Kanopolis Reservoir

Big Creek Middle Smoky Hill River Watersheds
9 Element Watershed Protection Plan

Watershed Restoration and Protection Strategy (WRAPS)
September 2011
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K-STATE Kansas State University Research and Extension

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Smoky Hill River Kanopolis Lake Watershed

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Glossary of Terms

Animal Feeding Operation (AFO): An agricultural enterprise where livestock are kept, raised, and feed in confined situations in which animal feed is brought to the animal rather than the animal grazing.

Animal Unit (AU): a mature (1,000-pound) cow or the equivalent, based on an average consumption rate of 26 pounds of forage dry matter per day.

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

Big Creek Middle Smoky Hill River Watersheds (BCMSHRW): Name of the two HUC 8 watersheds draining into Kanopolis Reservoir.

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: Green pigment found in algae and other aquatic plants that is used in photosynthesis.

Confined Animal Feeding Operation (CAFO): Any large scale animal feeding operation that confines animals for at least 45 days on land that does not produce forage. These operations are subject to state and federal (>999 AU) inspections and regulations.

Confined Feeding Facility (CFF): An enterprise where confined animals are feed whereas the land is not used for crop or any animal forage production

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

***E. coli* bacteria:** Bacteria normally found in gastrointestinal tracts of warm-blooded animals. Some strains cause human diseases and death.

Environmental Protection Agency (EPA): Federal agency charged with water quality protection efforts in cooperation with state agencies.

Eutrophication (EU): Excess of minerals and 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.

Geomean: A type of mean used to gain central tendency for a set of numbers whose growth is exponential (i.e. - bacteria).

Hydrologic Unit Code (HUC): An identification system for watersheds. Each watershed has a number in addition to a common name. As watersheds become smaller, the HUC number will become larger.

Kansas Department of Health and Environment (KDHE): State agency charged with water quality protection in the State of Kansas.

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

MS4 Permit: A permit for Municipal Separate Storm Sewer Systems (MS4s), from which stormwater is often discharged untreated into local water bodies. Cities to fall under this permit must also attain an NPDES permit and develop a stormwater management program.

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

Nitrate: Final product of ammonia's biochemical oxidation and is the primary source of nitrogen for plants; typically contained in all manures and fertilizers.
Nitrogen (N or TN): Element that is an essential building block for nucleic and amino acids for plants and animals. TN or total nitrogen is a chemical measurement of all nitrogen forms in a water sample.
National Pollutant Discharge Elimination System (NPDES Permit): a national program under Section 402 of the Clean Water Act for regulation of discharges of pollutants from point sources to waters of the United States. Discharges are illegal unless authorized by an NPDES permit.
Non-point Source (NPS): pollutants originating from diffuse areas, such as agricultural or urban areas that have no specific point of discharge.
NPS Load Allocation: The amount of pollution that originates from nonpoint sources and is the initial load the WRAPS project is directed to achieve.
Nutrients: Nitrogen and phosphorus in a water source.
Phosphorus (P or TP): Essential macronutrient for plants. Typically the limiting nutrient in an aquatic ecosystem but in excess leads to algal blooms.
Point Source (PS): pollutants originating from a specific area, typically a discharge pipe.
Riparian Zone: The boundary between uplands and a river or stream.
Sedimentation: Deposition of clay, sand, or silt in slow moving waters.
Secchi Disk: Circular plate 10-12" in diameter with alternating black and white quarters used to vertically measure water clarity by measuring the depth at which it can be seen.
Total Maximum Daily Load (TMDL): The maximum amount of a 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 the quantity of sediment or silt.
Watershed: An area of land that catches precipitation and funnels it to a particular creek, stream, or river until the water drains into an ocean. It has distinct elevation boundaries that do not follow political lines and can cover a few acres to thousands of square miles.
Watershed Restoration And Protection Strategy (WRAPS): The plan designed to outline restoration and protection goals and actions for surface waters of the watersheds.

1.0 Preface

The purpose of a 9 Element Watershed Restoration and Protection Strategy (WRAPS) report for the Big Creek and Middle Smoky Hill River Watersheds (BCMSHRW), which includes Kanopolis Reservoir, is to outline the methodology for restoration and protection of the surface waters of the watersheds. Watershed restoration is needed in surface waters that do not meet state and/or federal water quality standards and for regions of the watersheds that need improvement for aquatic habitat, land management, and conservation. Watershed protection is needed for surface waters that currently meet state and federal water quality standards, but are in need of protection from future degradation.

Kanopolis Reservoir was the first federal reservoir built in the State of Kansas. In May of 1948 the gates closed and surface water began to accumulate. Today, with one-half million visitors annually, the reservoir has a flood control pool of 13,958 surface acres and multi-purpose pool of 3,406 surface acres. As allocated by the State of Kansas, Kanopolis supplies 400 million gallons per year (MGY) for municipal and industrial water use. The watershed drainage encompasses 2,439 square miles (consisting of two Hydrologic Unit Code (HUC) 8s), and limited historical characterization. This presents problems in determining origination of nitrogen (TN), phosphorus (TP), sediment (TSS), and *E. coli* bacteria. Therefore, the need for extensive water quality monitoring, by subwatershed (HUC 12) condition analysis, and Best Management Practices (BMPs) targeting is necessary.

In the late 1990s, the Smoky Hill River Task Force, based out of the Post Rock Rural Water District, was formed to establish a network of agency and organization partners willing to evaluate the watersheds. For many years, the task force brought agencies together to identify areas of concern, conduct computer modeling exercises, and initiate the discussions to hire watershed personnel in order to oversee the implementation of the watershed plan.

In the fall of 2003, Kansas Department of Health and Environment (KDHE), with funding provided by the Environmental Protection Agency (EPA) Section 319 Funds, allowed Kansas State University (KSU) to hire a Watershed Specialist for the BCMSHRW who would ultimately be responsible for locating, developing, and deploying resources to protect and improve water quality. In 2004 and 2005, the Watershed Specialist was charged to develop a watershed protection plan. To gather local data and support within the watersheds, the Watershed Specialist worked with the Smoky Hill River Task Force to establish a Leadership Team. The role of the Leadership Team was to gather information on current water quality conditions, areas in need of restoration and protection, engage local residents, businesses, and government agencies and help develop and write the watershed protection plan. The initial watershed protection plan was approved and accepted by KDHE and EPA in July of 2005. In late 2009, the BCMSHRW was charged to update the watershed protection plan to meet the requirements of a 9 Elements Watershed Protection Plan as required by EPA.

The 9 Elements WRAPS Plan is intended to serve as the overall strategy to guide watershed restoration and protection efforts by individuals, local, state, federal agencies and other organizations. At the end of the WRAPS process, the BCMSHRW Leadership Team will have the capability, capacity, and confidence to make decisions that will restore and protect the water quality and watershed conditions of the Big Creek Middle Smoky Hill River Watersheds (Figure 1).

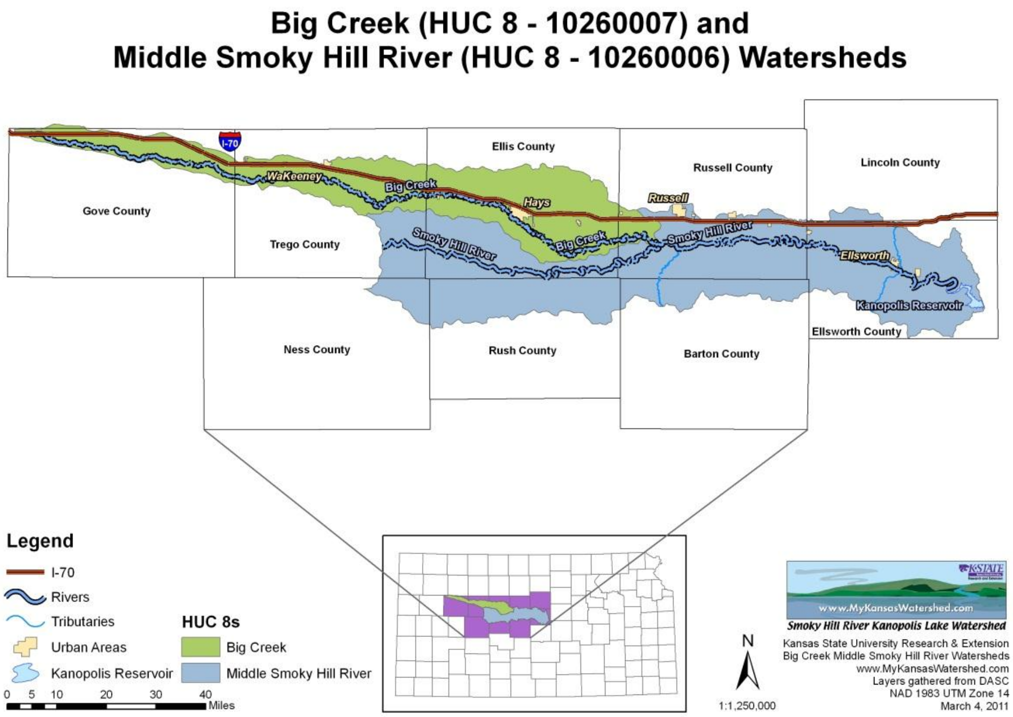


Figure 1. Map of the Big Creek Middle Smoky Hill River Watersheds.

2.0 Description & Review of the Watersheds

Twelve river basins are located in the State of Kansas. The BCMSHRW WRAPS project is a portion of the Smoky Hill-Saline Basin in west-central Kansas (Figure 2). The Smoky Hill-Saline Basin has a drainage area of 12,229 square miles and drains into the Kansas River. The extent of the BCMSHRW WRAPS area is all tributaries, streams, rivers, and water bodies including Big Creek, the Middle Smoky Hill River, and Kanopolis Reservoir. The geographical area this project is responsible for extends from the dam at Cedar Bluff Reservoir to the dam at Kanopolis Reservoir and from the headwaters of Big Creek in western Gove County to the junction into the Middle Smoky Hill River in west-central Russell County.

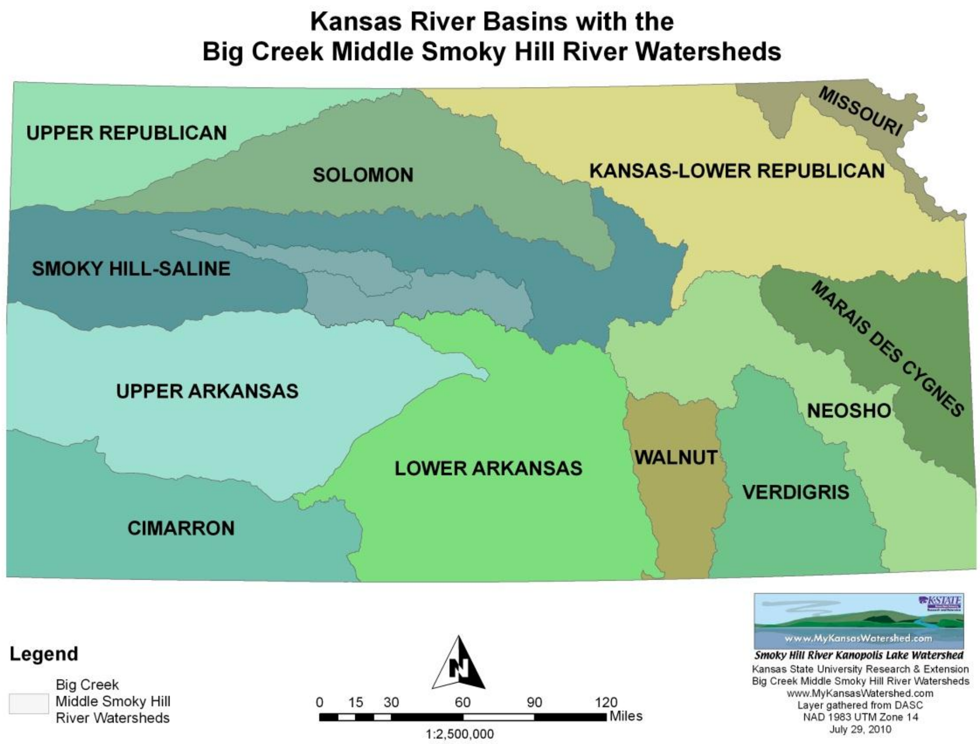


Figure 2. Kansas River Basins with Big Creek Middle Smoky Hill River Watersheds.

According to the United States Department of Agriculture (USDA) National Agricultural Statistics Center the Big Creek Watershed covers 551,092 acres and the Middle Smoky Hill River Watershed covers 1,009,878 acres for a total of 1,560,970 acres for the BCMSHRW. [1]

Each watershed has a unique HUC code in addition to a common name. As watersheds become smaller the HUC code becomes larger. Within the Smoky Hill-Saline Basin, there are ten HUC 8s. The Big Creek Watershed (HUC 8 code 10260007) and the Middle Smoky Hill River (HUC 8 code 10260006) cover one-fifth of the basin. These HUC 8s can further be delineated into smaller watersheds that are given HUC 10 codes and HUC 10 watersheds can be further delineated into smaller HUC 12s. The BCMSHRW is comprised of 54 HUC 12 delineations (Figs. 3-4). In many instances, the common name will have more meaning to local landowners and residents within the HUC rather than the HUC code. Therefore, the leadership team has determined that the BCMSHRW will identify HUCs based upon their common name.

2.1 Big Creek Watershed

The Big Creek Watershed (HUC 8 10260007) covers portions of Gove, Trego, Ellis, and Russell counties in western Kansas and consists of 18 HUC 12s (Figure 3). It encompasses 860.8 square miles which includes 321 stream miles and 28 acres of lakes. The Big Creek Watershed consists of 53.7% cropland, 28.3% grassland/rangeland, 9.0% urban, 8.3% open water, and 0.7% wetlands and wooded area. Big Creek Watershed drains Big Creek, Big Creek North Fork and their respective tributaries. Many of the stream segments are ephemeral having only seasonal flow or storm flow. Big Creek originates in Gove County west of the town of Grinnell and travels in an easterly direction until its convergence with the Smoky Hill River southwest of the City of Russell. Big Creek Oxbow Lake, located in the city limits of Hays, and the Ellis City Lake are the only registered lakes within the watershed. Major cities include Ellis (pop. 1,873) and Hays (pop. 20,013) according to the 2000 US Census Bureau. Approximately 31,234 people live in the Big Creek Watershed with an average population density of 36.3 persons per square mile (state average - 32.9 persons). [2]

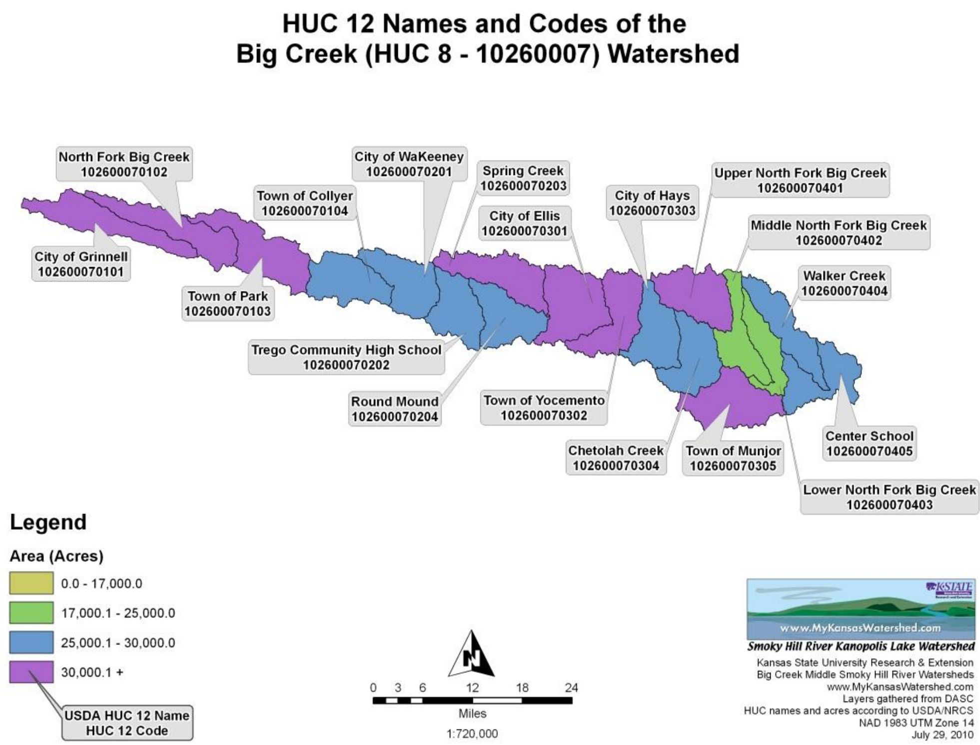


Figure 3. HUC 12 Names and Codes of the Big Creek Watershed.

2.2 Middle Smoky Hill River Watershed

The Middle Smoky Hill River Watershed (HUC 8 10260006) covers portions of Trego, Ellis, Russell, Lincoln, Ness, Rush, Barton, and Ellsworth counties in west-central Kansas and consists of 36 HUC 12s (Figure 4). It encompasses 1,578 square miles which includes 654 stream miles and 3,786 acres of lakes. The Smoky Hill River Watershed consists of 42.8% cropland, 38.9% grassland/rangeland, 7.7% urban, 9.0% open water, and 1.6% wetlands and wooded area. The Middle Smoky Hill River Watershed is the drainage waterway for the Smoky Hill River and its tributaries beginning at the dam below Cedar Bluff Reservoir in Trego County and traveling eastward to the dam below Kanopolis Lake in Ellsworth County. A major tributary contained in this watershed is Timber Creek at the western edge of the watershed in Ness and Rush counties. Major cities include Ellsworth (pop. 2,965) and Russell (pop. 4,696) according to the 2000 Census Bureau. Approximately 13,363 people reside in the watershed with an average population density of 8.5 persons per square mile.

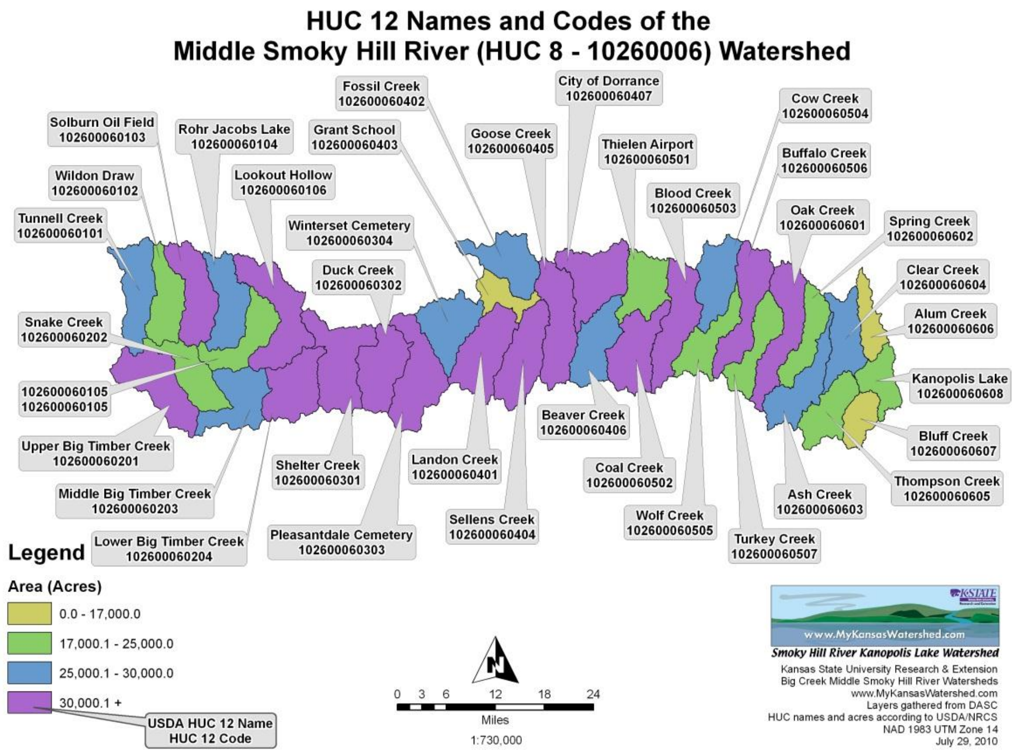


Figure 4. HUC 12 Names and Codes of the Middle Smoky Hill River Watershed.

2.3 Leadership Team & WRAPS Goals

The BCMSHRW Leadership Team has met over the years working with landowners, communities, and city and county governments to improve and protect water quality, crop yields, livestock feed efficiencies, rangeland conditions, recreation opportunities, wildlife habitat and ecosystems. It has also raised awareness about habits to improve urban neighborhoods within the BCMSHRW.

Through the implementation of the 9 Element Watershed Plan, the BCMSHRW WRAPS Leadership Team plans to accomplish the following goals either directly or indirectly:

- Protect and restore water quality
- Protect public drinking water supplies
- Protect and increase the productivity of agricultural lands
- Continue sustainability of land conservation
- Provide storm water management guidance
- Protect the water supply storage capacity at Kanopolis Reservoir
- Protect recreational uses at Kanopolis Reservoir
- Continue public awareness, education, and involvement in watershed issues

2.4 Watershed Classification

The Big Creek HUC 8 Watershed was classified as a "Category I – Watershed in Need of Restoration" by the 1999 Unified Watershed Assessment completed by KDHE and the Natural Resources Conservation Service (NRCS) (KDHE & USDA-NRCS 1999).[3] 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 Big Creek Watershed was ranked 56 out of 92 watersheds in the state. The assessment indicated that 82.5% of the total stream miles were impaired and approximately 67% of the waterways and 50% of the lakes sampled required TMDLs. Stream segments in this watershed were impaired by fecal coliform bacteria (FCB), chloride (Cl), sulfate (Sulf), ammonia (NH3), selenium (Se), and dissolved oxygen (DO). Lakes were impaired by Eutrophication (E) and insufficient water flow.

The Middle Smoky Hill River HUC 8 Watershed was also classified as a "Category I – Watershed in Need of Restoration" by the 1999 Unified Watershed Assessment.[3] The watershed received this classification due to degradation of aquatic systems including habitat, ecosystem health and living resources. The Middle Smoky Hill River Watershed was ranked 51 out of 92 watersheds in the state. The assessment also indicated 15.4% of the total stream miles were impaired with approximately 20% of the waterways and 40% of the lakes sampled required TMDLs. Stream segments in this watershed were impaired by FCB, Sulf, and Cl. Lakes were impaired by E and Sulf.

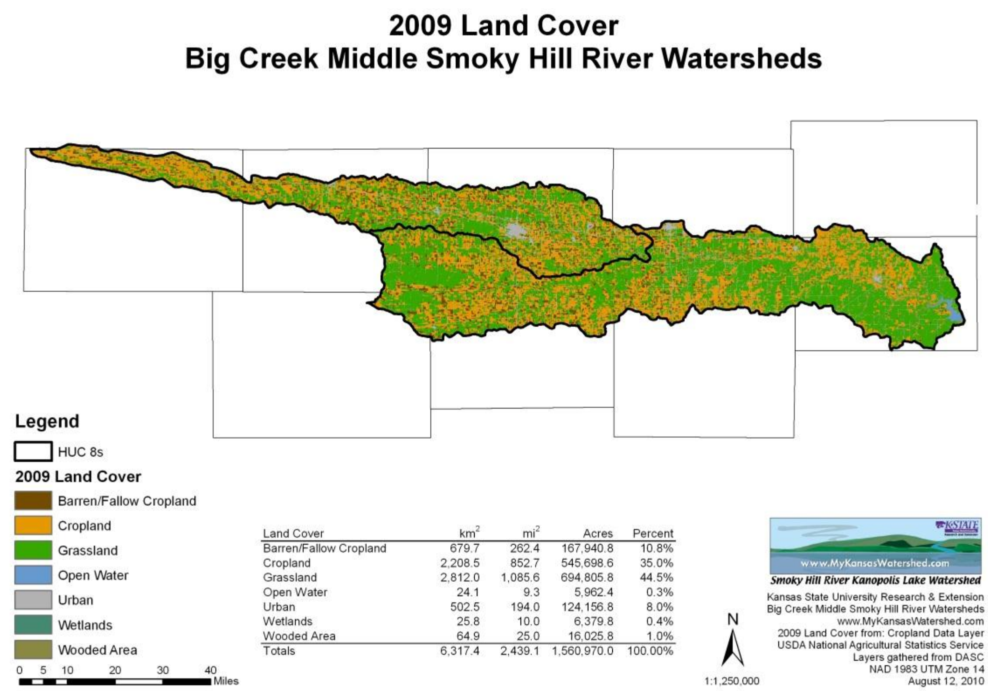
2.5 Land Cover & Land Uses in the BCMSHRW

Land use activities have a significant impact on the types and quantities of pollutants in the watersheds. The two major land uses in the BCMSHRW are cropland (including barren and fallow ground) at 45.8% and grassland at 44.5% (Figure 5).[4] According to the 2005 Big Creek Middle Smoky Hill River WRAPS Plan, approximately 50% of the cropland and 43% of the grassland in the BCMSHRW would benefit from the installation of best management practices (BMPs). The BMPs applied to cropland acres could include but would not be limited to: buffers, grassed waterways, terraces, terrace rebuilds, conversion from conventional tillage to minimum-till or no-till, conversion to the conservation reserve program (CRP), and/or streambank stabilization projects. Those BMPs applied to grassland acres could include but would not be limited to: buffer strips along streams, alternative water supplies, proper stocking rates, control of invasive species, and re-establishment of permanent grass cover.

Cropland has the greatest potential to produce significant amounts of sediment and nutrients that enter waterways affecting water quality. The sediment and nutrients move as overland flow when rainfall transports these elements downhill. Increasing the threats are nutrient overuse and fertilizer application just before a rainfall event. Another water quality threat is fecal coliform bacteria from manure application prior to a rainfall event.

The main grassland pollutant is fecal coliform bacteria from grazing livestock that have direct access to streams and ponds. Other pollutants travel as overland flow and include nitrogen (from livestock manure) and sediment from cattle trails and gullies as well as overgrazed rangelands with little canopy cover. Within the BCMSHRW, most grassland pollutant loading stems from overgrazing where there is little to no grass cover to protect soil surfaces.

The remainder of the land use in the BCMSHRW is open water (0.3 %), urban (8.0 %), wetlands (0.4 %), and wooded area (1.0 %).[4] Of these land uses, the 8.0 % of urban land poses a constant concern to the BCMSHRW pollutant loading. There are twenty-eight permitted discharging waste water facilities in the watersheds including urban communities. Two communities have recently undergone structural upgrades to their facilities. However, the largest facility, the City of Hays, has undergone chemical upgrades for nitrogen but has not yet undergone structural upgrades to lower all nutrient concentrations in its effluent waters. Therefore, they continue to have a major impact on water quality in the BCMSHRW.



Land Cover	km^2	mi^2	Acres	Percent
Barren/Fallow Cropland	679.7	262.4	167,940.8	10.8%
Cropland	2,208.5	852.7	545,698.6	35.0%
Grassland	2,812.0	1,085.6	694,805.8	44.5%
Open Water	24.1	9.3	5,962.4	0.3%
Urban	502.5	194.0	124,156.8	8.0%
Wetlands	25.8	10.0	6,379.8	0.4%
Wooded Area	64.9	25.0	16,025.8	1.0%
Totals	6,317.4	2,439.1	1,560,970.0	100.00%

Figure 5. 2009 Big Creek Middle Smoky Hill River Watersheds Land Cover.

2.6 Precipitation in the BCMSHRW

Rainfall plays the ultimate role in the transportation, quantity, and intensity of erosion, nutrients, and bacteria within the watersheds. Precipitation and subsequent runoff transports sediment, nutrients, and bacteria by dislodging particles from rural and urban areas into streams. Intense rainfall events trigger sheet and rill erosion forming the beginning of gully erosion and can also erode streambanks. Consequently, sediment and nutrients enter the streams and rivers and drain into Kanopolis Reservoir.

To gain a better understanding of precipitation patterns, intensities, and yearly totals in the BCMSHRW, the WRAPS project initiated a watershed precipitation monitoring program in January of 2008. The project was facilitated by the Community Collaborative Rain, Hail and Snow (CoCoRaHS) network by following their national guidelines and utilizing their online database. The initial goal was to cover the majority of the watershed (Trego, Ellis, Russell, and Ellsworth counties) with 24 National Weather Service endorsed all-weather rain gauges in close proximity to monitoring locations. As of August 2011, there were nearly 100 gauges/volunteers across all sections of the watershed reporting precipitation.

The CoCoRaHS network, www.CoCoRaHS.org, is a network of precipitation gauges posted online to allow anyone to access precipitation information reported daily across the United States. Reports are posted online and maps are generated which show daily precipitation totals along with hail, floods, and other significant weather phenomenon. With the gauge, everything from light showers and heavy rain, to the lightest of snow, as well as hail is captured and measured. Daily information is used by WRAPS, volunteers, and those that access the CoCoRaHS website to plan daily activities or help the local National Weather Service in issuing significant weather warnings such as flooding, hail, or intense precipitation. The WRAPS project uses the precipitation reports to facilitate water quality efforts across the watershed by triggering stream sampling when heavy rainfall events occur. Data is compiled from the gauges on a monthly, quarterly, semi-annual, and annual basis to create interpolation precipitation maps of the watershed and document the spatial variability.

2.7 Designated Water Uses in the BCMSHRW

Within the watershed, there are several points in which the waters are open and accessible to the public for recreation use. In the BCMSHRW, Kanopolis Reservoir is the only Primary Class A (160 MPN/100mL *E. coli*) contact recreational water for public swimming. Fossil Lake, Big Creek Oxbow, Ellis City Lake, and segment 5 of Big Creek are classified as Primary Class B (262 MPN/100mL *E. coli*) and are open to and accessible by the public. Segment 1 of Big Creek, eastern portion of Center School HUC 12 in Ellis County, is a Primary Contact C (427 MPN/100mL *E. coli*) recreational stream segment not open to and accessible by the public. Beaver Creek, Goose Creek, and portions of the Smoky Hill River are also Primary Contact C recreational streams. All other surface waters in this watershed are generally used for aquatic life support (fish), human health supply, domestic water supply, recreation (fishing, boating, and swimming), groundwater recharge, industrial water supply, irrigation, and livestock watering. These are commonly referred to as the designated use as stated in the Kansas Surface Water Register, 2009, issued by KDHE (Table 1 & 2, Figure 6) (KDHE 2009).[5]

Table 1. Designated Water Uses in the BCMSHRW
(Segments of major streams are referenced by HUC 12s.)

Streams	AL	CR	DS	FP	GR	IW	IR	LW
Middle Smoky Hill River HUC 8								
Ash Creek	E	b	X					
Beaver Creek	E	C		X				
Big Timber Creek	E	b						
Buck Creek	E	b	X	X	X	X	X	X
Buffalo Creek	E	b		X				
Clear Creek	E	b	X					
Coal Creek	E	b						
Cow Creek	E	b						
Eagle Creek	E	b						
Fossil Creek	E	b	X	X	X	X	X	X
Goose Creek	E	C						
Landon Creek	E	b		X				
Loss Creek	E	b						
Mud Creek	E	b						
Oxide Creek	E	b						
Sellens Creek	E	b	O	X	X	O	X	X
Shelter Creek	E	b						
Skunk Creek	E	b	X					
Smoky Hill River - Cedar Bluff to Lookout Hallow	S	b	X	X	X	X	X	X
Smoky Hill River - Lookout Hallow to Pleasantdale Cemetery	S	b						
Smoky Hill River - Pleasantdale Cemetery to Thielen Airport	E	b						
Smoky Hill River - Thielen Airport to Kanopolis Lake	E	c						
Spring Creek	E	b						
Thompson Creek	E	b	X					
Turkey Creek	E	b						
Unnamed Stream (a)	E	a						
Unnamed Stream (b)	E	b						
Wilson Creek	E	b						
Wolf Creek	E	b						
Big Creek HUC 8								
Big Creek - East Center School	E	C	X	X	X	X	X	X
Big Creek – West Center School	E	b	X	X	X	X	X	X
Big Creek - City of Ellis to Center School	E	B	X	X	X	X	X	X

	AL	CR	DS	FP	GR	IW	IR	LW
Big Creek -								
City of Grinnell to City of Ellis	E	b	X	X	X	X	X	X
North Fork Big Creek	E	b	X	X	X	X	X	X
Chetolah Creek	E	a						
Mud Creek	E	b						
Ogallah Creek	E	b						
Walker Creek	E	b	X	O	X	X	X	X

Lakes	AL	CR	DS	FP	GR	IW	IR	LW
Middle Smoky Hill River HUC 8								
Fossil Lake	E	B	X	X	O	X	X	X
Kanopolis Lake	E	A	X	X	X	X	X	X
Big Creek HUC 8								
Big Creek Oxbow	E	B	X	X	X	X	X	X
Ellis City Lake	E	B	X	X	X	X	X	X

Designated use

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

Classification codes

A Secondary contact recreation stream segment by law or written permission of the landowner open to and accessible by the public.
B Primary contact recreation stream segment is by law or written permission of the landowner open to and accessible by the public.
b Secondary contact recreation stream segment not open to the public
c Primary contact recreation stream segment is not open and accessible by the public under Kansas law.
E Exceptional state waters.
O Referenced stream segment does not support the indicated designated use.
S Special aquatic life use water.
X Referenced stream segment is assigned the indicated designated use.

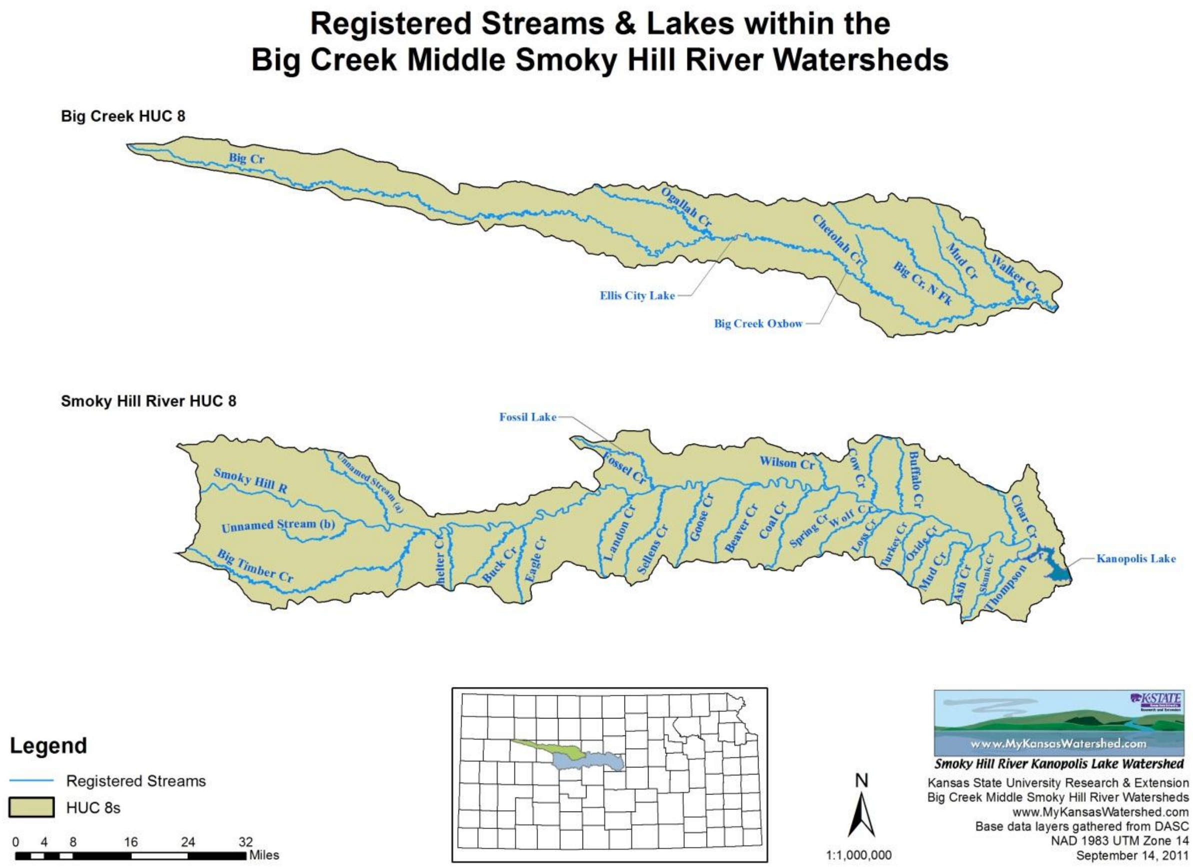


Figure 6. Registered Streams & Lakes within the BCMSHRW

2.8 Public Water Supply & NPDES Permits in the BCMSHRW

Many residents receive public water supply from Rural Water Districts (Figure. 7). Rural Water Districts derive their water supplies from groundwater sources and/or surface waters. A public water supply that derives its water from a surface water supply can be affected by sediment either with difficulties at the intake in accessing the water or in the treatment of the suspended sediment prior to distribution. Nutrients and fecal coliform bacteria also affect surface water supplies causing excessive chemical cost in treatment prior to distribution and public consumption and may also leave an undesirable taste or odor. Several public water suppliers reside within the BCMSHRW (Table 2).

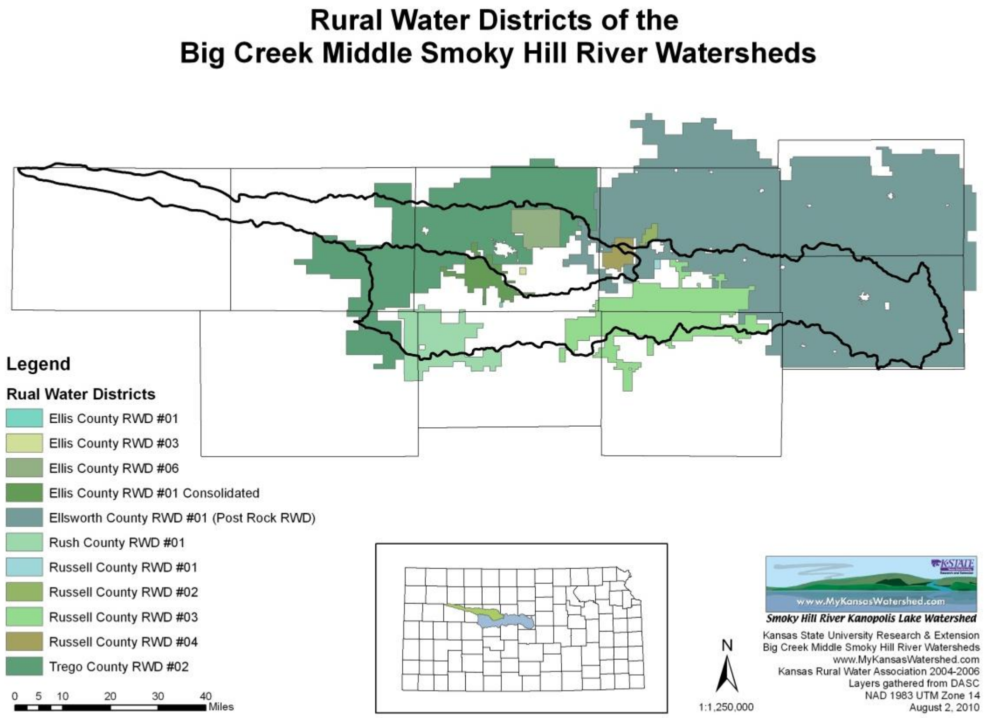


Figure 7. Rural Water Districts of the BCMSHRW.

Table 2. Public Water Supply Wells within the BCMSHRW and the Census 2000 Population of Service Area

Public Water Supply	Number of Wells within the BCMSHRW	Total Number of Wells	County	Population of Service Area [†]
Brownell, City of	1	4	Ness	48
Buffalo Hills Park	6	6	Ellis	90
Bunker Hill, City of	2	2	Russell	106
Collyer, City of	4	4	Trego	141
Country View Mobile Home Park	2	2	Ellis	358
Countryside Estates Mobile Home Park	5	5	Ellis	233
Dorrance, City of [a]	4	4	Russell	211
Ellis Co RWD #1	4	4	Ellis	232
Ellis Co RWD #2	2	2	Ellis	--
Ellis Co RWD #3	4	4	Ellis	269
Ellis Co RWD #5	4	4	Ellis	--
Ellis Co RWD #6	6	6	Ellis	490
Ellis Co RWD #7	3	3	Ellis	--
Ellis County RWD #1 Consolidated [f]	--	--	Ellis	455
Ellis, City of	13	13	Ellis	1,943
Ellsworth Co RWD #1 [a]	1[‡]	2	Ellsworth	7,894
Ellsworth, City of [a]	8	8	Ellsworth	3,075

Geneseo, City of	3	4	Rice	277
Grinnell, City of	2	4	Gove	351
Hays Suburban Estates	2	2	Ellis	65
Hays, City of	40	40	Ellis	20,449
Kanopolis, City of	6	6	Ellsworth	575
KDOT I-70 WaKeeney East Bound Rest Area	2	2	Trego	--
KDOT I-70 WaKeeney West Bound Rest Area	2	2	Trego	--
KSU Agricultural Research Center-Hays	3	3	Ellis	5
Liebenthal, City of	5	5	Rush	121
McCracken, City of [b]	4	4	Rush	218
Meadow Acres Mobile Home Court	5	5	Ellis	11
Nationwide Estates Mobile Home Court	3	3	Ellis	263
Park, City of	3	3	Gove	157
Quinstar Corporation	3	3	Gove	--
Quinter, City of	3	4	Gove	978
Rush Co RWD #1 [b]	4	4	Rush	217
Russell Co RWD #1	4	4	Russell	10
Russell Co RWD #2	--	2	Russell	106
Russell Co RWD #3 [c, d]	--	--	Russell	1,011
Russell Co RWD #4 [e]	5	5	Russell	99
Russell, City of	12‡	12	Russell	4,736
Trego County RWD #2 [f]	--	1	Trego	5,065
Victoria, City of	8	8	Ellis	1,239
WaKeeney, City of	11	11	Trego	2,074
USD 292 – Wheatland	3	3	Gove	--
Wilson, City of	4	4	Ellsworth	827
Sum of Supply Wells and Population	206	214		54,399

† Population according to Census 2000; values are for service, not the number of customers, values exclude any whole sell accounts supplied.
‡ One subsurface intake site within the BCMSHRW.

[a] Ellsworth Co RWD #1 supplies water to Brookville, Saline County RWD #7, Osborne County RWD #2, Luray, Gorham, Dorrance, Waldo, Ethanol Plant, and City of Ellsworth
[b] Rush Co RWD #1 purchases water from McCracken
[c] Purchases water from Otis, Rush County
[d] Supplies water to Susank, Barton County
[e] Purchases water from Gorham, Russell County
[f] Trego Co RWD #2 supplies water to Ellis Co RWD #1 Consolidated

Waste water treatment facilities are permitted and regulated by KDHE and are considered point sources of pollutants. The National Pollutant Discharge Elimination System (NPDES) permits specify the maximum amount of pollutants allowed to be discharged to surface waters by the permitee. It is important to know the location of these NPDES permitted facilities as their discharges impact waterways. Municipal waste water contains suspended solids, organisms that reduce oxygen in the water column, nitrates, phosphorus, inorganic compounds, and bacteria. Waste water is treated to remove solids and organic materials, disinfected to kill bacteria and viruses, and eventually discharged into surface waters. The end product of municipal waste water is similar across the country although there are different methods of how to reduce and remove potential pollutants. Any pollutant discharged from a point source is allowed by the state but is considered to be a Waste Load Allocation. The BCMSHRW has 28 NPDES facilities (Figure 8).

Based upon the intensive BCMSHRW monitoring network, several NPDES waste water treatment facility discharges have a significant influence on the pollutant levels within the watershed including total nitrogen and total phosphorus. This influence signals the need for facility operation upgrades. The Kanopolis Reservoir TMDL is taking into consideration allowable loads from point sources, with the City of Hays NPDES source being the largest contributor. As BMPs are implemented, the two primary waters that will benefit from implementation efforts will be Big Creek and Kanopolis Reservoir.

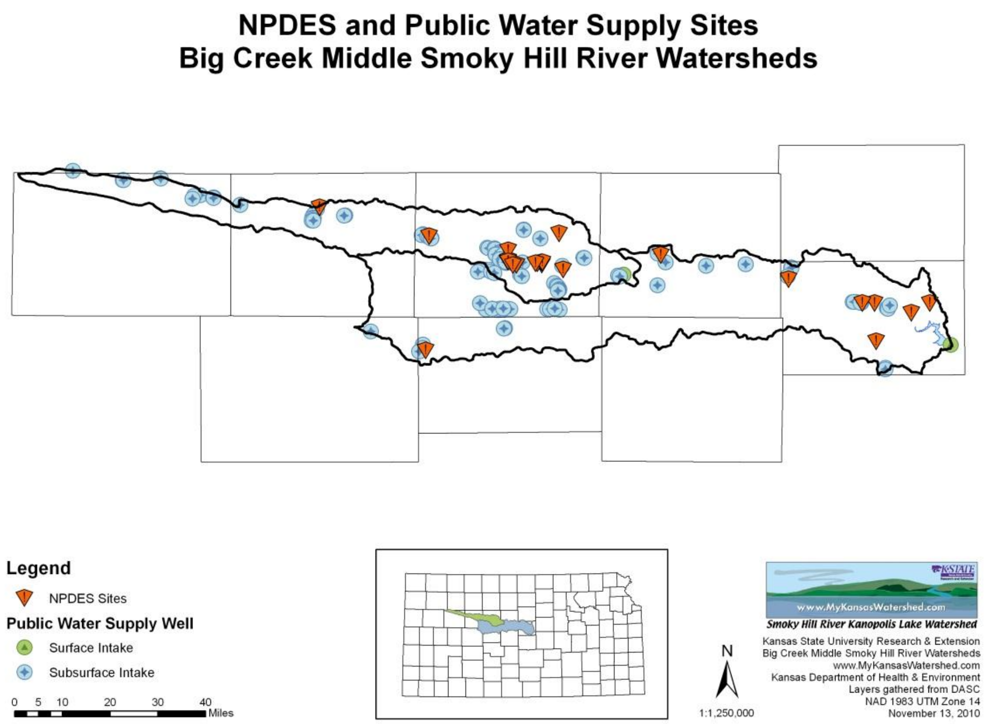


Figure 8. NPDES and Public Water Supply Sites in the BCMSHRW.

There are eight NPDES permitted facilities discharging to Big Creek and the Smoky Hill River above Kanopolis Lake. An additional twelve non-discharging facilities that do not contribute loads to Kanopolis are located within the watershed (Figure 7). There are also a number of cement plants, quarries, and dry batch concrete plants that retain their wastewater and reuse it for dust suppression. These plants do not contribute to any impairment in Kanopolis Lake.

The City of WaKeeney now operates a three-cell lagoon wastewater system in place of its old mechanical plant. Effluent from WaKeeney does not appear to flow consistently down channel toward Ellis. Observations made during use attainability analysis found the channel of Big Creek to be dry in Trego County.

The City of Ellis operates a low volume activated sludge treatment plant, whose effluent typically does not reach Hays according to Division of Water Resources field personnel. Effluent can be diverted to the municipal golf course for irrigation purposes. Ellis averaged 2.5 mg/L of phosphorus over 2004-2009 at an average discharge of 0.218 MGD.

The City of Hays discharges to Chetolah Creek which enters Big Creek south of the City. The plant averaged 1.9 MGD in discharge over 2003-2009 and averaged 6 mg/L of phosphorus in its wastewater. Like Ellis, effluent is diverted to irrigate several golf courses and ball fields with the remainder directed into Chetolah Creek.

Gorham's non-discharging, three cell lagoon system will be upgraded to discharge by August 2010. Wastewater will flow, maximum flow 0.0478 MGD, down an unnamed tributary to Walker Creek and then into lower Big Creek. Effluent can also be used to irrigate adjacent cropland.

McCracken has a three-cell lagoon system designed to discharge up to 0.035 MGD into the Big Timber Creek, but has not discharged since 2004 because of dry conditions and low population loads.

Russell discharges from a four-lagoon system into Fossil Creek, which then joins the Smoky Hill River downstream from the Big Creek confluence. Russell typically diverts a portion of its wastewater to irrigate its golf course. The city has averaged 0.6 MGD in wastewater the past six years with an average phosphorus content of 3.0 mg/L.

Wilson occasionally discharges from a 3-cell lagoon to Wilson Creek and has averaged 61 mg/L in TSS. Its designed wastewater flow is 88,000 gallons per day.

The City of Ellsworth discharges up to 0.5 MGD into Oak Creek from its 3-cell lagoon. The actual discharge averages 0.15 MGD and 2.5 mg/L of phosphorus. (NPDES information from KDHE T. Stiles, personal communication, October 25, 2010)

Table 3. NPDES facilities entering Big Creek and Middle Smoky Hill River Watersheds

	Type	Stream	Discharge (MGD)	Permit Expires
City of Hays - WWTP	Activated Sludge	Chetolah Creek	2.80	02/28/2014
City of Russell - WWTP	Activated Sludge	Fossil Creek	1.40	05/31/2014
City of Ellsworth - WWTF	3-Cell Lagoon	Oak Creek	0.50	06/30/1014
City of Ellis - WWTP	Aeromod Activated Sludge	Big Creek	0.30	03/31/2014
City of WaKeeney - WWTF	3-Cell Lagoon	Big Creek Tributary	0.25	12/31/2010
City of Wilson - WWTF	3-Cell Lagoon	Cole Creek	0.09	09/30/2014
City of Gorham -MWTP	3-Cell Lagoon	Walker Creek	0.06	09/30/2014
McCracken - MWTP	3-Cell Lagoon	Timber Creek	0.04	09/30/2014
APAC-KS-Shears Hays Plant	Retention Basin	Big Creek	0.00	09/30/2012
APAC-KS-Shears Hays Plant	Non-Overflowing	N/A	0.00	01/31/2010
City of Grainfield	Non-Overflowing	N/A	0.00	01/31/2010
City of Grinnell	Non-Overflowing	N/A	0.00	01/31/2010
City of Liebenthal – MWTP	Non-Overflowing	N/A	0.00	10/31/2012
City of Schoenchen - MWTP	Non-Overflowing	N/A	0.00	08/31/2010
City of Victoria	Non-Overflowing	N/A	0.00	05/31/2010
Ellis County Concrete	Retention Basin	Big Creek Tributary	0.00	09/30/2012
Kanopolis - MWRP	Non-Overflowing	N/A	0.00	02/28/2015
KDOT Gove I-70 Rest Area	Non-Overflowing	N/A	0.00	01/31/2010
KDOT Russell I-70 Rest Area	Non-Overflowing	N/A	0.00	03/31/2015

KDOT Trego I-70 Rest Area	Non-Overflowing	N/A	0.00	03/31/2010
KDWP - Kanopolis (East)	Non-Overflowing	N/A	0.00	05/31/2015
KDWP – Kanopolis (South)	Non-Overflowing	N/A	0.00	05/31/2015
Munjor Improvement District	Non-Overflowing	N/A	0.00	03/21/2010
Service Oil Company	Non-Overflowing	N/A	0.00	01/31/2015
SS Jests	Non-Overflowing	N/A	0.00	03/31/2008
Stuckey's Dairy Queen	Non-Overflowing	N/A	0.00	12/31/2010
SunMart	Non-Overflowing	N/A	0.00	05/31/2015
USD #292	Non-Overflowing	N/A	0.00	03/31/2010

There are numerous onsite waste water systems (home septic systems) within the watersheds. No accurate count of these systems exists and their functional condition is generally unknown. The BCMSHRW WRAPS Agency Advisors estimate in Trego County 15%, 21% in Ellis County, 15% in Russell County, and 65% in Ellsworth County are either failing or inadequately constructed. All counties in the watersheds have sanitary codes and work with Local Environmental Protection Groups (LEPG).

2.9Aquifers in the BCMSHRW

Three aquifers lie beneath the BCMSHRW: 1) an alluvial aquifer, 2) the High Plains Aquifer, and 3) the Dakota Aquifer (Figure 9). The alluvial aquifer is a part of and connected to the river system and consists of sediments deposited by the rivers in the stream valleys. The High Plains Aquifer sometimes referred to as the Ogallala Aquifer is a vast yet shallow underground water table located beneath the Great Plains from the southern panhandle of Texas to the southern portions of South Dakota. The Dakota Aquifer is mostly beneath Kansas, Colorado, and Nebraska. The Dakota aquifer is influenced primarily by regional and local topography and results in an easterly flow of ground water across the region. Dakota water is typically considered too high in chlorides for direct human consumption (KGS 1996).[6]

Private wells are an important water source for many residents in the watershed whether it be for drinking water for human or livestock consumption or irrigation for crops or lawns. The LEPG estimated the following numbers of private wells in the BCMSHRW counties: Trego County – 305, Ellis County – 6,300 (with approximately 2,800 in the City of Hays), Russell County – 281, Ellsworth County – 696, and Barton County – 1,720. It is noted that not all private wells are registered due to oversight or lack of willingness by well owners. Without the known registration which includes an inspection of proper construction, many of these wells may be improperly constructed and/or maintained and may be a source of nitrogen and phosphorus pollutants. However, there is no accurate way to account for the pollutant influence from the private wells

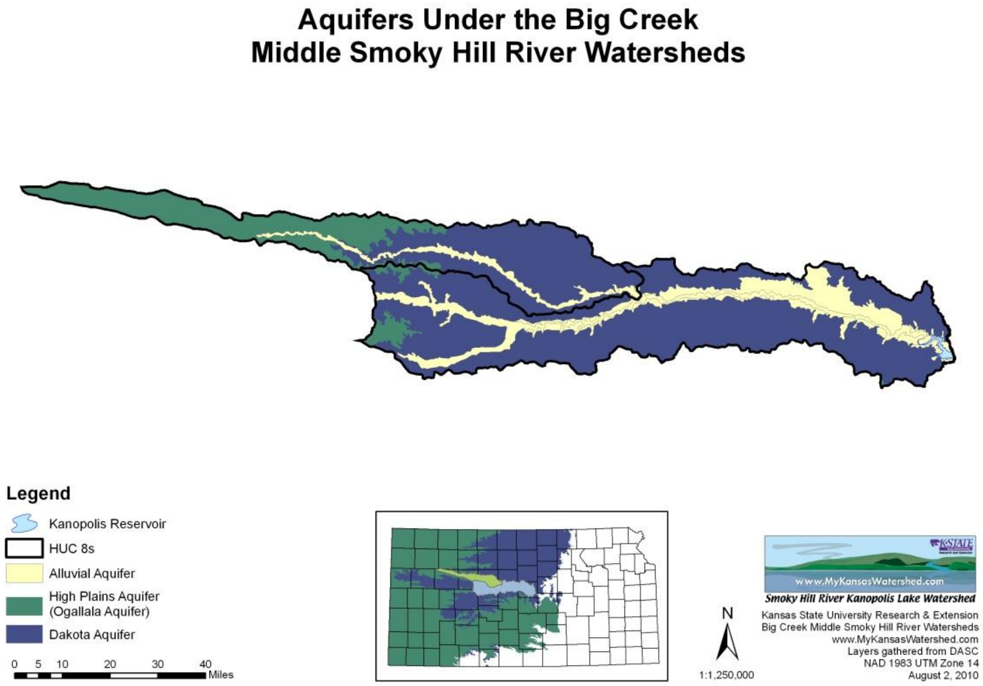


Figure9. Aquifers under the BCMSHRW.

2.10 Special Aquatic Life Use Waters in the BCMSHRW

Special aquatic life use waters are defined as surface waters that contain combinations of habitat types and indigenous biota not found commonly throughout the state, and/or surface waters that contain state and federal threatened and/or endangered species. The BCMSHRW has a special aquatic life use designation in segments 5, 7, and 9 of the Smoky Hill River (Figure 10).[5] The Topeka Shiner is a threatened and endangered species in Ellis County. Species in need of conservation include the Cylindrical Papershell Mussel and Wabash Pigtoe Mussel in Ellsworth County and the Plains Minnow in Ellis County. Pollutant threats to these waters are TSS reducing light penetration into streams and siltation; TN and TP leading to eutrophication and lowered dissolved oxygen levels.

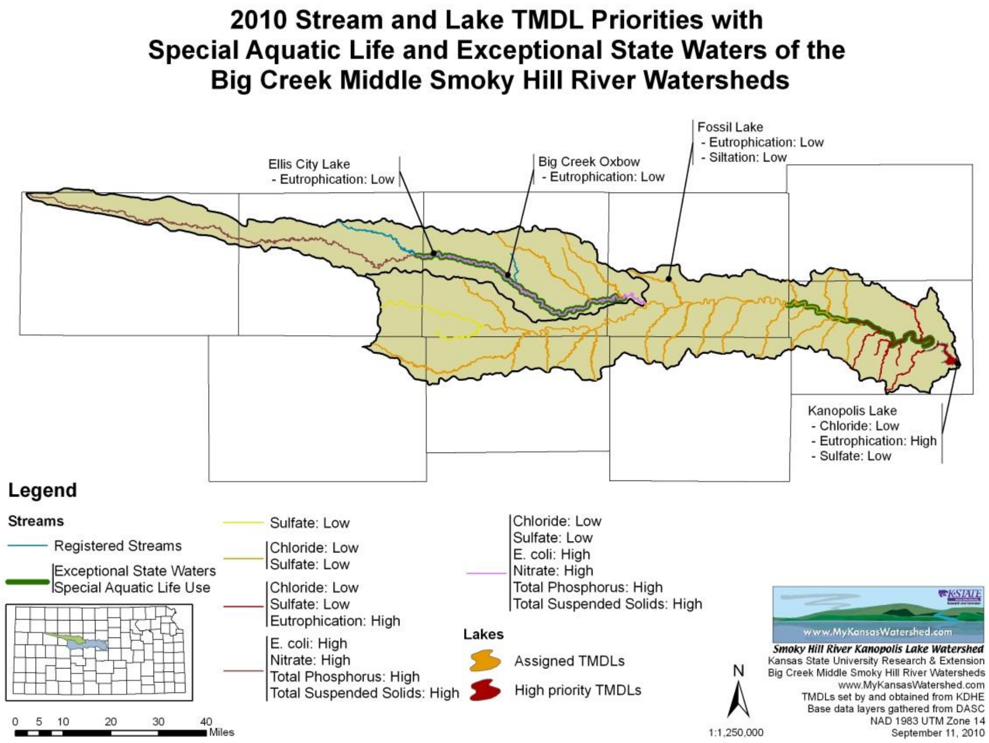


Figure 10. BCMSHRW Stream and Lake TMDL Priorities with Special Aquatic Life & Exceptional State Waters.

2.11 TMDLs in the BCMSHRW

A TMDL designation sets the maximum amount of a pollutant that a specific body of water can receive without violating the surface water quality standards, resulting in failure to support their designated uses. The TMDLs provide a tool to target and reduce point and nonpoint source pollution. The TMDLs established by Kansas are done on a watershed basis and may use a pollutant by pollutant approach, bio-monitoring approach, or both as appropriate.

The TMDLs in the BCMSHRW were established based on both approaches in cooperation with KDHE and the BCMSHRW WRAPS monitoring project (Figure 10 and Table 4). A TMDL establishment entailed a draft TMDL with a public notice and comment period, consideration of public comments, necessary revisions, and EPA approval. The desired outcome of the TMDL process was indicated, using the current situation as the baseline. Deviations from the water quality standards were documented. The TMDL states its objective of meeting the appropriate water quality standard by quantifying the degree of pollution reduction expected over time. Interim objectives were also defined for midpoints in the implementation process.[7]

Table 4. Impaired Waters with EPA Approved TMDLs in the Big Creek Middle Smoky Hill River Watersheds.

Water Body	Impaired Use	Impairment	Priority	KDHE Monitoring Station
Middle Smoky Hill (10260006)				
Coal Creek Near Wilson	Water Supply	Chloride	Low	SC733
Fossil Creek Near Russell	Water Supply	Chloride	Low	SC713
Kanopolis Lake	Water Supply	Chloride	Low	LM016001
Landon Creek Near Russell	Water Supply	Chloride	Low	SC714
Sellens Creek Near Russell	Water Supply	Chloride	Low	SC736
Smoky Hill River at Ellsworth	Water Supply	Chloride	Low	SC269
Smoky Hill River Near Russell	Water Supply	Chloride	Low	SC007
Smoky Hill River Near Wilson	Water Supply	Chloride	Low	SC723
Fossil Lake	Aquatic Life	Eutrophication	Low	LM052601
*Kanopolis Lake	Aquatic Life	Eutrophication	High	LM016001
Coal Creek Near Wilson	Water Supply	Sulfate	Low	SC733
Fossil Creek Near Russell	Water Supply	Sulfate	Low	SC713
Kanopolis Lake	Water Supply	Sulfate	Low	LM016001
Landon Creek Near Russell	Water Supply	Sulfate	Low	SC714
Sellens Creek Near Russell	Water Supply	Sulfate	Low	SC736
Smoky Hill River at Ellsworth	Water Supply	Sulfate	Low	SC269
Smoky Hill River Near Russell	Water Supply	Sulfate	Low	SC007
Smoky Hill River Near Schoenchen	Aquatic Life	Sulfate	Low	SC539
Smoky Hill River Near Wilson	Aquatic Life	Sulfate	Low	SC723
Big Creek (10260007)				
**Big Creek Oxbow	Aquatic Life	Eutrophication	Low	LM070301
Ellis City Lake	Aquatic Life	Eutrophication	Low	LM069601
N. Fork Big Creek Near Walker	Water Supply	Sulfate	Low	SC715
N. Fork Big Creek Near Walker	Water Supply	Chloride	Low	SC715
*Big Creek Near Munjor	Recreation	E. coli	High	SC540
*Big Creek Near Munjor	Water Supply	Nitrate	High	SC540
*Big Creek Near Munjor	Aquatic Life	TSS	High	SC540
Impaired Waters with Draft TMDLs Pending				
Big Creek (10260007)				
*Big Creek Near Munjor	Aquatic Life	Total Phosphorus	High	SC540

* Waters directly addressed by Target HUC 12s.
** Waters indirectly addressed by Target HUC 12s.

KDHE TMDL Watershed Management Section reviews TMDLs assigned in each of the twelve basins of Kansas every five years. The review schedule for the Smoky Hill/Saline Basin is listed in Table 5.

Table 5. TMDLs Review Schedule for the Smoky Hill/Saline River Basin.

Year Ending in September	Implementation Period	Possible TMDLs to Revise	TMDLs to Evaluate
2009	2010-2019	2003	N/A
2014	2015-2029	2003, 2004	2003, 2004, 2006
2019	2020-2029	2003, 2004, 2009	2003, 2004, 2006, 2009

2.12 303(d) Listings in the BCMSHRW

For the Smoky Hill/Saline Basin, the 303(d) list of non-TMDL impaired waters was reviewed in 2009 with new listings approved in 2010. The generation the 303(d) list is an essential planning and guidance tool for the State of Kansas and the BCMSHRW WRAPS project. The Kansas 2010 303(d) list not only identifies those water bodies from the 2008 303(d) list which still await TMDLs, but also identifies new water bodies and pollutants for which TMDLs will be needed. Water bodies were assigned a priority for TMDL development by assessing the frequency, magnitude, and duration of impairment by a pollutant, as well as considering public comment. To be included on the 303(d) list, samples taken through the KDHE monitoring program had to show that water quality standards were not being reached. These actions all had to be approved by the EPA (KDHE 2010).[8] The 303(d) listings for the BCMSHRW are indicated in Table 6 and Figure 11 and waters benefiting from targeting HUC 12 watersheds are shown in Figure 12.

Table 6. Non-TMDL Impaired Waters (303d List) in the Big Creek Middle Smoky Hill River Watersheds.

Water Body	Impaired Use	Impairment	KDHE Monitoring Station
Middle Smoky Hill (10260006)			
Fossil Creek Near Russell	Water Supply	Arsenic	SC713
**Smoky Hill River At Ellsworth	Aquatic Life	Biology	SC269
Coal Creek Near Wilson	Aquatic Life	Dissolved Oxygen	SC733
Fossil Creek Near Russell	Aquatic Life	Selenium	SC713
Landon Creek Near Russell	Aquatic Life	Selenium	SC714
Sellens Creek Near Russell	Aquatic Life	Selenium	SC736
Smoky Hill River Near Russell	Aquatic Life	Selenium	SC007
Smoky Hill River Near Schoenchen	Aquatic Life	Selenium	SC539
Smoky Hill River Near Wilson	Aquatic Life	Selenium	SC723
Fossil Creek Near Russell	Aquatic Life	Total Phosphorus	SC713
**Smoky Hill River Near Russell	Aquatic Life	Total Phosphorus	SC007
Coal Creek Near Wilson	Aquatic Life	TSS	SC733
Big Creek (10260007)			
*Big Creek Near Munjor	Aquatic Life	Total Phosphorus	SC540
*North Fork Big Creek Near Walker	Aquatic Life	Total Phosphorus	SC715

* Waters directly addressed by Target HUC 12s.

** Waters indirectly addressed by Target HUC 12s.

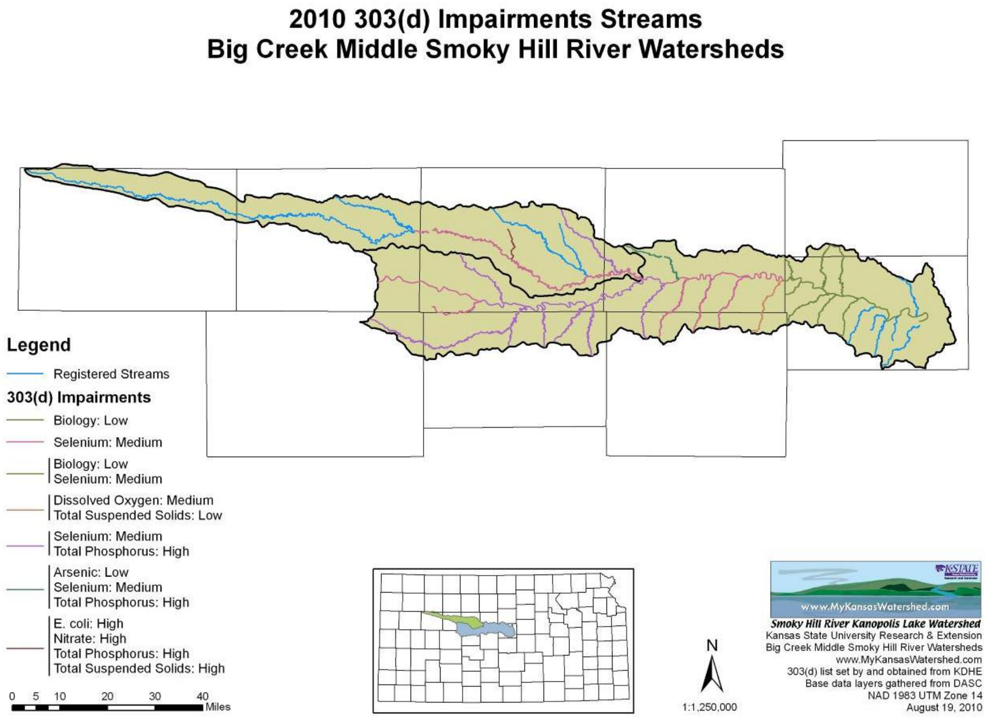


Figure 11. The 2010 303(d) Impairments Streams in the BCMSHRW.

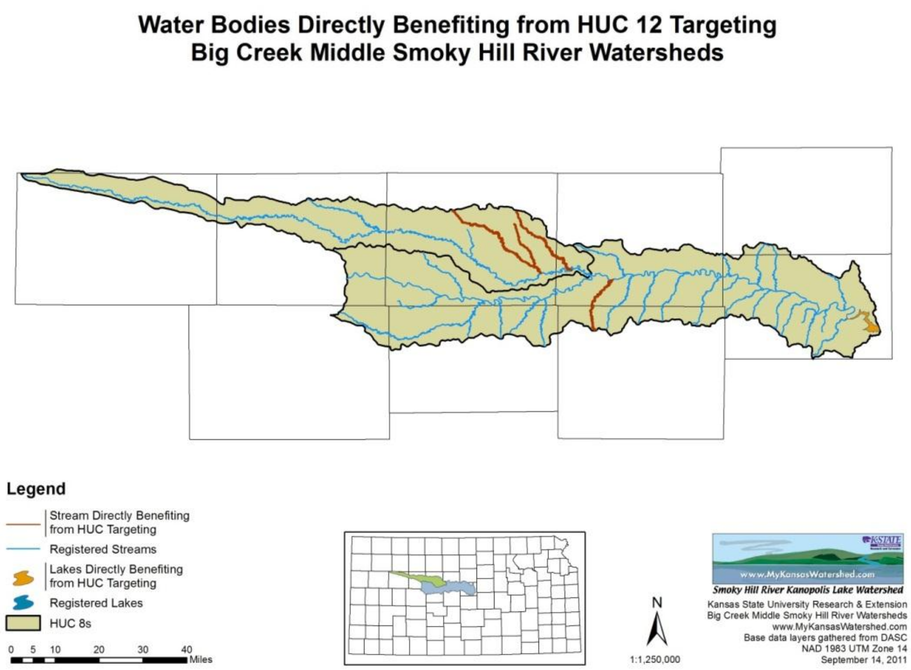


Figure 12. Water Bodies Directly Benefiting from HUC 12 Targeting in the BCMSHRW

2.13 TMDL-NPS Load Allocations in the BCMSHRW

TMDL loading is derived on several key factors. One factor is waste load allocations for point sources such as NPDES facilities, CAFOs, and other state and federally regulated sites. A second factor is the natural or background load allocations such as atmospheric deposition or natural mineral deposition content in the waters. After removing all point source and natural contributions, the amount of load remaining is the NPS Load Allocation. All Best Management Practices (BMPs) derived by the Leadership Team will be directed toward achieving load reductions from nonpoint sources to achieve the NPS load allocations as part of the new load capacity entering the reservoir (T. Stiles, personal communication, October 23, 2009).

2.13.1 Total Nitrogen and Phosphorus in the BCMSHRW

Estimated pollutant loads to achieve a chlorophyll concentration of 12 ppb in Kanopolis Lake were made through a simplified adaptation of the BATHTUB Eutrophication model (CNET). The 2003 TMDL used the results of this model to establish a desired annual TP load of 73,920 lbs/yr and a TN load of 384,345 lbs/yr as the load capacity to achieve the chlorophyll target in the reservoir. These were calculated to be 40% and 48% reductions in current annual phosphorus and nitrogen loading. An environmental margin of safety and point source waste load allocations (57% and 67% for TP and TN, respectively) comprise a majority of the load capacity, thereby requiring non-point sources to reduce their current annual loading by 48% (37,735 lbs/yr) for TP (Table 7) and 52% (288,780 lbs/yr) for TN (Table 8). These annual reduction targets for TN and TP are the basis for implementation decisions in selecting key contributing watersheds within the BCMSHRW as well as the preferred suite of Best Management Practices used to reduce nutrient loads and demonstrate the load reductions needed to meet the 2003 Kanopolis Lake EU TMDL and the Big Creek TMDLs**.** By reducing nutrient loads in the BCMSHRW, we will also accomplish the Watershed Plan goals to: protect and restore water quality; protect public drinking water supplies; protect the water supply storage capacity at Kanopolis Reservoir, and protect recreational uses at Kanopolis Reservoir.

Table 7. BCMSHRW TMDL Summary for Total Phosphorus including the Big Creek TMDL and the Kanopolis Lake EU TMDL

TP Load		TP pound/year
Load Allocation	+	73,920
Environmental Margin of Safety	-	7,392
TP Waste Load Allocation – NPDES	-	25,575
TP Load Allocation – NPS	-	40,953
TP Nonpoint Load that needs to be Reduced	=	37,735

Table 8. BCMSHRW TMDL Summary for Total Nitrogen including the Big Creek TMDL and the Kanopolis Lake EU TMDL

TN Load		TN pound/year
Load Allocation	+	384,345
Environmental Margin of Safety	-	0
TN Waste Load Allocation – NPDES	-	135,500
TN Load Allocation – NPS	-	248,845
TN Nonpoint Load that needs to be Reduced	=	288,780

2.13.2 Eutrophication & Dissolved Oxygen in the BCMSHRW

Nonpoint sources are the main contributor for eutrophication in the BCMSHRW. Excess nutrients (N & P) originate from rural and urban fertilizer, livestock and feedlot manure, wildlife, and failing onsite waste water systems. Eutrophication creates conditions favorable for undesirable algal blooms, fish kills, and excessive weedy plant growth. Excessive nutrient loading creates accelerated rates of eutrophication, blooms of undesirable algae, and decrease the amount of dissolved oxygen (DO) in the water. This phenomenon results in unfavorable habitat for aquatic life.

Abundant dissolved oxygen naturally occurs in the streams and creeks of the BCMSHRW during periods of sufficient flow and low pollutant loading. A lack of stream flow and an increase in water temperatures from a lack of riparian shading, and nutrient and organic enrichment are the primary causes for low dissolved oxygen in the watersheds.

2.13.3 Bacteria in the BCMSHRW

Bacteria sources in the BCMSHRW are found mainly from non-point sources related to livestock and pet waste. Within the Big Creek Watershed, bacteria sources within the urban environments are tied to pet waste and in the rural areas as a result of livestock having access to water sources. In addition, the presence of bacteria and quantities fluctuate due to the season and the amount of precipitation. Plus, in the spring and summer months, within the Big Creek Watershed the benchmark to check for quantities gets tighter due to primary contact of humans in Big Creek. The Middle Smoky Hill River Watershed also has minimal problems with bacteria counts seasonally as well but the primary contact for recreation is not of concern due to the lack of accessibility to the water bodies. In developing the Watershed Plan, accounting for bacteria and its relationship to nutrients is important and as nutrients from livestock and pet waste are addressed in the plan, bacteria is addressed as well which will result in reductions.

Based upon monitoring data, there are locations in the target areas and watersheds that would benefit from installation of BMPs addressing animal waste. The resiliency of *E. coli* is affected by environmental factors such as initial bacteria concentrations, intensity of storm events, temperature, the amount of ultraviolet radiation from sunlight, and amount of organic material in the surrounding area. As nutrient load reductions decrease, *E. coli* bacteria levels will follow. Bacteria reductions should be detected as a change (lowering) of the index profiles after 5 years of BMP implementation. BMPs that will reduce *E. coli* bacteria are listed in Table 18.

Bacteria TMDLs were first developed using fecal coliform bacteria data in 1999. Since then, the bacteria indicator has changed to *E. coli* and the manner in which to assess bacteria has also changed to look at the geometric mean of at least five samples taken within a given 30-day period. Bacteria loads are nonsensical, resulting in exponential numbers, given that high bacteria levels coincide with the high flows of storm water runoff. The ability of any given practice to abate bacteria pollution comes down to its ability to detain bacteria-laden water long enough to kill off the bacteria. Because of the unique situation that defines bacteria impairment, an alternative manner to assess “load” reductions was needed.

The critical measure of improving the sanitary conditions of a stream is to not only reduce the magnitude of bacteria in samples collected in any of the streams comprising the BCMSHRW, but to also reduce the frequency of high bacteria levels as well as the duration of time those levels exist. In order to measure these reductions, the bacteria count values of individual samples are transformed using logarithms and normalized by dividing by the logarithm of the applicable bacteria criterion. For many streams, the primary contact recreation criterion (B and C) is either 262 or 427 counts (units MPN/100mL). Depending upon the human accessibility of the stream around the urban centers, these streams are classified more stringently. For all other tributaries and streams, the contact recreation criterion is secondary and is either 2,358 or 3,842 counts. The resulting ratio creates an index of relative conformance to the water quality standards. The frequency distribution of the ratios for a given stream is then derived, creating a bacteria profile for the stream, displaying the proportion of samples that are less than the criterion (the unity line).

That profile line serves as the baseline of current conditions and the expectation for load reduction is that practices to abate bacteria entering the stream will result in a future profile of sample index values that lie under the current line, and hopefully with a majority of the profile below 1. The three characteristics of magnitude, duration, and frequency are represented by the profile lines and demarcate the reduction in "loading" of bacteria.

Reductions in magnitude are represented by smaller index values comprising the profile. Reduced duration is marked by a lowering of the profile line, thereby reducing the area lying between the unity line (criterion) and the upper portions of the profile. Reduced frequency is deduced by movement of the crossover point where the profile intersects unity further to the right, indicating that an increased percentage of samples show compliant conditions relative to the criterion value. (Note there is still allowance for occasional spikes of high bacteria, provided they do not occur frequently.)

Load reduction in the future is seen as downward movements of subsequent sample profiles to a point where there is reason to intensively sample the stream. Intensive sampling would then occur four different times during the April-October primary recreation season, in the manner prescribed by the water quality standards (five samples taken within 30-days). From those intensive data, the decision can be made as to whether the stream now meets water quality Standards.

As with the other impairments, bacteria should be fully treated by the point sources and thus, there are no waste load allocations to be assigned to the NPDES facilities.

2.13.4 Chloride & Sulfate in the BCMSHRW

Chloride (Cl) is a naturally occurring inorganic mineral found in Kansas lakes, streams, and groundwater. In high concentrations, chloride can cause adverse taste, hypertension in humans, and deterioration of domestic plumbing, water heaters, and municipal water works. The TMDL goal for chloride is set at 250 mg/L for drinking water consumption. Chloride intrusion results from parent bedrock material (halite) that underlies surface waters and leaches chloride into the water. Groundwater contamination is a result of natural leaching and improperly constructed water wells allowing confined aquifers to come into contact with each other.

Sulfate (S) is another naturally occurring mineral that is found dissolved in Kansas waters. It causes taste and odor problems in drinking water. Sources of sulfate are similar to those of chloride: natural leaching from parent bedrock material (gypsum and pyrite) and irrigation discharge from the Dakota Aquifer. Variations of water flow can cause fluctuations in sulfate concentrations in streams since runoff from a substantial rainstorm will dilute the sulfate concentration. Conversely, evaporation of surface waters and low water flow increases the sulfate concentration in the water.

Since these elements and compounds occur naturally at high concentrations within the BCMSHRW, the Leadership Team will not focus efforts to lower these concentrations through BMP implementation as costs would exceed reasonable justification.

3.0 Critical Targeted Areas in the BCMSHRW

The physical characteristics of BCMSHRW have been assessed using a variety of field and theoretical methods. These methods included: 1) a stream monitoring network to analyze, quantify, and target pollutant loading in subwatersheds of the BCMSHRW, 2) a watershed conditions driving tour using custom GIS assessment tool (WKCAT), and 3) computer modeling including the Universal Soil Loss Equation (USLE) and the Soil and Water Assessment Tool (SWAT) to estimate theoretical pollutant loads by subbasin and field. The WRAPS Leadership Team decided a diversity of assessments would yield a greater probability of pinpointing critical areas within the watersheds. By focusing efforts in critical targeted areas, we will also accomplish the Watershed Plan goals to: protect and increase the productivity of agricultural lands; continue sustainability of land conservation, and protect the water supply storage capacity at Kanopolis Reservoir.

3.1 Stream Monitoring Network in the BCMSHRW

In 2006, the WRAPS Leadership Team decided that due to the vast size of the watershed, an extensive stream monitoring network needed to be established. Serving as the baseline for BMP placement, the strategic placement of monitoring sites by a collaboration of local county extension agents, local NRCS field offices, local conservation districts, the WRAPS Leadership Team, KSU Watershed Staff, and KDHE Watershed Management Section would lead to cost effective use of targeting funds. Parameters analyzed in each sample included those whom had TMDLs listed throughout the BCMSHRW. Such parameters included TN, TP, TSS, and *E. coli* bacteria with other stream chemistry biological parameters such as pH, dissolved oxygen, and specific conductivity. Samples were collected for both base flow and storm flow events to gain natural background load and anthropogenic factors. Samples were collected following a TMDL sweep of 5 samples in 30 days completed on a quarterly and seasonal basis (January, April, July, and October) at each of the sites (Figure 13). A minimum of one sample was collected between these TMDL sweeps with not more than 35 days between samples. Storm flow samples were originally isolated to the City of Hays following a minimum of a 0.50 inch rainfall but soon expanded watershed wide. Storm flow watershed samples were collected after at least 1.50 inches rainfall in rural area. The grab samples were collected at a mid-channel (i.e., thalweg) location just below the water surface. Since 2006, monitoring locations have spatially moved as needs of targeting have changed. Once a location (i.e., subwatershed) has one year of sampling data, data is processed and if the location is deemed within pollutant loading standards that site is removed from routine monitoring. As of April 2011, there were 33 routine monitoring sites across the BCMSHRW. Stream monitoring is expected to continue to target and ground truth pollutant loading.

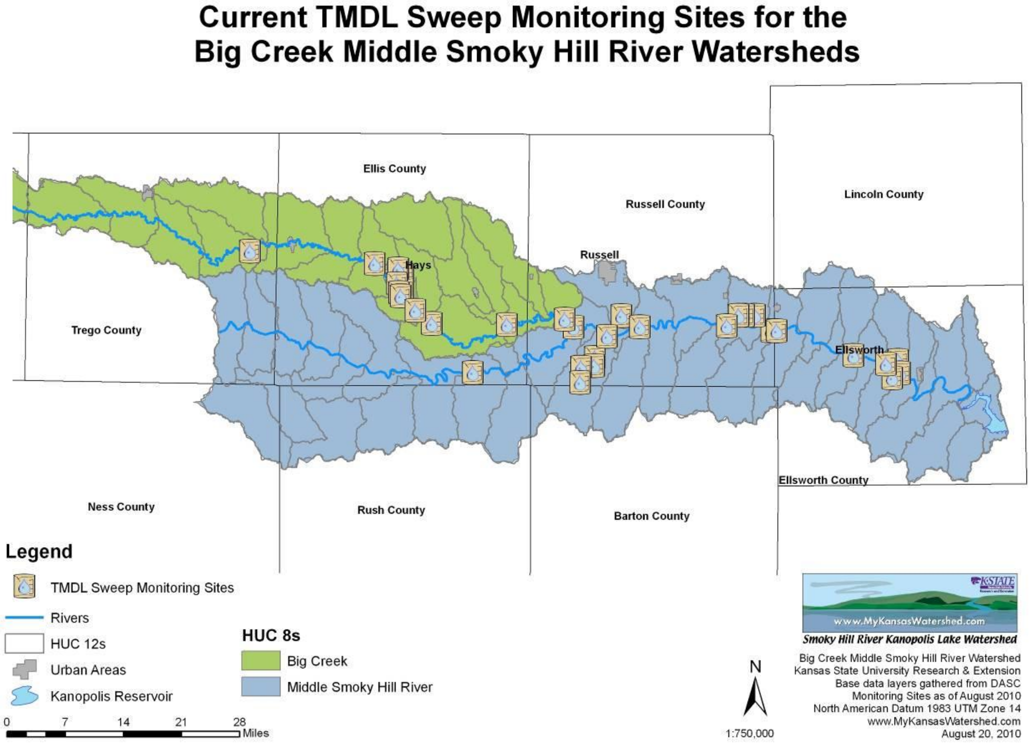


Figure 13. Current TMDL Monitoring Sites in the BCMSHRW.

To facilitate implementation of its water quality monitoring program, BCMSHRW has identified the following monitoring objectives for surface water quality monitoring. The monitoring objectives that are addressed include: 1) determine surface water quality conditions in the BCMSHRW, 2) characterize the spatial and temporal distribution of water quality conditions at various locations in the BCMSHRW, 3) determine if water quality conditions attributed to the urban and agriculture influences in the BCMSHRW are improving, degrading, or staying the same over time, 4) determine if these surface water conditions impact the quality of Kanopolis Reservoir, 5) determine which tributaries produce the largest negative water quality conditions at the primary inflow tributaries and their contribution to the contaminant loading in the reservoir, and 6) assess water quality conditions of sub-watersheds where best management practices have been implemented and measure the improvement in the impaired condition.[9]

In 2009, when the WRAPS team requested grant funds to continue to meet the WRAPS priority goals, targeting was one of the requirements by KDHE and EPA’s 9-Element Watershed Plan. The WRAPS team felt that the monitoring data was conclusive but needed more to justify to local landowners why potentially their land was a contributing pollutant loading. In addition to the stream monitoring network, the leadership team decided in order to implement a highly targeted BMP plan, a ground-truthed land cover characterization across the watersheds was needed.

3.2 Watershed Land Cover Characterization

In 2009-2010, a land cover characterization was accomplished using a custom GIS assessment tool, Western Kansas Cropland Assessment Tool (WKCAT), to characterize subwatersheds by common land units (CLUs). Identification of crop fields, grasslands, feeding sites, tillage practices, and conservation practices on the ground was vital to understanding areas within the watersheds which were contributing to pollutant loading. The BCMSHRW land cover and condition surveys completed within the targeted areas, as identified by the monitoring program, documented current conditions. These surveys were completed by watershed personnel, local agency personnel, and members of the Leadership Team that were familiar with the area and its historic land use. With a tablet computer and ArcView 3.3 software, subwatersheds were visually and spatially assessed looking at crop and tillage practices, rangeland conditions, visible erosion, and best management practices with the developed Western Kansas Cropland Assessment Tool (WKCAT)[Δ]. WKCAT used the attribute table of existing polygon shape files such as the UDSA Farm Service Agency's (FSA) common land units (CLUs). Georeferenced watershed data was used to spatially depict the condition of the subwatersheds in conjunction with the other geospatial erosion models and equations such as the Universal Soil Loss Equation (USLE).

The watershed condition survey provided ground-truth documentation on current BMP adoption rates, photographic documentation, and brought forth additional water quality concerns not captured by watershed modeling and monitoring. In 2009, the survey provided current adoption rates for four BMPs including buffer strips, no-till tillage, terraces, and grass waterways.

[Δ] *This assessment program was developed and designed to meet the data management and analysis needs of the BCMSHRW. It is available for download at http://sites.google.com/site/wkcathome/home in both ArcView 3.3 and ArcMap 9.3 formats.*

3.3 Universal Soil Loss Equation (USLE)

The Universal Soil Loss Equation (USLE) was developed by the National Runoff and Soil Loss Data Center and in corporation with Purdue University (Wischmeier & Smith, 1978)[10]. During development, more than 10,000 plot-years of runoff and soil loss data was analyzed in order to aid in the equation. The USLE can only predict the long-term average soil loss and is not what each field will lose every year. However, a theoretical prediction of the maximum loss that is possible is achievable and more accurate when comparing sites respectively with the USLE. Three major factors are used in the equation to estimate soil loss: soil erodibility factor (K-factor), length of slope (LS-factor), and land cover (C-factor). Other factors such as practices in place (P-factor), and precipitation factor (R-factor) can be added into the equation (Modified USLE). The USLE equation is expressed by the sum of the factors with the result being soil loss in tons per acre per year.

The USLE was processed in a GIS environment for the BCMSHRW in order to assess the soil loss spatially. The LS-factor from a 10 meter National Elevation Dataset was obtained from the United States Geological Survey (USGS). The K-factors were directly obtained from the NRCS Soil Survey (SSURGO) and C-factors were derived from the 2005 National Land Cover Database. The results of the USLE were then assigned to their respected CLUs and an overlay analysis was performed with the watershed condition survey data. The result was a cartograph depicting CLUs that theoretically erode five tons per acre per year or more, CLUs that exhibited visible erosion, and CLUs that did not have BMPs in place at the time of the field survey.

3.4 Soil and Water Assessment Tool (SWAT)

The Soil and Water Assessment Tool (SWAT) model was developed by the USDA Agricultural Research Service over the course of many years (Gassman et al., 2007)[11]. The SWAT models a watershed by dividing the study area spatially into subwatershed using digital elevation data. To distinguish between SWAT subwatersheds and current HUCs, the BCMSHRW will refer to subbasins in reference to the SWAT model. The SWAT is currently a supported soil erosion model by the USDA and is under continuous review with the latest version known as SWAT 2005. The BCMSHRW ran the SWAT 2005 model within the MapWindows GIS environment. Similar to the USLE, the major parameters within SWAT were land cover, soil properties, and topography. Data used for these parameters included the National Elevation Dataset, obtained from the USGS, 2009 land cover from the USDA National Agricultural Statistics Service, and soil data from the NRCS. The included SWAT 2005 climatic conditions were used in order to obtain a base run for all targeted areas within the BCMSHRW.

3.5 Selected Critical Target HUC 12s in the BCMSHRW

The WRAPS Leadership Team has and will target areas to focus BMP placement for sediment, nutrient runoff, and *E. coli* bacteria. BMPs implementations will be site specific for each of the three environments within the BCMSHRW:

1. Cropland targets – TSS, TN, & TP
    - Oak Creek HUC 12
    - Landon Creek HUC 12
    - Thielen Airport HUC 12
    - Town of Munjor HUC 12
    - Hays Consolidated HUC 12
2. Grassland/Rangeland targets – TSS, TN, TP, and *E. coli* bacteria
    - Oak Creek HUC 12
    - Landon Creek HUC 12
    - Thielen Airport HUC 12
    - Town of Munjor HUC 12
    - Hays Consolidated HUC 12
3. Urban/Residential targets – TSS, TN, TP, and *E. coli* bacteria
    - Hays Consolidated HUC 12

Based upon field methods and computer models, Hays Consolidated, Landon Creek, Oak Creek, Thielen Airport, and the Town of Munjor HUC 12s have been identified as critical target areas within the BCMSHRW (Figure 14).

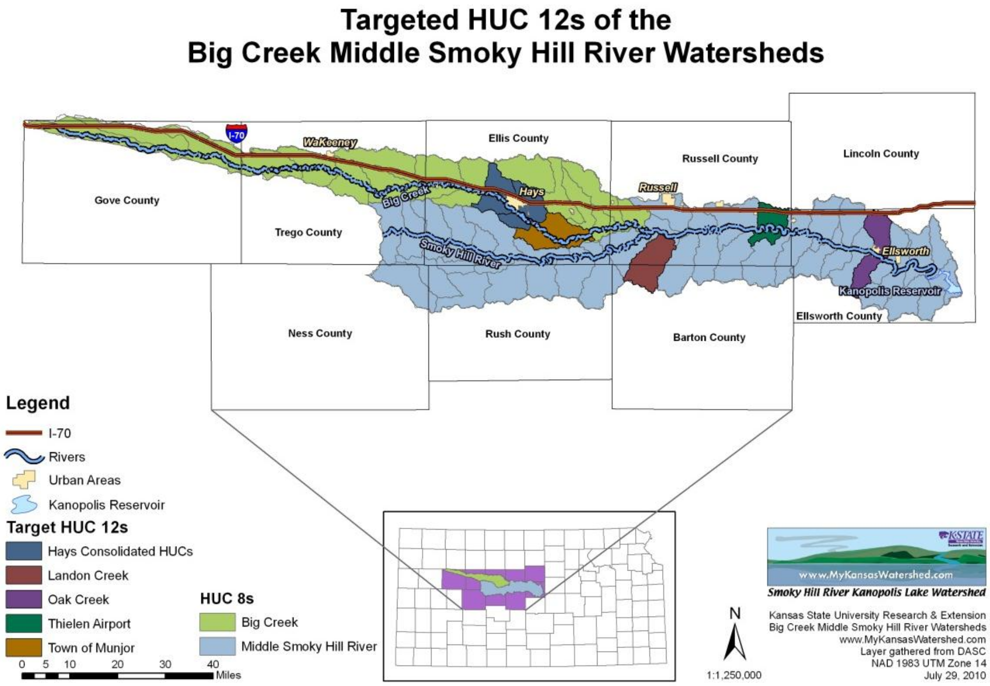


Figure 14. Targeted HUC 12s in the BCMSHRW

3.5.1 Oak Creek HUC 12 Subwatershed

Oak Creek subwatershed (HUC 102600060601) was selected as a critical target area primarily using the stream monitoring network with further future designation targeting via WKCAT, SWAT, and USLE. This drainage encompasses 34,042.5 acres or 53.2 square miles in Central Ellsworth County (Figure 15). The land cover in Oak Creek subwatershed includes: 32.3 % cropland, 45.1 % grassland/pasture (including CRP), 9.2 % open water, 9.6 % urban, and 3.8 % wetlands and wooded area.

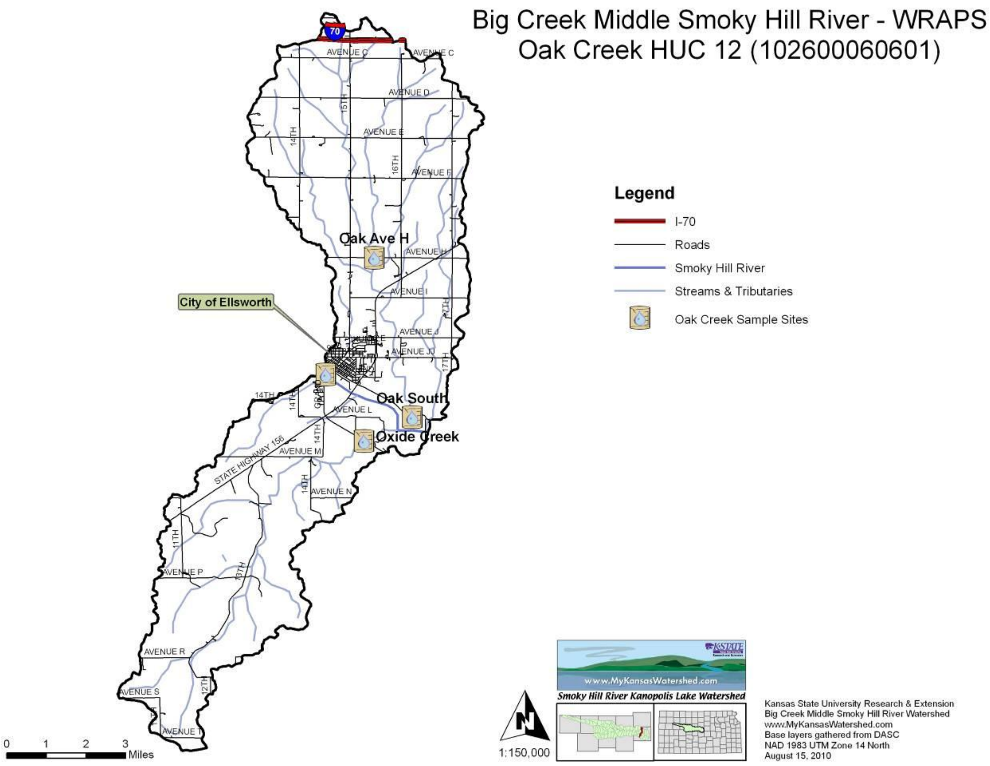


Figure 15. Oak Creek HUC 12 Subwatershed.

Stream monitoring in the Oak Creek subwatershed began in June 2007 and currently continues with multiple targeting sites throughout the northern half (Oak Creek) of the subwatershed with one site located in the southern drainage (Oxide Creek). Primary concerns in this subwatershed include in this order: nutrients (TN & TP), *E. coli*, and TSS (storm flow only). Located directly upstream of the most southerly monitoring location is the effluent discharge from the City of Ellsworth. Recent upgrades in 2009-2010 helped lower discharge nutrient values; however values remain above TMDL benchmarks for TN and TP. *E. coli* concerns come from fall-spring livestock feeding sites where monthly/seasonal geomean values exceeded the secondary contact Class b TMDL benchmark of 3,843.0 MPN/100mL. Median values as analyzed at the end of the Oak Creek tributary through July 2010 were: TSS – 16.0 mg/L, n = 73 (TMDL benchmark 50.0 mg/L), TN – 2.56 mg/L, n = 70 (TMDL benchmark 1.00 mg/L), TP – 0.46 mg/L, n = 70 (TMDL benchmark 0.10 mg/L), and *E. coli* – geomean 2272.1 MPN/100mL, n = 65 (TMDL benchmark 3,843.0 MPN/100mL). Storm flow means for the same time period (n = 5 for all parameters) were: TSS – 564.8 mg/L, TN – 3.94 mg/L, TP – 1.15 mg/L, and *E. coli* – geomean 22,144.0 MPN/100mL. Data from other targeting sites (start March 2009) within the subwatershed suggest TN and TP base flow impairments; however storm flow has been lacking to originate pollutant loads from their respective drainages. These high pollutant levels have a direct impact on Kanopolis Reservoir due to their close proximity. As of January 2011, the targeted sites within the Oak Creek subwatershed are no longer routinely monitored.

3.5.2 Landon Creek HUC 12 Subwatershed

Landon Creek subwatershed (HUC 102600060401) was selected as a critical target area using the stream monitoring network. Landon Creek subwatershed encompasses 35,117.0 acres or 54.9 square miles in Southwestern Russell and Northwestern Barton Counties (Figure 16). The land cover includes: 59.0 %.cropland, 31.3 % grassland/pasture (including CRP), 8.6 % urban, and 1.1 % open water, wetlands and wooded area.

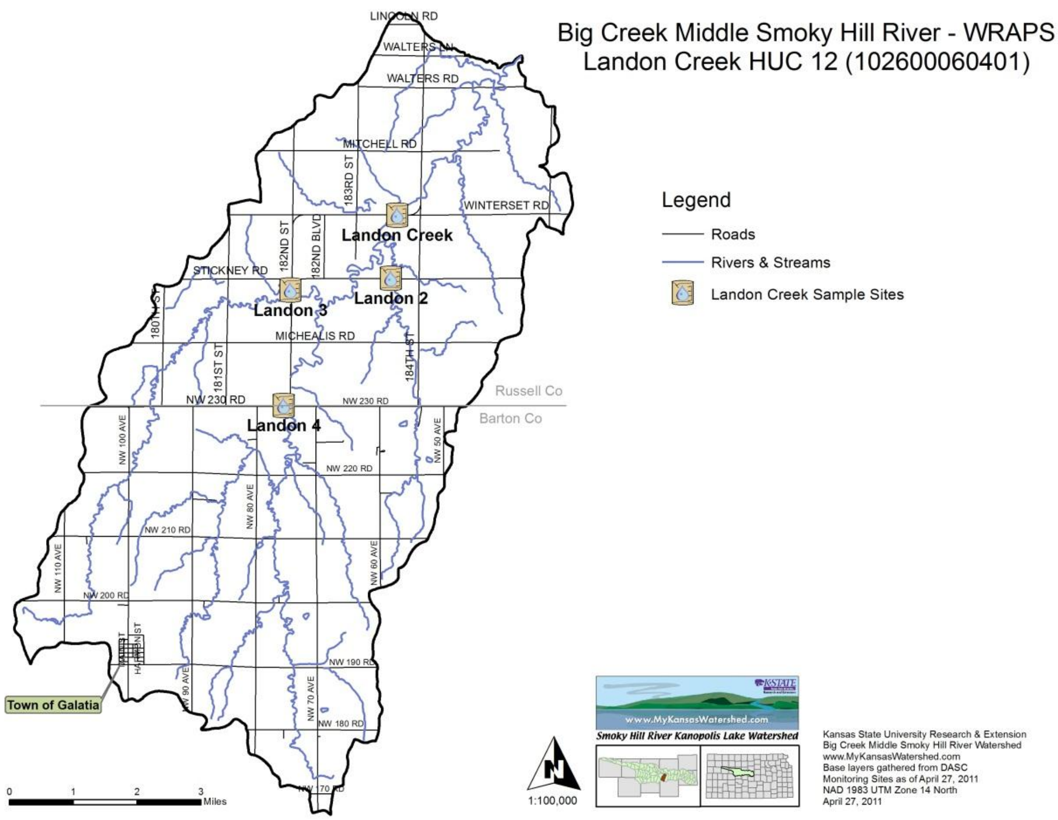


Figure 16. Landon Creek HUC 12 Subwatershed.

Stream monitoring in Landon Creek subwatershed began February of 2007 and continues today with three targeting sites located upstream of the Landon Creek monitoring site. Primary concerns in this subwatershed include TSS, TN, and TP. It is assumed that these high pollutant concentrations, based on data from WKCAT, are a result of multiple winter feeding sites/livestock operations, conventional tillage methods, and lack of BMPs. Median values as analyzed at the Landon Creek monitoring site through July 2010 were: TSS – 20.0 mg/L, n = 87 (TMDL benchmark 50.0 mg/L), TN – 1.41 mg/L, n = 83 (TMDL benchmark 1.00 mg/L), TP – 0.07 mg/L, n = 83 (TMDL benchmark 0.10 mg/L), and *E. coli* – geomean 181.1 MPN/100mL, n = 66 (TMDL benchmark 3,843.0 MPN/100mL). Storm flow means for the same time period were: TSS – 1,170.5 mg/L (n = 10), TN – 4.78 mg/L (n = 10), TP – 1.25 mg/L (n = 10), and *E. coli* – geomean 22,056.6 MPN/100mL (n = 7). These values are the highest amongst all 31 current monitoring locations across the BCMSHRW for storm flow data. Data from other targeting sites, began January 2009, within the subwatershed point to TN base flow impairments and high TSS, TN, and TP storm flow pollutant loading,. These additional targeting sites, although storm flow in 2009 was non-existent, are beginning to delineate subbasin loading on field scales where BMPs can be placed. Further targeting and monitoring will yield subbasin targeting to truly use cost effective funds for maximum pollutant reductions. Historical data (both from KDHE and KSU WRAPS) from this subwatershed suggests high pollutant loads (TN, TP, and TSS) are still an issue within this subwatershed.

3.5.3 Thielen Airport HUC 12 Subwatershed

Thielen Airport subwatershed (HUC 102600060501) was selected as a critical target area using primarily the stream monitoring network with further information gathered via WKCAT, USLE, and SWAT models. This drainage encompasses 23,844.8 acres or 37.3 square miles in Eastern Russell County (Figure 17). The Thielen Airport subwatershed land cover includes: 40.1 % cropland, 48.4 % grassland/pasture (including CRP), 0.6 % open water, 7.7 % urban, and 3.8 % open water, wetlands and wooded area.

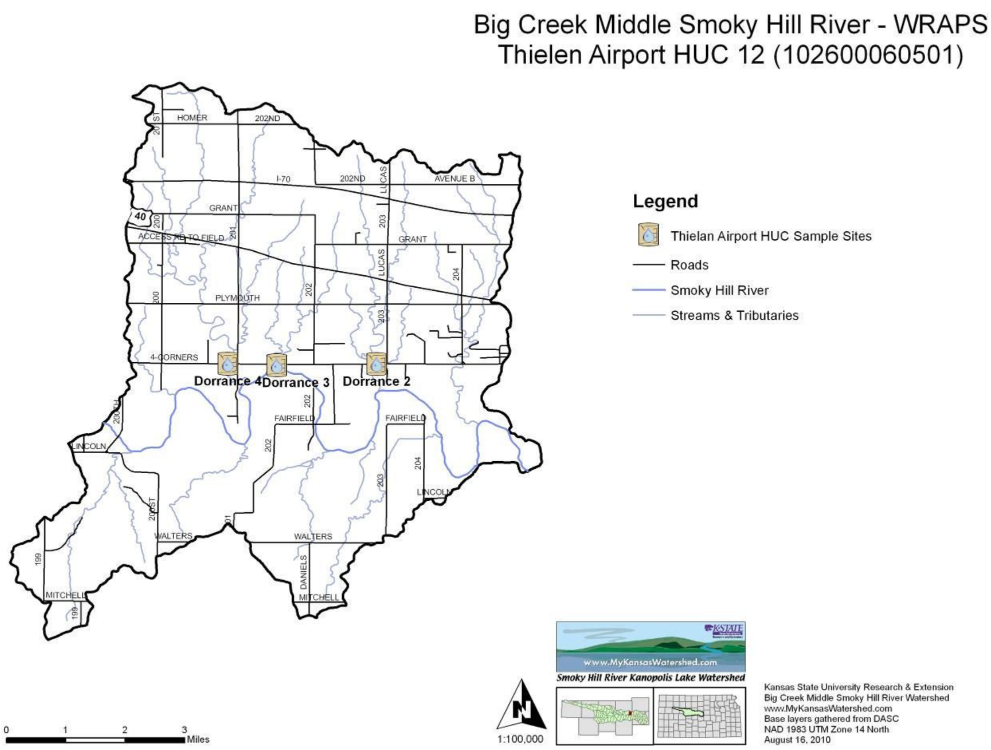


Figure 17. Thielen Airport HUC 12 subwatershed.

Stream monitoring began in this subwatershed in January 2009 and continues today to target pollutant loading established from base flow data and high storm flow data parameters at the SHR Wilson site just downstream of the junction of the Smoky Hill River and the Thielen Airport subwatershed. Targeting sites were selected in the northern section of the subwatershed where a majority of the land cover was conventional tillage cropland. Placement was based on the length and size of the tributary and access to a bridge, but primarily due to the sediment loads documented during storm flows. Primary concerns from the subwatershed are TN, TP, and TSS both at base and storm flows. As measured from June 2007 to July 2010 at the SHR Wilson site median values were: TSS – 45.0 mg/L, n = 72 (TMDL benchmark 50.0 mg/L), TN – 1.24 mg/L, n = 70 (TMDL benchmark 1.00 mg/L), TP – 0.17 mg/L, n = 70 (TMDL benchmark 0.10 mg/L), and *E. coli* – geomean 76.7 MPN/100mL, n = 62 (TMDL benchmark 3,843.0 MPN/100mL). Storm flow means for the same time period were: TSS – 955.1 mg/L (n = 10), TN – 2.88 mg/L (n = 10), TP – 0.83 mg/L (n = 10), and *E. coli* – geomean 12,941.7 MPN/100mL (n = 8). Base flow data indicates TMDL impairments of TN, TP, and TSS while storm flow data indicates excessive sediment loading. Although established in January 2009, only one targeted site of three saw marginal storm flow through July 2010. If storm flow cannot be captured, targeting will rely heavily on the WKCAT, USLE, and SWAT models.

3.5.4 Town of Munjor HUC 12 Subwatershed

The Town of Munjor (HUC 102600070305) subwatershed was selected as a critical target area using the stream monitoring network. This subwatershed is part of the Big Creek watershed that was listed in 2010 as a high priority area by KDHE for TMDL reductions and is subject to multiple Big Creek TMDLs. The USDA-NRCS also recognizes this subwatershed as a high pollutant area based on monitoring numbers supplied by the WRAPS. This area has such been tagged as a priority EQIP subwatershed for future funding years by the Ellis County EQIP Workgroup. The USLE and SWAT models will aid in identification of critical sub basins and placement of future stream monitoring target sites. The WKCAT will be conducted in the fall of 2010 and spring of 2011. This drainage encompasses 37,405 acres or 58.4 square miles in east-central Ellis County (Figure 18). The Town of Munjor land cover includes: 61.9 % cropland, 21.6 % grassland/pasture (including CRP), 8.7 % open water, 7.3 % urban, and 0.5 % wetlands and wooded area.

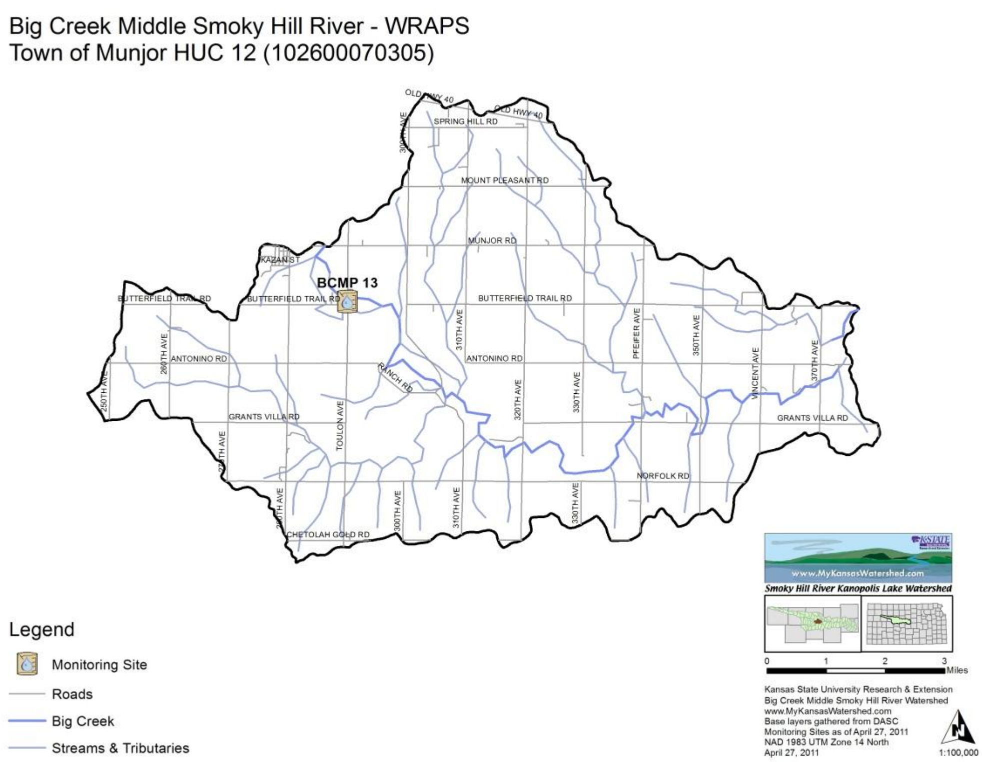


Figure 18. Town of Munjor HUC 12 Subwatershed.

Stream monitoring began in the Town of Munjor subwatershed in August 2007 with a monitoring site located at the top of the subwatershed (BCMP 13) and July 2008 with a monitoring location located at the bottom/junction of the North Fork Big Creek and Town of Munjor subwatershed (BC Walker). Primary concerns for this subwatershed are TSS, TN, TP, and *E. coli* both during base and storm flow. Waters of this subwatershed are designated as Primary Contact Recreation Class B with an *E. coli* geomean of 262.0 MPN/100ml from 1 April to 31 October and 2,358.0 MPN/100mL from 1 November to 31 March every year. Unique to the subwatershed is the inclusion of effluent waters from the City of Hays Waste Water Treatment Plant along with urban storm flow.

As measured from the BCMP 13 site, median parameter values for base flow from August 2007 through July 2010 were: TSS – 58.7 mg/L, n = 81 (TMDL benchmark 50.0 mg/L), TN – 6.04 mg/L, n = 78 (TMDL benchmark 1.00 mg/L), TP – 1.10 mg/L, n = 78 (TMDL benchmark 0.10 mg/L), and *E. coli* – geomean 337.3 MPN/100mL, n = 62 (TMDL benchmark 262.0 and 2,358.0 MPN/100mL seasonally). These base flow data indicate TMDL impairments for all listed parameters. Storm flow values were not included as the site is located near the top of the subwatershed.

As measured from the BC Walker site, median parameter values from July 2008 to July 2010 were: TSS – 87.8 mg/L, n = 53 (TMDL benchmark 50.0 mg/L), TN – 3.28 mg/L, n = 52 (TMDL benchmark 1.00 mg/L), TP – 0.73 mg/L, n = 51 (TMDL benchmark 0.10 mg/L), and *E. coli* – geomean 351.5 MPN/100mL, n = 53 (TMDL benchmark 262.0 and 2,358.0 MPN/100mL seasonally). Storm flow means for the same time period (n = 6 for all parameters) were: TSS – 442.9 mg/L, TN – 2.99 mg/L, TP – 0.90 mg/L, and *E. coli* – geomean 8,931.3 MPN/100mL. From the stream monitoring data it is apparent that the subwatershed is impaired for all measured parameters. Nutrient data, high TN and TP, can be correlated to inputs from the City of Hays however the *E. coli* and high TSS values suggest placement of BMPs. Building upon the stream monitoring network, WKCAT, SWAT, and USLE will help determine placement for these practices. Stream monitoring will need to continue to access success of BMP placement.

3.5.5 Hays Consolidated Subwatershed

The Hays Consolidated subwatershed (City of Hays (HUC 102600070303) and Chetolah Creek (HUC 102600070304)) was selected as a critical target area using the stream monitoring network established in late 2006. This subwatershed is part of the Big Creek watershed that was listed in 2010 as a high priority area by KDHE for TMDL reductions and is subject to multiple Big Creek TMDLS. The WKCAT will be conducted in the fall of 2010 and spring of 2011 to assess the rural portions of the subwatersheds and further target for BMP placement. This drainage encompasses 57,663.0 acres or 90.1 square miles in Central Ellis County (City of Hays) (Figure 19). The Hays Consolidated land cover includes: 41.4 % cropland, 32.2 % grassland/pasture (including CRP), 8.7 % open water, 16.8 % urban, and 0.8 % wetlands with no wooded areas. Hays Consolidated is the largest urban influenced critical targeted area in the BCMSHRW.

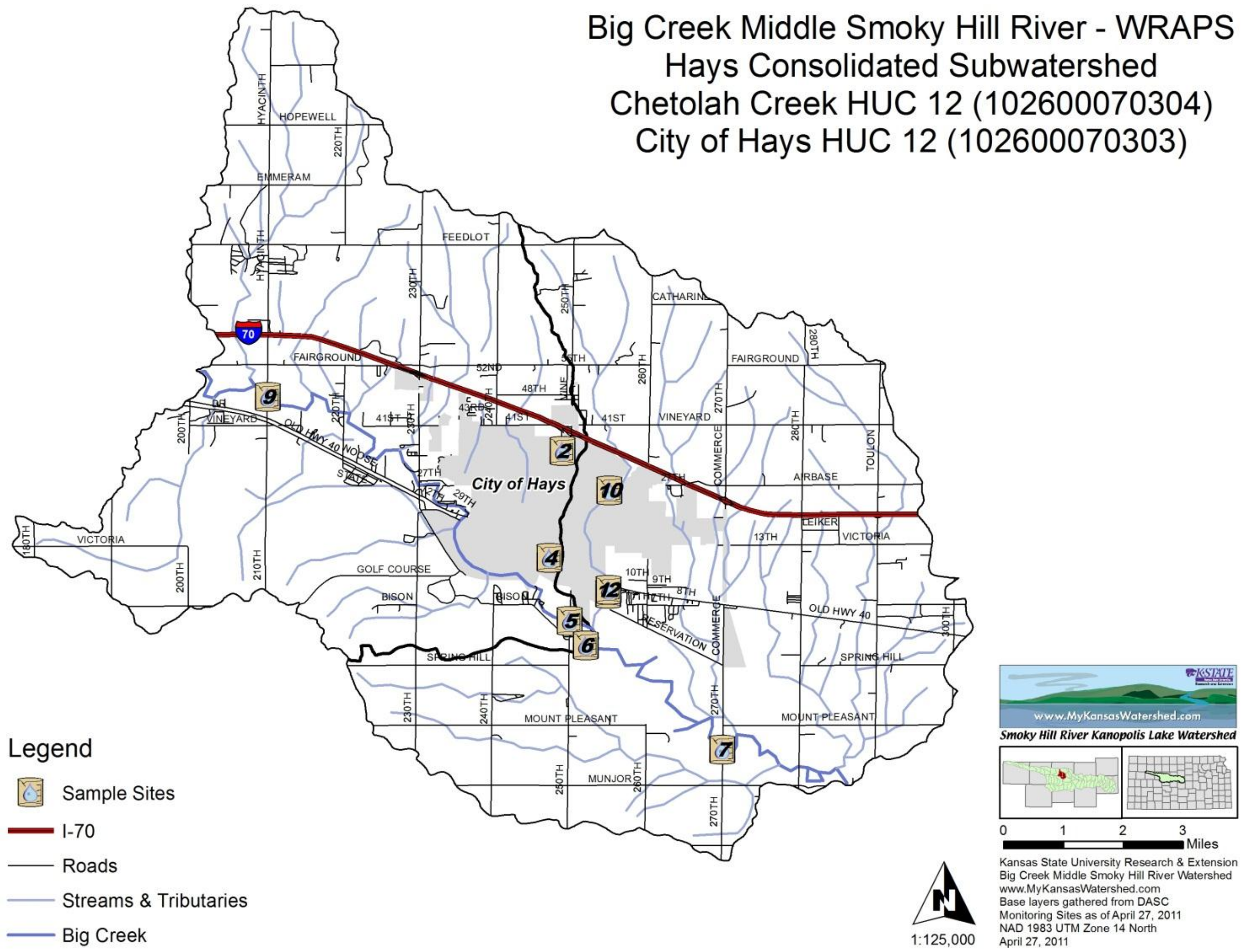


Figure 19. Hays Consolidated HUC12 subwatershed.

Stream monitoring in the Hays Consolidated subwatersheds began in December of 2006 with seven stations situated in and near the City of Hays to monitor storm flow and base flow characteristics. Primary concerns for this subwatershed are TSS, TN, TP and *E. coli*. Waters of this subwatershed are designated as Primary Contact Recreation Class B with an *E. coli* geomean of 262.0 MPN/100ml from 1 April to 31 October and 2,358.0 MPN/100mL from 1 November to 31 March every year. Effluent water from the City of Hays Waste Water Treatment Plant enters Chetolah Creek in this subwatershed. As measured by monitoring sites at the base of each subwatershed (Site 5 - City of Hays and Site 7 - Chetolah Creek), all measured parameters exceeded TMDL benchmarks and have been listed on the 2010 State of Kansas 303(d) list. As measured from Site 5, median parameter values from December 2006 to July 2010 were: TSS – 46.7 mg/L, n = 110 (TMDL benchmark 50.0 mg/L), TN – 1.51 mg/L, n = 107 (TMDL benchmark 1.00 mg/L), TP – 0.25 mg/L, n = 107 (TMDL benchmark 0.10 mg/L), and *E. coli* – geomean 340.2 MPN/100mL, n = 74 (TMDL benchmark 262.0 and 2358.0 MPN/100mL seasonally). Storm flow means for the same time period were: TSS – 432.2 mg/L (n = 27), TN – 2.14 mg/L (n = 28), TP – 0.56 mg/L (n = 28), and *E. coli* – geomean 8,588.8

MPN/100mL (n = 14). From the stream monitoring data it is apparent that the subwatershed is impaired for all measured parameters.

As measured from Site 7, median parameter values from December 2006 to July 2010 were: TSS – 64.5 mg/L, n = 110 (TMDL benchmark 50.0 mg/L), TN – 6.66 mg/L, n = 108 (TMDL benchmark 1.00 mg/L), TP – 1.13 mg/L, n = 108 (TMDL benchmark 0.10 mg/L), and *E. coli* – geomean 549.8 MPN/100mL, n = 73 (TMDL benchmark 262.0 and 2,358.0 MPN/100mL seasonally). Storm flow means for the same time period were: TSS – 352.7 mg/L (n = 19), TN – 6.50 mg/L (n = 28), TP – 1.60 mg/L (n = 28), and *E. coli* – geomean 6900.3 MPN/100mL (n = 15). From the stream monitoring data it is apparent that this subwatershed is impaired for all measured parameters during base flow with much of the nutrient issues originating from the effluent discharge. Along with the stream monitoring network, computer modeling will help identify the critical areas outside of the urban influence.

What makes the Hays Consolidated Subwatershed unique throughout the BCMSHRW critical target areas is that a majority of the pollutant load comes from urban factors. Based on the stream monitoring project that started in late 2006 to look at urban stormwater factors and base flow characteristics around an urban center, it is estimated that over 90% of the water draining these subwatersheds comes from the land area of the City. As of April 2010, the City of Hays implemented a stormwater utility to look at water quantity and quality to meet MS4 NPDES permitting. This utility will function as the funding mechanism to implement BMPs throughout the City reducing or eliminating negative effects on downstream Big Creek on to Kanopolis Reservoir. The WRAPS project will continue working with the City to educate citizens about water quality and maintain its monitoring program so BMP installment can be quantified. In addition, we will also accomplish the Watershed Plan goals to: provide storm water management guidance, and continue public awareness, education and involvement in watershed issues.

4.0 Load Reduction Methodology

To obtain water quality improvements within the BCMSHRW, estimates of pollutant load reductions are needed. These pollutant loads are derived empirically (stream monitoring data) and theoretically (SWAT model). Using TMDL baseline data and average stream flow discharges, pollutant loads into Kanopolis Reservoir can be calculated. Using mean stream flow discharged as gathered and estimated by KDHE watershed section and a USGS report by Perry, Wolock and Artman (2004), the WRAPS group was able to estimate load reductions. Using the mean stream flow values in the targeted subwatersheds, an estimated 30% load reduction from the empirical stream monitoring data was used as a target for pollutant reduction. Reductions overall on Big Creek and into Kanopolis Reservoir were provided by Tom Stiles of the KDHE Watershed Management Section. KDHE currently estimates NPS reduction loads for nutrients to meet the Kanopolis Lake EU TMDL to be 37,735 lbs/yr for TP and 288,780 lbs/yr for TN. These numbers are high as multiple permitted point sources exist in the watersheds. Local monitoring data is used for targeted reductions at the subwatershed level. Best management practices will continue to be placed throughout the watersheds; however there will be a focused effort to implement a higher percentage of BMPs throughout the targeted areas to meet TMDLs for successful reductions of the eutrophication TMDL for Kanopolis Reservoir.

To determine the types and quantities of BMPs needing to be installed in the target HUC 12s or in the watershed, we determined the percent of each county in each of the HUC 12 target areas. Those percentages were as follows: Oak Creek was 7.5% of Ellsworth County; Landon Creek was 2.8% of Barton County and 3.3% of Russell County; Thielen Airport was 4.2% of Russell County; Hays Consolidated was 9.9% of Ellis County; and Town of Munjor was 6.4% of Ellis County.

In addition, the State Conservation Commission and the Hays Area NRCS Office provided five to seven years of BMPs installed in the counties to use as a reference. The WRAPS Leadership team used these averages of BMPs installed to be conservative and realistic. Below is an example of the calculations utilized to generate the types and quantities of BMPs to be installed in the target HUC 12s or overall in the BCMSHRW. In addition, the County Extension Agents, Conservation District Managers, District Conservationists, Minson, Leiker, and Fross provided local knowledge for estimating BMPs while keeping in mind some of the target areas have no adoption of selected BMPs. Altering mindsets and farming operation histories would be needed in these areas. The group also took into consideration the mode farmer/producer age range in the watersheds of 45-54 years with 70+ years of age next (Figure 20). The group also understands that some key pieces of property may never have BMPs installed until the property changes ownership. The team was being conservative and realistic in estimating these numbers. Load reductions were calculated by KDHE Watershed Management Section.

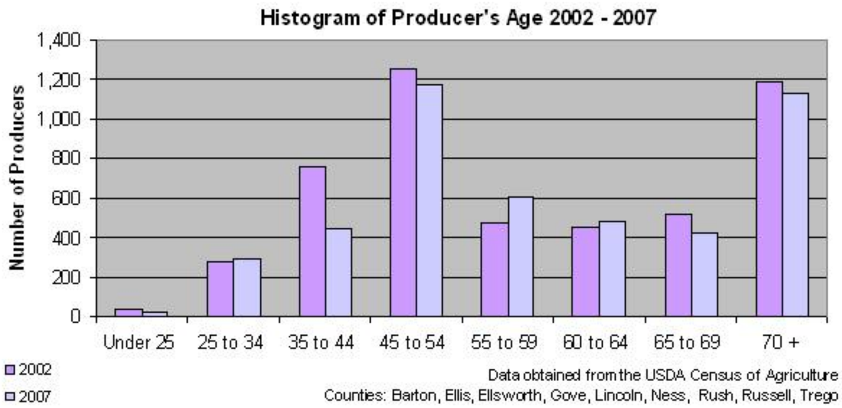


Figure 20. Histogram of Producer Age 2002 – 2007.

Example:
*Oak Creek – Install Terraces: 329 acres * 7.5% of Ellsworth County = 24.68 acres = 25 acres protected; 7,346 Linear Feet (LF) * 7.5% = 550.95 LF = 550 LF*

The six target areas cover 293.9 square miles or 13% of the watersheds for the Kanopolis Reservoir Eutrophication TMDL reduction goal. This is the first set of Critical Target Areas or Tier 1 Priorities. As work continues to progress and more areas of the watershed are established for a monitoring network, there may be another set of critical target areas or Tier 2 priorities called into implementation if load reductions don't achieve the TMDLs by 2020. The HUC 12s for Tier 2 priorities may include: Center School, Walker Creek, Lower North Fork, Yocemento, Big Creek in Ellis, and others below Thielen Airport and Oak Creek, in closer proximity to Kanopolis Reservoir.

Work in the Big Creek watershed of 860.8 square miles will be concentrated in 148.5 square miles, 3-HUC 12s or 18% of the Big Creek Watershed. Again, significant amounts of nutrient reductions will need to come from the City of Hays Waste Water Treatment Plant for overall watershed improvements.

4.1 Oak Creek Subwatershed

There are currently no TMDL listing for Oak Creek Subwatershed according to KDHE. Load reductions that need to occur, as identified by the leadership team, in the Oak Creek subwatershed include TN, TP, *E. coli*, and to a lesser extent TSS (storm flow). The SWAT models indicate that a majority of nitrogen and phosphorus loading occur near subbasins near WRAPS sample site Oak Ave H and south of the Smoky Hill River (Figures 21-23) while sediment comes mainly from areas neighboring the Smoky Hill River and at the northern end of the Oak Creek subwatershed. Targeted monitoring data from the site since March 2009 is consistent with the SWAT model. Best management practices consisting of terraces, waterways, and tillage conversion will help alleviate nitrogen loss from croplands while relocation of livestock feeding sites will move nutrients further upland where the potential for runoff into the streams will be diminished. KDHE and WRAPS will continue to monitor the water quality leaving the City of Ellsworth wastewater lagoons to further reduce nitrogen and phosphorus loads.

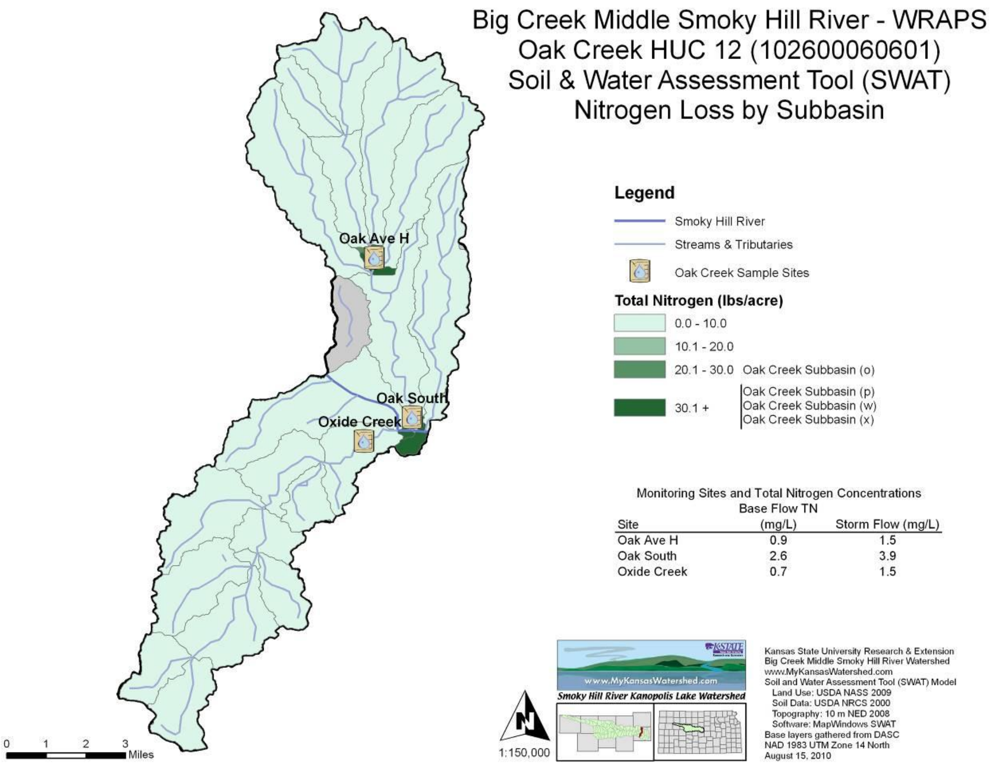


Figure 21. Total nitrogen loading (lbs/acre) as determined by the SWAT model.

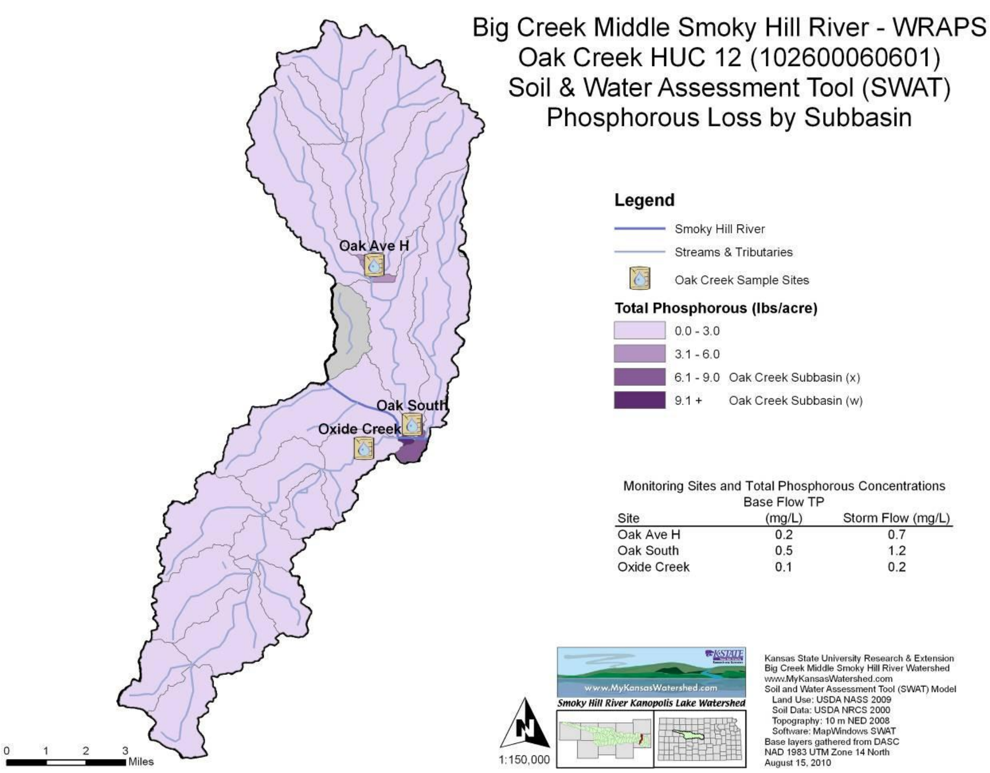


Figure 22. Total phosphorus loading (lbs/acre) as determined by the SWAT model.

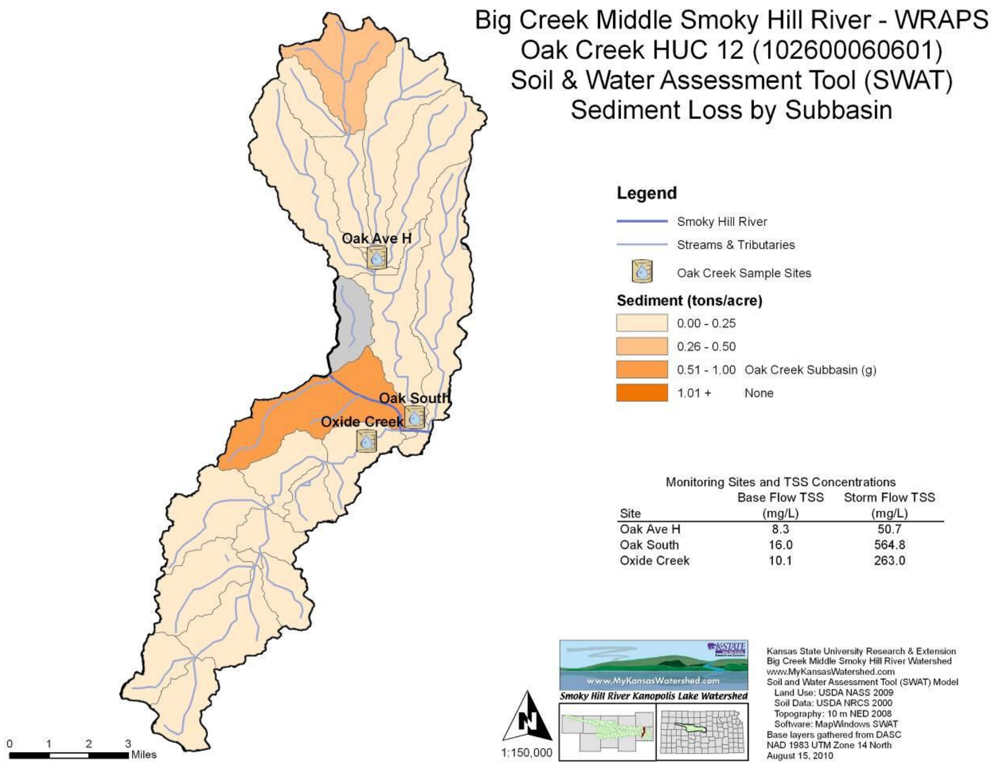


Figure 23. Total sediment loading (tons/acre) as determined by the SWAT model.

Another assessment, the WKCAT in association with the USLE model yields the same TSS results as the SWAT model in the upper reaches of the Oak Creek subwatershed (Figure 24). Estimated soil loses from CLUs with greater than 5 tons/year/acre losses are highlighted. Driving tour data documents many areas of poor rangeland condition and visible soil erosion on croplands. Management decisions in the rangeland will need to change, i.e. lower stocking rates, in order to improve vegetative conditions to slow or eliminate nutrient movement and soil erosion. Practices such as terraces and waterways will be needed to slow sediment erosion. Waterways and buffer strips will also help to filter nutrients and sediments.

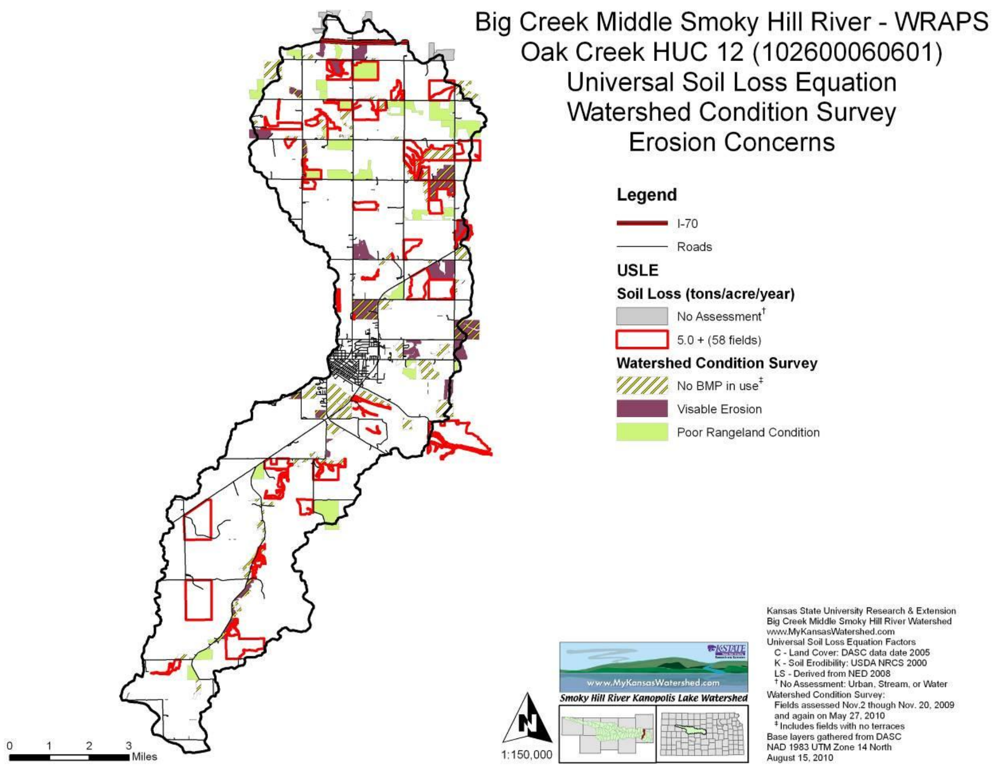


Figure 24. Oak Creek subwatershed WKCAT and USLE results with ground truth watershed conditions.

Not figured by the SWAT model was *E. coli* loading/concentrations for the subwatershed. Being a parameter that cannot be directly tied to a unit weight measurement, *E. coli* load reductions will result from practices that remove its potential to invade water sources (either moving or removing sources). From monitoring data, *E. coli* concentrations are an issue within the subbasin that contains the Oak South monitoring location. As per data, *E. coli* concentrations exceed TMDL benchmarks of 3,843.0 MPN/100mL concentrations from October to March of each year since 2008. Targeted monitoring had located the area(s) of concern to livestock feeding operations. Stream flows for this particular segment are typically non-existent or very minimal with most *E. coli* and nutrient movement occurring during none summer months. The BMP to alleviate bacteria loading would include winter feeding site relocations. All BMPs to be implemented are listed in Table 9.

Table 9. Oak Creek HUC 12 Subwatershed BMPs with total reductions for 23 years according to the BCMSHRW WRAPS Watershed Plan Reduction Goal & Kanopolis Lake EU TMDL Goal (7.5% of Ellsworth County)

Best Management Practice	Acres, Linear Feet, or Projects to be Implemented	Total TSS Reduction Achieved/Yr (tons)	Total N Reduction Achieved (lbs)/Yr *% towards Kanopolis Lake EU TMDL*	Total P Reduction Achieved (lbs)/Yr *% towards Kanopolis Lake EU TMDL*
Establish grass buffers/Critical area planting	5 acres/year	67	142 13%	102 13%
Relocate livestock operations away from streams	1 site/year (50 AU/site)	N/A	N/A	171 10%
Improve native vegetation in rangeland (range planting, brush control)	120 acres/year	154	452 11%	226 12%
Improve stocking rates & livestock distribution (rotational grazing, reduced head/acre)	120 acres/year	4	14 4%	7 4%
Promote alternative watering systems away from streams	2 systems/every 3 years (50 AU/site)	N/A	N/A	343 11%
Grassed Waterway Installation & Restoration	7 acres/year	34	17 15%	13 16%
Install terraces	25 Acres protected & 550 Linear Foot	29	14 2%	12 3%

Terrace restoration	155 Linear Foot (0.775 acres protected)	1	1 < 1%	1 < 1%
Conversion to minimum tillage	200 acres/year	12	29 2%	14 2%
Conversion to no-till	200 acres/year	30	78 2%	39 2%
Onsite Waste Water System Upgrades	2 systems/year (each system treating 100 gallons/day)	43.8 (lbs/year)	24 13%	9 13%
Total Reduction Load per year		331	771	937
Total Reduction Load in 23 years		7,613	17,733	21,551

4.2 Landon Creek Subwatershed

Although KDHE has not set any TMDLs for Landon Creek, load reductions need to occur to meet and benefit the overall Eutrophication goal for Kanopolis Reservoir. As identified by the leadership team, Landon Creek subwatershed impairments include TN, TP, and TSS. Total nitrogen concentrations are above the TMDL guideline of 1.0 ppm during median flow for the time period February 2007 through July 2010 (1.41 ppm, n = 83). Using the long term average flow data from KDHE for Landon Creek (at site Landon Creek), with regards to TN, there needs to be a 39% reduction in TN or a 4600 lbs yearly reduction from current levels during median flows. Total suspended solids and total phosphorus median flows are within and below current KDHE yearly load allocations. However, the main issues of pollutant loading from within this subwatershed come during storm flow events where nutrient and sediment levels exceed the means of all other monitoring sites (Mean storm flow TSS- 1170.5 mg/L).

Using the SWAT models for the subwatershed, many of the nutrient issues lay within the lower reaches of the subwatershed where very high yearly nutrient yields exist (Figures 25-26). It cannot be documented with monitoring whether the lower reaches of the subwatershed yield these estimated values.

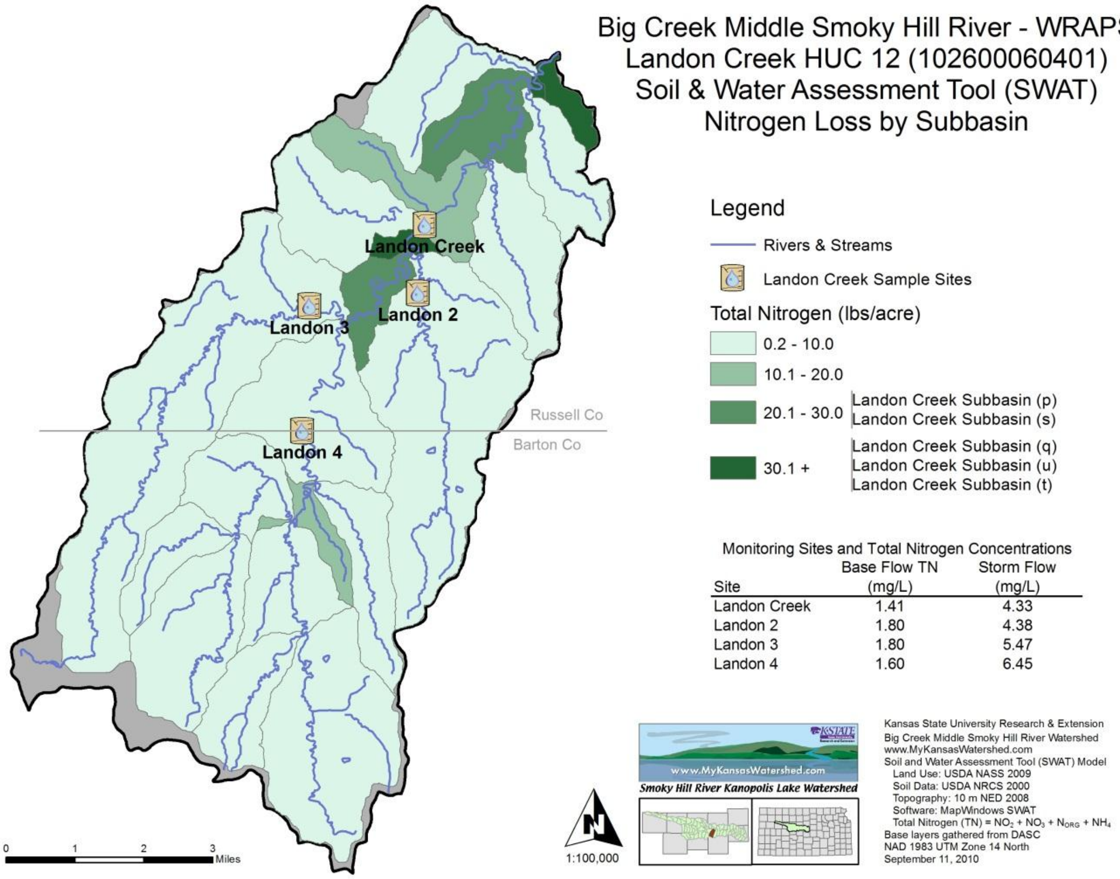


Figure 25. Total nitrogen loading (lbs/acre) as determined by the SWAT model.

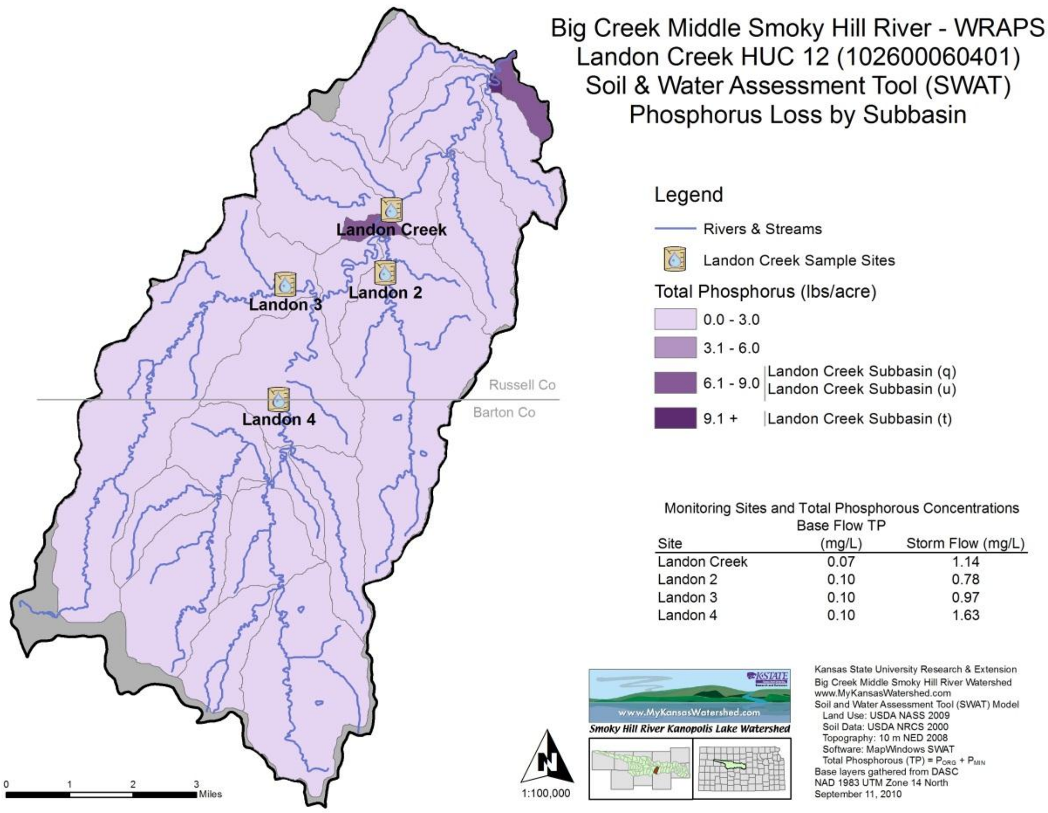


Figure 26. Total phosphorus loading (lbs/acre) as determined by the SWAT model.

The SWAT model theoretically estimates the yearly contribution of each subbasin based on long-term trends. Since targeting began in January 2009, the additional sites have yielded a different ground truth picture of the subwatershed compared to the SWAT model. Monitoring data documented median flow nutrient loading to come from upstream tributaries especially during the winter and spring months (max median concentration of 1.82 ppm TN – Landon 2). The leadership team has decided to use monitoring data as the primary targeting tool for BMP placement in regards to nutrients to help the Kanopolis eutrophication TMDL. The WKCAT additionally documented numerous winter feeding sites in the subwatershed, particularly upstream of the targeting sites in 2009-2010 that may correlate to high TN and TP values during winter and spring months.

For TSS, the SWAT model indicates that the high yielding subbasins of the subwatershed are on the lower and eastern drainages (Figure 27). Targeted monitoring agrees with the model on the eastern drainages; however it is in disagreement over potential yields from the upper subbasins. Storm flow data indicates that the drainage into the Landon 4 monitoring location yields the highest concentrations and estimate discharges of the three targeted monitoring locations. Using the information obtained from the WKCAT, monitoring data agrees with why the Landon 4 drainage contributes excessive sediment. The WKCAT database shows a low adoption rate of BMPs on cropland and numerous instances of visible erosion from the same crop fields (Figure 28). The USLE model depicts many CLUs that have the potential to yield over 5 tons/year/acre of sediment in the western and southern subbasins.

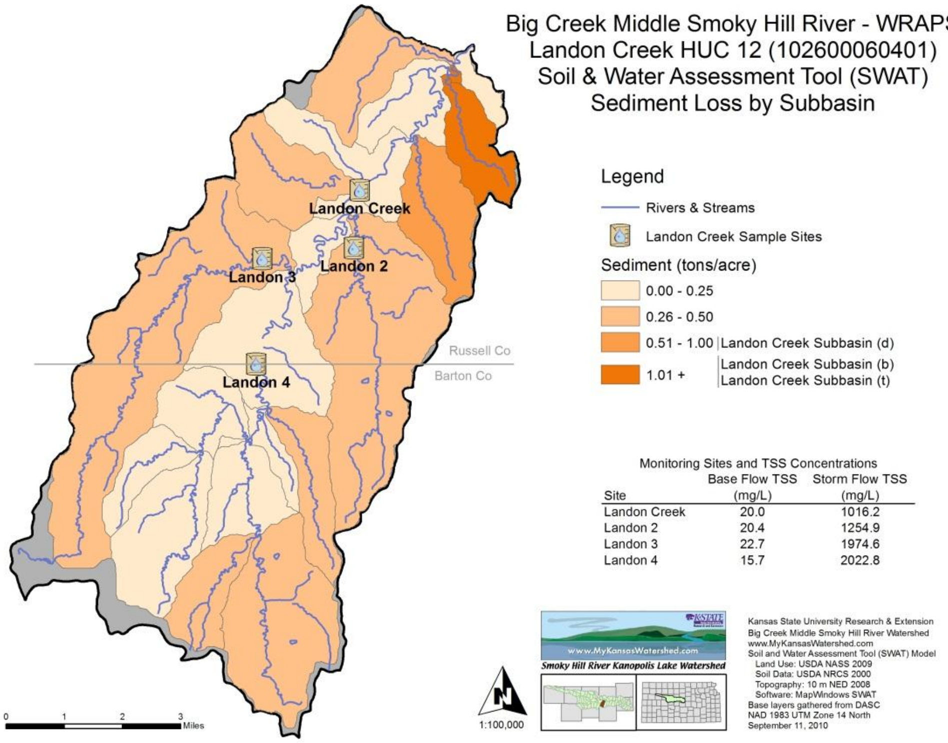


Figure 27. Total sediment loading (tons/acre) as determined by the SWAT model.

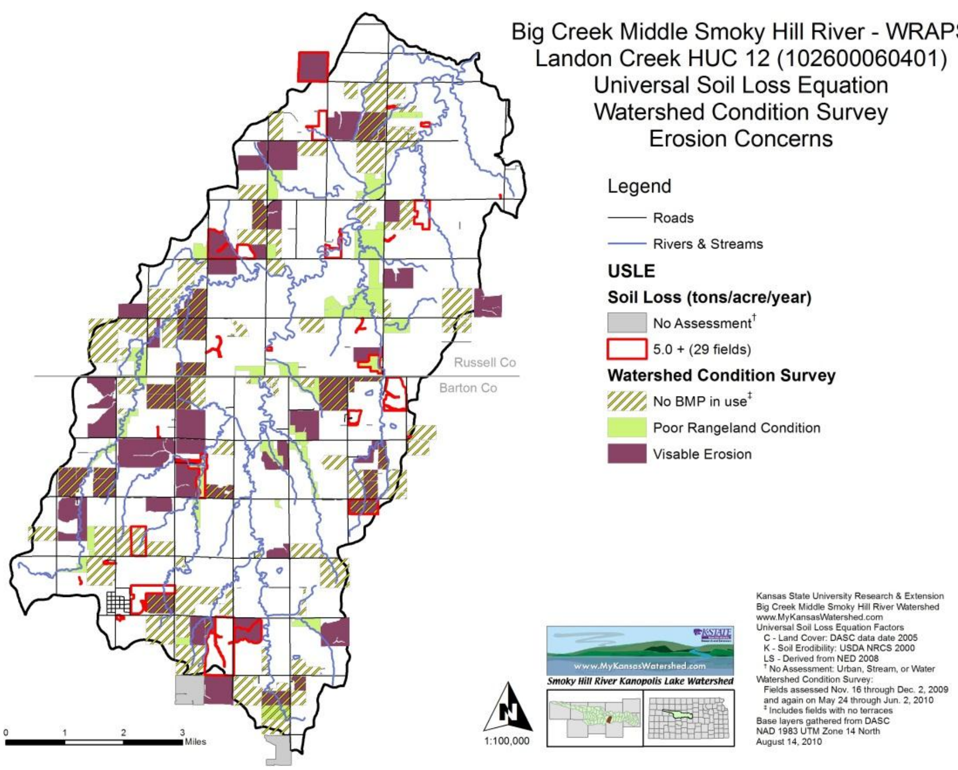


Figure 28. Landon Creek subwatershed WKCAT and USLE results.

With respects to pollutant load reductions, the leadership team believes in the ground truth monitoring data and information gathered from the WKCAT. Producers of the Landon Creek subwatershed are more likely to adopt practices to reduce pollutant loading based on tangible data. Because of the low adoption rate of BMPs in portions of the subwatershed there is much work and trust to be completed with the landowners. The BMPs that will most likely need to be adopted will first be those to control gully and ephemeral gully erosion. The WRAPS group has chosen to focus efforts into implementing BMPs that control soil erosion as there is a very high correlation between TP and TSS (Figure 29). This function assesses that even with all TSS removed there would still be a 0.07 ppm natural concentration in the water.

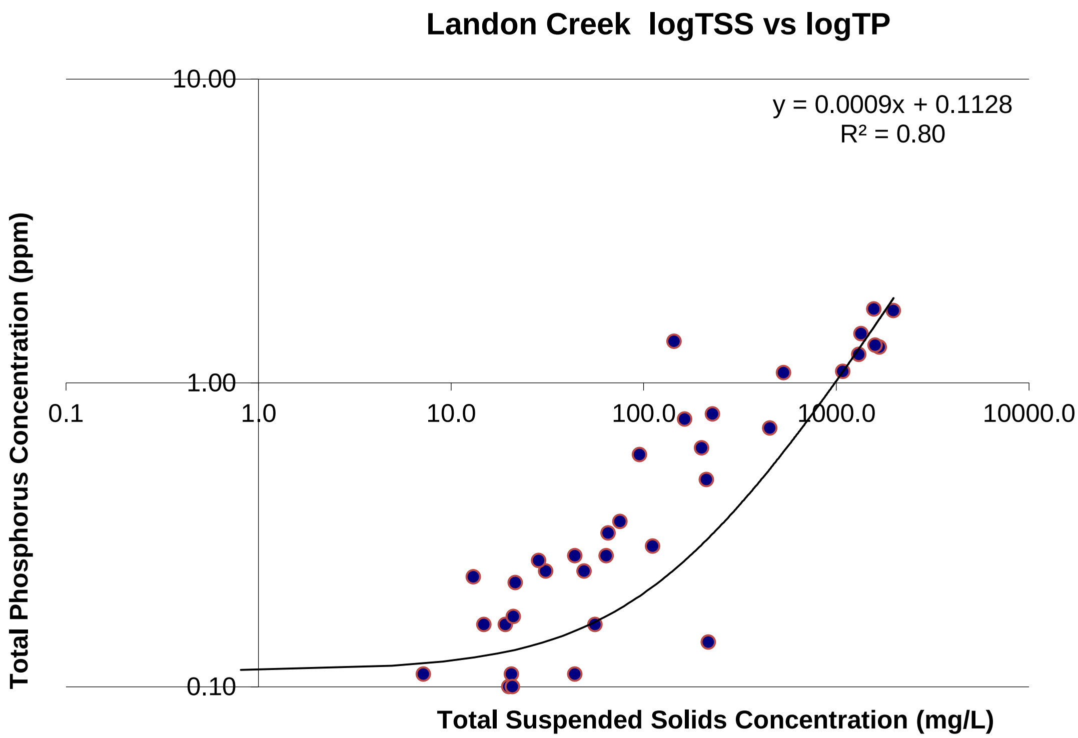


Figure 29. Log graph correlation of TSS to TP in the Landon Creek subwatershed as measured at site Landon Creek. Function is linear with an R^2 of 0.80.

According to the WKCAT survey, current adoption rates for BMPs that reduce soil erosion in the subwatershed are below average with a terrace adoption rate of 44%, of which 39% are failing, 25% of fields have grass waterways, and 69% of the tillage is conventional. A movement towards minimal and no-till alongside terrace rebuilds and installation will reduce most of the phosphorus load by reducing its transport mechanism. Also having producers test their soil for nutrient needs would also be a beneficial BMP so proper fertilizer rates could be applied. Currently the Russell County Conservation District does not offer free soil nutrient testing unlike Ellis and Ellsworth Counties that do. Meeting the TN TMDL will most likely be accomplished again through soil testing and relocation of winter feeding sites as many winter feeding sites exist in this subwatershed. A comprehensive list of BMPs to be implemented can be found in table 10.

Table 10. Landon Creek HUC 12 Subwatershed BMPs with total reductions for 23 years according to the BCMSHRW WRAPS Watershed Plan Reduction Goal & Kanopolis Lake EU TMDL Goal (3.3% Russell County & 2.8% Barton County)

Best Management Practice	Acres, Linear Feet, or Projects to be Implemented	Total TSS Reduction Achieved/Yr(tons)	Total N Reduction Achieved (lbs) *% towards Kanopolis Lake EU TMDL*	Total P Reduction Achieved (lbs) *% towards Kanopolis Lake EU TMDL*
Establish grass buffers/Critical area planting	5 acres/year	66	139 13%	99 13%
Relocate livestock operations away from streams	1 site/year (50 AU/site)	N/A	N/A	159 9%
Improve native vegetation in rangeland (range planting, brush control)	120 acres/year	139	396 10%	139 8%
Improve stocking rates & livestock distribution (rotational grazing, reduced head/acre)	120 acres/year	15	44 12%	22 12%
Promote alternative watering systems away from streams	2 systems/every 3 years (50 AU/site)	N/A	N/A	318 10%
Grassed Waterway Installation & Restoration	10 acres/years	47	23 21%	18 22%
Install terraces	20 Acres protected & 175 Linear Foot	23	12 2%	10 2%
Terrace restoration	360 Linear Foot & 1.8 acres protected	3	1 < 1%	1 < 1%
Conversion to minimum tillage	120 acres/year	46	116 8%	58 8%
Conversion to no-till	120 acres/yr	116	314 < 1%	157 8%
Onsite Waste Water System Upgrades	1 system/year (treating 100 gallons/day)	21.9 (lbs/year)	12 7%	4 7%
Total Reduction Load per year		455	1,057	985.5
Total Reduction Load in 23 years		10,465	24,311	22,666.5

4.3 Thielen Airport Subwatershed

There are currently no TMDLs identified by KDHE in the Theilen Airport Subwatershed although there is currently a TSS TMDL in the adjacent Coal Creek subwatershed. WRAPS monitoring data does not agree with the KDHE 82 mg/L median TSS value. As identified by the leadership team, Thielen Airport Subwatershed is in need of TN, TP, and TSS load reductions. As documented by the stream monitoring project at a monitoring site downstream at the junction of the subwatershed with the Smoky Hill River (Site SHR Wilson), storm flow TSS pollutant loading needs addressed. The SWAT model indicated small subbasins where there are high yield pollution potential (Figure 30-32). Currently, targeted stream monitoring is lacking storm flow data to pursue BMP placement. The BMP placement will rely on WKCAT and the USLE computer model should the absence of storm events continue.

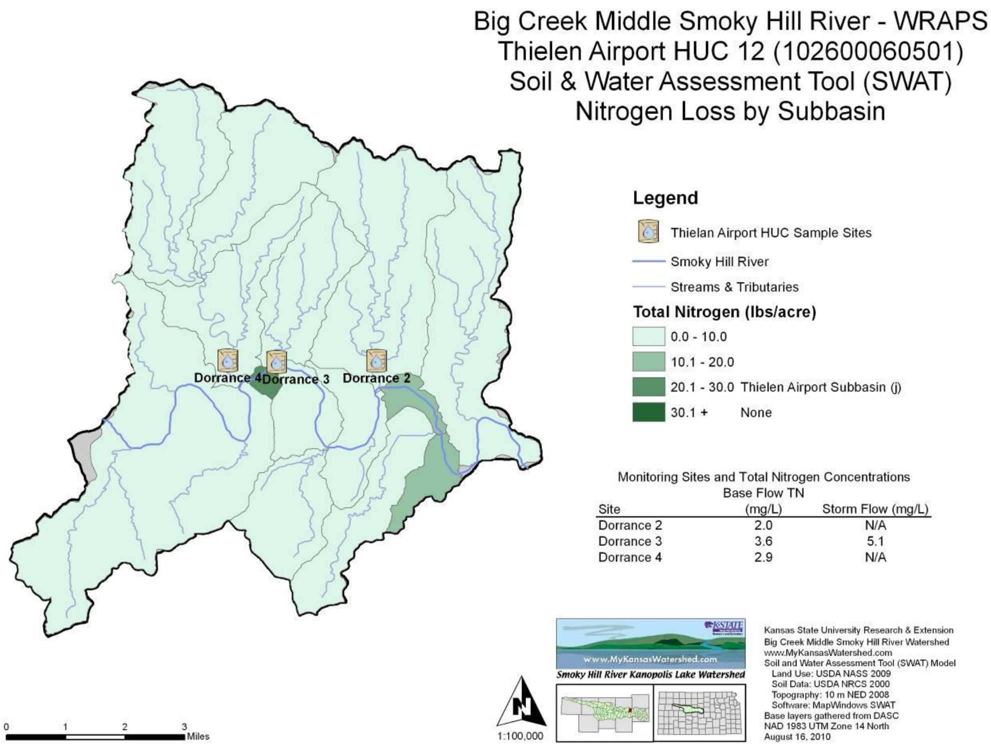


Figure 30. Total nitrogen loading (lbs/acre) as determined by the SWAT model.

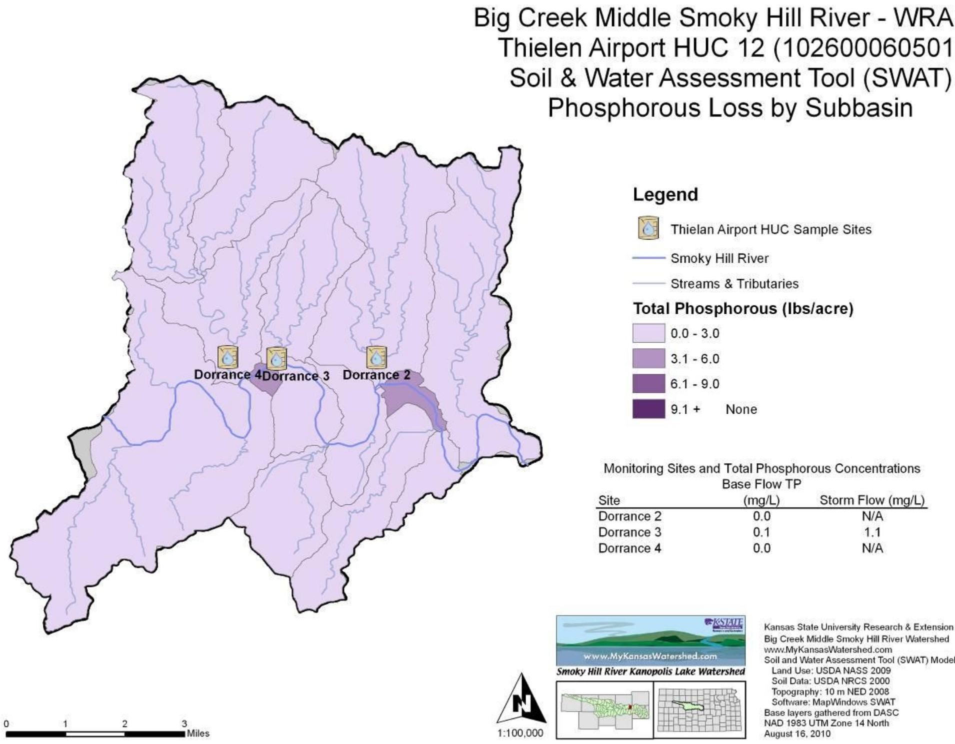


Figure 31. Total phosphorus loading (lbs/acre) as determined by the SWAT model.

Of concern for the subwatershed are TSS load values as documented by stream monitoring and the potential for soil erosion as document by the WKCAT survey. Best management practices that control sediment will be the focus for implementation as monitoring data indicates a high correlation of TSS value at SHR Wilson site to TP concentrations (Figure 32). Focusing efforts in this fashion will help to reduce the TP loads into Kanopolis. The SWAT model indicated that the highest potential for sediment erosion originates from the drainage into the Dorrance 4 monitoring location (Figure 32). WKCAT identified many fields without BMPs in areas not selected by SWAT (Figure 333). The data also determined that there was already 36% no-till tillage practice but nearly 46% of the terraces in this subwatershed were failing. From the field data and local knowledge, most practices that will need to be installed include terraces and waterways as the area is currently lacking these structures. Targeted monitoring will continue in the area and ground truthing of the fields selected by the USLE equation will determine needs for potential BMPs in the south half of the subwatershed. A comprehensive list of BMPs to be implemented in the subwatershed is found in Table 11.

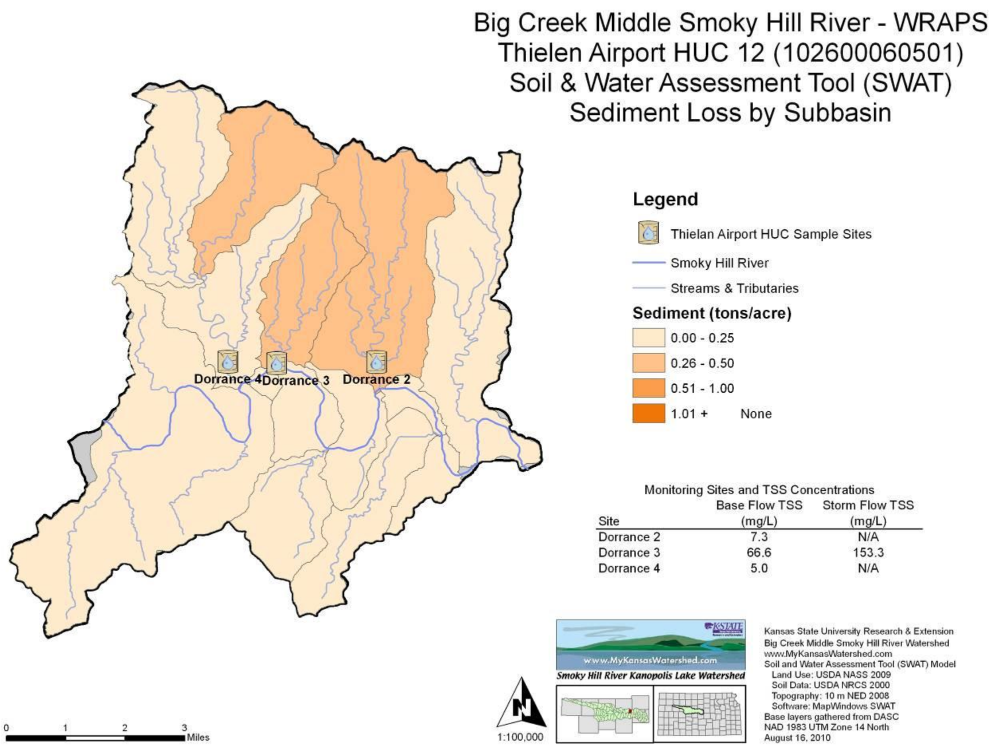


Figure 32. Total sediment loading (tons/acre) as determined by the SWAT model.

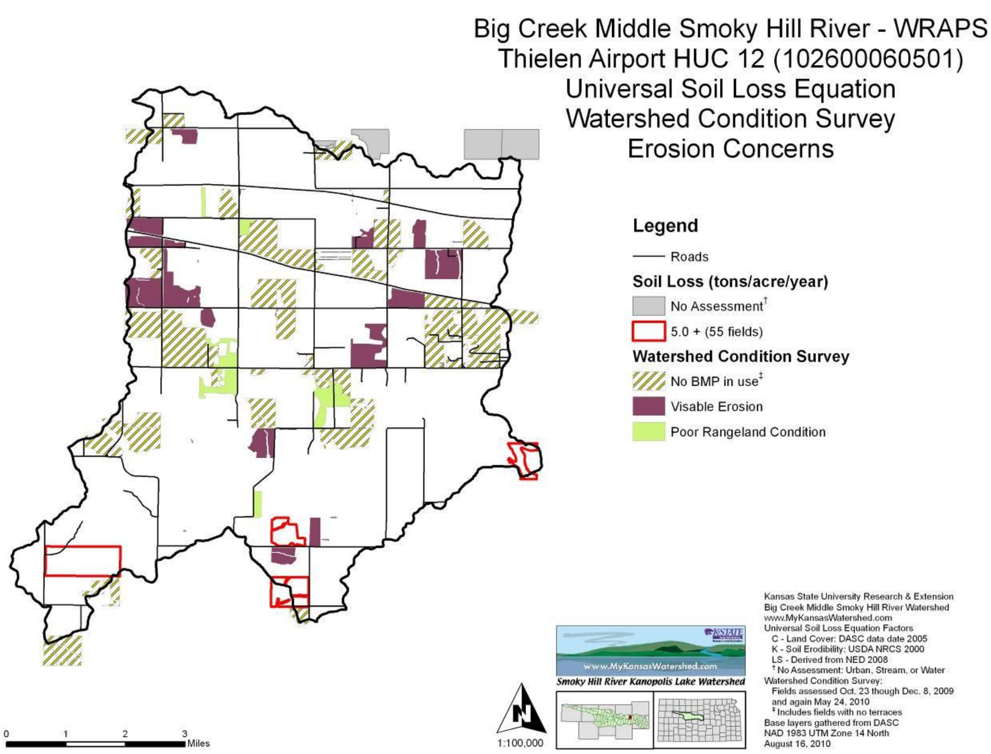


Figure 33. Thielen Airport subwatershed WKCAT and USLE results.

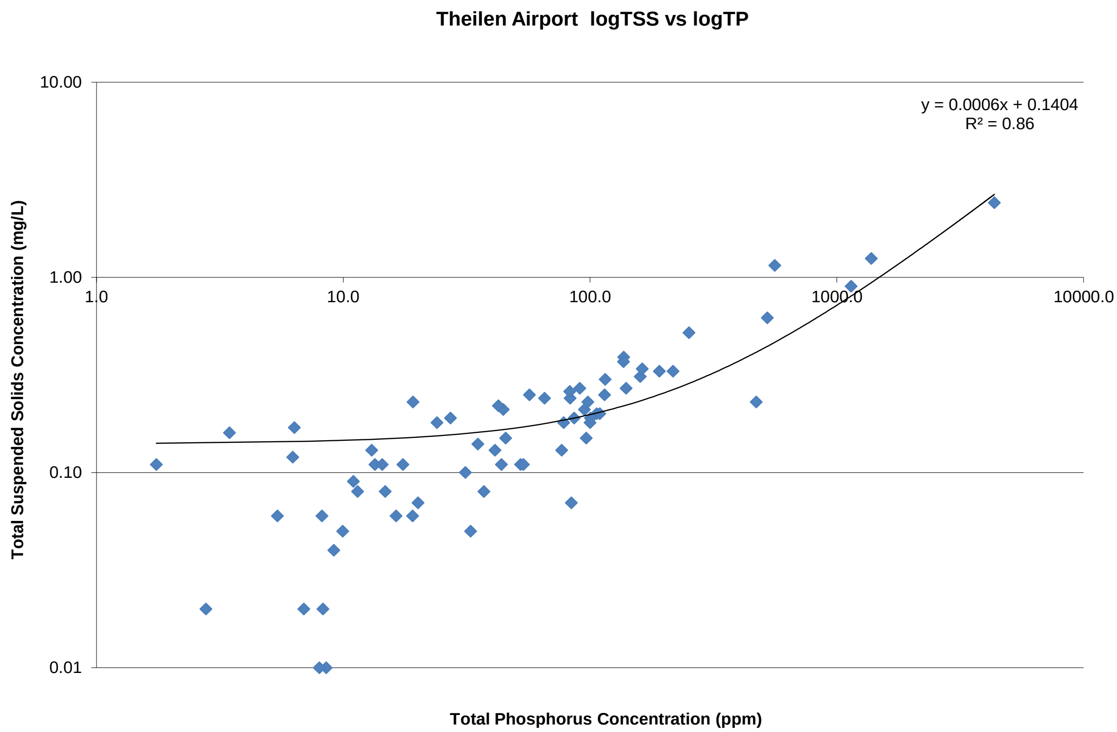


Figure 34. Log graph correlation of TSS to TP in the Thielen Airport subwatershed as measured at site SHR Wilson. Function is linear with an R^2 of 0.86.

Table 11. Thielen Airport HUC 12 Subwatershed BMPs with total reductions for 23 years according to the BCMSHRW WRAPS Watershed Plan Reduction Goal & Kanopolis Lake EU TMDL Goal (4.2% of Russell County)

Best Management Practice	Acres, Linear Feet, or Projects to be Implemented	Total TSS Reduction Achieved (tons)/Yr	Total N Reduction Achieved (lbs) *% towards Kanopolis Lake EU TMDL*	Total P Reduction Achieved (lbs) *% towards Kanopolis Lake EU TMDL*
Establish grass buffers/Critical area planting	5 acres/year	66	139 13%	99 13%
Relocate livestock operations away from streams	1 site/year (50 AU/site)	N/A	N/A	159 9%
Improve native vegetation in rangeland (range planting, brush control)	120 acres/year	139	396 10%	139 8%
Improve stocking rates & livestock distribution (rotational grazing, reduced	120 acres/year	15	44 12%	22 12%

head/acre)				
Promote alternative watering systems away from streams	2 systems/every 3 years (50 AU/site	N/A	N/A	318 10%
Grassed Waterway Installation & Restoration	7 acres/year	33	17 15%	13 16%
Install terraces	24 Acres protected & 220 Linear Foot	27	14 2%	11 3%
Terrace restoration	455 Linear Foot (2.275 acres protected)	3	2 < 1%	1 < 1%
Conversion to minimum tillage	120 acres/year	46	116 8%	58 8%
Conversion to no-till	120 acres/year	116	314 < 1%	157 8%
Onsite Waste Water System Upgrades	1 system/year (treating 100 gallons/day)	21.9 (lbs/year)	12 7%	4 7%
Total Reduction Load per year		445	1,054	981
Total Reduction Load in 23 years		10,235	24,242	22,563

4.4 Town of Munjor Subwatershed

The Town of Munjor subwatershed has been selected by multiple agencies for targeting. From the stream monitoring network, the leadership team has focused efforts into identifying fields for targeted BMP placement. Additionally, local NRCS EQIP workgroup, with data provided by the WRAPS group, has selected this subwatershed for targeted EQIP funds for nutrients and sediment. Finally, the waters of this subwatershed are listed by KDHE as a high priority TMDL impaired for TN, TP, TSS, and *E. coli* with excessive median TSS values. The TN and TP impairments stem mainly from the effluent waters of the City of Hays. It is currently uncertain by the WRAPS Leadership Team what contributes to the high *E. coli* concentrations, whether it is livestock or failing septic systems along Big Creek. The Big Creek TMDL calls for initial emphasis on riparian areas and livestock access points along Big Creek for implementation efforts.

Monitoring data, since 2006, documents constant exceedence of TMDL benchmarks for all four previously mentioned parameters. Although effluent water is mainly the culprit for the high nutrient values, elevated and continuously high median TSS and *E. coli* levels are problems within the subwatershed. From the upstream subwatershed, Chetolah Draw, concentration values are maintained or elevated by the end of the Town of Munjor subwatershed. From KDHE benchmarks, TSS levels are 78% above benchmark while *E. coli* is 34% above benchmark.

The SWAT model for the subwatershed is inconclusive for TN, TP, and TSS as there is very little indication of higher pollutant yielding subbasins. According to the model, almost all subbasins are ranked equally and equally contribute to the pollutant problem (Figures 35-37). Also, since this is a HUC 12 subwatershed only recently targeted, the WKCAT assessment has not yet been completed (planned for fall 2009), nor have targeted sites within the subwatershed been established (spring 2010).

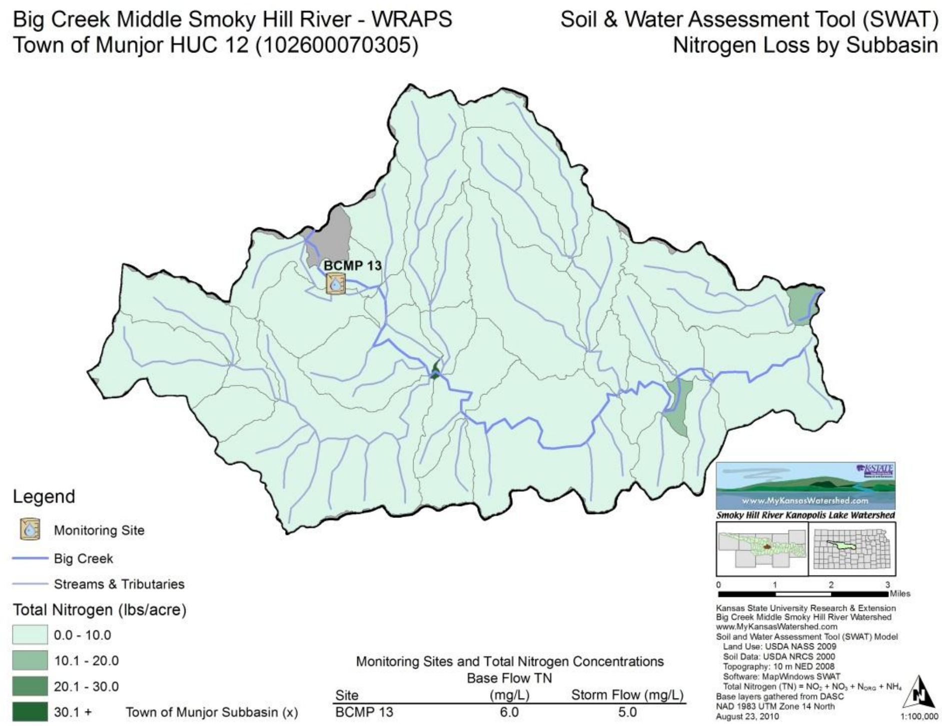


Figure 35. Total nitrogen loading (lbs/acre) as determined by the SWAT model.

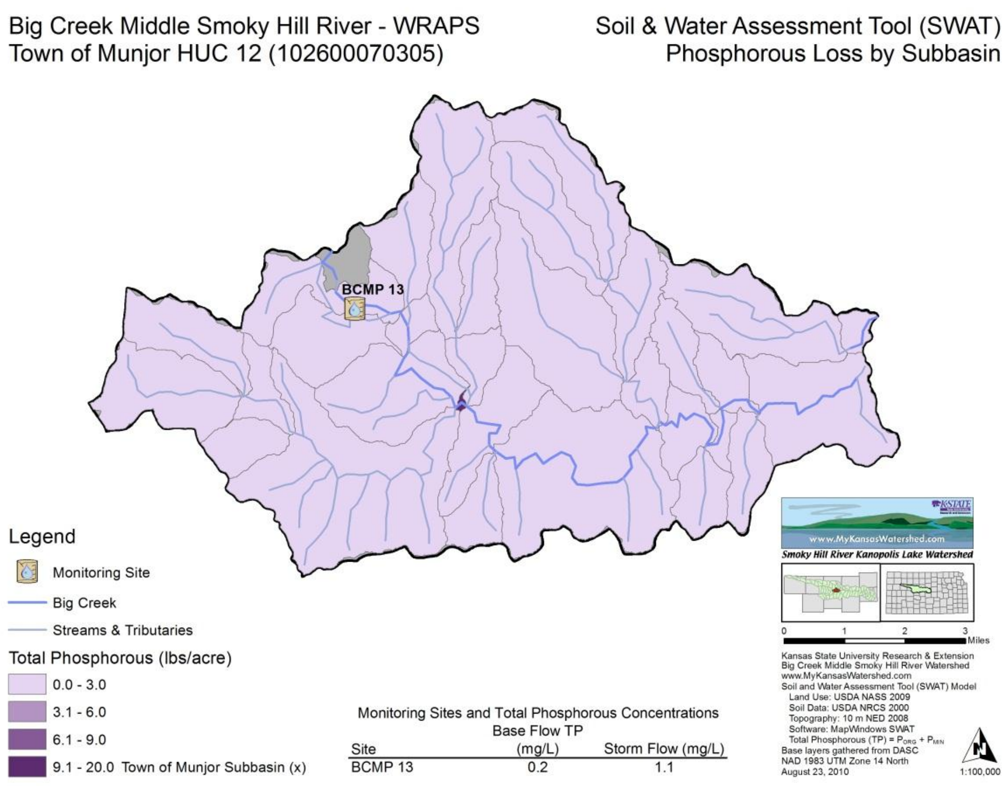


Figure 36. Total phosphorus loading (lbs/acre) as determined by the SWAT model.

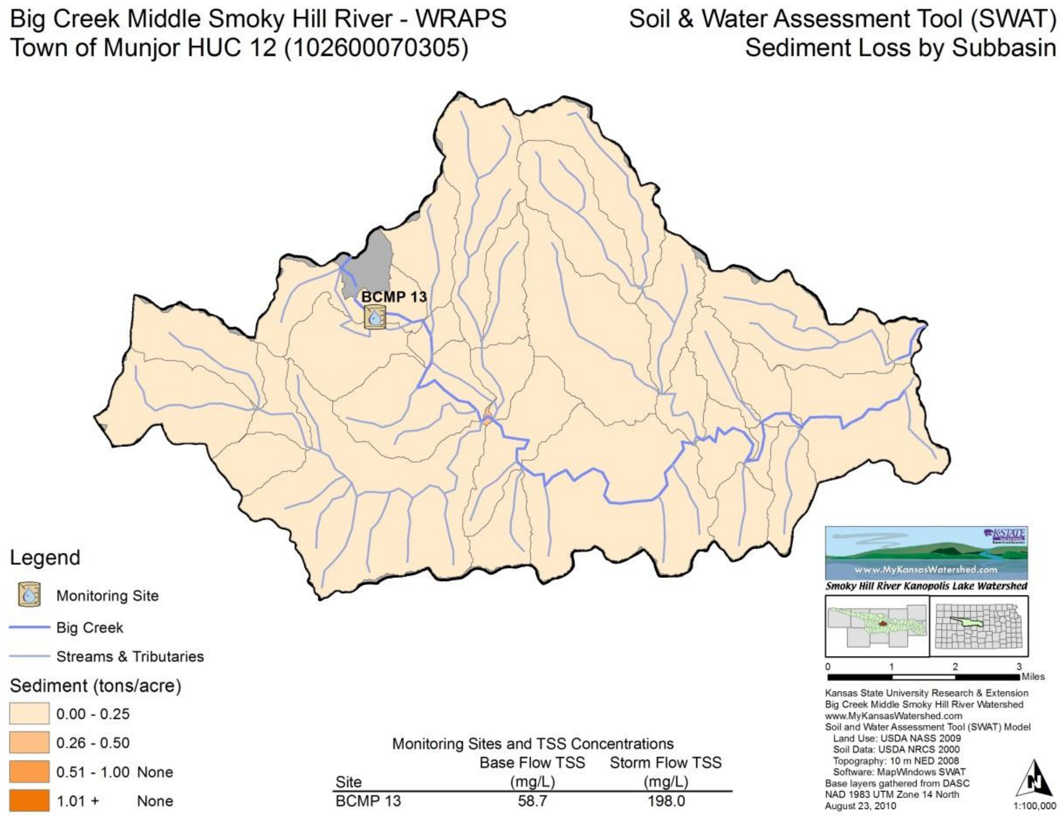


Figure 37. Total sediment loading (tons/acre) as determined by the SWAT model.

The current USLE model for the subwatershed indicated numerous CLUs within the subwatershed that theoretically yield more than 5 tons/acre/year of sediment (Figure 38). Local knowledge from producers in the subwatershed, extension specialists, and NRCS staff point to the high percentage of conventional tillage operations within the subwatershed as the most likely cause of the elevated TSS levels. Over 61% of the land cover in this subwatershed is cropland. Although many producers in this area already use BMPs such as terraces and waterways, erosion still occurs. Best management practices to reduce pollutant loads will most likely result from terrace rebuilds, rebuilt waterways, and conversions from conventional tillage to minimum or no-till practices. Unlike the other identified critical areas, there is a negative correlation between TSS and TP. This indicates to the WRAPS group that phosphorus is coming from a source other than overland flow (i.e. cropland erosion).

Also from that same knowledge base is the number of livestock feeding operations and livestock grazing lands that border or are on Big Creek and tributaries. Best management practices to effectively reduce the sediment and *E. coli* will be limiting livestock access to the stream and relocating feeding sites. When livestock have access to streams, they typically loaf in the stream during the summer and use the stream for protection during the winter. Their presence disturbs the stream and banks via trampling and the removal of vegetation. For a comprehensive list of BMPs to be implemented see Table 12.

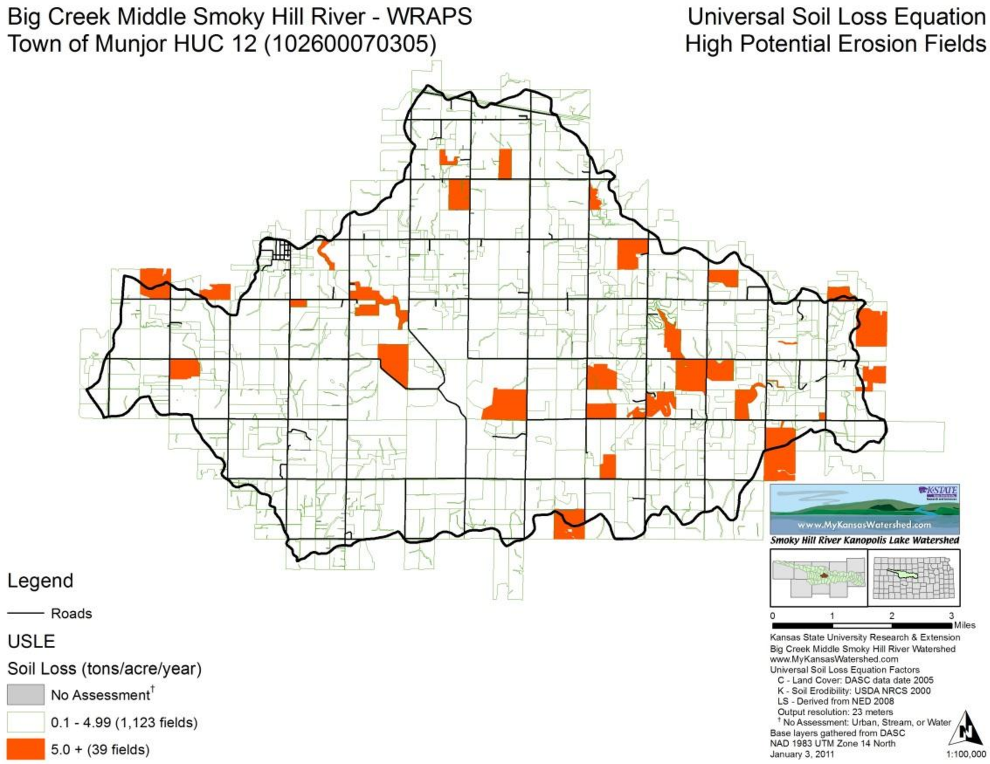


Figure 38. USLE model with high potential erosion fields: greater than 5.0 tons/acre/year of erosion.

Table 12. Town of Munjor HUC 12 Subwatershed BMPs with total reductions for 23 years according to the BCMSHRW WRAPS Big Creek TMDL Reduction Goals, Watershed Plan Reduction Goal (6.4% of Ellis County)

Best Management Practice	Acres, Linear Feet, or Projects to be Implemented	Total TSS Reduction Achieved (tons)/Yr *% towards Big Creek TMDL Goal*	Total N Reduction Achieved (lbs)/Yr *% towards Big Creek TMDL Goal*	Total P Reduction Achieved (lbs)/Yr *% towards Big Creek TMDL Goal*
Establish grass buffers/Critical area planting	5 acres/year	52 25%	116 11%	83 11%
Relocate livestock operations away from streams	1 site/year (50 AU/site)	N/A	N/A	171 10%
Improve native vegetation in rangeland (range planting, brush control)	120 acres/year	113 19%	336 9%	168 9%
Improve stocking rates & livestock distribution (rotational grazing, reduced head/acre)	120 acres/year	10 40%	31 9%	16 9%

Promote alternative watering systems away from streams	2 systems/every 3 years (50 AU/site)	N/A	N/A	342 11%
Grassed Waterway Installation & Restoration	7 acres/year	38 40%	19 17%	13 16%
Install terraces	110 Acres protected & 825 Linear Foot	90 11%	45 6%	34 7%
Terrace restoration	755 Linear Foot (3.775 acres protected)	4 8%	2 4%	2 5%
Conversion to minimum tillage	200 acres/year	58 19%	154 10%	77 10%
Conversion to no-till	200 acres/year	144 19%	415 10%	208 10%
Onsite Waste Water System Upgrades	1 system/year (treating 100 gallons/day)	21.9 (lbs/year) 14%	12.0 7%	4.5 7%
Total Reduction Loads/Yr		509	1,130	1,118.5
Total Reduction Loads in 23 years		11,707	2,599	25,725.5

4.5 Hays Consolidated Subwatershed

The Hays Consolidated Subwatershed (HUC 12 City of Hays and Chetolah Creek) will be treated and targeted as one subwatershed as the City of Hays equally lies within each subwatershed. The leadership team has chosen to target these subwatersheds based on monitoring data since 2006 along with the 2010 KDHE high priority TMDL for TN, TP, TSS, and *E. coli*. Targeting in this subwatershed will be different from previous as a majority of the issues lay within urban stormwater and wastewater treatment facilities. The WRAPS group will work with the City of Hays and its officials to find best management practices suited to the urban environment. In 2009, the WRAPS group assisted the City in locating funds to build a bioretention center at one of the monitoring locations. Currently, the WRAPS group is providing technical assistance on maintenance of the structure.

Monitoring data provided by the WRAPS group closely matches the results of the SWAT models for TP and TSS but is inconclusive for TN. Total nitrogen loading, from the SWAT model, points to very small acreages contributing the majority of the total nitrogen load for the subwatersheds (Figure 39). Monitoring data in the rural areas of the subwatershed cannot verify nor define where the loading is from as most sample sites are located in and around the City of Hays. The WKCAT model may highlight areas of potential high nitrogen loading.

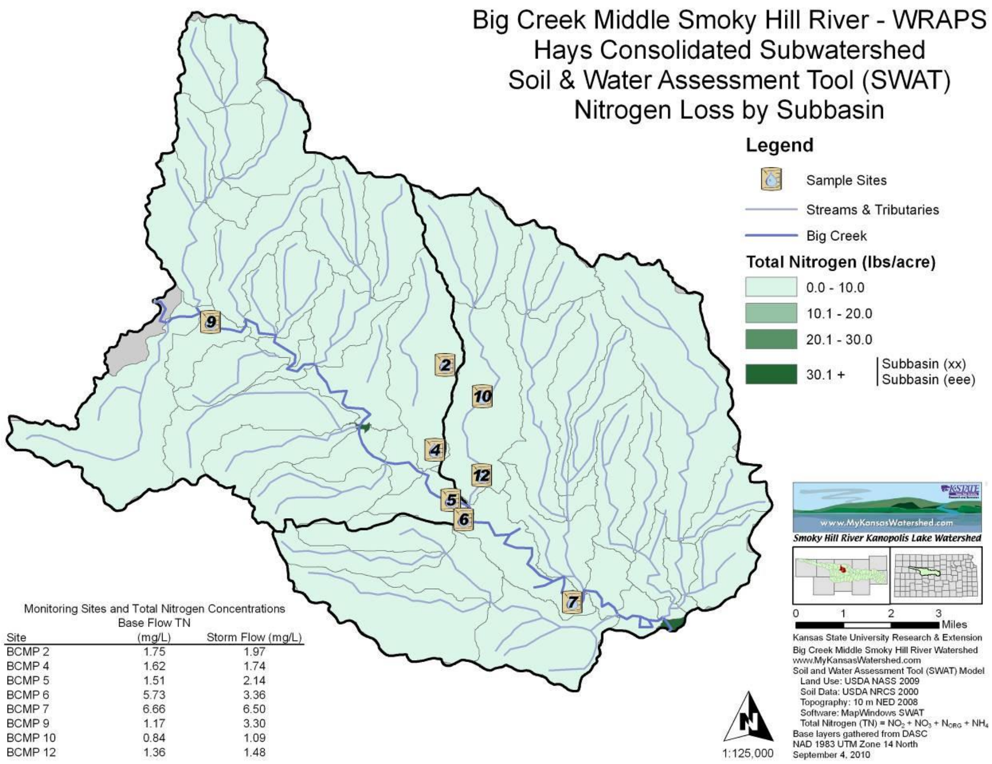


Figure 39. Total nitrogen loading (lbs/acre) as determined by the SWAT model.

In agreement with the SWAT model are TP and TSS contributing areas. According to the SWAT model most of the phosphorus loading of the subwatershed, outside of wastewater discharge, comes from areas adjacent to Big Creek (Figure 40). Monitoring values on Big Creek from west of Hays to downstream of Hays all indicate a high phosphorus load during base flows and storm flow. Consequently, this stream segment also has a high priority TMDL for TP.

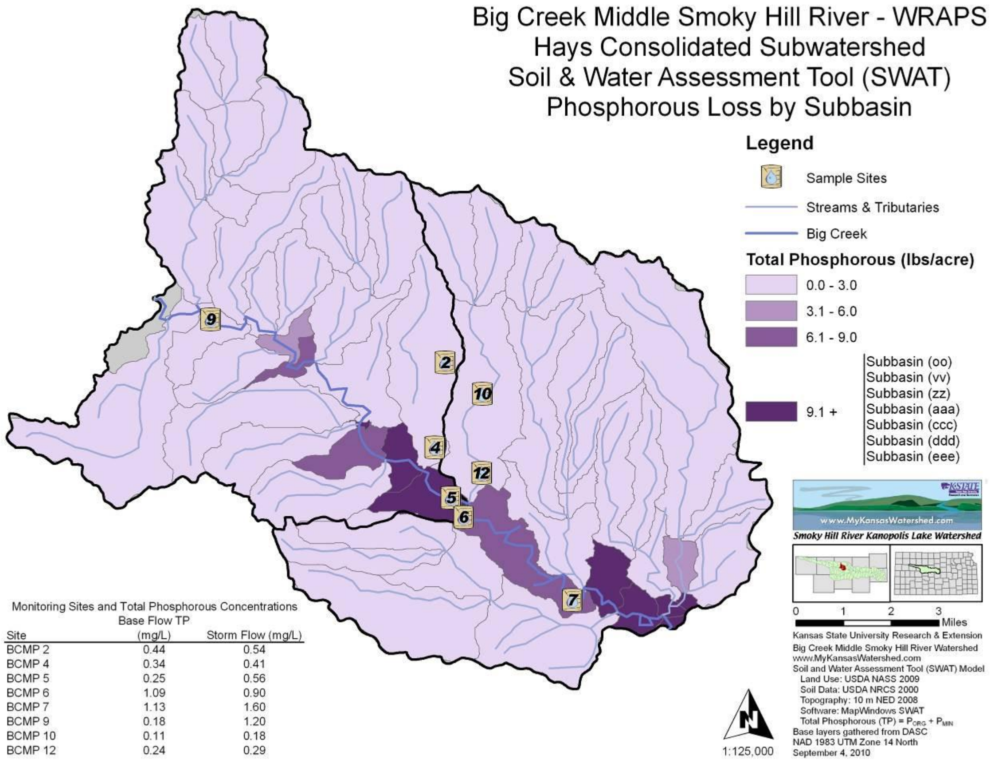


Figure 40. Total phosphorus loading (lbs/acre) as determined by the SWAT model.

Total suspended solids during base flow are greatest downstream of the City of Hays where the median value is above the TMDL benchmark of 50.0 mg/L. Above the City of Hays as measured at Site 5, median TSS concentrations are below the TMDL threshold. Current load reductions as provided by KDHE support large reductions from the Big Creek watershed during both base (584 tons sediment) and high flow (2010 tons sediment). The SWAT model predicts the majority of sediment to come from the City of Hays subwatershed (western urban subwatershed) (Figure 41). Monitoring data at sites 2 and 4 agree with the model as these monitoring locations during storm flow exhibit high TSS concentrations when compared to adjacent subwatershed sites. However, according to the USLE model, excluding the City of Hays boundaries, most of the potential sediment erosion may be from many areas adjacent to Big Creek (Figure 42).

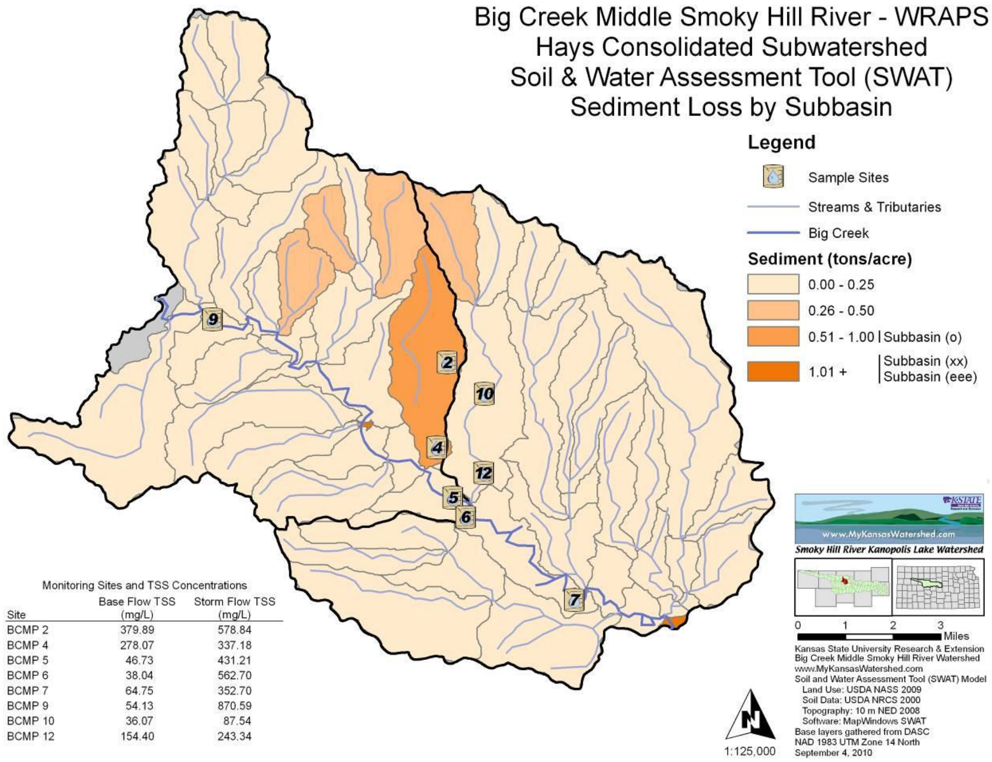


Figure 41. Total suspended solids (tons/acre) as determined by the SWAT model.

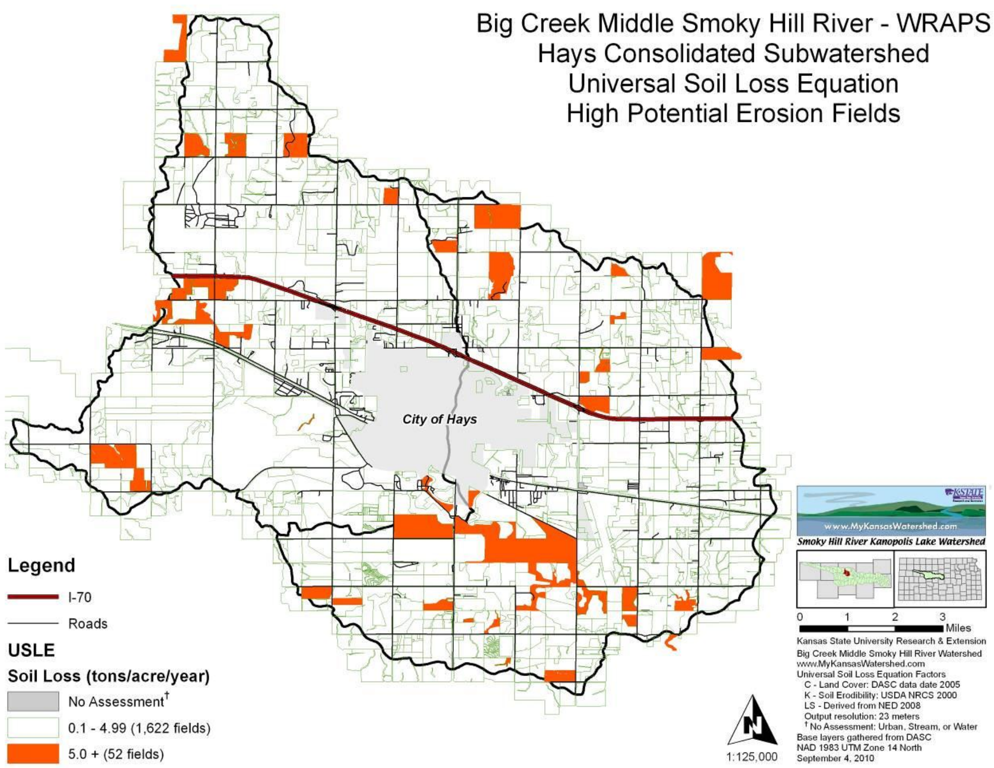


Figure 42. High potential erosion fields with greater than 5.0 tons/acre/year of erosion.

For this subwatershed the WKCAT model has not yet been completed but future plans are to do so. The leadership team, as well as many agencies, feel that modeling will not pinpoint targeted areas in need of BMPs but rather urban issues such as open space, willingness of citizens to alter habits, and local government input will drive stormwater management, wastewater nutrient reduction numbers, and reduction goals as the urban factor is the largest contributing factor in these subwatersheds. The urban BMPs to be installed within the Hays Consolidated subwatershed will include retention ponds, native vegetation in drainages, and stormwater education at the discretion of the stormwater superintendent. Other BMPs outside of the City of Hays limits will focus on traditional practices that retain, filter, or infiltrate stormwater. For a comprehensive list of BMPs see Table 13.

Table 13. Hays Consolidated HUC 12 Subwatershed BMPS with total reductions for 23 years according to the BCMSHRW WRAPS Big Creek TMDL Reduction Goals & Watershed Plan Reduction Goal (9.9% of Ellis County)

Best Management Practice	Acres, Linear Feet, or Projects to be Implemented	Total TSS Reduction Achieved (tons)/Yr *% towards Big Creek TMDL Goal*	Total N Reduction Achieved (lbs) *% towards Big Creek TMDL Goal*	Total P Reduction Achieved (lbs) *% towards Big Creek TMDL Goal*
Upgrade WWTP	As Per City Code	Not Available	Not Available	Not Available
Implement & Manage Stormwater Utility Regulations	As Per City Code	Not Available	Not Available	Not Available
Establish grass buffers/Critical area planting	5 acres/year	52 25%	116 11%	83 11%
Relocate livestock operations away from streams	1 site/year (50 AU/site)	N/A	N/A	171 10%
Improve native vegetation in rangeland (range planting, brush control)	120 acres/year	113 19%	336 9%	168 9%
Improve stocking rates & livestock distribution	120 acres/year	10 20%	31 9%	16 9%
Promote alternative watering systems away from streams	2 systems/every 3 years (50 AU/site)	N/A	N/A	342 11%
Grassed Waterway Installation & Restoration	10 acres/year	38 40%	19 17%	13 16%
Install terraces	165 Acres protected & 1,275 Linear Foot	129 15%	65 9%	49 9%
Terrace restoration	1,170 Linear Foot (5.85 acres protected)	6 11%	3 6%	3 8%

Conversion to minimum tillage	275 acres/year	76 25%	205 14%	103 14%
Conversion to no-till	275 acres/year	191 25%	553 14%	277 14%
Onsite Waste Water System Upgrades	1 system/year (treating 100 gallons/day)	21.9 (lbs/year) 14%	12.0 7%	4.5 7%
Total Reduction Load per year		636.9	1,340	1,229
Total Reduction Load in 23 years		14,648.7	30,820	28,267

4.6 Additional Reduction

As well as targeting in the selected critical areas as identified by the WRAPS group, BMPs will still be placed throughout the BCMSHR watersheds. Many of the BMPs will focus on rural practices in croplands and rangelands as provided through federal, state, and county cost-share programs. A complete list of expected BMPs to be implemented is found in Table 14. Practices listed are the sum of both Big Creek and the Middle Smoky Hill River Watersheds. Estimates are based on the premise that half of these practices will be placed in the Big Creek Watershed and half in the Middle Smoky Hill River Watershed.

Table 14. Big Creek Middle Smoky Hill River HUC 8s BMPs with total reductions for 23 years according to the BCMSHRW WRAPS Big Creek TMDL Reduction Goals & Watershed Plan Reduction Goal. (Practices not included in the Target Areas)

Best Management Practice	Acres, Linear Feet, or Projects to be Implemented	Total TSS Reduction Achieved (tons)	Total N Reduction Achieved (lbs)	Total P Reduction Achieved (lbs)
Establish grass buffers/Critical area planting	20 acres/year	208	464	332
Relocate livestock operations away from streams	6 sites/year (50 AU/site)	N/A	N/A	1,026
Improve native vegetation in rangeland (range planting, brush control)	1,000 acres/year	719	2,268	1,136
Improve stocking rates & livestock distribution (rotational grazing, reduced head/acre)	1,000 acres/yr	62	211	106
Promote alternative watering systems away from streams	10 systems every 3 years (50 AU/site)	N/A	N/A	1710
Grassed Waterway Installation & Restoration	18 acres/yr	38	19	13
Install terraces	2,000 Acres protected & 22,000 Linear Foot	1,222	612	433
Terrace restoration	21,000 Linear Foot (105	86	43	33

	acres protected)			
Conversion to minimum tillage	1,500 acres/year	337	943	472
Conversion to no-till	1,500 acres/year	841	2,546	1,275
Onsite Waste Water System Upgrades	10 systems/year (each system treating 100 gallons/day)	219 (lbs/year)	120.4	45.6
Total Reduction Load per year		3,513	7,226.4	6,581.6
Total Reduction Load in 23 years		80,799	166,207.2	151,376.8

5.0 Impairments addressed in the Critical HUC 12 Targets

5.1 Sediment

Silt or sediment accumulation in water bodies reduces storage capacity and limits access to lakes, reservoirs, ponds, and wetlands. Sediment also reduces the recreational accessibility to boat ramps, beaches, and water. Although the presence of sediment is a natural phenomenon (Huggins et al., 2008)[12], it acts as a delivery vehicle for other pollutants such as phosphorus and pesticides (deNoyelles et al., 2008)[13], and in excess it causes much degradation.

Physical components along with natural and human activities occurring on the landscape affect how and when sediment is transported. Physical components such as the slope of the land, soil type, and streambank conditions are the ultimate factor in sediment movement. Natural components include rainfall intensity and frequency along with animal activity. Human activities that influence sediment transport include, but are not limited to variable amounts of ground cover, implementations of retention structures, construction in and near stream channels, and the degradation of the riparian zone. BMPs suggested by the BCMSHRW Leadership Team will be installed in the critical HUC 12 target areas based on acceptability of the landowners, cost effectiveness, cost-share availability, and pollutant load reduction effectiveness.

5.1.1 Cropland Erosion

For cropland erosion reduction, the Leadership Team utilized WKCAT, USLE, local knowledge, and monitoring data to select the type and quantities of BMPs needed to address the sediment impairments. The WKCAT documented critical areas within the HUC 12s that were in need of practices such as terraces, grassed waterways, conversion to minimum till or no-till, grass buffer strips along the edge of fields, or streambank stabilizations. Implementing these BMPs will lead to reduced erosion and decreases in TSS values of impaired waters. Consolidating monitoring data, WKCAT, and USLE data verifies these areas are in need of targeting.

5.1.2 Grassland/Rangeland Erosion

For grassland/rangeland erosion reduction, the Leadership Team utilized WKCAT, USLE, local knowledge, and monitoring data to select type and quantities of BMPs needed to address the sediment impairments in the BCMSHRW. The WKCAT documented locations within the target areas that would benefit from BMPs or alternative management decisions. These practices include rest rotations, stocking rate adjustments, removal of invasive species, alternative water sources, and brush management that will prevent erosion.

5.1.3 Streambank Erosion and Riparian Areas

A lack of riparian canopy and streambank cover results in erosion of the streambanks and rivers. During intense storm events, streambank erosion only intensifies as the vegetative cover is removed. Properly functioning and healthy riparian zones, with the installation of grass buffers or filter strips, will retard sediment flow from both rangeland and cropland. Riparian zones are vulnerable to runoff and erosion with the presence of human or livestock activity. Providing selected access points for livestock or restrictions along stream segments will reduce the degradation of the streambanks. Buffers and filter strips along wooded riparian areas reduces erosion by extending the riparian area thereby dissipating flow energy into the streambank. Cropland adjacent to the stream without buffer protection only increases erosion along the streambanks as there is no riparian protection from sediment movement.

In the summer of 2008, a streambank stability assessment was conducted in the BCMSHRW by the WRAPS project. Stream segments were categorized and analyzed on a multitude of parameters including canopy cover, bank stability, riparian zone health, bank erodibility, and bank vegetation type. Numerous points were documented in each subwatershed and overall conditions found average streambank stabilities and health across the watershed. This information guides the leadership team to believe that most pollutants are coming from the upland areas of each subwatershed.

In the Oak Creek subwatershed banks were overall moderately stable with vegetation present on the banks. The Landon Creek subwatershed included streambanks that had moderately unstable banks with both bank sides eroding and little vegetation (only 2 sites were documented). Theilen Airport subwatershed had overall moderately unstable but vegetated banks. The Town of Munjor subwatershed had bank erosion on both banks and moderately unstable to unstable banks. The City of Hays consolidated had much bank alteration due to the urban factors controlling water flow with highly vegetated but eroded stream channels.

5.1.4 Sediment Pollutant Loads & Load Reductions

The current estimated Total Suspended Solids (TSS) load on Big Creek, which is the only drainage within the Kanopolis watershed with a TSS TMDL, is 9,693 lbs/day or 1,769 tons/yr at a representative flow of 25 cfs at the confluence of Big Creek and the Smoky Hill River. The desired load capacity or TMDL is 5,789 pounds per day or 1,056 tons/yr, which reflects a median TSS concentration of 43 mg/L along Big Creek in Ellis and Russell counties. This is a 40% reduction in TSS concentration below Hays and matches the current concentrations observed by KDHE at its monitoring station located above Hays on Big Creek. Eighteen percent of the TMDL comprises waste load allocations from municipal wastewater and stormwater, under NPDES permit, leaving a load allocation for non-point sources of 4,747 pounds per day or 866 tons/yr. Once again, this is under normal flow conditions near the mouth of Big Creek. At higher flows, the permissible load capacity increases two-to-three-fold, driven predominantly by runoff from rural lands. At higher flows, urban stormwater comprises about 6% of the TSS load from the lower watershed in Ellis and Russell counties. The final component of the TMDL, the margin of safety, is implied through the use of a target median concentration of 43 mg/L which is lower than the necessary concentration of 50 mg/L, tied to good quality biological communities. The Leadership Team is concentrating efforts on TSS reductions first while keeping in mind that some reductions in TN and TP benefits will occur simultaneously.

Municipal wastewater is already governed by secondary treatment and NPDES permit limits of 30 mg/L TSS for mechanical plants and 80 mg/L TSS for lagoon systems. Taken together, the four municipal dischargers into Big Creek do not constitute a significant contribution to the TSS load. Particularly since Hays comprises the majority of dry-weather flow on the lower creek, the low TSS content in its wastewater dominates low flow conditions allowing the creek to comply with the TMDL under those conditions. Runoff from rural lands makes up 98–99% of the load at higher flows, therefore, the necessary load reduction to be achieved by non-point sources can be derived as the difference between the current load and the desired TMDL (9,693 – 5,789 = 3,904 pounds per day or 712 tons per year) (Table 15a). These values are at normal flows. Necessary load reductions at high flows (> 75 cfs) are three times the normal flow value because of the increased volume of sediment-laden water during wet weather. These load reductions can be accomplished through implementation of sediment control measures in the critical areas identified by the Leadership Team along Big Creek in Ellis County. The TMDL NPS load reduction expectation focuses on concentrating in the lower riparian zones below the City of Hays while the City of Hays is working on reducing their waste loads through the waste water treatment plant as well as the newly formed stormwater utility.

Table 15a. Big Creek TMDL Summary for Total Suspended Solids

TSS Load		TSS lbs/day
NPS Load Allocation	+	9,693
NPS Desired Load	-	5,789
TSS NPS Load that needs to be Reduced	=	3,904 or 712 tons/yr

As previously noted, with the exception of Big Creek, TSS is not a primary State of Kansas interest for watershed management above Kanopolis Reservoir. However, based on more than three full years of sampling by the WRAPS team, sediment and TSS are important locally during wet weather. There is a direct correlation between TSS and phosphorus concentrations based upon WRAPS monitoring data. Therefore, supporting locally driven implementation of sediment and erosion reduction measures above Kanopolis Reservoir, obtains a secondary benefit of reducing phosphorus loadings into the reservoir. Reducing TSS is actively working to achieve the endpoints of the Kanopolis Lake EU eutrophication TMDL, a high priority.

TSS load reduction targets in the remaining three critical areas outside of Big Creek are estimated by estimating the 10% exceedence flows generated on Landon Creek, Oak Creek, and the north side drainages to the Smoky Hill River near Thielen Airport by Dorrance (as measured at the SHR). WRAPS data are used to ascertain the typical TSS storm flow concentrations seen in those areas. Reductions represent the lowering of the current mean TSS storm flow values 30% based on current practices at KDHE when no TMDLs are set for the particular stream segment. These annual reductions for the three critical areas 2,830, 4,800, and 6,680 tons per year for Landon, Oak and Thielen Airport subwatersheds respectively or 14,310 tons/yr total.

To meet the TSS reduction goal for the Big Creek TMDL of 712 tons/yr and to meet the watershed plan goal for TSS reduction in the target HUC 12s in the Middle Smoky Hill River Watershed of 14,310 tons/yr, we need a 15,022 tons/yr total reduction load. Table 15b lists all the BMPs the Leadership Team has accepted annually to reduce sediment to meet the TSS reduction goals in the Big Creek watershed including the two targeted HUC 12s of the Town of Munjor and Hays Consolidated subwatersheds while Table 15c lists the BMPs in the three critical HUC 12 subwatershed areas of Oak Creek, Landon Creek and Thielen Airport along with all work identified in the Middle Smoky Hill River watershed above Kanopolis Lake. The table also shows the process to achieve the sediment (TSS) load reductions. The feasibility and methodology for the types and quantities of BMPs to be implemented in the plan are described in more detail in section 4.1 Load Reduction Methodology.

Table 15b. All BMPs Installed Annually in the Big Creek Watershed (Including the Town of Munjor & Hays Consolidated HUC 12 Target Areas), Estimated Years, and Load Reductions Needed to Meet Big Creek Total Suspended Solids TMDL set by the BCMSHRW WRAPS Leadership Teams Watershed Plan.

BMP	Acres/Projects Implemented Annually	Annual Soil Erosion Reduction (tons/yr)	Years Needed to reach TMDL Goal	Total Reduction Load (tons/yr)
Establish grass buffers/Critical area planting	20 acres	208	1	208
Improve native vegetation in rangeland (range planting, brush control)	740 acres	586	1	586
Improve stocking rates & livestock distribution (rotational grazing, reduced head/acre)	740 acres	51	1	51
Grassed Waterway Installation & Restoration	26 acres	95	1	95
Install terraces	1,275 protected & 13,100 LF	830	1	830
Terrace restoration	12,425 LF & 62.625 acres protected	53	1	53
Conversion to minimum tillage	1,225 acres	303	1	303
Conversion to no-till	1,225 acres	756	1	756
ONWWS Upgrades	7 systems/yr (treating 100 gallons/day	153.3 lbs/yr	1	153.3 lbs/yr

Big Creek TMDL reduction goal met in 1 year is 2,882 tons total TSS reduction at 2,882 tons per year.

Table 15c. All BMPs Installed Annually in the Middle Smoky Hill River Watershed (including the Oak Creek, Landon Creek, & Thielen Airport HUC 12 Target Areas), Estimated Years, and Load Reductions Needed to Meet Total Suspended Solids TMDL set by the BCMSHRW WRAPS Leadership Teams Watershed Plan.

BMP	Acres/Projects Implemented Annually	Annual Soil Erosion Reduction (tons/yr)	Years Needed to reach TMDL Goal	Total Reduction Load (tons/yr)
Establish grass buffers/Critical area planting	25 acres	303	5	1,515
Improve native vegetation in rangeland (range planting, brush control)	860 acres	791	5	3,955
Improve stocking rates & livestock distribution (rotational grazing, reduced head/acre)	860 acres	65	5	325
Grassed Waterway Installation & Restoration	33 acres	133	5	665
Install terraces	1,069 acres protected & 11,945 LF	690	5	3,450
Terrace restoration	11,470 LF & 56.85 acres protected	50	5	250
Conversion to minimum tillage	1,190 acres	272	5	1,360
Conversion to no-till	1,190 acres	682	5	3,410
ONWWS Upgrades	9 systems/year (treating 100 gallons/day)	196.6 lbs/year	5	983 lbs

MSHR Target Areas WRAPS Watershed Plan TSS reduction goal met in 5 years is 14,930 tons at 2,986 tons per year.

5.2 Nutrients

Excess nutrients pose a problem within the BCMSHRW by causing nutrient related pollutant issues including: eutrophication, low levels of dissolved oxygen, undesirable algal blooms, and undesirable aquatic plants. Excess nutrients can originate naturally but tend to come from human activities and their land practices. These land practices include fertilizer runoff from agricultural and urban lands, failing BMP structures, overgrazing, livestock waste runoff from confined feeding facilities, improper pet waste disposal, and failing onsite wastewater systems.

Land cover in the BCMSHRW is predominately agriculture with the exception of one major urban center. Agriculture best management practices needed for nitrogen and phosphorus reductions include: soil samples for proper fertilizer application rates, conversion to minimum and/or no-till operations, installation of grass buffers and filter strips along streams, limiting livestock access to streams, adjusting livestock stocking rates, developing nutrient management plans for proper manure application, and identifying and replacing failing onsite wastewater systems. For urban environments, best management practices include landscaping using native species to reduce fertilizer and water needs, proper disposal of pet waste, and an assessment of onsite wastewater systems.

Within the BCMSHRW, demographics play a role in the percentage of failing onsite wastewater system. Older residents, with less dependents living at home, will place less of a load on a septic system while younger couples with families will put stress on an older septic system. This additional stress is attributed to everyday activities associated with a family. When older systems are placed under load stress, these systems have a tendency to fail and leach waste (nitrogen, phosphorus, and bacteria) into surface and/or ground waters. Since all counties in the BCMSHRW have adopted sanitary codes, on-site waste water systems are increasingly replaced, maintained, and/or upgraded.

Additionally, livestock plays a major role in nutrient loading into Kanopolis Lake. Many of these operations are confined and permitted by state or federal agencies but most operations are small farm, non-confined, and unregulated. Knowing the types and sizes of livestock operations within the BCMSHRW is important in nutrient reduction due of the amounts of livestock waste that is generated and must be disposed of by the operators. Figure 43 shows the locations of permitted CAFOs within the BCMSHRW.

Confined animal feeding operations are considered point source pollutant sources as the operations must collect, document, and manage the manure and waste created. Manure from these facilities are typically surface land applied which creates a large potential load of nutrients leaving the fields and entering the streams. Most producers haul this waste to cropland fields to be used as fertilizer. However, due to factors such as hauling costs and time, fields in close proximity to the operation disproportionately receive more manure than those with greater distances. Typically these fields have a higher concentration of phosphorus and nitrogen. Similarly, improperly managed grasslands can lead to overgrazed areas exposing bare soil, livestock waste build-up, and direct cattle access to the streams. The use of proper stocking rates, rotational grazing in pastures, and access to alternative water supplies will reduce nitrogen and phosphorus loading.

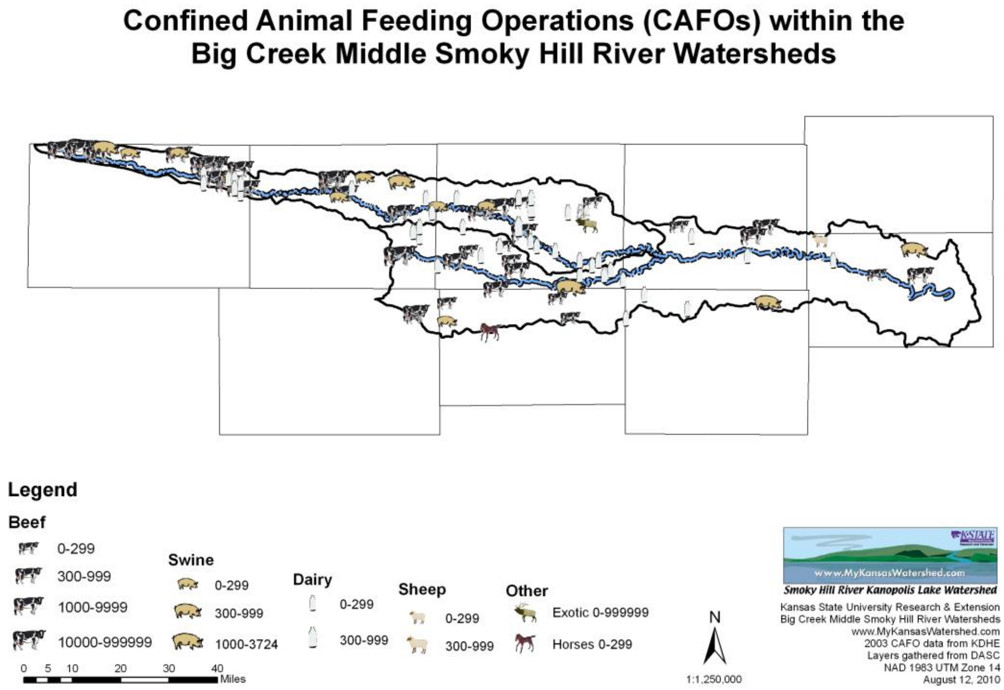


Figure 43. CAFOs located in the BCMSHRW along with unit size.

5.2.1 Nutrient Pollutant Loads & Load Reductions

A desired annual TN load of 384,345 lbs/ yr and TP load of 73,920 lbs/yr is the load capacity to achieve the chlorophyll target in Kanopolis Reservoir. These loads were 40% and 48% reductions in current annual phosphorus and nitrogen loads. An environmental margin of safety and point source waste load allocations comprise the majority of the load capacity, thereby requiring non-point sources to reduce their current annual loading to the reservoir by 52% (288,780 lbs/yr) for TN and 48% (37,735 lbs/yr) for TP. Table 16 lists BMPs that the Leadership Team has accepted to meet the TN TMDL Reduction Goal of 40% or 288,780 lbs/year & the Kanopolis Lake EU TMDL Goal. Table 17 lists BMPs that the Leadership Team has accepted to meet the TP TMDL Reduction Goal of 48% or 37,735 lbs/year & the Kanopolis Lake EU TMDL Goal.

Table 16. All BMPs Installed in BCMSHRW & Target Areas, Estimated Years, and Load Reductions Needed to Meet Total Nitrogen TMDL & Kanopolis Lake EU TMDL Goals *(Target areas values are italicized)*

BMP	Acres/Projects Implemented Annually	Annual TN Reduction (lbs/yr)	Years Needed to reach TMDL Goal	Total TN Reduction Load (lbs/yr)
Establish grass buffers/Critical area planting	45 acres *(25 acres)*	1,116 *(652)*	23	25,668
Improve native vegetation in rangeland	1,600 acres *(600 acres)*	4,184 *(1,916)*	23	96,232
Improve stocking rates & livestock distribution (rotational grazing, reduced head/acre)	1,600 acres *(600 acres)*	375 *(164)*	23	8,625
Grassed Waterway Installation & Restoration	59 acres *(41 acres)*	114 *(95)*	23	2,622
Install terraces	2,394 acres protected (25,045 LF) *(344 acres protected - 3,045 LF)*	762 *(213)*	23	17,526
Terrace restoration	119.48 acres protected (23,895 LF) *(11.48 acres protected - 2,895 LF)*	52 *(9)*	23	1,196
Conversion to minimum tillage	2,415 acres *(915 acres)*	1,563 *(620)*	23	35,949
Conversion to no-till	2,415 acres *(915 acres)*	4,220 *(1,674)*	23	97,060
ONWWS Upgrades	16 systems (1,600 gal/day) *6 systems (600 gal/day)*	192 *(71.6)*	23	4,416

TMDL reduction goal met in 23 years is 291,180 pounds total N at 12,578 lbs per year.

Table 17. All BMPs Installed in BCMSHRW & Target Areas, Estimated Years, and Load Reductions Needed to Meet Total Phosphorus TMDL & Kanopolis Lake EU TMDL Goals *(Target areas values are italicized)*

BMP	Acres/Projects Implemented Annually	Annual TP Reduction (lbs/yr)	Years Needed to reach TMDL Goal	Total TP Reduction Load (lbs/yr)
Establish grass buffers/Critical area planting	45 acres *(25 acres)*	798 *(466)*	4	3,192
Relocate livestock operations away from streams	11 systems 550 AU *(5 systems - 250 AU)*	1,857 *(831)*	4	7,428
Improve native vegetation in rangeland	1,600 acres *(600 acres)*	1,976 *(840)*	4	7,904
Improve stocking rates & livestock distribution (rotational grazing, reduced head/acre)	1,600 acres *(600 acres)*	189 *(83)*	4	756
Promote alternative watering systems away from streams	16 systems every 3 years 800 AU *(6 systems every 3 years - 50 AU/site)*	3,373 *(1,673)*	4	13,492
Grassed Waterway Installation & Restoration	59 acres *(41 acres)*	83 *(70)*	4	332
Install terraces	2,344 acres protected (25,045 LF) *(344 acres protected - 3,045 LF)*	549 *(116)*	4	2,196
Terrace restoration	119.48 acres protected - 23,895 LF *(11.48 acres protected -2,895 LF)*	41 *(8)*	4	164
Conversion to minimum tillage	2,415 acres *(915 acres)*	782 *(310)*	4	3,128
Conversion to no-till	2,415 acres *(915 acres)*	2,113 *(836)*	4	8,452
ONWWS Upgrades	16 systems (1,600 gal/day) *6 systems (600 gal/day)*	72 *(26.4)*	4	288

TMDL reduction goal met in 4 years is 47,332 pounds total P at 11,833 lbs per year.

5.3 *E. coli* Bacteria

Fecal coliform bacteria (FCB) includes a broad spectrum of bacteria species including *E. coli* bacteria. Fecal coliform bacteria itself is not harmful to humans, but its presence indicates that disease causing organisms and pathogens may be present in the water from contact with animal waste. Currently, KDHE water quality standards for the presence of waterborne pathogens is now restricted to the presence of *E. coli*. Qualification for listing on the 303(d) list, water samples need to exceed the criteria of a geomean of five samples collected within 30 days. Presence of *E. coli* comes from both point and nonpoint source pollution. *E. coli* is found in waterways originating from failing onsite waste water systems, runoff from livestock production areas, animals near water sources, improper pet waste disposal, and manure application to agricultural fields. Properly managing grasslands, picking up after pets, maintaining and upgrading onsite waste water systems, and incorporating livestock manure properly onto croplands will also help reduce the presence of *E .coli* bacteria.

5.3.1 *E. coli* Bacteria Pollutant Loads & Load Reductions

Based upon monitoring data, there are locations in the target areas and watersheds that would benefit from installation of BMPs addressing animal waste. The resiliency of *E. coli* is affected by environmental factors such as initial bacteria concentrations, intensity of storm events, temperature, the amount of ultraviolet radiation from sunlight, and amount of organic material in the surrounding area. As nutrient load reductions decrease, *E. coli* bacteria levels will follow. Bacteria reductions should be detected as a change (lowering) of the index profiles after 5 years of BMP implementation. BMPs that will reduce *E. coli* bacteria are listed in Table 18.

Table 18. BMPs & Quantities Needed to Reduce *E.coli* Bacteria including the Big Creek TMDL and Watershed Plan Reduction Goal

BMP	Acres/Projects Implemented Annually
Establish grass buffers/Critical area planting	45 acres
Relocate livestock operations away from streams	11 systems (550 AU)
Improve native vegetation in rangeland (range planting, brush control)	1,600 acres
Improve stocking rates & livestock distribution (rotational grazing, reduced head/acre)	1,600 acres
Promote alternative watering systems away from streams (ponds, pipelines, spring development, well, watering facilities)	16 systems every 3 years (800 AU)
Grassed Waterway Installation & Restoration	59
Install terraces	2,344 acres protected (25,045 LF)
Terrace restoration	119.48 acres protected (23,895) LF
Conversion to minimum tillage	2,415 acres
Conversion to no-till	2,415 acres
ONWWS Upgrades	16 systems (1,600 gal/day)

5.4 Description/Definition of BMPs to be installed

Alternative Watering System: Any system that will provide livestock fresh, clean water away from open water sources (i.e. - streams, ponds, riparian areas). Typical alternative systems are pipelines, wells, ponds (with access point only), and spring development. Studies show cattle will drink from a tank over a pond/stream 80% of the time with a 30-98% average P reduction.

Critical Area Planting: Seeding of an area with native grasses and forb mixtures. These areas in fields are prone to erosion from wind or water and by installing permanent cover (i.e. - grass) nutrient and sediment losses should decrease and provide wildlife habitat.

Grass Buffer: A strip of grass of varying widths placed alongside the edge of a field or bordering a stream as a means to protect sensitive areas from erosion from nearby fields.

Grassed Waterway: A natural or engineered vegetated channel that carries water, without any erosion in the channel from a field. May include restoration of an existing waterway.

Minimum and No-till Conversion: A shift in tillage management from either conventional tillage or minimal tillage to a system where the land is no longer tilled mechanically and chemicals may be used for weed control and seedbed preparation. The soil surface is only disturbed for planting or drilling operations.

Rangeland Improvements: Special treatments, management changes, or structures that improve rangeland conditions (i.e. - vegetative cover and species) to improve water quality. This could include range planting, brush control (removing undesirable plant species), or rotational grazing.

Relocation of Livestock from Water Sources: moving the location of feeding sites from close proximity to the streams, creeks, or rivers and could include cleaning up feeding sites on an annual basis to reduce historic pollutant loads.

Rotational Grazing: Rotating livestock within a pasture to spread grazing distribution across the acres. May involve cross fencing and alternative watering systems.

Stocking Rates & Livestock Distribution: management practice changes that lead to controlled rotational grazing, reduced head/acre, paddock systems, or flash grazing

Terrace: An earthen structure constructed across the field slope used to break the slope length thus reducing soil erosion and nutrient load potential. Terraces are built with a lifespan and after many years of use may need restoration for proper water quality protection.

On-site Waste Water System (ONWWS) Upgrade: Structural changes made to private waste water systems to reduce or eliminate wastewater from directly infiltrating soil without prior biological treatment.

5.5 Current Adoption Rates & Target Adoption Rates

Table 19 shows the 2011 BMP adoption rate percent calculated from the driving tours and also lists the target adoption rate goals for 2034. Target adoption rates were calculated based upon BMP implementation and reduction loads listed in Tables 10 through 15. Target adoption rates reached before 2034 are based on total acres available from the 2010 driving tour conditions. Target rates assume that all terraces and rangelands will be maintained at their current condition. Additionally, target adoption rates assume that no BMPs will be implemented without the work of the Agency Partners and/or the WRAPS team. However, the WRAPS team acknowledges that existing BMPs and land cover, specifically terraces and rangeland, will decrease in condition and will need to be rehabilitated. Therefore, the WRAPS Leadership Team is prepared to continue the schedule of BMP implementation beyond any early target date reached.

Table 19. Current 2011 BMP Adoption Rate Percentages Calculated from Driving Tours and their Target Adoption Rate in 2034.

	Hays Consolidated [a]		Landon Creek		Oak Creek		Thielen Airport		Town of Munjor [a]		BCMSHRW	
	Current	Target	Current	Target	Current	Target	Current	Target	Current	Target	Current	Target
Field Buffers	0.9%	1.6%	1.5%	2.1%	0.0%	1.4%	1.5%	2.9%	1.6%	2.1%	0.2%	0.7%
Grass Waterways	26.4%	27.8%	39.3%	40.6%	28.9%	30.9%	34.8%	36.8%	36.6%	37.3%	30.4%	30.8%
Install Terraces	43.0%	66.0%	48.2%	50.8%	66.9%	73.7%	45.6%	52.6%	42.8%	53.6%	48.6%	85.4%[d]
Terrace Restoration [b]	35.1%	35.9%	36.9%	85.2%	59.9%	60.2%	39.4%	40.1%	28.7%	29.5%	44.4%	47.1%
Conversion to minimum tillage	8.6%	46.9%	12.1%	28.3%	11.7%	67.5%	14.2%	48.7%	8.8%	27.9%	0.5%	38.1%
Conversion to no-till	33.0%	71.3%	21.3%	37.5%	35.6%	84.2%[e]	42.7%	77.0%	45.9%	65.0%	47.5%	85.0%
Range Management [c]	2.7%	39.5%	7.9%	86.5%[f]	37.1%	85.7%[g]	6.9%	85.4%[h]	1.6%	65.6%	14.3%	30.7%

Target adoption rates calculated from BMP implementations listed in Table 10 through Table 15.

[a] Reflects fall 2010 driving tour data only.
[b] Sum of terraces greater than six inches; data from driving tour.
[c] Rangeland classified as “good” during the driving tours. Target meet by improving native species and reducing stocking rates.
[d] Target adoption rate reached in year 2028 ceteris paribus
[e] Target adoption rate reached in year 2031 ceteris paribus
[f] Target adoption rate reached in year 2026 ceteris paribus
[g] Target adoption rate reached in year 2030 ceteris paribus
[h] Target adoption rate reached in year 2025 ceteris paribus

6.0 Information and Education in Support of BMPs

6.1 Information and Education Projects

The BCMSHRW Leadership Team predicts the following information and education (I&E) activities are and will be needed in the watershed which will help us accomplish meeting the Watershed goals to: protect public drinking water supplies and continue public awareness, education, and involvement in watershed issues. These activities provide and continue to provide residents in the watershed with a higher awareness of water quality issues. Raising awareness will lead to behavior and management changes to increase the adoption rates of all BMPs in the watersheds.

The WRAPS Leadership Team will provide technical assistance and work with NRCS field offices, County Conservation Districts, and KSU Extension Offices to identify and create the HUC 12 target area landowner groups including homeowners, landowners, and tenants. Design HUC 12 surveys and mail to database; hold two meetings annually in the selected targeted HUC 12s, present HUC 12 watershed work/data sets (water monitoring data, tillage conditions/driving tour data and SWAT) to landowners, collect input from landowners on locations needing BMPs, and determine high priority high pollutant loading areas, compare BMP requests to WRAPS BMP data sets, and select/rank BMPs to be installed. Notify landowners selected to install BMPs using WRAPS demonstration dollars. Producers will install BMPs. All other producers interested in BMPs will be referred to other local, state, and federal cost-share programs.

The WRAPS Leadership Team will educate agricultural producers and landowners, and provide technical assistance and guidance on cropland, riparian and rangeland/pasture nutrient and sedimentation management to implement the 9 Elements Watershed Plan.

The WRAPS Leadership Team will educate citizens, youth, businesses, schools, and city/county elected officials on the importance of changing daily habits to increase the likelihood of making better choices to protect and improve local water sources to implement the 9 Elements Watershed Plan.

Below (Table 20) is a list of suggested projects alongside associated estimate costs and possible sponsoring agencies. As the plan is implemented and progress is made, there will be new Information and Education projects that could present themselves that may not be included in the table. Likewise, some of the projects identified in the plan may never come to fruition due to lack of funding or interest. The BCMSHRW WRAPS will remain flexible towards its information and education efforts adjusting to public response as needed.

Table 20. Information & Education Projects as Suggested by BCMSHRW Leadership Team.

BMP	Target Audience	I/E Project	Time Frame	Estimated Costs	**Sponsor/Responsible Agency** *(provide cash/in-kind services if available and/or present at the programs, tours, etc.)*
Grass Buffers/Critical Area Planting	Landowners & Tenants, Watershed Residents	Self-Guided BMP Tour	Annual – Ongoing	No Charge	BCMSHRW, Conservation Districts, K-State Extension
		News Articles, Newsletters	Annual – Ongoing	No Charge	Conservation Districts, K-State Extension, NRCS
		One-on-One Contact/Technical Assistance	Annual – Ongoing	Included in personnel salary	Conservation Districts, K-State Extension, Buffer Coordinators
		Field Day/Workshop at Sternberg Nature Trails	Annual – Spring, Fall	$1,000	BCMSHRW, Fort Hays State University, Sternberg Museum
		HUC 12 Meetings	Annual – Winter, Spring	$600	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		Tillage & Watershed Conditions Driving Tour	Bi-Annual – Spring, Fall	$2,500	BCMSHRW, K-State Extension, Conservation Districts, NRCS
Relocate Livestock Feeding Sites	Ranchers, Landowners & Tenants	News Articles and Newsletters	Annual – Ongoing	No Charge	BCMSHRW, K-State Extension
		Livestock Workshop	Bi-annual – Winter	$300	K-State Extension, BCMSHRW
		HUC 12 Meetings	Annual – Winter, Spring	Included above	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		Tillage & Watershed Conditions Driving Tour	Bi-Annual – Spring, Fall	Included above	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		One-on-One Contact/Technical Assistance	Annual – Ongoing	Included in personnel salary	Conservation Districts, K-State Extension, NRCS, BCMSHRW
Grassed Waterways	Ranchers, Landowners & Tenants	HUC 12 Meetings	Annual – Winter, Spring	Included above	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		Self-Guided BMP Tour	Annual – Ongoing	No Charge	BCMSHRW, Conservation Districts, K-State Extension
		News Articles, Newsletters	Annual – Ongoing	No Charge	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		Tillage & Watershed Conditions Driving Tour	Bi-Annual – Spring, Fall	Included above	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		One-on-One Contact/Technical Assistance	Annual – Ongoing	Included in personnel salary	Conservation Districts, K-State Extension, NRCS, BCMSHRW

Rangeland Rehabilitation, Improve Native Vegetation, Improve Stocking Rates/Distribution	Ranchers, Landowners & Tenants	News Articles, Newsletters	Annual – Ongoing	No Charge	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		HUC 12 Meetings	Annual – Winter, Spring	Included above	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		Self-Guided BMP Tour	Annual – Ongoing	No Charge	BCMSHRW, Conservation Districts, K-State Extension
		Livestock Workshop	Bi-annual – Winter	Included above	K-State Extension, BCMSHRW
		Field Day/Workshop at Sternberg Nature Trails	Annual – Spring, Fall	Included above	BCMSHRW, Fort Hays State University, Sternberg Museum
		Wildflower Tour & Rangeland Management Workshop	Bi-Annual – Spring or Fall	$300	BCMSHRW, Conservation Districts, K-State Extension
		Tillage & Watershed Conditions Driving Tour	Bi-Annual – Spring, Fall	Included above	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		One-on-One Contact/Technical Assistance	Annual – Ongoing	Included in personnel salary	Conservation Districts, K-State Extension, NRCS, BCMSHRW
Alternative Watering Systems	Ranchers, Landowners & Tenants	HUC 12 Meetings	Annual – Winter, Spring	Included above	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		News Articles, Newsletters	Annual – Ongoing	No Charge	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		One-on-One Contact/Technical Assistance	Annual – Ongoing	Included in personnel salary	Conservation Districts, K-State Extension, NRCS, BCMSHRW
Terraces	Ranchers, Landowners & Tenants	HUC 12 Meetings	Annual – Winter, Spring	Included above	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		Self-Guided BMP Tour	Annual – Ongoing	No Charge	BCMSHRW, Conservation Districts, K-State Extension
		News Articles, Newsletters	Annual – Ongoing	No Charge	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		Tillage & Watershed Conditions Driving Tour	Bi-Annual – Spring, Fall	Included above	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		One-on-One Contact/Technical Assistance	Annual – Ongoing	Included in personnel salary	Conservation Districts, K-State Extension, NRCS, BCMSHRW

Conversion to Minimum Tillage	Ranchers, Landowners & Tenants	HUC 12 Meetings	Annual – Winter, Spring	Included above	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		One-on-One Contact/Technical Assistance	Annual – Ongoing	Included in personnel salary	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		Self-Guided BMP Tour	Annual – Ongoing	No Charge	BCMSHRW, Conservation Districts, K-State Extension
		News Articles, Newsletters	Annual – Ongoing	No Charge	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		Crop Field Days	Annual – Spring/Fall	$1,000	K-State Extension
		Tillage & Watershed Conditions Driving Tour	Bi-Annual – Spring, Fall	Included above	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		One-on-One Contact/Technical Assistance	Annual – Ongoing	Included in personnel salary	Conservation Districts, K-State Extension, NRCS, BCMSHRW
		Soil Testing	Annual – Ongoing	$5,000	Conservation Districts, NRCS, K-State Extension, BCMSHRW
Conversion to No-Till	Ranchers, Landowners & Tenants	HUC 12 Meetings	Annual – Winter, Spring	Included above	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		No-Till Meetings	Annual – Summer	$1,500	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		One-on-One Contact/Technical Assistance	Annual – Ongoing	Included in personnel salary	Conservation District, BCMSHRW, K-State Extension, Conservation Districts, NRCS
		Self-Guided BMP Tour	Annual – Ongoing	No Charge	BCMSHRW, Conservation Districts, K-State Extension
		News Articles, Newsletters	Annual – Ongoing	No Charge	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		Crop Field Days	Annual – Spring/Fall	Included above	K-State Extension
		Tillage & Watershed Conditions Driving Tour	Bi-Annual – Spring, Fall	Included above	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		One-on-One Contact/Technical Assistance	Annual – Ongoing	Included in personnel salary	Conservation Districts, K-State Extension, NRCS, BCMSHRW
		Soil Testing	Annual – Ongoing	Included above	Conservation Districts, NRCS, K-State Extension, BCMSHRW

OWWS Upgrades	Ranchers, Landowners & Tenants	HUC 12 Meetings	Annual – Winter, Spring	Included above	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		News Articles, Newsletters	Annual – Ongoing	No Charge	BCMSHRW, K-State Extension, Conservation Districts, NRCS
		One-on-One Contact/Technical Assistance	Annual – Ongoing	Included in personnel salary	Conservation Districts, K-State Extension, NRCS, BCMSHRW, Local Environmental Protection
Upgrade WWTP	City of Hays	Upgrades, Management Changes at WWTP	Annual – Ongoing	Not available	City of Hays
Implement/Manage Stormwater Utility (MS4 Community)	City of Hays Residents, City Officials	Rain Barrel Workshop	Annual – Spring	Registration Fee Funded	BCMSHRW, Conservation District, K-State Extension, FHSU
		Recycling Barrel Project	Annual – Spring	$1,000	BCMSHRW, Conservation District, K-State Extension, FFA Chapter
		Field Day/Workshop at Sternberg Nature Trail	Annual – Spring, Fall	$500	BCMSHRW, Fort Hays State University, Sternberg Museum
		Fact Sheets for Water Bills	Annual – 3/yr	$8,000	BCMSHRW, City of Hays
		Storm Drain Marking Project	Annual – Ongoing	$500	BCMSHRW, City of Hays, Scouts
		What's in Your Water Workshop for City Official, Employees	Bi-annual – Seasonal	$500	BCMSHRW, City of Hays
		Healthy Yards, Healthy Streams Workshop Series	Bi-annual – Seasonal	$1,000	BCMSHRW, City of Hays, K-State Extension
		Skyline ARRA Project Workshop	Bi-annual – Seasonal	$400	BCMSHRW, City of Hays, FHSU
		Create & Establish Hays Water Watchers Business Group	Annual – Spring, Summer	$1,000	BCMSHRW, City of Hays, Chamber of Commerce, K-State Extension
		Create & Establish Hays Private Lawn Care Business Certification Program & Workshop	Annual – Ongoing	$1,000	BCMSHRW, City of Hays, Chamber of Commerce, K-State Extension
Watershed Youth Education	Watershed Educators, K-12 Students, Fort Hays State University	Kids Ag Day Events (3)	Annual – 3 events, fall, spring	$300	BCMSHRW, Conservation Districts, Farm Bureau, FFA Chapters, K-State Extension
		Wonders of Wetlands, Water & Wildlife Field Day	Annual – Fall	$750	BCMSHRW, Conservation District
		Service Learning Project	Annual – Spring or Fall	$5,000	BCMSHRW, Fort Hays State University
		WOW Trailer	Annual – Ongoing	$1,000	BCMSHRW

		H20 Community Water Festival	Annual – Spring	$500	BCMSHRW, City of Hays
		EARTH Program	Annual – Ongoing	$10,000	BCMSHRW, School Districts
		Posters, Essay, and Speech Contests promoting conservation and water quality	Annual – Winter	$200	Conservation Districts
		Individual School Presentations	Annual- Ongoing	$300	BCMSHRW, Schools
Watershed Resident Education	Watershed Residents	CoCoRaHS Project	Annual – Ongoing	$500	BCMSHRW
		Media Campaign of all Watershed Projects (includes annual lake guide, newspaper special editions, radio promotion, and television)	Annual – Ongoing	$3,000	BCMSHRW
		Displays, Booths at Home & Garden Shows, Home Show, Career Fairs, Conservation District Annual Meetings, etc.	Annual – Ongoing	$1,000	BCMSHRW
		www.MyKansasWatershed.com updates	Annual – Ongoing	Included in personnel salary	BCMSHRW
		WOW Trailer	Annual – Ongoing	Included above	BCMSHRW
		H20 Community Water Festival	Annual – Spring	Included above	BCMSHRW, City of Hays
		Xeriscaping Workshop	Bi-annual – Seasonal	$500	BCMSHRW, K-State Extension
		Wildflower Tour & Rangeland Management Workshop	Annual – Spring or Fall	Included above	BCMSHRW, Conservation Districts, K-State Extension
		News Articles and Newsletters	Annual – Ongoing	No Charge	BCMSHRW, K-State Extension, Conservation Districts
		Community Organization Presentations about water quality, WRAPS, etc.	Annual – Ongoing	No Charge	BCMSHRW
Total Annual Cost for Information and Education if all events are held				**$49,150.00**	

6.2 Evaluation of Information and Education Activities

Information and educational efforts for the BCMSHRW WRAPS project will include an evaluation component. At a minimum, all I&E projects will include specific learning objectives for all participants and depending upon the project, goals will be identified based upon short-term, medium-term, and long-term in order to measure behavioral and social outcomes.

The BCMSHRW WRAPS project will provide a brief summary in quarterly reports of the I&E projects by summarizing the success of the project in achieving learning objectives, how the project contributed to achieving the long-term WRAPS goals, and objectives for pollutant load reductions.

The BCMSHRW WRAPS has a strong history of utilizing specific evaluation tools or methods which may include but are not limited to:

- I&E project feedback forms allowing participants to provide feedback rankings of content, presenters, usefulness of information, and actions they plan to do as a result of the project. More than likely this will be collected via online surveys with hardcopy evaluation forms for those not having Internet access.
- Pre and post-tests/surveys to determine amount of knowledge gained, anticipated behavior changes, and need for further learning.
- Follow up interviews (one-on-one contacts, phone calls, emails) with selected participants to gather more in-depth input regarding the effectiveness of I&E projects.
- Informal use of list serves from previous I&E projects indicating the willingness and sign-up of future events.
- The www.MyKansasWatershed.com website is used for educational outreach as well as tracking purposes of audiences to understand how I&E programs are gaining support. The website includes past projects, upcoming projects, and watershed quality protection and improvement informational resources.

7.0 Costs of Implementing BMPs and Possible Funding Sources

The BCMSHRW Leadership Team has reviewed all the recommended BMPs for each impairment addressed. The specific BMPs listed will be the target of implementation funding for the impairments. Most of the targeted BMPs will reduce loadings for multiple impairments which is more advantageous in overall water quality improvement and the most cost effective.

The costs associated with the various BMPs have been determined collectively by County Extension Agents, District Conservationists, and District Managers within the watersheds in conjunction with the WRAPS Leadership Team. Cost calculations used the 2010 County average costs and the FY 2011 EQIP Practice Payment Schedule. These costs also include technical assistance costs such as NRCS planning and engineering.

Table 21. Summarized BMP Cost Estimates

Best Management Practice	Cost of Practice
Establish grass buffers/Critical area planting [a]	$ 101.60/acre
Relocate livestock operations away from streams [b]	$2,203/each
Improve native vegetation in rangeland (range planting, brush control)[c]	$83.03/acre Range Planting $90.03/acre Brush Control
Improve stocking rates & livestock distribution (rotational grazing, reduced head/acre)[d]	$47.24/acre
Promote alternative watering systems away from streams (ponds, pipelines, spring development, well, watering facilities)[e]	$3,410/each
Grassed Waterway Installation & Restoration	$1,788/acre
Install terraces	$1.13/LF
Terrace restoration	$.57/LF
Conversion to minimum tillage	$6.73/acre
Conversion to no-till	$ 12.26/acre
Onsite Waste Water System (ONWWS) Upgrades [f]	$5,024.95/each

a Established with native grass and forb mixture
b Includes installing ¼ mile of fence, permeable surface, and labor
c Brush control takes into consideration aerial, ground and spot chemical treatments along with mechanical treatments based upon infestation, noting that the farther east in the watersheds, the higher the infestations
d Includes allowing for at least 30% rest during growing season at $7.64 per acre and ½ mile fencing $4,752 per 120 acres = $39.60 per acre
e Average costs calculated from BMPs installed within the watersheds from 2004-2010 ($4,237 ponds, $4,703 pipelines, $2,338 spring development, $4,194 well, and $1,576 watering facilities)
f Calculated from ONWWS cost-shared systems installed in the watersheds from 2004-2010

Prices in Tables 22 and 23, reflect 2011 dollar values with increasing costs per year adjusted by 3% yearly to meet long-term inflation trends for both rangeland and cropland practices.

Table 22. Total Annual Estimated Costs through 2034 of Rangeland Improvements per Best Management Practice Unit.

Year	Relocate Livestock away from Streams	Range Planting	Brush Control	Improve Stocking Rates/ Distribution	Alternative Water Sources
2011	$24,233.00	$16,606.00	$126,042.00	$75,584.00	$14,492.50
2012	$24,959.99	$17,104.18	$129,823.26	$77,851.52	$14,927.28
2013	$25,708.79	$17,617.31	$133,717.96	$80,187.07	$15,375.09
2014	$26,480.05	$18,145.82	$137,729.50	$82,592.68	$15,836.35
2015	$27,274.45	$18,690.20	$141,861.38	$85,070.46	$16,311.44
2016	$28,092.69	$19,250.91	$146,117.22	$87,622.57	$16,800.78
2017	$28,935.47	$19,828.43	$150,500.74	$90,251.25	$17,304.80
2018	$29,803.53	$20,423.29	$155,015.76	$92,958.79	$17,823.95
2019	$30,697.64	$21,035.98	$159,666.23	$95,747.55	$18,358.67
2020	$31,618.57	$21,667.06	$164,456.22	$98,619.98	$18,909.43
2021	$32,567.13	$22,317.08	$169,389.91	$101,578.58	$19,476.71
2022	$33,544.14	$22,986.59	$174,471.61	$104,625.93	$20,061.01
2023	$34,550.46	$23,676.19	$179,705.75	$107,764.71	$20,662.84
2024	$35,586.98	$24,386.47	$185,096.93	$110,997.65	$21,282.72
2025	$36,654.59	$25,118.06	$190,649.83	$114,327.58	$21,921.21
2026	$37,754.22	$25,871.61	$196,369.33	$117,757.41	$22,578.84
2027	$38,886.85	$26,647.76	$202,260.41	$121,290.13	$23,256.21
2028	$40,053.46	$27,447.19	$208,328.22	$124,928.84	$23,953.89
2029	$41,255.06	$28,270.60	$214,578.07	$128,676.70	$24,672.51
2030	$42,492.71	$29,118.72	$221,015.41	$132,537.00	$25,412.69
2031	$43,767.49	$29,992.28	$227,645.87	$136,513.11	$26,175.07
2032	$45,080.52	$30,892.05	$234,475.25	$140,608.50	$26,960.32
2033	$46,432.93	$31,818.81	$241,509.51	$144,826.76	$27,769.13
2034	$47,825.92	$32,773.38	$248,754.79	$149,171.56	$28,602.20
				Total	$8,846,139.72

Table 23. Total Annual Estimated Costs through 2034 of Cropland Improvements per Best Management Practice Unit.

Year	Grass Buffers/ Critical Plantings	Grassed Waterway Install/ Restoration	Terrace Installation	Terrace Restoration	Convert to Minimum Tillage	Convert to No-till	Onsite Waste Water System Upgrades
2011	$4,572.00	$105,492.00	$28,300.85	$13,620.15	$16,252.95	$29,607.90	$80,399.20
2012	$4,709.16	$108,656.76	$29,149.88	$14,028.75	$16,740.54	$30,496.14	$82,811.18
2013	$4,850.43	$111,916.46	$30,024.37	$14,449.62	$17,242.75	$31,411.02	$85,295.51
2014	$4,995.95	$115,273.96	$30,925.10	$14,883.11	$17,760.04	$32,353.35	$87,854.38
2015	$5,145.83	$118,732.18	$31,852.86	$15,329.60	$18,292.84	$33,323.95	$90,490.01
2016	$5,300.20	$122,294.14	$32,808.44	$15,789.49	$18,841.62	$34,323.67	$93,204.71
2017	$5,459.21	$125,962.96	$33,792.69	$16,263.17	$19,406.87	$35,353.38	$96,000.85
2018	$5,622.98	$129,741.85	$34,806.48	$16,751.07	$19,989.08	$36,413.98	$98,880.87
2019	$5,791.67	$133,634.11	$35,850.67	$17,253.60	$20,588.75	$37,506.40	$101,847.30
2020	$5,965.42	$137,643.13	$36,926.19	$17,771.21	$21,206.41	$38,631.59	$104,902.72
2021	$6,144.39	$141,772.43	$38,033.98	$18,304.34	$21,842.61	$39,790.54	$108,049.80
2022	$6,328.72	$146,025.60	$39,175.00	$18,853.47	$22,497.88	$40,984.26	$111,291.30
2023	$6,518.58	$150,406.37	$40,350.24	$19,419.08	$23,172.82	$42,213.79	$114,630.03
2024	$6,714.14	$154,918.56	$41,560.75	$20,001.65	$23,868.01	$43,480.20	$118,068.94
2025	$6,915.56	$159,566.12	$42,807.57	$20,601.70	$24,584.05	$44,784.61	$121,611.00
2026	$7,123.03	$164,353.10	$44,091.80	$21,219.75	$25,321.57	$46,128.14	$125,259.33
2027	$7,336.72	$169,283.69	$45,414.56	$21,856.34	$26,081.21	$47,511.99	$129,017.11
2028	$7,556.82	$174,362.20	$46,776.99	$22,512.03	$26,863.65	$48,937.35	$132,887.63
2029	$7,783.52	$179,593.07	$48,180.30	$23,187.39	$27,669.56	$50,405.47	$136,874.26
2030	$8,017.03	$184,980.86	$49,625.71	$23,883.02	$28,499.65	$51,917.63	$140,980.48
2031	$8,257.54	$190,530.29	$51,114.48	$24,599.51	$29,354.64	$53,475.16	$145,209.90
2032	$8,505.27	$196,246.19	$52,647.92	$25,337.49	$30,235.27	$55,079.42	$149,566.20
2033	$8,760.42	$202,133.58	$54,227.36	$26,097.62	$31,142.33	$56,731.80	$154,053.18
2034	$9,023.24	$208,197.59	$55,854.18	$26,880.54	$32,076.60	$58,433.75	$158,674.78
						Total	$9,578,994.93

Taking into consideration the on average cost share rate of 70%, landowner investments in specific BMPs will need to be 30% of the total cost. Below in Tables 24 and 25 are rangeland and cropland estimates for total investments needed by landowners for successful pollutant reductions.

Table 24. Total Annual Estimated Costs through 2034 of Rangeland Improvements per Best Management Practice Unit made by Landowners.

Year	Relocate Livestock away from Streams	Range Planting	Brush Control	Improve Stocking Rates/ Distribution	Alternative Water Sources
2011	$7,269.90	$4,981.80	$37,812.60	$22,675.20	$4,347.75
2012	$7,488.00	$5,131.25	$38,946.98	$23,355.46	$4,478.18
2013	$7,712.64	$5,285.19	$40,115.39	$24,056.12	$4,612.53
2014	$7,944.02	$5,443.75	$41,318.85	$24,777.80	$4,750.90
2015	$8,182.34	$5,607.06	$42,558.41	$25,521.14	$4,893.43
2016	$8,427.81	$5,775.27	$43,835.17	$26,286.77	$5,040.23
2017	$8,680.64	$5,948.53	$45,150.22	$27,075.37	$5,191.44
2018	$8,941.06	$6,126.99	$46,504.73	$27,887.64	$5,347.18
2019	$9,209.29	$6,310.80	$47,899.87	$28,724.26	$5,507.60
2020	$9,485.57	$6,500.12	$49,336.87	$29,585.99	$5,672.83
2021	$9,770.14	$6,695.12	$50,816.97	$30,473.57	$5,843.01
2022	$10,063.24	$6,895.98	$52,341.48	$31,387.78	$6,018.30
2023	$10,365.14	$7,102.86	$53,911.73	$32,329.41	$6,198.85
2024	$10,676.09	$7,315.94	$55,529.08	$33,299.30	$6,384.82
2025	$10,996.38	$7,535.42	$57,194.95	$34,298.27	$6,576.36
2026	$11,326.27	$7,761.48	$58,910.80	$35,327.22	$6,773.65
2027	$11,666.06	$7,994.33	$60,678.12	$36,387.04	$6,976.86
2028	$12,016.04	$8,234.16	$62,498.47	$37,478.65	$7,186.17
2029	$12,376.52	$8,481.18	$64,373.42	$38,603.01	$7,401.75
2030	$12,747.81	$8,735.62	$66,304.62	$39,761.10	$7,623.81
2031	$13,130.25	$8,997.68	$68,293.76	$40,953.93	$7,852.52
2032	$13,524.16	$9,267.62	$70,342.57	$42,182.55	$8,088.10
2033	$13,929.88	$9,545.64	$72,452.85	$43,448.03	$8,330.74
2034	$14,347.78	$9,832.01	$74,626.44	$44,751.47	$8,580.66
				Total	$2,653,841.92

Table 25. Total Annual Estimated Costs through 2034 of Cropland Improvements per Best Management Practice Unit made by Landowners

Year	Grass Buffers/ Critical Plantings	Grassed Waterway Install/ Restoration	Terrace Installation	Terrace Restoration	Convert to Minimum Tillage	Convert to No-till	Onsite Waste Water System Upgrades
2011	$1,371.60	$31,647.60	$8,490.26	$4,086.05	$4,875.89	$8,882.37	$24,119.76
2012	$1,412.75	$32,597.03	$8,744.96	$4,208.63	$5,022.16	$9,148.84	$24,843.35
2013	$1,455.13	$33,574.94	$9,007.31	$4,334.89	$5,172.83	$9,423.31	$25,588.65
2014	$1,498.78	$34,582.19	$9,277.53	$4,464.93	$5,328.01	$9,706.01	$26,356.31
2015	$1,543.75	$35,619.65	$9,555.86	$4,598.88	$5,487.85	$9,997.19	$27,147.00
2016	$1,590.06	$36,688.24	$9,842.53	$4,736.85	$5,652.49	$10,297.10	$27,961.41
2017	$1,637.76	$37,788.89	$10,137.81	$4,878.95	$5,822.06	$10,606.01	$28,800.25
2018	$1,686.89	$38,922.56	$10,441.94	$5,025.32	$5,996.72	$10,924.19	$29,664.26
2019	$1,737.50	$40,090.23	$10,755.20	$5,176.08	$6,176.63	$11,251.92	$30,554.19
2020	$1,789.63	$41,292.94	$11,077.86	$5,331.36	$6,361.92	$11,589.48	$31,470.82
2021	$1,843.32	$42,531.73	$11,410.19	$5,491.30	$6,552.78	$11,937.16	$32,414.94
2022	$1,898.62	$43,807.68	$11,752.50	$5,656.04	$6,749.37	$12,295.28	$33,387.39
2023	$1,955.57	$45,121.91	$12,105.07	$5,825.72	$6,951.85	$12,664.14	$34,389.01
2024	$2,014.24	$46,475.57	$12,468.23	$6,000.49	$7,160.40	$13,044.06	$35,420.68
2025	$2,074.67	$47,869.83	$12,842.27	$6,180.51	$7,375.21	$13,435.38	$36,483.30
2026	$2,136.91	$49,305.93	$13,227.54	$6,365.92	$7,596.47	$13,838.44	$37,577.80
2027	$2,201.02	$50,785.11	$13,624.37	$6,556.90	$7,824.36	$14,253.60	$38,705.13
2028	$2,267.05	$52,308.66	$14,033.10	$6,753.61	$8,059.09	$14,681.20	$39,866.29
2029	$2,335.06	$53,877.92	$14,454.09	$6,956.22	$8,300.87	$15,121.64	$41,062.28
2030	$2,405.11	$55,494.26	$14,887.71	$7,164.90	$8,549.89	$15,575.29	$42,294.15
2031	$2,477.26	$57,159.09	$15,334.34	$7,379.85	$8,806.39	$16,042.55	$43,562.97
2032	$2,551.58	$58,873.86	$15,794.38	$7,601.25	$9,070.58	$16,523.82	$44,869.86
2033	$2,628.13	$60,640.07	$16,268.21	$7,829.28	$9,342.70	$17,019.54	$46,215.95
2034	$2,706.97	$62,459.28	$16,756.25	$8,064.16	$9,622.98	$17,530.13	$47,602.43
						Total	$2,873,698.48

Assuming the average cost-share rate for the stated BMPs remains at 70%, the Tables 26 and 27 below demonstrate the investment needed through local, state, and federal cost-share programs for successful pollutant reduction loads.

Table 26. Total Annual Estimated Costs through 2034 of Rangeland Improvements per Best Management Practice Unit made through Cost-Share Programs.

Year	Relocate Livestock away from Streams	Range Planting	Brush Control	Improve Stocking Rates/ Distribution	Alternative Water Sources
2011	$16,963.10	$11,624.20	$88,229.40	$52,908.80	$10,144.75
2012	$17,471.99	$11,972.93	$90,876.28	$54,496.06	$10,449.09
2013	$17,996.15	$12,332.11	$93,602.57	$56,130.95	$10,762.57
2014	$18,536.04	$12,702.08	$96,410.65	$57,814.87	$11,085.44
2015	$19,092.12	$13,083.14	$99,302.97	$59,549.32	$11,418.01
2016	$19,664.88	$13,475.63	$102,282.06	$61,335.80	$11,760.55
2017	$20,254.83	$13,879.90	$105,350.52	$63,175.87	$12,113.36
2018	$20,862.47	$14,296.30	$108,511.03	$65,071.15	$12,476.76
2019	$21,488.35	$14,725.19	$111,766.36	$67,023.28	$12,851.07
2020	$22,133.00	$15,166.94	$115,119.36	$69,033.98	$13,236.60
2021	$22,796.99	$15,621.95	$118,572.94	$71,105.00	$13,633.70
2022	$23,480.90	$16,090.61	$122,130.12	$73,238.15	$14,042.71
2023	$24,185.32	$16,573.33	$125,794.03	$75,435.30	$14,463.99
2024	$24,910.88	$17,070.53	$129,567.85	$77,698.36	$14,897.91
2025	$25,658.21	$17,582.65	$133,454.88	$80,029.31	$15,344.84
2026	$26,427.96	$18,110.12	$137,458.53	$82,430.19	$15,805.19
2027	$27,220.80	$18,653.43	$141,582.29	$84,903.09	$16,279.35
2028	$28,037.42	$19,213.03	$145,829.75	$87,450.18	$16,767.73
2029	$28,878.54	$19,789.42	$150,204.65	$90,073.69	$17,270.76
2030	$29,744.90	$20,383.11	$154,710.79	$92,775.90	$17,788.88
2031	$30,637.25	$20,994.60	$159,352.11	$95,559.18	$18,322.55
2032	$31,556.36	$21,624.44	$164,132.67	$98,425.95	$18,872.22
2033	$32,503.05	$22,273.17	$169,056.65	$101,378.73	$19,438.39
2034	$33,478.15	$22,941.36	$174,128.35	$104,420.09	$20,021.54
				Total	$6,192,297.80

Table 27. Total Annual Estimated Costs through 2034 of Cropland Improvements per Best Management Practice Unit made through Cost-Share Programs.

Year	Grass Buffers/ Critical Plantings	Grassed Waterway Install/ Restoration	Terrace Installation	Terrace Restoration	Convert to Minimum Tillage	Convert to No-till	Onsite Waste Water System Upgrades
2011	$3,200.40	$73,844.40	$19,810.60	$9,534.11	$11,377.07	$20,725.53	$56,279.44
2012	$3,296.41	$76,059.73	$20,404.91	$9,820.13	$11,718.38	$21,347.30	$57,967.82
2013	$3,395.30	$78,341.52	$21,017.06	$10,114.73	$12,069.93	$21,987.71	$59,706.86
2014	$3,497.16	$80,691.77	$21,647.57	$10,418.17	$12,432.03	$22,647.35	$61,498.06
2015	$3,602.08	$83,112.52	$22,297.00	$10,730.72	$12,804.99	$23,326.77	$63,343.01
2016	$3,710.14	$85,605.90	$22,965.91	$11,052.64	$13,189.14	$24,026.57	$65,243.30
2017	$3,821.44	$88,174.08	$23,654.89	$11,384.22	$13,584.81	$24,747.37	$67,200.59
2018	$3,936.09	$90,819.30	$24,364.53	$11,725.75	$13,992.35	$25,489.79	$69,216.61
2019	$4,054.17	$93,543.88	$25,095.47	$12,077.52	$14,412.13	$26,254.48	$71,293.11
2020	$4,175.80	$96,350.19	$25,848.33	$12,439.84	$14,844.49	$27,042.12	$73,431.90
2021	$4,301.07	$99,240.70	$26,623.78	$12,813.04	$15,289.82	$27,853.38	$75,634.86
2022	$4,430.10	$102,217.92	$27,422.50	$13,197.43	$15,748.52	$28,688.98	$77,903.91
2023	$4,563.01	$105,284.46	$28,245.17	$13,593.35	$16,220.97	$29,549.65	$80,241.02
2024	$4,699.90	$108,442.99	$29,092.53	$14,001.15	$16,707.60	$30,436.14	$82,648.26
2025	$4,840.89	$111,696.28	$29,965.30	$14,421.19	$17,208.83	$31,349.22	$85,127.70
2026	$4,986.12	$115,047.17	$30,864.26	$14,853.82	$17,725.10	$32,289.70	$87,681.53
2027	$5,135.70	$118,498.58	$31,790.19	$15,299.44	$18,256.85	$33,258.39	$90,311.98
2028	$5,289.77	$122,053.54	$32,743.90	$15,758.42	$18,804.55	$34,256.14	$93,021.34
2029	$5,448.47	$125,715.15	$33,726.21	$16,231.18	$19,368.69	$35,283.83	$95,811.98
2030	$5,611.92	$129,486.60	$34,738.00	$16,718.11	$19,949.75	$36,342.34	$98,686.34
2031	$5,780.28	$133,371.20	$35,780.14	$17,219.65	$20,548.24	$37,432.61	$101,646.93
2032	$5,953.69	$137,372.34	$36,853.54	$17,736.24	$21,164.69	$38,555.59	$104,696.34
2033	$6,132.30	$141,493.51	$37,959.15	$18,268.33	$21,799.63	$39,712.26	$107,837.23
2034	$6,316.27	$145,738.31	$39,097.92	$18,816.38	$22,453.62	$40,903.63	$111,072.34
						Total	$6,705,296.45

Table 28. Total Annual Costs of Technical Assistance and Assessment Needed to Implement BMPs in 2011 dollar amount

	BMP	Technical Assistance	Projected Annual Cost
Rangeland	Relocate Livestock Away from Streams	WRAPS Coordinator WRAPS Technician NRCS & Conservation Districts	KSU Watershed Specialist - $71,434
	Range Planting	WRAPS Coordinator WRAPS Technician NRCS & Conservation Districts	KSU Watershed Technician- $51,503
	Brush Control	NRCS & Conservation Districts	Monitoring Project for Assessment Purposes $20,000
	Improve Stocking Rates/Distribution	NRCS & Conservation Districts	
	Alternative Water Sources	NRCS & Conservation Districts	Support Costs for KSU Staff (travel, office rent, supplies)- $13,700
Cropland	Grass Buffers/Critical Planting	NRCS & Conservation Districts	
	Grassed Waterway Install/Restoration	NRCS & Conservation Districts	County Conservation District Managers- Funded by SCC
	Terrace Installation	NRCS & Conservation Districts	
	Terrace Restoration	NRCS & Conservation Districts	District Conservationists & Technicians- Funded by NRCS
	Convert to Minimum Tillage	NRCS & Conservation Districts	
	Convert to No-till	NRCS & Conservation Districts	KSRE County Extension Staff- Funded by KSRE
	On-site Waste Water Systems	NRCS & Conservation Districts	
	Total		$156,637.00

Table 29. Total Annual Costs of Implementing Complete BCMSHRW WRAPS Plan in Support of Attaining TMDLs as Funded by Private, Local, State, and Federal Resources

	BMPs Implemented		I&E and Technical & Assessment Assistance		
Year	Cropland	Rangeland	I&E	Technical Assistance	Total
1	$194,771.54	$179,870.25	$49,150.00	$156,637.00	$580,428.79
2	$200,614.68	$185,266.36	$50,624.50	$161,336.11	$597,841.65
3	$206,633.12	$190,824.35	$52,143.24	$166,176.19	$615,776.90
4	$212,832.12	$196,549.08	$53,707.53	$171,161.48	$634,250.21
5	$219,217.08	$202,445.55	$55,318.76	$176,296.32	$653,277.71
6	$225,793.59	$208,518.92	$56,978.32	$181,585.21	$672,876.04
7	$232,567.40	$214,774.49	$58,687.67	$187,032.77	$693,062.33
8	$239,544.42	$221,217.72	$60,448.30	$192,643.75	$713,854.19
9	$246,730.75	$227,854.25	$62,261.75	$198,423.07	$735,269.81
10	$254,132.68	$234,689.88	$64,129.60	$204,375.76	$757,327.92
11	$261,756.66	$241,730.58	$66,053.49	$210,507.03	$780,047.76
12	$269,609.36	$248,982.49	$68,035.09	$216,822.24	$803,449.19
13	$277,697.64	$256,451.97	$70,076.15	$223,326.91	$827,552.67
14	$286,028.57	$264,145.53	$72,178.43	$230,026.72	$852,379.25
15	$294,609.42	$272,069.89	$74,343.78	$236,927.52	$877,950.61
16	$303,447.71	$280,231.99	$76,574.10	$244,035.34	$904,289.14
17	$312,551.14	$288,638.95	$78,871.32	$251,356.40	$931,417.81
18	$321,927.67	$297,298.12	$81,237.46	$258,897.09	$959,360.35
19	$331,585.50	$306,217.06	$83,674.58	$266,664.01	$988,141.15
20	$341,533.07	$315,403.57	$86,184.82	$274,663.93	$1,017,785.39
21	$351,779.06	$324,865.68	$88,770.37	$282,903.85	$1,048,318.95
22	$362,332.43	$334,611.65	$91,433.48	$291,390.96	$1,079,768.52
23	$373,202.40	$344,650.00	$94,176.48	$300,132.69	$1,112,161.57
24	$384,398.47	$354,989.50	$97,001.78	$309,136.67	$1,145,526.42
				Total	$19,982,114.34

Table 30. Potential BMP Funding Sources.

Potential Funding Sources	Potential Funding Programs
Natural Resources Conservation Service (NRCS)	Conservation Reserve Program (CRP)
	Environmental Quality Incentives Program (EQIP)
	Farmable Wetlands Program (FWP)
	Grassland Reserve Program (GRP)
	State Acres for Wildlife Enhancement (SAFE)
	Wetland Reserve Program (WRP)
	Wildlife Habitat Incentive Program (WHIP)
EPA/KDHE	319 Funding Grants/State Water Plan Funds
	Environmental Education Grants (EE)
Kansas Department of Wildlife and Parks	Partnering for Wildlife
Stumps Trust	Private Trust for work around Kanopolis Reservoir
Kansas Alliance for Wetlands and Streams	
State Conservation Commission	
Conservation Districts	
No-Till on the Plains	
Kansas Forest Service	
US Fish & Wildlife	

Table 31. Services Needed to Implement BMPs.

BMP	Technical Assistance	Information & Education
Field Buffers	Design, cost-share, and maintenance	BMP workshops, tours, field days
Grassed Waterways	Design, cost-share, and maintenance	BMP workshops, tours, field days
Install Terraces	Design, cost-share, and maintenance	BMP workshops, tours, field days
Terrace Restoration	Design, cost-share, and maintenance	BMP workshops, tours, field days
Minimum Till	Design, cost-share, and maintenance	BMP workshops, tours, field days
No-Till	Design, cost-share, and maintenance	BMP workshops, tours, field days
Range Management	Design, cost-share, and maintenance	BMP workshops, tours, field days
Livestock Relocation	Design, cost-share, and maintenance	BMP workshops, tours, field days
Alternative Water Access	Design, cost-share, and maintenance	BMP workshops, tours, field days
Onsite Waste Water System Upgrades	Design, cost-share, and maintenance	BMP workshops, tours, field days

Service provider for all BMPs include but are not limited to NRCS, FSA, SCC, No Till on the Plains, Kansas Forest Service, Kansas Rural Center, K-State, Local Conservation Districts, RC&D, Department of Wildlife and Parks, Stumps Trust, Local Environmental Protection Groups. See Appendix for service provider directory

8.0 Timeframe

The current plan is expected to be reviewed once every 5 years starting in 2015 until the end of the plan when TMDLs are expected to be met in 2034.

Table 32. Review Schedule for Pollutants and BMPs.

Review Year	Sediment	Phosphorus	Nitrate	*E. coli* Bacteria	BMP Placement
2015	X	X	X	X	X
2020	X	X	X	X	X
2025	X	X	X	X	X
2030	X	X	X	X	X
2034	X	X	X	X	X

- Targeting and BMP implementation might shift over time in order to achieve TMDLs.
- Time frame for reaching the Total Nitrogen (TN) TMDL is 23 years or 2034.
- Time frame for reaching the Total Phosphorus (TP) TMDL is 4 years or 2014. Continued work on reducing TP will occur in tandem with the TN TMDL reductions in the years following until 2034.
- Time frame for reaching the Total Suspended Solids (TSS) or Sediment TMDL is 3 years or 2013. Continued work on reducing TSS will occur in tandem with the TN TMDL reductions in the years following until 2034.
- Time frame for reaching *E. coli* bacteria will be measured as detected as a change (lowering) of the index profiles after each 5 year increment of BMP implementation.

9.0 Measurable Milestones

The following list of milestones is meant to encompass a best case scenario with landowner and homeowner by-in. Assuming that residents will accept willingly to the change presented through the placement of BMPs is critical to the overall success of the plan of action. Every attempt will be made to inform, educate, and show residents the reason for BMP implementation, but in the end the success of the plan relies on the cooperation of the homeowners and landowners of the watersheds. Along with BMP implementation milestones, water quality milestones are also included in this section.

9.1 Measurable Milestones for BMP Implementation

Milestones will be determined by the progress made by the BCMSHRW Leadership Team in implementing BMPs and educating residents on water quality after five years (2015), fifteen years (2025), and twenty-three years (2034). The Leadership Team will exam the implementation rates in comparison to the targeted rates to determine if adequate progress has been meet. If adequate progress has not been met, the BCMSHRW Leadership Team will work with KDHE and will readjust the projects and strategies in order to achieve the TMDLs set forth.

Table 33a. All BMP Implementation in the BCMSHRW for Each Year with Running Total to meet Kanopolis Lake EU TMDL and Big Creek TMDLs for TN, TP, TSS, and E. *coli* bacteria

	Year	Field Buffers (acres)	Grass Waterways (acres)	Install Terraces (acres)	Terrace Restoration (acres)	Minimum Till (acres)	No-Till (acres)	Range Management (acres)	Total Acres	Livestock Relocation	Alternative Water Access	Onsite Waste Water System Upgrades
Short Term	2011	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	3,200.0	10,598.5	11	--	16
	2012	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	3,200.0	10,598.5	11	--	16
	2013	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	3,200.0	10,598.5	11	16	16
	2014	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	3,200.0	10,598.5	11	--	16
	2015	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	3,200.0	10,598.5	11	--	16
	Total	*225.0*	*295.0*	*11,720.0*	*597.4*	*12,075.0*	*12,075.0*	*16,000.0*	*52,992.4*	*55*	*16*	*80*
Medium Term	2016	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	3,200.0	10,598.5	11	16	16
	2017	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	3,200.0	10,598.5	11	--	16
	2018	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	3,200.0	10,598.5	11	--	16
	2019	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	3,200.0	10,598.5	11	16	16
	2020	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	3,200.0	10,598.5	11	--	16
	2021	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	3,200.0	10,598.5	11	--	16
	2022	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	3,200.0	10,598.5	11	16	16
	2023	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	3,200.0	10,598.5	11	--	16
	2024	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	3,200.0	10,598.5	11	--	16
	2025	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	3,200.0	10,598.5	11	16	16
	Total	*675.0*	*8850*	*35,160.0*	*1,792.1*	*36,225.0*	*36,225.0*	*48,000.0*	*158,977.1*	*165*	*80*	*240*
Long Term	2026	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	2,960.0	10,598.5	11	--	16
	2027	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	2,720.0	10,598.5	11	--	16
	2028	45.0	59.0	2,344.0	119.5	2,415.0	2,415.0	2,720.0	10,598.5	11	16	16
	2029	45.0	59.0	344.0	119.5	2,415.0	2,415.0	2,720.0	8,117.5	11	--	16
	2030	45.0	59.0	344.0	119.5	2,415.0	2,415.0	2,720.0	8,117.5	11	--	16
	2031	45.0	59.0	344.0	119.5	2,415.0	2,415.0	2,480.0	7,877.5	11	16	16
	2032	45.0	59.0	344.0	119.5	2,415.0	2,215.0	2,480.0	7,677.5	11	--	16
	2033	45.0	59.0	344.0	119.5	2,415.0	2,215.0	2,480.0	7,677.5	11	--	16
	2034	45.0	59.0	344.0	119.5	2,415.0	2,215.0	2,480.0	7,677.5	11	16	16
	Total	*1,080.0*	*1,416.0*	*44,256.0*	*2,867.4*	*57,960.0*	*57,360.0*	*71,760.0*	*237,917.4*	*264*	*128*	*384*

Table 33b. All BMP Implementation in the Big Creek Watershed Including Town of Munjor and Hays Consolidated HUC 12 Target Areas for Each Year with Running Total to meet the Big Creek TMDLs for TN, TP, TSS, and E. *coli* bacteria

Term	Year	Field Buffers (acres)	Grass Waterways (acres)	Install Terraces (acres)	Terrace Restoration (acres)	Minimum Till (acres)	No-Till (acres)	Range Management (acres)	Total Acres	Livestock Relocation	Alternative Water Access	Onsite Waste Water System Upgrades
Short Term	2011	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	--	7
	2012	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	--	7
	2013	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	7	7
	2014	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	--	7
	2015	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	--	7
	Total	*100.0*	*130.0*	*6,375.0*	*313.1*	*6,125.0*	*6,125.0*	*7,400.0*	*26,568.1*	*25*	*7*	*35*
Medium Term	2016	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	7	7
	2017	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	--	7
	2018	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	--	7
	2019	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	7	7
	2020	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	--	7
	2021	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	--	7
	2022	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	7	7
	2023	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	--	7
	2024	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	--	7
	2025	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	7	7
	Total	*300.0*	*390.0*	*19,125.0*	*939.4*	*18,375.0*	*18,375.0*	*22,200.0*	*79,704.4*	*75*	*35*	*105*
Long Term	2026	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,240.0	5,073.6	5	--	7
	2027	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	--	7
	2028	20.0	26.0	1,275.0	62.6	1,225.0	1,225.0	1,480.0	5,313.6	5	7	7
	2029	20.0	26.0	275.0	62.6	1,225.0	1,225.0	1,480.0	4,313.6	5	--	7
	2030	20.0	26.0	275.0	62.6	1,225.0	1,225.0	1,480.0	4,313.6	5	--	7
	2031	20.0	26.0	275.0	62.6	1,225.0	1,225.0	1,480.0	4,313.6	5	7	7
	2032	20.0	26.0	275.0	62.6	1,225.0	1,225.0	1,480.0	4,313.6	5	--	7
	2033	20.0	26.0	275.0	62.6	1,225.0	1,225.0	1,480.0	4,313.6	5	--	7
	2034	20.0	26.0	275.0	62.6	1,225.0	1,225.0	1,480.0	4,313.6	5	7	7
	Total	*480.0*	*624.0*	*24,600.0*	*1,503.0*	*29,400.0*	*29,400.0*	*35,280.0*	*121,287.0*	120	*56*	*168*

Table 33c. All BMP Implementation in the Middle Smoky Hill River Watershed Including Oak Creek, Landon Creek, & Thielen Airport HUC 12 Target Areas for Each Year with Running Total to meet the Kanopolis Lake EU TMDL

	Year	Field Buffers (acres)	Grass Waterways (acres)	Install Terraces (acres)	Terrace Restoration (acres)	Minimum Till (acres)	No-Till (acres)	Range Management (acres)	Total Acres	Livestock Relocation	Alternative Water Access	Onsite Waste Water System Upgrades
Short Term	2011	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,720.0	5,283.9	6	--	9
	2012	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,720.0	5,283.9	6	--	9
	2013	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,720.0	5,283.9	6	9	9
	2014	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,720.0	5,283.9	6	--	9
	2015	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,720.0	5,283.9	6	--	9
	Total	*125.0*	*165.0*	*5,345.0*	*284.3*	*5,950.0*	*5,950.0*	*8,600.0*	*26,419.3*	*30*	*9*	*45*
Medium Term	2016	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,720.0	5,283.9	6	9	9
	2017	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,720.0	5,283.9	6	--	9
	2018	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,720.0	5,283.9	6	--	9
	2019	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,720.0	5,283.9	6	9	9
	2020	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,720.0	5,283.9	6	--	9
	2021	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,720.0	5,283.9	6	--	9
	2022	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,720.0	5,283.9	6	9	9
	2023	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,720.0	5,283.9	6	--	9
	2024	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,720.0	5,283.9	6	--	9
	2025	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,720.0	5,283.9	6	9	9
	Total	*375.0*	*495.0*	*16,035.0*	*852.8*	*17,850.0*	*17,850.0*	*25,800.0*	*79,257.8*	*90*	*45*	*135*
Long Term	2026	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,480.0	5,043.9	6	--	9
	2027	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,240.0	4,803.9	6	--	9
	2028	25.0	33.0	1,069.0	56.9	1,190.0	1,190.0	1,240.0	4,803.9	6	9	9
	2029	25.0	33.0	69.0	56.9	1,190.0	1,190.0	1,240.0	3,803.9	6	--	9
	2030	25.0	33.0	69.0	56.9	1,190.0	1,190.0	1,240.0	3,803.9	6	--	9
	2031	25.0	33.0	69.0	56.9	1,190.0	1,190.0	1,000.0	3,563.9	6	9	9
	2032	25.0	33.0	69.0	56.9	1,190.0	1,190.0	1,000.0	3,563.9	6	--	9
	2033	25.0	33.0	69.0	56.9	1,190.0	1,190.0	1,000.0	3,563.9	6	--	9
	2034	25.0	33.0	69.0	56.9	1,190.0	1,190.0	1,000.0	3,563.9	6	9	9
	Total	*600.0*	*792.0*	*19,656.0*	*1,364.4*	*28,560.0*	*28,560.0*	*36,240.0*	*115,772.4*	144	*72*	216

Table 34. Estimates of Information and Education Events for the BCMSHRW 2011-2034.

	Year	Education & Field Days [a]	News Articles [b]	Meetings	Monitoring Program	Service Learning	Workshops
Short Term	2011	15	12	4	42	2	8
	2012	15	12	4	42	2	8
	2013	15	12	4	42	2	8
	2014	15	12	4	42	2	8
	2015	15	12	4	42	2	8
	Total	*75*	*60*	*20*	*210*	*10*	*40*
Medium Term	2016	15	12	4	42	2	8
	2017	15	12	4	42	2	8
	2018	15	12	4	42	2	8
	2019	15	12	4	42	2	8
	2020	15	12	4	42	2	8
	2021	15	12	4	42	2	8
	2022	15	12	4	42	2	8
	2023	15	12	4	42	2	8
	2024	15	12	4	42	2	8
	2025	15	12	4	42	2	8
	Total	*225*	*180*	*60*	*630*	*30*	*120*
Long Term	2026	15	12	4	42	2	8
	2027	15	12	4	42	2	8
	2028	15	12	4	42	2	8
	2029	15	12	4	42	2	8
	2030	15	12	4	42	2	8
	2031	15	12	4	42	2	8
	2032	15	12	4	42	2	8
	2033	15	12	4	42	2	8
	2034	15	12	4	42	2	8
	Total	*360*	*288*	*96*	*1,008*	*48*	*192*

[a] Includes field days, education programs, water festivals, WOW trailer events.
[b] Newspaper articles, water bill inserts, and other media events.

9.2 Benchmarks to Measure Water Quality Progress

The primary goal of the BCMSHRW Watershed Plan is restoration of water quality of Big Creek and Kanopolis Lake to support its designated uses. The plan specifically addresses several TMDLs and 303(d) listings for Big Creek and Kanopolis Lake. The following is a list of the impairments being directly addressed by the plan:

Kanopolis Lake (KDHE Station LM016001)

- High Priority Eutrophication TMDL

Big Creek near Munjor (KDHE Station SC540)

- High Priority Bacteria (ECB) TMDL
- High Priority Total Suspended Solids TMDL
- Low Priority Total Phosphorus 303(d) listing
    - *High Priority draft TMDL pending (9/15/2011)*

In order to reach the load reduction goals associated these impairments; an implementation schedule for BMPs spanning 23 years has been developed. The selected practices included in the plan will be implemented throughout the targeted areas within the BCMSHRW. Water quality milestones have been developed for Kanopolis Lake, Big Creek, and the Smoky Hill River 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. The water quality milestones are tied to the sampling stations that the BCMSHRW and KDHE continue to monitor (Figure 44).

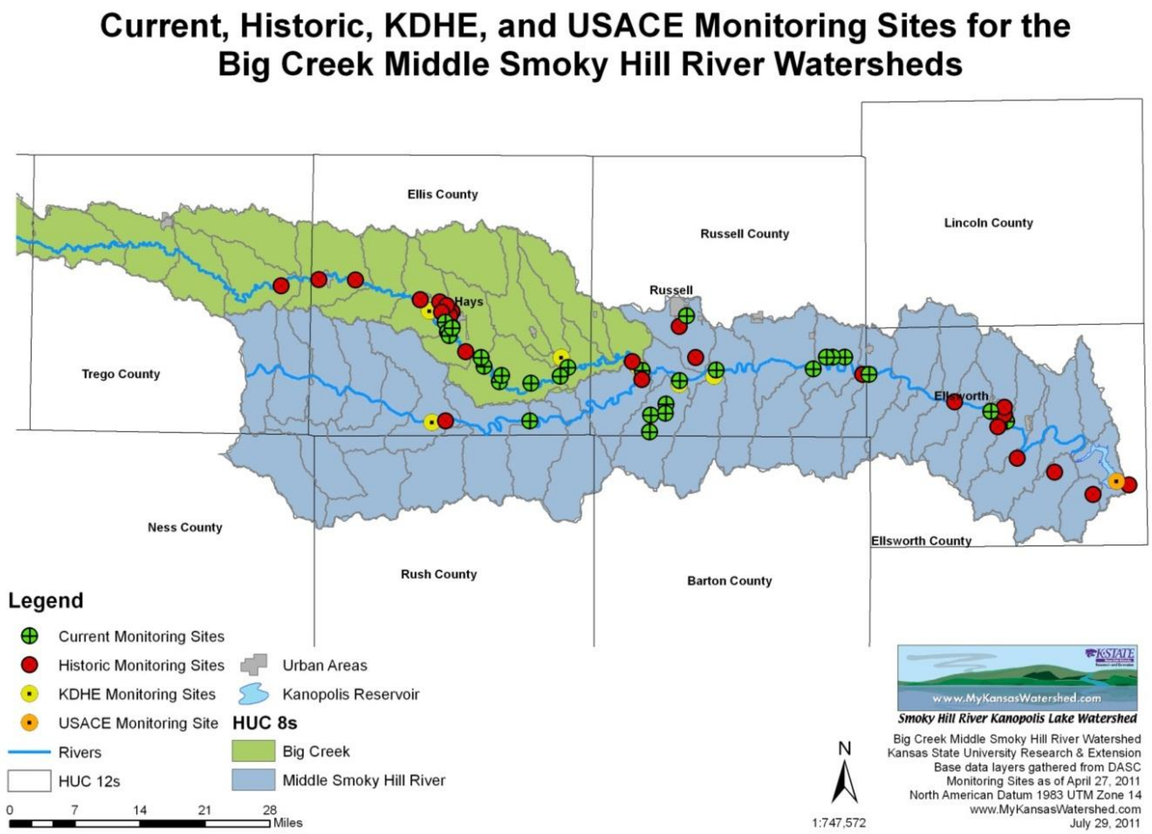


Figure 44. Location of current and historic BCMSHRW monitoring sites along with KDHE and USACE monitoring sites

Throughout the next 23 years, the BCMSHWR Leadership Team will use the stream monitoring data to measure water quality improvements. Additionally, future driving tours will also be used to measure BMP implementation thought the targeted HUC 12s and the watershed. When the data is available, the Leadership Team will assess and revise the watershed plan to reflect the real conditions of the watershed and its current trend. If required, new goals may be set in order to reach the TMDL benchmarks. Using the data described above in addition to monitoring data from KDHE, the leadership team will assess the progress towards meeting the set TMDLs.

In working with the KDHE TMDL Watershed Management Section, suggested water quality benchmarks have been set and is what we are trying to achieve. The water quality goal suggested benchmark to meet across stream segments with TMDLs as well as those that do not have TMDLs will be 50.0 mg/L TSS, 1.00 ppm TN, 0.10 ppm TP, and *E. coli* concentrations will vary by stream segment and recreational usage. These goals may change over time and the WRAPS plan and monitoring network will shift with these goals.

Currently the WRAPS group utilized a stream monitoring network to analyze TSS, TN, TP and *E. coli* concentrations across the watersheds. There are other agencies including KDHE, USGS, and the USACE collecting data as well across varying portions of the watersheds. The WRAPS groups' dataset is the most intensive in relation to overall watershed loading of the three entities and focuses efforts on storm flow as well as base flow. The USGS stations measure only precipitation, discharge, and stage height of the streams. These three entities currently share data.

Sampling sites across the watersheds vary by year with monitoring sites added or removed after one year's data has been collected and verified compliant. Targeted subwatershed monitoring sites are located in subwatersheds where targeted BMP placement is needed either because of standing TMDLs or the WRAPS groups' justification in the dataset of high pollutant loading. Current as well as historic monitoring locations (also known as permanent sites, as these sites will be used for assessment purposes in meeting short, mid, and long-term water quality milestones) as monitored by the BCMSHRW WRAPS Leadership Team as well as KDHE and the USACE (Table 35).

The permanent monitoring sites are continuously sampled, while the rotational sites are typically sampled every four years. The stream monitoring sites are sampled for nutrients, E. *coli* bacteria, chemicals, turbidity, alkalinity, dissolved oxygen, pH, ammonia and metals. The KDHE & USACE lake monitoring sites are typically sampled once every 3 years between April and October. Lake monitoring sites are sampled for chlorophyll a, total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), turbidity, dissolved oxygen, and secchi disk depth. The pollutant indicators tested for at each site may vary depending on the season at collection time and other factors.

Table 35. BCMSHR Water Quality Milestones in meeting Suggested TMDL Water Quality Benchmarks for TN, TP, and TSS

			10 Year Goal (2011 to 2021)		Long Term Goal	
KDHE Site	Water Quality Parameter	Current Condition	Improved Condition	Reduction Needed	Improved Condition	Reduction Needed
Kanopolis Lake (LM016001)	TP (mean µb/L)	68	58	15%	43	37%
Kanopolis Lake (LM016001)	TN (mean mg/L)	0.75	0.69	8%	0.62	17%
Kanopolis Lake (LM016001)	Chlorophyll a (mean µg/L)	15.8	13.4	15%	10.0	37%
Kanopolis Lake (LM016001)	Secchi Depth (mean meters)	1.0	> 1.2	--	> 1.5	--
SHR Near Russell (SC 007)	TP (median µg/L)	270	240	11%	200	26%
SHR at Ellsworth (SC 269)	TP (median µg/L)	131	116	11%	97	26%
BC Near Munjor (SC 540)	TP (median µg/L)	1570	975	38%	200	87%
BC Near Hays (SC 541)	TP (median µg/L)	174	154	11%	129	26%
SHR Near Russell (SC 007)	TSS (median mg/L)	45	40	11%	33	26%
SHR at Ellsworth (SC 269)	TSS (median mg/L)	31	27	13%	23	26%
BC Near Munjor (SC 540)	TSS (median mg/L)	79	66	16%	49	38%
BC Near Hays (SC 541)	TSS (median mg/L)	37	33	11%	27	26%

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

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

Bacteria load reductions should result in less frequent exceedence of the nominal ECB criterion. For Big Creek Near Munjor (KDHE site SC540), a primary recreation class B, the bacteria index is based on the criteria of 427 Colony Forming Units (CFUs)/100ml. These bacteria index values represent the natural logarithm of each sample value taken during the primary recreation season, divided by the natural logarithm of the bacteria criteria for primary recreation class B [ln(262)].

$$\textit{E. Coli}\ \text{Index} = \ln(\textit{E. Coli}\ \text{Count}) / \ln(262)$$

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

KDHE sampling station SC540 on Big Creek Near Munjor was sampled in accordance with the Water Quality Standard in April and June of 2006. The geometric mean for the five samples collected over a 30-day period was 382 CFUs/100ml for the April sampling and 788 CFUs/100ml for the June sampling. Both of these intensive sampling geometric mean results for this station are well above the Water Quality Standard, thus justifying the *E. Coli* stream impairment.

Ultimately, compliance with water quality standards for E. *coli* will be determined by the geometric mean of sampling 5 times within 30 days during the primary recreation seasons. Meeting this goal will be justification for delisting the stream impairment.

In working with the KDHE TMDL Section, TMDLs were developed with data from the WRAPS team sites and from KDHE's site but data is not compiled due to the difference in sampling frequency.

Sampling across the BCMSHRW by the WRAPS group focuses on the use of a TMDL sweep along with storm flow monitoring. Samples are collected 5 times during a 30 day period seasonally (April, July, and October) as well as a minimum of once between sampling periods. Storm flow sampling occurs at each site once the criterion of rainfall has occurred with 0.50 inches in urban areas and 1.50 inches in rural portions of the watersheds. These are standard guidelines but change during wet patterns when runoff is more likely to occur. The WRAPS group has an approved QAPP from KDHE for the monitoring project.

To meet the WRAPS group and KDHE benchmarks of water quality, the WRAPS group will continue to focus monitoring efforts into determining high pollutant loading subwatersheds until suggested water quality benchmarks as set by KDHE are met. These benchmarks are continuously reviewed by the group as sampling continues, but will be of prime focus during intensive sampling years by KDHE for TMDL determination. Using the monitoring data, the WRAPS group will implement BMPs into these areas and continuously monitor the water quality focusing more efforts into BMPs until water quality benchmarks are met. Those areas already meeting water quality benchmarks will be monitored on an as needed basis and if they start to exceed benchmarks, investigations will occur via watershed driving tours to see if BMPs are needed for water quality protection and if those areas will need to be added to the targeted HUC 12 areas in the future.

In addition to the monitoring data, other water quality indicators can be utilized. Indicators may include, but are not limited to anecdotal information from the Leadership Team and other citizens about skin rash outbreaks, fish kills, nuisance odors, taste discrepancies, algal blooms, visitor and boating traffic, trends in the quantity and/or quality of fishing, and beach closings. These additional indicators can act as trigger-points that might initiate further revisions or modifications to the WRAPS plan.

9.3 Benchmarks to Measure Social Progress

There are many measureable social progress benchmarks that the WRAPS group will be utilizing to see improvements in water quality. These benchmarks will vary by county and region as the diversity of the watersheds controls the efforts being taken by individuals. Across urban areas, indicators will include the use of rain barrels, xeriscaping, native landscaping, and decreases in storm water runoff quality as more and more small and large scale BMPs are being implemented. Attendance at water quality related events as well as school and community field days will be measured with hopeful yearly increases in attendance. Visits to the watershed's website, www.MyKansasWatershed.com, will continue to be tracked as water quality information is available electronically. Across rural portions of the watersheds, social progress will be made typically by the continued and gained usage of BMPs in croplands, rangelands, and upgrades to ONWWS. Stream monitoring will indicate the success of these BMPs through decreases in pollutant concentrations. An overall measure of the social progress can be made at Kanopolis Reservoir whereas water quality increases so too should visitor rates to the reservoir.

10.0 Monitoring Water Quality Progress

Every quarter data is reviewed by the watershed specialist and yearly by the watershed specialist and WRAPS group. Yearly, the monitoring sites are analyzed to compare values across seasons and years with sites of historic data while new sites are analyzed for contributions to the overall pollutant loading of Kanopolis Reservoir. Once new sites are analyzed, the particular subwatershed is marked either a targeted area in need of further research to determine BMP placement or removed from monitoring as there is no indication of significant pollutant contributions.

There are multiple groups that have monitoring locations throughout the BCMSHRW. These entities include WRAPS, KDHE, USGS, and the USCOE. Of these, USGS is the only one to not collect pollutant parameter data. The USGS maintains 5 gages in the BCMSHRW that measure precipitation, stage height, and discharge in real-time. These gauges include BC Riga, BCMP 5, BCMP 8, SHR Pioneer, and SHR Ellsworth. They also maintain a gage downstream of Kanopolis; however the group no longer monitors the water quality leaving Kanopolis Reservoir on a routine basis. KDHE had two types of stations much like the WRAPS group however they are either permanent or rotational. Permanent sites are monitored every year while rotational are monitored typically on a 4 year basis (TMDL purposes). The KDHE analyzes water quality for a variety of organic and inorganic pollutants of which TN, TP, TSS, and *E. coli* are relevant to the WRAPS group. The USCOE as well as KDHE monitors for specific pollutants again of which TSS, TN, TP, and *E. coli* are relevant to the WRAPS group at this time.

Spatial gaps do exist in the monitoring network of these 4 agencies as the BCMSHRW encompasses a very large area. Yearly these gaps are looked at to see if particular subwatersheds need targeted from stream flow data gathered on Big Creek and the Middle Smoky Hill River. If pollutant levels are high in a given stream segment, the WRAPS group will decide when and where to place these monitoring stations to gauge pollutant loading. Unlike other water quality groups, this WRAPS project has the flexibility to relocate, add, and remove monitoring sites within a short window as they do all of their own water quality analysis.

The water quality monitoring data is very important to the WRAPS group as it provides definitive data to producers about erosion and pollutant issues happening on the ground. The WRAPS group along with KDHE takes much stock in the data generated in the BCMSHRW. With base flow and storm flow data gathered, the WRAPS group can quickly target point source and non-point source pollution back to the subwatershed. Once within the subwatershed, targeted tributaries are monitored, landowner stakeholder groups are assembled, and decisions are made by local landowners based on data where to most productively place BMPs with input from the WRAPS group. Once these BMPs are placed on the ground, monitoring continues to see if pollutant loads have decreased enough to no longer produce significant loading to Kanopolis Reservoir and determine the effectiveness of the implementation of conservation practices outlined in this plan

The implementation schedule and water quality milestones for the BCMSHRW extend through a 23-year period from 2011 to 2034. 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 BCMSHRW to analyze and understand the context for non-achievement, as well as the need to review and/or revise the water quality milestones. KDHE and the Leadership Team can address any necessary modifications or revisions to the plan based on the data analysis. In 2034, at the end of the plan, a final determination can be made as to whether the water quality standards have been attained for Kanopolis Lake, Big Creek and the Smoky Hill River.

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

11.0 Review of the Watershed Plan in 2015

In the year 2015, the BCMSHRW plan will be reviewed and revised according to the results acquired from watershed conditions driving tour data and water quality monitoring data. At this time, the BCMSHRW Leadership Team will review the following criteria in addition to any other concerns that may occur at that time. Plan revisions will occur if criteria are not being met.

1. BCMSHRW Leadership Team will compare TSS, TP, TN and E.*coli* concentrations during base flow and runoff conditions between the initial implementation period of 2011-2015 as compared to what was seen from 2000-2010.

2. The BCMSHRW Leadership Team will request a report from KDHE concerning revising the watershed TMDLs, revised load allocations, and new waste load allocations defined from point sources in the watersheds.

3. The BCMSHRW Leadership Team will request a report from KDHE and USACOE on trends in water quality in Kanopolis Reservoir.

4. The BCMSHRW Leadership Team will report on progress towards achieving benchmarks listed in this plan.

5. The BCMSHRW Leadership Team will report on progress towards achieving BMP adoption rates listed in this plan.

6. The BCMSHRW Leadership Team will discuss necessary adjustments and revisions needed with the targets listed in this plan and if necessary additional targeted areas will be assessed if more reduction load is needed.

12.0 Appendix

12.1 Directory of Service Providers

City of Hays – Public Works Department **www.haysusa.com**
Support: Technical and Financial
Purpose: Responsible for snow removal & stormwater, solid waste collection, flood structure maintenance, street maintenance, code enforcement, and city planning.
Programs: Administers all projects for the City of Hays
Local Office: 1002 Vine .... Hays, KS 67601 .... (785) 628-7350

Environmental Protection Agency (EPA) **www.epa.gov**
Support: Financial
Purpose: Advise and oversee restoration and protection of aquatic resources based on hydrology rather than political boundaries
Programs: Clean Water State Revolving Fund, Watershed Protection

Fort Hays State University – Department of Agriculture **www.fhsu.edu/agriculture**
Support: Technical
Purpose: Provide real-world agricultural work experiences for students through community projects.
Programs: Sources of undergraduate students and resources, both knowledge and physical resources for projects.
Local Office: 600 Park St .... Hays, KS 67601 .... (785) 628-4196

Fort Hays State University – Department of Biology **www.fhsu.edu/biology**
Support: Technical
Purpose: Provide real-world biological work experiences for students through community projects.
Programs: Sources of undergraduate and graduate students and resources, both knowledge and physical resources for projects. In addition provides laboratory facilities for the analysis of stream samples.
Local Office: 600 Park St .... Hays, KS 67601 .... (785) 628-4214

Fort Hays State University – Department of Geosciences **www.fhsu.edu/geo**
Support: Technical
Purpose: Provide real-world geospatial work experiences for students through community projects.
Programs: Sources of undergraduate and graduate students and resources, both knowledge and physical resources for projects.
Local Office: 600 Park St .... Hays, KS 67601 .... (785) 628-5389

Fort Hays State University – Sternberg Museum **http://sternberg.fhsu.edu/**

Support: Technical
Purpose: Provide educational exhibits, programs, and lectures for all age groups of the general public. Additional, the museum will provide research support and training programs to university staff and students.
Programs: Educational programs for all age groups of the general public.
Local Office: 3000 Sternberg Drive ....Hays, KS 67601 .... (785) 628-4286

Kansas Alliance for Wetlands and Streams (KAWS) **www.kaws.org**

Support: Technical and Financial
Purpose: KAWS organized in 1996 to promote the protection, enhancement, restoration, and enhancement of wetlands and streams within Kansas.
Programs: Streambank Stabilization, Wetland Restoration, Cost share programs
Local Office: 1835 I Road ....Stockton, KS 67669 .... (785) 425-7325

Kansas Department of Agriculture **www.ksda.gov**

Support: Technical and Financial
Purpose: Advise and permit physical watershed structures.
Programs: Watershed structures and permitting

Kansas Department of Health and Environment **www.kdhe.gov**

Support: Technical and Financial
Purpose: Provide technical assistance in determining load allocations and reductions for non-point source pollutants and provide funding to support corrective actions deemed necessary.
Programs: Non-point Source Pollution Program, Municipal and Livestock Waste, State Revolving Loan Fund, Clean Water Neighbor Grant
Local Office: 2301 E. 13th ....Hays, KS 67601 .... (785) 625-5663

Kansas Department of Wildlife and Parks **www.kdwp.state.ks.us**

Support: Technical and Financial
Purpose: Provide assistance in order to enhance quality areas for wildlife habitat and limited access for outdoor activities.
Programs: Land and Water Conversation Funds, Conservation Easements for Riparian and Wetland Areas, Wildlife Habitat Improvement Program
Local Office: 1426 US Highway 183 Alt.....Hays, KS 67601 .... (785) 628-8614

Kansas Forest Service **www.kansasforests.org**

Support: Technical and Financial
Purpose: Provide low cost native trees and shrubs for conservation planting and to promote good riparian forestland.
Programs: Conservation Tree Planting Program, Riparian and Wetland Protection Program
Local Office: 1232 240th Ave ....Hays, KS 67601 .... (785) 625-3425

Kansas Rural Center **www.kansasruralcenter.org**

Support: Technical and Financial
Purpose: The Center is committed to economically, environmentally, and socially sustainable rural culture
Programs: The Heartland Network, Clean Water Farms, River Friendly Farms, Sustainable Food Systems Project, Cost Share Programs

Kansas Rural Water Association **www.krwa.net**

Support: Technical
Purpose: Provide education, technical assistance, and leadership to public water and wastewater utilities.
Programs: Technical assistance for water systems

Kansas State Research and Extension **www.ksre.ksu.edu**

Support: Technical
Purpose: Provide programs, expertise, and education that relate to water quality, water protection, rural living, urban living, and other human actives that affect our environment.
Programs: Water Quality Programs, Waste Management Programs, Kansas Environmental Leadership Program, Kansas Local Government Water Quality Planning and Management, Rangeland and Natural Area Services, WaterLINK, Kansas Pride, Healthy Ecosystems/Healthy Communities, and Citizen Science

Local Office:	210 N Kansas	Ellsworth, KS 67439	(785) 472-4442
	1800 12th St	Great Bend, KS 67530	(620) 793-1910
	520 Washington	Gove, KS 67736	(785) 938-4480
	601 Main St	Hays, KS 67601	(785) 628-9430
	702 Main St	LaCrosse, KS 67548	(785) 222-2710
	216 E. Lincoln Ave	Lincoln, KS 67455	(785) 524-4432
	202 W. Sycamore	Ness City, KS 67560	(785) 798-3921
	401 N. Main St	Russell, KS 67665	(785) 483-3157
	216 Main St	WaKeeney, KS 67672	(785) 743-6361

Kansas Water Office **www.kwo.org**

Support: Technical and Financial
Purpose: Provide information and education to the public on Kansas Water Resources
Programs: Public Information and Education

No-Till on the Plains **www.notill.org**

Support: Technical
Purpose: Provide information and assistance concerning continuous no-till farming practices
Programs: Field Days, Meetings, Tours, Technical Consulting

State Conservation Commission & Conservation Districts **www.scc.ks.gov**

Support: Technical and Financial

Purpose: Provide cost share assistance and other financial incentives for conservation practices.

Programs: Water Resources Cost Share, Non-point Source Pollution Control Fund, Riparian and Wetland Protection Program, Stream Rehabilitation Program, and Kansas Water Quality Buffer Initiative

Local Office:

402 W. 15th St	Ellsworth, KS 67439	(785) 472-4999
1520 Kansas Ave	Great Bend, KS 67530	(620) 792-3346
318 Broad St	Gove, KS 67736	(785) 938-2365
2715 Canterbury Dr	Hays, KS 67601	(785) 623-4888
1515 Oak St	LaCrosse, KS 67548	(785) 222-2615
112 E. Court St	Lincoln, KS 67455	(785) 524-4482
N. Highway 283	Ness City, KS 67560	(785) 798-3911
555 South Fossil	Russell, KS 67665	(785) 483-2826
519 Russell Ave	WaKeeney, KS 67672	(785) 743-2191

Stumps Trust

Support: Financial

Purpose: Increase and restore wetlands.

Programs: Provide financial support for wetland enhancements. Administrators are Marvin and Jack Dorhman.

Local Office:

M. Dorhman: 2406 7th Rd	Bushton, KS 67427	(620) 562-3514
J. Dorhman: 540 5th Rd	Bushton, KS 67427	(620) 562-3340

U.S. Army Corps of Engineers **www.usace.army.mil**

Support: Technical

Purpose: Assist in the development of plans of water related resources.

Programs: Planning Assistance to States, Environmental Restoration

U.S. Fish and Wildlife Service **www.fws.gov**

Support: Technical

Purpose: Provide technical assistance on wetland design and construction

Programs: Fish and Wildlife Enhancement Program, Private Lands Program

USDA Natural Resources Conservation Service (NRCS) **www.nrcs.usda.gov**
and USDA Farm Service Agency (FSA) **www.fsa.usda.gov**

Support: Technical and Financial

Purpose: Provide technical assistance in designing and planning of conservation practices and to provide financial assistance for the implementation of such practices.

Programs: Conservation Compliance, Conservation Operations, Watershed Planning and Operations, Wetland Reserve Program, Wildlife Habitat Incentives Program, Grassland Reserve Program, EQIP, and CRP

Local Office:

402 W. 15th St	Ellsworth, KS 67439	(785) 472-4999
1520 Kansas Ave	Great Bend, KS 67530	(620) 792-3346
318 Broad St	Gove, KS 67736	(785) 938-2365

3012 Broadway Ave	Hays, KS 67601	(785) 625-2588
2715 Canterbury Dr	Hays, KS 67601	(785) 623-4888
1515 Oak St	LaCrosse, KS 67548	(785) 222-2615
112 E. Court St	Lincoln, KS 67455	(785) 524-4482
N. Highway 283	Ness City, KS 67560	(785) 798-3911
555 South Fossil	Russell, KS 67665	(785) 483-2826
519 Russell Ave	WaKeeney, KS 67672	(785) 743-2191

12.2 Big Creek Middle Smoky Hill River Watersheds (BCMSHRW) – Kanopolis Lake Leadership Team.

The leadership team strives to obtain and maintain a diverse representation of all stakeholders within the watershed. Based upon the composition of the Leadership Team as listed below, we exceed the recommended expectations set forth by KDHE.

1) Formal Leaders – no minimum expectations
   a) Municipalities .... Barbara Wasinger, Mayor, City of Hays
   b) County Commissioners ....
   c) County Conservation District
      Board Members .... Lyman Nuss, Russell County
      Kent Truan, Russell County
      Bradley Zweifel, Russell County
   d) Watershed District Board .... Not Applicable
   e) County Extension Councils/Districts ....
   f) Water District Boards .... David Bailey, Post Rock Rural Water
   g) School Board .... James Leiker, USD 489
   h) Conservation Commissioner (1 of 5) ....
   i) Other ....

2) Formal Leaders (Appointed) – Representative from at least three of these categories. One must be a Conservation District representative
   a) Basin Advisory/Water Authority .... David Bailey Smoky Hill/Saline BAC
   b) Public Works Representative .... John Braun, City of Hays
   c) City & County Representative .... Nicholas Willis, City of Hays – MS4 Permit
      Ralph Wise, City of Russell
   d) Rural Water Districts/KRWA ....
   e) Public Health Officer .... Karen Purvis, Ellis County Environmental Office
   f) Sanitarian .... Jo Funk, LEFG
   g) Planning & Zoning Representative .... Ken Richmeier, Ellis County & City of Hays Representative
   h) County Extension Personnel .... Scott Barrows, Trego County
      Stacy Campbell, Ellis County
      John Stannard, Russell County
      Brent Goss, Ellsworth County

i) District Conservationist .... Mike Grogan, Trego County
Brad Shank, Ellis County
Andy Phelps, Russell County
Phil Chegwidden, Ellsworth Count
Greg Bauer, Baron County
j) Conservation District Representative .... Dustin Becker, Trego County
Sandi Scott, Ellis County
Landon Leiker, Ellis County
Donna Fay Major, Russell County
Pamela Hays, Ellsworth County
k) Watershed District Representative................ Not Applicable
l) Other – Fort Hays State University............... Robert Stephenson, Dept. of Agriculture
Eric Gillock, Dept. of Biological Sciences

3) Informal Leaders – Representatives from at least three categories. One must be a landowner.
a) Newspaper Editor/Reporter ....
b) Major Employers ....
c) Civic Club Representative .... Marcia Blundon, Kiwanis/4-H
Jean Gleichsner, Lions Club
d) Natural Resource Not For Profit................... John Heinrichs, Ellis County Wellhead Protection Committee
e) Environmental Advocates............................. Brenden Wirth, Farm Bureau
f) State or Federal Natural Resource Agency... Marvin Boyer, USACE
Tom Stiles, KDHE
Matt Unruh, KDHE
Dan Wells, KDHE
Doug Schneweis, KDHE
g) Trade Associations.......................................
h) Landowners Representative of Land Use ..... Carroll & Judy Fabrizius, Trego County
Landon Leiker, Ellis County
Taylor Bemis, Ellis County
Lyman Nuss, Russell County
Ken Truan, Russell County
Bradley Zweifel, Russell County
Allan Pflughoegt, Ellsworth County
Brad Kratzer, Ellsworth County
i) Other – Kansas State University................... Stacie Minson, Watershed Specialist
James Leiker, Watershed Technician
Dustin Fross, Watershed GIS Specialist
Dan Devlin, Director of KCARE
Phil Barnes, Bio & Ag Engineering

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