Hillsdale Lake Watershed Restoration & Protection Strategy

9-Element Watershed Plan Summary

Impairments to be addressed:

- Directly addressing the **High Priority TMDL for Eutrophication on Hillsdale Lake**, which includes focusing on reducing the phosphorus and sediment loading within the watershed.
- Hillsdale Lake is not listed as having a TMDL for **sedimentation**; however, the SLT believes sediment is currently present and increasing and is also therefore addressing this issue with this WRAPS plan.
- BMPs implemented to address Hillsdale Lake will *indirectly* address the **Medium Priority TMDLs for Eutrophication and Atrazine for Edgerton City Lake**.

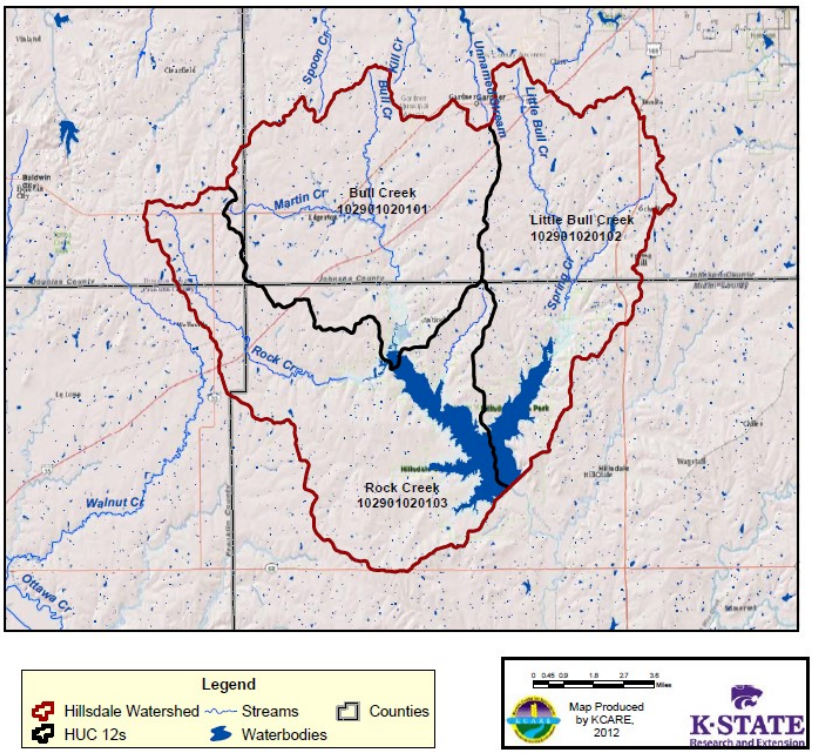

Figure 5. HUC 12s in the Watershed.

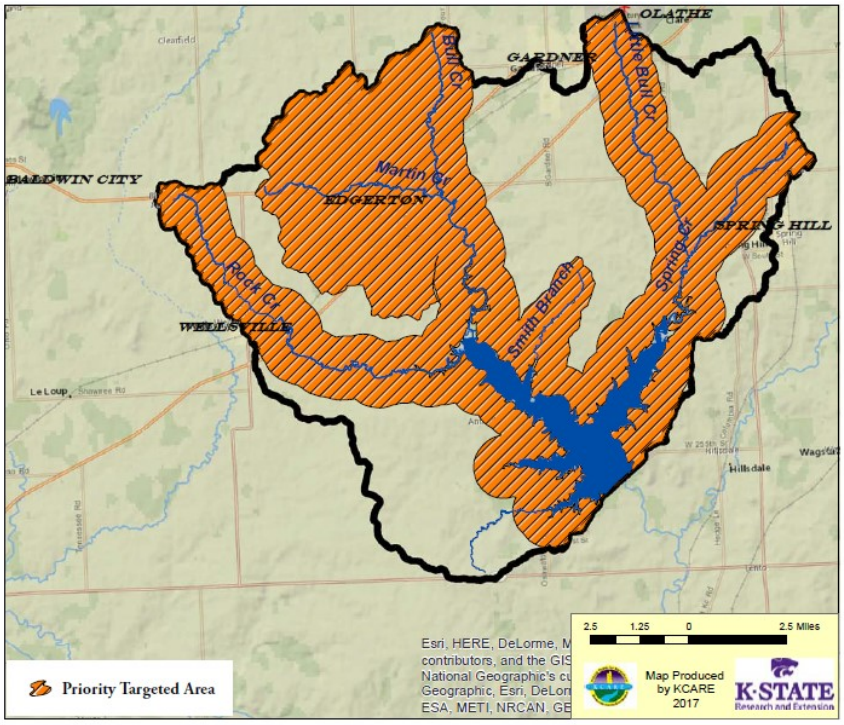

Figure 18. Priority Targeted Areas in the Watershed.

Targeting Determinations:

- From studies conducted, a Priority Targeted Area for BMP placement has been determined.
- The Priority Targeted Area consists of a 3/4 mile buffer along each side of KDHE classified streams in the watershed, including adjacent to Hillsdale Lake.
- Targeted included streams are: Big Bull Creek, Rock Creek, Little Bull Creek, Martin Creek, Smith Creek, and Spring Creek.
- Priority Targeted Areas will address degraded fields lying adjected to streams and lakes, the BNSF Intermodal Facility, and upland areas containing high numbers of forested restoration sites or KDHE determined restoration sites.

Priority areas are targeted for both cropland and livestock practices, based upon land use within the targeted HUC 12s.

Best Management Practices and Load Reduction Goals

Best Management Practices (BMPs) to address nutrients and sediment in the watershed were chosen by the SLT based upon local acceptance/adoption rate and amount of load reduction gained per dollar spent.

Nutrient and Sediment Reducing **Cropland BMPs**:

- Buffers
- Encouragement of continuous no-till by producers, followed by implementation of cover crops
- Preparation of Nutrient Management Plans with producers
- Grassed Waterways
- Permanent Vegetation
- Subsurface Fertilizer Application

Nutrient and Sediment Reducing **Livestock BMPs**:

- Vegetative filter strips between small feeding operations and streams
- Relocation of small feeding operations away from streams
- Relocation of pasture feeding sites away from streams
- Promotion of alternative watering sites away from streams
- Rotational grazing

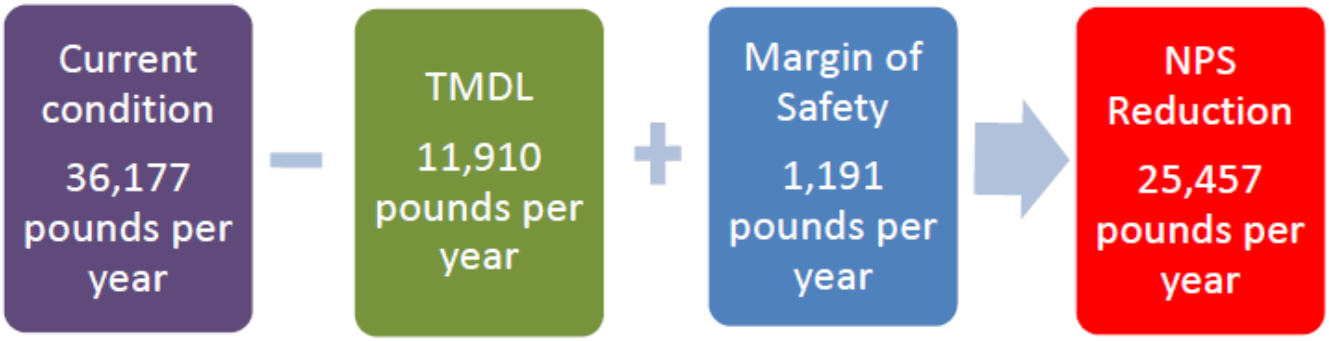

Figure 14. Phosphorus Load Reduction Needed to Meet TMDL Endpoint in Hillsdale Lake.

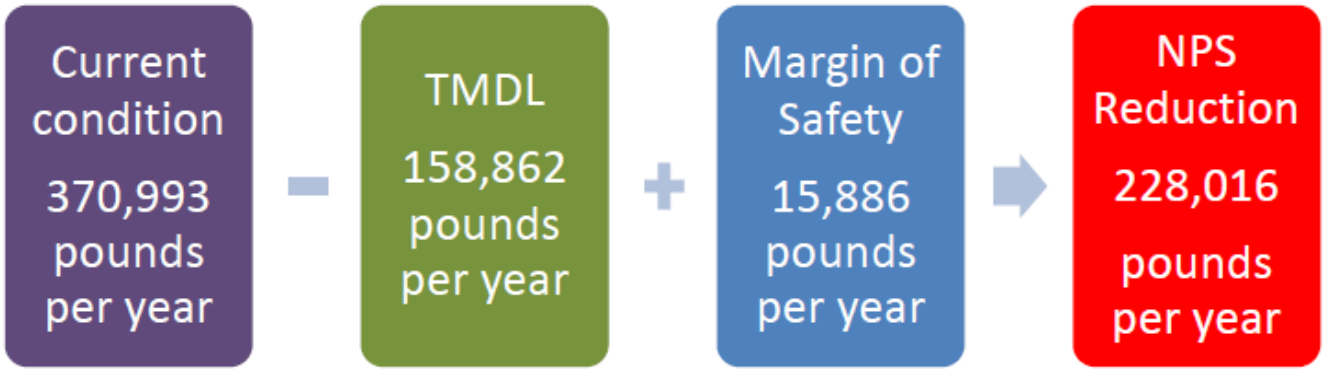

Figure 15. Nitrogen Load Reduction Needed to Meet TMDL Endpoint in Hillsdale Lake.

Hillsdale Watershed Restoration & Protection Strategy

2017

The Hillsdale Watershed WRAPS is possible through United States Environmental Protection Agency Clean Water Act, Section 319, grant funds administered by the Kansas Department of Health and Environment.

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Glossary of Terms

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

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

Biota: Plant and animal life of a particular region.

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

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

E. coli bacteria (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. Preface and Plan Update

The purpose of this Watershed Restoration and Protection Strategy (WRAPS) report for the Hillsdale Lake Watershed (Figure 1) 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 Hillsdale Lake Watershed.

A. Watershed Plan Update

The original WRAPS Watershed Plan was written in 2012. In 2017, the WRAPS Watershed Plan was updated. Motivation for revising and rewriting the Watershed Plan was triggered by a TMDL revision by KDHE. The TMDL revision caused the implementation goals from the 2012 plan to be outdated. This document contains changes made in 2017.

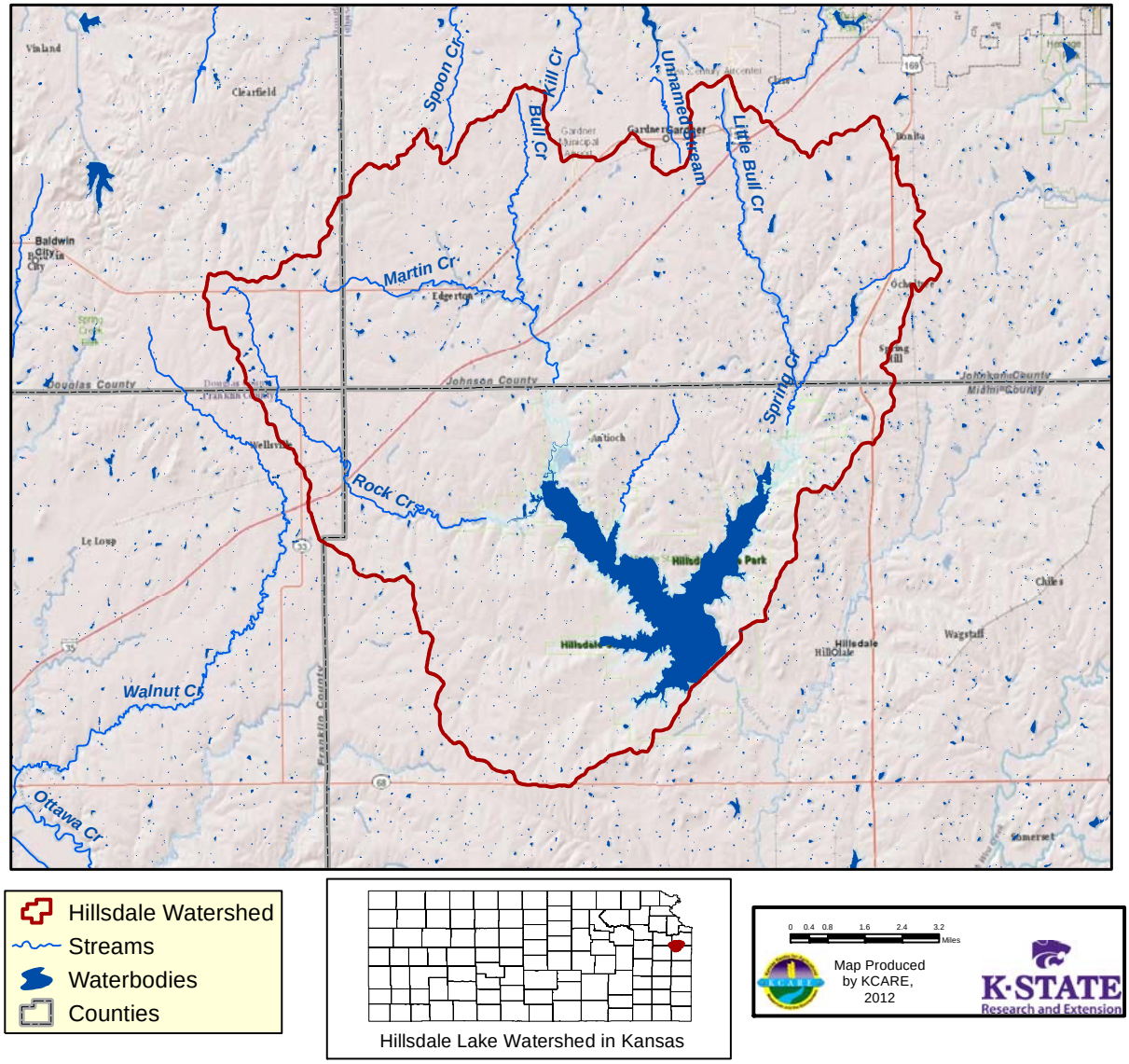


Figure 1. Hillsdale Lake Watershed Map.

2. Introduction

A. What is a Watershed Restoration And Protection Strategy (WRAPS)?

WRAPS is a planning and management framework that engages stakeholders within a particular watershed in a process to:

- Identify watershed restoration and protection needs and opportunities.
- Establish management goals for the watershed community.
- Create a cost-effective action plan to achieve goals.
- Implement the action plan.

WRAPS represents a shift from "top-down" government intervention in watershed issues, to a more citizen-stakeholder approach, in which funds, guidance and technical assistance are provided for stakeholders to reach consensus on issues of relevance in their watershed, and then design and execute a plan to address those issues.

The term "WRAPS" was coined by the Kansas Department of Health and Environment (KDHE) in response to the 1998 Clean Water Action Plan issued by the Clinton Administration. The Clean Water Action Plan directed the state environmental agency and the State Conservationist of each state to complete a "unified watershed assessment." Once the assessment was completed, states were then directed to develop "watershed restoration action strategies" (WRAS). Kansas' has long contended that restoration of damages is only part of the need and that action to *protect* water is also necessary, hence the term WRAPS. As used by KDHE, WRAPS referred to the development of action plans to address NPS pollution sources on a watershed basis. WRAPS projects were initiated by watershed stakeholders and received financial support from the KDHE to address Total Maximum Daily Load(s) (TMDLs) and related water quality concerns.

In 2003, a review of the Basin Sections of the Kansas Water Plan showed that watershed restoration and protection was a priority issue in most of the river basins of Kansas, and an interagency work group was appointed to develop a Water Issue Strategic Plan. The work group found that Kansas and the federal government have many different programs and activities that address related water resource management issues. The work group determined that much more could be accomplished through a collaborative watershed planning process that addressed not only water quality/pollution issues but the entire spectrum of watershed water resources needs.

The WRAPS initiative is the result of a long history of Kansas' water resource management programs and activities. Watershed planning and management is not a new concept in Kansas. Since the 1950's, watershed districts have been developing and implementing watershed general plans to address flooding and erosion concerns with federal and state assistance. The Kansas Department of Agriculture, Division of

Water Resources has been initiating the development of subbasin (i.e. watershed) management plans since the early 1990's to address ground and surface water quantity issues in selected areas of western Kansas. The current WRAPS initiative is intended to address priority issues identified in the basin sections of the Kansas Water Plan through the development and implementation of WRAPS in priority watersheds.

B. Who are considered stakeholders within a watershed?

Anyone with an interest or deriving value from the watershed's resources is a stakeholder and member of the Stakeholder Leadership Team (SLT). In reality, everyone who lives in a watershed is a stakeholder in the restoration and protection of that watershed. We all want to drink clean water, swim in clean water, eat fish that came from clean water, and have a river or lake that is healthy and full of life. Examples of stakeholders include: urban and rural residents; local, state or federal government agencies; elected officials; agricultural producers; recreational users and wildlife enthusiasts.

C. Hillsdale WRAPS History

The Hillsdale WRAPS project originated in 1992 and was sponsored by the Hillsdale Water Quality Project, Inc. until 2010. During this time the WRAPS development and assessment phases were completed and the planning phase was initiated, resulting in the development of a preliminary watershed plan. In 2012, local agency staff in Johnson and Miami Counties requested that K-State Research and Extension assist them in reorganizing the Hillsdale WRAPS. A stakeholder meeting was conducted in November 2012 and the watershed plan was finalized to meet the requirements of EPA's Nine Elements.

D. 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 Hillsdale Lake Watershed has set the following watershed restoration and protection goals to address their watershed issues:

- To restore water quality and protect water storage capacity and recreational uses at Hillsdale Lake,
- To protect water quality in the Big Bull, Little Bull, and Rock Creek subwatersheds,. and
- To protect public water supplies.

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 future impairments will not reach the stage of TMDL development.

E. Regional Advisory Committee

In 2013, the Governor of Kansas issued a call to action to develop a 50-Year Vision Plan to be incorporated into the Kansas Water Plan. Regional Advisory Committees (RACs) were developed in 2015. The Hillsdale Watershed is contained in the Marais des Cygnes RAC. The Marais des Cygnes RAC has developed two goals for the future of the Marais des Cygnes basin. They are closely aligned with the WRAPS process.

- Reduce Sediment - To reduce sediment loads entering public water impoundments by 20 percent every 10 years in the Marais des Cygnes basin. However, the RAC has given the Hillsdale Lake watershed an independent sediment reduction goal of 28,394 tons. If all the conservation practices outlined in this watershed plan are implemented, the WRAPS plan will meet 58% of the RAC goal or 16,457 tons of sediment reduction at the end of 20 years.

Table 1. RAC Sediment Reduction Goals for the Hillsdale Watershed.

Annual Sedimentation Rate (Acre Feet)	176
RAC Reduction Goal (Acre Feet)	17.6
RAC Reduction Goal (tons)	28,394.7
WRAPS Reduction Goal in 20 Years (tons)	16,457
% of RAC Goal that will be met through WRAPS Watershed Plan	58%

- Increase Supply - To meet increased water demands in specific growth areas by ensuring that water supply from storage exceeds projected demand by at least 10 percent through 2050.

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

F. 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 Hillsdale Watershed has an elevation of 677 meters (2,221 feet) and the lowest point of the watershed has an elevation of 200 meters (656 feet) above sea level. Figure 2.

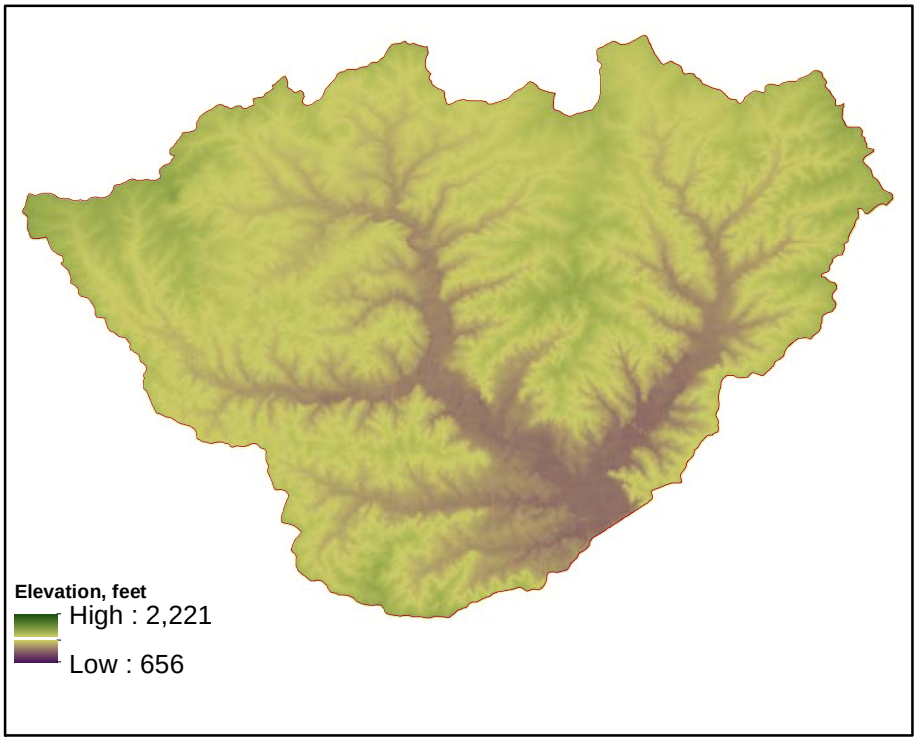


Figure 2. Relief Map of the Watershed.

G. What is a HUC?

HUC is an acronym for **H**ydrologic **U**nit **C**odes. HUCs are an identification system for watersheds. Each watershed has a HUC number in addition to a common name. As watersheds become smaller, the HUC number will become larger. The first 2 numbers in the HUC 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 [i]. For example:

10290102 = Region drainage of the Missouri River, the Saskatchewan River and several small closed basins.. (Area = 519,847 sq. miles)
10**29**0102 = The Gasconade and Osage River Basins. (Area = 18,400 sq. miles)
1029**01**02 = The Osage River Basin (Area = 14,800 sq. miles)
102901**02** = Cataloging units drainage of the Lower Marais des Cygnes. (Area = 1,560 sq. miles)

The Marais des Cygnes Basin is one of twelve basins in the state of Kansas. Figure 3.

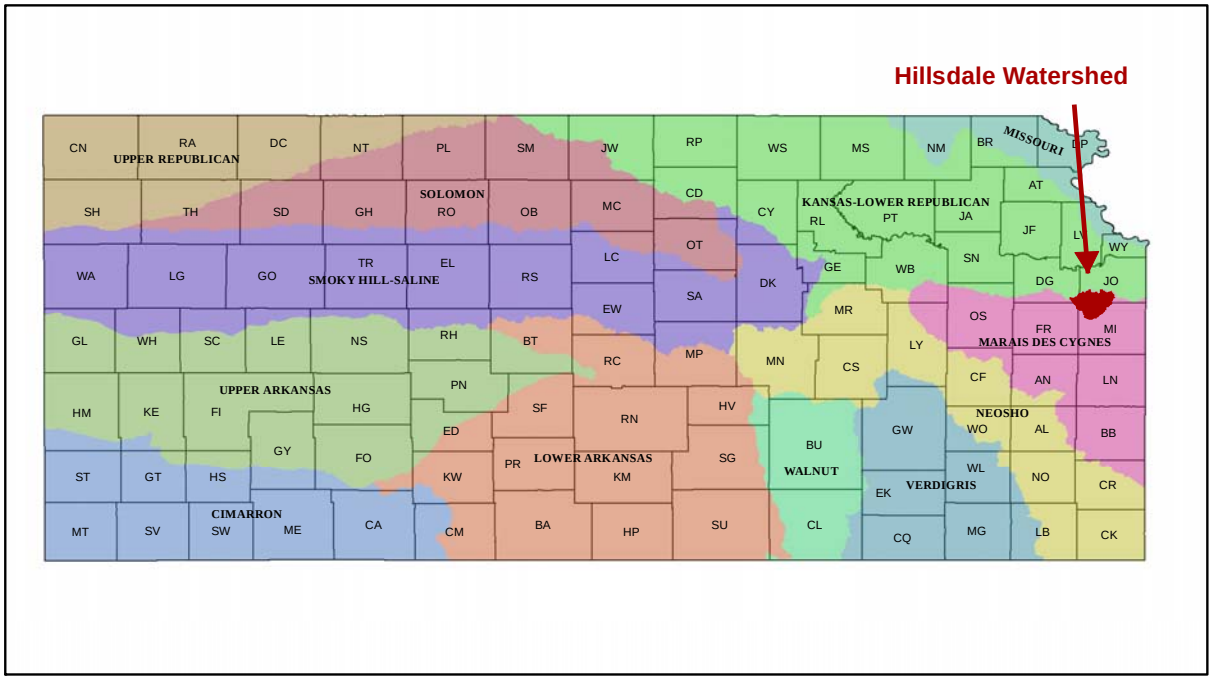


Figure 3. Hillsdale Lake Watershed in the State.

Within the Marais des Cygnes Basin are five HUC 8 classifications. The Lower Marais des Cygnes Watershed, which contains Hillsdale Lake, has an 8 digit HUC number of 10290102. This HUC 8 is then split into smaller watersheds that are given HUC 10 numbers. Hillsdale Lake lies within HUC 10 code number: 1029010201. This HUC 10 watershed is further divided into smaller watersheds with HUC 12 identifiers. The area of this WRAPS project is a combination of the land area covered by three HUC 12s. Figure 4. These HUC 12 subwatersheds include: 102901020101-Bull Creek, 102901020102-Little Bull Creek, 102901020103-Rock Creek. Figure 5.

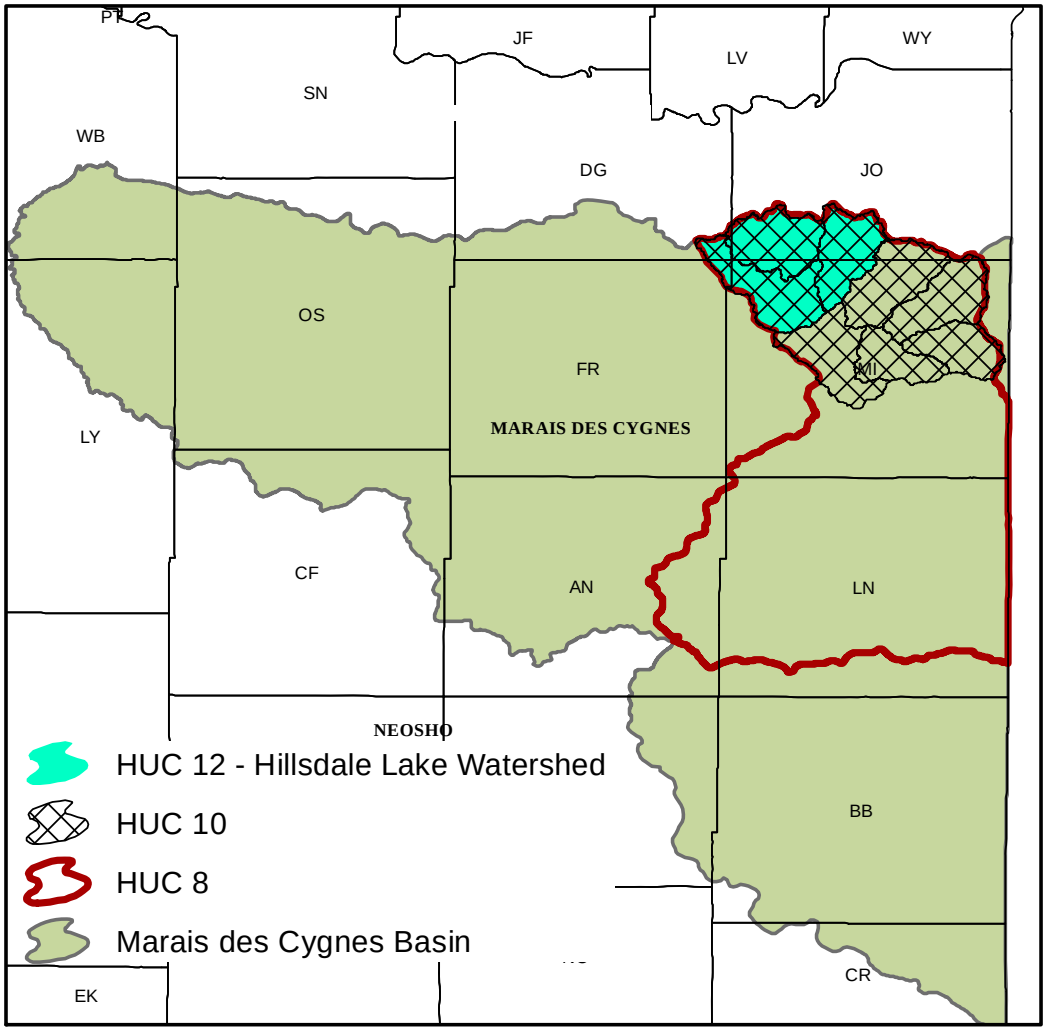


Figure 4. Hillsdale Lake Watershed in the Marais des Cygnes Basin.

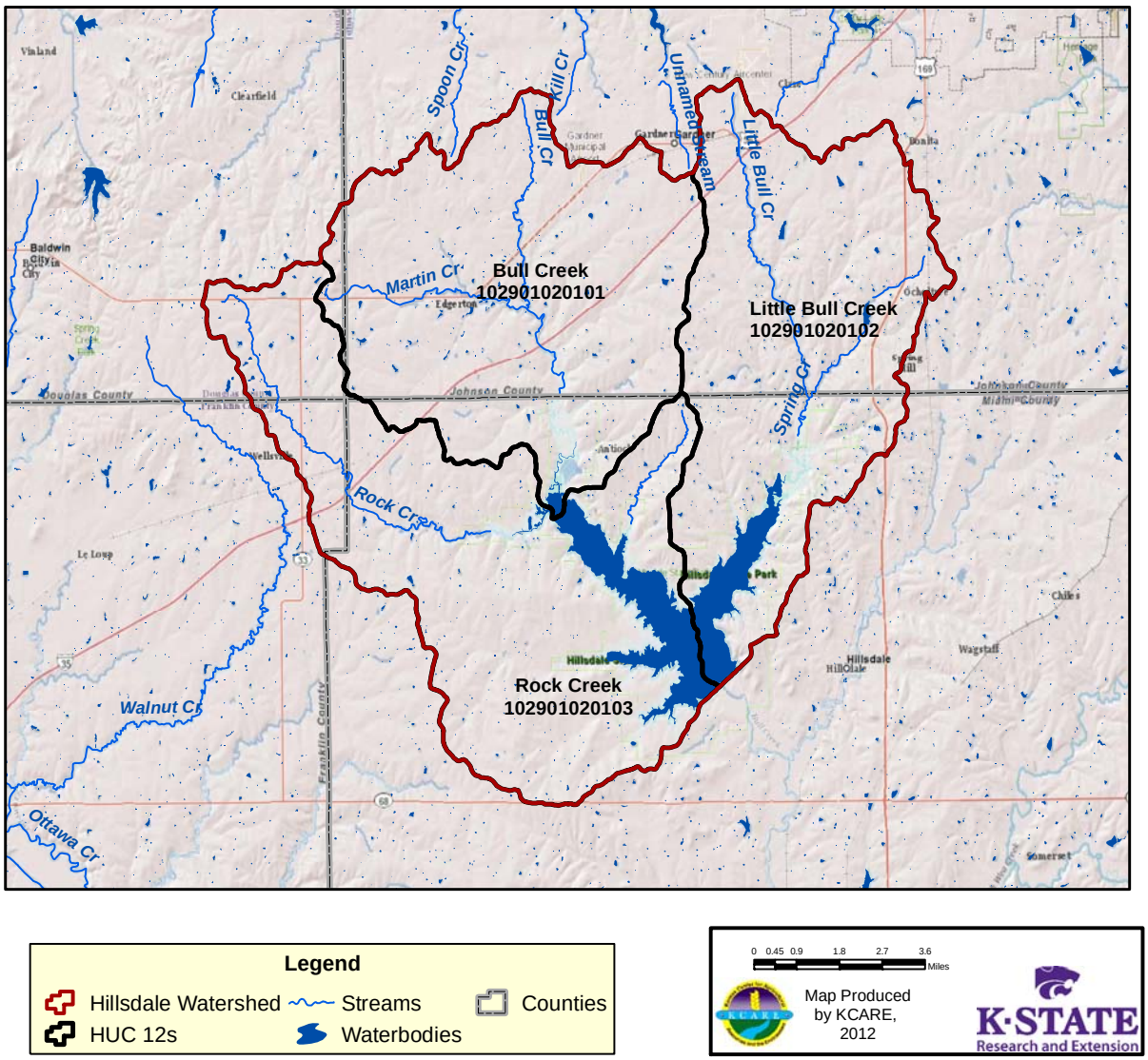


Figure 5. HUC 12s in the Watershed.

H. Watershed Setting

Hillsdale Lake is located in eastern Kansas, in northwest Miami County, about 30 miles southwest of Kansas City or approximately 5 miles northwest of Paola, Kansas. The dam, built on Big Bull Creek, is located 29.1 km (18.2 miles) upstream of its confluence with the Marais des Cygnes River. The watershed includes southern Johnson County, southwest Douglas County, Franklin County, and Miami County. The 92,000-acre watershed is split between four counties, as follows: Miami County- 47 percent; Johnson County- 46 percent; Douglas County- 5 percent and Franklin County- 2 percent.

In the 1940s, area landowners began lobbying for a flood control device. In 1954, the United States Congress authorized the Hillsdale Lake Project because of the strong support by local citizens and the Hillsdale Lake Development Association. Through their work, the lake became a reality. In 1973, construction funds were allocated and land acquisition began. The U.S. Army Corps of Engineers began construction in 1978. The dam was completed in 1982. Hillsdale Reservoir contributes to flood protection on the Marais des Cygnes, Osage and Missouri rivers. The Hillsdale Reservoir is located in Miami County, Kansas. Its multipurpose pool contains 4,580 surface acres. As a flood control device, it is designed to contain up to 7,410 surface acres. By 2002, its recreational opportunities provided a destination for more than 2 million visitors annually.

Hillsdale Lake Watershed is important in the state of Kansas because it is located near metropolitan Kansas City, which has a population of approximately 1.6 million. Demographics have shown a shift in population to the metropolitan area's southern sections towards Hillsdale Lake. The Hillsdale Lake Watershed includes the expanding communities of Spring Hill, Edgerton and Gardner.

3. Watershed Review

A. Land Cover/Land Uses

1. Hillsdale Watershed Land Use

Hillsdale Lake Watershed land use has and continues to change as growth from the Kansas City Metro area expands south. The following sections describe current and projected land use.

The latest available data that corresponded with the targeting and Best Management Practice (BMP) placement is included below.

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.

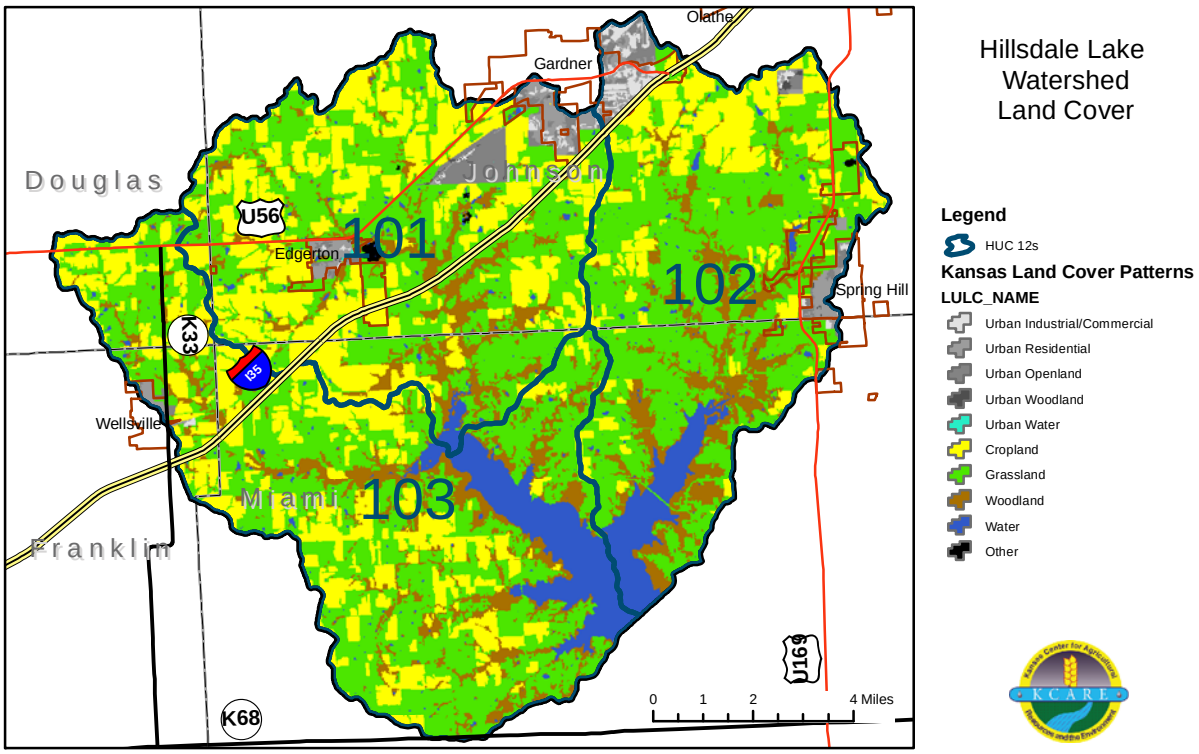


Figure 6. Land Cover in the Hillsdale Watershed. [ii]

Table 2. Land Use in the Hillsdale Watershed. [iii]

Targeted Area	Watershed
Land Use	**Acres**
Grassland	44,715
Cropland	25,317
Woodland	11,768
Water	5,969
Urban Openland	1,484
Residential	1,785
Commercial/Industrial	747
Other	121
Urban Woodland	67
Urban Water	13
Total	**91,974**

2. Urbanization:

Hillsdale Lake Watershed is experiencing rapid growth areas in its communities. Urban sprawl negatively influences physical habitats supporting aquatic life. The potential elimination of wetlands and riparian buffers within the watershed has the potential to diminish streams' capacity to remove pollutants and mitigate flooding effects.

The eventual channelization of most urban streams results in highly simplified aquatic habitats incapable of supporting the full range of fish and wildlife indigenous to this region. Stormwater runoff from impervious surfaces such as paved areas and rooftops can lead to powerful flooding events, scouring stream bottoms and effectively eliminating the habitat required by some native aquatic species.

In addition, with increased urban growth occurring throughout the watershed, the demand for drinking water continues to increase. Water quality and quantity are important issues for the residents and community leaders in the four-county area who depend on Hillsdale Lake. Hillsdale's water supply is now fully allocated.

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

Fertilizer applications to lawns and golf courses within the drainage and stormwater delivery to the lake are probable loading sources. Educational activities to provide the public the opportunity to reduce and properly use fertilizers are included in the Hillsdale WRAPS Educational component along with soil testing activities.

3. Agricultural Chemical Use, Crops and Livestock:

One source of phosphorus within Hillsdale Lake is runoff from agricultural lands where phosphorus has been applied. Phosphorus is a contributing factor to the eutrophication levels in Hillsdale Lake.

Land use coverage analysis indicates that 25 percent of the watershed is cropland. Nutrient runoff from cropland may originate in fertilizers that have runoff the land during a rainfall event.

Fifty percent of land around the lake is grassland; the grazing density of livestock is moderate. Animal waste from grazing animals or distributed from confined animal feeding operations can add to the nitrogen and phosphorus load going into Hillsdale Lake.

B. Designated Uses

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. Table 3. These are commonly referred to as "designated uses" as stated in the Kansas Surface Water Register, 2010, issued by KDHE. If the designated uses of a water body are not being met, the Water Quality Standard for that water body is not being met and therefore, it is impaired.

Table 3. Designated Uses of the Streams and Lakes in the Watershed.

River/Lake Name	County Name	CLASS	AL	CR	FP	DS	GR	IW	IR	LW
Bull Cr, seg 24	Johnson/Miami	GP	E	B	X	X	X	X	X	X
Bull Cr, seg 26	Johnson	GP	E	B	X	O	X	X	X	X
Little Bull Cr	Johnson	GP	E	C	X	X	X	X	X	X
Martin Cr	Douglas/Johnson	GP	E	b	O	O	O	O	X	X
Rock Cr	Douglas/Franklin/Miami	GP	E	b	O	X	X	O	O	X
River/Lake Name	**County Name**	**CLASS**	**AL**	**CR**	**FP**	**DS**	**GR**	**IW**	**IR**	**LW**
Smith Branch	Miami	GP	E	b	O	OX	X	O	X	X
Spring Cr	Johnson/Miami	GP	E	a	X	X	X	X	X	X
Edgerton City Lake	Johnson	GP	E	B	X	X	O	X	X	X
Hillsdale Lake	Miami	GP	S	A	X	X	X	X	X	X
Spring Hill City Lake	Johnson	GP	E	B	X	X	X	X	X	X

AL = Aquatic Life Support
CR = Contact Recreation Use
DS = Domestic Water Supply
FP = Food Procurement
GR = Groundwater Recharge
IW = Industrial Water Supply
IR = Irrigation Water Supply
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
C=Primary contact recreation stream segment is not open to and accessible by the public under Kansas law
a=Secondary contact recreation lakes that are 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
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

C. Special Aquatic Life Use Waters

Special aquatic life use waters are defined as “surface waters that contain combinations of habitat types and indigenous biota not found commonly in the state, or surface waters that contain representative populations of threatened or endangered species”. Hillsdale Lake is designated as a Special Aquatic Life Use (SALU) water. Figure 7.

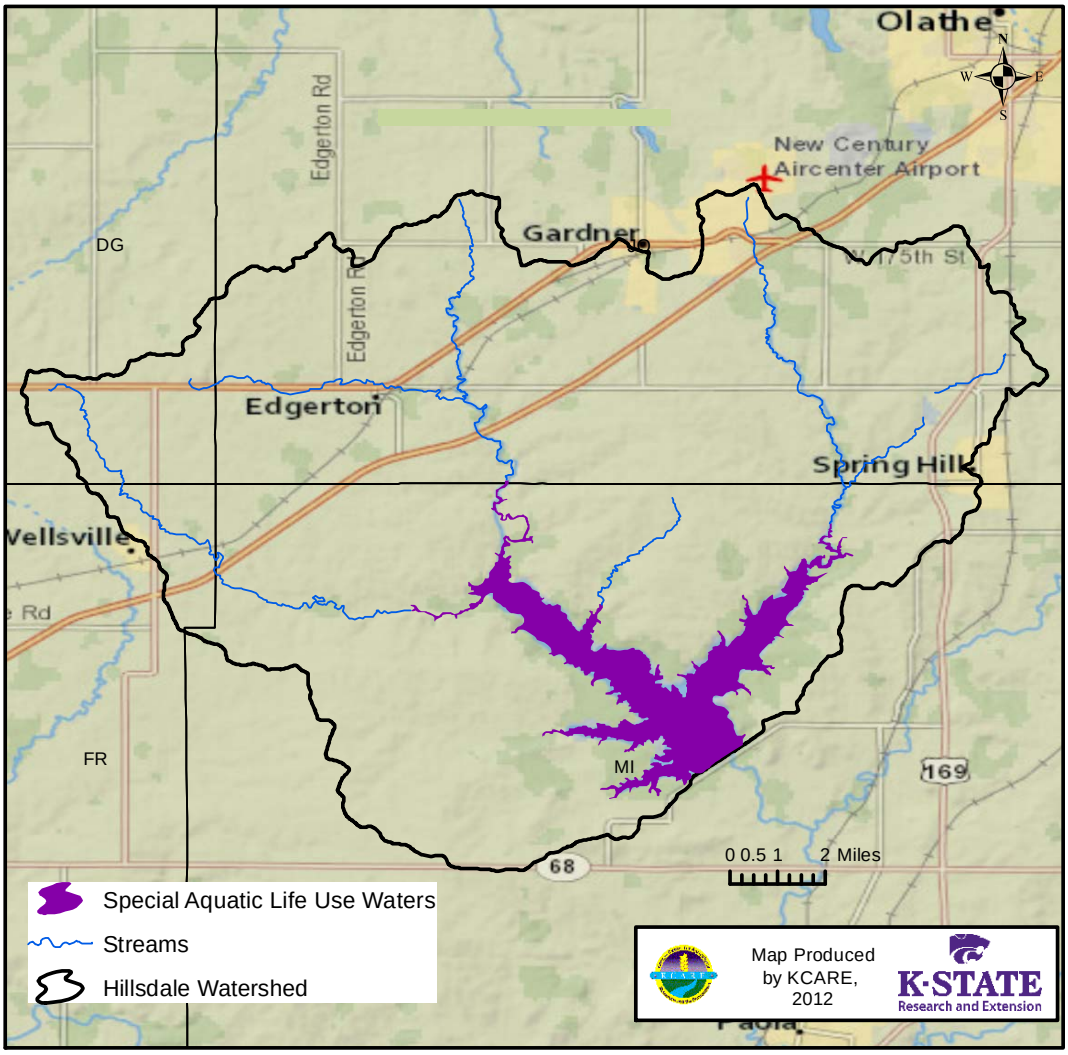


Figure 7. Special Aquatic Life Use Waters.

Pollutants that might threaten the health of these waters would be sediment or nutrient related. Sediment in Hillsdale Lake would destroy habitat for mussels and fish. Fertilizer or manure in the streams would concentrate nutrients and alter dissolved oxygen concentrations, pH, and phosphorus concentrations. Since Hillsdale Lake has a TMDL

for eutrophication due to excess nutrients, the Special Aquatic Life Use designation is in danger of being rescinded.

D. Exceptional State 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". There are no ESW in this watershed.

E. Rainfall and Runoff

Rainfall rates and duration will affect sediment and nutrient runoff during high rainfall events. Most high intensity rainfall events will occur in late spring and early summer. Figure 8. This is the time frame 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.

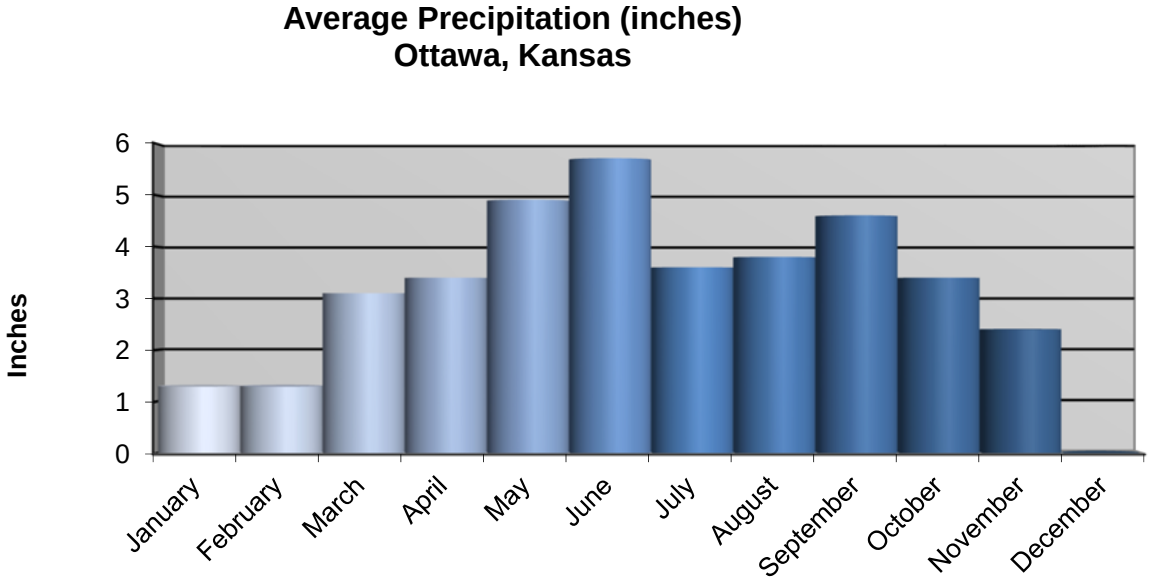


Figure 8. Average Precipitation in the Watershed by Month. [iv]

The Hillsdale Watershed averages 39 inches of rainfall yearly. Figure 9. The watershed's average soil permeability is 0.6 inches/hour according to NRCS STATSGO database. The watershed produces runoff even under relatively low (1.5''/hour) potential rainfall conditions. Runoff is chiefly generated when rainfall intensities are greater than soil permeability. As the watersheds' soil profiles become saturated,

excess overland flow is produced. Generally, storms producing less than 0.5"/hour of rain will only generate runoff from 23.4 percent of this watershed, chiefly along the stream channels.

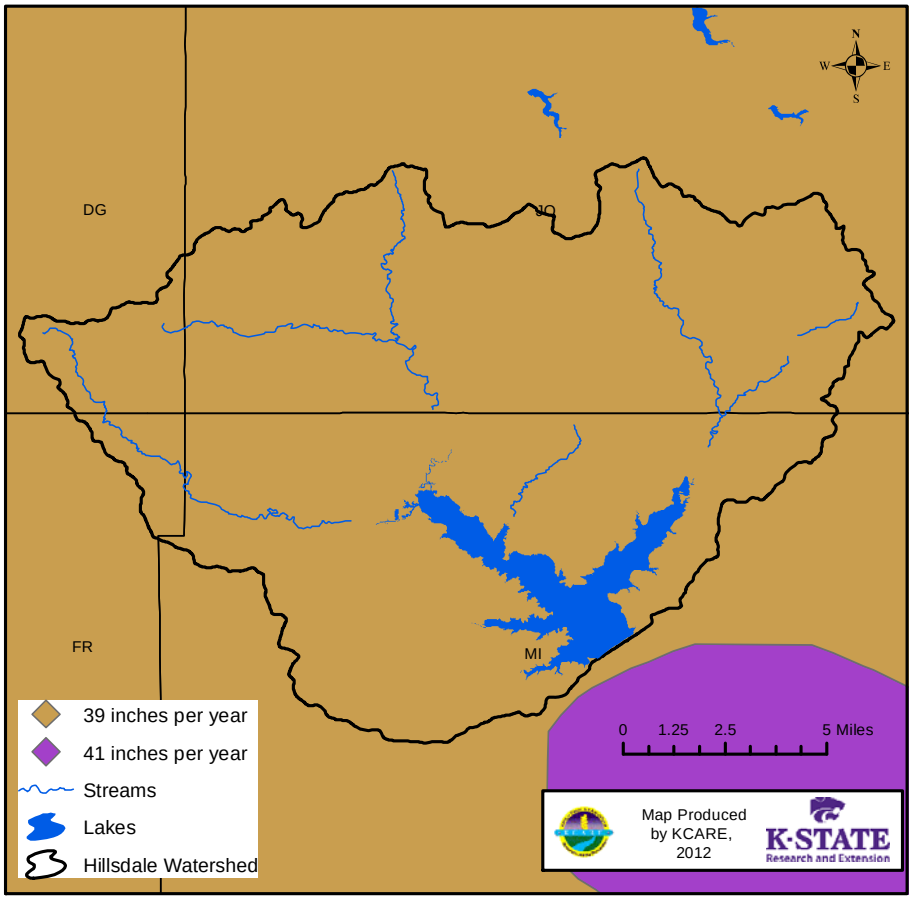


Figure 9. Annual Precipitation Averages in the Watershed.

F. Population and Wastewater Systems

The population within the Hillsdale Lake watershed is expected to increase significantly in the next 20 years. From 2000 to 2010, Miami and Johnson counties had a population increase of 14% and 17%, respectively, according to the U.S. Census. The population in Gardner increased by 50%.[v] This area is experiencing rapid urban sprawl, thus urban pollutants will become an increasingly important issue over time. The population increase numbers do not take into consideration the surrounding population dependent on the lake as water supply users. See Figure 10.

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 Fecal Coliform Bacteria (FCB) or nutrients to the watershed through leakage or drainage of

untreated sewage. Even though all the counties in the watershed have County Sanitarian Codes, there is no way of knowing how many failing or improperly constructed systems exist in the watershed. It is estimated that 2,252 onsite wastewater treatment systems are installed in the watershed with a failure rate of 0.93%.[vi]

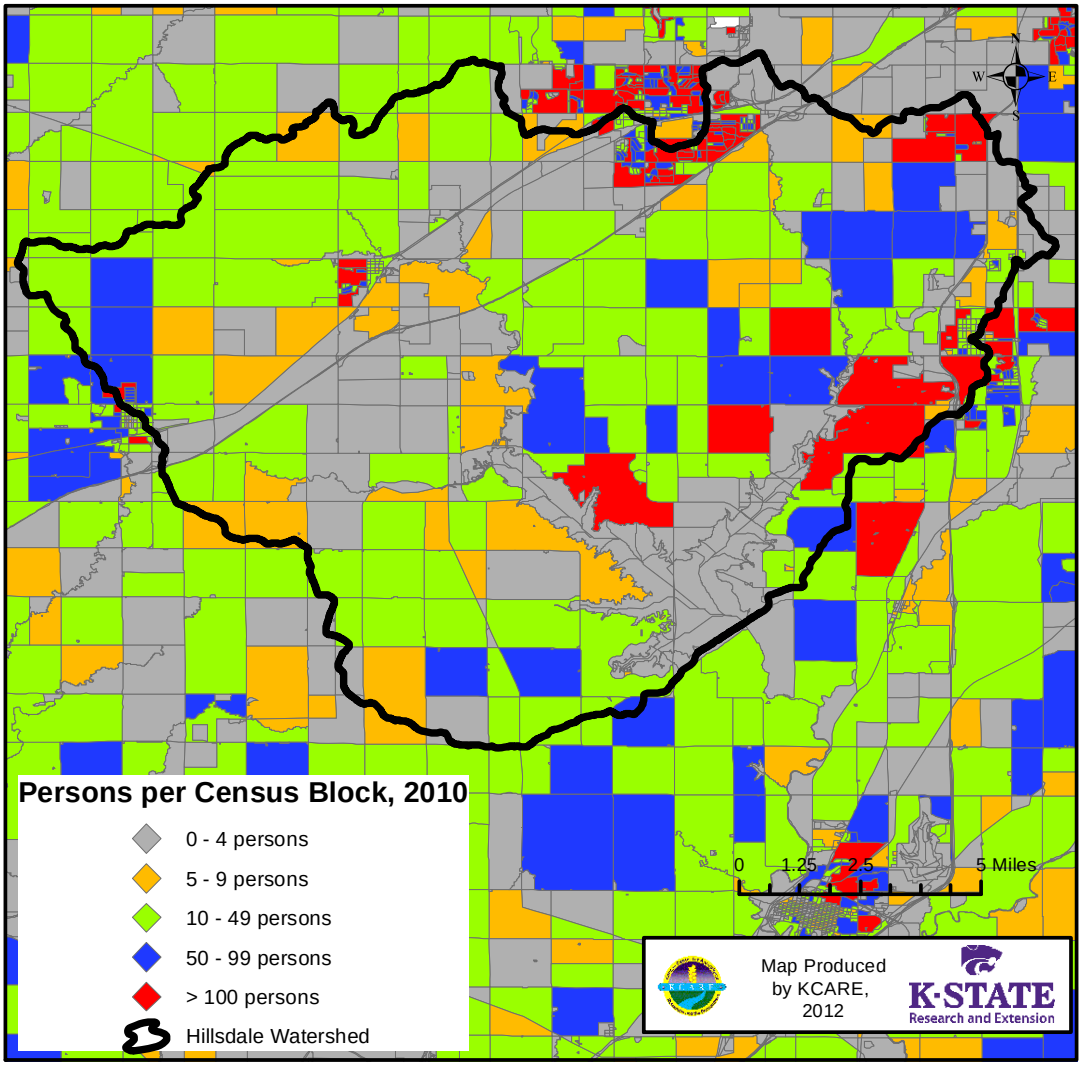


Figure 10. Census Blocks in the Watershed, 2010

G. Aquifers

The watershed, specifically Hillsdale Lake is underlain with a small portion of alluvial aquifer. Figure 11. No other major aquifers exist in this watershed. An alluvial aquifer

is a part of and connected to a river or stream system and consists of sediments deposited by rivers in the stream valleys. A sign of a healthy and sustainable alluvial system is adequate stream flow.

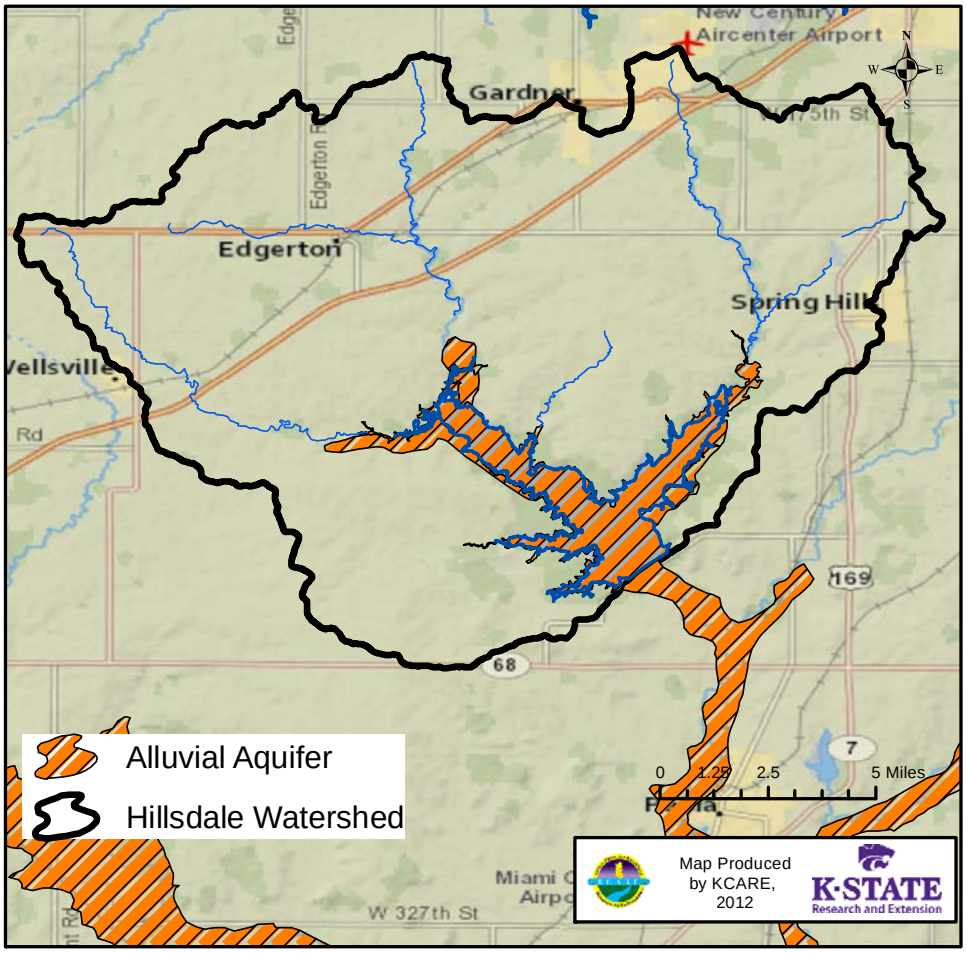


Figure 11. Alluvial Aquifer in the Watershed.

H. Public Water Supplies

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 FCB will also affect surface water supplies causing excess cost in treatment prior to public consumption. Hillsdale Lake drains a watershed covering about 144 square miles. Thousands of individuals in the surrounding area rely on Hillsdale Lake as their primary source of drinking water. More than 30,000 residents of southern Johnson County and northern Miami County

use it for this purpose. As a water supply source, the lake can provide 17.3 million gallons of water daily for municipal and industrial needs of surrounding communities. Since the lake's construction, several PWS have taken advantage of the KWO's water marketing program at Hillsdale and have been awarded an allocation from KWO. Those entities include: Miami County Rural Water District's No. 1, 2, & 4, the cities of Edgerton, Gardner & Spring Hill, and finally Johnson County Rural Water District No. 7.

To ensure the availability of water supplies in times of prolonged drought, and to increases the effective management of the entire marketing pool available at Hillsdale Lake, nine public water suppliers formed an interlocal entity called the Hillsdale Area Water Cooperative (HAWC) in March, 2011. The HAWC membership consists of the following public water supplies: City of Edgerton; City of Gardner; City of Spring Hill; City of Wellsville; Franklin County Rural Water District No. 1; Johnson County Rural Water District No. 7; Miami County Rural Water District No. 1; Miami County Rural Water District No. 2; and, Miami County Rural Water District No. 4. As a result of the cooperative agreement, all but one fixed rate contract to Miami County Rural Water District No. 2 (Contract #81-1 for 239.44 MGY, which expires in Oct. 21, 2023), have now been consolidated into a single contract under HAWC and all water storage is now fully allocated with the water marketing program at Hillsdale."

Table 4. Population Served by Public Water Suppliers in Hillsdale Lake. [vii]

Water Connections			
Public Water Supplier	**Population Served in 2009**	**Population Served in 2017**	**Difference**
Douglas County RWD #4	1,100	3,000	+1,900
Edgerton	696	1,736	+1,040
Franklin County RWD #1	660	665	+5
Gardner	6,689	20,868	+14,179
Johnson County RWD #7	2,151	6,457	+4,306
Miami County RWD #1	605	1,680	+1,075
Miami County RWD #2	3,564	8,631	+5,067
Miami County RWD #3	978	2,435	+1,457
Miami County RWD #4	396	875	+479
Spring Hill	1,455	3,502	+2,047
Wellsville	780	1,818	+1,038
New Air Center		500	+500
Louisburg		4,276	+4,276
Total	**19,074**	**56,443**	**+37,369**

The Hillsdale Lake Area Region Map, next page, identifies the water suppliers' boundaries (cities and rural water districts), water source, treatment facilities, storage

facilities, pumps, mainlines, boundaries and communities serviced by the listed water suppliers.

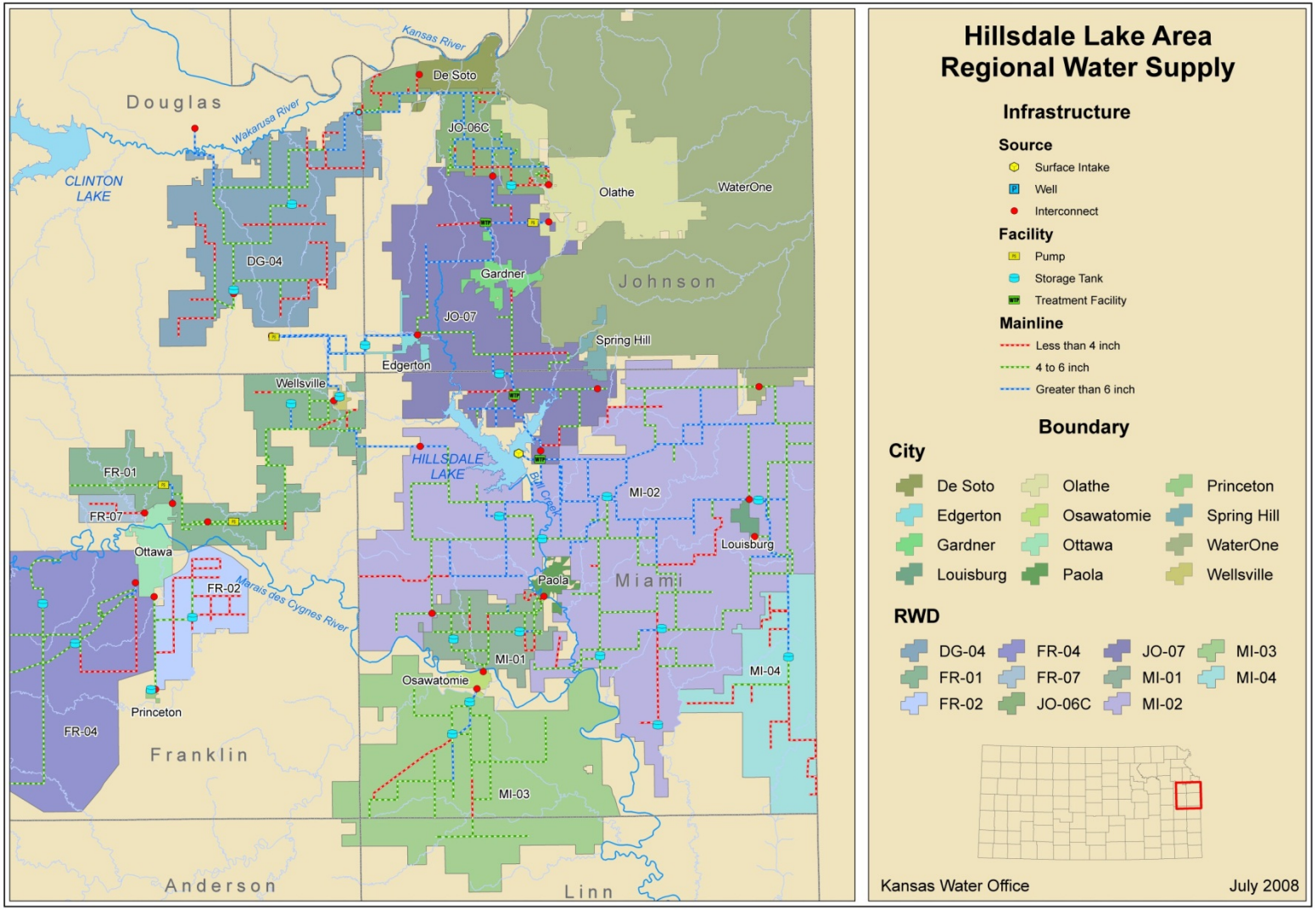


Figure 12. Hillsdale Lake Regional Water Supply. [viii]

I. National Pollutant Discharge Elimination Systems (NPDES)

Wastewater treatment facilities are permitted and regulated through KDHE. They are considered point sources of pollutants. National Pollutant Discharge Elimination System (NPDES) permits specify the maximum allowable amount of pollutants to be discharged into surface waters. Having theses point sources located on streams or rivers could impact water quality in the waterways. For example, municipal wastewater can contain suspended solids, biological pollutants that reduce oxygen in the water column, inorganic compounds or bacteria. Wastewater is treated to remove solids and organic materials, disinfected to kill bacteria and viruses, and discharged to surface water. Treatment of municipal waste water is similar across the country. Industrial point sources can contribute toxic chemicals or heavy metals. Treatment of industrial waste water is specific to the industry and pollutant discharged. Any pollutant discharge from point sources that is allowed by the state is considered to be Wasteload Allocation. There are eight NPDES sites in the watershed. See Table 5.

Table 5. NPDES Sites in the Hillsdale Lake Watershed. [ix]

Name	NPDES Permit #	Type	Expiration Date
Hillsdale State Park (KDPWT)	KSJ000357	Non-overflowing	5/31/20
Hillsdale State Park (KDPWT)	KSJ000657	Non-overflowing	12/31/20
Johnson County	KSR410007	Stormwater Discharge	1/31/19
Penny's Concrete, Inc.	KSG110189	Catch Basin	9/30/17
Edgerton Quarry	KS0095371	Settling Basin	12/31/17
Youth Front West Camp	KSJ000186	Non-overflowing	5/31/20
Big Bull Creek WWTF	KS0100374	Aerobic Sludge CNR/BNR/UV	12/31/21
Edgerton WWTF	KS0046388	Oxidation/UV/CPPR	6/30/19
Fordyce Concrete	KSG110205	Non-Discharging Catch Basin	9/30/17
JoCo New Century WWTF	KS0119296	Activated Sludge/UV	10/31/19
Gardiner WTP	KS0099295	Settling Basin	12/31/19

J. Burlington Northern Santa Fe Railroad Intermodal Facility

The Burlington Northern Santa Fe (BNSF) Railroad has constructed an Intermodal Facility in Edgerton, which is in the Bull Creek sub watershed. This facility will provide connective transfer of all modalities, specifically transfers between trucks and trains. It will offer companies quick and efficient ability to ship goods by rail and truck throughout the country and into the global supply chain.

To accommodate the increase in population needed to run a large facility, the City of Edgerton has built the Big Bull Creek Waste Water Treatment Facility and conveyance system.

The Intermodal Facility covers 1,000 acres. Runoff from the facility is treated in a constructed wetland system, and then flows into Big Bull Creek. The SLT of the Hillsdale Lake Watershed are concerned with potential stormwater runoff issues degrading Big Bull Creek from the increased amount of concrete and buildings that are being constructed. Quantity of the stormwater runoff is not the only concern. The increase in runoff will also affect the quality of water in Bull Creek. More sediment will be present in the creek, which ultimately drains into Hillsdale Lake. The SLT would like to have low-impact development BMPs incorporated into all new development in the watershed.

K. Water Quality Conditions and Pollution Load Reductions

The Lower Marais des Cygnes Watershed is designated as a Category I watershed indicating it is in need of restoration as defined by the Kansas Unified Watershed Assessment 1999 submitted by the Kansas Department of Health and Environment (KDHE) and the United States Department of Agriculture (USDA) in 1999. A Category I watershed does not meet state water quality standards or fails to achieve aquatic system goals related to habitat and ecosystem health. Category I watersheds are also assigned a priority for restoration. The Lower Marais des Cygnes Watershed is ranked 12th in priority out of 92 watersheds in the state. As a part of the Lower Marais des Cygnes Watershed, the Hillsdale Lake Watershed of this WRAPS process is also in need of protection and restoration.

1. Total Maximum Daily Loads (TMDLs)

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. 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.

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.

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 Marais des Cygnes Basin.

Table 6. TMDLs Review Schedule for the Marais des Cygnes Basin.

Year Ending in September	Implementation Period	Possible TMDLs to Revise	TMDLs to Evaluate
2012	2013-2022	2001	2001
2017	2018-2027	2001, 2007	2001, 2007

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

- Category 5 – Waters needing TMDLs
- Category 4a – Waters that have TMDLs developed for them and remain impaired
- Category 4b – NPDES permits addressed impairment or watershed planning is addressing atrazine problem
- Category 4c – Pollution (typically insufficient hydrology) is causing impairment
- Category 3 – Waters that are indeterminate and need more data or information
- Category 2 – Waters that are now compliant with certain water quality standards
- Category 1 – All designated uses are supported, no use is threatened

In 2001, a high priority TMDL was developed for Hillsdale Lake by KDHE for Eutrophication. This TMDL was revised and updated in 2014. The Hillsdale Lake Watershed also has medium priority TMDLs in Edgerton City Lake for eutrophication and atrazine. Edgerton City Lake is located in the Big Bull Creek subwatershed which is a high priority targeted area. The eutrophication table below lists the TMDLs in Hillsdale Watershed and date TMDL was adopted by KDHE and EPA.

Table 7. TMDLs in Hillsdale Lake Watershed.

TMDL Listing for Hillsdale Watershed Including Priority Level Placed by the State [xi]					
Subbasin: Lower Marais Des Cygnes (HUC 10290102)					
Category	**Water Body**	**Impairment**	**Priority**	**Sampling Site**	**Date of TMDL**
4a	Edgerton City Lake	Eutrophication	Medium	LM065001	8/28/01
4a	Edgerton City Lake	Atrazine	Medium	LM065001	8/28/01
4a	Hillsdale Lake	Eutrophication	High	LM035001 LM035002 LM035003	8/28/01 Revision approved 2014

Table 8. 303(d) Listing for Hillsdale Lake Watershed.

303(d) Listing for Hillsdale Watershed Including Priority Level Placed by the State [xii]			
Subbasin: Lower Marais Des Cygnes (HUC 10290102)			
Water Body	**Impairment**	**Sampling Site**	**TMDL Priority Development Date**
Spring Hill City Lake	Eutrophication	LM073501	2023

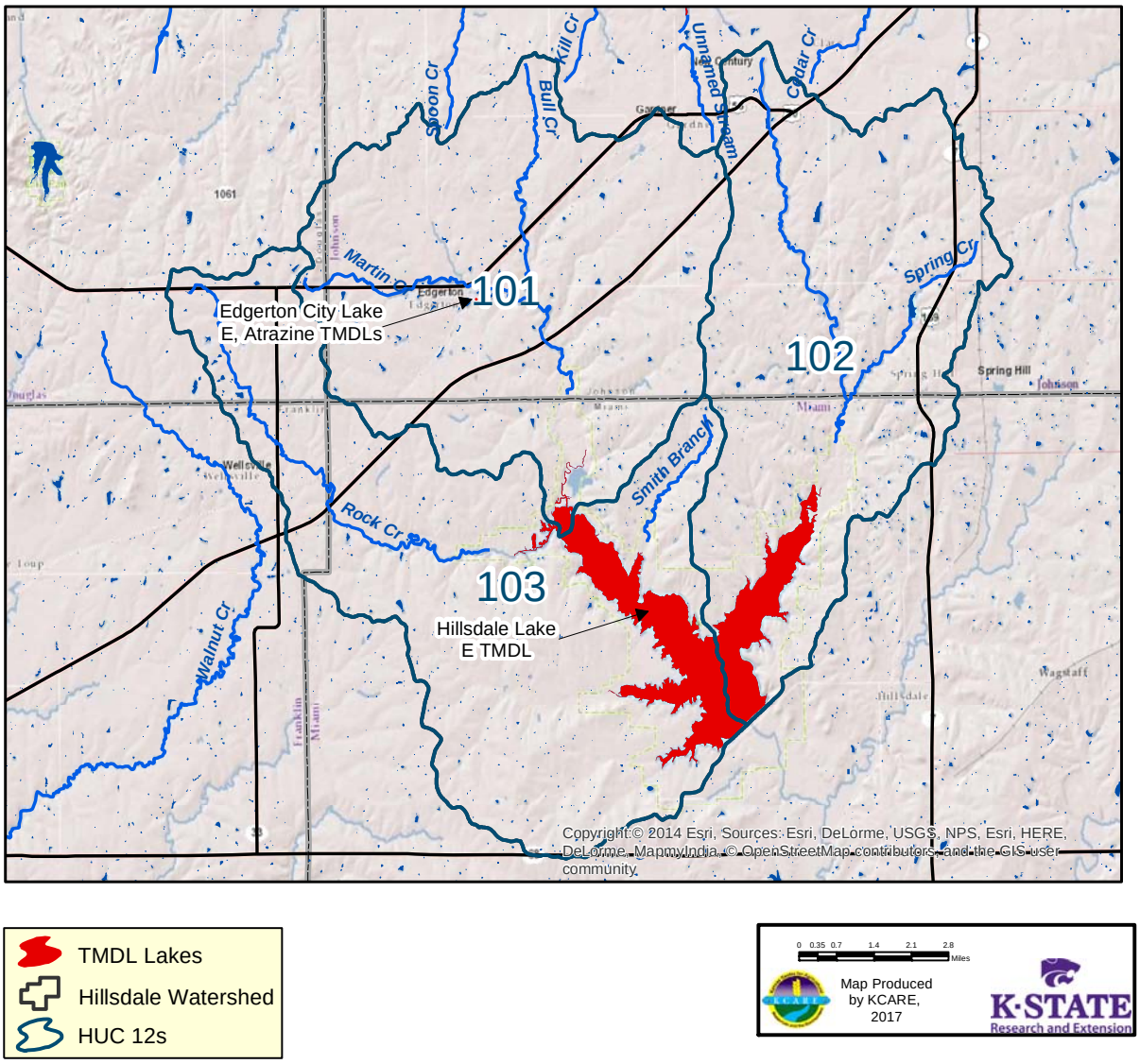


Figure 13. TMDL Waterbodies and Priority Areas for Implementation in the Watershed.

2. Eutrophication TMDL for Phosphorus in Hillsdale Lake

In the 2014 TMDL revision, Hillsdale Lake was declared Very Eutrophic, with a Trophic State Index of 60.20. This level is higher than the 2001 TMDL of 58.85. This number shows that excessive nutrients are not being controlled in the watershed and are flowing into Hillsdale Lake. Excessive nutrients cause increased algae growth, which is detrimental to contact recreation, and threatens the domestic water supply use. Algal communities in the lake are dominated by blue-green algae. For these reasons, chlorophyll *a* concentration of 10 ug/l (a reduction from the 2001 TMDL of 17.9 ug/l) was set as an endpoint to address the domestic water supply use and corresponds to a Carlson Trophic State Index (TSI) of 53.2. If this level is achieved, all other designated uses will be met. The focus will be the reduction of phosphorus and nitrogen loads.

Trophic State Index is derived from the chlorophyll *a* concentration. Trophic state assessments of potential algal productivity were made based on chlorophyll *a*

concentrations, nutrient levels and values of the Carlson TSI. Generally, some degree of eutrophic conditions is seen with chlorophyll *a* concentrations over 12 ug/l and hypereutrophy occurs at levels over 30 ug/l. The Carlson TSI, derives from the chlorophyll "a" concentrations and scales the trophic state as follows:

1. Oligotrophic TSI < 40
2. Mesotrophic TSI: 40 - 49.99
3. Slightly Eutrophic TSI: 50- 54.99
4. Fully Eutrophic TSI: 55 - 59.99
5. Very Eutrophic TSI: 60 - 63.99
6. Hypereutrophic TSI: > 64

Within Hillsdale Watershed there are two overall causes of the nutrient loading: point and nonpoint sources of pollution.

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

Industrial, municipal and other facilities that discharge wastes must obtain permits that require pollution control of any wastes discharged. In Kansas, the program is administered by KDHE. The point sources of pollution details are found in the upcoming sections.

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

Because Hillsdale Lake is a Federal reservoir with a large regional benefit for recreation and water supply, this TMDL is a high priority for implementation in the State Water Plan.

As recommended through the TMDL; in order to improve the trophic condition of the lake from its current fully eutrophic status, the desired endpoint will be summer chlorophyll "a" concentrations at or below 10 ug/l, corresponding to a trophic state indicative of slightly eutrophic conditions. The chlorophyll *a* endpoint must be met in order to comply with the Water Quality Standards.

The 2014 TMDL Revision has determined that phosphorus and nitrogen in Hillsdale Lake are "co-limited". Lakes that are co-limited by phosphorus and nitrogen have water column Total Nitrogen:Total Phosphorus ratios between 8 and 29. Since Hillsdale Lake is determined to be co-limited, both phosphorus and nitrogen endpoints are needed in the TMDL.

a) Phosphorus Loading

As part of the 2014 TMDL revision, Total Phosphorus loads were updated. The 2001 TMDL allowed an annual phosphorus load of 82,658 pounds. The 2014 TMDL allows an annual phosphorus load of 11,910 pounds. This represents a reduction of 67% (not including a margin of safety) in the amount of phosphorus that will be allowed in the lake to meet the TMDL.

Currently 36,177 pounds of phosphorus are entering the lake yearly. The reduction goal to meet the TMDL endpoint of 11,910 pounds is 25,457 pounds including a margin of safety. **The eutrophication TMDL in Hillsdale Lake will be directly addressed in this plan by implementation of BMPs**.

The TMDL Load Capacity (11,910 lb/yr) is equal to the current condition (36,177 lb/yr) minus the load reduction of 70 percent (25,457 lb/yr) plus the Margin of Safety (1,191 lb/yr).

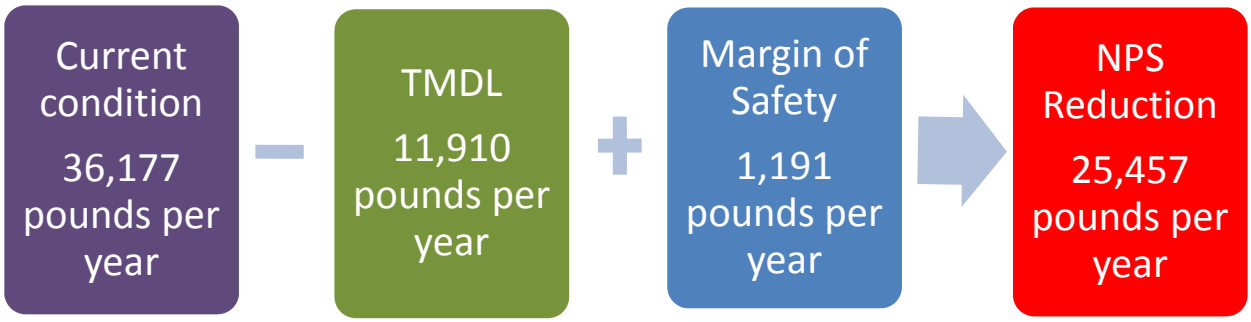


Figure 14. Phosphorus Load Reduction Needed to Meet TMDL Endpoint in Hillsdale Lake.

b) Nitrogen Loading

As part of the 2014 TMDL revision, Total Nitrogen loads were created. The 2001 TMDL did not include nitrogen data. The 2014 TMDL allows an annual nitrogen load of 158,862 pounds. This represents the amount of nitrogen that will be allowed in the lake to meet the TMDL.

Currently 370,993 pounds of nitrogen are entering the lake yearly. The reduction goal to meet the TMDL endpoint of 158,862 pounds is 228,016 pounds including a margin of safety. **The eutrophication TMDL in Hillsdale Lake will be directly addressed in this plan by implementation of BMPs**.

The TMDL Load Capacity (158,862 lb/yr) is equal to the current condition (370,993 lb/yr) minus the load reduction of 61 percent (228,016 lb/yr) plus the Margin of Safety (15,886 lb/yr).

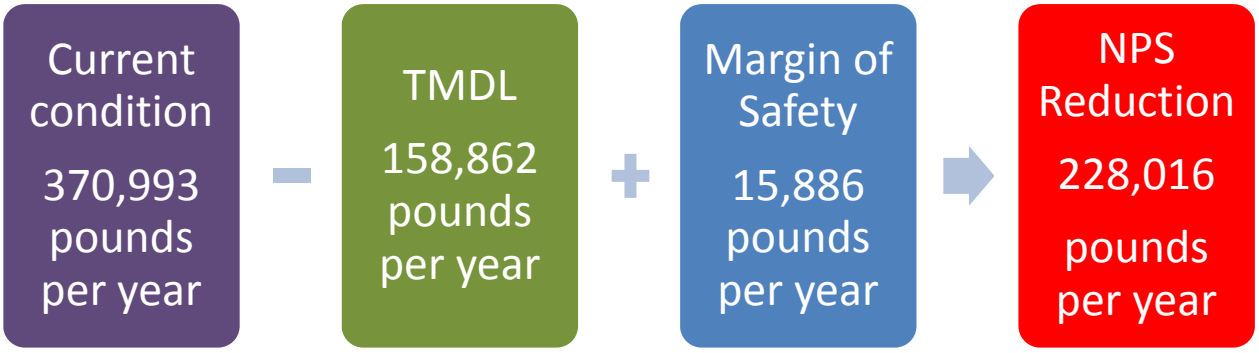


Figure 15. Nitrogen Load Reduction Needed to Meet TMDL Endpoint in Hillsdale Lake.

The EPA and KDHE list no streams with TMDLs in the Hillsdale Watershed.

3. Eutrophication TMDL for Phosphorus in Edgerton City Lake

Edgerton City Lake is fully Eutrophic, with a Trophic State Index of 74.76, therefore it has been given a TMDL for eutrophication. The Trophic Index is discussed in the previous section. In order to improve the trophic condition of the lake from its current hypereutrophic status, the desired endpoint will be summer chlorophyll *a* concentrations at or below 20 ug/l.

BMPs that are implemented for Hillsdale Lake will indirectly address the water quality conditions in Edgerton City Lake if they are implemented in the watershed above Edgerton City Lake. The BMPs that are included in the Hillsdale Lake Watershed scenario include the Edgerton City Lake Watershed. Edgerton City Lake is included in the highest priority targeted area of Bull Creek for the Hillsdale Lake Watershed.

4. Targeted areas

Specific areas that require BMP placement in order to meet load reductions that have been identified in this WRAPS are:

- Cropland areas targeted for nutrient and sediment runoff
- Livestock areas targeted for nutrients

A. Studies Conducted to Determine Targeted Areas

Two studies have been conducted in the Hillsdale Watershed that have led to revision of the Targeted Areas in 2017. KDHE analyzed aerial images and determined areas of interest that are either in close proximity to a stream or have been degraded over time. These are crop fields and livestock facilities. Figure 16. KDHE Study on Degraded Areas in the Watershed.

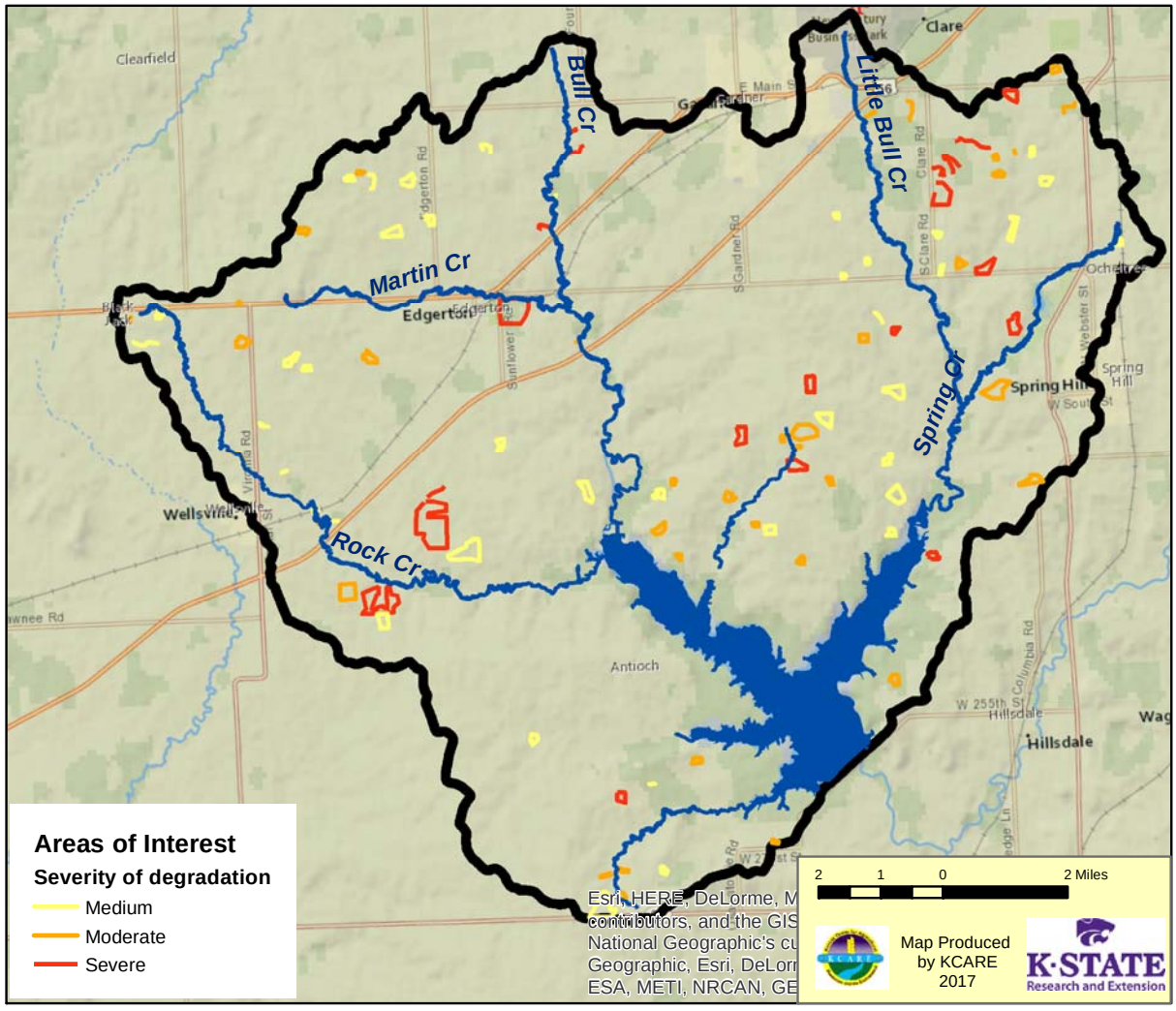


Figure 16. KDHE Study on Degraded Areas in the Watershed. [xiii]

Mid America Regional Council (MARC) conducted a study examining forest degradation and possible restoration areas. These areas were ranked on a scale from 1 to 5, 5 being the most in need of restoration. By only highlighting levels 4 or 5 in Figure 17, it appeared that the majority of restoration sites were in close proximity to the classifieds streams.

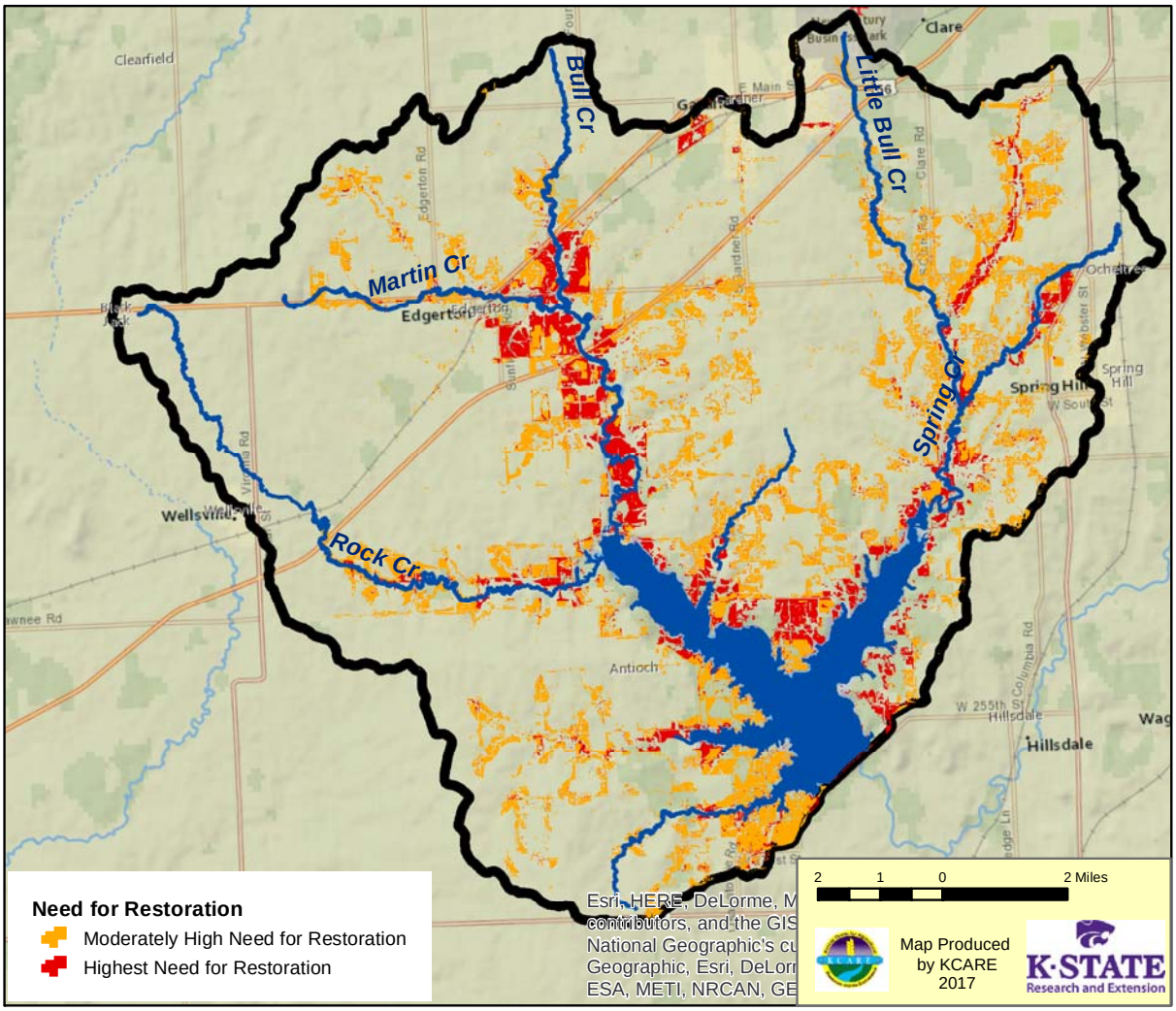


Figure 17. Forest Restoration Areas Needing Restoration. [xiv]

Due to the studies conducted, a "Priority Targeted Area" for BMP placement has been determined. This geographic area consists of a ¾ mile buffer along each side of the classified streams in the watershed, including adjacent to Hillsdale Lake. This targeted area also includes upland areas that contain high numbers of forested restoration or KDHE determined restoration sites. The included streams are Big Bull, Rock Creek, Little Bull Creek, Martin Creek, Smith Creek, and Spring Creek. This Priority Targeted Area will address degraded fields that lie adjacent the streams and lake, the BNSF Intermodal Facility for runoff quantity and quality, and upland areas that contain high numbers of forested restoration or KDHE determined restoration sites.

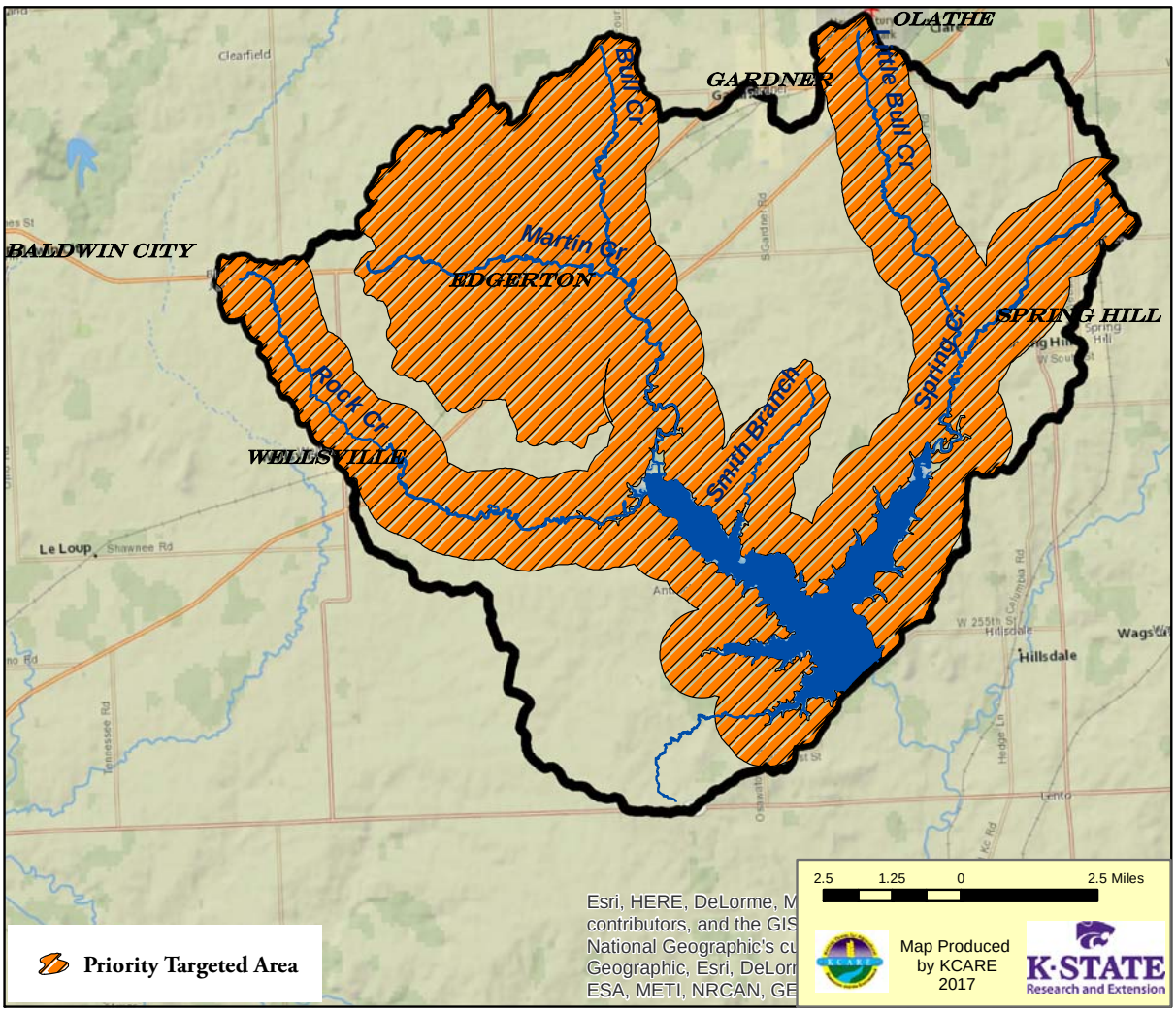


Figure 18. Priority Targeted Areas in the Watershed.

Table 9. Land Use by Targeted Areas. [xv]

Targeted Area	Priority Targeted Area	Watershed
Land Use	**Acres**	**Acres**
Grassland	27,487	44,715
Cropland	14,610	25,317
Woodland	9,045	11,768
Water	1,101	5,969
Urban Openland	466	1,484
Residential	842	1,785
Commercial/Industrial	482	747
Other	98	121
Urban Woodland	30	67
Urban Water	9	13
Total	**54,168**	**91,974**

NOTE: The SLT of Hillsdale Lake Watershed has determined that the focus of this WRAPS process will be on key impairments of Hillsdale Lake: **nutrients** and **sedimentation**. All goals for nutrient reduction will be aimed at the addressing the TMDL for eutrophication in the lake. All goals for sedimentation will be aimed at protecting the lake from further degradation from siltation. The following sections in this report will address these concerns.

5. Impairments

A. Eutrophication

Hillsdale Lake has a TMDL for an impairment of **eutrophication**. To be issued a TMDL, 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.

Eutrophication is caused by excess nutrient loading (primarily nitrogen and phosphorus) from the watershed which creates conditions favorable for algae blooms and aquatic plant growth. While this abundance of algae may temporarily increase oxygen levels, the bloom will eventually die off after the nutrients become in short supply. During die off, dissolved oxygen levels are diminished in the water due to the oxygen being used in algal decomposition. This results in an unfavorable habitat for aquatic life. Desirable criteria for healthy water includes dissolved oxygen rates greater than 5 mg/L and biological oxygen demand (BOD) less than 3.5 mg/L. Excess nutrients originate from manure and fertilizer runoff in rural and urban areas. In the Hillsdale Lake Watershed, urbanization, agricultural land use, and small livestock operations are all contributing excess phosphorus to the watershed system. Hillsdale Lake and Edgerton City Lake both have Eutrophication TMDLs in which excess phosphorus is cited as the nutrient of concern.

NOTE: The **eutrophication** TMDL in Hillsdale Lake is due to excess nutrients in the lake. The term "nutrients" usually includes **phosphorus** and **nitrogen**. Therefore, all nutrient BMPs implemented in this report will be aimed at reducing phosphorus and nitrogen in Hillsdale Lake.

1. Possible Sources of the Impairment

Nutrient loading can originate in both rural and urban areas. It can be caused by both point and nonpoint sources. For this report, the focus will be primarily on agricultural nonpoint source contributions even though other possible sources will be included as part of the following discussion.

Nutrient runoff into waterways can be affected by land use activities. Fertilizer or manure that is applied to cropland prior to a rainfall event or on frozen ground can easily be transported downstream. Livestock that are allowed access to streams to drink or loaf will contribute manure directly in the stream. Overgrazed pastures do not provide adequate biomass to trap manure runoff.

Agricultural BMPs that will help reduce nutrient runoff 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
- Grazing management plans
- Providing off stream watering sites with fencing of streams and ponds
- Relocating pasture feeding sites away from streams
- Relocate feeding pens away from streams
- Rotational grazing
- Vegetative filter strips along waterways.

a) Wastewater Treatment Facilities

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. There are five NPDES facilities in the watershed at this time. This area of potential pollutant contribution should be regulated by KDHE.

b) Population

Population of the watershed can have an effect on nutrient runoff. Hundreds of onsite wastewater systems may exist in the basin, mainly in rural areas. Although the functional condition of these systems is generally unknown, this is an area of possible pollution contribution that should be evaluated over time.

c) Confined Animal Feeding Operations

In Kansas, animal feeding operations (AFOs) with greater than 300 animal units (AUs) and less than 1,000 AUs must register with KDHE. Confined animal feeding operations (CAFOs), those with more than 999 animal units, must be federally permitted. An AU is an equal standard for all animals based on size and manure production. For example: 1 AU=one animal weighing 1,000 pounds. The watershed has 19 certified or permitted AFOs spread throughout the area. Potential animal units for all facilities in the watershed total 5,688. The actual number of animal units on site is variable, but typically less than potential numbers. There are also numerous small livestock and horse farms that contribute to the nutrient loads. Pet waste could also be a contributor.

Table 10. Registered AFOs in the Hillsdale Lake Watershed. [xvi]

Animal Type	County	Total Animals
Beef	Miami	500
Swine	Miami	560
Beef, Horses	Miami	444
Animal Type	County	Total Animals
Dairy	Miami	299
Beef, Horses, Sheep, Goats	Miami	155
Beef	Johnson	460
Beef	Johnson	100
Beef	Johnson	15
Beef	Johnson	460
Beef	Johnson	40
Beef	Johnson	12
Beef	Johnson	20
Beef	Johnson	150
Beef	Johnson	400
Beef	Johnson	410
Beef	Johnson	50
Beef, Swine	Johnson	1,093
Dairy	Johnson	120

d) Grazing Density

Grasslands consist of approximately fifty-two percent of the watershed. Grassland in this area of Kansas is a highly productive forage source for beef cattle. Grazing density will affect grass cover and potential manure runoff. An overgrazed pasture will not have the needed forage biomass to trap and hold manure in a high rainfall event. Also allowing cattle to drink and loaf in streams will increase the occurrence of nutrients and e. coli bacteria in the waterway. Grazing density ranges from 13.1 to 17.43 cattle per 100 acres across the watershed. [xvii] This is considered to be medium density when compared with statewide density numbers. Figure 19.

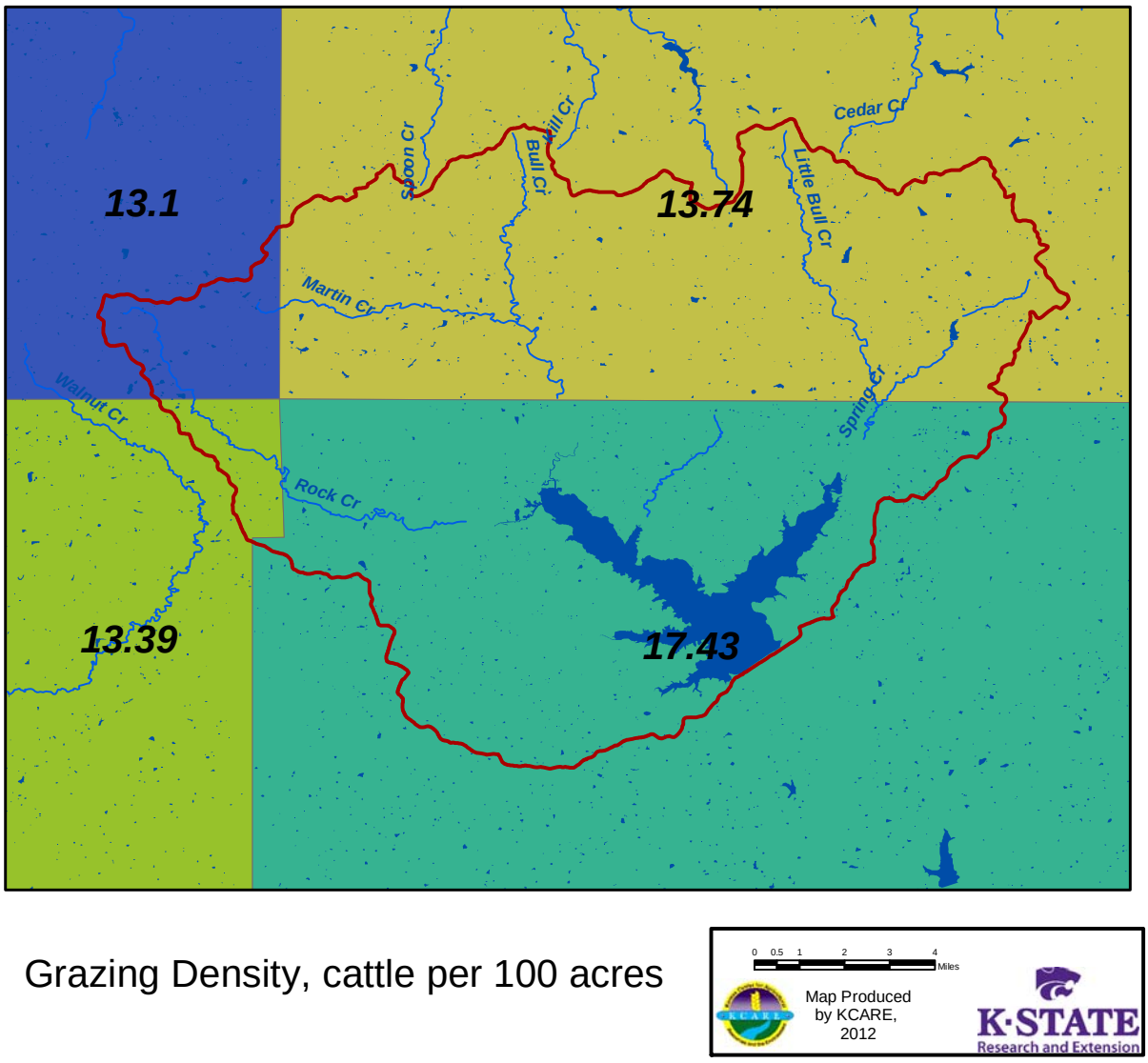
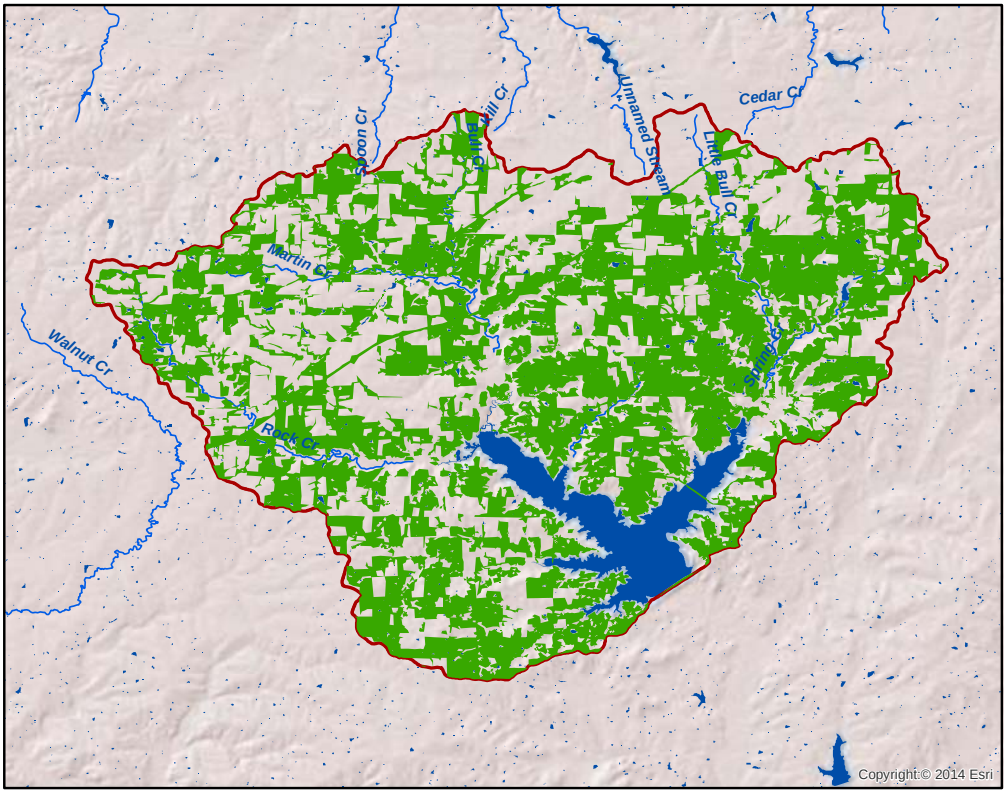


Figure 19. Grazing Density in the Watershed.

e) Land Use

Land use activities have a significant impact on the types and quantity of nonpoint source pollutants in the watershed. Urban sprawl or the conversion of agricultural land to suburban homes and small acreages farms can have an impact on water quality. In addition, agricultural activities and lack of maintenance of agricultural structures can have cumulative effects on land transformation. Manure runoff from grasslands will provide nutrients to accelerate eutrophication. Grassland is fairly evenly distributed throughout the watershed. Figure 20.



Grassland in the Watershed

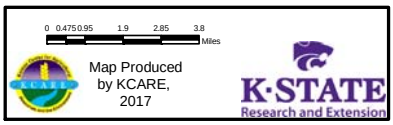


Figure 20. Grassland in the Watershed[xviii]

f) Rainfall and Runoff

Rainfall amounts and subsequent runoff can affect nutrient runoff from agricultural areas and urban areas into streams and Hillsdale Lake. Manure runoff from livestock that are allowed access to stream or manure applied before a rainfall or on frozen ground is affected by the amount and timing of rainfall events. Therefore it is important to maintain adequate grass density to slow the runoff of manure over the pasture.

B. Sedimentation

Silt or sediment accumulation in lakes and wetlands reduces reservoir volume and limits public access for boating in the lake. In addition to the problem of sediment loading in lakes, pollutants can be attached to the suspended soil particles in the water column causing higher than normal concentrations. Reducing erosion is necessary for 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.

According to the 2009 survey in Hillsdale Lake conducted by the Kansas Water Office, Hillsdale Lake has lost 6.26% of its storage capacity due to siltation from the watershed. The calculated sedimentation rate is 176 acre feet/year. Although the siltation rate in Hillsdale Lake is not extreme compared to other reservoirs, the SLT believes addressing sediment entering the lake is important because of the high public water supply demand. Therefore, even though Hillsdale Lake is not listed as having a TMDL for **sedimentation**, the SLT believes sediment is currently present and increasing and is therefore addressing this issue in this WRAPS plan.

1. Possible Sources of the Impairment

Activities performed on the land affects sediment that is transported downstream to the lakes. Physical components of the terrain are important in sediment movement. Physical components of the terrain are important in sediment movement, such as:

- Slope of the land, propensity to generate runoff and soil type
- Streambank erosion and sloughing of the sides of the river and streambank. A lack of riparian cover can cause washing on the banks of streams or rivers and enhance erosion.
- Animal movement, such as livestock that regularly cross the stream 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.

Activities performed on the land affects sediment that is transported downstream to the lakes. 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

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 activities and lack of maintenance of agricultural BMP structures can have cumulative effects on land transformation through sheet and rill erosion. Cropland typically lies along the streams and rivers since historic flooding events deposited rich soils as the streams flooded. Even though this watershed only has 25 percent cropland, it is important to implement agricultural BMPs to mitigate any further soil loss.

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 sediment as well as nutrients through erosion. CRP lands are scattered throughout the watershed. According land use data, CRP comprised only 0.7 percent of the farmable land in the watershed. If more marginal farmland were enrolled in CRP, there would be less erosion and subsequent sediment in Hillsdale Lake.

b) Rainfall and Runoff

Rainfall amounts and subsequent runoff can affect sediment runoff from agricultural and disturbed areas into Hillsdale Lake. High rainfall events can cause cropland erosion and undercutting and therefore, sloughing of streambanks, which add sediment to creeks and ultimately end in Hillsdale Lake.

6. BMPs Needed to be Implemented to Address Water Quality Impairments

The SLT has selected specific BMPs that they have determined will be acceptable to watershed residents as listed below. Landuse calculations are derived from the 2015 Kansas Land Cover Patterns dataset. As depicted in the summary tables, there is an estimated 25,318 acres of cropland within the targeted areas. BMP adoption rates are listed next to each BMP in the table below. Acres treated is calculated by multiplying the adoption rate by the cropland acreage. (i.e. 25,318 acres of cropland x 20% terrace adoption rate=5,064 acres of additional or rebuilt terraces over the life of the plan.) Proposed load reductions are derived from a Kansas State University Extension publication. [xix]

Specific acreages or projects that need to be implemented have been determined through economic analysis and approved by the SLT as listed below. The duration of this plan is 20 years as determined by the time required to meet the nitrogen TMDL reduction goal. Phosphorus TMDL reduction goal will be reached in year 7. The sediment goal will be characterized as "protection" instead of "restoration". Below are the tables with acreages, reductions and implementation rates for installed BMPs.

Table 11. BMPs and Acres or Projects Needed to Reduce Nutrient and Sediment Contribution in Hillsdale Lake for the Life of the WRAPS Plan.

Protection Measures	Best Management Practices and Other Actions	Treated Acres Needed to be Implemented
Prevention of nutrient and sediment contribution from cropland	1. No-Till	2,532 acres
	2. Grassed Waterways	5,064 acres
	3. Vegetative Buffers	2,532 acres
	4. Nutrient Management Plans	1,266 acres
	5. Terraces	5,064 acres
	6 Permanent Vegetation	1,266 acres
	7. Subsurface Fertilizer Application	1,266 acres
Protection Measures	**Best Management Practices and Other Actions**	**Projects Needed to be Implemented**
Prevention of nutrient and sediment contribution from livestock	1. Vegetative Filter Strip	10 in 20 years
	2. Relocate Feeding Pens	10 in 20 years
	3. Relocate Pasture Feeding Sites	60 in 20 years
	4. Off Stream Watering Systems	100 in 20 years
	5. Rotational Grazing	60 in 20 years
	6. Grazing Management Plans	100 in 20 years

Implementing these BMPs will have an estimated nitrogen load reduction of 230,046 pounds, phosphorus load reduction of 80,780 pounds and sediment load reduction of 16,457 tons over the 20-year life of the plan.

Table 12. Sediment Load Reduction for Cropland BMPs.

Annual Soil Erosion Reduction (tons)								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total
1	190	203	127	32	152	120	0	**823**
2	380	405	253	63	304	241	0	**1,646**
3	570	608	380	95	456	361	0	**2,469**
4	760	810	506	127	608	481	0	**3,291**
5	949	1,013	633	158	760	601	0	**4,114**
6	1,139	1,215	760	190	911	722	0	**4,937**
7	1,329	1,418	886	222	1,063	842	0	**5,760**
8	1,519	1,620	1,013	253	1,215	962	0	**6,583**
9	1,709	1,823	1,139	285	1,367	1,082	0	**7,406**
10	1,899	2,025	1,266	316	1,519	1,203	0	**8,228**
11	2,089	2,228	1,392	348	1,671	1,323	0	**9,051**
12	2,279	2,431	1,519	380	1,823	1,443	0	**9,874**
13	2,469	2,633	1,646	411	1,975	1,563	0	**10,697**
14	2,658	2,836	1,772	443	2,127	1,684	0	**11,520**
15	2,848	3,038	1,899	475	2,279	1,804	0	**12,343**
16	3,038	3,241	2,025	506	2,431	1,924	0	**13,165**
17	3,228	3,443	2,152	538	2,582	2,044	0	**13,988**
18	3,418	3,646	2,279	570	2,734	2,165	0	**14,811**
19	3,608	3,848	2,405	601	2,886	2,285	0	**15,634**
20	3,798	4,051	2,532	633	3,038	2,405	0	**16,457**

Table 13. Phosphorus Load Reductions for Cropland BMPs.

Annual Phosphorus Load Reduction (lbs)								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total
1	127	253	158	40	190	150	79	**997**
2	253	506	316	79	380	301	158	**1,994**

Annual Phosphorus Load Reduction (lbs)								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total
3	380	760	475	119	570	451	237	**2,991**
4	506	1,013	633	158	760	601	316	**3,988**
5	633	1,266	791	198	949	752	396	**4,984**
6	760	1,519	949	237	1,139	902	475	**5,981**
7	886	1,772	1,108	277	1,329	1,052	554	**6,978**
8	1,013	2,025	1,266	316	1,519	1,203	633	**7,975**
9	1,139	2,279	1,424	356	1,709	1,353	712	**8,972**
10	1,266	2,532	1,582	396	1,899	1,503	791	**9,969**
11	1,392	2,785	1,741	435	2,089	1,654	870	**10,966**
12	1,519	3,038	1,899	475	2,279	1,804	949	**11,963**
13	1,646	3,291	2,057	514	2,469	1,954	1,029	**12,960**
14	1,772	3,545	2,215	554	2,658	2,105	1,108	**13,957**
15	1,899	3,798	2,374	593	2,848	2,255	1,187	**14,953**
16	2,025	4,051	2,532	633	3,038	2,405	1,266	**15,950**
17	2,152	4,304	2,690	673	3,228	2,556	1,345	**16,947**
18	2,279	4,557	2,848	712	3,418	2,706	1,424	**17,944**
19	2,405	4,810	3,007	752	3,608	2,856	1,503	**18,941**
20	2,532	5,064	3,165	791	3,798	3,007	1,582	**19,938**

Table 14. Phosphorus Load Reductions for Livestock BMPs.

Annual Phosphorous Load Reductions (lbs)								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total
1	638	0	189	315	420	1,400	**2,962**	
2	638	797	378	631	840	2,800	**6,084**	
3	1,276	797	568	946	1,260	4,200	**9,047**	
4	1,276	1,595	757	1,261	1,680	5,600	**12,168**	
5	1,914	1,595	946	1,577	2,100	7,000	**15,131**	
6	1,914	2,392	1,135	1,892	2,520	8,400	**18,253**	
7	2,552	2,392	1,324	2,207	2,940	9,800	**21,215**	
8	2,552	3,189	1,513	2,522	3,360	11,200	**24,337**	
9	3,189	3,189	1,703	2,838	3,780	12,600	**27,299**	
10	3,189	3,987	1,892	3,153	4,200	14,000	**30,421**	
11	3,827	3,987	2,081	3,468	4,620	15,400	**33,383**	
12	3,827	4,784	2,270	3,784	5,040	16,800	**36,505**	
13	4,465	4,784	2,459	4,099	5,460	18,200	**39,468**	
14	4,465	5,581	2,649	4,414	5,880	19,600	**42,589**	
15	5,103	5,581	2,838	4,730	6,300	21,000	**45,552**	
16	5,103	6,379	3,027	5,045	6,720	22,400	**48,674**	
17	5,741	6,379	3,216	5,360	7,140	23,800	**51,636**	
18	5,741	7,176	3,405	5,675	7,560	25,200	**54,758**	

Annual Phosphorous Load Reductions (lbs)								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total
19	6,379	7,176	3,594	5,991	7,980	26,600		**57,720**
20	6,379	7,973	3,784	6,306	8,400	28,000		**60,842**

Table 15. Nitrogen Load Reductions for Cropland BMPs.

Annual Nitrogen Load Reduction (lbs)								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total
1	506	1,620	506	253	1,215	962	709	**5,773**
2	1,013	3,241	1,013	506	2,431	1,924	1,418	**11,545**
3	1,519	4,861	1,519	760	3,646	2,886	2,127	**17,318**
4	2,025	6,481	2,025	1,013	4,861	3,848	2,836	**23,090**
5	2,532	8,102	2,532	1,266	6,076	4,810	3,545	**28,863**
6	3,038	9,722	3,038	1,519	7,292	5,773	4,253	**34,635**
7	3,545	11,342	3,545	1,772	8,507	6,735	4,962	**40,408**
8	4,051	12,963	4,051	2,025	9,722	7,697	5,671	**46,180**
9	4,557	14,583	4,557	2,279	10,937	8,659	6,380	**51,953**
10	5,064	16,204	5,064	2,532	12,153	9,621	7,089	**57,725**
11	5,570	17,824	5,570	2,785	13,368	10,583	7,798	**63,498**
12	6,076	19,444	6,076	3,038	14,583	11,545	8,507	**69,270**
13	6,583	21,065	6,583	3,291	15,798	12,507	9,216	**75,043**
14	7,089	22,685	7,089	3,545	17,014	13,469	9,925	**80,815**
15	7,595	24,305	7,595	3,798	18,229	14,431	10,634	**86,588**
16	8,102	25,926	8,102	4,051	19,444	15,393	11,342	**92,360**
17	8,608	27,546	8,608	4,304	20,659	16,355	12,051	**98,133**
18	9,114	29,166	9,114	4,557	21,875	17,318	12,760	**103,905**
19	9,621	30,787	9,621	4,810	23,090	18,280	13,469	**109,678**
20	10,127	32,407	10,127	5,064	24,305	19,242	14,178	**115,450**

Table 16. Nitrogen Load Reductions for Livestock BMPs.

Annual Nitrogen Load Reductions (lbs)								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total
1	1,201	0	356	594	791	2,637		**5,580**
2	1,201	1,502	713	1,188	1,582	5,274		**11,460**
3	2,403	1,502	1,069	1,782	2,373	7,911		**17,039**
4	2,403	3,004	1,425	2,375	3,164	10,548		**22,919**
5	3,604	3,004	1,782	2,969	3,955	13,185		**28,499**
6	3,604	4,505	2,138	3,563	4,746	15,821		**34,379**

Annual Nitrogen Load Reductions (lbs)							
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total
7	4,806	4,505	2,494	4,157	5,537	18,458	**39,958**
8	4,806	6,007	2,851	4,751	6,329	21,095	**45,838**
9	6,007	6,007	3,207	5,345	7,120	23,732	**51,418**
10	6,007	7,509	3,563	5,939	7,911	26,369	**57,298**
11	7,209	7,509	3,920	6,533	8,702	29,006	**62,877**
12	7,209	9,011	4,276	7,126	9,493	31,643	**68,757**
13	8,410	9,011	4,632	7,720	10,284	34,280	**74,337**
14	8,410	10,513	4,989	8,314	11,075	36,917	**80,217**
15	9,612	10,513	5,345	8,908	11,866	39,554	**85,797**
16	9,612	12,014	5,701	9,502	12,657	42,190	**91,677**
17	10,813	12,014	6,058	10,096	13,448	44,827	**97,256**
18	10,813	13,516	6,414	10,690	14,239	47,464	**103,136**
19	12,014	13,516	6,770	11,284	15,030	50,101	**108,716**
20	12,014	15,018	7,126	11,877	15,821	52,738	**114,596**

Table 17. Sediment Load Reduction by Category.

Sediment		
Year	Cropland Reduction	Total Reduction (tons)
1	823	**823**
2	1,646	**1,646**
3	2,469	**2,469**
4	3,291	**3,291**
5	4,114	**4,114**
6	4,937	**4,937**
7	5,760	**5,760**
8	6,583	**6,583**
9	7,406	**7,406**
10	8,228	**8,228**
11	9,051	**9,051**
12	9,874	**9,874**
13	10,697	**10,697**
14	11,520	**11,520**
15	12,343	**12,343**
16	13,165	**13,165**
17	13,988	**13,988**
18	14,811	**14,811**
19	15,634	**15,634**
20	16,457	**16,457**

Table 18. Phosphorus Load Reduction by Category.

Annual Phosphorous Reduction				
Year	Cropland Reduction	Livestock Reduction	Total Reduction (lbs)	% of TMDL
1	997	2,962	3,959	**16%**
2	1,994	6,084	8,078	**32%**
3	2,991	9,047	12,037	**47%**
4	3,988	12,168	16,156	**63%**
5	4,984	15,131	20,115	**79%**
6	5,981	18,253	24,234	**95%**
7	6,978	21,215	28,193	**111%**
8	7,975	24,337	32,312	**127%**
9	8,972	27,299	36,271	**142%**
10	9,969	30,421	40,390	**159%**
11	10,966	33,383	44,349	**174%**
12	11,963	36,505	48,468	**190%**
13	12,960	39,468	52,427	**206%**
14	13,957	42,589	56,546	**222%**
15	14,953	45,552	60,505	**238%**
16	15,950	48,674	64,624	**254%**
17	16,947	51,636	68,583	**269%**
18	17,944	54,758	72,702	**286%**
19	18,941	57,720	76,661	**301%**
20	19,938	60,842	80,780	**317%**
Phosphorous TMDL:		**25,457**	**Pounds**	

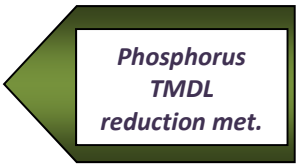


Table 19. Nitrogen Load Reduction by Category.

Annual Nitrogen Reduction				
Year	Cropland Reduction	Livestock Reduction	Total Reduction (lbs)	% of TMDL
1	5,773	5,580	11,352	**5%**
2	11,545	11,460	23,005	**10%**
3	17,318	17,039	34,357	**15%**
4	23,090	22,919	46,009	**20%**
5	28,863	28,499	57,361	**25%**
6	34,635	34,379	69,014	**30%**
7	40,408	39,958	80,366	**35%**
8	46,180	45,838	92,018	**40%**
9	51,953	51,418	103,370	**45%**
10	57,725	57,298	115,023	**50%**
11	63,498	62,877	126,375	**55%**

Annual Nitrogen Reduction				
Year	Cropland Reduction	Livestock Reduction	Total Reduction (lbs)	% of TMDL
12	69,270	68,757	138,027	**61%**
13	75,043	74,337	149,380	**66%**
14	80,815	80,217	161,032	**71%**
15	86,588	85,797	172,384	**76%**
16	92,360	91,677	184,037	**81%**
17	98,133	97,256	195,389	**86%**
18	103,905	103,136	207,041	**91%**
19	109,678	108,716	218,393	**96%**
20	115,450	114,596	230,046	**101%**
Phosphorous TMDL:		**228,016**	**Pounds**	

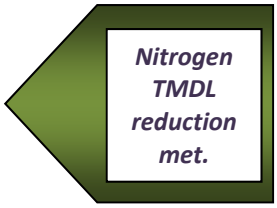


Table 20. Phosphorus Load Reduction by BMP Category.

Hillsdale Reservoir Phosphorus TMDL		
Best Management Practice Category	Total Load Reduction (lbs)	% of Phosphorous TMDL
Livestock	60,842	**239%**
Cropland	19,938	**78%**
Total	**80,780**	**317%**

Table 21. Nitrogen Load Reduction by BMP Category.

Hillsdale Reservoir Phosphorus TMDL		
Best Management Practice Category	Total Load Reduction (lbs)	% of Nitrogen TMDL
Livestock	114,596	**50%**
Cropland	115,450	**51%**
Total	**230,046**	**101%**

7. Information and Education

A. Information and Education (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 activities are categorized according to BMP implementation activities.

Table 22. Annual I&E Activities and Cost Estimates.

Target Audience	Information/Education Activity/Event	Technical Assistance Services	Timeframe and Estimates Cost	Responsible Organization
Suburban and rural homeowners/ "hobby farmers" Horse owners	Tour/field day combined with workshop and/or demonstration project (1/year) to promote proper land management of horses	One-on-one technical assistance for suburban and rural landowners to identify and implement land management practices for horses	$5,000/year for combined tour/workshop/demonstration project No additional cost for technical assistance provided by K-State Watershed Specialist	K-State Research and Extension (including county Extension offices) Johnson and Miami County Conservation Districts
Urban/suburban homeowners and landowners General public Educators	Stream Monitoring Program (spring/fall) Summer Teacher Institute (1/yr) Educational display/booth at county fairs (2/year) Newsletter for watershed residents (2/year) Articles in local newspapers, press releases, articles in conservation district and Extension newsletters		On-going / Seasonal $15,000 for Stream Team $10,000 for Teacher Institute $5,000 for educational displays $4,000 for newsletters No cost for articles and press releases	K-State Research and Extension (including county Extension offices) Johnson and Miami County Conservation Districts
Project Management				
Technical assistance, project management and coordination, provided by Project Coordinator		Annual Salary	$30,000	Miami County Conservation District

1. Evaluation of I&E Activities

All service providers conducting I&E activities funded through the Hillsdale 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. Costs of Implementing BMPs and Possible Funding Sources

The SLT has reviewed all the recommended BMPs for cropland, livestock areas and streambank restoration. It has been determined by the SLT that specific BMPs will be the target of implementation funding for each category. Most of the BMPs that are targeted will be advantageous to more than one impairment, thus being more efficient.

The following BMP cost-share rates are based on 70% of the County Average Cost, derived by local Conservation Districts. The exceptions are the no-till incentive payments and the cover crop incentive payments, which are based on approximately 70% of NRCS Environmental Quality Incentives Program (EQIP) rates.

Table 23. Cost Estimates used to Determine BMP Cost Estimations. [xx]

Livestock Practices	Measurement	Cost	Cost Share
Fencing (5-Wire)	Linear Foot	$2.38	Yes
Fencing (Perm. Power)	Linear Foot	$1.17	Yes
Pipeline	Linear Foot	$1.47	Yes
Watering Facility	One Unit	$840.00	Yes
Forage Planting	Acre	$70.00	Yes
Filter Strip	Acre	$171.00	Yes
Pumping Plant (Solar)	One Unit	$2000.00	Yes
Cropping Practices			
Grass Waterway (Shaping)	Acre	$1330.00	Yes
Grass Waterway (Topsoiling)	Acre	$455.00	Yes
Grass Waterway (Critical Area Planting)	Acre	$171.00	Yes
No-Till Incentive Payment	Acre	$15.00	No - Up to 3 Years (Depending on $$$)
Cover Crop (Single)	Acre	$30.00	No - Up to 3 Years (Depending on $$$)
Cover Crop (Multi)	Acre	$40.00	No - Up to 3 Years (Depending on $$$)
Subsurface N and P Application	Acre	$12.00	No - Up to 3 Years
Permanent Vegetation (Native Grass/Forbs)	Acre	$161.00	Yes

Table 24. Cost Before Cost-Share for Cropland BMPs.

Total Annual Cost Before Cost-Share, Cropland BMPs								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Cost
1	$1,899	$49,370	$8,861	$3,589	$25,824	$10,190	$760	**$100,494**
2	$1,956	$50,851	$9,127	$3,697	$26,599	$10,496	$782	**$103,509**
3	$2,014	$52,377	$9,401	$3,808	$27,397	$10,811	$806	**$106,614**
4	$2,075	$53,948	$9,683	$3,922	$28,219	$11,135	$830	**$109,813**
5	$2,137	$55,566	$9,973	$4,040	$29,066	$11,469	$855	**$113,107**
6	$2,201	$57,233	$10,273	$4,161	$29,938	$11,814	$881	**$116,500**
7	$2,267	$58,950	$10,581	$4,286	$30,836	$12,168	$907	**$119,995**
8	$2,335	$60,719	$10,898	$4,415	$31,761	$12,533	$934	**$123,595**
9	$2,405	$62,541	$11,225	$4,547	$32,714	$12,909	$962	**$127,303**
10	$2,478	$64,417	$11,562	$4,683	$33,695	$13,296	$991	**$131,122**
11	$2,552	$66,349	$11,909	$4,824	$34,706	$13,695	$1,021	**$135,056**
12	$2,628	$68,340	$12,266	$4,969	$35,747	$14,106	$1,051	**$139,107**
13	$2,707	$70,390	$12,634	$5,118	$36,819	$14,529	$1,083	**$143,281**
14	$2,789	$72,502	$13,013	$5,271	$37,924	$14,965	$1,115	**$147,579**
15	$2,872	$74,677	$13,404	$5,429	$39,062	$15,414	$1,149	**$152,006**
16	$2,958	$76,917	$13,806	$5,592	$40,234	$15,876	$1,183	**$156,567**
17	$3,047	$79,225	$14,220	$5,760	$41,441	$16,353	$1,219	**$161,264**
18	$3,139	$81,601	$14,646	$5,933	$42,684	$16,843	$1,255	**$166,101**
19	$3,233	$84,049	$15,086	$6,111	$43,964	$17,349	$1,293	**$171,084**
20	$3,330	$86,571	$15,538	$6,294	$45,283	$17,869	$1,332	**$176,217**

Table 25. Cost After Cost-Share for Cropland BMPs.

Total Annual Cost After Cost-Share, Cropland BMPs								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Cost
1	$1,899	$24,685	$886	$1,795	$12,912	$5,095	$760	**$48,032**
2	$1,956	$25,426	$913	$1,849	$13,300	$5,248	$782	**$49,473**
3	$2,014	$26,188	$940	$1,904	$13,699	$5,406	$806	**$50,957**
4	$2,075	$26,974	$968	$1,961	$14,109	$5,568	$830	**$52,486**
5	$2,137	$27,783	$997	$2,020	$14,533	$5,735	$855	**$54,060**
6	$2,201	$28,617	$1,027	$2,081	$14,969	$5,907	$881	**$55,682**
7	$2,267	$29,475	$1,058	$2,143	$15,418	$6,084	$907	**$57,352**
8	$2,335	$30,359	$1,090	$2,207	$15,880	$6,267	$934	**$59,073**
9	$2,405	$31,270	$1,123	$2,274	$16,357	$6,455	$962	**$60,845**
10	$2,478	$32,208	$1,156	$2,342	$16,847	$6,648	$991	**$62,671**
11	$2,552	$33,175	$1,191	$2,412	$17,353	$6,848	$1,021	**$64,551**

Total Annual Cost After Cost-Share, Cropland BMPs								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Cost
12	$2,628	$34,170	$1,227	$2,484	$17,873	$7,053	$1,051	**$66,487**
13	$2,707	$35,195	$1,263	$2,559	$18,410	$7,265	$1,083	**$68,482**
14	$2,789	$36,251	$1,301	$2,636	$18,962	$7,483	$1,115	**$70,536**
15	$2,872	$37,338	$1,340	$2,715	$19,531	$7,707	$1,149	**$72,652**
16	$2,958	$38,459	$1,381	$2,796	$20,117	$7,938	$1,183	**$74,832**
17	$3,047	$39,612	$1,422	$2,880	$20,720	$8,176	$1,219	**$77,077**
18	$3,139	$40,801	$1,465	$2,966	$21,342	$8,422	$1,255	**$79,389**
19	$3,233	$42,025	$1,509	$3,055	$21,982	$8,674	$1,293	**$81,771**
20	$3,330	$43,285	$1,554	$3,147	$22,642	$8,935	$1,332	**$84,224**

Table 26. Cost Before Cost-Share for Livestock BMPs.

Annual Cost*Before Cost-Share of Implementing Livestock BMPs								
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Cost
1	$171	$0	$6,609	$15,615	$21,000	$8,000	**$51,395**	
2	$0	$6,820	$6,807	$16,083	$21,630	$8,240	**$59,580**	
3	$181	$0	$7,011	$16,566	$22,279	$8,487	**$54,525**	
4	$0	$7,235	$7,222	$17,063	$22,947	$8,742	**$63,209**	
5	$192	$0	$7,438	$17,575	$23,636	$9,004	**$57,846**	
6	$0	$7,676	$7,662	$18,102	$24,345	$9,274	**$67,058**	
7	$204	$0	$7,891	$18,645	$25,075	$9,552	**$61,368**	
8	$0	$8,143	$8,128	$19,204	$25,827	$9,839	**$71,142**	
9	$217	$0	$8,372	$19,781	$26,602	$10,134	**$65,106**	
10	$0	$8,639	$8,623	$20,374	$27,400	$10,438	**$75,475**	
11	$230	$0	$8,882	$20,985	$28,222	$10,751	**$69,071**	
12	$0	$9,165	$9,148	$21,615	$29,069	$11,074	**$80,071**	
13	$244	$0	$9,423	$22,263	$29,941	$11,406	**$73,277**	
14	$0	$9,723	$9,706	$22,931	$30,839	$11,748	**$84,947**	
15	$259	$0	$9,997	$23,619	$31,764	$12,101	**$77,740**	
16	$0	$10,315	$10,297	$24,328	$32,717	$12,464	**$90,121**	
17	$274	$0	$10,606	$25,057	$33,699	$12,838	**$82,474**	
18	$0	$10,944	$10,924	$25,809	$34,710	$13,223	**$95,609**	
19	$291	$0	$11,251	$26,583	$35,751	$13,619	**$87,497**	
20	$0	$11,610	$11,589	$27,381	$36,824	$14,028	**$101,432**	
3% Annual Cost Inflation								

Table 27. Costs After Cost-Share for Livestock BMPs.

Annual Cost* After Cost-Share of Implementing Livestock BMPs							
Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Cost
1	$86	$0	$3,305	$7,808	$10,500	$4,000	**$25,698**
2	$0	$3,410	$3,404	$8,042	$10,815	$4,120	**$29,790**
3	$91	$0	$3,506	$8,283	$11,139	$4,244	**$27,262**
4	$0	$3,617	$3,611	$8,531	$11,474	$4,371	**$31,604**
5	$96	$0	$3,719	$8,787	$11,818	$4,502	**$28,923**
6	$0	$3,838	$3,831	$9,051	$12,172	$4,637	**$33,529**
7	$102	$0	$3,946	$9,323	$12,538	$4,776	**$30,684**
8	$0	$4,071	$4,064	$9,602	$12,914	$4,919	**$35,571**
9	$108	$0	$4,186	$9,890	$13,301	$5,067	**$32,553**
10	$0	$4,319	$4,312	$10,187	$13,700	$5,219	**$37,737**
11	$115	$0	$4,441	$10,493	$14,111	$5,376	**$34,535**
12	$0	$4,583	$4,574	$10,807	$14,534	$5,537	**$40,036**
13	$122	$0	$4,711	$11,132	$14,970	$5,703	**$36,638**
14	$0	$4,862	$4,853	$11,466	$15,420	$5,874	**$42,474**
15	$129	$0	$4,998	$11,810	$15,882	$6,050	**$38,870**
16	$0	$5,158	$5,148	$12,164	$16,359	$6,232	**$45,060**
17	$137	$0	$5,303	$12,529	$16,849	$6,419	**$41,237**
18	$0	$5,472	$5,462	$12,905	$17,355	$6,611	**$47,804**
19	$146	$0	$5,626	$13,292	$17,876	$6,810	**$43,748**
20	$0	$5,805	$5,794	$13,690	$18,412	$7,014	**$50,716**
3% Annual Cost Inflation							

Table 28. Costs After Cost-Share for All BMPs.

Total Annual WRAPS Cost after Cost-Share by BMP Category			
Year	Cropland	Livestock	Total Annual Cost
1	$48,032	$27,649	**$75,681**
2	$49,473	$31,521	**$80,993**
3	$50,957	$29,333	**$80,290**
4	$52,486	$33,440	**$85,926**
5	$54,060	$31,119	**$85,179**
6	$55,682	$35,477	**$91,159**
7	$57,352	$33,014	**$90,367**
8	$59,073	$37,637	**$96,710**
9	$60,845	$35,025	**$95,870**
10	$62,671	$39,929	**$102,600**
11	$64,551	$37,158	**$101,709**
12	$66,487	$42,361	**$108,848**
13	$68,482	$39,421	**$107,903**

Total Annual WRAPS Cost after Cost-Share by BMP Category			
Year	**Cropland**	**Livestock**	**Total Annual Cost**
14	$70,536	$44,941	**$115,477**
15	$72,652	$41,822	**$114,474**
16	$74,832	$47,678	**$122,510**
17	$77,077	$44,369	**$121,445**
18	$79,389	$50,581	**$129,970**
19	$81,771	$47,071	**$128,841**
20	$84,224	$53,662	**$137,886**

Table 29. Costs After Cost-Share by Category.

Total Annual WRAPS Cost* after Cost-Share by Category					
Year	**Cropland**	**Livestock**	**Technical Assistance**	**Information and Education**	**Total Annual Cost**
1	$48,032	$27,649	$30,000	$39,000	**$144,681**
2	$49,473	$31,521	$30,900	$40,170	**$152,063**
3	$50,957	$29,333	$31,827	$41,375	**$153,492**
4	$52,486	$33,440	$32,782	$42,616	**$161,324**
5	$54,060	$31,119	$33,765	$43,895	**$162,839**
6	$55,682	$35,477	$34,778	$45,212	**$171,149**
7	$57,352	$33,014	$35,822	$46,568	**$172,756**
8	$59,073	$37,637	$36,896	$47,965	**$181,571**
9	$60,845	$35,025	$38,003	$49,404	**$183,277**
10	$62,671	$39,929	$39,143	$50,886	**$192,629**
11	$64,551	$37,158	$40,317	$52,413	**$194,439**
12	$66,487	$42,361	$41,527	$53,985	**$204,360**
13	$68,482	$39,421	$42,773	$55,605	**$206,280**
14	$70,536	$44,941	$44,056	$57,273	**$216,806**
15	$72,652	$41,822	$45,378	$58,991	**$218,843**
16	$74,832	$47,678	$46,739	$60,761	**$230,009**
17	$77,077	$44,369	$48,141	$62,584	**$232,170**
18	$79,389	$50,581	$49,585	$64,461	**$244,017**
19	$81,771	$47,071	$51,073	$66,395	**$246,309**
20	$84,224	$53,662	$52,605	$68,387	**$258,878**
***3% Annual Inflation**					

Table 30. 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
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	
Hillsdale Area Water Cooperative	Water User Fees

Table 31. 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	KSRE NRCS KDA/DOC KFS KSRE CD 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	
	Subsurface Fertilizer Application	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 KDA/DOC KAWS CD KDWP
	2. Relocate feeding pens	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. 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	
	6. Grazing Management Plans	Design, cost share and maintenance	BMP workshops, field days, tours	

** 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.*

A. Timeframe

The plan will be reviewed every five years starting in 2017. This plan has undergone its first revision. The eutrophication TMDL was revised by KDHE in 2014 to include nitrogen and updated phosphorus goals. The timeframe of this document for BMP implementation to meet the phosphorus TMDL would be 20 years from the original date of publication (2012) of this report. Possible trends can be reviewed in 2022 for

phosphorus reductions in the water column, but due to a lag time from implementation of BMPs the resulting improvements in water quality, they might not be noticeable. The SLT will examine BMP placement and implementation every subsequent five years after.

Table 32. Review Schedule for Pollutants and BMP Implementation

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

The timeframe for all BMP implementation would be 20 years from the original date of publication of this report. Targeting and BMP implementation might shift over time in order to achieve TMDLs.

- The WRAPS estimate timeframe for reaching the **nitrogen portion of the eutrophication TMDL in Hillsdale Lake** will be in year 20 of the plan.
- The WRAPS estimate timeframe for reaching the **phosphorus portion of the eutrophication TMDL in Hillsdale Lake** will be year 7 of the plan. After the phosphorus TMDL is achieved, the process will become one of protection instead of restoration.
- Prevention of sedimentation in Hillsdale Lake is a protection goal instead of a restoration goal. However, progress on sediment control will be monitored.

9. Measureable Milestones

A. 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 33. Short, Medium and Long Term Goals for BMP Cropland Adoption Rates.

BMP Implementation Milestones, Cropland BMPs									
	Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Adoption
Short Term	1	127	253	127	63	253	63	63	949
	2	127	253	127	63	253	63	63	949
	3	127	253	127	63	253	63	63	949
	4	127	253	127	63	253	63	63	949
	5	127	253	127	63	253	63	63	949
Total		*633*	*1,266*	*633*	*316*	*1,266*	*316*	*316*	*4,747*
Medium Term	6	127	253	127	63	253	63	63	949
	7	127	253	127	63	253	63	63	949
	8	127	253	127	63	253	63	63	949
	9	127	253	127	63	253	63	63	949
	10	127	253	127	63	253	63	63	949
Total		*1,266*	*2,532*	*1,266*	*633*	*2,532*	*633*	*633*	*9,494*
Long Term	11	127	253	127	63	253	63	63	949
	12	127	253	127	63	253	63	63	949
	13	127	253	127	63	253	63	63	949
	14	127	253	127	63	253	63	63	949
	15	127	253	127	63	253	63	63	949
	16	127	253	127	63	253	63	63	949
	17	127	253	127	63	253	63	63	949
	18	127	253	127	63	253	63	63	949
	19	127	253	127	63	253	63	63	949
	20	127	253	127	63	253	63	63	949
Total		*2,532*	*5,064*	*2,532*	*1,266*	*5,064*	*1,266*	*1,266*	*18,989*

Table 34. 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	Grazing Management Plan
Short-Term	1	1	0	3	5	3	5
	2	0	1	3	5	3	5
	3	1	0	3	5	3	5
	4	0	1	3	5	3	5
	5	1	0	3	5	3	5
	Total	3	2	15	25	15	25
Medium-Term	6	0	1	3	5	3	5
	7	1	0	3	5	3	5
	8	0	1	3	5	3	5
	9	1	0	3	5	3	5
	10	0	1	3	5	3	5
	Total	5	5	30	50	30	50
Long-Term	11	1	0	3	5	3	5
	12	0	1	3	5	3	5
	13	1	0	3	5	3	5
	14	0	1	3	5	3	5
	15	1	0	3	5	3	5
	16	0	1	3	5	3	5
	17	1	0	3	5	3	5
	18	0	1	3	5	3	5
	19	1	0	3	5	3	5
	20	0	1	3	5	3	5
	Total	10	10	60	100	60	100

10. Water Quality Milestones Used to Determine Improvements [xxi]

The goal of the Hillsdale Lake WRAPS plan is to restore water quality for uses supportive of aquatic life, domestic water supply, irrigation, livestock watering, and recreation for Hillsdale Lake. The plan specifically addresses the high priority eutrophication TMDL for the lake. In order to reach the load reduction goals associated with this impairment, a BMP implementation schedule spanning 20 years has been developed.

A. Water Quality Milestones to Determine Improvements

The goal of the Hillsdale WRAPS plan is to restore water quality for uses supportive of aquatic life, industrial water supply, and recreation for Hillsdale Lake. The plan specifically addresses the high priority eutrophication TMDL for Hillsdale Lake. In order to reach the load reduction goals associated with the Hillsdale Lake impairment, an implementation schedule for conservation practices spanning 20 years has been developed.

The selected practices included in the plan will be implemented throughout the targeted areas within the Hillsdale Lake watershed. Water quality milestones have been developed for Hillsdale Lake, along with additional indicators of water quality. The purpose of the milestones and indicators is to measure water quality improvements associated with the implementation schedule contained in this plan.

B. Water Quality Milestones for Hillsdale Lake

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 impairment being addressed in the Hillsdale Lake watershed. The table below includes 10-year water quality goals, as well as long term water quality goals for various parameters monitored in Hillsdale Lake.

Table 35. Water Quality Milestones for Hillsdale Lake.

Water Quality Milestones for Hillsdale Lake								
	Current Condition* (1990 - 2011) Median TP	10-Year Goal		Long Term Goal		Current Condition** (1990 - 2011) Secchi (Avg)	10-Year Goal	Long Term Goal
		Improved Condition (2012 - 2022) Median TP	Total Reduction Needed	Improved Condition Median TP	Total Reduction Needed		Improved Condition (2012 - 2022) Secchi (Avg)	Improved Condition Secchi (Avg)

Sampling Site	Total Phosphorus (median of data collected at lake surface during indicated period), ppb					Secchi (average of data collected during indicated period), m		
Hillsdale Lake LM035001	37	32	14%	21.8	41%	1.33	Secchi depth >1.5	Maintain Average Secchi depth > 1.5

	Current Condition* (1990 - 2011) Chlorophyll a	10-Year Goal		Long Term Goal	Current Condition* (1990 - 2011) % Samples DO > 5 ppm	10-Year Goal	Long Term Goal
		Improved Condition (2012 - 2022) Chlorophyll a	Total Reduction Needed	Improved Condition Chlorophyll a		Improved Condition	Improved Condition
Sampling Site	Chlorophyll a (average of data collected at lake surface during indicated period), ppb				% Samples with DO > 5 ppm (data collected during indicated period at depth < 3 m), ppm		
Hillsdale Lake LM035001	15.7	12	24%	Maintain Average Chlorophyll a < 10	100	Maintain DO > 5 ppm all samples at Depth < 3 m	

	Current Condition* (1990-2011) Median TN	10-Year Goal		Long Term Goal	
		Improved Condition (2012 - 2022) Median TN	Total Reduction Needed	Improved Condition Median TN	Total Reduction Needed
Sampling Site	Total Nitrogen (median of data collected at lake surface during indicated period), ppb				
Hillsdale Lake LM035001	690	550	20%	489	41%

**The current conditions for Total Phosphorus, Chlorophyll a and Dissolved Oxygen (DO) were calculated utilizing sampling data taken at the lake surface (depths less than 3 m) from the KDHE lake monitoring station at Hillsdale Lake from 1990 to 2011.*

***The current condition for Secchi depth was calculated utilizing all sampling data taken from the KDHE lake monitoring station at Hillsdale Lake from 1990 to 2011.*

Table 36. Water Quality Goals for Individual Tributaries.

Tributary	10-Year Goal		Long Term Goal	
	TP (µg/L)	TN (µg/L)	TP (µg/L)	TN (µg/L)
Rock Creek	35	300	21	160
Bull Creek	120	1000	71	557
Little Bull Creek	70	700	39	400

C. 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 Hillsdale Lake
- Visitor traffic to Hillsdale Lake
- Boating traffic in Hillsdale Lake
- Trends of quantity and quality of fishing in Hillsdale Lake
- Beach closings

11. Monitoring Water Quality Progress

KDHE continues to monitor water quality in the Hillsdale Lake watershed by maintaining the monitoring station located at Hillsdale Lake. The map below indicates the location of the KDHE lake monitoring sites.

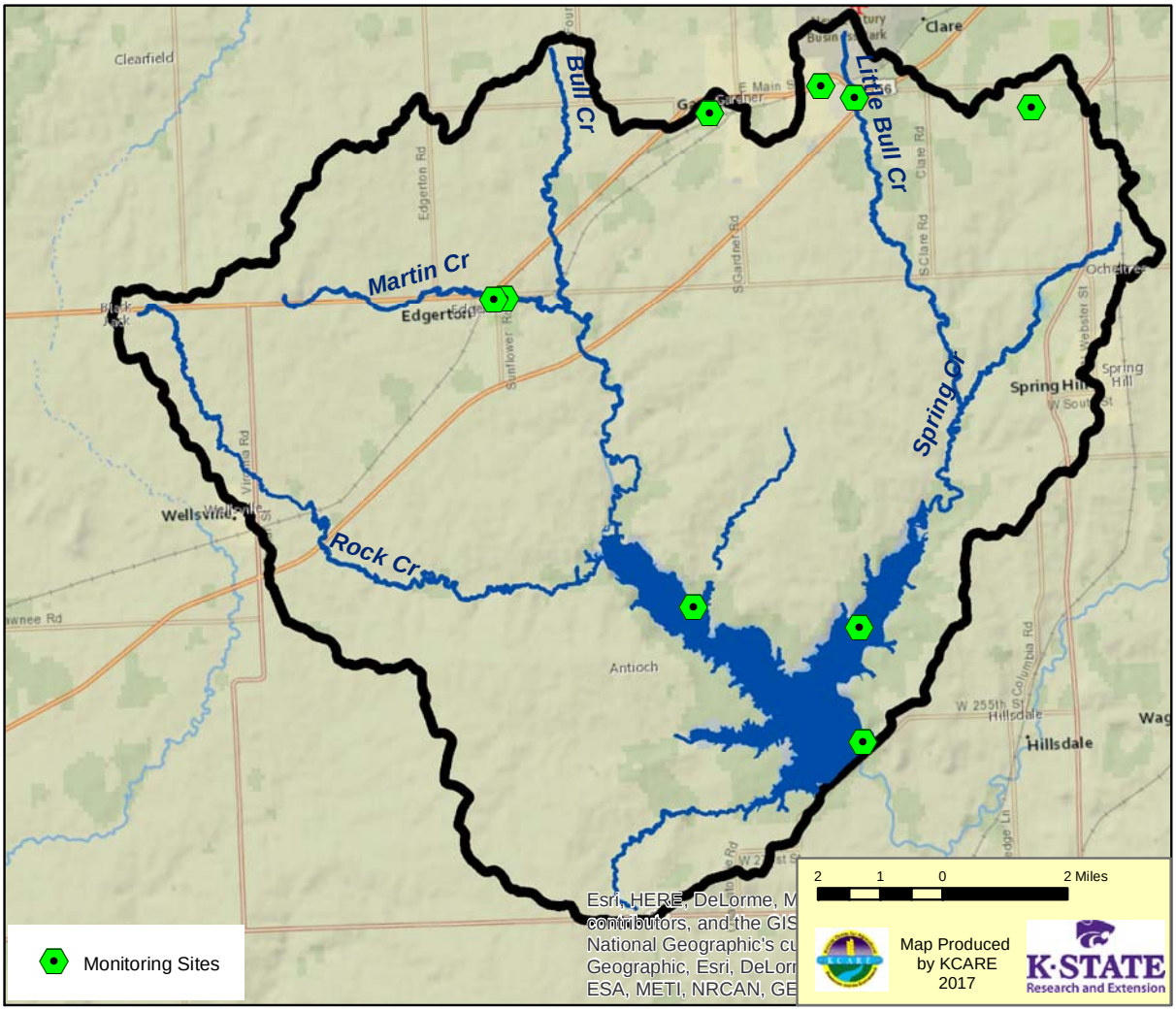


Figure 21. Monitoring Sites in Hillsdale Watershed.

Existing monitoring currently ongoing or scheduled to occur in the near future make it possible to evaluate the effectiveness of the Hillsdale WRAPS without the need for any additional large-scale monitoring efforts conducted by Project. Existing monitoring networks that the Project will collect data from to evaluate the effectiveness of implementation include the following:

- KDHE:
  - KDHE conducts one-time sampling within Hillsdale Lake every three years, typically between April and October
  - Data that will be evaluated from KDHE in-lake sampling include:
    - Chlorophyll “a”
    - Total Nitrogen (TN)

        - Total Phosphorus (TP)
        - E. coli bacteria
        - Chemicals
        - Total Suspended Solids (TSS)
        - Turbidity
        - Dissolved Oxygen (DO)
        - Alkalinity
        - pH
        - Ammonia
        - Metals
        - Secchi Disk Depth
- U.S. Army Corps of Engineers:
    - U.S. Army Corps of Engineers conducts monthly (April-October) sampling within Hillsdale Lake every year.
    - Data that will be evaluated from KDHE in-lake sampling include:
        - Chlorophyll “a”
        - Total Nitrogen (TN)
        - Total Phosphorus (TP)
        - Total Suspended Solids (TSS)
        - Turbidity
        - Dissolved Oxygen (DO)
        - Secchi Disk Depths
- Johnson County Stormwater Management Program:
    - Johnson County Stormwater Management Program conducts event-driven stormwater sampling at various locations around the county.
    - Data will be evaluated to demonstrate the effects of urbanization within southern Johnson County on Big Bull and Little Bull Creeks subwatersheds.
    - Data that will be evaluated from stormwater sampling include:
        - Total Nitrogen (TN)
        - Total Phosphorus (TP)
        - Total Suspended Solids (TSS)
- Kansas Water Office (KWO) / Kansas Biological Survey (KBS):
    - KWO and KBS have collaborated on bathymetric survey of Hillsdale Lake
    - New bathymetric survey in 2020 compared to previous survey to show changes in sediment deposition within Hillsdale Lake.
- U.S. Geological Survey (USGS):
    - Hillsdale Lake sediment cores
        - Cores collected previously during 1990s.
        - New sediment core collection in 2020 compared to previous survey to show changes in sediment deposition and chemistry of sediment within Hillsdale Lake.

A. Evaluation of Monitoring Data

Monitoring data in the Hillsdale Lake 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, as well as the frequency of the sampling data.

The implementation schedule and water quality milestones for the Hillsdale Lake watershed extend through a 20-year period. Throughout that period, KDHE will continue to analyze and evaluate the monitoring data collected. After the first ten years of monitoring and implementation of conservation practices, KDHE will evaluate the available water quality data to determine whether the water quality milestones have been achieved. If milestones are not achieved, KDHE will assist the Hillsdale Lake WRAPS group to analyze and understand the context for non-achievement, as well as

the need to review and/or revise the water quality milestones included in the plan. KDHE 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.

In the future, KDHE will be requested to add three additional monitoring sites. These would be at the entrance to the lake from Bull Creek, Little Bull Creek and Rock Creek. This would provide information concerning each of the subwatersheds in addition to pre-entry water quality in the lake to be compared to exiting water quality from the lake.

The monitoring program must also have a variety of elements to ensure a full range of scientific data to best provide quality and quantifiable data to determine the impact, positive or not, of BMPs and educational activities on water quality.

B. Monitoring Indicators

Various environmental indicators will be recorded and evaluated by HWQP staff to demonstrate improvements in water quality conditions within Hillsdale Lake over the duration of the Hillsdale Watershed WRAPS. Indicators that will be evaluated include the following:

- Summer secchi disk depth measurements
  - Big Bull Arm – Hillsdale Lake
  - Little Bull Arm – Hillsdale Lake
  - Main body – Hillsdale Lake
    - Publicize and solicit collection of secchi disk depth measurements to provide opportunity for public involvement
      - Include yearly data in Hillsdale newsletter
- Reported algal blooms or vegetated mats
  - Hillsdale Lake
- Reported submerged or emerged floating vegetation in public use areas
  - Hillsdale Lake
- Reported taste and odor complaints from public regarding drinking water:
  - City of Gardner, KS
  - City of Spring Hill, KS
  - City of Edgerton, KS
  - Johnson County RWD #7
  - Franklin County RWD #1
  - Miami County RWD #1
  - Miami County RWD #2
  - Miami County RWD #3

Secchi disk depth measurements will be evaluated by monitoring trends in water clarity conditions within Hillsdale Lake. Improvements in water clarity illustrate decreases in

nutrient and sediment loads reaching Hillsdale Lake. Effective implementation of the Hillsdale WRAPS should produce increased Secchi disk depth measurements.

Unchanged or diminished Secchi disk depth observations from 2017-2022 will trigger re-evaluation of implementation efforts as outlined in the Hillsdale WRAPS, as well as subsequent monitoring efforts in the watershed.

Monitoring of reported conditions within Hillsdale Lake as well as the public water supplies that utilize the lake as a drinking water source is another method that will be utilized to evaluate progress of the Hillsdale WRAPS.

Reported algal blooms, vegetated mats, submerged and/or emerged floating vegetation within public use areas of Hillsdale Lake, as well as reported taste and odor complaints from the water sources previously listed are all examples of indirect environmental indicators that can be evaluated over time.

Effective implementation of the Hillsdale WRAPS should reduce the frequency of these indirect environmental indicators. Increases in the reported frequency of these indicators from 2017-2022 will trigger re-evaluation of implementation efforts as outline in the Hillsdale WRAPS.

12. Review of the Watershed Plan in 2022

This plan began in 2012. In the year 2017, the plan was reviewed and revised. Due to changes in the Eutrophication TMDL, BMP adoptions, load reductions and costs were altered in the original plan. In the year 2022, 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 request from KDHE a report on the milestone achievements in phosphorus load reductions. The 2022 milestone for phosphorus should be based on available data at the time in the trend of the phosphorus concentration in Hillsdale Lake.
2. The SLT will ask KDHE for a report on the milestone achievements in sediment load reductions. The 2022 milestone for sediment should be based on the available data at the time in the trend of total suspended solids concentration in Hillsdale Lake.
3. The SLT will request a report from KDHE concerning the revisions of the TMDLs from 2014.
4. The SLT will request a report from KDHE and the US Army Corps of Engineers on trends in water quality in Hillsdale Lake.
5. The SLT will report on progress towards achieving the adoption rates listed in this report.
6. The SLT will report on progress towards achieving the benchmarks listed in this report.
7. The SLT will report on progress towards achieving the milestones listed in this report.
8. The SLT will discuss impairments on the 303d list and the possibility of addressing these impairments prior to them being listed as TMDLs.
9. The SLT will discuss the effect of implementing BMPs aimed at specific impairments listed on the 303d list.
10. The SLT will discuss necessary adjustments and revisions needed in the targets listed in this plan.

13. Appendix

A. Service Providers

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			

F.I.S.H. Program	Landowners receive a payment incentive to allow public hunting on their property.	
	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	Provide programs, expertise and educational materials that relate to minimizing the impact of rural and urban	Technical	www.kcare.ksu.edu

Environment (KCARE)	activities on water quality.	www.ksu.edu/kelp
Kansas Environmental Leadership Program (KELP)	Educational program to develop leadership for improved water quality.	www.ksu.edu/olg
Kansas Local Government Water Quality Planning and Management	Provide guidance to local governments on water protection programs.	www.k-state.edu/waterlink/ www.kansasprideprogram.ksu.edu/healthyecosystems/
Rangeland and Natural Area Services (RNAS)	Reduce non-point source pollution emanating from Kansas grasslands.	www.ksu.edu/kswater/
Kansas Pride: Healthy Ecosystems/Healthy Communities	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.	

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

B. BMP Definitions

(Reduction explanations are provided in Section 7)

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.
-The Hillsdale WRAPS group cost share is $15 an acre and NRCS cost share is $12.52 per acre, 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.
-Hillsdale WRAPS cost share is $1330 per acre for shaping, $455 per acre for topsoiling and $171 critical area seeding, 50% cost-share available from NRCS.

Vegetative Buffer Strips:
-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
-Hillsdale WRAPS cost share is $171 per acre, 90% cost-share available from NRCS.

Nutrient Management Plans:
-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.
-To preserve the lifetime of this very expensive structural practice, only farms in continuous no-till systems are eligible for terrace financial assistance through the WRAPS
-30% Erosion Reduction Efficiency, 30% phosphorous reduction efficiency
-$1.00 per linear foot with higher rates available through other state and federal programs, 50% cost-share available from NRCS

Establish Permanent Vegetation:
Hillsdale WRAPS cost share is $161 per acre, but may vary with species selection.

Subsurface Fertilizer Application:
-Placing or injecting fertilizer beneath the soil surface.
-Reduces fertilizer runoff.
-0% soil and 50% P reduction efficiency.
-$3.50 an acre for 10 years, no cost-share.
-Hillsdale WRAPS cost share is $12 per acre and must be done with subsurface nitrogen application.

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%.
-$171 per 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 Pasture 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.

Grazing Management Plans:
Grazing management plan to avoid over grazing of pastures and improved grazing distribution..
-Average P reduction: 25-30%
-$1,600 average cost

C. Sub Watershed Tables

Table 37. Phosphorus Reductions by Subwatershed.

Stream Buffer and Big Bull Upland Annual Phosphorus Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	73	146	91	23	110	87	46	575
2	146	292	183	46	219	173	91	1,151
3	219	438	274	68	329	260	137	1,726
4	292	584	365	91	438	347	183	2,301
5	365	731	457	114	548	434	228	2,876
6	438	877	548	137	657	520	274	3,452
7	511	1,023	639	160	767	607	320	4,027
8	584	1,169	731	183	877	694	365	4,602
9	657	1,315	822	205	986	781	411	5,177
10	731	1,461	913	228	1,096	867	457	5,753
11	804	1,607	1,004	251	1,205	954	502	6,328
12	877	1,753	1,096	274	1,315	1,041	548	6,903
13	950	1,899	1,187	297	1,424	1,128	594	7,478
14	1,023	2,045	1,278	320	1,534	1,214	639	8,054
15	1,096	2,192	1,370	342	1,644	1,301	685	8,629
16	1,169	2,338	1,461	365	1,753	1,388	731	9,204
17	1,242	2,484	1,552	388	1,863	1,475	776	9,780
18	1,315	2,630	1,644	411	1,972	1,561	822	10,355
19	1,388	2,776	1,735	434	2,082	1,648	867	10,930
20	1,461	2,922	1,826	457	2,192	1,735	913	11,505

Remainder of Big Bull and Rock Creek Watersheds Annual Phosphorus Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	38	76	48	12	57	45	24	300
2	76	152	95	24	114	90	48	600
3	114	228	143	36	171	136	71	899
4	152	305	190	48	228	181	95	1,199
5	190	381	238	59	285	226	119	1,499
6	228	457	285	71	343	271	143	1,799
7	266	533	333	83	400	316	167	2,098

8	305	609	381	95	457	362	190	2,398
9	343	685	428	107	514	407	214	2,698
10	381	761	476	119	571	452	238	2,998
11	419	837	523	131	628	497	262	3,297
12	457	914	571	143	685	542	285	3,597
13	495	990	619	155	742	588	309	3,897
14	533	1,066	666	167	799	633	333	4,197
15	571	1,142	714	178	856	678	357	4,496
16	609	1,218	761	190	914	723	381	4,796
17	647	1,294	809	202	971	768	404	5,096
18	685	1,370	856	214	1,028	814	428	5,396
19	723	1,446	904	226	1,085	859	452	5,695
20	761	1,523	952	238	1,142	904	476	5,995

Remainder of Little Bull Watershed Annual Phosphorus Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	15	31	19	5	23	18	10	122
2	31	62	39	10	46	37	19	244
3	46	93	58	15	70	55	29	366
4	62	124	77	19	93	74	39	487
5	77	155	97	24	116	92	48	609
6	93	186	116	29	139	110	58	731
7	108	217	135	34	162	129	68	853
8	124	248	155	39	186	147	77	975
9	139	279	174	44	209	165	87	1,097
10	155	310	193	48	232	184	97	1,219
11	170	340	213	53	255	202	106	1,341
12	186	371	232	58	279	221	116	1,462
13	201	402	251	63	302	239	126	1,584
14	217	433	271	68	325	257	135	1,706
15	232	464	290	73	348	276	145	1,828
16	248	495	310	77	371	294	155	1,950
17	263	526	329	82	395	312	164	2,072
18	279	557	348	87	418	331	174	2,194
19	294	588	368	92	441	349	184	2,315
20	310	619	387	97	464	368	193	2,437

Table 38. Sediment Reduction by Subwatershed.

Stream Buffer and Big Bull Upland Annual Soil Erosion Reduction (tons)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total
1	110	117	73	18	88	69	0	475

2	219	234	146	37	175	139	0	950
3	329	351	219	55	263	208	0	1,424
4	438	468	292	73	351	278	0	1,899
5	548	584	365	91	438	347	0	2,374
6	657	701	438	110	526	416	0	2,849
7	767	818	511	128	614	486	0	3,324
8	877	935	584	146	701	555	0	3,799
9	986	1,052	657	164	789	625	0	4,273
10	1,096	1,169	731	183	877	694	0	4,748
11	1,205	1,286	804	201	964	763	0	5,223
12	1,315	1,403	877	219	1,052	833	0	5,698
13	1,424	1,519	950	237	1,140	902	0	6,173
14	1,534	1,636	1,023	256	1,227	972	0	6,648
15	1,644	1,753	1,096	274	1,315	1,041	0	7,122
16	1,753	1,870	1,169	292	1,403	1,110	0	7,597
17	1,863	1,987	1,242	310	1,490	1,180	0	8,072
18	1,972	2,104	1,315	329	1,578	1,249	0	8,547
19	2,082	2,221	1,388	347	1,666	1,319	0	9,022
20	2,192	2,338	1,461	365	1,753	1,388	0	9,497

Remainder of Big Bull and Rock Creek Watersheds Annual Soil Erosion Reduction (tons)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total
1	57	61	38	10	46	36	0	247
2	114	122	76	19	91	72	0	495
3	171	183	114	29	137	108	0	742
4	228	244	152	38	183	145	0	990
5	285	305	190	48	228	181	0	1,237
6	343	365	228	57	274	217	0	1,485
7	400	426	266	67	320	253	0	1,732
8	457	487	305	76	365	289	0	1,979
9	514	548	343	86	411	325	0	2,227
10	571	609	381	95	457	362	0	2,474
11	628	670	419	105	502	398	0	2,722
12	685	731	457	114	548	434	0	2,969
13	742	792	495	124	594	470	0	3,216
14	799	853	533	133	639	506	0	3,464
15	856	914	571	143	685	542	0	3,711
16	914	974	609	152	731	579	0	3,959
17	971	1,035	647	162	777	615	0	4,206
18	1,028	1,096	685	171	822	651	0	4,454
19	1,085	1,157	723	181	868	687	0	4,701
20	1,142	1,218	761	190	914	723	0	4,948

Remainder of Little Bull Watershed Annual Soil Erosion Reduction (tons)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total
1	23	25	15	4	19	15	0	101
2	46	50	31	8	37	29	0	201
3	70	74	46	12	56	44	0	302
4	93	99	62	15	74	59	0	402
5	116	124	77	19	93	74	0	503
6	139	149	93	23	111	88	0	604
7	162	173	108	27	130	103	0	704
8	186	198	124	31	149	118	0	805
9	209	223	139	35	167	132	0	905
10	232	248	155	39	186	147	0	1,006
11	255	272	170	43	204	162	0	1,106
12	279	297	186	46	223	176	0	1,207
13	302	322	201	50	241	191	0	1,308
14	325	347	217	54	260	206	0	1,408
15	348	371	232	58	279	221	0	1,509
16	371	396	248	62	297	235	0	1,609
17	395	421	263	66	316	250	0	1,710
18	418	446	279	70	334	265	0	1,811
19	441	470	294	74	353	279	0	1,911
20	464	495	310	77	371	294	0	2,012

Table 39. Nitrogen Reductions by Subwatershed.

Stream Buffer and Upland Annual Nitrogen Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	292	935	292	146	701	555	409	3,331
2	584	1,870	584	292	1,403	1,110	818	6,662
3	877	2,805	877	438	2,104	1,666	1,227	9,993
4	1,169	3,740	1,169	584	2,805	2,221	1,636	13,324
5	1,461	4,675	1,461	731	3,506	2,776	2,045	16,655
6	1,753	5,610	1,753	877	4,208	3,331	2,454	19,986
7	2,045	6,545	2,045	1,023	4,909	3,886	2,864	23,318
8	2,338	7,480	2,338	1,169	5,610	4,441	3,273	26,649
9	2,630	8,415	2,630	1,315	6,312	4,997	3,682	29,980
10	2,922	9,350	2,922	1,461	7,013	5,552	4,091	33,311
11	3,214	10,285	3,214	1,607	7,714	6,107	4,500	36,642
12	3,506	11,220	3,506	1,753	8,415	6,662	4,909	39,973
13	3,799	12,156	3,799	1,899	9,117	7,217	5,318	43,304
14	4,091	13,091	4,091	2,045	9,818	7,773	5,727	46,635

15	4,383	14,026	4,383	2,192	10,519	8,328	6,136	49,966
16	4,675	14,961	4,675	2,338	11,220	8,883	6,545	53,297
17	4,967	15,896	4,967	2,484	11,922	9,438	6,954	56,628
18	5,260	16,831	5,260	2,630	12,623	9,993	7,363	59,959
19	5,552	17,766	5,552	2,776	13,324	10,548	7,773	63,291
20	5,844	18,701	5,844	2,922	14,026	11,104	8,182	66,622

Remainder of Big Bull and Rock Creek Watersheds Annual Nitrogen Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	152	487	152	76	365	289	213	1,736
2	305	974	305	152	731	579	426	3,472
3	457	1,462	457	228	1,096	868	639	5,207
4	609	1,949	609	305	1,462	1,157	853	6,943
5	761	2,436	761	381	1,827	1,446	1,066	8,679
6	914	2,923	914	457	2,193	1,736	1,279	10,415
7	1,066	3,411	1,066	533	2,558	2,025	1,492	12,150
8	1,218	3,898	1,218	609	2,923	2,314	1,705	13,886
9	1,370	4,385	1,370	685	3,289	2,604	1,918	15,622
10	1,523	4,872	1,523	761	3,654	2,893	2,132	17,358
11	1,675	5,360	1,675	837	4,020	3,182	2,345	19,093
12	1,827	5,847	1,827	914	4,385	3,472	2,558	20,829
13	1,979	6,334	1,979	990	4,751	3,761	2,771	22,565
14	2,132	6,821	2,132	1,066	5,116	4,050	2,984	24,301
15	2,284	7,308	2,284	1,142	5,481	4,339	3,197	26,036
16	2,436	7,796	2,436	1,218	5,847	4,629	3,411	27,772
17	2,588	8,283	2,588	1,294	6,212	4,918	3,624	29,508
18	2,741	8,770	2,741	1,370	6,578	5,207	3,837	31,244
19	2,893	9,257	2,893	1,446	6,943	5,497	4,050	32,980
20	3,045	9,745	3,045	1,523	7,308	5,786	4,263	34,715

Remainder of Little Bull Watershed Annual Nitrogen Reduction (pounds)

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Water Retention Structures	Total
1	62	198	62	31	149	118	87	706
2	124	396	124	62	297	235	173	1,411
3	186	594	186	93	446	353	260	2,117
4	248	792	248	124	594	470	347	2,823
5	310	990	310	155	743	588	433	3,528
6	371	1,188	371	186	891	706	520	4,234

7	433	1,387	433	217	1,040	823	607	4,940
8	495	1,585	495	248	1,188	941	693	5,645
9	557	1,783	557	279	1,337	1,058	780	6,351
10	619	1,981	619	310	1,486	1,176	867	7,057
11	681	2,179	681	340	1,634	1,294	953	7,762
12	743	2,377	743	371	1,783	1,411	1,040	8,468
13	805	2,575	805	402	1,931	1,529	1,127	9,174
14	867	2,773	867	433	2,080	1,647	1,213	9,879
15	929	2,971	929	464	2,228	1,764	1,300	10,585
16	990	3,169	990	495	2,377	1,882	1,387	11,291
17	1,052	3,367	1,052	526	2,526	1,999	1,473	11,996
18	1,114	3,565	1,114	557	2,674	2,117	1,560	12,702
19	1,176	3,764	1,176	588	2,823	2,235	1,647	13,408
20	1,238	3,962	1,238	619	2,971	2,352	1,733	14,113

Table 40. Annual Adoption Rates by Subwatershed.

Stream Buffer and Big Bull Upland Annual Adoption (treated acres), Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Adoption
1	73	146	73	37	146	37	37	548
2	73	146	73	37	146	37	37	548
3	73	146	73	37	146	37	37	548
4	73	146	73	37	146	37	37	548
5	73	146	73	37	146	37	37	548
6	73	146	73	37	146	37	37	548
7	73	146	73	37	146	37	37	548
8	73	146	73	37	146	37	37	548
9	73	146	73	37	146	37	37	548
10	73	146	73	37	146	37	37	548
11	73	146	73	37	146	37	37	548
12	73	146	73	37	146	37	37	548
13	73	146	73	37	146	37	37	548
14	73	146	73	37	146	37	37	548
15	73	146	73	37	146	37	37	548
16	73	146	73	37	146	37	37	548
17	73	146	73	37	146	37	37	548
18	73	146	73	37	146	37	37	548
19	73	146	73	37	146	37	37	548
20	73	146	73	37	146	37	37	548

Remainder of Big Bull and Rock Creek Watersheds Annual Adoption (treated acres), Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Adoption

1	38	76	38	19	76	19	19	285
2	38	76	38	19	76	19	19	285
3	38	76	38	19	76	19	19	285
4	38	76	38	19	76	19	19	285
5	38	76	38	19	76	19	19	285
6	38	76	38	19	76	19	19	285
7	38	76	38	19	76	19	19	285
8	38	76	38	19	76	19	19	285
9	38	76	38	19	76	19	19	285
10	38	76	38	19	76	19	19	285
11	38	76	38	19	76	19	19	285
12	38	76	38	19	76	19	19	285
13	38	76	38	19	76	19	19	285
14	38	76	38	19	76	19	19	285
15	38	76	38	19	76	19	19	285
16	38	76	38	19	76	19	19	285
17	38	76	38	19	76	19	19	285
18	38	76	38	19	76	19	19	285
19	38	76	38	19	76	19	19	285
20	38	76	38	19	76	19	19	285

Remainder of Little Bull Watershed Annual Adoption (treated acres), Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Adoption
1	15	31	15	8	31	8	8	116
2	15	31	15	8	31	8	8	116
3	15	31	15	8	31	8	8	116
4	15	31	15	8	31	8	8	116
5	15	31	15	8	31	8	8	116
6	15	31	15	8	31	8	8	116
7	15	31	15	8	31	8	8	116
8	15	31	15	8	31	8	8	116
9	15	31	15	8	31	8	8	116
10	15	31	15	8	31	8	8	116
11	15	31	15	8	31	8	8	116
12	15	31	15	8	31	8	8	116
13	15	31	15	8	31	8	8	116
14	15	31	15	8	31	8	8	116
15	15	31	15	8	31	8	8	116
16	15	31	15	8	31	8	8	116
17	15	31	15	8	31	8	8	116
18	15	31	15	8	31	8	8	116
19	15	31	15	8	31	8	8	116
20	15	31	15	8	31	8	8	116

Table 41. Milestones by Subwatershed.

Stream Buffer and Big Bull Upland BMP Implementation Milestones, Cropland BMPs

	Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Adoption
Short Term	1	73	146	73	37	146	37	37	548
	2	73	146	73	37	146	37	37	548
	3	73	146	73	37	146	37	37	548
	4	73	146	73	37	146	37	37	548
	5	73	146	73	37	146	37	37	548
Total		*365*	*731*	*365*	*183*	*731*	*183*	*183*	2,739
Medium Term	6	73	146	73	37	146	37	37	548
	7	73	146	73	37	146	37	37	548
	8	73	146	73	37	146	37	37	548
	9	73	146	73	37	146	37	37	548
	10	73	146	73	37	146	37	37	548
Total		*731*	*1,461*	*731*	*365*	*1,461*	*365*	*365*	5,479
Long Term	11	73	146	73	37	146	37	37	548
	12	73	146	73	37	146	37	37	548
	13	73	146	73	37	146	37	37	548
	14	73	146	73	37	146	37	37	548
	15	73	146	73	37	146	37	37	548
	16	73	146	73	37	146	37	37	548
	17	73	146	73	37	146	37	37	548
	18	73	146	73	37	146	37	37	548
	19	73	146	73	37	146	37	37	548
	20	73	146	73	37	146	37	37	548
Total		*1,461*	*2,922*	*1,461*	*731*	*2,922*	*731*	*731*	10,958

Remainder of Big Bull and Rock Creek Watersheds BMP Implementation Milestones, Cropland BMPs

	Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Adoption
Short Term	1	38	76	38	19	76	19	19	285
	2	38	76	38	19	76	19	19	285
	3	38	76	38	19	76	19	19	285
	4	38	76	38	19	76	19	19	285
	5	38	76	38	19	76	19	19	285
Total		*190*	*381*	*190*	*95*	*381*	*95*	*95*	1,427
Medium Term	6	38	76	38	19	76	19	19	285
	7	38	76	38	19	76	19	19	285
	8	38	76	38	19	76	19	19	285
	9	38	76	38	19	76	19	19	285
	10	38	76	38	19	76	19	19	285
Total		*381*	*761*	*381*	*190*	*761*	*190*	*190*	2,855
Long Term	11	38	76	38	19	76	19	19	285
	12	38	76	38	19	76	19	19	285

	13	38	76	38	19	76	19	19	285
	14	38	76	38	19	76	19	19	285
	15	38	76	38	19	76	19	19	285
	16	38	76	38	19	76	19	19	285
	17	38	76	38	19	76	19	19	285
	18	38	76	38	19	76	19	19	285
	19	38	76	38	19	76	19	19	285
	20	38	76	38	19	76	19	19	285
Total		*761*	*1,523*	*761*	*381*	*1,523*	*381*	*381*	5,710

Remainder of Little Bull Watershed BMP Implementation Milestones, Cropland BMPs

	Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Adoption
Short Term	1	15	31	15	8	31	8	8	116
	2	15	31	15	8	31	8	8	116
	3	15	31	15	8	31	8	8	116
	4	15	31	15	8	31	8	8	116
	5	15	31	15	8	31	8	8	116
Total		*77*	*155*	*77*	*39*	*155*	*39*	*39*	580
Medium Term	6	15	31	15	8	31	8	8	116
	7	15	31	15	8	31	8	8	116
	8	15	31	15	8	31	8	8	116
	9	15	31	15	8	31	8	8	116
	10	15	31	15	8	31	8	8	116
Total		*155*	*310*	*155*	*77*	*310*	*77*	*77*	1,161
Long Term	11	15	31	15	8	31	8	8	116
	12	15	31	15	8	31	8	8	116
	13	15	31	15	8	31	8	8	116
	14	15	31	15	8	31	8	8	116
	15	15	31	15	8	31	8	8	116
	16	15	31	15	8	31	8	8	116
	17	15	31	15	8	31	8	8	116
	18	15	31	15	8	31	8	8	116
	19	15	31	15	8	31	8	8	116
	20	15	31	15	8	31	8	8	116
Total		*310*	*619*	*310*	*155*	*619*	*155*	*155*	2,321

Table 42. Annual Cost Before Cost Share for Cropland BMPs by Subwatershed.

Stream Buffer and Big Bull Upland Total Annual Cost Before Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Cost
1	$5,675	$23,376	$4,870	$2,071	$14,902	$5,479	$986	$57,360
2	$5,846	$24,077	$5,016	$2,133	$15,349	$5,643	$1,016	$59,081
3	$6,021	$24,800	$5,167	$2,197	$15,810	$5,812	$1,046	$60,853

4	$6,202	$25,544	$5,322	$2,263	$16,284	$5,987	$1,078	$62,679
5	$6,388	$26,310	$5,481	$2,331	$16,773	$6,166	$1,110	$64,559
6	$6,579	$27,099	$5,646	$2,401	$17,276	$6,351	$1,143	$66,496
7	$6,777	$27,912	$5,815	$2,473	$17,794	$6,542	$1,178	$68,490
8	$6,980	$28,750	$5,989	$2,547	$18,328	$6,738	$1,213	$70,545
9	$7,189	$29,612	$6,169	$2,624	$18,878	$6,940	$1,249	$72,662
10	$7,405	$30,500	$6,354	$2,703	$19,444	$7,149	$1,287	$74,841
11	$7,627	$31,415	$6,545	$2,784	$20,027	$7,363	$1,325	$77,087
12	$7,856	$32,358	$6,741	$2,867	$20,628	$7,584	$1,365	$79,399
13	$8,092	$33,329	$6,943	$2,953	$21,247	$7,811	$1,406	$81,781
14	$8,334	$34,328	$7,152	$3,042	$21,884	$8,046	$1,448	$84,235
15	$8,584	$35,358	$7,366	$3,133	$22,541	$8,287	$1,492	$86,762
16	$8,842	$36,419	$7,587	$3,227	$23,217	$8,536	$1,536	$89,365
17	$9,107	$37,512	$7,815	$3,324	$23,914	$8,792	$1,583	$92,045
18	$9,380	$38,637	$8,049	$3,424	$24,631	$9,056	$1,630	$94,807
19	$9,662	$39,796	$8,291	$3,526	$25,370	$9,327	$1,679	$97,651
20	$9,952	$40,990	$8,540	$3,632	$26,131	$9,607	$1,729	$100,581

Remainder of Big Bull and Rock Creek Watersheds Total Annual Cost Before Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Cost
1	$2,957	$12,181	$2,538	$1,079	$7,765	$2,855	$514	$29,889
2	$3,046	$12,546	$2,614	$1,112	$7,998	$2,941	$529	$30,786
3	$3,137	$12,923	$2,692	$1,145	$8,238	$3,029	$545	$31,709
4	$3,231	$13,310	$2,773	$1,179	$8,485	$3,120	$562	$32,661
5	$3,328	$13,710	$2,856	$1,215	$8,740	$3,213	$578	$33,640
6	$3,428	$14,121	$2,942	$1,251	$9,002	$3,310	$596	$34,650
7	$3,531	$14,545	$3,030	$1,289	$9,272	$3,409	$614	$35,689
8	$3,637	$14,981	$3,121	$1,327	$9,550	$3,511	$632	$36,760
9	$3,746	$15,430	$3,215	$1,367	$9,837	$3,616	$651	$37,863
10	$3,859	$15,893	$3,311	$1,408	$10,132	$3,725	$670	$38,998
11	$3,974	$16,370	$3,410	$1,451	$10,436	$3,837	$691	$40,168
12	$4,094	$16,861	$3,513	$1,494	$10,749	$3,952	$711	$41,373
13	$4,216	$17,367	$3,618	$1,539	$11,071	$4,070	$733	$42,615
14	$4,343	$17,888	$3,727	$1,585	$11,404	$4,192	$755	$43,893
15	$4,473	$18,425	$3,838	$1,633	$11,746	$4,318	$777	$45,210
16	$4,607	$18,977	$3,954	$1,682	$12,098	$4,448	$801	$46,566
17	$4,746	$19,547	$4,072	$1,732	$12,461	$4,581	$825	$47,963
18	$4,888	$20,133	$4,194	$1,784	$12,835	$4,719	$849	$49,402
19	$5,035	$20,737	$4,320	$1,837	$13,220	$4,860	$875	$50,884
20	$5,186	$21,359	$4,450	$1,893	$13,616	$5,006	$901	$52,411

Remainder of Little Bull Watershed Total Annual Cost Before Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Cost

1	$1,202	$4,952	$1,032	$439	$3,157	$1,161	$209	$12,151
2	$1,238	$5,101	$1,063	$452	$3,252	$1,195	$215	$12,516
3	$1,275	$5,254	$1,094	$466	$3,349	$1,231	$222	$12,891
4	$1,314	$5,411	$1,127	$479	$3,450	$1,268	$228	$13,278
5	$1,353	$5,574	$1,161	$494	$3,553	$1,306	$235	$13,676
6	$1,394	$5,741	$1,196	$509	$3,660	$1,345	$242	$14,087
7	$1,436	$5,913	$1,232	$524	$3,770	$1,386	$249	$14,509
8	$1,479	$6,090	$1,269	$540	$3,883	$1,427	$257	$14,944
9	$1,523	$6,273	$1,307	$556	$3,999	$1,470	$265	$15,393
10	$1,569	$6,461	$1,346	$573	$4,119	$1,514	$273	$15,854
11	$1,616	$6,655	$1,386	$590	$4,243	$1,560	$281	$16,330
12	$1,664	$6,855	$1,428	$607	$4,370	$1,607	$289	$16,820
13	$1,714	$7,060	$1,471	$626	$4,501	$1,655	$298	$17,325
14	$1,766	$7,272	$1,515	$644	$4,636	$1,704	$307	$17,844
15	$1,819	$7,490	$1,560	$664	$4,775	$1,756	$316	$18,380
16	$1,873	$7,715	$1,607	$684	$4,918	$1,808	$325	$18,931
17	$1,929	$7,947	$1,656	$704	$5,066	$1,862	$335	$19,499
18	$1,987	$8,185	$1,705	$725	$5,218	$1,918	$345	$20,084
19	$2,047	$8,430	$1,756	$747	$5,374	$1,976	$356	$20,687
20	$2,108	$8,683	$1,809	$769	$5,536	$2,035	$366	$21,307

Table 43. Annual Cost After Cost Share for Cropland BMPs by Subwatershed.

Stream Buffer and Big Bull Upland Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Cost
1	$3,462	$11,688	$487	$1,036	$7,451	$2,739	$986	$27,849
2	$3,566	$12,039	$502	$1,067	$7,675	$2,822	$1,016	$28,685
3	$3,673	$12,400	$517	$1,099	$7,905	$2,906	$1,046	$29,545
4	$3,783	$12,772	$532	$1,132	$8,142	$2,993	$1,078	$30,432
5	$3,896	$13,155	$548	$1,166	$8,386	$3,083	$1,110	$31,345
6	$4,013	$13,550	$565	$1,201	$8,638	$3,176	$1,143	$32,285
7	$4,134	$13,956	$582	$1,237	$8,897	$3,271	$1,178	$33,253
8	$4,258	$14,375	$599	$1,274	$9,164	$3,369	$1,213	$34,251
9	$4,385	$14,806	$617	$1,312	$9,439	$3,470	$1,249	$35,279
10	$4,517	$15,250	$635	$1,351	$9,722	$3,574	$1,287	$36,337
11	$4,653	$15,708	$654	$1,392	$10,014	$3,681	$1,325	$37,427
12	$4,792	$16,179	$674	$1,434	$10,314	$3,792	$1,365	$38,550
13	$4,936	$16,664	$694	$1,477	$10,623	$3,906	$1,406	$39,706
14	$5,084	$17,164	$715	$1,521	$10,942	$4,023	$1,448	$40,898
15	$5,236	$17,679	$737	$1,567	$11,270	$4,144	$1,492	$42,124
16	$5,394	$18,210	$759	$1,614	$11,609	$4,268	$1,536	$43,388
17	$5,555	$18,756	$781	$1,662	$11,957	$4,396	$1,583	$44,690
18	$5,722	$19,318	$805	$1,712	$12,316	$4,528	$1,630	$46,031
19	$5,894	$19,898	$829	$1,763	$12,685	$4,664	$1,679	$47,411
20	$6,070	$20,495	$854	$1,816	$13,066	$4,804	$1,729	$48,834

Remainder of Big Bull and Rock Creek Watersheds Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Cost
1	$1,804	$6,090	$254	$540	$3,883	$1,427	$514	$14,512
2	$1,858	$6,273	$261	$556	$3,999	$1,470	$529	$14,947
3	$1,914	$6,461	$269	$573	$4,119	$1,514	$545	$15,395
4	$1,971	$6,655	$277	$590	$4,243	$1,560	$562	$15,857
5	$2,030	$6,855	$286	$607	$4,370	$1,607	$578	$16,333
6	$2,091	$7,060	$294	$626	$4,501	$1,655	$596	$16,823
7	$2,154	$7,272	$303	$644	$4,636	$1,704	$614	$17,328
8	$2,219	$7,490	$312	$664	$4,775	$1,756	$632	$17,848
9	$2,285	$7,715	$321	$684	$4,918	$1,808	$651	$18,383
10	$2,354	$7,947	$331	$704	$5,066	$1,862	$670	$18,934
11	$2,424	$8,185	$341	$725	$5,218	$1,918	$691	$19,503
12	$2,497	$8,431	$351	$747	$5,374	$1,976	$711	$20,088
13	$2,572	$8,683	$362	$769	$5,536	$2,035	$733	$20,690
14	$2,649	$8,944	$373	$793	$5,702	$2,096	$755	$21,311
15	$2,729	$9,212	$384	$816	$5,873	$2,159	$777	$21,950
16	$2,810	$9,489	$395	$841	$6,049	$2,224	$801	$22,609
17	$2,895	$9,773	$407	$866	$6,230	$2,291	$825	$23,287
18	$2,982	$10,067	$419	$892	$6,417	$2,359	$849	$23,986
19	$3,071	$10,368	$432	$919	$6,610	$2,430	$875	$24,705
20	$3,163	$10,680	$445	$946	$6,808	$2,503	$901	$25,446

Remainder of Little Bull Watershed Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Grassed Waterways	Vegetative Buffers	Nutrient Mgmt Plans	Terraces	Permanent Vegetation	Subsurface Fertilizer Application	Total Cost
1	$733	$2,476	$103	$219	$1,578	$580	$209	$5,900
2	$755	$2,550	$106	$226	$1,626	$598	$215	$6,077
3	$778	$2,627	$109	$233	$1,675	$616	$222	$6,259
4	$801	$2,706	$113	$240	$1,725	$634	$228	$6,447
5	$825	$2,787	$116	$247	$1,777	$653	$235	$6,640
6	$850	$2,870	$120	$254	$1,830	$673	$242	$6,839
7	$876	$2,956	$123	$262	$1,885	$693	$249	$7,044
8	$902	$3,045	$127	$270	$1,941	$714	$257	$7,256
9	$929	$3,137	$131	$278	$2,000	$735	$265	$7,473
10	$957	$3,231	$135	$286	$2,060	$757	$273	$7,698
11	$986	$3,328	$139	$295	$2,121	$780	$281	$7,929
12	$1,015	$3,427	$143	$304	$2,185	$803	$289	$8,166
13	$1,046	$3,530	$147	$313	$2,250	$827	$298	$8,411
14	$1,077	$3,636	$152	$322	$2,318	$852	$307	$8,664
15	$1,109	$3,745	$156	$332	$2,388	$878	$316	$8,924
16	$1,143	$3,858	$161	$342	$2,459	$904	$325	$9,191
17	$1,177	$3,973	$166	$352	$2,533	$931	$335	$9,467

18	$1,212	$4,092	$171	$363	$2,609	$959	$345	$9,751
19	$1,249	$4,215	$176	$374	$2,687	$988	$356	$10,044
20	$1,286	$4,342	$181	$385	$2,768	$1,018	$366	$10,345

Table 44. Livestock Adoption Rates, Costs and Load Reductions by Subwatershed.

Livestock BMP Adoption by Sub Watershed

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Grazing Management Plan	Total Adoption
Stream Buffer and Big Bull Upland	4	4	20	34	20	34	116
Remainder of Big Bull and Rock Creek Watersheds	3	3	20	33	20	33	112
Remainder of Little Bull Watershed	3	3	20	33	20	33	112
Total	10	10	60	100	60	100	340

Livestock BMP Cost* Before Cost-Share by Sub Watershed

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Grazing Management Plan	Total Cost
Stream Buffer and Big Bull Upland	$2,856	$26,484	$44,060	$129,030	$140,000	$54,400	$396,830
Remainder of Big Bull and Rock Creek Watersheds	$2,142	$19,863	$44,060	$125,235	$140,000	$52,800	$384,100
Remainder of Little Bull Watershed	$2,142	$19,863	$44,060	$125,235	$140,000	$52,800	$384,100

Total	$7,140	$66,210	$132,180	$379,500	$420,000	$160,000	$1,165,030

**2012 Dollars*

Livestock BMP Cost After Cost-Share by Sub Watershed

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Grazing Management Plan	Total Cost
Stream Buffer and Big Bull Upland	$1,428	$13,242	$22,030	$64,515	$70,000	$27,200	$198,415
Remainder of Big Bull and Rock Creek Watersheds	$1,071	$9,932	$22,030	$62,618	$70,000	$26,400	$192,050
Remainder of Little Bull Watershed	$1,071	$9,932	$22,030	$62,618	$70,000	$26,400	$192,050
Total	$3,570	$33,105	$66,090	$189,750	$210,000	$80,000	$582,515

**2012 Dollars*

Livestock BMP Phosphorous Load Reduction by Sub Watershed (pounds)

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Grazing Management Plan	Total Load Reduction
Stream Buffer and Big Bull Upland	2,552	3,189	1,261	2,144	2,800	9,520	21,466
Remainder of Big Bull and Rock Creek Watersheds	1,914	2,392	1,261	2,081	2,800	9,240	19,688
Remainder of Little Bull Watershed	1,914	2,392	1,261	2,081	2,800	9,240	19,688

Total	6,379	7,973	3,784	6,306	8,400	28,000	60,842

Livestock BMP Nitrogen Load Reduction by Sub Watershed (pounds)

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Grazing Management Plan	Total Load Reduction	
Stream Buffer and Big Bull								
Upland	4,806	6,007	2,375	4,038	5,274	17,931	40,432	
Remainder of Big Bull and Rock Creek Watersheds	3,604	4,505	2,375	3,920	5,274	17,404	37,082	
Remainder of Little Bull Watershed	3,604	4,505		2,375	3,920	5,274	17,404	37,082
Total	12,014	15,018		7,126	11,877	15,821	52,738	114,596

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