAPS Coordinator	
Streambank	Streambank restoration	WRAPS Coordinator WRAPS Technician Watershed Specialist	
Total			**$115,000**

Table 37. Total Costs for BMPs, I&E and Technical Support if All BMPs and I&E Projects are Implemented.

Total Annual WRAPS Cost* after Cost-Share by Category					
Year	Cropland	Livestock	Technical Assistance	Information and Education	Total Annual Cost
1	$200,529	$8,754	$115,000	$59,000	**$383,283**
2	$206,545	$12,058	$118,450	$60,770	**$397,823**
3	$212,741	$9,287	$122,004	$62,593	**$406,625**

Total Annual WRAPS Cost* after Cost-Share by Category, cont.					
Year	Cropland	Livestock	Technical Assistance	Information and Education	Total Annual Cost
4	$219,123	$12,793	$125,664	$64,471	**$422,050**
5	$225,697	$9,852	$129,434	$66,405	**$431,388**
6	$232,468	$13,572	$133,317	$68,397	**$447,754**
7	$239,442	$10,452	$137,316	$70,449	**$457,659**
8	$246,625	$14,398	$141,435	$72,563	**$475,021**
9	$254,024	$11,089	$145,679	$74,739	**$485,531**
10	$261,645	$15,275	$150,049	$76,982	**$503,951**
11	$269,494	$11,764	$154,550	$79,291	**$515,099**
12	$277,579	$16,205	$159,187	$81,670	**$534,641**
13	$285,906	$12,480	$163,963	$84,120	**$546,468**
14	$294,484	$17,192	$168,881	$86,643	**$567,201**
15	$303,318	$13,240	$173,948	$89,243	**$579,749**
16	$312,418	$18,239	$179,166	$91,920	**$601,743**
17	$321,790	$14,047	$184,541	$94,678	**$615,056**
18	$331,444	$19,350	$190,077	$97,518	**$638,389**
19	$341,387	$14,902	$195,780	$100,444	**$652,512**
20	$351,629	$20,528	$201,653	$103,457	**$677,267**

3% Annual Inflation

8.2 Potential Funding Sources

Table 38. Potential BMP 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 KDHE WRAPS Funding Clean Water Neighbor Grants

Potential Funding Sources, cont.	Potential Funding Programs
Kansas Alliance for Wetlands and Streams	
State Conservation Commission	State Cost Share
Conservation Districts	
No-Till on the Plains	
Kansas Forest Service	
US Fish and Wildlife	
National Wild Turkey Federation	
Quail Unlimited	
Ducks Unlimited	

Table 39. Service Providers for BMP Implementation.

BMP		Services Needed to Implement BMP		Service Provider *
		Technical Assistance	Information and Education	
Cropland	1. No-till	Design, cost share and maintenance	BMP workshops, tours, field days	NRCS FSA SCC KFS KSRE CD RC&D KDWP
	2.Waterways	Design, cost share and maintenance	BMP workshops, tours, field days	
	3. Vegetative buffers	Development of management plan	BMP workshops	
	4. Nutrient management plans	Design, cost share and maintenance	BMP workshops, tours, and field days	
	5. Terraces	Design, cost share and maintenance	BMP workshops, field days, tours	
	6. Permanent vegetation	Design, cost share and maintenance	BMP workshops, field days, tours	
	7.Water retention structures	Design, cost share and maintenance	BMP workshops, field days, tours	
Livestock	1. Vegetative filter strips	Design, cost share and maintenance	BMP workshops, field days, tours	KSRE NRCS SCC KAWS CD RC&D KDWP
	2. Relocate pasture pens feeding sites	Design, cost share and maintenance	BMP workshops, field days, tours	
	3.Relocate pasture feeding sites	Design, cost share and maintenance	BMP workshops, field days, tours	
	4. Establish off stream watering systems	Design, cost share and maintenance	BMP workshops, field days, tours	
	5.Rotational grazing	Design, cost share and maintenance	BMP workshops, field days, tours	

BMP		Services Needed to Implement BMP, cont.		Service Provider *
		Technical Assistance	Information and Education	
Streambank and Riparian Buffers	Streambank restoration	Design, cost share and maintenance	BMP workshops, field days, tours	KAWS NRCS SCC FSA KFS KSRE CD RC&D KDWP

** All service providers are responsible for evaluation of the installed or implemented BMPs and/or other services provided and will report to SLT for completion approval.*

9.0 Timeframe

The plan will be reviewed every five years starting in 2017. In 2013, the SLT will request a review of data by KDHE for the Smoky Hill Saline Basin. 2012 is the year that the TMDLs will officially be reviewed for additions or revisions. The timeframe of this document for BMP implementation to meet both sediment and phosphorus TMDLs would be twenty years from the date of publication of this report. Sediment and phosphorus reductions in the water column will not be noticeable by the year 2017 due to a lag time from implementation of BMPs and resulting improvements in water quality. Therefore, the SLT will review sediment and phosphorus concentrations in year 2022, but possible trends can be reviewed in 2017. They will examine BMP placement and implementation in 2017 and every subsequent five years after.

Table 40. Review Schedule for Pollutants and BMPs.

Review Year	Sediment	Phosphorus	BMP Placement
2017			X
2022	X	X	X
2027	X	X	X
2032	X	X	X

The interim timeframe for all BMP implementation would be ten years from the date of publication of this report. Targeting and BMP implementation might shift over time in order to achieve TMDLs.

- Timeframe for reaching the **siltation TMDL in LLS Watershed** will be attained at year 6 of the plan. After the sediment TMDL is achieved, the process will become one of protection instead of restoration.
- The WRAPS estimate timeframe for reaching the **phosphorus portion of the E TMDL in Herington Reservoir** will be year 10 of the plan. After the phosphorus TMDL is achieved, the process will become one of protection instead of restoration.

10.0 Measureable Milestones

10.1 Adoption Rates for BMP Implementation

Milestones will be determined by number of acres treated, projects installed, contacts made to residents of the watershed and water quality parameters at the end of every five years. The SLT will examine these criteria to determine if adequate progress has been made from the current BMP implementations. If they determine that adequate progress has not been made, they will readjust the implementation projects in order to achieve the TMDL. Below are tables outlining the expected adoption rates of BMPs in order to attain impairment reduction goals.

Table 41. Short, Medium and Long Term Goals for BMP Cropland Adoption Rates. Sub watershed adoption rates are provided in the Appendix.

Total Cropland BMP Adoption Milestones									
	Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Adoption
Short Term	1	702	1,054	702	351	702	140	351	4,004
	2	702	1,054	702	351	702	140	351	4,004
	3	702	1,054	702	351	702	140	351	4,004
	4	702	1,054	702	351	702	140	351	4,004
	5	702	1,054	702	351	702	140	351	4,004
	Total	*3,512*	*5,268*	*3,512*	*1,756*	*3,512*	*702*	*1,756*	*20,019*
Medium Term	6	702	1,054	702	351	702	140	351	4,004
	7	702	1,054	702	351	702	140	351	4,004
	8	702	1,054	702	351	702	140	351	4,004
	9	702	1,054	702	351	702	140	351	4,004
	10	702	1,054	702	351	702	140	351	4,004
	Total	*7,024*	*10,536*	*7,024*	*3,512*	*7,024*	*1,405*	*3,512*	*40,038*
Long Term	11	702	1,054	702	351	702	140	351	4,004
	12	702	1,054	702	351	702	140	351	4,004
	13	702	1,054	702	351	702	140	351	4,004
	14	702	1,054	702	351	702	140	351	4,004
	15	702	1,054	702	351	702	140	351	4,004
	16	702	1,054	702	351	702	140	351	4,004
	17	702	1,054	702	351	702	140	351	4,004
	18	702	1,054	702	351	702	140	351	4,004
	19	702	1,054	702	351	702	140	351	4,004
	20	702	1,054	702	351	702	140	351	4,004
	Total	*14,048*	*21,072*	*14,048*	*7,024*	*14,048*	*2,810*	*7,024*	*80,075*

Table 42. Short, Medium and Long Term Goals for BMP Livestock Adoption Rates.

Livestock BMP Adoption Milestones						
	Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing
Short-Term	1	1	0	1	2	1
	2	0	1	1	2	1
	3	1	0	1	2	1
	4	0	1	1	2	1
	5	1	0	1	2	1
	Total	3	2	5	10	5
Medium-Term	6	0	1	1	2	1
	7	1	0	1	2	1
	8	0	1	1	2	1
	9	1	0	1	2	1
	10	0	1	1	2	1
	Total	5	5	10	20	10
Long-Term	11	1	0	1	2	1
	12	0	1	1	2	1
	13	1	0	1	2	1
	14	0	1	1	2	1
	15	1	0	1	2	1
	16	0	1	1	2	1
	17	1	0	1	2	1
	18	0	1	1	2	1
	19	1	0	1	2	1
	20	0	1	1	2	1
	Total	10	10	20	40	20

10.3 Water Quality Milestones Used to Determine Improvements [34]

The goal of the LLS WRAPS plan is to restore water quality for uses supportive of aquatic life, domestic water supply, irrigation, livestock watering, and recreation for the Smoky Hill River and the Herington Reservoir. The plan specifically addresses the high priority total suspended solids (TSS) TMDL for the Smoky Hill River from Salina to Junction City, and the high priority eutrophication TMDL for Herington Reservoir. In order to reach the load reduction goals associated with these impairments, a BMP implementation schedule spanning 20 years has been developed.

In addition to the above impairments, a high priority dissolved oxygen (DO) TMDL has been developed for Holland Creek. There is also a high priority DO TMDL and a medium priority Atrazine TMDL for Herington Reservoir. While this plan is not directly addressing these impairments, it is anticipated that they will be positively affected by the BMP implementation plan that has been developed as part of this WRAPS plan.

Separate water quality milestones have been developed for both Smoky Hill River (from Salina to Junction City) and Herington Reservoir, along with additional indicators of water quality. The purpose of the milestones and indicators is to measure water quality improvements associated with the BMP implementation schedules contained in this plan.

Water Quality Milestones Smoky Hill River
As previously stated, this plan estimates that it will take 20 years to implement the planned BMPs necessary to meet the load reduction goals for the impairments being addressed in the LLS watershed. The table below includes 10-year and long term water quality goals for total phosphorus (TP) and total suspended solids (TSS) for LLS.

Table 43. Water Quality Milestones. [35]

Water Quality Milestones for Smoky Hill River					
	Current Condition* Median TSS	10 Year Goal		Long Term Goal	
		Improved Condition Median TSS	Total Reduction Needed	Improved Condition Median TSS	Total Reduction Needed
Sampling Sites	Median TSS All Flows (median of data collected during indicated period), ppm				
Smoky Hill River at Enterprise SC265	190	120	70	50	140
Smoky Hill River at Junction City SC264	127	88	39	50	77

*The current conditions for SC265 were determined utilizing sampling data from the KDHE stream monitoring station from 1990 to 2010. The current conditions for SC264 were determined utilizing sampling data from the KDHE stream monitoring station from 1996, 1997, 1998, 2003, 2007, 2010.

Water Quality Milestones for Herington Reservoir

As previously stated, in order to reach the sediment and nutrient reduction goals for Herington Reservoir, a BMP implementation schedule spanning 20 years has been developed. Several water quality milestones and indicators have been developed for Herington, as included herein.

The table below includes 10-year water quality goals, as well as long term water quality goals for total phosphorus (TP), chlorophyll a (phosphorus indicators), total nitrogen (TN), and Secchi depth (TSS indicator) monitored in Herington Reservoir.

Table 44. Water Quality Milestones for Herington Reservoir. [36]

Water Quality Milestones for Herington Reservoir								
	Current Condition* (1987 - 2007) Average TP	10 Year Goal		Long Term Goal		Current Condition* (1987 - 2007) Secchi (Avg)	10 Year Goal	Long Term Goal
		Improved Condition Average TP	Total Reduction Needed	Improved Condition Average TP	Total Reduction Needed		Improved Condition Secchi (Avg)	Improved Condition Secchi (Avg)
Sampling Site	Total Phosphorus (average of data collected during indicated period), ppb					Secci (average of data collected during indicated period), m		
Herington Reservoir LM047201	69.7	52	17.7	35	34.7	0.69	Secchi depth > 1.0	Maintain Secchi depth > 1.5

Water Quality Milestones for Herington Reservoir, cont.										
		10 Year Goal		Long Term Goal			10 Year Goal		Long Term Goal	
	Current Condition* (1987 - 2007) Chlorophyll a	Improved Condition Chlorophyll a	Total Reduction Needed	Improved Condition Chlorophyll a	Total Reduction Needed	Current Condition* (1987 - 2007) Average TN	Improved Condition Average TN	Total Reduction Needed	Improved Condition Average TN	Total Reduction Needed
Sampling Site	Chlorophyll a (average of data collected during indicated period), ppb					Total Nitrogen (average of data collected during indicated period), ppm				
Herington Reservoir LM047201	21.1	15	6.1	≤ 10	≥ 11.1	1.17	0.90	0.27	0.62	0.55

*The lake monitoring site is typically sampled every 3 years.

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.

- Occurrence of algal blooms in watershed lakes and reservoirs
- Visitor traffic to watershed lakes and reservoirs, including Herington Reservoir
- Boating traffic in watershed lakes and reservoirs, including Herington Reservoir
- Trends of quantity and quality of fishing in watershed lakes and reservoirs, including Herington Reservoir

11.0 Monitoring Water Quality Progress

KDHE continues to monitor water quality in the LLS Watershed by maintaining the monitoring stations located within the watershed. The map included in this section shows the monitoring stations located within the LLS Watershed. The map has been color-coded to indicate the sub watersheds that have been targeted for BMP implementation and water quality monitoring by this plan.

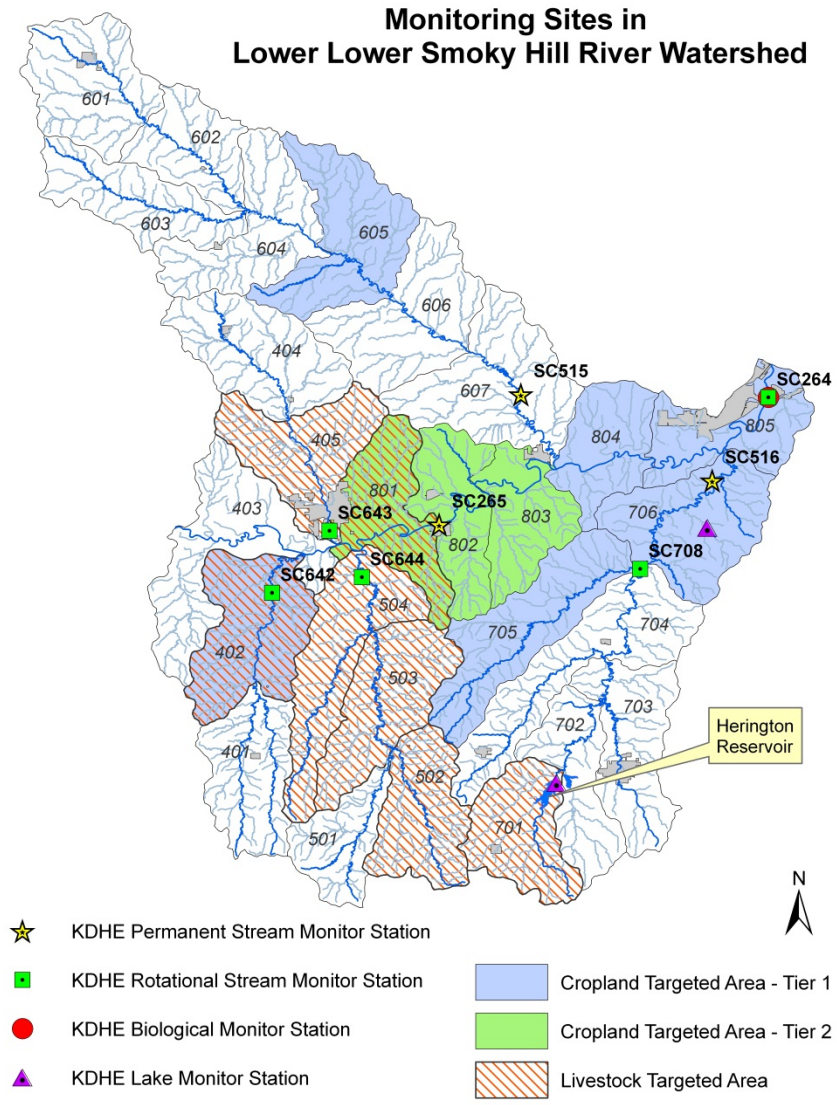


Figure 32. Monitoring Sites in LLS Watershed. [37]

The map above shows the KDHE monitoring stations located in streams and lakes. The permanent stream monitoring sites are continuously sampled, the rotational sites are typically sampled every four years, and the KDHE lake monitoring sites are typically sampled every 3 years. The sites are sampled for

nutrients, *E. Coli* bacteria, chemicals, turbidity, alkalinity, dissolved oxygen, pH, ammonia and metals. The pollutant indicators tested for each site may vary depending on the season at collection time and other factors.

Evaluation of Monitoring Data

Monitoring data in the LLS Watershed will be used to determine water quality progress, track water quality milestones, and to determine the effectiveness of the BMP implementation outlined in the plan. The schedule of review for the monitoring data will be tied to the water quality milestones that have been developed for each watershed, as well as the frequency of the sampling data.

The BMP implementation schedule and water quality milestones for the LLS Watershed extend through a twenty-year period. Throughout the plan period, KDHE will continue to analyze and evaluate the monitoring data collected. After the first ten years of monitoring and BMP implementation, KDHE will evaluate the available water quality data to determine whether the water quality milestones have been achieved. KDHE and the SLT can address any necessary modifications or revisions to the plan based on the data analysis. 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 and the SLT may revisit the plan in shorter increments. This would allow KDHE and the SLT to evaluate newer available information, incorporate any revisions to applicable TMDLs, or address any potential water quality indicators that might trigger an immediate review.

12.0 Review of the Watershed Plan in 2017

This plan will begin in 2012. In the year 2017, 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 **sediment** load reductions. The 2017 milestone for sediment should be based on the available data at the time in the trend of total suspended solids concentration in the watershed.
2. The SLT will request from KDHE a report on the milestone achievements in **phosphorus** load reductions. The 2017 milestone for phosphorus should be based on available data at the time in the trend of the phosphorus concentration in the watershed.
3. The SLT will request a report from KDHE concerning the revisions of the TMDLs from 2012.
4. The SLT will request a report from KDHE and US Corps of Engineers on trends in water quality in Herington Reservoir.
5. The SLT will request a report from Kansas Department of Parks and Wildlife on trends in wildlife (aquatic and terrestrial) in LLS Watershed.
6. The SLT will report on progress towards achieving the adoption rates listed in Section 10.1 of this report.
7. The SLT will report on progress towards achieving the benchmarks listed in Section 10.2 of this report.
8. The SLT will report on progress towards achieving the milestones in Section 10.3 of this report.
9. The SLT will discuss impairments on the 303d list and the possibility of addressing these impairments prior to them being listed as TMDLs.
10. The SLT will discuss the effect of implementing BMPs aimed at specific TMDLs on the impairments listed on the 303d list.
11. The SLT will discuss necessary adjustments and revisions needed in the targets listed in this plan.

13.0 Appendix

13.1 Service Providers

Table 45. Potential Service Provider Listing.

Organization	Programs	Purpose	Technical or Financial Assistance	Website address
East Central Kansas N0-Till Alliance	Field days, seasonal meetings, tours and technical consulting	Provide information and assistance concerning continuous no-till farming practices.	Technical	www.notill.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.	Financial	www.epa.gov
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.	Technical	www.kaws.org
Kansas Dept. of Agriculture	Watershed structures permitting.	Available for watershed districts and multipurpose small lakes development.	Technical and Financial	www.accesskansas.org/kda

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Website address
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.	Technical and Financial	www.kdheks.ks.us

Kansas Department of Wildlife and Parks	Land and Water Conservation Funds	Provides funds to preserve develop and assure access to outdoor recreation.	Technical and Financial	www.kdwp.state.ks.us/
	Conservation Easements for Riparian and Wetland Areas	To provide easements to secure and enhance quality areas in the state.		
	Wildlife Habitat Improvement Program	To provide limited assistance for development of wildlife habitat.		
	North American Waterfowl Conservation Act	To provide up to 50 percent cost share for the purchase and/or development of wetlands and wildlife habitat.		
	MARSH program in coordination with Ducks Unlimited	May provide up to 100 percent of funding for small wetland projects.		
	Chickadee Checkoff	Projects help with all nongame species. Funding is an optional donation line item on the KS Income Tax form.		
	Walk In Hunting Program	Landowners receive a payment incentive to allow public hunting on their property.		
	F.I.S.H. Program	Landowners receive a payment incentive to allow public fishing access to their ponds and streams.		

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Website address
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.	Technical	www.kansasforests.org
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.	Technical and Financial	www.kansasruralcenter.org
Kansas Rural Water Association	Technical assistance for Water Systems with Source Water Protection Planning.	Provide education, technical assistance and leadership to public water and wastewater utilities to enhance the public health and to sustain Kansas' communities	Technical	www.krwa.net
Kansas State Research and Extension	Water Quality Programs, Waste Management Programs Kansas Center for Agricultural Resources and Environment (KCARE)	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.	Technical	www.kcare.ksu.edu

	Kansas Environmental Leadership Program (KELP)	Provide guidance to local governments on water protection programs.		www.ksu.edu/kelp
	Kansas Local Government Water Quality Planning and Management	Reduce non-point source pollution emanating from Kansas grasslands.		www.ksu.edu/olg
	Rangeland and Natural Area Services (RNAS)	Service-learning projects available to college and university faculty and community watersheds in Kansas.		www.k-state.edu/waterlink/
	WaterLINK	Help citizens appraise their local natural resources and develop short and long term plans and activities to protect, sustain and restore their resources for the future.		www.kansasprideprogram.ksu.edu/healthyecosystems/
	Kansas Pride: Healthy Ecosystems/Healthy Communities			www.ksu.edu/kswater/
	Citizen Science	Education combined with volunteer soil and water testing for enhanced natural resource stewardship.		

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Website address
Kansas Water Office	Public Information and Education	Provide information and education to the public on Kansas Water Resources	Technical and Financial	www.kwo.org

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Website address
State Conservation Commission and Conservation Districts	Water Resources Cost Share	Provide cost share assistance to landowners for establishment of water conservation practices.	Technical and Financial	www.accesskansas.org/kscc www.kacdnet.org
	Nonpoint Source Pollution Control Fund	Provides financial assistance for nonpoint pollution control projects which help restore water quality.		
	Riparian and Wetland Protection Program	Funds to assist with wetland and riparian development and enhancement.		
	Stream Rehabilitation Program	Assist with streams that have been adversely altered by channel modifications.		
	Kansas Water Quality Buffer Initiative	Compliments Conservation Reserve Program by offering additional financial incentives for grass filters and riparian forest buffers.		
	Watershed district and multipurpose lakes	Programs are available for watershed district and multipurpose small lakes.		
US Army Corps of Engineers	Planning Assistance to States	Assistance in development of plans for development, utilization and conservation of water and related land resources of drainage	Technical	www.usace.army.mil
	Environmental Restoration	Funding assistance for aquatic ecosystem restoration.		

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Website address
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.	Technical	www.fws.gov
US Geological Survey	National Streamflow Information Program Water Cooperative Program	Provide streamflow data Provide cooperative studies and water-quality information	Technical	ks.water.usgs.gov Nrtwq.usgs.gov

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

13.2 BMP Definitions

(Reduction explanations are provided on pages 88-89)

Cropland

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.
-WRAPS groups and KSU Ag Economists have decided $10 an acre for 10 years is an adequate payment to entice producers to convert, 50% cost-share available from NRCS.

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.
-$800 an acre, 50% cost-share available from NRCS.

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
-Approx. $1,000/acre, 90% cost-share available from NRCS.

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.
-WRAPS groups and KSU Ag Economists have decided $7.30 an acre for 10 years is an adequate payment to entice producers to convert, 50% cost-share is available from NRCS.

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
-$1.02 per linear foot, 50% cost-share available from NRCS

Establish Permanent Vegetation
The cost of $150 an acre was calculated based on K-State Research and Extension estimates of the cost of planting and maintaining native grass.

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

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%.
-$714 an acre

Relocate Feeding Pens
Feeding Pens- Move feedlot or pens away from a stream, waterway, or body of water to increase filtration and waste removal of manure. Highly variable in price, average of $6,600 per unit (1 unit equals 1 acre, 100 AU pen).
-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). Highly variable in price, average of $2,203 per unit (1 unit equals 1 acre, 100 AU pen).
-Average P reduction: 30-80%

Relocate Feeding Sites
-Feedlot- Move feedlot or pens away from a stream, waterway, or body of water to increase filtration and waste removal of manure. Highly variable in price, average of $6,600 per unit.
-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). Highly variable in price, average of $2,203 per unit.
-Average P reduction: 30-80%

Alternative (Off-Stream) Watering System
-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.
-$3,795 installed for solar system, including present value of maintenance costs.

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.
-Approximately $7,000 with complex systems significantly more expensive.

13.3 Sub Watershed Tables

13.3.1 Cropland Scenarios

Table 46. Cropland Scenario for Targeted Areas.

Cropland Scenerio											
Lower Lower Smoky, Targeted Area BMP Scenario											
		Tier 1						Tier 2			
		402	605	705	706	804	805	801	802	803	Total
Acres of Cropland		24,164	20,314	22,157	7,527	10,914	8,296	13,931	11,381	9,777	**128,461**
BMP Implementation (treated acres)	Increased Adoption										Total
No-Till	15%	3,625	3,047	3,324	1,129	1,637	1,244	2,090	1,707	1,467	**19,269**
Grassed Waterways	20%	4,833	4,063	4,431	1,505	2,183	1,659	2,786	2,276	1,955	**25,692**
Vegetative Buffers	10%	2,416	2,031	2,216	753	1,091	830	1,393	1,138	978	**12,846**
Nutrient Mgmt Plans	2%	483	406	443	151	218	166	279	228	196	**2,569**
Terraces	20%	4,833	4,063	4,431	1,505	2,183	1,659	2,786	2,276	1,955	**25,692**
Permanent Vegetation	2%	483	406	443	151	218	166	279	228	196	**2,569**
Water Retention Structures	15%	3,625	3,047	3,324	1,129	1,637	1,244	2,090	1,707	1,467	**19,269**
Total	84%	20,298	17,064	18,612	6,323	9,167	6,968	11,703	9,560	8,214	**107,907**
Estimated Cost											Total
Total Investment Cost		$2,261,856	$1,901,479	$2,073,992	$704,560	$1,021,598	$776,542	$1,304,002	$1,065,311	$915,170	**$12,024,511**
Available Cost-Share		$1,164,390	$978,870	$1,067,679	$362,703	$525,913	$399,759	$671,293	$548,416	$471,124	**$6,190,146**
Net Cost		$1,097,466	$922,609	$1,006,313	$341,857	$495,686	$376,783	$632,710	$516,895	$444,046	**$5,834,365**
Estimated Annual Runoff Reduction											Total

Soil Erosion (tons)	6,888	6,199	6,138	3,868	9,772	4,830	3,244	2,650	2,277	**45,866**
Phosphorus (pounds)	16,613	16,306	14,615	5,521	13,561	7,115	8,119	6,395	5,459	**93,706**
Nitrogen (pounds)	57,992	63,207	53,175	19,046	39,636	22,869	31,543	25,495	21,548	**334,513**
Estimated Average Annual Runoff										
Soil Erosion (tons/acre)	0.71	0.76	0.69	1.28	2.23	1.45	0.58	0.58	0.58	
Phosphorus (pounds/acre)	1.97	2.30	1.89	2.10	3.56	2.46	1.67	1.61	1.60	
Nitrogen (pounds/acre)	7.96	10.32	7.96	8.39	12.05	9.14	7.51	7.43	7.31	

	Crops	**Livestock**	**Streambank**		**Total**	**Required Load Reduction**	**% of TMDL**
Sediment	48,762		0		48,762	48,545	100%
Phosphorus	100,671	20,936			121,607	n/a	n/a
Josh Roe, roe@ksu.edu 785-532-3035							

Table 47. Cropland Scenario for Herington Reservoir.

Herington Reservoir			
Lower Lower Smoky, Targeted Area BMP Scenario			
		Priority Area	
		Herington Reservoir	**Total**
Acres of Cropland		12,022	12,022
BMP Implementation (treated acres)	**Increased Adoption**		**Total**
No-Till	15%	1,803	1,803

Grassed Waterways	20%	2,404	2,404
Vegetative Buffers	10%	1,202	1,202
Nutrient Mgmt Plans	2%	240	240
Terraces	20%	2,404	2,404
Permanent Vegetation	2%	240	240
Water Retention Structures	15%	1,803	1,803
Total	84%	10,098	10,098

Estimated Cost		**Total**
Total Investment Cost	$1,125,312	$1,125,312
Available Cost-Share	$579,304	$579,304
Net Cost	$546,008	$546,008

Estimated Annual Runoff Reduction		**Total**	
Soil Erosion (tons)	2,896	2,896	48,762
Phosphorus (pounds)	6,965	6,965	100,671
Nitrogen (pounds)	27,402	27,402	361,915

Estimated Average Annual Runoff	
Soil Erosion (tons/acre)	0.60
Phosphorus (pounds/acre)	1.66
Nitrogen (pounds/acre)	7.56

Percent Reduction	**Average**
Soil Erosion (tons/acre)	40%
Phosphorus (pounds/acre)	35%

Nitrogen (pounds/acre)				30%		30%
	Crops	**Livestock**	**Streambank**	**Total**	**Required Load Reduction**	**% of TMDL**
Sediment	2,896			2,896	n/a	n/a
Phosphorus	6,965			6,965	4,281	163%
Josh Roe, roe@ksu.edu 785-532-3035						

13.3.2 Load Reduction Rates by Sub Watershed

Table 48. Load Reduction Rates for Siltation.

Herington Reservoir (#701) Annual Soil Erosion Reduction (tons)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	27	22	18	5	11	7	9	98
2	54	43	36	9	22	14	18	196
3	81	65	54	14	32	21	27	294
4	108	87	72	18	43	27	36	392
5	135	108	90	23	54	34	45	490
6	162	130	108	27	65	41	54	588
7	189	151	126	32	76	48	63	685
8	216	173	144	36	87	55	72	783
9	243	195	162	41	97	62	81	881
10	270	216	180	45	108	69	90	979
11	298	238	198	50	119	75	99	1,077
12	325	260	216	54	130	82	108	1,175
13	352	281	234	59	141	89	117	1,273
14	379	303	252	63	151	96	126	1,371
15	406	325	270	68	162	103	135	1,469
16	433	346	289	72	173	110	144	1,567
17	460	368	307	77	184	116	153	1,665
18	487	390	325	81	195	123	162	1,763
19	514	411	343	86	206	130	171	1,860
20	541	433	361	90	216	137	180	1,958

Sub Watershed #402 Annual Soil Erosion Reduction (tons)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	64	51	43	11	26	16	21	233
2	129	103	86	21	51	33	43	466
3	193	154	129	32	77	49	64	699
4	257	206	172	43	103	65	86	932
5	322	257	214	54	129	81	107	1,164
6	386	309	257	64	154	98	129	1,397
7	450	360	300	75	180	114	150	1,630
8	515	412	343	86	206	130	172	1,863
9	579	463	386	97	232	147	193	2,096
10	643	515	429	107	257	163	214	2,329

11	708	566	472	118	283	179	236	2,562
12	772	618	515	129	309	196	257	2,795
13	836	669	558	139	335	212	279	3,028
14	901	721	600	150	360	228	300	3,261
15	965	772	643	161	386	244	322	3,493
16	1,029	824	686	172	412	261	343	3,726
17	1,094	875	729	182	437	277	365	3,959
18	1,158	926	772	193	463	293	386	4,192
19	1,222	978	815	204	489	310	407	4,425
20	1,287	1,029	858	214	515	326	429	4,658

Sub Watershed #605 Annual Soil Erosion Reduction (tons)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	58	46	39	10	23	15	19	210
2	116	93	77	19	46	29	39	419
3	174	139	116	29	69	44	58	629
4	232	185	154	39	93	59	77	838
5	289	232	193	48	116	73	96	1,048
6	347	278	232	58	139	88	116	1,257
7	405	324	270	68	162	103	135	1,467
8	463	371	309	77	185	117	154	1,677
9	521	417	347	87	208	132	174	1,886
10	579	463	386	96	232	147	193	2,096
11	637	509	425	106	255	161	212	2,305
12	695	556	463	116	278	176	232	2,515
13	753	602	502	125	301	191	251	2,725
14	811	648	540	135	324	205	270	2,934
15	868	695	579	145	347	220	289	3,144
16	926	741	618	154	371	235	309	3,353
17	984	787	656	164	394	249	328	3,563
18	1,042	834	695	174	417	264	347	3,772
19	1,100	880	733	183	440	279	367	3,982
20	1,158	926	772	193	463	293	386	4,192

Sub Watershed #705 Annual Soil Erosion Reduction (tons)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	57	46	38	10	23	15	19	208
2	115	92	76	19	46	29	38	415
3	172	138	115	29	69	44	57	623
4	229	183	153	38	92	58	76	830

5	287	229	191	48	115	73	96	1,038
6	344	275	229	57	138	87	115	1,245
7	401	321	268	67	161	102	134	1,453
8	459	367	306	76	183	116	153	1,660
9	516	413	344	86	206	131	172	1,868
10	573	459	382	96	229	145	191	2,075
11	631	505	420	105	252	160	210	2,283
12	688	550	459	115	275	174	229	2,490
13	745	596	497	124	298	189	248	2,698
14	803	642	535	134	321	203	268	2,906
15	860	688	573	143	344	218	287	3,113
16	917	734	612	153	367	232	306	3,321
17	975	780	650	162	390	247	325	3,528
18	1,032	826	688	172	413	261	344	3,736
19	1,089	871	726	182	436	276	363	3,943
20	1,147	917	764	191	459	290	382	4,151

Sub Watershed #706 Annual Soil Erosion Reduction (tons)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	36	29	24	6	14	9	12	131
2	72	58	48	12	29	18	24	262
3	108	87	72	18	43	27	36	392
4	145	116	96	24	58	37	48	523
5	181	145	120	30	72	46	60	654
6	217	173	145	36	87	55	72	785
7	253	202	169	42	101	64	84	916
8	289	231	193	48	116	73	96	1,046
9	325	260	217	54	130	82	108	1,177
10	361	289	241	60	145	92	120	1,308
11	397	318	265	66	159	101	132	1,439
12	434	347	289	72	173	110	145	1,569
13	470	376	313	78	188	119	157	1,700
14	506	405	337	84	202	128	169	1,831
15	542	434	361	90	217	137	181	1,962
16	578	462	385	96	231	146	193	2,093
17	614	491	409	102	246	156	205	2,223
18	650	520	434	108	260	165	217	2,354
19	686	549	458	114	275	174	229	2,485
20	723	578	482	120	289	183	241	2,616

Sub Watershed #804 Annual Soil Erosion Reduction (tons)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	91	73	61	15	37	23	30	330
2	183	146	122	30	73	46	61	661
3	274	219	183	46	110	69	91	991
4	365	292	243	61	146	92	122	1,322
5	456	365	304	76	183	116	152	1,652
6	548	438	365	91	219	139	183	1,982
7	639	511	426	106	256	162	213	2,313
8	730	584	487	122	292	185	243	2,643
9	821	657	548	137	329	208	274	2,974
10	913	730	608	152	365	231	304	3,304
11	1,004	803	669	167	402	254	335	3,634
12	1,095	876	730	183	438	277	365	3,965
13	1,186	949	791	198	475	301	395	4,295
14	1,278	1,022	852	213	511	324	426	4,625
15	1,369	1,095	913	228	548	347	456	4,956
16	1,460	1,168	974	243	584	370	487	5,286
17	1,552	1,241	1,034	259	621	393	517	5,617
18	1,643	1,314	1,095	274	657	416	548	5,947
19	1,734	1,387	1,156	289	694	439	578	6,277
20	1,825	1,460	1,217	304	730	462	608	6,608

Sub Watershed #805 Annual Soil Erosion Reduction (tons)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	45	36	30	8	18	11	15	163
2	90	72	60	15	36	23	30	327
3	135	108	90	23	54	34	45	490
4	180	144	120	30	72	46	60	653
5	226	180	150	38	90	57	75	816
6	271	217	180	45	108	69	90	980
7	316	253	211	53	126	80	105	1,143
8	361	289	241	60	144	91	120	1,306
9	406	325	271	68	162	103	135	1,470
10	451	361	301	75	180	114	150	1,633
11	496	397	331	83	198	126	165	1,796
12	541	433	361	90	217	137	180	1,960
13	586	469	391	98	235	149	195	2,123
14	632	505	421	105	253	160	211	2,286
15	677	541	451	113	271	171	226	2,449
16	722	577	481	120	289	183	241	2,613

17	767	613	511	128	307	194	256	2,776
18	812	650	541	135	325	206	271	2,939
19	857	686	571	143	343	217	286	3,103
20	902	722	601	150	361	229	301	3,266

Sub Watershed #801 Annual Soil Erosion Reduction (tons)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	30	24	20	5	12	8	10	110
2	61	48	40	10	24	15	20	219
3	91	73	61	15	36	23	30	329
4	121	97	81	20	48	31	40	439
5	151	121	101	25	61	38	50	548
6	182	145	121	30	73	46	61	658
7	212	170	141	35	85	54	71	768
8	242	194	162	40	97	61	81	877
9	273	218	182	45	109	69	91	987
10	303	242	202	50	121	77	101	1,097
11	333	267	222	56	133	84	111	1,207
12	364	291	242	61	145	92	121	1,316
13	394	315	263	66	158	100	131	1,426
14	424	339	283	71	170	107	141	1,536
15	454	364	303	76	182	115	151	1,645
16	485	388	323	81	194	123	162	1,755
17	515	412	343	86	206	130	172	1,865
18	545	436	364	91	218	138	182	1,974
19	576	461	384	96	230	146	192	2,084
20	606	485	404	101	242	154	202	2,194

Sub Watershed #802 Annual Soil Erosion Reduction (tons)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	25	20	17	4	10	6	8	90
2	50	40	33	8	20	13	17	179
3	74	59	50	12	30	19	25	269
4	99	79	66	17	40	25	33	358
5	124	99	83	21	50	31	41	448
6	149	119	99	25	59	38	50	538
7	173	139	116	29	69	44	58	627
8	198	158	132	33	79	50	66	717
9	223	178	149	37	89	56	74	806
10	248	198	165	41	99	63	83	896

11	272	218	182	45	109	69	91	986
12	297	238	198	50	119	75	99	1,075
13	322	257	215	54	129	82	107	1,165
14	347	277	231	58	139	88	116	1,255
15	371	297	248	62	149	94	124	1,344
16	396	317	264	66	158	100	132	1,434
17	421	337	281	70	168	107	140	1,523
18	446	356	297	74	178	113	149	1,613
19	470	376	314	78	188	119	157	1,703
20	495	396	330	83	198	125	165	1,792

Sub Watershed #803 Annual Soil Erosion Reduction (tons)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	21	17	14	4	9	5	7	77
2	43	34	28	7	17	11	14	154
3	64	51	43	11	26	16	21	231
4	85	68	57	14	34	22	28	308
5	106	85	71	18	43	27	35	385
6	128	102	85	21	51	32	43	462
7	149	119	99	25	60	38	50	539
8	170	136	113	28	68	43	57	616
9	191	153	128	32	77	48	64	693
10	213	170	142	35	85	54	71	770
11	234	187	156	39	94	59	78	847
12	255	204	170	43	102	65	85	924
13	276	221	184	46	111	70	92	1,001
14	298	238	198	50	119	75	99	1,078
15	319	255	213	53	128	81	106	1,155
16	340	272	227	57	136	86	113	1,232
17	362	289	241	60	145	92	121	1,309
18	383	306	255	64	153	97	128	1,386
19	404	323	269	67	162	102	135	1,463
20	425	340	284	71	170	108	142	1,540

Table 49. Load Reduction Rates for Phosphorus by Subwatershed

Herington Reservoir (#701) Annual Phosphorus Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	40	60	50	12	30	19	25	236
2	80	120	100	25	60	38	50	472
3	120	180	150	37	90	57	75	708

4	160	239	200	50	120	76	100	944
5	200	299	249	62	150	95	125	1,180
6	239	359	299	75	180	114	150	1,416
7	279	419	349	87	210	133	175	1,652
8	319	479	399	100	239	152	200	1,888
9	359	539	449	112	269	171	225	2,124
10	399	599	499	125	299	190	249	2,360
11	439	659	549	137	329	209	274	2,596
12	479	718	599	150	359	228	299	2,832
13	519	778	649	162	389	246	324	3,068
14	559	838	698	175	419	265	349	3,304
15	599	898	748	187	449	284	374	3,540
16	639	958	798	200	479	303	399	3,776
17	679	1,018	848	212	509	322	424	4,012
18	718	1,078	898	225	539	341	449	4,248
19	758	1,138	948	237	569	360	474	4,484
20	798	1,197	998	249	599	379	499	4,720

Sub Watershed #402 Annual Phosphorus Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	95	143	119	30	71	45	60	563
2	190	286	238	60	143	90	119	1,126
3	286	428	357	89	214	136	179	1,689
4	381	571	476	119	286	181	238	2,252
5	476	714	595	149	357	226	298	2,815
6	571	857	714	179	428	271	357	3,377
7	666	1,000	833	208	500	317	417	3,940
8	762	1,142	952	238	571	362	476	4,503
9	857	1,285	1,071	268	643	407	536	5,066
10	952	1,428	1,190	298	714	452	595	5,629
11	1,047	1,571	1,309	327	785	497	655	6,192
12	1,142	1,714	1,428	357	857	543	714	6,755
13	1,238	1,857	1,547	387	928	588	774	7,318
14	1,333	1,999	1,666	417	1,000	633	833	7,881
15	1,428	2,142	1,785	446	1,071	678	893	8,444
16	1,523	2,285	1,904	476	1,142	724	952	9,007
17	1,619	2,428	2,023	506	1,214	769	1,012	9,569
18	1,714	2,571	2,142	536	1,285	814	1,071	10,132
19	1,809	2,713	2,261	565	1,357	859	1,131	10,695
20	1,904	2,856	2,380	595	1,428	904	1,190	11,258

Sub Watershed #605 Annual Phosphorus Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	93	140	117	29	70	44	58	552
2	187	280	234	58	140	89	117	1,105
3	280	420	350	88	210	133	175	1,657
4	374	561	467	117	280	178	234	2,210
5	467	701	584	146	350	222	292	2,762
6	561	841	701	175	420	266	350	3,315
7	654	981	818	204	491	311	409	3,867
8	748	1,121	934	234	561	355	467	4,420
9	841	1,261	1,051	263	631	399	526	4,972
10	934	1,402	1,168	292	701	444	584	5,525
11	1,028	1,542	1,285	321	771	488	642	6,077
12	1,121	1,682	1,402	350	841	533	701	6,630
13	1,215	1,822	1,518	380	911	577	759	7,182
14	1,308	1,962	1,635	409	981	621	818	7,735
15	1,402	2,102	1,752	438	1,051	666	876	8,287
16	1,495	2,243	1,869	467	1,121	710	934	8,840
17	1,589	2,383	1,986	496	1,191	755	993	9,392
18	1,682	2,523	2,102	526	1,261	799	1,051	9,945
19	1,775	2,663	2,219	555	1,332	843	1,110	10,497
20	1,869	2,803	2,336	584	1,402	888	1,168	11,050

Sub Watershed #705 Annual Phosphorus Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	84	126	105	26	63	40	52	495
2	168	251	209	52	126	80	105	990
3	251	377	314	79	188	119	157	1,486
4	335	503	419	105	251	159	209	1,981
5	419	628	523	131	314	199	262	2,476
6	503	754	628	157	377	239	314	2,971
7	586	879	733	183	440	278	366	3,466
8	670	1,005	838	209	503	318	419	3,962
9	754	1,131	942	236	565	358	471	4,457
10	838	1,256	1,047	262	628	398	523	4,952
11	921	1,382	1,152	288	691	438	576	5,447
12	1,005	1,508	1,256	314	754	477	628	5,942
13	1,089	1,633	1,361	340	817	517	680	6,438
14	1,173	1,759	1,466	366	879	557	733	6,933
15	1,256	1,884	1,570	393	942	597	785	7,428
16	1,340	2,010	1,675	419	1,005	637	838	7,923

17	1,424	2,136	1,780	445	1,068	676	890	8,418
18	1,508	2,261	1,884	471	1,131	716	942	8,913
19	1,591	2,387	1,989	497	1,193	756	995	9,409
20	1,675	2,513	2,094	523	1,256	796	1,047	9,904

Sub Watershed #706 Annual Phosphorus Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	32	47	40	10	24	15	20	187
2	63	95	79	20	47	30	40	374
3	95	142	119	30	71	45	59	561
4	127	190	158	40	95	60	79	748
5	158	237	198	49	119	75	99	935
6	190	285	237	59	142	90	119	1,122
7	221	332	277	69	166	105	138	1,310
8	253	380	316	79	190	120	158	1,497
9	285	427	356	89	214	135	178	1,684
10	316	475	396	99	237	150	198	1,871
11	348	522	435	109	261	165	218	2,058
12	380	570	475	119	285	180	237	2,245
13	411	617	514	129	308	195	257	2,432
14	443	664	554	138	332	210	277	2,619
15	475	712	593	148	356	225	297	2,806
16	506	759	633	158	380	240	316	2,993
17	538	807	672	168	403	255	336	3,180
18	570	854	712	178	427	271	356	3,367
19	601	902	751	188	451	286	376	3,554
20	633	949	791	198	475	301	396	3,741

Sub Watershed #804 Annual Phosphorus Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	78	117	97	24	58	37	49	459
2	155	233	194	49	117	74	97	919
3	233	350	291	73	175	111	146	1,378
4	311	466	389	97	233	148	194	1,838
5	389	583	486	121	291	185	243	2,297
6	466	699	583	146	350	221	291	2,757
7	544	816	680	170	408	258	340	3,216
8	622	933	777	194	466	295	389	3,676
9	699	1,049	874	219	525	332	437	4,135
10	777	1,166	971	243	583	369	486	4,595

11	855	1,282	1,069	267	641	406	534	5,054
12	933	1,399	1,166	291	699	443	583	5,514
13	1,010	1,515	1,263	316	758	480	631	5,973
14	1,088	1,632	1,360	340	816	517	680	6,433
15	1,166	1,749	1,457	364	874	554	729	6,892
16	1,243	1,865	1,554	389	933	591	777	7,352
17	1,321	1,982	1,651	413	991	628	826	7,811
18	1,399	2,098	1,749	437	1,049	664	874	8,271
19	1,477	2,215	1,846	461	1,107	701	923	8,730
20	1,554	2,331	1,943	486	1,166	738	971	9,190

Sub Watershed #805 Annual Phosphorus Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	41	61	51	13	31	19	25	241
2	82	122	102	25	61	39	51	482
3	122	183	153	38	92	58	76	723
4	163	245	204	51	122	77	102	964
5	204	306	255	64	153	97	127	1,205
6	245	367	306	76	183	116	153	1,447
7	285	428	357	89	214	136	178	1,688
8	326	489	408	102	245	155	204	1,929
9	367	550	459	115	275	174	229	2,170
10	408	612	510	127	306	194	255	2,411
11	449	673	561	140	336	213	280	2,652
12	489	734	612	153	367	232	306	2,893
13	530	795	663	166	398	252	331	3,134
14	571	856	714	178	428	271	357	3,375
15	612	917	765	191	459	291	382	3,616
16	652	979	816	204	489	310	408	3,857
17	693	1,040	866	217	520	329	433	4,098
18	734	1,101	917	229	550	349	459	4,340
19	775	1,162	968	242	581	368	484	4,581
20	816	1,223	1,019	255	612	387	510	4,822

Sub Watershed #801 Annual Phosphorus Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	47	70	58	15	35	22	29	275
2	93	140	116	29	70	44	58	550
3	140	209	174	44	105	66	87	825
4	186	279	233	58	140	88	116	1,100

5	233	349	291	73	174	111	145	1,376
6	279	419	349	87	209	133	174	1,651
7	326	489	407	102	244	155	204	1,926
8	372	558	465	116	279	177	233	2,201
9	419	628	523	131	314	199	262	2,476
10	465	698	582	145	349	221	291	2,751
11	512	768	640	160	384	243	320	3,026
12	558	838	698	174	419	265	349	3,301
13	605	907	756	189	454	287	378	3,576
14	651	977	814	204	489	309	407	3,851
15	698	1,047	872	218	523	332	436	4,127
16	744	1,117	931	233	558	354	465	4,402
17	791	1,187	989	247	593	376	494	4,677
18	838	1,256	1,047	262	628	398	523	4,952
19	884	1,326	1,105	276	663	420	553	5,227
20	931	1,396	1,163	291	698	442	582	5,502

Sub Watershed #802 Annual Phosphorus Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	37	55	46	11	27	17	23	217
2	73	110	92	23	55	35	46	433
3	110	165	137	34	82	52	69	650
4	147	220	183	46	110	70	92	867
5	183	275	229	57	137	87	115	1,083
6	220	330	275	69	165	104	137	1,300
7	257	385	321	80	192	122	160	1,517
8	293	440	366	92	220	139	183	1,733
9	330	495	412	103	247	157	206	1,950
10	366	550	458	115	275	174	229	2,167
11	403	605	504	126	302	191	252	2,383
12	440	660	550	137	330	209	275	2,600
13	476	715	596	149	357	226	298	2,817
14	513	770	641	160	385	244	321	3,033
15	550	825	687	172	412	261	344	3,250
16	586	880	733	183	440	279	366	3,467
17	623	934	779	195	467	296	389	3,683
18	660	989	825	206	495	313	412	3,900
19	696	1,044	870	218	522	331	435	4,117
20	733	1,099	916	229	550	348	458	4,333

Sub Watershed #803 Annual Phosphorus Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	31	47	39	10	23	15	20	185
2	63	94	78	20	47	30	39	370
3	94	141	117	29	70	45	59	555
4	125	188	156	39	94	59	78	740
5	156	235	196	49	117	74	98	925
6	188	282	235	59	141	89	117	1,110
7	219	329	274	68	164	104	137	1,295
8	250	375	313	78	188	119	156	1,480
9	282	422	352	88	211	134	176	1,665
10	313	469	391	98	235	149	196	1,850
11	344	516	430	108	258	163	215	2,035
12	375	563	469	117	282	178	235	2,220
13	407	610	508	127	305	193	254	2,405
14	438	657	548	137	329	208	274	2,590
15	469	704	587	147	352	223	293	2,775
16	501	751	626	156	375	238	313	2,960
17	532	798	665	166	399	253	332	3,145
18	563	845	704	176	422	267	352	3,330
19	594	892	743	186	446	282	372	3,515
20	626	939	782	196	469	297	391	3,700

Table 50. Load Reduction Rates for Nitrogen by Subwatershed.

Herrington Reservoir (#701) Annual Nitrogen Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	114	273	114	57	136	86	114	893
2	227	545	227	114	273	173	227	1,786
3	341	818	341	170	409	259	341	2,679
4	454	1,091	454	227	545	345	454	3,572
5	568	1,363	568	284	682	432	568	4,465
6	682	1,636	682	341	818	518	682	5,358
7	795	1,909	795	398	954	604	795	6,251
8	909	2,181	909	454	1,091	691	909	7,144
9	1,022	2,454	1,022	511	1,227	777	1,022	8,037
10	1,136	2,727	1,136	568	1,363	863	1,136	8,930
11	1,250	2,999	1,250	625	1,500	950	1,250	9,823
12	1,363	3,272	1,363	682	1,636	1,036	1,363	10,715
13	1,477	3,545	1,477	738	1,772	1,122	1,477	11,608
14	1,591	3,817	1,591	795	1,909	1,209	1,591	12,501
15	1,704	4,090	1,704	852	2,045	1,295	1,704	13,394

16	1,818	4,363	1,818	909	2,181	1,381	1,818	14,287
17	1,931	4,635	1,931	966	2,318	1,468	1,931	15,180
18	2,045	4,908	2,045	1,022	2,454	1,554	2,045	16,073
19	2,159	5,181	2,159	1,079	2,590	1,640	2,159	16,966
20	2,272	5,453	2,272	1,136	2,727	1,727	2,272	17,859

Sub Watershed #402 Annual Nitrogen Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	240	577	240	120	289	183	240	1,890
2	481	1,154	481	240	577	365	481	3,780
3	721	1,731	721	361	866	548	721	5,669
4	962	2,308	962	481	1,154	731	962	7,559
5	1,202	2,885	1,202	601	1,443	914	1,202	9,449
6	1,443	3,462	1,443	721	1,731	1,096	1,443	11,339
7	1,683	4,039	1,683	842	2,020	1,279	1,683	13,229
8	1,923	4,616	1,923	962	2,308	1,462	1,923	15,118
9	2,164	5,193	2,164	1,082	2,597	1,645	2,164	17,008
10	2,404	5,770	2,404	1,202	2,885	1,827	2,404	18,898
11	2,645	6,347	2,645	1,322	3,174	2,010	2,645	20,788
12	2,885	6,924	2,885	1,443	3,462	2,193	2,885	22,678
13	3,126	7,501	3,126	1,563	3,751	2,375	3,126	24,567
14	3,366	8,079	3,366	1,683	4,039	2,558	3,366	26,457
15	3,606	8,656	3,606	1,803	4,328	2,741	3,606	28,347
16	3,847	9,233	3,847	1,923	4,616	2,924	3,847	30,237
17	4,087	9,810	4,087	2,044	4,905	3,106	4,087	32,126
18	4,328	10,387	4,328	2,164	5,193	3,289	4,328	34,016
19	4,568	10,964	4,568	2,284	5,482	3,472	4,568	35,906
20	4,809	11,541	4,809	2,404	5,770	3,655	4,809	37,796

Sub Watershed #605 Annual Nitrogen Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	262	629	262	131	314	199	262	2,060
2	524	1,258	524	262	629	398	524	4,119
3	786	1,887	786	393	943	597	786	6,179
4	1,048	2,516	1,048	524	1,258	797	1,048	8,239
5	1,310	3,145	1,310	655	1,572	996	1,310	10,299
6	1,572	3,774	1,572	786	1,887	1,195	1,572	12,358
7	1,834	4,402	1,834	917	2,201	1,394	1,834	14,418
8	2,096	5,031	2,096	1,048	2,516	1,593	2,096	16,478
9	2,358	5,660	2,358	1,179	2,830	1,792	2,358	18,537

10	2,621	6,289	2,621	1,310	3,145	1,992	2,621	20,597
11	2,883	6,918	2,883	1,441	3,459	2,191	2,883	22,657
12	3,145	7,547	3,145	1,572	3,774	2,390	3,145	24,717
13	3,407	8,176	3,407	1,703	4,088	2,589	3,407	26,776
14	3,669	8,805	3,669	1,834	4,402	2,788	3,669	28,836
15	3,931	9,434	3,931	1,965	4,717	2,987	3,931	30,896
16	4,193	10,063	4,193	2,096	5,031	3,187	4,193	32,955
17	4,455	10,692	4,455	2,227	5,346	3,386	4,455	35,015
18	4,717	11,321	4,717	2,358	5,660	3,585	4,717	37,075
19	4,979	11,950	4,979	2,489	5,975	3,784	4,979	39,135
20	5,241	12,578	5,241	2,621	6,289	3,983	5,241	41,194

Sub Watershed #705 Annual Nitrogen Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	220	529	220	110	265	168	220	1,733
2	441	1,058	441	220	529	335	441	3,466
3	661	1,587	661	331	794	503	661	5,198
4	882	2,116	882	441	1,058	670	882	6,931
5	1,102	2,646	1,102	551	1,323	838	1,102	8,664
6	1,323	3,175	1,323	661	1,587	1,005	1,323	10,397
7	1,543	3,704	1,543	772	1,852	1,173	1,543	12,130
8	1,764	4,233	1,764	882	2,116	1,340	1,764	13,863
9	1,984	4,762	1,984	992	2,381	1,508	1,984	15,595
10	2,205	5,291	2,205	1,102	2,646	1,676	2,205	17,328
11	2,425	5,820	2,425	1,213	2,910	1,843	2,425	19,061
12	2,646	6,349	2,646	1,323	3,175	2,011	2,646	20,794
13	2,866	6,878	2,866	1,433	3,439	2,178	2,866	22,527
14	3,086	7,408	3,086	1,543	3,704	2,346	3,086	24,260
15	3,307	7,937	3,307	1,653	3,968	2,513	3,307	25,992
16	3,527	8,466	3,527	1,764	4,233	2,681	3,527	27,725
17	3,748	8,995	3,748	1,874	4,497	2,848	3,748	29,458
18	3,968	9,524	3,968	1,984	4,762	3,016	3,968	31,191
19	4,189	10,053	4,189	2,094	5,027	3,183	4,189	32,924
20	4,409	10,582	4,409	2,205	5,291	3,351	4,409	34,657

Sub Watershed #706 Annual Nitrogen Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	79	190	79	39	95	60	79	621
2	158	379	158	79	190	120	158	1,241
3	237	569	237	118	284	180	237	1,862

4	316	758	316	158	379	240	316	2,483
5	395	948	395	197	474	300	395	3,103
6	474	1,137	474	237	569	360	474	3,724
7	553	1,327	553	276	663	420	553	4,345
8	632	1,516	632	316	758	480	632	4,965
9	711	1,706	711	355	853	540	711	5,586
10	790	1,895	790	395	948	600	790	6,207
11	869	2,085	869	434	1,042	660	869	6,827
12	948	2,274	948	474	1,137	720	948	7,448
13	1,027	2,464	1,027	513	1,232	780	1,027	8,069
14	1,105	2,653	1,105	553	1,327	840	1,105	8,689
15	1,184	2,843	1,184	592	1,421	900	1,184	9,310
16	1,263	3,032	1,263	632	1,516	960	1,263	9,931
17	1,342	3,222	1,342	671	1,611	1,020	1,342	10,551
18	1,421	3,411	1,421	711	1,706	1,080	1,421	11,172
19	1,500	3,601	1,500	750	1,800	1,140	1,500	11,792
20	1,579	3,790	1,579	790	1,895	1,200	1,579	12,413

Sub Watershed #804 Annual Nitrogen Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	164	394	164	82	197	125	164	1,292
2	329	789	329	164	394	250	329	2,583
3	493	1,183	493	246	592	375	493	3,875
4	657	1,578	657	329	789	500	657	5,167
5	822	1,972	822	411	986	624	822	6,458
6	986	2,366	986	493	1,183	749	986	7,750
7	1,150	2,761	1,150	575	1,380	874	1,150	9,041
8	1,315	3,155	1,315	657	1,578	999	1,315	10,333
9	1,479	3,550	1,479	739	1,775	1,124	1,479	11,625
10	1,643	3,944	1,643	822	1,972	1,249	1,643	12,916
11	1,808	4,338	1,808	904	2,169	1,374	1,808	14,208
12	1,972	4,733	1,972	986	2,366	1,499	1,972	15,500
13	2,136	5,127	2,136	1,068	2,564	1,624	2,136	16,791
14	2,301	5,521	2,301	1,150	2,761	1,748	2,301	18,083
15	2,465	5,916	2,465	1,232	2,958	1,873	2,465	19,374
16	2,629	6,310	2,629	1,315	3,155	1,998	2,629	20,666
17	2,794	6,705	2,794	1,397	3,352	2,123	2,794	21,958
18	2,958	7,099	2,958	1,479	3,550	2,248	2,958	23,249
19	3,122	7,493	3,122	1,561	3,747	2,373	3,122	24,541
20	3,287	7,888	3,287	1,643	3,944	2,498	3,287	25,833

Sub Watershed #805 Annual Nitrogen Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	95	228	95	47	114	72	95	745
2	190	455	190	95	228	144	190	1,490
3	284	683	284	142	341	216	284	2,236
4	379	910	379	190	455	288	379	2,981
5	474	1,138	474	237	569	360	474	3,726
6	569	1,365	569	284	683	432	569	4,471
7	664	1,593	664	332	796	504	664	5,217
8	759	1,820	759	379	910	576	759	5,962
9	853	2,048	853	427	1,024	649	853	6,707
10	948	2,276	948	474	1,138	721	948	7,452
11	1,043	2,503	1,043	521	1,252	793	1,043	8,198
12	1,138	2,731	1,138	569	1,365	865	1,138	8,943
13	1,233	2,958	1,233	616	1,479	937	1,233	9,688
14	1,327	3,186	1,327	664	1,593	1,009	1,327	10,433
15	1,422	3,413	1,422	711	1,707	1,081	1,422	11,179
16	1,517	3,641	1,517	759	1,820	1,153	1,517	11,924
17	1,612	3,868	1,612	806	1,934	1,225	1,612	12,669
18	1,707	4,096	1,707	853	2,048	1,297	1,707	13,414
19	1,801	4,324	1,801	901	2,162	1,369	1,801	14,160
20	1,896	4,551	1,896	948	2,276	1,441	1,896	14,905

Sub Watershed #801 Annual Nitrogen Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	131	314	131	65	157	99	131	1,028
2	262	628	262	131	314	199	262	2,056
3	392	942	392	196	471	298	392	3,084
4	523	1,255	523	262	628	398	523	4,112
5	654	1,569	654	327	785	497	654	5,140
6	785	1,883	785	392	942	596	785	6,167
7	915	2,197	915	458	1,099	696	915	7,195
8	1,046	2,511	1,046	523	1,255	795	1,046	8,223
9	1,177	2,825	1,177	588	1,412	895	1,177	9,251
10	1,308	3,139	1,308	654	1,569	994	1,308	10,279
11	1,439	3,453	1,439	719	1,726	1,093	1,439	11,307
12	1,569	3,766	1,569	785	1,883	1,193	1,569	12,335
13	1,700	4,080	1,700	850	2,040	1,292	1,700	13,363
14	1,831	4,394	1,831	915	2,197	1,391	1,831	14,391
15	1,962	4,708	1,962	981	2,354	1,491	1,962	15,419
16	2,092	5,022	2,092	1,046	2,511	1,590	2,092	16,447

17	2,223	5,336	2,223	1,112	2,668	1,690	2,223	17,474
18	2,354	5,650	2,354	1,177	2,825	1,789	2,354	18,502
19	2,485	5,963	2,485	1,242	2,982	1,888	2,485	19,530
20	2,616	6,277	2,616	1,308	3,139	1,988	2,616	20,558

Sub Watershed #802 Annual Nitrogen Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	106	254	106	53	127	80	106	831
2	211	507	211	106	254	161	211	1,662
3	317	761	317	159	381	241	317	2,492
4	423	1,015	423	211	507	321	423	3,323
5	529	1,268	529	264	634	402	529	4,154
6	634	1,522	634	317	761	482	634	4,985
7	740	1,776	740	370	888	562	740	5,816
8	846	2,029	846	423	1,015	643	846	6,646
9	951	2,283	951	476	1,142	723	951	7,477
10	1,057	2,537	1,057	529	1,268	803	1,057	8,308
11	1,163	2,791	1,163	581	1,395	884	1,163	9,139
12	1,268	3,044	1,268	634	1,522	964	1,268	9,970
13	1,374	3,298	1,374	687	1,649	1,044	1,374	10,801
14	1,480	3,552	1,480	740	1,776	1,125	1,480	11,631
15	1,586	3,805	1,586	793	1,903	1,205	1,586	12,462
16	1,691	4,059	1,691	846	2,029	1,285	1,691	13,293
17	1,797	4,313	1,797	898	2,156	1,366	1,797	14,124
18	1,903	4,566	1,903	951	2,283	1,446	1,903	14,955
19	2,008	4,820	2,008	1,004	2,410	1,526	2,008	15,785
20	2,114	5,074	2,114	1,057	2,537	1,607	2,114	16,616

Sub Watershed #803 Annual Nitrogen Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	89	214	89	45	107	68	89	702
2	179	429	179	89	214	136	179	1,404
3	268	643	268	134	322	204	268	2,107
4	357	858	357	179	429	272	357	2,809
5	447	1,072	447	223	536	339	447	3,511
6	536	1,286	536	268	643	407	536	4,213
7	625	1,501	625	313	750	475	625	4,915
8	715	1,715	715	357	858	543	715	5,618
9	804	1,930	804	402	965	611	804	6,320
10	893	2,144	893	447	1,072	679	893	7,022

11	983	2,359	983	491	1,179	747	983	7,724
12	1,072	2,573	1,072	536	1,286	815	1,072	8,426
13	1,161	2,787	1,161	581	1,394	883	1,161	9,128
14	1,251	3,002	1,251	625	1,501	951	1,251	9,831
15	1,340	3,216	1,340	670	1,608	1,018	1,340	10,533
16	1,429	3,431	1,429	715	1,715	1,086	1,429	11,235
17	1,519	3,645	1,519	759	1,822	1,154	1,519	11,937
18	1,608	3,859	1,608	804	1,930	1,222	1,608	12,639
19	1,697	4,074	1,697	849	2,037	1,290	1,697	13,342
20	1,787	4,288	1,787	893	2,144	1,358	1,787	14,044

13.3.3 Adoption Rates by Sub Watershed

Table 51. Adoption Rates by Sub Watershed.

Herington Reservoir (#701) Annual Adoption (treated acres), Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Adoption
1	60	90	60	30	60	12	30	343
2	60	90	60	30	60	12	30	343
3	60	90	60	30	60	12	30	343
4	60	90	60	30	60	12	30	343
5	60	90	60	30	60	12	30	343
6	60	90	60	30	60	12	30	343
7	60	90	60	30	60	12	30	343
8	60	90	60	30	60	12	30	343
9	60	90	60	30	60	12	30	343
10	60	90	60	30	60	12	30	343
11	60	90	60	30	60	12	30	343
12	60	90	60	30	60	12	30	343
13	60	90	60	30	60	12	30	343
14	60	90	60	30	60	12	30	343
15	60	90	60	30	60	12	30	343
16	60	90	60	30	60	12	30	343
17	60	90	60	30	60	12	30	343
18	60	90	60	30	60	12	30	343
19	60	90	60	30	60	12	30	343
20	60	90	60	30	60	12	30	343

Sub Watershed #402 Annual Adoption (treated acres), Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Adoption

1	121	181	121	60	121	24	60	689
2	121	181	121	60	121	24	60	689
3	121	181	121	60	121	24	60	689
4	121	181	121	60	121	24	60	689
5	121	181	121	60	121	24	60	689
6	121	181	121	60	121	24	60	689
7	121	181	121	60	121	24	60	689
8	121	181	121	60	121	24	60	689
9	121	181	121	60	121	24	60	689
10	121	181	121	60	121	24	60	689
11	121	181	121	60	121	24	60	689
12	121	181	121	60	121	24	60	689
13	121	181	121	60	121	24	60	689
14	121	181	121	60	121	24	60	689
15	121	181	121	60	121	24	60	689
16	121	181	121	60	121	24	60	689
17	121	181	121	60	121	24	60	689
18	121	181	121	60	121	24	60	689
19	121	181	121	60	121	24	60	689
20	121	181	121	60	121	24	60	689

Sub Watershed #605 Annual Adoption (treated acres), Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Adoption
1	102	152	102	51	102	20	51	579
2	102	152	102	51	102	20	51	579
3	102	152	102	51	102	20	51	579
4	102	152	102	51	102	20	51	579
5	102	152	102	51	102	20	51	579
6	102	152	102	51	102	20	51	579
7	102	152	102	51	102	20	51	579
8	102	152	102	51	102	20	51	579
9	102	152	102	51	102	20	51	579
10	102	152	102	51	102	20	51	579
11	102	152	102	51	102	20	51	579
12	102	152	102	51	102	20	51	579
13	102	152	102	51	102	20	51	579
14	102	152	102	51	102	20	51	579
15	102	152	102	51	102	20	51	579
16	102	152	102	51	102	20	51	579
17	102	152	102	51	102	20	51	579
18	102	152	102	51	102	20	51	579
19	102	152	102	51	102	20	51	579

20	102	152	102	51	102	20	51	579

Sub Watershed #705 Annual Adoption (treated acres), Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Adoption
1	111	166	111	55	111	22	55	631
2	111	166	111	55	111	22	55	631
3	111	166	111	55	111	22	55	631
4	111	166	111	55	111	22	55	631
5	111	166	111	55	111	22	55	631
6	111	166	111	55	111	22	55	631
7	111	166	111	55	111	22	55	631
8	111	166	111	55	111	22	55	631
9	111	166	111	55	111	22	55	631
10	111	166	111	55	111	22	55	631
11	111	166	111	55	111	22	55	631
12	111	166	111	55	111	22	55	631
13	111	166	111	55	111	22	55	631
14	111	166	111	55	111	22	55	631
15	111	166	111	55	111	22	55	631
16	111	166	111	55	111	22	55	631
17	111	166	111	55	111	22	55	631
18	111	166	111	55	111	22	55	631
19	111	166	111	55	111	22	55	631
20	111	166	111	55	111	22	55	631

Sub Watershed #706 Annual Adoption (treated acres), Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Adoption
1	38	56	38	19	38	8	19	215
2	38	56	38	19	38	8	19	215
3	38	56	38	19	38	8	19	215
4	38	56	38	19	38	8	19	215
5	38	56	38	19	38	8	19	215
6	38	56	38	19	38	8	19	215
7	38	56	38	19	38	8	19	215
8	38	56	38	19	38	8	19	215
9	38	56	38	19	38	8	19	215
10	38	56	38	19	38	8	19	215
11	38	56	38	19	38	8	19	215
12	38	56	38	19	38	8	19	215
13	38	56	38	19	38	8	19	215

14	38	56	38	19	38	8	19	215
15	38	56	38	19	38	8	19	215
16	38	56	38	19	38	8	19	215
17	38	56	38	19	38	8	19	215
18	38	56	38	19	38	8	19	215
19	38	56	38	19	38	8	19	215
20	38	56	38	19	38	8	19	215

Sub Watershed #804 Annual Adoption (treated acres), Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Adoption
1	55	82	55	27	55	11	27	311
2	55	82	55	27	55	11	27	311
3	55	82	55	27	55	11	27	311
4	55	82	55	27	55	11	27	311
5	55	82	55	27	55	11	27	311
6	55	82	55	27	55	11	27	311
7	55	82	55	27	55	11	27	311
8	55	82	55	27	55	11	27	311
9	55	82	55	27	55	11	27	311
10	55	82	55	27	55	11	27	311
11	55	82	55	27	55	11	27	311
12	55	82	55	27	55	11	27	311
13	55	82	55	27	55	11	27	311
14	55	82	55	27	55	11	27	311
15	55	82	55	27	55	11	27	311
16	55	82	55	27	55	11	27	311
17	55	82	55	27	55	11	27	311
18	55	82	55	27	55	11	27	311
19	55	82	55	27	55	11	27	311
20	55	82	55	27	55	11	27	311

Sub Watershed #805 Annual Adoption (treated acres), Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Adoption
1	41	62	41	21	41	8	21	236
2	41	62	41	21	41	8	21	236
3	41	62	41	21	41	8	21	236
4	41	62	41	21	41	8	21	236
5	41	62	41	21	41	8	21	236
6	41	62	41	21	41	8	21	236
7	41	62	41	21	41	8	21	236

8	41	62	41	21	41	8	21	236
9	41	62	41	21	41	8	21	236
10	41	62	41	21	41	8	21	236
11	41	62	41	21	41	8	21	236
12	41	62	41	21	41	8	21	236
13	41	62	41	21	41	8	21	236
14	41	62	41	21	41	8	21	236
15	41	62	41	21	41	8	21	236
16	41	62	41	21	41	8	21	236
17	41	62	41	21	41	8	21	236
18	41	62	41	21	41	8	21	236
19	41	62	41	21	41	8	21	236
20	41	62	41	21	41	8	21	236

Sub Watershed #801 Annual Adoption (treated acres), Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Adoption
1	70	104	70	35	70	14	35	397
2	70	104	70	35	70	14	35	397
3	70	104	70	35	70	14	35	397
4	70	104	70	35	70	14	35	397
5	70	104	70	35	70	14	35	397
6	70	104	70	35	70	14	35	397
7	70	104	70	35	70	14	35	397
8	70	104	70	35	70	14	35	397
9	70	104	70	35	70	14	35	397
10	70	104	70	35	70	14	35	397
11	70	104	70	35	70	14	35	397
12	70	104	70	35	70	14	35	397
13	70	104	70	35	70	14	35	397
14	70	104	70	35	70	14	35	397
15	70	104	70	35	70	14	35	397
16	70	104	70	35	70	14	35	397
17	70	104	70	35	70	14	35	397
18	70	104	70	35	70	14	35	397
19	70	104	70	35	70	14	35	397
20	70	104	70	35	70	14	35	397

Sub Watershed #802 Annual Adoption (treated acres), Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Adoption
1	57	85	57	28	57	11	28	324

2	57	85	57	28	57	11	28	324
3	57	85	57	28	57	11	28	324
4	57	85	57	28	57	11	28	324
5	57	85	57	28	57	11	28	324
6	57	85	57	28	57	11	28	324
7	57	85	57	28	57	11	28	324
8	57	85	57	28	57	11	28	324
9	57	85	57	28	57	11	28	324
10	57	85	57	28	57	11	28	324
11	57	85	57	28	57	11	28	324
12	57	85	57	28	57	11	28	324
13	57	85	57	28	57	11	28	324
14	57	85	57	28	57	11	28	324
15	57	85	57	28	57	11	28	324
16	57	85	57	28	57	11	28	324
17	57	85	57	28	57	11	28	324
18	57	85	57	28	57	11	28	324
19	57	85	57	28	57	11	28	324
20	57	85	57	28	57	11	28	324

Sub Watershed #803 Annual Adoption (treated acres), Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Adoption
1	49	73	49	24	49	10	24	279
2	49	73	49	24	49	10	24	279
3	49	73	49	24	49	10	24	279
4	49	73	49	24	49	10	24	279
5	49	73	49	24	49	10	24	279
6	49	73	49	24	49	10	24	279
7	49	73	49	24	49	10	24	279
8	49	73	49	24	49	10	24	279
9	49	73	49	24	49	10	24	279
10	49	73	49	24	49	10	24	279
11	49	73	49	24	49	10	24	279
12	49	73	49	24	49	10	24	279
13	49	73	49	24	49	10	24	279
14	49	73	49	24	49	10	24	279
15	49	73	49	24	49	10	24	279
16	49	73	49	24	49	10	24	279
17	49	73	49	24	49	10	24	279
18	49	73	49	24	49	10	24	279
19	49	73	49	24	49	10	24	279
20	49	73	49	24	49	10	24	279

13.3.4 Costs by Sub Watershed

Table 52. Costs Before Cost Share by Sub Watershed.

Herington Reservoir (#701) Total Annual Cost Before Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$4,670	$14,426	$4,007	$1,704	$6,131	$1,803	$3,757	$36,499
2	$4,810	$14,859	$4,128	$1,756	$6,315	$1,857	$3,870	$37,594
3	$4,954	$15,305	$4,251	$1,808	$6,505	$1,913	$3,986	$38,722
4	$5,103	$15,764	$4,379	$1,862	$6,700	$1,971	$4,105	$39,884
5	$5,256	$16,237	$4,510	$1,918	$6,901	$2,030	$4,228	$41,081
6	$5,414	$16,724	$4,646	$1,976	$7,108	$2,091	$4,355	$42,313
7	$5,576	$17,226	$4,785	$2,035	$7,321	$2,153	$4,486	$43,582
8	$5,743	$17,743	$4,929	$2,096	$7,541	$2,218	$4,620	$44,890
9	$5,916	$18,275	$5,076	$2,159	$7,767	$2,284	$4,759	$46,236
10	$6,093	$18,823	$5,229	$2,224	$8,000	$2,353	$4,902	$47,624
11	$6,276	$19,388	$5,386	$2,291	$8,240	$2,423	$5,049	$49,052
12	$6,464	$19,970	$5,547	$2,359	$8,487	$2,496	$5,200	$50,524
13	$6,658	$20,569	$5,713	$2,430	$8,742	$2,571	$5,356	$52,040
14	$6,858	$21,186	$5,885	$2,503	$9,004	$2,648	$5,517	$53,601
15	$7,064	$21,821	$6,061	$2,578	$9,274	$2,728	$5,683	$55,209
16	$7,276	$22,476	$6,243	$2,655	$9,552	$2,809	$5,853	$56,865
17	$7,494	$23,150	$6,431	$2,735	$9,839	$2,894	$6,029	$58,571
18	$7,719	$23,845	$6,624	$2,817	$10,134	$2,981	$6,210	$60,328
19	$7,950	$24,560	$6,822	$2,902	$10,438	$3,070	$6,396	$62,138
20	$8,189	$25,297	$7,027	$2,989	$10,751	$3,162	$6,588	$64,002

Sub Watershed #402 Total Annual Cost Before Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$9,387	$28,997	$8,055	$3,426	$12,324	$3,625	$7,551	$73,363
2	$9,668	$29,867	$8,296	$3,529	$12,693	$3,733	$7,778	$75,564
3	$9,958	$30,763	$8,545	$3,634	$13,074	$3,845	$8,011	$77,831
4	$10,257	$31,686	$8,802	$3,744	$13,466	$3,961	$8,251	$80,166
5	$10,565	$32,636	$9,066	$3,856	$13,870	$4,080	$8,499	$82,571
6	$10,882	$33,615	$9,338	$3,972	$14,286	$4,202	$8,754	$85,048
7	$11,208	$34,624	$9,618	$4,091	$14,715	$4,328	$9,017	$87,600
8	$11,544	$35,662	$9,906	$4,213	$15,157	$4,458	$9,287	$90,228
9	$11,891	$36,732	$10,203	$4,340	$15,611	$4,592	$9,566	$92,934
10	$12,247	$37,834	$10,510	$4,470	$16,080	$4,729	$9,853	$95,722

11	$12,615	$38,969	$10,825	$4,604	$16,562	$4,871	$10,148	$98,594
12	$12,993	$40,138	$11,150	$4,742	$17,059	$5,017	$10,453	$101,552
13	$13,383	$41,343	$11,484	$4,884	$17,571	$5,168	$10,766	$104,599
14	$13,784	$42,583	$11,829	$5,031	$18,098	$5,323	$11,089	$107,736
15	$14,198	$43,860	$12,183	$5,182	$18,641	$5,483	$11,422	$110,969
16	$14,624	$45,176	$12,549	$5,337	$19,200	$5,647	$11,765	$114,298
17	$15,063	$46,531	$12,925	$5,497	$19,776	$5,816	$12,118	$117,727
18	$15,514	$47,927	$13,313	$5,662	$20,369	$5,991	$12,481	$121,258
19	$15,980	$49,365	$13,713	$5,832	$20,980	$6,171	$12,855	$124,896
20	$16,459	$50,846	$14,124	$6,007	$21,610	$6,356	$13,241	$128,643

Sub Watershed #605 Total Annual Cost Before Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$7,891	$24,377	$6,771	$2,880	$10,360	$3,047	$6,348	$61,674
2	$8,128	$25,108	$6,974	$2,966	$10,671	$3,139	$6,539	$63,525
3	$8,372	$25,861	$7,184	$3,055	$10,991	$3,233	$6,735	$65,430
4	$8,623	$26,637	$7,399	$3,147	$11,321	$3,330	$6,937	$67,393
5	$8,881	$27,436	$7,621	$3,241	$11,660	$3,430	$7,145	$69,415
6	$9,148	$28,259	$7,850	$3,339	$12,010	$3,532	$7,359	$71,498
7	$9,422	$29,107	$8,085	$3,439	$12,371	$3,638	$7,580	$73,643
8	$9,705	$29,980	$8,328	$3,542	$12,742	$3,748	$7,807	$75,852
9	$9,996	$30,880	$8,578	$3,648	$13,124	$3,860	$8,042	$78,127
10	$10,296	$31,806	$8,835	$3,758	$13,518	$3,976	$8,283	$80,471
11	$10,605	$32,760	$9,100	$3,871	$13,923	$4,095	$8,531	$82,885
12	$10,923	$33,743	$9,373	$3,987	$14,341	$4,218	$8,787	$85,372
13	$11,251	$34,755	$9,654	$4,106	$14,771	$4,344	$9,051	$87,933
14	$11,588	$35,798	$9,944	$4,229	$15,214	$4,475	$9,322	$90,571
15	$11,936	$36,872	$10,242	$4,356	$15,671	$4,609	$9,602	$93,288
16	$12,294	$37,978	$10,550	$4,487	$16,141	$4,747	$9,890	$96,087
17	$12,663	$39,118	$10,866	$4,622	$16,625	$4,890	$10,187	$98,969
18	$13,043	$40,291	$11,192	$4,760	$17,124	$5,036	$10,492	$101,939
19	$13,434	$41,500	$11,528	$4,903	$17,637	$5,187	$10,807	$104,997
20	$13,837	$42,745	$11,874	$5,050	$18,167	$5,343	$11,131	$108,147

Sub Watershed #705 Total Annual Cost Before Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$8,607	$26,588	$7,386	$3,141	$11,300	$3,324	$6,924	$67,270
2	$8,865	$27,386	$7,607	$3,236	$11,639	$3,423	$7,132	$69,288
3	$9,131	$28,208	$7,835	$3,333	$11,988	$3,526	$7,346	$71,367

4	$9,405	$29,054	$8,071	$3,433	$12,348	$3,632	$7,566	$73,508
5	$9,687	$29,925	$8,313	$3,536	$12,718	$3,741	$7,793	$75,713
6	$9,978	$30,823	$8,562	$3,642	$13,100	$3,853	$8,027	$77,984
7	$10,277	$31,748	$8,819	$3,751	$13,493	$3,968	$8,268	$80,324
8	$10,585	$32,700	$9,083	$3,863	$13,898	$4,088	$8,516	$82,734
9	$10,903	$33,681	$9,356	$3,979	$14,315	$4,210	$8,771	$85,216
10	$11,230	$34,692	$9,637	$4,099	$14,744	$4,336	$9,034	$87,772
11	$11,567	$35,733	$9,926	$4,222	$15,186	$4,467	$9,305	$90,405
12	$11,914	$36,805	$10,223	$4,348	$15,642	$4,601	$9,585	$93,117
13	$12,271	$37,909	$10,530	$4,479	$16,111	$4,739	$9,872	$95,911
14	$12,640	$39,046	$10,846	$4,613	$16,595	$4,881	$10,168	$98,788
15	$13,019	$40,217	$11,171	$4,752	$17,092	$5,027	$10,473	$101,752
16	$13,409	$41,424	$11,507	$4,894	$17,605	$5,178	$10,787	$104,804
17	$13,812	$42,667	$11,852	$5,041	$18,133	$5,333	$11,111	$107,949
18	$14,226	$43,947	$12,207	$5,192	$18,677	$5,493	$11,444	$111,187
19	$14,653	$45,265	$12,574	$5,348	$19,238	$5,658	$11,788	$114,523
20	$15,092	$46,623	$12,951	$5,508	$19,815	$5,828	$12,141	$117,958

Sub Watershed #706 Total Annual Cost Before Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$2,924	$9,032	$2,509	$1,067	$3,839	$1,129	$2,352	$22,852
2	$3,012	$9,303	$2,584	$1,099	$3,954	$1,163	$2,423	$23,538
3	$3,102	$9,582	$2,662	$1,132	$4,073	$1,198	$2,495	$24,244
4	$3,195	$9,870	$2,742	$1,166	$4,195	$1,234	$2,570	$24,971
5	$3,291	$10,166	$2,824	$1,201	$4,321	$1,271	$2,647	$25,721
6	$3,390	$10,471	$2,909	$1,237	$4,450	$1,309	$2,727	$26,492
7	$3,491	$10,785	$2,996	$1,274	$4,584	$1,348	$2,809	$27,287
8	$3,596	$11,109	$3,086	$1,312	$4,721	$1,389	$2,893	$28,106
9	$3,704	$11,442	$3,178	$1,352	$4,863	$1,430	$2,980	$28,949
10	$3,815	$11,785	$3,274	$1,392	$5,009	$1,473	$3,069	$29,817
11	$3,929	$12,139	$3,372	$1,434	$5,159	$1,517	$3,161	$30,712
12	$4,047	$12,503	$3,473	$1,477	$5,314	$1,563	$3,256	$31,633
13	$4,169	$12,878	$3,577	$1,521	$5,473	$1,610	$3,354	$32,582
14	$4,294	$13,264	$3,685	$1,567	$5,637	$1,658	$3,454	$33,560
15	$4,423	$13,662	$3,795	$1,614	$5,806	$1,708	$3,558	$34,566
16	$4,555	$14,072	$3,909	$1,663	$5,981	$1,759	$3,665	$35,603
17	$4,692	$14,494	$4,026	$1,712	$6,160	$1,812	$3,775	$36,671
18	$4,833	$14,929	$4,147	$1,764	$6,345	$1,866	$3,888	$37,772
19	$4,978	$15,377	$4,271	$1,817	$6,535	$1,922	$4,004	$38,905
20	$5,127	$15,838	$4,400	$1,871	$6,731	$1,980	$4,125	$40,072

Sub Watershed #804 Total Annual Cost Before Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$4,240	$13,097	$3,638	$1,547	$5,566	$1,637	$3,411	$33,136
2	$4,367	$13,490	$3,747	$1,594	$5,733	$1,686	$3,513	$34,130
3	$4,498	$13,894	$3,860	$1,642	$5,905	$1,737	$3,618	$35,153
4	$4,633	$14,311	$3,975	$1,691	$6,082	$1,789	$3,727	$36,208
5	$4,772	$14,741	$4,095	$1,742	$6,265	$1,843	$3,839	$37,294
6	$4,915	$15,183	$4,217	$1,794	$6,453	$1,898	$3,954	$38,413
7	$5,062	$15,638	$4,344	$1,848	$6,646	$1,955	$4,072	$39,566
8	$5,214	$16,107	$4,474	$1,903	$6,846	$2,013	$4,195	$40,753
9	$5,371	$16,591	$4,609	$1,960	$7,051	$2,074	$4,320	$41,975
10	$5,532	$17,088	$4,747	$2,019	$7,263	$2,136	$4,450	$43,234
11	$5,698	$17,601	$4,889	$2,079	$7,480	$2,200	$4,584	$44,531
12	$5,869	$18,129	$5,036	$2,142	$7,705	$2,266	$4,721	$45,867
13	$6,045	$18,673	$5,187	$2,206	$7,936	$2,334	$4,863	$47,243
14	$6,226	$19,233	$5,343	$2,272	$8,174	$2,404	$5,009	$48,661
15	$6,413	$19,810	$5,503	$2,340	$8,419	$2,476	$5,159	$50,120
16	$6,605	$20,404	$5,668	$2,411	$8,672	$2,551	$5,314	$51,624
17	$6,803	$21,017	$5,838	$2,483	$8,932	$2,627	$5,473	$53,173
18	$7,007	$21,647	$6,013	$2,558	$9,200	$2,706	$5,637	$54,768
19	$7,218	$22,296	$6,193	$2,634	$9,476	$2,787	$5,806	$56,411
20	$7,434	$22,965	$6,379	$2,713	$9,760	$2,871	$5,981	$58,103

Sub Watershed #805 Total Annual Cost Before Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$3,223	$9,955	$2,765	$1,176	$4,231	$1,244	$2,593	$25,187
2	$3,319	$10,254	$2,848	$1,211	$4,358	$1,282	$2,670	$25,943
3	$3,419	$10,561	$2,934	$1,248	$4,489	$1,320	$2,750	$26,721
4	$3,521	$10,878	$3,022	$1,285	$4,623	$1,360	$2,833	$27,523
5	$3,627	$11,205	$3,112	$1,324	$4,762	$1,401	$2,918	$28,348
6	$3,736	$11,541	$3,206	$1,363	$4,905	$1,443	$3,005	$29,199
7	$3,848	$11,887	$3,302	$1,404	$5,052	$1,486	$3,096	$30,075
8	$3,963	$12,244	$3,401	$1,447	$5,204	$1,530	$3,188	$30,977
9	$4,082	$12,611	$3,503	$1,490	$5,360	$1,576	$3,284	$31,906
10	$4,205	$12,989	$3,608	$1,535	$5,520	$1,624	$3,383	$32,864
11	$4,331	$13,379	$3,716	$1,581	$5,686	$1,672	$3,484	$33,849
12	$4,461	$13,780	$3,828	$1,628	$5,857	$1,723	$3,589	$34,865
13	$4,595	$14,194	$3,943	$1,677	$6,032	$1,774	$3,696	$35,911
14	$4,732	$14,620	$4,061	$1,727	$6,213	$1,827	$3,807	$36,988
15	$4,874	$15,058	$4,183	$1,779	$6,400	$1,882	$3,921	$38,098
16	$5,021	$15,510	$4,308	$1,832	$6,592	$1,939	$4,039	$39,241

17	$5,171	$15,975	$4,438	$1,887	$6,789	$1,997	$4,160	$40,418
18	$5,326	$16,454	$4,571	$1,944	$6,993	$2,057	$4,285	$41,631
19	$5,486	$16,948	$4,708	$2,002	$7,203	$2,119	$4,414	$42,879
20	$5,651	$17,457	$4,849	$2,062	$7,419	$2,182	$4,546	$44,166

Sub Watershed #801 Total Annual Cost Before Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$5,411	$16,717	$4,644	$1,975	$7,105	$2,090	$4,353	$42,295
2	$5,574	$17,219	$4,783	$2,034	$7,318	$2,152	$4,484	$43,564
3	$5,741	$17,735	$4,926	$2,095	$7,537	$2,217	$4,619	$44,871
4	$5,913	$18,267	$5,074	$2,158	$7,764	$2,283	$4,757	$46,217
5	$6,091	$18,815	$5,226	$2,223	$7,997	$2,352	$4,900	$47,604
6	$6,273	$19,380	$5,383	$2,290	$8,236	$2,422	$5,047	$49,032
7	$6,462	$19,961	$5,545	$2,358	$8,484	$2,495	$5,198	$50,503
8	$6,655	$20,560	$5,711	$2,429	$8,738	$2,570	$5,354	$52,018
9	$6,855	$21,177	$5,882	$2,502	$9,000	$2,647	$5,515	$53,578
10	$7,061	$21,812	$6,059	$2,577	$9,270	$2,727	$5,680	$55,186
11	$7,273	$22,467	$6,241	$2,654	$9,548	$2,808	$5,851	$56,841
12	$7,491	$23,141	$6,428	$2,734	$9,835	$2,893	$6,026	$58,547
13	$7,716	$23,835	$6,621	$2,816	$10,130	$2,979	$6,207	$60,303
14	$7,947	$24,550	$6,819	$2,900	$10,434	$3,069	$6,393	$62,112
15	$8,185	$25,286	$7,024	$2,987	$10,747	$3,161	$6,585	$63,975
16	$8,431	$26,045	$7,235	$3,077	$11,069	$3,256	$6,783	$65,895
17	$8,684	$26,826	$7,452	$3,169	$11,401	$3,353	$6,986	$67,872
18	$8,944	$27,631	$7,675	$3,264	$11,743	$3,454	$7,196	$69,908
19	$9,213	$28,460	$7,906	$3,362	$12,095	$3,557	$7,411	$72,005
20	$9,489	$29,314	$8,143	$3,463	$12,458	$3,664	$7,634	$74,165

Sub Watershed #802 Total Annual Cost Before Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$4,421	$13,657	$3,794	$1,614	$5,804	$1,707	$3,557	$34,553
2	$4,554	$14,067	$3,907	$1,662	$5,978	$1,758	$3,663	$35,590
3	$4,690	$14,489	$4,025	$1,712	$6,158	$1,811	$3,773	$36,658
4	$4,831	$14,924	$4,145	$1,763	$6,343	$1,865	$3,886	$37,757
5	$4,976	$15,371	$4,270	$1,816	$6,533	$1,921	$4,003	$38,890
6	$5,125	$15,832	$4,398	$1,871	$6,729	$1,979	$4,123	$40,057
7	$5,279	$16,307	$4,530	$1,927	$6,931	$2,038	$4,247	$41,259
8	$5,437	$16,797	$4,666	$1,984	$7,139	$2,100	$4,374	$42,496
9	$5,600	$17,301	$4,806	$2,044	$7,353	$2,163	$4,505	$43,771

10	$5,768	$17,820	$4,950	$2,105	$7,573	$2,227	$4,641	$45,084
11	$5,941	$18,354	$5,098	$2,168	$7,801	$2,294	$4,780	$46,437
12	$6,120	$18,905	$5,251	$2,234	$8,035	$2,363	$4,923	$47,830
13	$6,303	$19,472	$5,409	$2,301	$8,276	$2,434	$5,071	$49,265
14	$6,492	$20,056	$5,571	$2,370	$8,524	$2,507	$5,223	$50,743
15	$6,687	$20,658	$5,738	$2,441	$8,780	$2,582	$5,380	$52,265
16	$6,888	$21,277	$5,910	$2,514	$9,043	$2,660	$5,541	$53,833
17	$7,094	$21,916	$6,088	$2,589	$9,314	$2,739	$5,707	$55,448
18	$7,307	$22,573	$6,270	$2,667	$9,594	$2,822	$5,878	$57,111
19	$7,526	$23,250	$6,458	$2,747	$9,881	$2,906	$6,055	$58,825
20	$7,752	$23,948	$6,652	$2,829	$10,178	$2,993	$6,236	$60,590

Sub Watershed #803 Total Annual Cost Before Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$3,798	$11,732	$3,259	$1,386	$4,986	$1,467	$3,055	$29,684
2	$3,912	$12,084	$3,357	$1,428	$5,136	$1,511	$3,147	$30,574
3	$4,029	$12,447	$3,457	$1,471	$5,290	$1,556	$3,241	$31,491
4	$4,150	$12,820	$3,561	$1,515	$5,449	$1,603	$3,339	$32,436
5	$4,275	$13,205	$3,668	$1,560	$5,612	$1,651	$3,439	$33,409
6	$4,403	$13,601	$3,778	$1,607	$5,780	$1,700	$3,542	$34,411
7	$4,535	$14,009	$3,891	$1,655	$5,954	$1,751	$3,648	$35,444
8	$4,671	$14,429	$4,008	$1,705	$6,132	$1,804	$3,758	$36,507
9	$4,811	$14,862	$4,128	$1,756	$6,316	$1,858	$3,870	$37,602
10	$4,955	$15,308	$4,252	$1,809	$6,506	$1,914	$3,986	$38,730
11	$5,104	$15,767	$4,380	$1,863	$6,701	$1,971	$4,106	$39,892
12	$5,257	$16,240	$4,511	$1,919	$6,902	$2,030	$4,229	$41,089
13	$5,415	$16,728	$4,647	$1,976	$7,109	$2,091	$4,356	$42,322
14	$5,577	$17,229	$4,786	$2,036	$7,323	$2,154	$4,487	$43,591
15	$5,745	$17,746	$4,930	$2,097	$7,542	$2,218	$4,621	$44,899
16	$5,917	$18,279	$5,077	$2,160	$7,768	$2,285	$4,760	$46,246
17	$6,094	$18,827	$5,230	$2,224	$8,001	$2,353	$4,903	$47,633
18	$6,277	$19,392	$5,387	$2,291	$8,242	$2,424	$5,050	$49,062
19	$6,466	$19,974	$5,548	$2,360	$8,489	$2,497	$5,201	$50,534
20	$6,660	$20,573	$5,715	$2,431	$8,743	$2,572	$5,358	$52,050

Table 53. Costs by BMP After Cost Share.

Herington Reservoir (#701) Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$2,849	$7,213	$401	$852	$3,066	$902	$1,878	$17,161
2	$2,934	$7,430	$413	$878	$3,158	$929	$1,935	$17,675

3	$3,022	$7,652	$425	$904	$3,252	$957	$1,993	$18,206
4	$3,113	$7,882	$438	$931	$3,350	$985	$2,053	$18,752
5	$3,206	$8,119	$451	$959	$3,450	$1,015	$2,114	$19,314
6	$3,302	$8,362	$465	$988	$3,554	$1,045	$2,178	$19,894
7	$3,401	$8,613	$478	$1,018	$3,660	$1,077	$2,243	$20,491
8	$3,504	$8,871	$493	$1,048	$3,770	$1,109	$2,310	$21,105
9	$3,609	$9,137	$508	$1,080	$3,883	$1,142	$2,380	$21,738
10	$3,717	$9,412	$523	$1,112	$4,000	$1,176	$2,451	$22,391
11	$3,828	$9,694	$539	$1,145	$4,120	$1,212	$2,524	$23,062
12	$3,943	$9,985	$555	$1,180	$4,244	$1,248	$2,600	$23,754
13	$4,062	$10,284	$571	$1,215	$4,371	$1,286	$2,678	$24,467
14	$4,183	$10,593	$588	$1,251	$4,502	$1,324	$2,759	$25,201
15	$4,309	$10,911	$606	$1,289	$4,637	$1,364	$2,841	$25,957
16	$4,438	$11,238	$624	$1,328	$4,776	$1,405	$2,927	$26,736
17	$4,571	$11,575	$643	$1,368	$4,919	$1,447	$3,014	$27,538
18	$4,708	$11,922	$662	$1,409	$5,067	$1,490	$3,105	$28,364
19	$4,850	$12,280	$682	$1,451	$5,219	$1,535	$3,198	$29,215
20	$4,995	$12,648	$703	$1,494	$5,376	$1,581	$3,294	$30,091

Sub Watershed #402 Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$5,726	$14,498	$805	$1,713	$6,162	$1,812	$3,776	$34,492
2	$5,898	$14,933	$830	$1,764	$6,347	$1,867	$3,889	$35,527
3	$6,074	$15,381	$855	$1,817	$6,537	$1,923	$4,006	$36,593
4	$6,257	$15,843	$880	$1,872	$6,733	$1,980	$4,126	$37,691
5	$6,444	$16,318	$907	$1,928	$6,935	$2,040	$4,249	$38,821
6	$6,638	$16,808	$934	$1,986	$7,143	$2,101	$4,377	$39,986
7	$6,837	$17,312	$962	$2,045	$7,358	$2,164	$4,508	$41,186
8	$7,042	$17,831	$991	$2,107	$7,578	$2,229	$4,644	$42,421
9	$7,253	$18,366	$1,020	$2,170	$7,806	$2,296	$4,783	$43,694
10	$7,471	$18,917	$1,051	$2,235	$8,040	$2,365	$4,926	$45,005
11	$7,695	$19,485	$1,082	$2,302	$8,281	$2,436	$5,074	$46,355
12	$7,926	$20,069	$1,115	$2,371	$8,529	$2,509	$5,226	$47,745
13	$8,164	$20,671	$1,148	$2,442	$8,785	$2,584	$5,383	$49,178
14	$8,408	$21,291	$1,183	$2,515	$9,049	$2,661	$5,545	$50,653
15	$8,661	$21,930	$1,218	$2,591	$9,320	$2,741	$5,711	$52,173
16	$8,921	$22,588	$1,255	$2,669	$9,600	$2,824	$5,882	$53,738
17	$9,188	$23,266	$1,293	$2,749	$9,888	$2,908	$6,059	$55,350
18	$9,464	$23,964	$1,331	$2,831	$10,185	$2,995	$6,241	$57,011
19	$9,748	$24,683	$1,371	$2,916	$10,490	$3,085	$6,428	$58,721
20	$10,040	$25,423	$1,412	$3,004	$10,805	$3,178	$6,621	$60,482

Sub Watershed #605 Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$4,813	$12,188	$677	$1,440	$5,180	$1,524	$3,174	$28,997
2	$4,958	$12,554	$697	$1,483	$5,335	$1,569	$3,269	$29,867
3	$5,107	$12,931	$718	$1,528	$5,496	$1,616	$3,367	$30,763
4	$5,260	$13,319	$740	$1,574	$5,660	$1,665	$3,468	$31,685
5	$5,418	$13,718	$762	$1,621	$5,830	$1,715	$3,572	$32,636
6	$5,580	$14,130	$785	$1,669	$6,005	$1,766	$3,680	$33,615
7	$5,748	$14,554	$809	$1,719	$6,185	$1,819	$3,790	$34,624
8	$5,920	$14,990	$833	$1,771	$6,371	$1,874	$3,904	$35,662
9	$6,098	$15,440	$858	$1,824	$6,562	$1,930	$4,021	$36,732
10	$6,281	$15,903	$884	$1,879	$6,759	$1,988	$4,141	$37,834
11	$6,469	$16,380	$910	$1,935	$6,962	$2,048	$4,266	$38,969
12	$6,663	$16,872	$937	$1,993	$7,170	$2,109	$4,394	$40,138
13	$6,863	$17,378	$965	$2,053	$7,386	$2,172	$4,525	$41,342
14	$7,069	$17,899	$994	$2,115	$7,607	$2,237	$4,661	$42,583
15	$7,281	$18,436	$1,024	$2,178	$7,835	$2,305	$4,801	$43,860
16	$7,499	$18,989	$1,055	$2,243	$8,070	$2,374	$4,945	$45,176
17	$7,724	$19,559	$1,087	$2,311	$8,312	$2,445	$5,093	$46,531
18	$7,956	$20,146	$1,119	$2,380	$8,562	$2,518	$5,246	$47,927
19	$8,195	$20,750	$1,153	$2,452	$8,819	$2,594	$5,404	$49,365
20	$8,440	$21,372	$1,187	$2,525	$9,083	$2,672	$5,566	$50,846

Sub Watershed #705 Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$5,250	$13,294	$739	$1,571	$5,650	$1,662	$3,462	$31,627
2	$5,408	$13,693	$761	$1,618	$5,820	$1,712	$3,566	$32,576
3	$5,570	$14,104	$784	$1,666	$5,994	$1,763	$3,673	$33,554
4	$5,737	$14,527	$807	$1,716	$6,174	$1,816	$3,783	$34,560
5	$5,909	$14,963	$831	$1,768	$6,359	$1,870	$3,897	$35,597
6	$6,086	$15,412	$856	$1,821	$6,550	$1,926	$4,013	$36,665
7	$6,269	$15,874	$882	$1,875	$6,746	$1,984	$4,134	$37,765
8	$6,457	$16,350	$908	$1,932	$6,949	$2,044	$4,258	$38,898
9	$6,651	$16,841	$936	$1,990	$7,157	$2,105	$4,386	$40,065
10	$6,850	$17,346	$964	$2,049	$7,372	$2,168	$4,517	$41,267
11	$7,056	$17,866	$993	$2,111	$7,593	$2,233	$4,653	$42,505
12	$7,268	$18,402	$1,022	$2,174	$7,821	$2,300	$4,792	$43,780
13	$7,486	$18,954	$1,053	$2,239	$8,056	$2,369	$4,936	$45,093
14	$7,710	$19,523	$1,085	$2,307	$8,297	$2,440	$5,084	$46,446
15	$7,941	$20,109	$1,117	$2,376	$8,546	$2,514	$5,237	$47,839

16	$8,180	$20,712	$1,151	$2,447	$8,803	$2,589	$5,394	$49,275
17	$8,425	$21,333	$1,185	$2,520	$9,067	$2,667	$5,556	$50,753
18	$8,678	$21,973	$1,221	$2,596	$9,339	$2,747	$5,722	$52,275
19	$8,938	$22,632	$1,257	$2,674	$9,619	$2,829	$5,894	$53,844
20	$9,206	$23,311	$1,295	$2,754	$9,907	$2,914	$6,071	$55,459

Sub Watershed #706 Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$1,784	$4,516	$251	$534	$1,919	$565	$1,176	$10,744
2	$1,837	$4,652	$258	$550	$1,977	$581	$1,211	$11,067
3	$1,892	$4,791	$266	$566	$2,036	$599	$1,248	$11,399
4	$1,949	$4,935	$274	$583	$2,097	$617	$1,285	$11,741
5	$2,007	$5,083	$282	$601	$2,160	$635	$1,324	$12,093
6	$2,068	$5,236	$291	$619	$2,225	$654	$1,363	$12,456
7	$2,130	$5,393	$300	$637	$2,292	$674	$1,404	$12,829
8	$2,194	$5,554	$309	$656	$2,361	$694	$1,446	$13,214
9	$2,259	$5,721	$318	$676	$2,431	$715	$1,490	$13,610
10	$2,327	$5,893	$327	$696	$2,504	$737	$1,535	$14,019
11	$2,397	$6,069	$337	$717	$2,579	$759	$1,581	$14,439
12	$2,469	$6,251	$347	$739	$2,657	$781	$1,628	$14,873
13	$2,543	$6,439	$358	$761	$2,737	$805	$1,677	$15,319
14	$2,619	$6,632	$368	$784	$2,819	$829	$1,727	$15,778
15	$2,698	$6,831	$380	$807	$2,903	$854	$1,779	$16,252
16	$2,779	$7,036	$391	$831	$2,990	$880	$1,832	$16,739
17	$2,862	$7,247	$403	$856	$3,080	$906	$1,887	$17,241
18	$2,948	$7,465	$415	$882	$3,172	$933	$1,944	$17,759
19	$3,036	$7,689	$427	$908	$3,268	$961	$2,002	$18,291
20	$3,127	$7,919	$440	$936	$3,366	$990	$2,062	$18,840

Sub Watershed #804 Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$2,586	$6,548	$364	$774	$2,783	$819	$1,705	$15,579
2	$2,664	$6,745	$375	$797	$2,867	$843	$1,756	$16,046
3	$2,744	$6,947	$386	$821	$2,953	$868	$1,809	$16,528
4	$2,826	$7,156	$398	$845	$3,041	$894	$1,863	$17,024
5	$2,911	$7,370	$409	$871	$3,132	$921	$1,919	$17,534
6	$2,998	$7,591	$422	$897	$3,226	$949	$1,977	$18,060
7	$3,088	$7,819	$434	$924	$3,323	$977	$2,036	$18,602
8	$3,181	$8,054	$447	$952	$3,423	$1,007	$2,097	$19,160
9	$3,276	$8,295	$461	$980	$3,526	$1,037	$2,160	$19,735

10	$3,374	$8,544	$475	$1,009	$3,631	$1,068	$2,225	$20,327
11	$3,476	$8,801	$489	$1,040	$3,740	$1,100	$2,292	$20,937
12	$3,580	$9,065	$504	$1,071	$3,852	$1,133	$2,361	$21,565
13	$3,687	$9,336	$519	$1,103	$3,968	$1,167	$2,431	$22,212
14	$3,798	$9,617	$534	$1,136	$4,087	$1,202	$2,504	$22,878
15	$3,912	$9,905	$550	$1,170	$4,210	$1,238	$2,579	$23,565
16	$4,029	$10,202	$567	$1,205	$4,336	$1,275	$2,657	$24,271
17	$4,150	$10,508	$584	$1,242	$4,466	$1,314	$2,737	$25,000
18	$4,274	$10,824	$601	$1,279	$4,600	$1,353	$2,819	$25,750
19	$4,403	$11,148	$619	$1,317	$4,738	$1,394	$2,903	$26,522
20	$4,535	$11,483	$638	$1,357	$4,880	$1,435	$2,990	$27,318

Sub Watershed #805 Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$1,966	$4,978	$277	$588	$2,115	$622	$1,296	$11,842
2	$2,025	$5,127	$285	$606	$2,179	$641	$1,335	$12,197
3	$2,085	$5,281	$293	$624	$2,244	$660	$1,375	$12,563
4	$2,148	$5,439	$302	$643	$2,312	$680	$1,416	$12,940
5	$2,212	$5,602	$311	$662	$2,381	$700	$1,459	$13,328
6	$2,279	$5,770	$321	$682	$2,452	$721	$1,503	$13,728
7	$2,347	$5,944	$330	$702	$2,526	$743	$1,548	$14,140
8	$2,418	$6,122	$340	$723	$2,602	$765	$1,594	$14,564
9	$2,490	$6,305	$350	$745	$2,680	$788	$1,642	$15,001
10	$2,565	$6,495	$361	$767	$2,760	$812	$1,691	$15,451
11	$2,642	$6,689	$372	$790	$2,843	$836	$1,742	$15,915
12	$2,721	$6,890	$383	$814	$2,928	$861	$1,794	$16,392
13	$2,803	$7,097	$394	$838	$3,016	$887	$1,848	$16,884
14	$2,887	$7,310	$406	$864	$3,107	$914	$1,904	$17,390
15	$2,973	$7,529	$418	$890	$3,200	$941	$1,961	$17,912
16	$3,063	$7,755	$431	$916	$3,296	$969	$2,020	$18,449
17	$3,154	$7,988	$444	$944	$3,395	$998	$2,080	$19,003
18	$3,249	$8,227	$457	$972	$3,497	$1,028	$2,143	$19,573
19	$3,347	$8,474	$471	$1,001	$3,601	$1,059	$2,207	$20,160
20	$3,447	$8,728	$485	$1,031	$3,710	$1,091	$2,273	$20,765

Sub Watershed #801 Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$3,301	$8,359	$464	$988	$3,552	$1,045	$2,177	$19,885
2	$3,400	$8,609	$478	$1,017	$3,659	$1,076	$2,242	$20,482
3	$3,502	$8,868	$493	$1,048	$3,769	$1,108	$2,309	$21,096

4	$3,607	$9,134	$507	$1,079	$3,882	$1,142	$2,379	$21,729
5	$3,715	$9,408	$523	$1,111	$3,998	$1,176	$2,450	$22,381
6	$3,827	$9,690	$538	$1,145	$4,118	$1,211	$2,523	$23,053
7	$3,942	$9,981	$554	$1,179	$4,242	$1,248	$2,599	$23,744
8	$4,060	$10,280	$571	$1,215	$4,369	$1,285	$2,677	$24,457
9	$4,182	$10,588	$588	$1,251	$4,500	$1,324	$2,757	$25,190
10	$4,307	$10,906	$606	$1,289	$4,635	$1,363	$2,840	$25,946
11	$4,436	$11,233	$624	$1,327	$4,774	$1,404	$2,925	$26,724
12	$4,569	$11,570	$643	$1,367	$4,917	$1,446	$3,013	$27,526
13	$4,706	$11,917	$662	$1,408	$5,065	$1,490	$3,103	$28,352
14	$4,848	$12,275	$682	$1,450	$5,217	$1,534	$3,197	$29,202
15	$4,993	$12,643	$702	$1,494	$5,373	$1,580	$3,292	$30,079
16	$5,143	$13,022	$723	$1,539	$5,535	$1,628	$3,391	$30,981
17	$5,297	$13,413	$745	$1,585	$5,701	$1,677	$3,493	$31,910
18	$5,456	$13,815	$768	$1,632	$5,872	$1,727	$3,598	$32,868
19	$5,620	$14,230	$791	$1,681	$6,048	$1,779	$3,706	$33,854
20	$5,788	$14,657	$814	$1,732	$6,229	$1,832	$3,817	$34,869

Sub Watershed #802 Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$2,697	$6,829	$379	$807	$2,902	$854	$1,778	$16,246
2	$2,778	$7,033	$391	$831	$2,989	$879	$1,832	$16,733
3	$2,861	$7,244	$402	$856	$3,079	$906	$1,887	$17,235
4	$2,947	$7,462	$415	$882	$3,171	$933	$1,943	$17,752
5	$3,035	$7,686	$427	$908	$3,266	$961	$2,001	$18,284
6	$3,126	$7,916	$440	$935	$3,364	$990	$2,062	$18,833
7	$3,220	$8,154	$453	$963	$3,465	$1,019	$2,123	$19,398
8	$3,317	$8,398	$467	$992	$3,569	$1,050	$2,187	$19,980
9	$3,416	$8,650	$481	$1,022	$3,676	$1,081	$2,253	$20,579
10	$3,519	$8,910	$495	$1,053	$3,787	$1,114	$2,320	$21,197
11	$3,624	$9,177	$510	$1,084	$3,900	$1,147	$2,390	$21,833
12	$3,733	$9,452	$525	$1,117	$4,017	$1,182	$2,462	$22,488
13	$3,845	$9,736	$541	$1,150	$4,138	$1,217	$2,535	$23,162
14	$3,960	$10,028	$557	$1,185	$4,262	$1,254	$2,611	$23,857
15	$4,079	$10,329	$574	$1,220	$4,390	$1,291	$2,690	$24,573
16	$4,201	$10,639	$591	$1,257	$4,521	$1,330	$2,771	$25,310
17	$4,328	$10,958	$609	$1,295	$4,657	$1,370	$2,854	$26,069
18	$4,457	$11,287	$627	$1,333	$4,797	$1,411	$2,939	$26,851
19	$4,591	$11,625	$646	$1,373	$4,941	$1,453	$3,027	$27,657
20	$4,729	$11,974	$665	$1,415	$5,089	$1,497	$3,118	$28,487

Sub Watershed #803 Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total Cost
1	$2,317	$5,866	$326	$693	$2,493	$733	$1,528	$13,956
2	$2,386	$6,042	$336	$714	$2,568	$755	$1,573	$14,375
3	$2,458	$6,223	$346	$735	$2,645	$778	$1,621	$14,806
4	$2,532	$6,410	$356	$757	$2,724	$801	$1,669	$15,250
5	$2,607	$6,602	$367	$780	$2,806	$825	$1,719	$15,708
6	$2,686	$6,801	$378	$803	$2,890	$850	$1,771	$16,179
7	$2,766	$7,005	$389	$828	$2,977	$876	$1,824	$16,664
8	$2,849	$7,215	$401	$852	$3,066	$902	$1,879	$17,164
9	$2,935	$7,431	$413	$878	$3,158	$929	$1,935	$17,679
10	$3,023	$7,654	$425	$904	$3,253	$957	$1,993	$18,209
11	$3,113	$7,884	$438	$931	$3,351	$985	$2,053	$18,756
12	$3,207	$8,120	$451	$959	$3,451	$1,015	$2,115	$19,318
13	$3,303	$8,364	$465	$988	$3,555	$1,045	$2,178	$19,898
14	$3,402	$8,615	$479	$1,018	$3,661	$1,077	$2,243	$20,495
15	$3,504	$8,873	$493	$1,048	$3,771	$1,109	$2,311	$21,110
16	$3,609	$9,139	$508	$1,080	$3,884	$1,142	$2,380	$21,743
17	$3,718	$9,414	$523	$1,112	$4,001	$1,177	$2,451	$22,395
18	$3,829	$9,696	$539	$1,146	$4,121	$1,212	$2,525	$23,067
19	$3,944	$9,987	$555	$1,180	$4,244	$1,248	$2,601	$23,759
20	$4,062	$10,286	$571	$1,215	$4,372	$1,286	$2,679	$24,472

14.0 Bibliography

[1] National Elevation Dataset, East Kansas, Kansas Geospatial Community Commons. http://www.kansasgis.org/catalog/catalog.cfm

[2] Extracted from 2001 National Land Cover Dataset. Provided by NRCS, 2011.

[3] Extracted from 2001 National Land Cover Dataset. Provided by NRCS, 2011.

[4] Kansas Surface Water Register, 2010. Kansas Department of Health and Environment. http://www.kdheks.gov/befs/download/Current_Kansas_Surface_Register.pdf

[5] Kansas Department of Health and Environment, 2004. http://www.kdheks.gov/nps/resources/specwaterinfo.pdf

[6] USDA/NRCS National Water and Climactic Center.

[7] EPA estimates "10 to 20 % of onsite wastewater systems malfunction each year". http://cfpub.epa.gov/owm/septic/septic.cfm?page_id=265 The KSU technical team used best professional guess to claim the number of failing septic systems to be 10%.

[8] Kansas Geospatial Commons. US Census Bureau. Tiger 2000 Census Blocks. http://www.kansasgis.org/catalog/catalog.cfm

[9] Kansas Geospatial Community Commons. http://www.kansasgis.org/catalog/catalog.cfm

[10] Data provided by KDHE. May, 2012.

[11] Kansas Department of Health and Environment. 2009.

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

[13] Data provided by KDHE. May, 2012.

[14] Kansas Department of Health and Environment. The Basics of TMDLs. http://www.kdheks.gov/tmdl/basic.htm#tmdl

[15] Kansas Department of Health and Environment. Kansas TMDL Development Cycle. 2009. http://www.kdheks.gov/tmdl/download/Kansas_TMDL_Development_Cycle.pdf

[16] Kansas Department of Health and Environment. 2010 303d list. http://www.kdheks.gov/tmdl/

[17] Kansas Department of Health and Environment, 2012.

[18] Kansas Geospatial Community Commons. http://www.kansasgis.org/catalog/catalog.cfm

[19] TMDL sheet.

[20] Kansas Department of Health and Environment, 2012.

[21] Provided by KDHE TMDL Watershed Management Section, 2011.

[22] Determined by KDHE TMDL Watershed Management Section, 2012.

[23] Determined by KDHE TMDL Watershed Management Section, 2012.

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

[25] STEPL conducted by KDHE.

[26] Provided by KDHE, 2012.

[27] The Watershed Institute.

[28] Available at: http://www.oznet.ksu.edu/library/h20ql2/mf2572.pdf

[29] Available at:
http://www.mwps.org/index.cfm?fuseaction=c_Categories.viewCategory&catID=719

[30] MF-2737 Available at: http://www.oznet.ksu.edu/library/h20ql2/mf2737.pdf
MF-2454 Available at: http://www.oznet.ksu.edu/library/ageng2/mf2454.pdf

[31] Kansas Land Cover Patterns, 2005.

[32] Kansas Department of Health and Environment, 2012.

[33] National Agricultural Statistics Service. Corn, sorghum and soybeans, 2010. Wheat, 2008.
http://quickstats.nass.usda.gov/

[34] Data provided by KDHE TMDL section. 2011.

[35] Kansas Department of Health and Environment, 2012

[36] Kansas Department of Health and Environment, 2012

[37] Kansas Department of health and Environment, 2012.