Delaware River WRAPS – 9 Element Watershed Plan Summary

The Delaware River WRAPS 9 Element Plan will be directly addressing the following impaired waters:

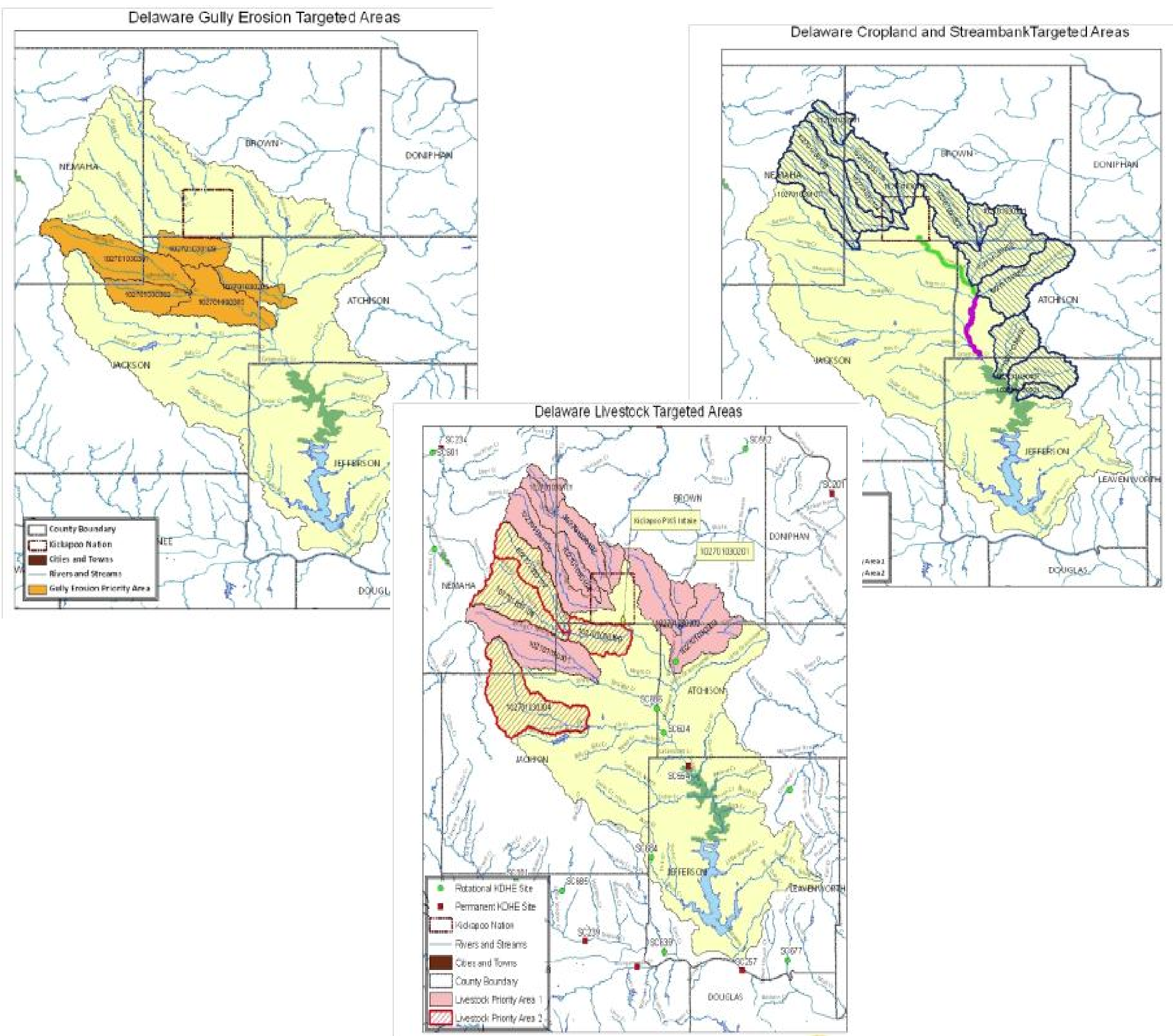
- Perry Lake (EU)
- Perry Wildlife Area Wetland (EU, DO)
- Delaware River above Perry Lake (Bacteria)
- Grasshopper Creek near Muscotah (TP)
- Grasshopper Creek (Bacteria)
- Mission Lake (Silt)

The Delaware River WRAPS 9 Element Plan will be positively affecting the following impaired waters:

- Delaware River near Mound (DO)
- Elk Creek near Larkinburg
- Grasshopper Creek near Muscotah (Atrazine)
- Mission Lake (EU, Atrazine)
- Little Lake (EU)
- Atchison Co. Park Lake (EU, Silt)
- Sabetha (EU)

Prioritized Critical Areas for Targeting BMPs

Implementing BMPs in smaller targeted areas achieves the end goals of water quality improvement of impaired waters in the most cost and time effective way.



Delaware River WRAPS – 9 Element Watershed Plan Summary

Targeting Considerations:

- Cropland Targeted areas were identified after reviewing a SWAT model and a KDHE Cropland/Slope analysis. Landowner knowledge was also considered.
- Livestock Targeted areas were identified after landowners in the watershed determined which areas had the largest number of uncertified animal operations.
- Streambank targeted areas where identified based on several studies including the TWI 2008 stream channel morphology and a 2007 Geological Survey study .
- Gully targeted areas where identified by a 2010 KWO study of gully erosion sites using GIS layers.

Best Management Practices and Load Reduction Goal

Cropland BMPs

- Riparian Vegetative Buffers
- Permanent Vegetation
- Grassed Waterways
- Retention Structures
- No-Till systems
- Sub-surface fertilizer application

Livestock BMPs

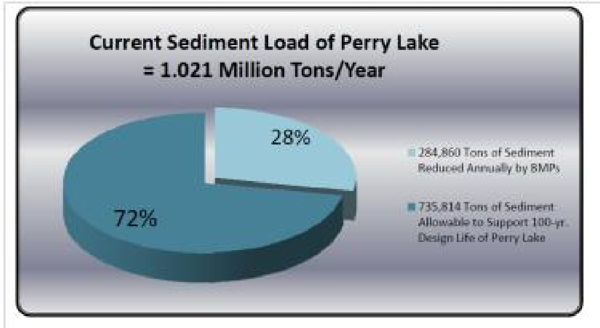
- Vegetative Filter Strip
- RelocateLivestock feedlots & Feeding Pens
- Relocate Pasture Feeding Sites
- Alternative (Off-Stream) Watering System
- Rotational Grazing Systems

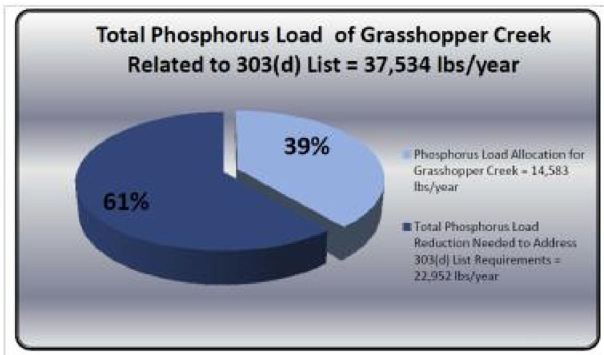
Gully BMPs

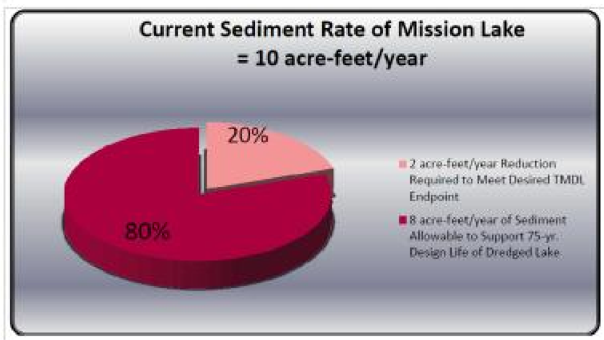
- Sediment basins
- Diversions
- Constructed Wetlands
- Riparian Buffers

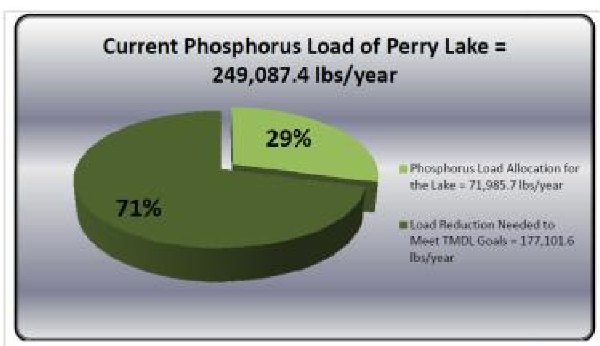
Streambank BMPs

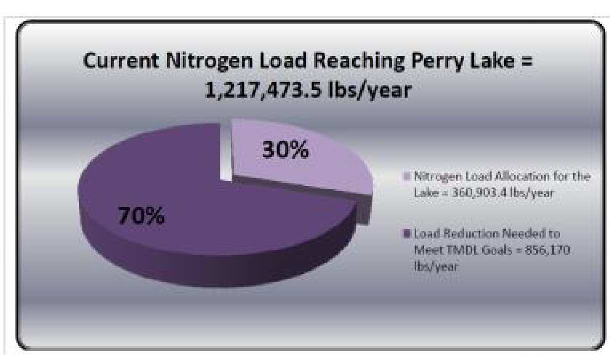
- Willow Cuttings/ Native Vegetation
- Bank Re-shaping
- Stone Toe Protection
- Rock Vanes and Weirs











DELAWARE RIVER WATERSHED RESTORATION AND PROTECTION STRATEGY

Nine-Element Plan Supplement

8/30/2011

Delaware River Watershed Restoration and Protection Strategy (WRAPS)

Marlene Bosworth, Coordinator

Delaware River WRAPS is sponsored by the Glacial Hills Resource Conservation and Development Region, Inc.

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Funding for development of this plan was provided by a U.S. Environmental Protection Agency CWA Section 319 grant through the Kansas Department of Health and Environment

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Part 1: Introduction

1.1 Purpose of the Plan

The purpose of the Delaware River Watershed Restoration and Protection Strategy (WRAPS) plan is to outline an approach with specific strategies that will be used to address the most significant non-point source pollution problems in the Delaware River Watershed. The plan was developed with input from local stakeholders. Stakeholders (those individuals and groups that live in, own land in or work in the watershed) have the most to gain or lose when water resources are protected and when they are negatively impacted by pollutants. They are also the individuals and groups with the greatest influence over pollutant sources, land use, and protection efforts.

This plan provides the guidance needed to create and direct a water resource protection agenda for the watershed. The plan lends legitimacy and focus to water resource decisions, provides the framework for advancement of watershed objectives and establishes a structure that will be used to assemble the resources necessary to advance watershed restoration work.

1.2 Historical Background of Delaware River WRAPS

Stakeholders in the watershed began formulating a Watershed Restoration and Protection Strategy (WRAPS) in late 2005. The Glacial Hills Resource Conservation & Development Region, Inc. (RC&D) initiated the watershed planning process at that time, and has continued to support the project since.

The WRAPS process started when local people gathered to identify water resource protection needs and goals and to develop a plan. After months of collaboration and discussion, a large number of stakeholders had become involved. Seven key water pollutants, a list of best management practices (BMPs) to reduce non-point source pollution and various educational and outreach strategies were identified to promote water restoration and protection objectives. This information was used to formulate a watershed plan that was officially adopted in May 2007 (1). Immediately thereafter, a formal Stakeholder Leadership Team (SLT) was formed and an action plan to implement BMPs to support the various planned goals and objectives was initiated.

Actions taken as a result of the adoption of the 2007 watershed plan, under the leadership of the SLT and sponsorship of the Glacial Hills RC&D, have already benefited water resources in the watershed. The Delaware River Streambank Restoration Program, which got underway in 2009, will result in the stabilization of over 24,000 linear feet of severely eroding riverbanks on the Delaware River above Perry Reservoir. More than $1.85 million in funding and technical assistance will be supplied for the program from various federal, state and local sources to support the program. Stabilization efforts will significantly reduce the sediment load of the Delaware River and sedimentation in Perry Lake Reservoir, improve aquatic habitat and increase water quality.

Delaware River WRAPS was also instrumental in the establishment of a multi-county regional household hazardous waste program in 2008. The program came about as a result of discussions facilitated by Delaware River WRAPS between county commissioners, waste departments, KDHE and others in

Atchison, Brown, Doniphan and Jackson counties. Delaware River WRAPS also assisted the newly established Northeast Kansas Regional Household Hazardous Waste Program that was created to obtain a $105,000 grant and $32,000 in Supplemental Environmental Program funds from KDHE. This funding was sufficient to start and support the regional program through its first year of operations. As a result of this effort, all counties in the watershed (and Doniphan County located outside the watershed area) now offer hazardous waste disposal service to their residents.

An extensive education and outreach effort was also initiated by Delaware River WRAPS following adoption of the 2007 watershed plan. These efforts have significantly raised the awareness of watershed issues and the importance of protecting watershed resources. Monthly editorials and other information are provided to local newspapers, radio and television outlets in the watershed. Delaware River WRAPS hosts educational workshops and watershed tours, and is available to give presentations to local organizations and school groups. A project website was created (www.delawarewraps.org) and highway road signs informing passersby that they are in the Delaware River Watershed were posted in 2008. Delaware River WRAPS has also worked with local conservation districts, natural resource organizations, school groups and others on many other information and education projects that have helped to enhance understanding of watershed issues as well as raise the visibility of Delaware River WRAPS.

1.3 Meeting EPA's 9-Element Requirements

In order for Delaware River WRAPS to continue to receive funding, certain updates to the 2007 watershed plan have become necessary. These updates address points that are commonly referred to as the "9-Elements" and are required by the U.S. Environmental Protection Agency (EPA) and the Kansas Dept. of Health & Environment (KDHE) in order for any project to receive financial support through Section 319 Clean Water Act funds. The 9-Element requirements address specific components of a watershed plan. The table below briefly describes the objectives of each element.

Table 1 EPA's 9-Elements for Watershed Planning

ELEMENT	DESCRIPTION
Element 1:	Identify and quantify causes and sources of the impairments
Element 2:	Estimate expected load reductions
Element 3:	Identify BMPs needed to achieve load reductions and critical areas where BMPs will be implemented
Element 4:	Estimate needed technical and financial resources
Element 5:	Provide an information, education, and public participation component
Element 6:	Include schedule for implementing nonpoint source management measures (who does what when?)
Element 7:	Identify and describe interim measurable milestones for implementation
Element 8:	Establish criteria to determine if load reductions and targets are being achieved
Element 9:	Provide a monitoring component to evaluate effectiveness of the implementation over time for criteria in element 8.

Much of the original watershed plan adopted in 2007 contained aspects of the 9 Elements. However, under direction from KDHE, stronger emphasis and missing components of the 9 Elements were required. This was the motivation for creation of this watershed plan update. This update is considered to be a supplement to the original watershed plan that was adopted in May 2007.

1.4 Scope of Watershed Plan Update

One of the major outcomes of stakeholder meetings held when the Delaware River WRAPS effort was initiated in 2006 was the identification of seven major water issues for the Delaware River basin. These issues represent the most important water quality concerns that stakeholders agreed should receive priority in any restoration or protection effort, including the implementation of Best Management Practices. A detailed discussion of all seven watershed priority issues is contained within the 2007 watershed plan document.

This 9-Element plan update will not address all seven original watershed issues, but will specifically focus on the three considered to be of highest priority. These three issues represent the most urgent and critical issues affecting the watershed. Addressing the most significant issues first serves to focus resources to the most pressing concerns, and because water resource concerns are often intricately interrelated, addressing the most significant issues first will also benefit the remaining water resource concerns.

The issues specifically addressed by this plan update are (listed in order of priority):

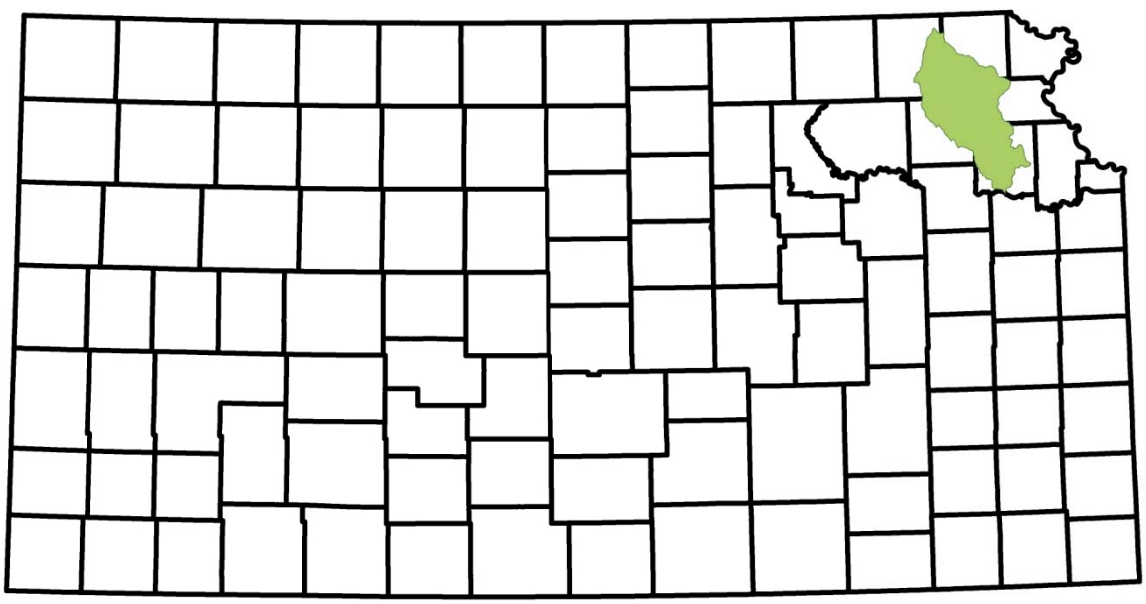
1. **Sedimentation**
2. **Nutrients**
3. **Bacteria**

Part 2: Watershed Information

2.1 Location

The Delaware River Watershed is the area of land in northeast Kansas that drains to the Delaware River and its tributaries. The watershed is 740,772 acres in size (approximately 1,157 square miles). The headwaters of the Delaware River arise northwest of Sabetha in Nemaha County. The river flows generally southeast through Nemaha, Brown, Jackson, Atchison and Jefferson Counties and enters Perry Lake Reservoir south of the city of Valley Falls in Jefferson County. Perry Lake is a federal reservoir operated and maintained by the U.S. Army Corps of Engineers primarily for flood control, recreation and water supply. Outflow from Perry Lake continues south from the reservoir down the Delaware River for approximately 4 miles to the confluence with the Kansas River north of Lecompton, Kansas.

Figure 1: Delaware River Watershed located in northeast Kansas

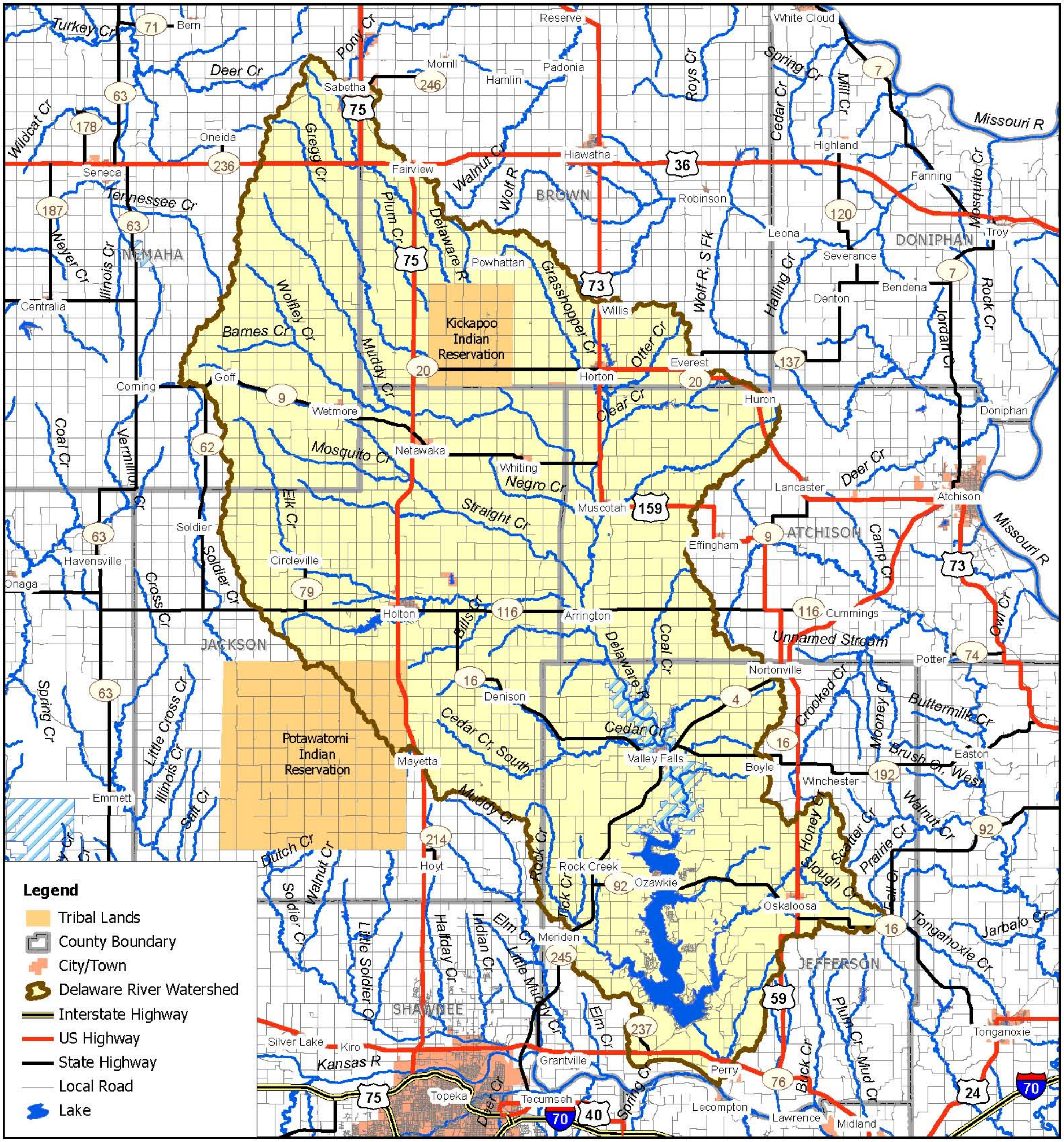


2.2 Local Cities and Roads

The watershed is characterized as being very rural with numerous small towns and scattered rural homes and farms of varying size. Municipalities within the Delaware River Watershed are relatively small. According to the 2010 U.S. Census, the cities of Holton (population 3,329) and Sabetha (population 2,504) are the largest cities in the watershed.

The figure on the following page **(Figure 2)** is a map showing major streams, towns and roads in the watershed.

Figure 2: Major streams, towns and roads in the Delaware River Watershed



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Kansas Department of Health & Environment

July 2010

2.3 Hydrology

There are twelve major river basins in Kansas (see **Figure 3**). The Delaware River is a major tributary to the Kansas River and is located within the Kansas-Lower Republican River Basin. The Kansas-Lower Republican basin is located within the larger Missouri River Basin and the Mississippi River Basin, the largest watershed in North America (see **Figure 4**).

Figure 3: The 12 major river basins in Kansas. The Delaware River Watershed is located within the Kansas-Lower Republican River Basin (area in light blue).

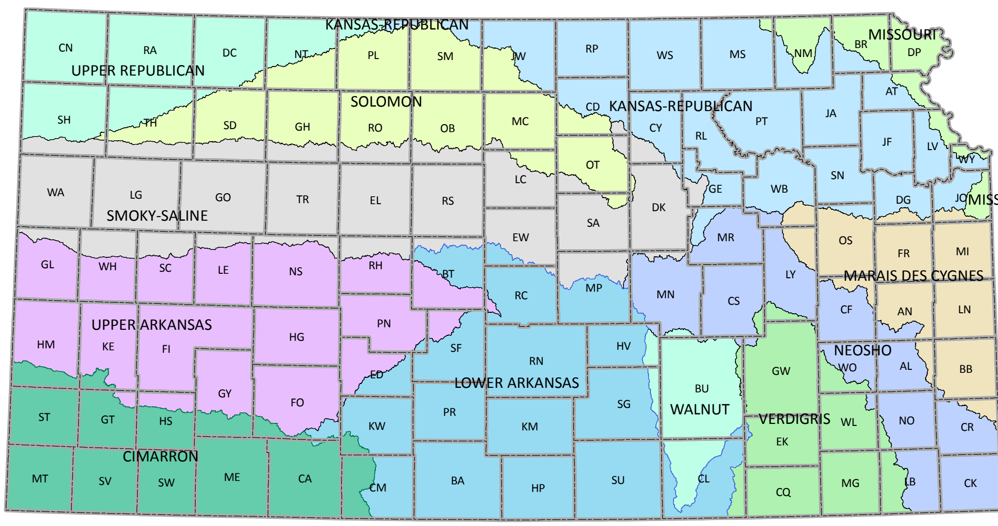

Figure 4: Map of the U.S. showing the Mississippi River Basin. The Delaware River Watershed is part of the Missouri River Basin, a large sub-watershed of the Mississippi Basin.

2.3.1 Hydrologic Unit Codes

The **Hydrologic Unit Code** (HUC) system was developed by the U.S. Geological Survey in the 1970's as a classification system designed to aid in the identification of watershed areas in the U.S. Hydrologic Unit Codes are organized within a nested hierarchy that is structured by size from larger to smaller. The number of digits in a HUC number becomes progressively greater as the size of the watershed represented becomes smaller.

The Delaware River Watershed is identified by the unique Hydrologic Unit Code designation of **10270103.** This is an 8-digit number that specifically identifies the "address" of the watershed, its size and boundaries.

The Delaware River Watershed also contains forty-one 12-digit HUC watershed areas within its boundaries. Each of these HUC-12 units corresponds to a smaller sub-watershed area within the larger Delaware basin, as shown in **Figure 5** on the following page. These smaller sub-watershed designations are useful for targeting purposes within large watersheds like the Delaware River Basin.

There are numerous tributaries (smaller streams and creeks) to the Delaware River in the watershed (see **Figure 6**). Each stream has its own unique characteristics that are a function of the land area through which it passes. Generally speaking, 12-digit HUC sub-watersheds correspond to land areas that drain to major tributaries or sections (also called "reaches") of tributaries or the Delaware River itself.

Table 2 shows the acreage of the land are contained within each of the 12-digit HUC sub-watersheds in the Delaware River basin.

Figure 5: HUC-12 Sub-watersheds located within the Delaware River Watershed

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Figure 6: Major streams in the Delaware River Watershed

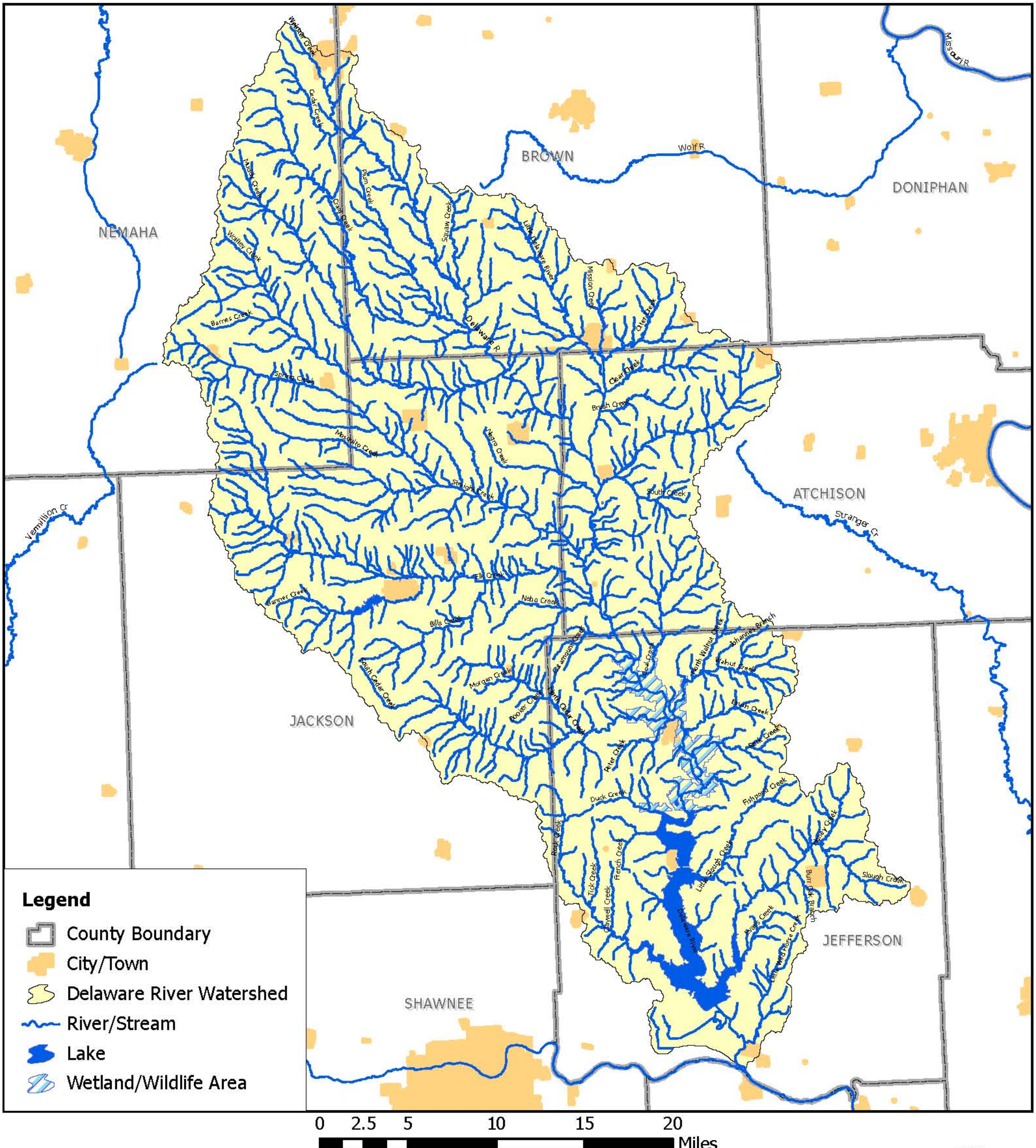

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Table 2: Acreage of the forty-one HUC-12 sub-watersheds located within the Delaware River Watershed

HUC 12 No.	HUC 12 NAME	SHAPE_AREA (acres)
102701030405	Cedar Creek	10977.0
102701030504	Delaware River-Upper Lake Perry	19532.6
102701030308	Town of Arrington-Delaware River	9258.3
102701030304	Headwaters Elk Creek	42477.8
102701030303	Outlet Straight Creek	27304.3
102701030107	Headwaters Muddy Creek	22923.7
102701030510	Lake Perry Spillway-Delaware River	10034.5
102701030506	Rock Creek-Lake Perry	26524.5
102701030407	Walnut Creek	18810.4
102701030204	Little Grasshopper Creek	30777.5
102701030103	Squaw Creek	6151.4
102701030508	Delaware River-Lower Lake Perry	15336.1
102701030201	Mission Lake	6495.5
102701030203	Outlet Grasshopper Creek	32506.6
102701030108	Wolfley Creek	28366.0
102701030101	Grasshopper Creek	7074.2
102701030401	Nebo Creek	9062.4
102701030402	Coal Creek	18504.4
102701030110	Walnut Creek-Delaware River	18889.3
102701030301	Spring Creek	37156.9
102701030306	Bills Creek	15733.6
102701030307	Outlet Elk Creek	15920.3
102701030104	Headwaters Plum Creek	11636.7
102701030109	Outlet Muddy Creek	15283.5
102701030106	City of Powhattan-Delaware River	11180.4
102701030503	Bowies Creek-Delaware River	10621.8
102701030505	Little Slough Creek-Lake Perry	14855.1
102701030509	Little Wild Horse Creek	7924.8
102701030302	Headwaters Straight Creek	16668.2
102701030105	Outlet Plum Creek	29316.3
102701030406	Peter Creek	4940.2
102701030502	Rock Creek	7668.1
102701030202	Headwaters Grasshopper Creek	22051.1
102701030205	Negro Creek-Delaware River	11867.5
102701030403	South Cedar Creek	27794.9
102701030404	North Cedar Creek	15372.7
102701030305	Banner Creek	15435.6
102701030102	Cedar Creek-Delaware River	25345.8
102701030408	Catamount Creek-Delaware River	20087.2
102701030501	Brush Creek	5152.9
102701030507	Slough Creek-Lake Perry	38007.5

2.4 Special Aquatic Life Use Waters

Special Aquatic Life Use (SALU) is a special designation assigned to bodies of water that are unique or which support or contain unique biological life that may be in peril in the state. As defined by K.A.R. 28-16-28d (b)(2)(A) (2), Special Aquatic Life Use waters are "surface waters that contain combinations of habitat types and indigenous biota not found commonly in the state, or surface waters that contain representative populations of threatened or endangered species".

2.4.1 Muscotah Marsh, Atchison County

Muscotah Marsh is located in Atchison County approximately 1 ½ miles south of the town of Muscotah (see **Figure 7**). It is unique in that it is a raised marsh surrounded by a semi-permanent swampy area. The marsh owes its existence to artesian water coming out of the ground at this location.

Muscotah Marsh is the home to the only population of Slender Walker Snails (*Pomatiopsis lapidaria*) in Kansas. Wetlands and contiguous drainageways in Sections 15 and 16 of Township 6 South, Range 17 East in Atchison County where the marsh is located have been designated as "Critical Habitat" for the snail. Although this species of snail is fairly common in the eastern U.S., only isolated populations can be found in the Plains region. Interestingly, many remains of the species have been reported in Pleistocene deposits in Russell County, Kansas. The species is currently listed as ***endangered*** in Kansas (3).

The population of the Slender Walker Snail at Muscotah Marsh is unique not only because it is so isolated and rare in Kansas, but also because they are so abundant here. Densities of 1,255 individuals per square meter have been described in raised portions of the marsh. The snail prefers terrestrial conditions with very high relative humidity, and the raised characteristic of the marsh with stable artesian groundwater flow creates conditions favorable for the snail.

The land where Muscotah Marsh is located is privately owned, and there is potential for adverse impact on the Slender Walker Snail population from changing land use. The snails' very specific habitat requirements make the species vulnerable to any dewatering of the marsh and water pollution. Dewatering of the marsh could result from groundwater pumping in the surrounding area or changes in area geology that could influence the artesian flow. Increased variability of environmental conditions (drier conditions and/or lowered humidity) caused by reduced artesian flow would have a devastating effect on the snail's population. Pollution of groundwater or runoff reaching the marsh could also have a negative impact on the snail population. Since the area is surrounded by agricultural land, nutrients, sediment and agricultural chemicals present the greatest threat to water quality. However, because the marsh receives constant artesian flow, it is unlikely that the area could be drained and converted to another type of land use than currently exists.

Because the Slender Walker Snail populations are so restricted, any adverse conditions imposed on the Muscotah Marsh could impact this single population and result in the reduction or total loss of the species in Kansas. The vulnerability of this endangered species warrants close attention by Kansas Dept. of Wildlife & Parks, Delaware River WRAPS and other partner agencies. To date, only limited research has been done on Muscotah Marsh and the Slender Walker Snail population found there. A Recovery Plan for the species was developed by the Kansas Dept. of Wildlife & Parks in 2003.

2.4.2 Perry Lake Reservoir, Jefferson County

Perry Lake Reservoir (see **Figure 7**) is also designated as a Special Aquatic Life Use Water. Most federal reservoirs in the state of Kansas are considered SALUs because of the uniqueness of the large expanse of open water and large wetland areas associated with these reservoirs. With over 11,000 acres of open water and large wetlands located at its north end, Perry Lake provides unique support for wildlife, aquatic species and other biota that would not exist otherwise.

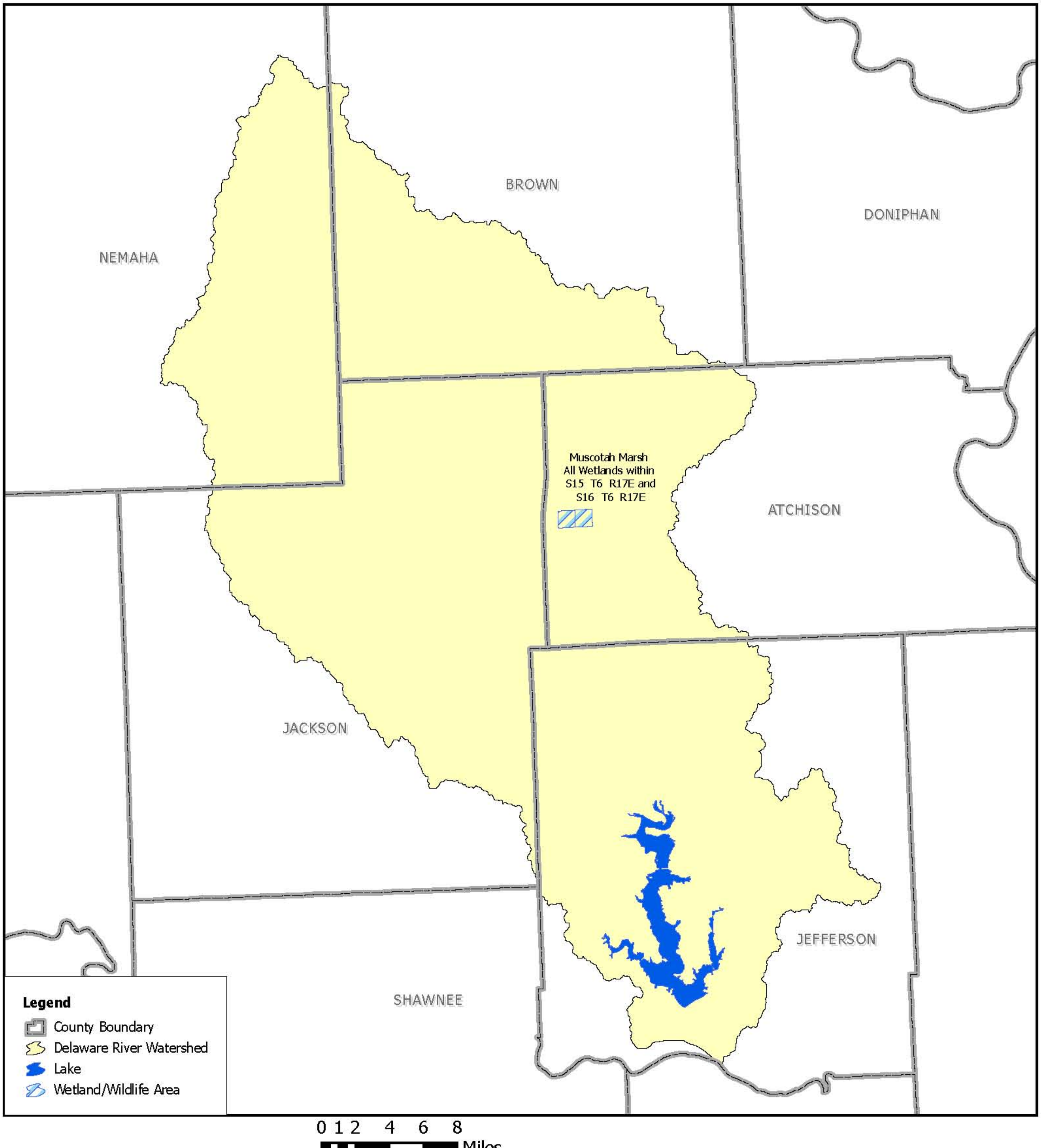
Perry Lake is located at the south end of the watershed. Streams in the basin generally flow southward; thus the lake receives inflow from nearly the entire basin. As a result, Perry Lake directly reflects the effects of land uses in the entire watershed. In many ways it acts like a barometer, indicating watershed and runoff conditions and the impact of water impairments.

Perry Lake has been negatively impacted by heavy sediment and nutrient loading. Sediment from upland erosion, unstable streambanks and stream channel degradation has reduced the water storage capacity of the lake, negatively impacted recreation, harmed aquatic life and impaired water quality. The effects of sedimentation are most evident at the north end of the lake where the Delaware River enters the water body. Water depth and open water area are decreasing as the heavy sediment load carried by the River is deposited in the lake. As the upper area of the lake fills in, the impact of sedimentation continues to work its way south into the main body of the lake.

Nutrient enrichment which causes eutrophication is also a significant threat to Perry Lake. Eutrophication (which comes from the Greek word “eutrophic” meaning richly nourished) is a process in which excessive nutrients are deposited in a lake causing accelerated algae growth. Algae blooms that are produced as a result can release toxins that are harmful to humans and other animals, cause taste and odor problems in drinking water, negatively impacts recreation and can have very harmful effects on aquatic species including fish kills.

Perry Lake experienced the most significant algae bloom in its history in July 2011 (4). Heavy nutrient loading from the watershed spawned explosive blue-green algae growth throughout the lake body with heaviest populations noted in the Old Town region on the north and the Rock Creek Arm on the west side of the lake. The bloom prompted the Kansas Dept. of Health & Environment (KDHE) to issue a Public Health Warning, advising that conditions in the lake were unsafe for human or animal exposure due to the release of toxins by the blue-green algae. As a result, swimming beaches were closed and other recreational traffic at the lake was significantly reduced.

Figure 7: Special Aquatic Life Use (SALU) waters in the Delaware River Watershed



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2.5 Designated Uses

Water resource protection and management is based on several foundational concepts. ***Surface water quality standards*** are developed by the State and used as a measure of how well water resources can support their "designated uses". ***Designated uses*** are the desirable uses or purposes that streams or lakes should be able to support, and include things like fishing, swimming, drinking water supply, livestock water or aquatic life support. When the water quality of a stream or lake is determined to be at or above the minimum water quality standard established for the designated uses of that water body, the designated use(s) of the water body are said to be supported. However, when the water quality of a stream or lake falls below the water quality standards for that water body, the designated use(s) of the water body are not supported and the stream or lake is said to be ***impaired***.

The State of Kansas has established water quality standards for all classified streams and lakes in the state designed to address designated uses of those water bodies. For a definition of what a classified stream is, please refer to this document: www.kdheks.gov/water/download/implement_wqs.pdf.

Designated uses for streams and lakes addressed by water quality standards in Kansas include the following:

- *Agricultural Water Supply Use*: Surface water used for agricultural purposes including irrigation or livestock watering
- *Aquatic Life Support Use*: Waters used for maintenance of the ecological integrity of streams, lakes and wetlands including aquatic, semi-aquatic or terrestrial species dependent on surface water for survival, including the following:
  - *Special Aquatic Life Use* -- Surface waters that support unique habitats or biota that are not commonly found in the state
  - *Expected Aquatic Life Use* -- Surface waters that contain habitats or biota found commonly in the state
  - *Restricted Aquatic Life Use* -- Surface waters that contain biota in a limited abundance or diversity due to physical quality or availability of the habitat compared to more productive habitats in adjacent waters
- *Domestic Water Supply Use*: Surface waters used for a potable water resource (after appropriate treatment)
- *Food Procurement Use*: Surface waters used for obtaining edible aquatic or semi-aquatic life for human consumption
- *Groundwater Recharge Use*: Surface water used for replenishing useable groundwater resources
- *Industrial Water Supply Use*: Surface water used for non-potable purposes including cooling or process water
- *Recreational Uses*: Surface water used for recreation in one of two main categories
  - *Primary Contact Recreation* -- Immersion of the body where probability of ingestion of water is high; primary contact recreation season is from April 1 to October 31 of each year; swimming is an example of primary contact recreation

- *Secondary Contact Recreation* -- Recreational use where the body is not immersed in water; ingestion of surface water is not probable; examples include fishing and wading

Tables 2 and **3** show the designated uses of the major classified streams, lakes and other waters in the Delaware River Watershed. The tables are a listing of the desirable uses that these waters should support; they do not indicate whether or not the waters listed support their designated uses or are impaired and do not support their designated use. For a discussion of impairments, see **Section 2.9**.

Table 3: Designated Uses of major classified *streams* in the Delaware River Watershed (5)

Designated Uses of Major Classified Streams Delaware River Watershed -- HUC 10270103									
Stream Segment Name	Segment Number	Expected Aquatic Life	Contact Recreation (see key)	Domestic Water Supply	Food Procure-ment	Ground Water Recharge	Industrial Water Use	Irrigation Water Use	Livestock Water supply
Banner Cr	45	E	b	X	X	X	X	X	X
Barnes Cr	39	E	b	X	O	X	X	X	X
Bills Cr	47	E	b	X	X	X	X	X	X
Brush Cr	44	E	b	O	X	O	O	O	O
Brush Cr	54	E	C	X	O	X	X	X	X
Burr Oak Cr	8	E	C	X	X	X	X	X	X
Catamount Cr	49	E	C	O	X	X	O	X	X
Cedar Cr	32	E	B	X	X	X	X	X	X
Cedar Cr	37	E	b	X	X	X	X	X	X
N. Cedar Cr	46	E	C	X	X	X	X	X	X
S. Cedar Cr	9032	E	C	X	O	X	X	X	X
Claywell Cr	56	E	C	O	O	X	O	X	X
Clear Cr	19	E	B	X	X	X	X	X	X
Coal Cr	50	E	B	O	O	X	O	X	X
Delaware R	1	E	B	X	X	X	X	X	X
Delaware R	12	E	B	X	X	X	X	X	X
Delaware R	13	E	C	X	X	X	X	X	X
Delaware R	14	E	C	X	X	X	X	X	X
Delaware R	15	E	C	X	X	X	X	X	X
Delaware R	17	E	B	X	X	X	X	X	X
Delaware R	21	E	C	X	X	X	X	X	X
Delaware R	22	E	B	X	X	X	X	X	X
Delaware R	23	E	b	X	X	X	X	X	X
Elk Cr	29	E	C	X	X	X	X	X	X
Elk Cr	30	E	C	X	X	X	X	X	X
Grasshopper Cr	18	E	C	X	X	X	X	X	X
Grasshopper Cr	20	E	b	X	X	X	X	X	X

Table 3 (continued): Designated Uses of major classified *streams* in the Delaware River Watershed

Stream Segment Name	Segment Number	Expected Aquatic Life	Contact Recreation (see key)	Domestic Water Supply	Food Procure-ment	Ground Water Recharge	Industrial Water Use	Irrigation Water Use	Livestock Water supply
Gregg Cr	24	E	C	X	X	X	X	X	X
Honey Cr	55	E	b	O	O	O	O	X	X
Little Grasshopper Cr	16	E	b	X	O	X	X	X	X
Little Slough Cr	805	E	C	X	O	X	X	X	X
Little Wild Horse Cr	57	E	C	X	O	X	X	X	X
Mission Cr	40	E	B	X	X	X	X	X	X
Mosquito Cr	602	E	b	X	O	X	X	X	X
Muddy Cr	25	E	C	X	X	X	X	X	X
Muddy Cr	26	E	b	X	O	X	X	X	X
Nebo Cr	48	E	b	X	O	X	X	X	X
Negro Cr	43	E	b	O	X	X	O	X	X
Otter Cr	41	E	b	O	X	X	O	X	X
Plum Cr	36	E	b	X	O	X	X	X	X
Rock Cr	34	E	C	X	O	X	X	X	X
Rock Cr	53	E	C	X	O	X	X	X	X
Slough Cr	7	E	C	X	X	X	X	X	X
Slough Cr	9	E	b	X	O	X	X	X	X
Spring Cr	42	E	C	X	O	X	X	X	X
Squaw Cr	38	E	b	O	O	O	O	O	O
Straight Cr	28	E	b	X	X	X	X	X	X
Tick Cr	52	E	C	O	O	O	O	X	X
Unnamed Stream	31	E	b	X	O	X	X	X	X
Walnut Cr	51	E	C	X	X	X	X	X	X
Wolfley Cr	27	E	b	X	O	X	X	X	X

Key:
HUC = Hydrologic Unit Code; a unique number identifier for a watershed area
E = Expected aquatic life use
S = Special aquatic life use
Segment Number = Streams segments within a watershed are assigned a segment number to aid in identification; sections of larger streams may be broken up into more than one segment, each with a unique number identifier
X = Referenced stream segment is assigned the designated use indicated in this column
O =Referenced stream segment is not assigned the designated use indicated in this column
Contact Recreation Column Key:
A = Primary contact recreation stream segment is a designated public swimming area
B = Primary contact recreation stream segment is by law or written permission of the landowner open to and accessible by the public
C = Primary contact recreation stream segment is not open to and accessible by the public under Kansas law
a = Secondary contact recreation stream segment is by law or written permission of the landowner open to and accessible by the public
b = Secondary contact recreation stream segment is not open to and accessible by the public under Kansas law

Source: http://www.kdheks.gov/befs/download/Current_Kansas_Surface_Register.pdf

Table 4: Designated Uses of major classified *lakes and other waters* in the Delaware River Watershed (5)

Designated Uses of Major Classified Lakes and Other Waters Delaware River Watershed -- HUC 10270103									
Lake Name	**Type of Water Body**	**Expected Aquatic Life**	**Contact Recreation (see key)**	**Domestic Water Supply**	**Food Procure-ment**	**Ground Water Recharge**	**Industrial Water Use**	**Irrigation Water Use**	**Livestock Water supply**
Atchison Co. Park Lake	Lake	E	B	X	X	O	X	X	X
Banner Creek	Lake	E	A	X	X	O	X	X	X
Elkhorn Lake	Lake	E	B	X	X	X	X	X	X
Lake Jayhawk	Lake	E	A		X				
Little Lake	Lake	E	B	X	X	O	X	X	X
Mission Lake	Lake	E	A	X	X	O	X	X	X
Muscotah Marsh	Wetland	E	a	X	X	X	X	X	X
Nebo St. Fishing Lake	Lake	E	B	X	X	O	X	X	X
Oskaloosa Lake	Lake	E	A	X	X		X		
Perry Lake	Lake	S	A	X	X	X	X	X	X
Perry Lake Wildlife Area	Wetland	E	B	X	X	X	X	X	X
Prairie Lake	Lake	E	A	X	X	O	X	X	X
Sabetha Watershed Lake	Lake	E	B	O	X		O	O	O

Key:
HUC = Hydrologic Unit Code; a unique number identifier for a watershed area
E = Expected aquatic life use
S = Special aquatic life use
X = Referenced lake is assigned the designated use indicated in this column
O =Referenced lake is not assigned the designated use indicated in this column
Blank = Capacity of the referenced lake to support the indicated designated use has not been determined by a use attainability analysis
Contact Recreation Column Key:
A = Primary contact recreation lakes that have a posted public swimming area
B = Primary contact recreation lakes that are by law or written permission of the landowner open to and accessible by the public
C = Primary contact recreation lakes that are not open to and accessible by the public under Kansas law
a = Secondary contract recreation lakes that are by law or written permission of the landowner open to and accessible by the public
b = Secondary contact recreation lakes that are not open to and accessible by the public under Kansas law

Source: http://www.kdheks.gov/befs/download/Current_Kansas_Surface_Register.pdf

2.6 Land Cover

The primary land use in the Delaware River Watershed is agriculture. Of the 740,772 total acres in the watershed, approximately 85% of these acres are used for agricultural production (row crops, small grains, hay production, livestock pasture, etc.) or farmstead use. A breakdown of major land uses in the watershed is provided in **Table 5**. **Figure 8** is a map of the watershed showing land cover based on the 2001 National Land Cover Dataset.

Table 5: Land use in the Delaware River Watershed (6)

Land Cover/Land Use	Acres	Percentage of Total
Grassland, Pasture and Hay	375,132	50.6
Cropland	256,354	34.7
Deciduous Forest	73,774	10
Open Water	18,107	2.4
Other	17,404	2.3
Totals	740,772(a)	100

(a) Totals are approximate due to rounding and small unknown acres.

Land cover and land use included in the "Other" category includes residential areas, roads, wetlands, and other minor land uses. Less than 1 percent of the agricultural land in the watershed is irrigated. The rural character of the watershed is evident in that urban land use comprises less than 1 percent of the entire area.

2.6.1 Land Ownership

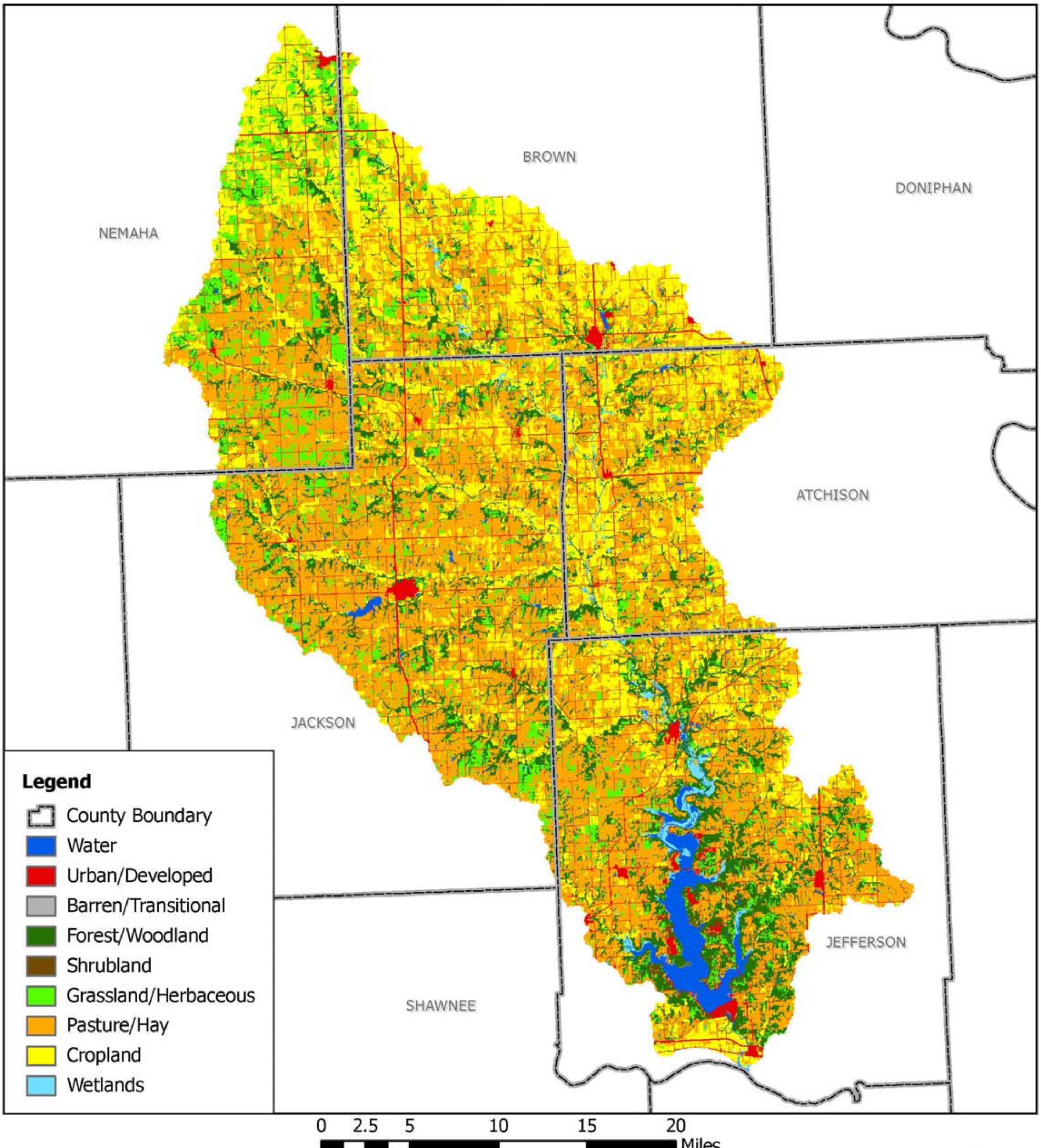
A breakdown of land ownership in the watershed is shown in **Table 6.** Public land is defined as land which is held by local, state or federal governments. Private lands are those lands which are owned by individuals and other private entities. Tribal lands are those lands which are owned by Native American tribal trusts or individuals, primarily in an established Native American reservation. There are two Native American reservations located wholly or partially within the Delaware River Watershed: the Kickapoo Tribe in Kansas (located wholly within the watershed) and the Prairie Band Potawatomi (located partially within the watershed) Reservations.

Table 6: Land Ownership in the Delaware River Watershed (6)

Land Ownership Type	Acres	Percentage of Total
Public	25,109	3.4
Private	580,697	78.4
Tribal	134,962	18.2
Totals	740,768(a)	100

(a) Totals are approximate due to rounding and small unknown acres.

<u>Figure 8</u>: Land cover in the Delaware River Watershed, 2001 National Land Cover Dataset, KDHE 2010



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February 2010

2.7 Point Sources in the Watershed

The Clean Water Act (CWA) passed in 1972 is the primary federal law in the United States governing water pollution. The CWA established goals for eliminating the release of toxic substances to water and introduced a permitting system for regulating point sources of water pollution. Point sources of pollution are identifiable and localized sources of water pollution that generally discharge pollutants at a finite location such as the end of a pipe or a drainage ditch. Examples of point sources include industrial facilities (manufacturing plants, mining, oil and gas extraction, etc.), municipal wastewater treatment facilities and some agricultural facilities such as large animal feedlots.

2.7.1 Livestock Feeding Facilities

2.7.1.a Confined Livestock Feeding Facilities

In Kansas, any confined livestock facility with a capacity of 300 or more animal units or any livestock facility with a daily discharge, regardless of size, must register with the Kansas Dept. of Health & Environment (KDHE). In addition, any facility that is investigated by KDHE due to a complaint and that is found to pose a significant pollution potential must register with KDHE. Registered facilities are site inspected to determine whether a significant pollution potential exists. If it is deemed that a significant pollution potential does NOT exist, a registered facility can be certified, so long as best management practices as recommended by an established technical service provider and approved by KDHE are followed (examples: properly managing manure storage areas, regular cleaning of animal stalls, etc).

Confined livestock facilities with a capacity of between 300 and 999 animal units are known as Confined Feeding Facilities (CFFs). CFFs which have been identified as having a significant pollution potential must obtain a State of Kansas Livestock Waste Management Permit, install structures and implement management practices outlined by the permit. In addition, all livestock operations with a daily discharge (such as a dairy operation that generates daily outflow from a milking barn) are required to obtain a permit.

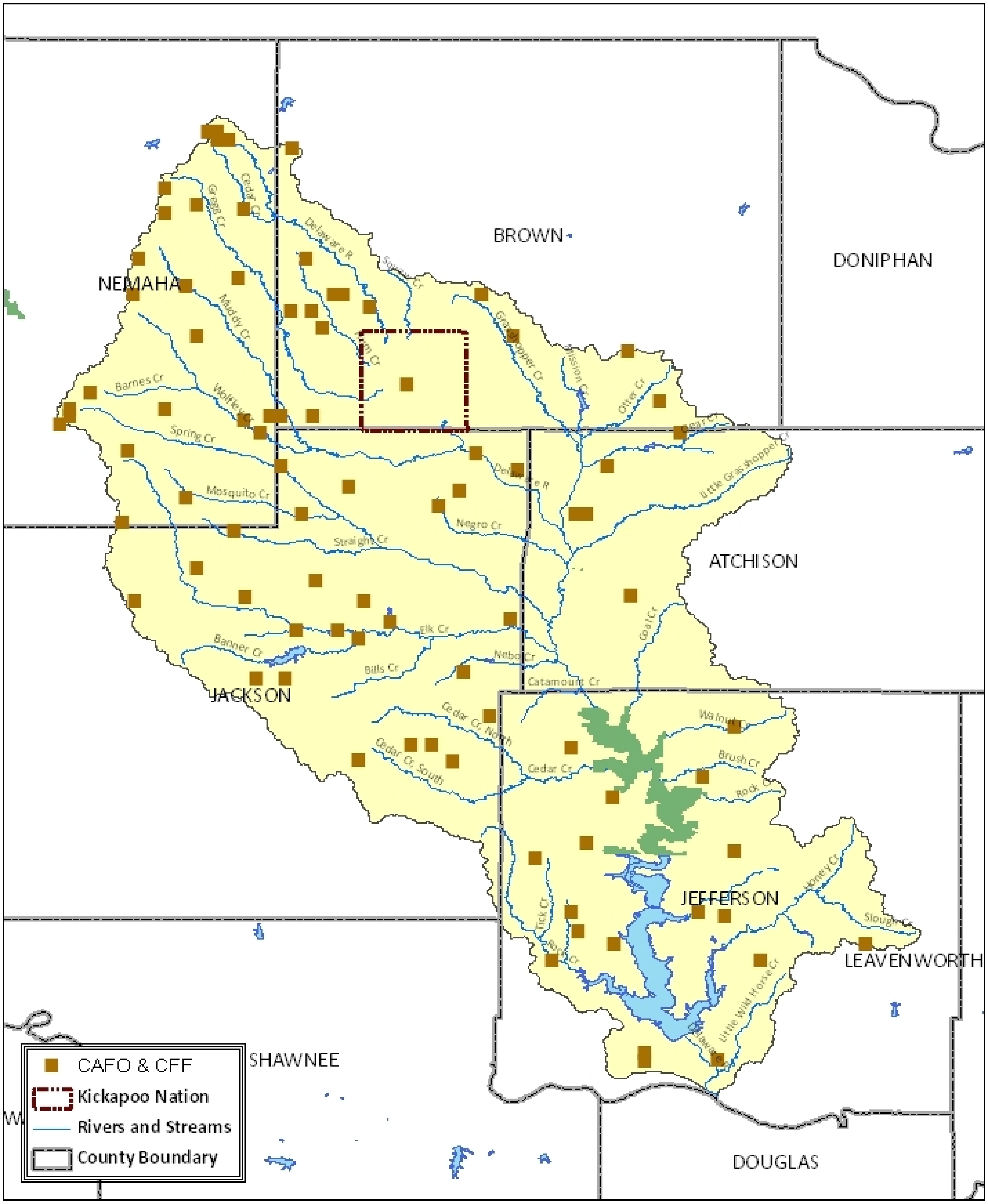
Facilities with a capacity of 1,000 or more animal units are known as Confined Animal Feeding Operations (CAFOs). CAFOs must obtain a federal NPDES (National Pollution Discharge Elimination System) Livestock Waste Management Permit from KDHE. More information about permitting requirement can be found at www.kdheks.gov/feedlots.

There are 80 registered CFFs and CAFOs in the Delaware River Watershed area. **Figure 9** shows the location of these facilities in the basin. Although they are of note in relation to water resource planning, these facilities are registered and monitored by KDHE. While operating according to their permit requirements, confined livestock operations should not present a significant threat to water resources.

2.7.1.b Unconfined Concentrated Livestock Areas

Unconfined areas where livestock are concentrated can pose significant potential for water pollution if not managed properly. Examples of unconfined areas of livestock concentration include winter feeding sites, watering sites and loafing areas (areas where animals seek shade or protection from wind).

Figure 9: Confined Feeding Facilities (CFFs) and Confined Animal Feeding Operations (CAFOs) in the Delaware River Watershed



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Kansas Department of Health and Environment
August 2011

Small unconfined livestock operations are very common in the Delaware River Watershed. Because they can be a significant pollutant sources, often lack waste management practices and are not monitored by KDHE, unconfined livestock operations are an important concern in the watershed.

Best management practices that reduce impacts from these unconfined livestock operations include cleaning and proper application of accumulated manure to cropland, alternative water supplies, rotational grazing, locating windbreaks to encourage loafing in areas away from water resources, rotating mineral and feeding locations, and fencing to restrict livestock access to streams.

2.7.2 NPDES Facilities

The Clean Water Act also regulates point sources such as industrial and municipal wastewater treatment facilities. These facilities may not discharge pollutants into surface waters without a permit from the **National Pollutant Discharge Elimination System** (NPDES). In Kansas, the Kansas Dept. of Health & Environment (KDHE) is authorized by the U.S. Environmental Protection Agency (EPA) to regulate and issue permits to facilities under the NPDES system. KDHE applies technology-based water quality standards to permitted facilities to ensure that the waters of the state are not negatively impacted.

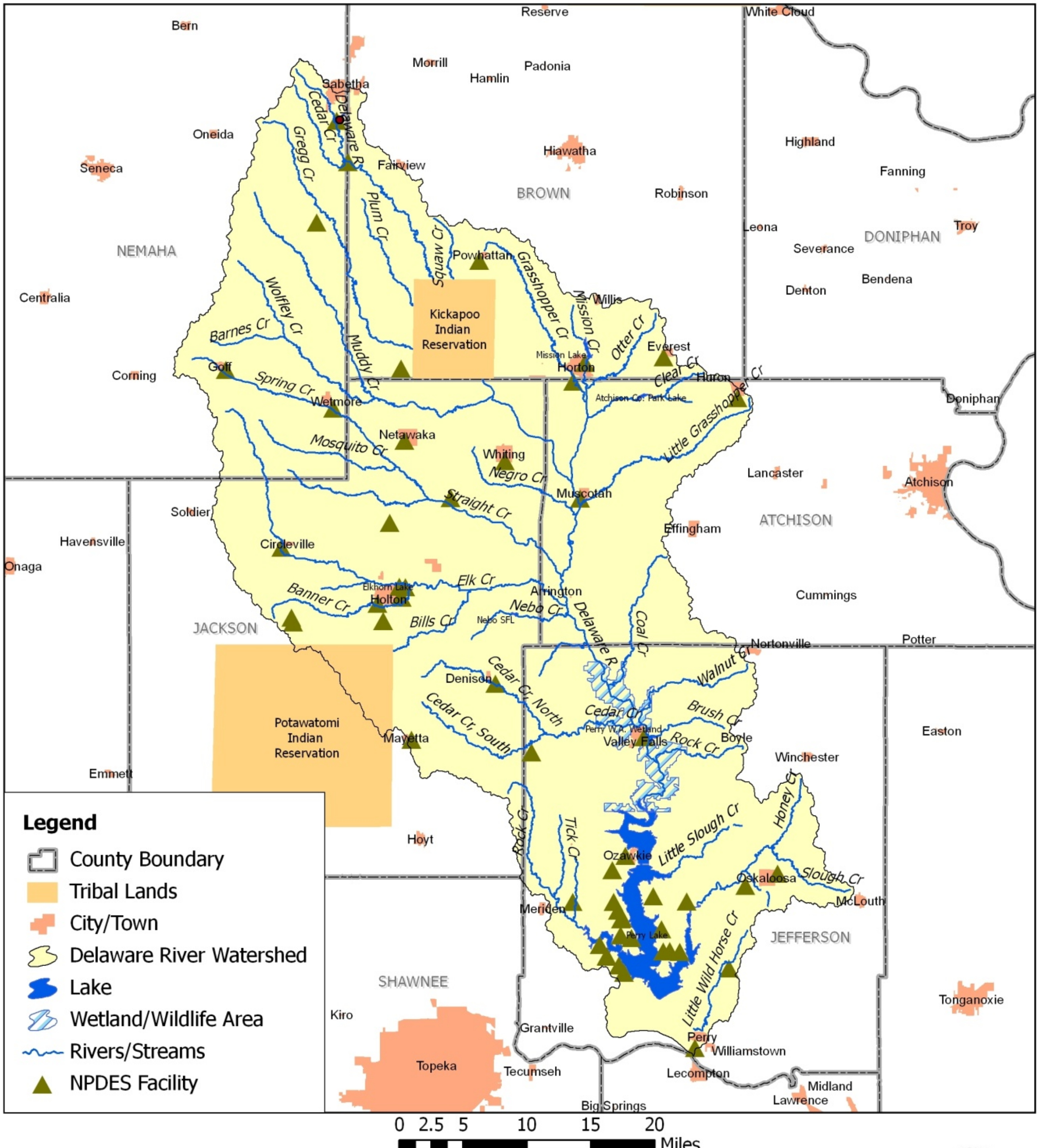
Although NPDES facilities are required to follow conditions stipulated in their permit, are regularly monitored and should not present a hazard to area water resources, there is some potential for water quality impacts. Primary pollutants of concern from NPDES facilities are bacteria, nutrients (nitrogen and phosphorus) and biological oxygen demand.

Table 7 lists permitted NPDES facilities in the watershed that discharge effluent containing nutrients and bacteria. These discharges are regulated, approved and monitored by KDHE. **Figure 10** shows the location of all NPDES facilities in the watershed including those listed in **Table 7**. There are 53 facilities on the map, the majority of which are municipal wastewater treatment facilities, including non-discharging lagoon and discharging sewage treatment systems, industrial facilities and quarries.

Table 7: Discharging NPDES facilities in the Delaware River Watershed; discharges are regulated and approved by KDHE

Facility	Discharge Location	Discharge Type
City of Holton	Elk Creek	Nutrients, Bacteria
Oldham's LLC	Banner Creek	Nutrients, Bacteria
City of Denison	North Cedar Creek	Bacteria
City of Mayetta	Mayetta	Bacteria
City of Netawaka	Spring Creek	Bacteria
City of Whiting	Delaware River	Bacteria
USD #335 Jackson Heights School	Straight Creek	Bacteria
City of Goff	Spring Creek	Bacteria
City of Sabetha	Delaware River	Nutrients, Bacteria
City of Wetmore	Spring Creek	Bacteria
City of Powhattan	Delaware River	Bacteria
KDOT-Brown Co. Rest Area	Cedar Creek	Bacteria
City of Muscotah	Delaware River	Bacteria
City of Huron	Little Grasshopper Creek	Bacteria

Figure 10: Location of all National Pollutant Discharge Elimination System (NPDES) facilities in the Delaware River Watershed



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Kansas Department of Health & Environment

March 2010

2.8 Public Water Supplies

A "Public Water Supply" (PWS) is defined as any system that supplies piped water to the public for human consumption if that system has at least 10 service connections or regularly serves an average of 25 or more individuals for at least 60 days out of the year. Municipal water supplies and rural water districts are considered public water supplies.

PWSs utilize water from either surface water or groundwater sources, or a combination of both. Generally speaking, groundwater sources are less prone to man-made contamination than surface water sources since soil overlying aquifers acts as a protective barrier and filter. However, groundwater quality can be negatively impacted by contaminants that are able to leach through the soil, or where aquifers are shallow.

Frequently, there is a close relationship between groundwater and surface water sources. Underground aquifers that are closely tied to surface waters receive recharge water from rainfall infiltrating through the soil and also through a connection with streams or lakes. On the other hand, groundwater resources can also have an impact on surface water quality. Springs, seeps and stream base flow (that part of stream flow that is not attributable to runoff from rain or melting snow, and which is usually sustained by groundwater) directly contribute water to streams and lakes.

Contaminants such as nitrates and atrazine (a common herbicide) frequently contaminate groundwater in rural areas. Underground aquifers that are shallow are especially vulnerable. Aquifers that are connected to surface water supplies are also vulnerable since contaminants in streams and lakes can reach groundwater more easily via this connection.

Surface water is more vulnerable to contamination than groundwater supplies since surface water is open and subject to runoff and other outside influences. Surface water is also generally more costly to treat and may experience taste and odor problems caused by algae or other substances in raw water. Additional treatment to remove sediment and other materials from the water are necessary; bacterial contamination from waste-laden runoff also pose a threat to surface PWSs. Pesticides, fertilizers, runoff from roads and livestock areas can negatively impact any surface water supply when rainfall creates runoff that carries these substances directly into raw water supplies.

Protection of PWS water sources is an essential component of this watershed protection effort. PWSs supply water to the majority of people living in the Delaware River Watershed. Because human beings require contaminant-free water for drinking, the quality of raw water used by these systems impacts the cost and process required to treat the water to make it safe.

Table 8 provides a summary of all Public Water Supplies in the Delaware River Watershed and the population served by each. Please note that not all of the PWSs listed in this table obtain water from sources located within the watershed and that many water systems purchase water from each other.

Drought conditions, well yields and other factors can also influence where water is sourced. As a result, PWS territories tend to be complicated, crossing political and watershed boundaries. **Figure 11** shows district boundaries of Public Water Supply systems in the Delaware River Watershed area. **Figure 12** shows the general location of wells, surface water intakes and/or springs used by PWSs in the watershed.

Table 8: Public Water Suppliers (PWSs) in the Delaware River Watershed region (7)

Public Water Supplier	Population Served	Own Source[a/,b/]	Other Source[b/]	Purchaser Other Than Own Customers[b/]	Basin
Atchison RWD 05C (formerly AT 2, 4 & 5)	3,375		Atchison, (Valley Falls)	Atchison, Doniphan RWD 3, Lancaster, (Valley Falls)	MO
Brown RWD 01	900	6 Wells (6)	Hiawatha	Reserve	MO
Brown RWD 02	1,135		Hiawatha	Doniphan RWD1, Powhattan, Robinson	MO
Circleville	170		Jackson RWD3		KR
Denison	223		Jackson RWD3		KR
Everest	304	2 Wells (1)		(Horton)	KR
Goff	150	2 Wells (0)	Nemaha RWD4		KR
Holton	3,353	2 Wells (2), (Prairie Lake)	PWWSD 18-Banner Creek Reservoir		KR
Horton	1,940	6 Wells (6), (Mission Lake)	(Everest)	Willis	KR
Jackson RWD 01	2,565		Topeka	Hoyt, Jackson RWD 3	KR
Jackson RWD 03	3,700	5 Wells (5)	Jackson RWD 1, PWWSD 18	Circleville, Denison, Mayetta, Netawaka, Soldier, Whiting	KR
Jefferson RWD 01	2,256	3 Wells (3)		Jefferson RWD 8 & 15, Anderson's Trailer Park	KR
Jefferson RWD 02	697	2 Wells (2)		Corps of Engineers	KR
Jefferson RWD 03	1,861	3 Wells (2)			KR
Jefferson RWD 07	1,641	3 Wells (1)		Oskaloosa	KR
Jefferson RWD 08	65	2 Wells (0)	Jefferson RWD1		KR
Jefferson RWD 09	375	2 Wells (2)			KR
Jefferson RWD 10	306	2 Wells (2)			KR
Jefferson RWD 11	350	(Perry Lake,) 2 Wells (2)		Jefferson RWD 14	KR
Jefferson RWD 12	3,310	4 Wells (3)	Leavenworth	(Easton), Winchester	KR
Jefferson RWD 14 (Wind and Waves Estates)	NA		Jefferson RWD 11		KR
Mayetta	461		Jackson RWD 3		KR
Muscotah	197	2 Wells (2)			KR
Nemaha RWD 01	240	3 Wells (3)	Nebraska Wells, (Bern)	Bern, Oneida, Pawnee RWD-NE	MO

Table 8 (continued): Public Water Suppliers in the Delaware River Watershed Region

Public Water Supplier	Population Served	Own Source[a/,b/]	Other Source[b/]	Purchaser Other Than Own Customers[b/]	Basin
Nemaha RWD 03	1,850	4 Wells (4)	Nemaha RWD 2	Axtell, Centralia, Corning, Nemaha RWD 2	KR
Nemaha RWD 04	545	2 Wells (2)		Goff	KR
Netawaka	NA		Jackson RWD 3		KR
Oskaloosa	1,157		Jefferson RWD7		KR
Ozawkie	700	3 Wells (3)			KR
Perry	867	2 Wells (2)			KR
Powhattan	NA		Brown RWD 2 (retail)		KR
Sabetha	2,594	(City Lake), 2 Wells (0), Pony Creek Lake		Morrill	MO
Valley Falls	1,203	Delaware River, 5 Artesian Wells	(Atchison RWD 5C)	(Atchison RWD 5C)	KR
Wetmore	372	2 Wells (2)			KR
Whiting	210	2 Wells (2)	Jackson RWD 3		KR
Willis	NA		Horton		MO

KEYS for Table:
[a/] Wells or diversion points with active water rights, as shown on the 2008 Division of Water Resources Municipal Water Use Report. Number in parentheses indicates the number of wells or diversion points in service during 2008.
[b/] Any source, other source, or purchaser shown in parentheses is an active connection but was not used in 2008.
RWD = Rural Water District
Purchaser Other Than Own Customers = Water Suppliers that purchase water from the source other than the PWS's own customers
Basin = Water for PWSs in the Delaware River Watershed is obtained from sources located within the Missouri River Basin (MO) or the Kansas/Lower Republican Basin (KR).
Source of water for PWSs Highlighted in green is located within the Delaware River Watershed

<u>Figure 11</u>: Public Water Suppliers (PWSs) serving the Delaware River Basin

Note: Not all PWSs on this map obtain raw water from within the basin. Some PWSs also purchase water from other PWSs or other sources outside the watershed area. **(7)**

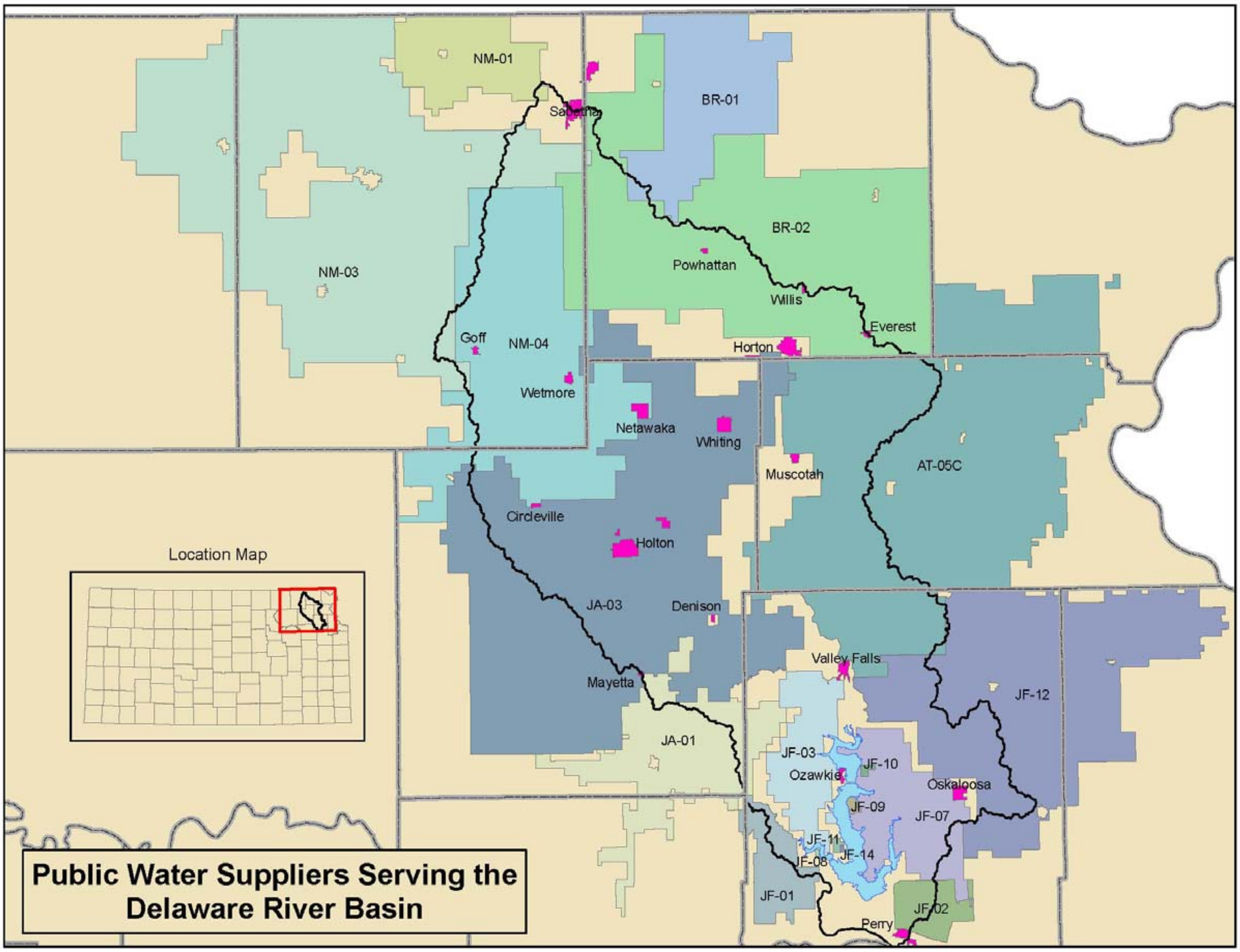
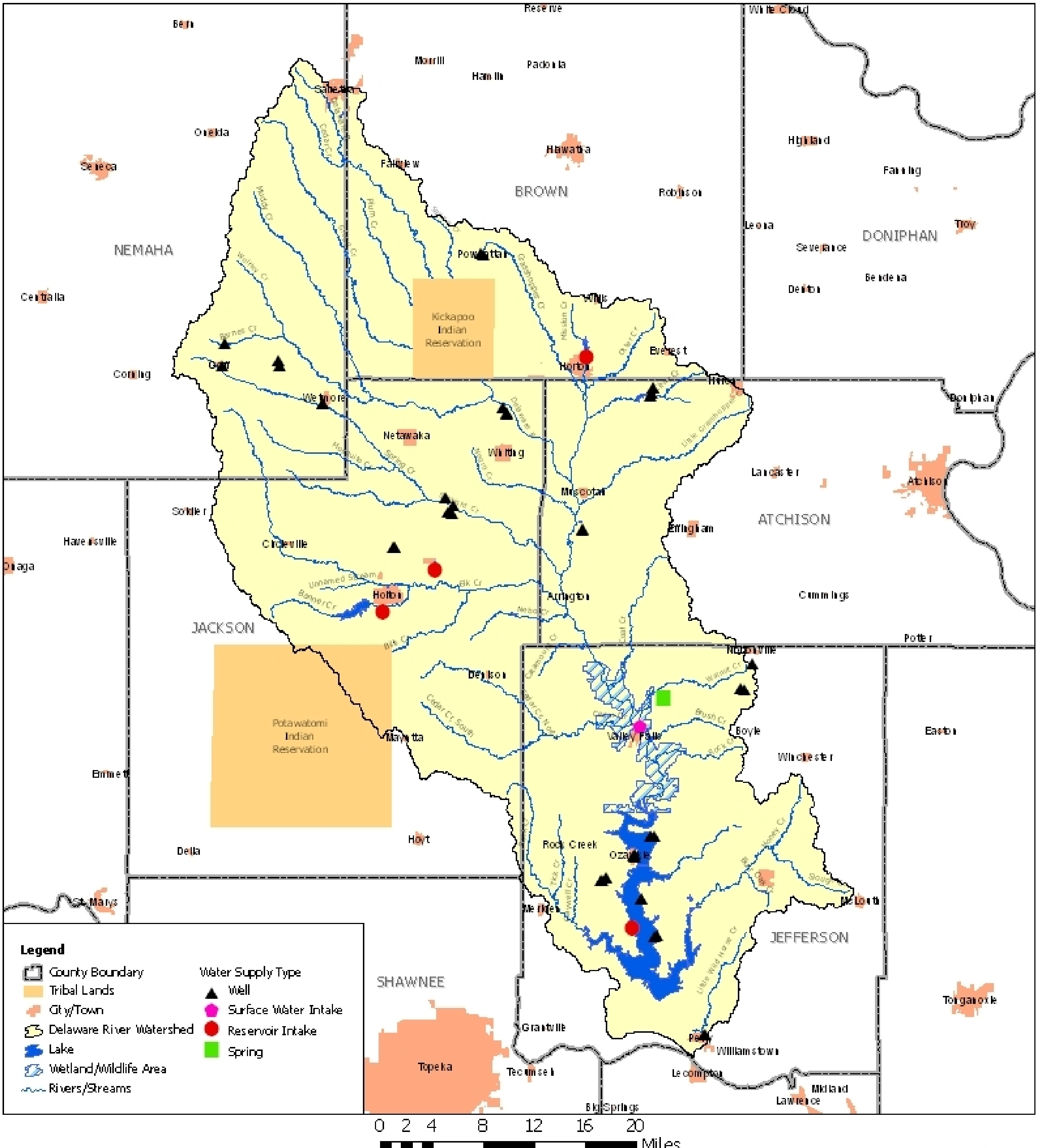


Figure 12: **Location of wells, surface water intakes or springs used by Public Water Supplies in the Delaware River Watershed**



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Kansas Department of Health & Environment

March 2010

2.9 Impaired Waters

2.9.1 The 303(d) List

Section 303(d) of the Clean Water Act requires that states develop a list of water bodies that do not sufficiently meet water quality standards to support the designated use(s) of those water bodies. The **303(d) List**, as it is called, thus created lists those streams and lakes which require additional protection and restoration work beyond that currently underway in order to achieve water quality standards and restore designated uses of the waters.

The 303(d) List is used to identify waters that will require development of Total Maximum Daily Loads (TMDLs) -- see **Section 2.9.2** for a detailed discussion of TMDLs. However, not all water bodies on the 303(d) List have a TMDL. Whether or not a TMDL is developed for an impaired water body depends on if the impairment rises to the level where a TMDL is warranted, and whether there is sufficient data to make accurate judgments regarding designated use support.

Water bodies on the 303(d) List will remain on the list until they are “delisted”. Delisting occurs when water quality conditions improve and designated uses are once again adequately supported.

Water bodies in the Delaware River Watershed that are on the 303(d) List of impaired waters are listed in **Table 9**. Whether or not a TMDL has been developed or is pending is noted for each in the last column of the table. Waters on the **303(d) List** that will be ***positively affected*** by BMP implementation in targeted areas of the watershed are highlighted in **yellow.** Water bodies that will be ***directly addressed*** by BMP implementation in the targeted areas of the watershed are highlighted in blue**.** **Table 10** lists those waters that were formerly on the 303(d) List but which have been removed due to improvements in water quality. **Figure 13** is a map of non-TMDL water bodies that are on the 303(d) List the Delaware River Watershed. **Figure 14** is a map of TMDL water bodies in the watershed.

2.9.2 Total Maximum Daily Loads (TMDL)

Total Maximum Daily Loads (TMDLs) contain quantitative objectives and strategies for application to impaired waters in order to achieve water quality standards. Water quality standards represent water quality conditions that are adequate to fully support designated uses of streams, lakes, and wetlands.

TMDLs are developed to address significant water quality impairments for water bodies that are on the Section 303(d) List. The ultimate goal of a TMDL, once it is developed, is to initiate a process of planning and implementation that will improve the quality of water bodies that are being negatively impacted by non-point and/or point sources. A TMDL identifies the following information:

1. The pollutants causing water quality impairment(s)
2. The degree of deviation from applicable water quality standards
3. The level of pollution reduction needed to achieve water quality standards
4. Corrective actions, including load allocations, to be implemented proportionately assigned among point and nonpoint sources that are affecting water quality of the impaired water body

Table 9: 303(d) List of *Impaired Waters* in the Delaware River Watershed (8)

Name of Water Body	Impaired Use(s)	Impairment	Station	Counties	Type	Priority	TMDL (yes/no) and TMDL approval date
Perry Lake	All	Eutrophication	LM029001	JF	Lake	High	Yes -- Pending
Perry Wildlife Area Wetland	All	Eutrophication	LM029041	JF	Lake	High	Yes -- Pending
Perry Wildlife Area Wetland	All	Dissolved Oxygen	LM029041	JF	Lake	High	Yes -- Pending
Delaware River near Half Mound	Aquatic Life	Total Phosphorus	SC554	NM, BR, JA, AT	Watershed	High	No
Delaware River above Perry Lake	Recreation	Bacteria	SC554, SC103	NM,BR,	Watershed	High	Yes -- Approved 1/26/2000
Elk Creek near Larkinburg	Aquatic Life	Total Phosphorus	SC604	JA, PT	Watershed	High	No
Grasshopper Cr. near Muscotah	Aquatic Life	Total Phosphorus	SC603	BR, AT	Watershed	High	No
Grasshopper Cr. near Muscotah	Aquatic Life	Atrazine	SC603, SC137, SC139	BR, AT	Watershed	Medium	Yes -- Pending
Grasshopper Cr. near Muscotah	Aquatic Life	Copper	SC603	BR, AT	Watershed	Low	No
Grasshopper Creek	Recreation	Bacteria	SC603, SC137, SC139	BR, AT	Watershed	High	Yes -- Approved 1/26/2000
Mission Lake	All	Siltation	LM013601	BR	Lake	High	Yes -- Pending
Mission Lake	All	Eutrophication	LM013601	BR	Lake	High	Yes-–– Approved 1/26/2000
Mission Lake	Water Supply; Aq. Life	Atrazine	LM013601	BR	Lake	High	Yes --Approved 1/26/2000
Little Lake	All	Eutrophication	LM062601	BR	Lake	Low	Yes -- Approved 1/26/2000
Atchison Co. Park Lake	Aquatic Life	Eutrophication	LM060601	AT	Lake	Low	No
Elkhorn Lake	Aquatic Life	Eutrophication	LM061001	JA	Lake	Low	No
Nebo State Fishing Lake	Aquatic Life	Eutrophication	LM061501	JA	Lake	Low	No
Atchison Co. Park Lake	Water Supply	Siltation	LM060601	AT	Lake	Low	No
Sabetha Watershed Pond	Aq. Life; Recreation	Eutrophication	LM075101	NM	Lake	Low	Yes -- Approved 1/26/2000

Table 10: Waters *Formerly Impaired* in the Delaware River Watershed (9)

Stream/Lake	Impaired Use	Impairment	Station	Counties	Type	Comment
Banner Creek	Aquatic Life	Ammonia	NPDES03271	JA	Facility	No longer impaired
Elk Creek Near Larkinburg	Aquatic Life	Ammonia	SC604	JA, AT	Watershed	No longer impaired
Upper Delaware River (Cedar Creek)	Aquatic Life	Ammonia	NPDES24724	NM	Facility	No longer impaired
Upper Delaware River (Cedar Creek)	Aquatic Life	Dissolved Oxygen	NPDES24724	NM	Facility	No longer impaired
Banner Creek Lake	Aquatic Life	Eutrophication	LM032001	JA	Lake	Adequate water quality
Upper Delaware River (Cedar Creek)	Recreation	Fecal Coli	NPDES24724	NM	Facility	No longer impaired
Grasshopper Creek Near Muscotah	Aquatic Life	Zinc	SC603	BR, AT	Watershed	No longer impaired

5. The monitoring and evaluation strategies needed to assess the impact of corrective actions in achieving TMDL goals and water quality standards
6. Provisions for future revision of the TMDL based on monitoring and evaluation strategies

TMDLs are developed in Kansas for each of the 12 major river basins in the state on a rotating 5-year cycle. **Table 11** lists the TMDL review schedule for the Kansas-Lower Republican Basin in which the Delaware River Watershed is located.

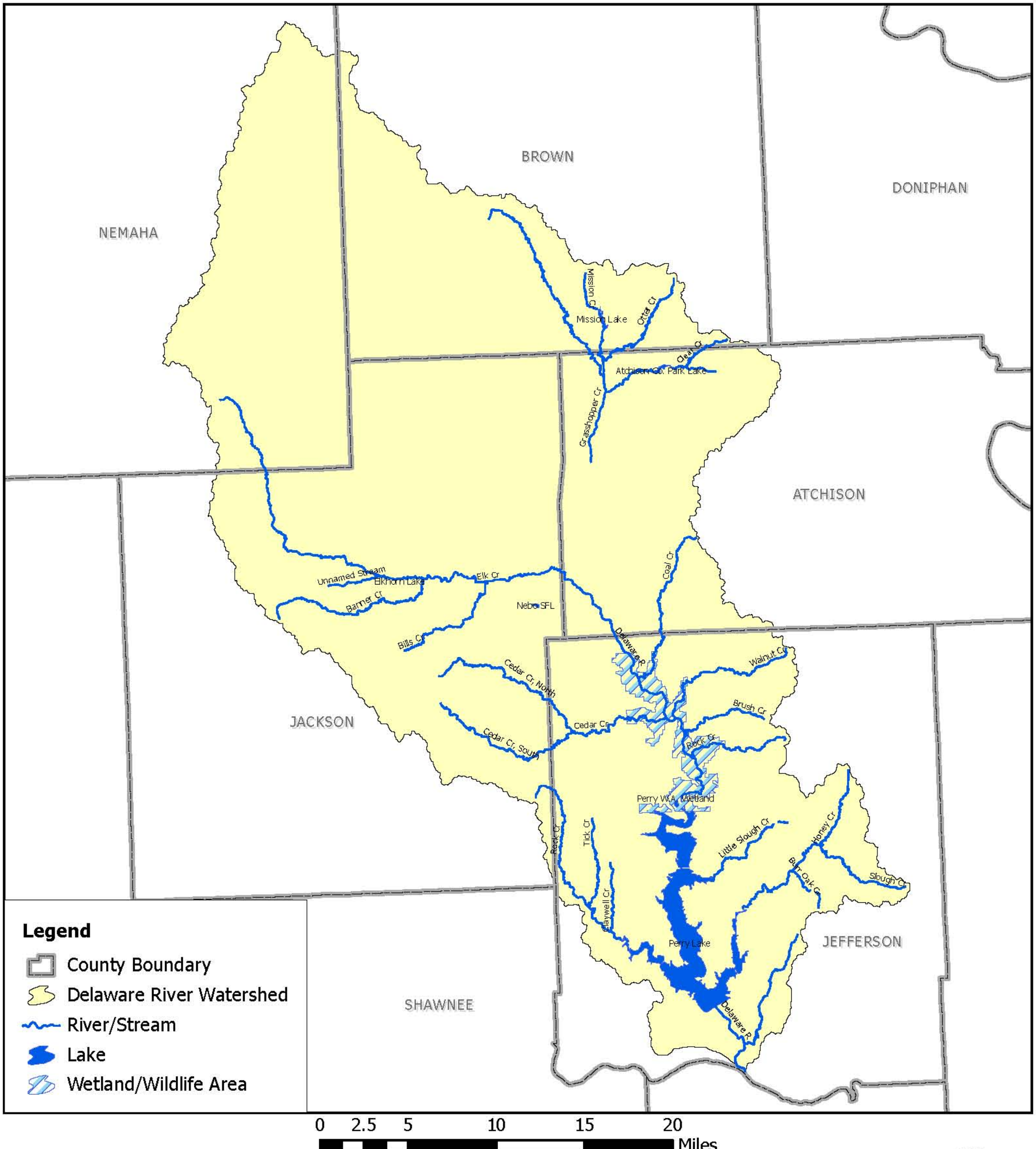
Table 11: TMDL review schedule for the Kansas Lower Republican Basin

Year Ending in September	Implementation Period	Possible TMDLs to Revise	TMDLs to Evaluate
2010	2011-2020	1999	1999
2015	2016-2025	1999, 2007	1999, 2007
2020	2021-2030	1999, 2007, 2010	1999, 2007, 2010

The Kansas-Lower Republican Basin, and subsequently the Delaware River Watershed, was reviewed in 2010 and new TMDLs were developed. A new **Eutrophication TMDL** for ***Perry Lake*** was developed along with **Eutrophication** and **Dissolved Oxygen TMDLs** for the ***Perry Lake Wildlife Area Wetlands***.

These three TMDLs were “bundled” together into one because of the close connection between the Wetlands and Perry Lake. Desired endpoints for the Perry Lake Wildlife Area Wetlands will likely be achieved if the Eutrophication TMDL endpoint for Perry Lake is reached; emphasis is therefore placed upon the Eutrophication TMDL for Perry Lake. In addition, a new high priority **Siltation TMDL** for ***Mission Lake*** and medium priority **Atrazine TMDL** for ***Grasshopper Creek*** were also developed in 2010.

Figure 13: Location of streams and lakes that are on the 303(d) List of Impaired waters in the Delaware River Watershed; TMDLs have not been developed for these waters



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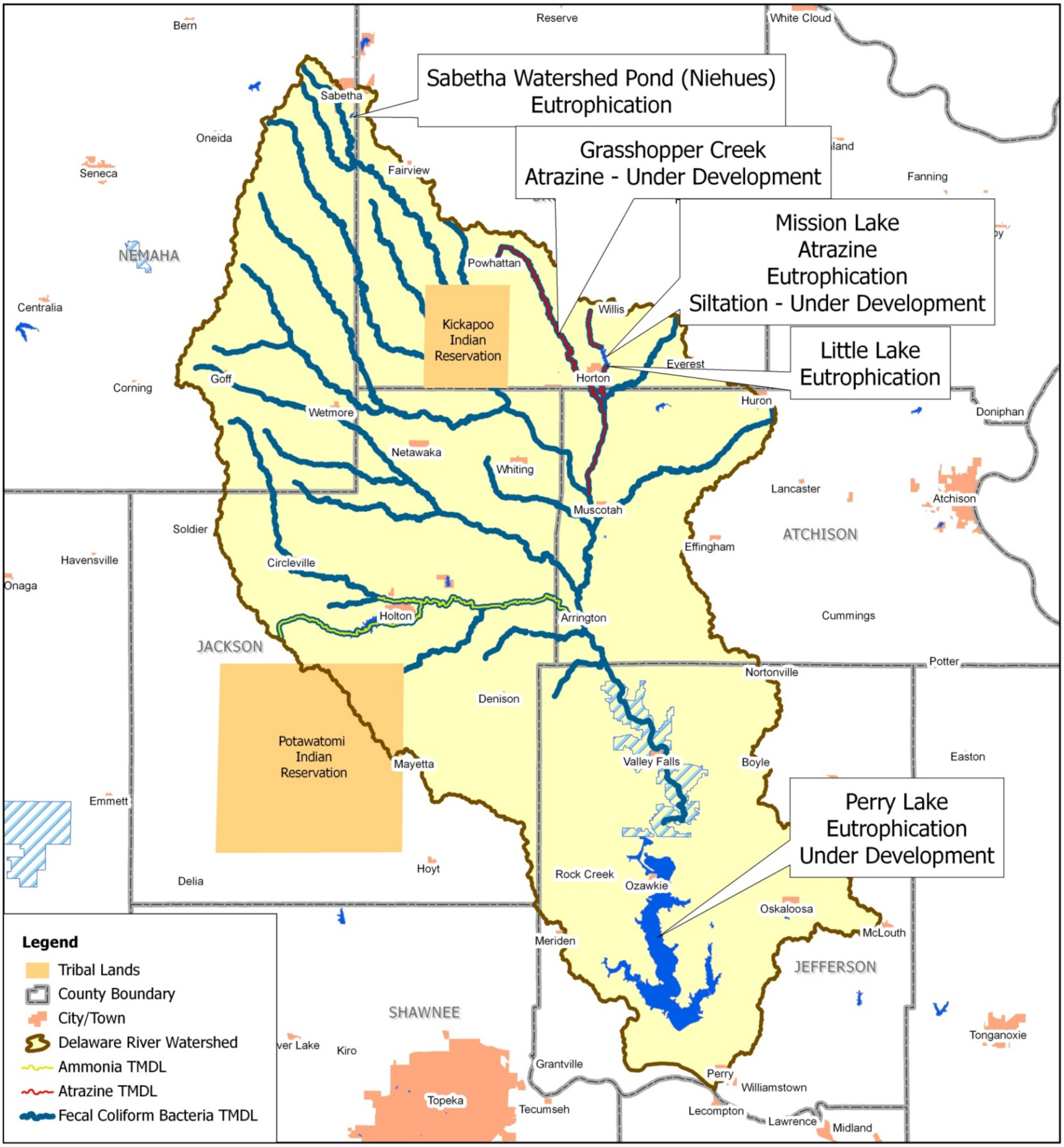
February 2010

Figure 14: TMDL streams and lakes in the Delaware River Watershed



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October 2010

<u>Part 3</u>: Assessment of Water Resources and Targeting BMP Implementation

Due to the presence of multiple water quality impairments, the size of the Delaware River Watershed and limited resources, targeting of BMPs is essential. Resources to address non-point source pollutants go further and provide greater water quality benefit when they are concentrated in areas where the need is greatest. It is therefore necessary to identify and target those areas of the watershed with the greatest needs and where the greatest impact can be gained. Targeting in this way applies limited resources where they are most efficient.

The Delaware River WRAPS Stakeholder Leadership Team (SLT) analyzed a great deal of information about the watershed and used several tools to make targeting decisions. Many factors weigh into targeting decisions, including the location and concentration of pollutant sources, Total Maximum Daily Loads (TMDLs) and other impaired waters, location of public water supplies, varying land use across the watershed, availability of assessment data, variations in soils and geology, and local knowledge of the watershed.

The Delaware River Watershed in Kansas is designated with the 8-digit Hydrologic Unit Code (HUC) of 10270103. It is further divided into 41 smaller 12-digit HUC sub-watersheds (see **Figure 5**). Areas targeted for BMP implementation were identified using the 12-digit sub-watershed classification system.

The three most serious water quality problems in the watershed, as determined by stakeholders early in the development of the Delaware River WRAPS program, are ***sediment, nutrient enrichment*** and ***bacterial contamination***. All targeting efforts address at least one of these three impairments.

A list of BMPs that most effectively address the top three impairments in the watershed was also developed by stakeholders in the watershed. The BMPs selected for targeted implementation were chosen on the basis of their effectiveness, applicability to local land use, cost of implementation and the likelihood of adoption by local landowners. The BMPs selected for targeted implementation fell within 5 general categories:

1) Streambank Stabilization
2) Sediment Control in or near Riparian Zones
3) Livestock Waste Controls
4) Riparian Buffers
5) Cropland BMPs

Following is a discussion of information that was used to make targeting decisions regarding BMP selection and implementation to achieve load reduction goals for the watershed.

3.1 Targeting for Sediment Load Reductions

The most significant sources of sediment in the Delaware River watershed are: **streambank erosion**, **gully erosion** in and near riparian areas and **cropland erosion**.

Sediment is considered to be the number one water resource concern in the Delaware River Watershed. Excessive sediment delivery to lakes and ponds results in the rapid decline of these water bodies as water storage capacity is replaced by silt. Sediment can also have a negative impact on aquatic life, increases water treatment costs, negatively impacts water recreation, and contributes to a variety of other water quality problems. In addition, sediment can transport contaminants that are attached to soil particles. Because sedimentation is so prevalent in the watershed and is closely related to multiple water quality impairments, controlling sediment will result in major water quality improvements on several fronts.

3.1.1 Targeting Streambank Erosion Reduction Efforts

3.1.1.a Assessment Data Supporting Selection of Streambank Targeted Area

Streambank Erosion Most Significant Source of Sediment: Targeting sediment reduction utilized a variety of information and assessment data. According to a study conducted in 2007 by the U.S. Geological Survey (10), channel-bank (i.e. streambank) sources are the most significant contributors of sediment to Perry Lake. Furthermore, the significance of channel-bank sources increases in importance with distance downstream in the watershed (that is, closer to Perry Lake). Because Perry Lake is one of the highest priority federal reservoirs in Kansas, reducing the rate of sedimentation is essential to prolonging the longevity and usefulness of this important lake. Stabilizing eroding streambanks on the river closest to the lake will address this need.

Impact of Channelization on the Delaware River: The U.S. Army Corps of Engineers (USACE) contracted with Gulf South Research Corporation and The Watershed Institute, Inc. (TWI) in 2008 to conduct a stream channel morphology and erosion study in the Kansas River Basin (11). This study focused on streambank erosion sites in selected areas above Perry Lake and on the Delaware River. The report on this study can be found at http://www.kwo.org/reservoirs/sediment_Baseline_Group.htm .

Data from the study and field observations were used to help identify streambank erosion processes and the effects of past channelization on streambank erosion. Significant bank instability was noted in the lower sections of the Delaware River where channelization was most commonly practiced. See **Figure 15** for an illustration of changes effected by channelization. This practice contributes significantly to streambank instability. Nearly the entire length of the river south of Highway K-20 in southern Brown County has been channelized over the years.

Figure 15: Illustration of impact of past channelization on the channel of the Delaware River South of Muscotah, KS. Channelization involves removal of stream meanders.

Channelization steepens stream channel grade, removes native riparian vegetation, shortens the distance water must travel, and causes significant streambank instability, channel degradation and erosion (11).

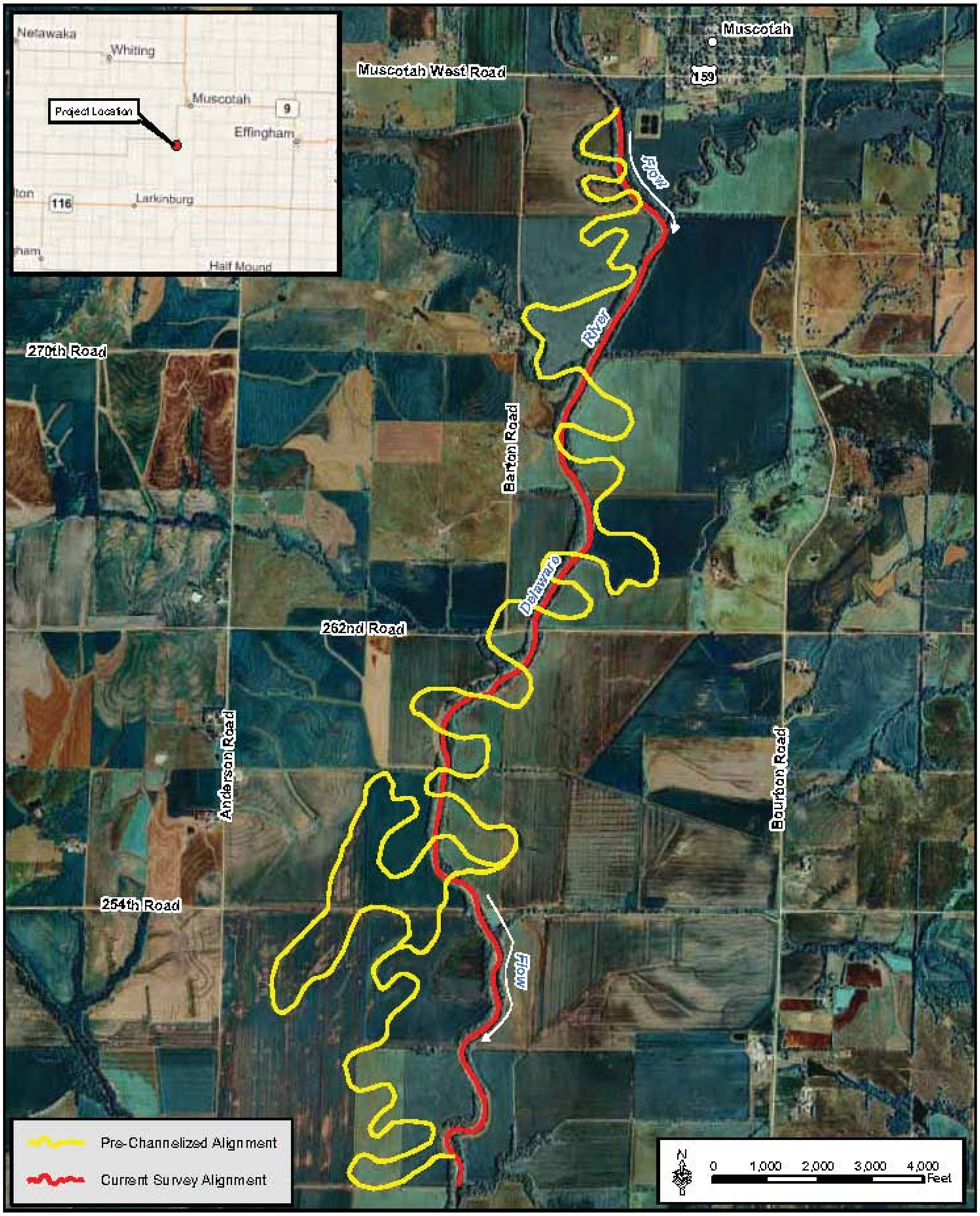


Figure ES-1: Channelization of Delaware River at USGS Muscotah Gauge

ES-3

Pinpointing Eroding Sites and on the Delaware River: In 2008, Delaware River WRAPS contracted with the Kansas Alliance for Wetlands and Streams (KAWS) to conduct an assessment of the main stem of the Delaware River (12). It also examined riparian vegetation (or lack thereof) along the river's edge, categorized land use adjacent to the river and located potential livestock operations that could impact the river. The complete assessment report and maps showing eroding sites on the river can be found at www.delawarewraps.org/publications.html.

The KAWS assessment identified 69 significant eroding streambank sites on the Delaware River. The data from this assessment was used to obtain funding for the Delaware River Streambank Restoration Program which got underway in 2009. Since then, the restoration program has utilized funds from the 2009 American Recovery and Reinvestment Act, the Kansas State Revolving Fund, Kansas Water Office, Dept. of Agriculture/ Division of Conservation and participating landowners in a multi-phase stabilization effort which will address more than 30 eroding sites on the Delaware River through 2012.

In 2010, the Kansas Water Office (KWO) conducted an aerial assessment of sediment sources in the watershed (13). This assessment used GIS data and a comparison of aerial photos taken in 1991 and 2008 to identify streambank erosion sites along the Delaware River and major tributaries, similar to the KAWS assessment. Although the KWO assessment identified several additional streambank erosion sites that were not identified by the KAWS assessment, the two studies essentially were in agreement as to location and concentration of streambank erosion sites on the Delaware. In addition, the KWO assessment identified locations where concentrated runoff is causing gully erosion in or near the riparian zones on the Delaware and other major streams. The KWO assessment data may be found on the KWO website at: www.kwo.org/projects_programs/Streambank_Erosion_Assessments.html .

Field Observations of the Delaware River: Field visits were conducted to evaluate potential streambank stabilization sites with interested landowners starting in 2008. This field data has verified findings of both the KAWS and KWO streambank erosion assessments. Observations show that larger eroding sites with the most significant bank erosion typically exist in the lower half of the river south of Hwy K-20.

3.1.1.b Streambank Targeted Area Description

Based on assessment data and field observations, streambank stabilization efforts were targeted to the southern reaches of main stem of the Delaware River. The targeted area begins at Highway K-20 on the Kickapoo Reservation in southern Brown County and extends into northern Jefferson County. Areas adjacent to the river south of the ending point in Jefferson County are public lands owned by the U.S. Army Corps of Engineers and are not included in the targeted area.

Concentrating stabilization work on the lower Delaware River focuses on reducing streambank erosion closest to Perry Lake. The targeted area was divided into two sections to further refine prioritization of streambank stabilization efforts. The southernmost section of the river from Muscotah to northern Jefferson County was designated as **Priority Area 1**. The section of the river from Highway K-20 in Brown County south to Muscotah was designated as **Priority Area 2** (See **Figure 18).**

3.1.2 Targeting Cropland Erosion Reduction Efforts

3.1.2.a Assessment Data Supporting Selection of Cropland Targeted Area

Potential upland sources of sediment were also examined to make BMP targeting decisions. Although streambank and gully erosion in and near riparian areas are significant contributors to sediment issues in the watershed, erosion from upland areas, and especially cropland, cannot be ignored.

Approximately 35% of the land area in the Delaware River Watershed is used to produce crops (6). Modern crop production has significant potential to impact local water resources. The planting of an annual crop that germinates, produces seed, is harvested and then dies within one growing season every year involves disturbing the soil and significant nutrient and other chemical inputs, all of which can have a negative impact on water quality. If tillage is used, the soil is bare and exposed to erosion for extended lengths of time. The absence of an actively growing root system for much of the year also increases the vulnerability of soil to erosion. Herbicides, insecticides and other pesticides, fertilizers or manure are applied to increase yields. Runoff from heavy rains can carry large quantities of soil and other substances directly into local streams. Best Management Practices that reduce soil erosion, increase water infiltration, filter runoff and reduce the availability of nutrients and pesticides to runoff are needed to protect water quality in agricultural watersheds.

Stakeholders used two tools in concert with local knowledge of the watershed to select target areas for implementation of Cropland BMPs. First, a SWAT (Soil Water Assessment Tool) model for the watershed was conducted by Kansas State University in 2010. SWAT is a river basin scale model designed to quantify the impact of land management practices on water resources in large, complex watersheds. The SWAT model identified eleven HUC-12 sub-watersheds where cropland contributions to pollutant loads were the greatest. Most of these sub-watersheds are located in Nemaha, Brown and northwestern Atchison counties (see **Figure 16**).

Because the SWAT model generated extremely low soil erosion rate estimates, stakeholders involved in targeting decisions requested KDHE to create a cross-referencing tool using observable data to check results of the SWAT model. This method (Cropland/Slope Analysis) factored the percentage of cropland in all HUC-12 sub-watersheds with land slope to estimate soil erosion potential from cropland on a HUC-12 sub-watershed basis.

Land slope was used along with total cropland acres because the degree of incline (slope) of soils is a significant factor in soil erosion. Generally speaking, the risk of erosion and generation of pollutant-carrying runoff increases as the slope of the land increases. A land slope of 4% or greater was used as the slope factor since most fields defined as Highly Erodible Land by USDA in northeast Kansas have a slope of 4% or greater. This Cropland/Slope Analysis identified fourteen HUC-12 sub-watersheds having a high percentage of cropland with a land slope of 4% or greater (see **Figure 17**). Interestingly, the eleven HUC-12 sub-watersheds identified by Kansas State University SWAT model were also identified by the Cropland/Slope Analysis, lending confidence to the results of the SWAT model. However three additional HUC-12 sub-watersheds in Atchison and northern Jefferson counties that were not identified by the SWAT model were identified as being significant potential sediment contributors by the Cropland/Slope Analysis.

Based on the SWAT hydrology model and the Cropland/Slope Analysis, stakeholders targeted fourteen HUC-12 sub-watersheds in the Delaware River basin for implementation of cropland BMPs (See **Figure 18**).

3.1.2.b Cropland Targeted Area Description

The targeted area for implementation of BMPs to reduce sediment loading from cropland includes a total of 14 different HUC-12 sub-watersheds (see **Figure 18**) in the northern and eastern areas of the watershed, including:

102701030101	102701030201	102701030402	102701030501
102701030102	102701030202	102701030407	
102701030103	102701030203		
102701030104	102701030204		
102701030105			
102701030107			
102701030108			

Figure 16: Eleven HUC-12 sub-watersheds identified as having the high potential for cropland pollutant loading based on SWAT (Soil Water Assessment Tool) model by Kansas State University

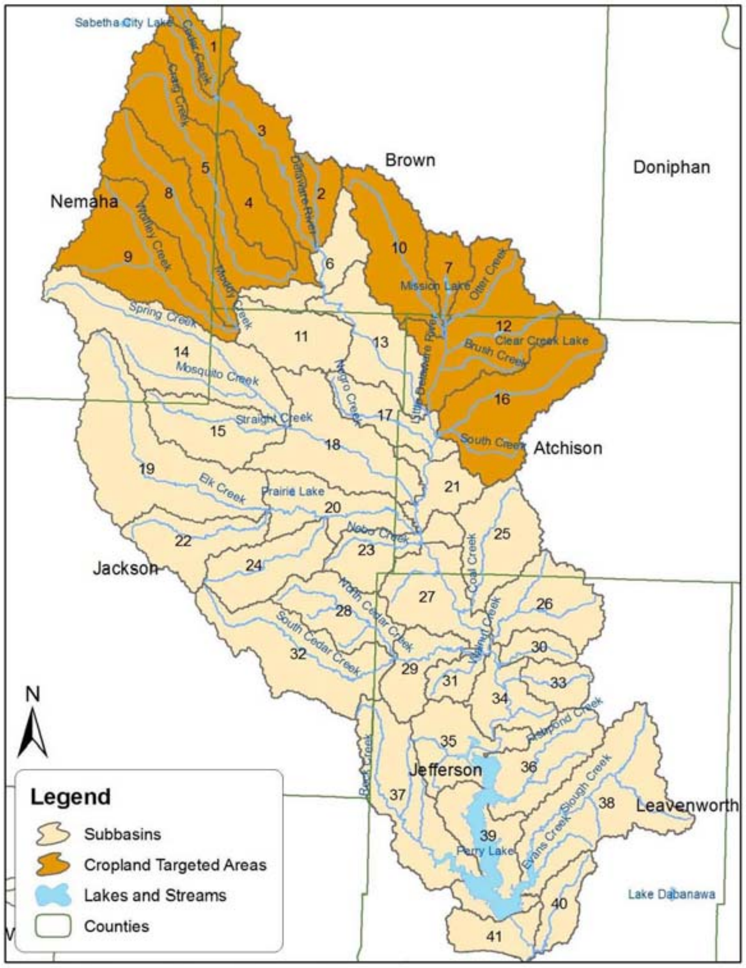
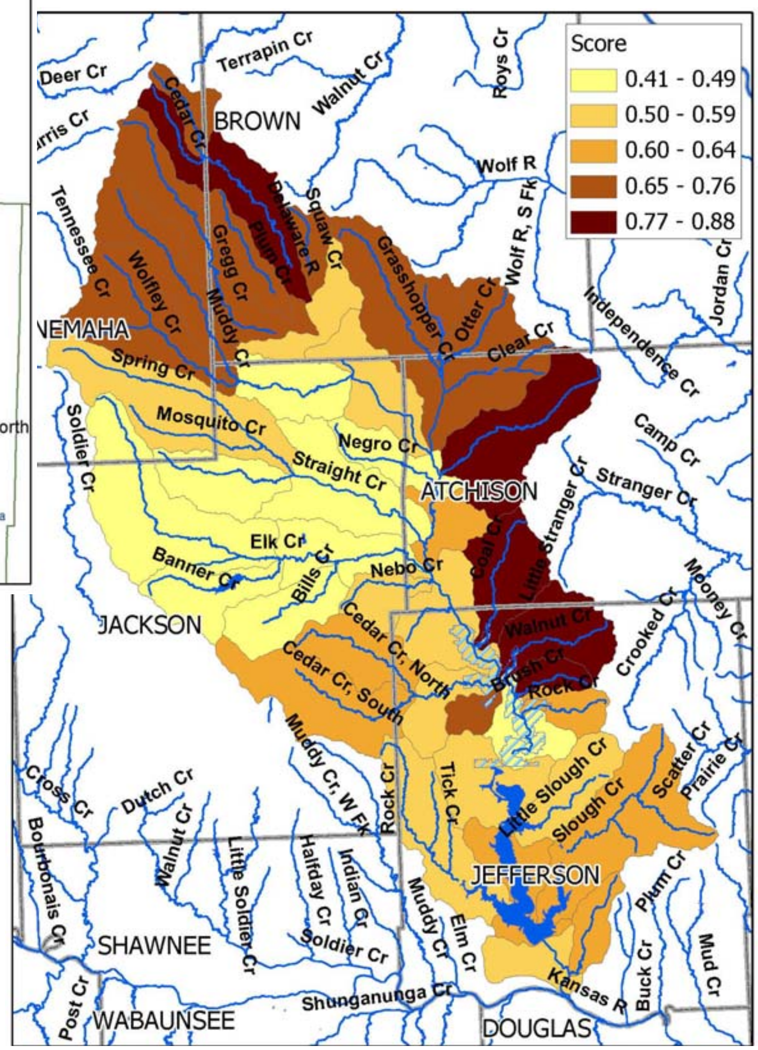


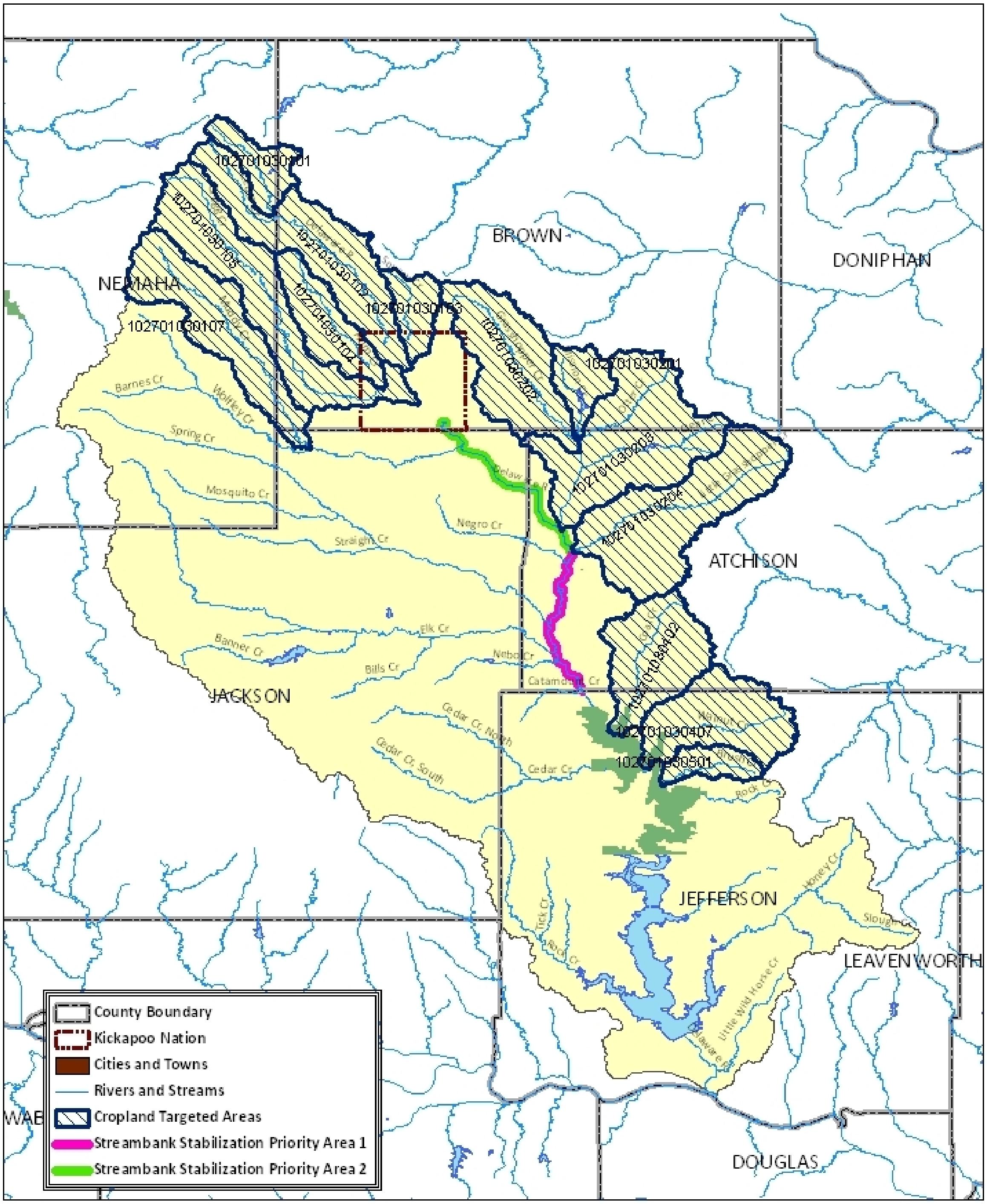
Figure 17: Cropland load potential results from Cropland/Slope Analysis. Darker colors indicate a high pollution potential from cropland. Fourteen of the HUCs darkest in color were selected for cropland BMP targeting.



<u>Figure 18</u>: Cropland Target Area containing fourteen HUC-12 sub-watersheds selected for targeting resources to address cropland pollutant loads.

Selection was based on SWAT modeling (Figure 16), a Cropland/Slope Analysis (Figure 17) and local knowledge.

Delaware Cropland and StreambankTargeted Areas



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3.1.3 Targeting Gully Erosion Reduction Efforts

3.1.3.a Assessment Data Supporting Selection of Gullies Targeted Area

In addition to identifying streambank erosion sites on the Delaware and major tributaries, the 2010 KWO assessment (13) also identified gully erosion sites in and near riparian zones along major streams in the watershed. Concentrated flow in these areas causes significant gully erosion. KWO used aerial photo comparisons and GIS information to locate stream channel changes, ephemeral gullies in bottomland fields next to streams, "knick points" (locations where a sharp change in slope occurs), and poor riparian vegetative cover as indicators of gullies along and near streams. The KWO assessment report maps can be found at www.kwo.org/projects_programs/Streambank_Erosion_Assessments.html.

Gully erosion sites identified in the KWO study were categorized as low, medium and high priority, based on the apparent severity of the erosion observed. The number of sites and severity of erosion on major streams in the watershed, including the Delaware River, was tabulated and the data was used to target sub-watershed areas with the most significant gully erosion. Five HUC-12 sub-watershed areas were selected in this way for sediment control practices that specifically address riparian gully erosion.

3.1.3.b Gully Erosion Targeted Area Description

Five HUC-12 sub-watersheds in the watershed were targeted for sediment control practices to address gully erosion. These include HUCs: 102701030301 (Spring-Mosquito Creek); 102701030302 (Upper Straight Creek); 102701030303 (Lower Spring-Straight Creek); 102701030109 (Lower Muddy Creek); and 102701030205 (Negro Creek). See **Figure 19** for a map showing these targeted areas.

Sediment control practices in this application are considered to be primarily structures located in close proximity to streams that will retain concentrated flow from upland sources. This type of structure captures runoff and sediment immediately before it enters into a stream system. In addition to sediment, nutrients, pesticides and bacteria in runoff can also be significantly reduced.

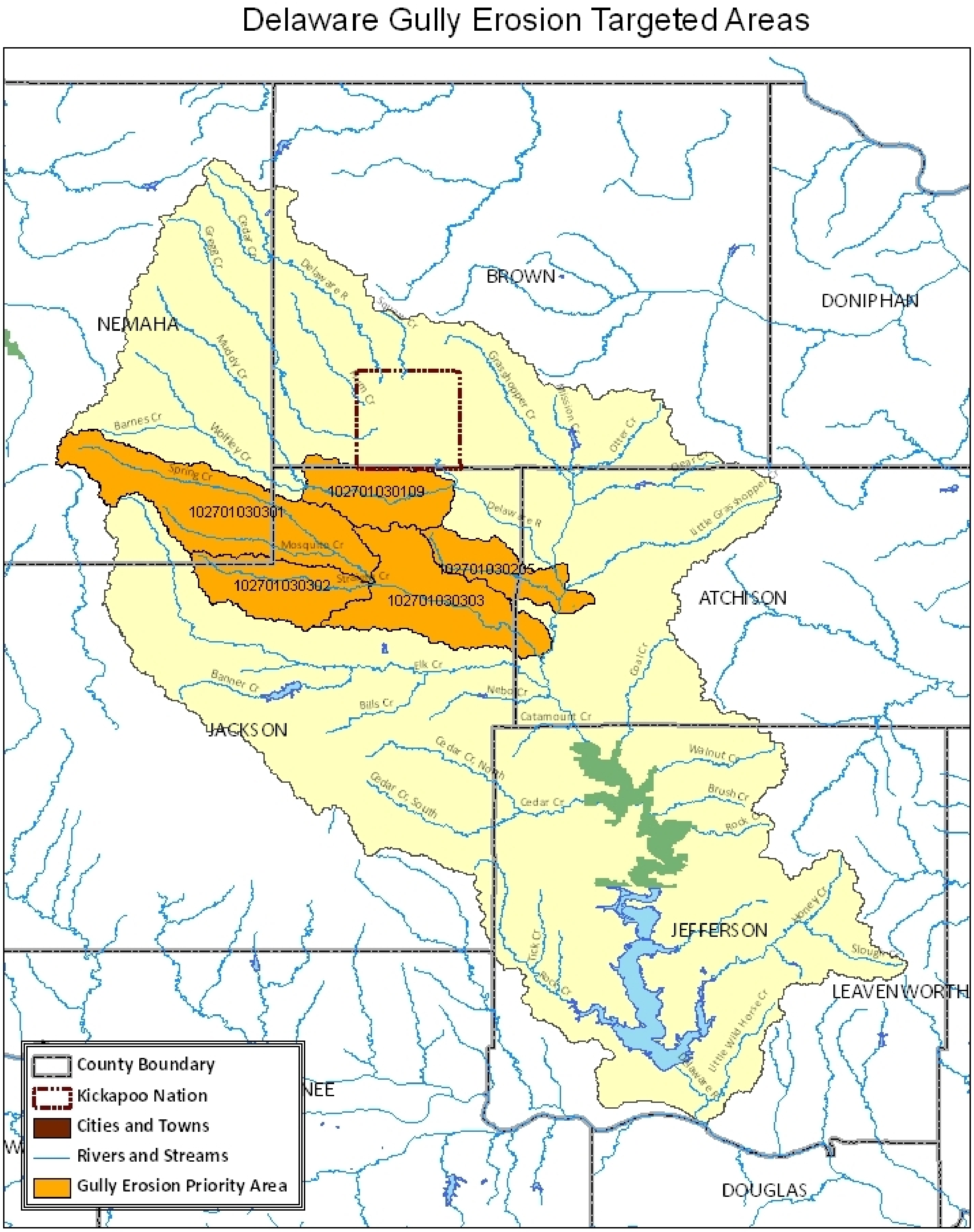
3.2 Targeting for Nutrient and Bacteria Load Reductions

BMPs that address sediment loading of streams also reduce nutrient and bacteria loads. However BMPs that specifically address nutrient and bacteria sources must also be implemented to achieve water quality goals set for the watershed and TMDL endpoints.

Significant sources of nutrients and bacteria in the Delaware River watershed are livestock and human wastes. While programs such as the National Pollutant Discharge Elimination System (NPDES), county sanitary codes and the Local Environmental Protection Program (LEPP) address most potential sources of ***human*** wastes (municipal, on-site and industrial wastewater), ***livestock*** wastes from unconfined livestock operations still pose a significant potential threat to water resources.

Nutrients (especially nitrogen and phosphorus) and bacteria are the primary pollutants resulting from livestock waste loading of water. Livestock waste control practices effectively reduce livestock waste entering streams by either retaining waste in off-stream areas, spreading wastes over large areas to

Figure 19: Gully Erosion Targeted Area in the Delaware River Watershed



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be used by plants, filtered out or otherwise broken down, or by reducing the amount of time livestock spend in and around streams.

3.2.1 Targeting Livestock Waste Reduction Efforts and Riparian Buffers

3.2.1.a Assessment Data Supporting Selection of Livestock Waste Targeted Area

To target BMP resources that address livestock waste loading, stakeholders in the Delaware watershed determined which areas of the watershed had the largest number of livestock in uncertified, unregistered operations, since these are the operations most likely to lack waste management practices. While data for Confined Feeding Facilities (CFFs) that are registered with KDHE is easily obtainable, information about livestock that are not contained within registered facilities is not tracked on a watershed basis. However, local knowledge of livestock operations in the area indicated that Nemaha, Jackson and western Brown Counties have larger numbers of unregistered livestock operations than other areas of the watershed.

Maps were created overlaying water quality impairment information from various sources. This information along with local knowledge about where livestock operations were located was used to help narrow the focus of livestock waste control BMPs. High Priority TMDLs for Bacteria in the Grasshopper Creek Watershed and Upper Delaware River Watershed area, a new Eutrophication TMDL for Perry Lake and "Improvement Potential Index (IPI) for Nutrient Reduction" provided by the Livestock Management Section at the Kansas Department of Health & Environment were used in this comparison.

The culmination of these comparisons highlighted eight HUC-12 sub-watersheds in the northeast, and another five HUC-12 sub-watersheds in northwest portions of the watershed where bacteria and nutrient enrichment from livestock sources are most significant and where the IPI showed greatest potential for improvement. The location of surface public water supplies (Mission Lake and the Kickapoo Nation water intake on the Delaware River) was also considered. These two water supplies are vulnerable to nutrient and bacterial contamination and have experienced significant water quality problems in recent years. The location of new KDHE monitoring stations on Spring-Straight Creek (HUC 102701030301) and Grasshopper Creek (HUC 10270100202) was also considered in final targeting decisions. A two-tiered prioritization system was also devised in which those areas with surface public water supply uses and new KDHE monitoring sites were ranked as **Priority Level 1**, and other areas were ranked as **Priority Level 2** (see **Figure 20**).

3.2.1.b Selection of Riparian Buffer Targeted Area

Research shows that riparian buffer strips implemented in the headwater areas of stream systems (those adjacent to first, second and third order streams) have a much greater influence on overall water quality within a watershed than riparian buffers installed in downstream reaches (14). Since livestock waste controls and the innovative riparian buffer program offered by Delaware River WRAPS are specifically designed to address livestock waste loading and livestock producers, the target area for implementation for livestock waste control BMPs and riparian buffers is the same.

3.2.1.c Livestock Waste and Riparian Buffers Targeted Area Description

The target area for livestock BMPs and riparian buffers was developed with a two-tiered priority level system. **Priority Area 1** includes the Grasshopper Creek watershed above the US Geological Survey Muscotah gauge station, the Delaware River and tributaries above the public water supply intake on the Kickapoo Reservation and Spring Creek above the new KDHE monitoring station. This includes the following HUC-12 sub-watersheds:

HUC 102701030201 (Mission Lake)
HUC 102701030202 (Upper Grasshopper Creek)
HUC 102701030203 (Otter-Clear Creek)
HUC 102701030101 (Upper Delaware aka Webster Creek near Sabetha)
HUC 102701030102 (Cedar Creek)
HUC 102701030103 (Squaw Creek)
HUC 102701030104 (Plum Creek)
HUC 102701030105 (Gregg Creek)
HUC 102701030301 (Spring Creek)

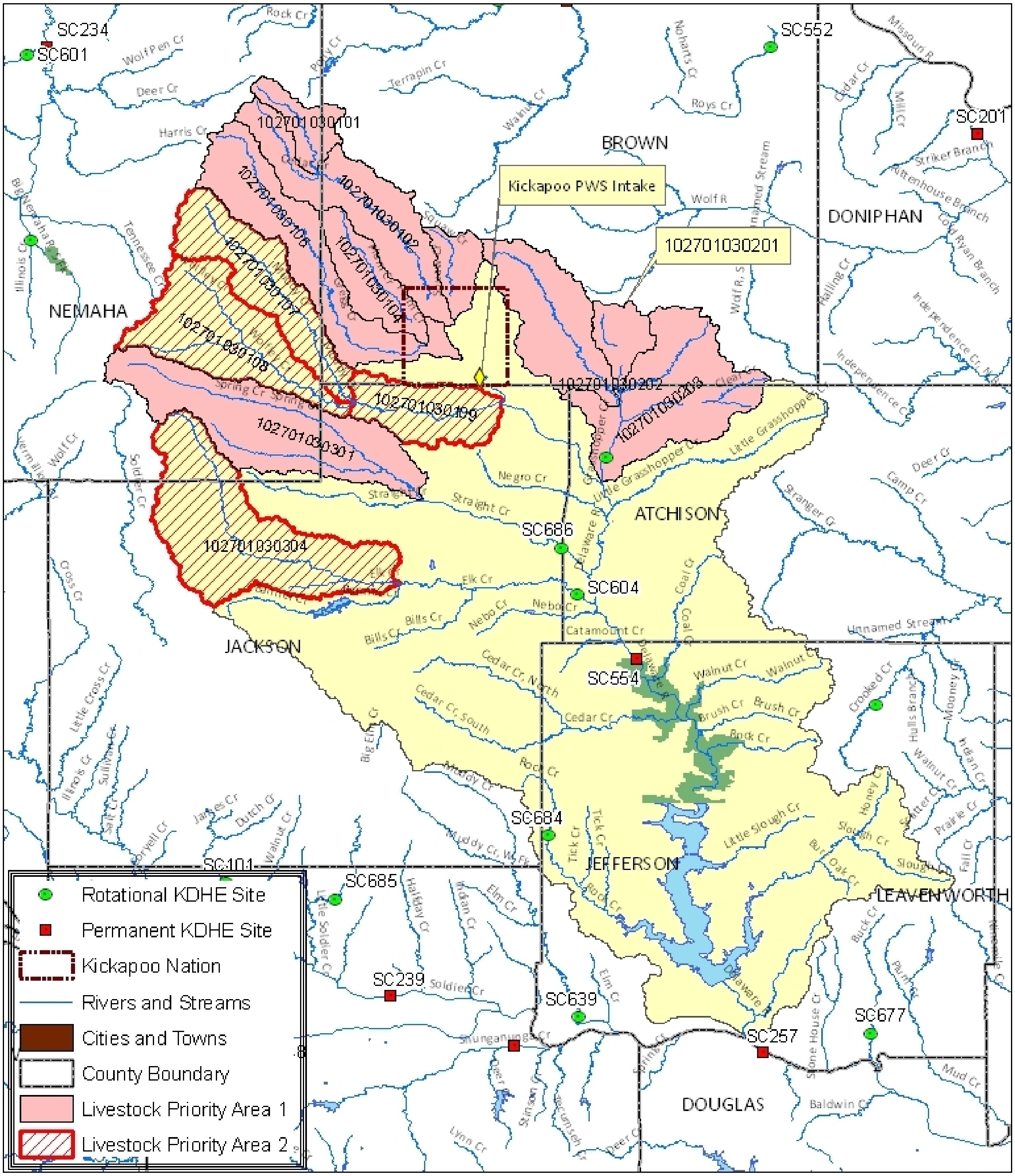
Priority Area 2 includes the following HUC 12 sub-watersheds:

HUC 102701030107 (Upper Muddy Creek)
HUC 102701030108 (Wolfley-Barnes Creek)
HUC 102701030109 (Lower Muddy Creek)
HUC 102701030304 (Upper Elk Creek)

See **Figure 20** for a map of the watershed showing the Livestock and Riparian Buffer targeted areas of the watershed. Since these targeted HUC-12 sub-watersheds represent a very large area, BMP resources will be focused within 200 linear feet of major streams.

Figure 20: Livestock and Riparian Buffer Target Areas in the Delaware River Watershed

Delaware Livestock Targeted Areas



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3.4 Description of Best Management Practices (BMPs) Targeted for Implementation in the Delaware River Watershed

A description of major categories of practices to address sediment, nutrient and bacteria reductions and specific BMPs targeted for implementation in the Delaware River Watershed follows.

3.4.1 Streambank Stabilization

Streambank stabilization BMPs are designed to stabilize the eroding banks of streams and rivers. This type of BMP reduces the sediment load originating from within stream channels, decreases sedimentation of downstream lakes, improves aquatic habitat, and increases diversity and riparian habitat.

Stream systems go through a series of evolutionary stages when disturbed by channelization, major changes in the watershed or removal of riparian vegetation. These stages are illustrated in **Figure 21.** The Delaware River and many of the larger streams in the watershed are undergoing similar evolutionary changes with a majority of the larger streams in the watershed in Stage V.

Techniques used to stabilize streambanks can be structural, vegetative, manipulative, or a combination of these. The size of eroding sites and the stage of channel evolution of an individual stream dictates which method(s) of streambank stabilization are most effective. Streambank stabilization techniques planned for use in the Delaware River Watershed are described below.

3.4.1.a Willow Cuttings and other Native Vegetation

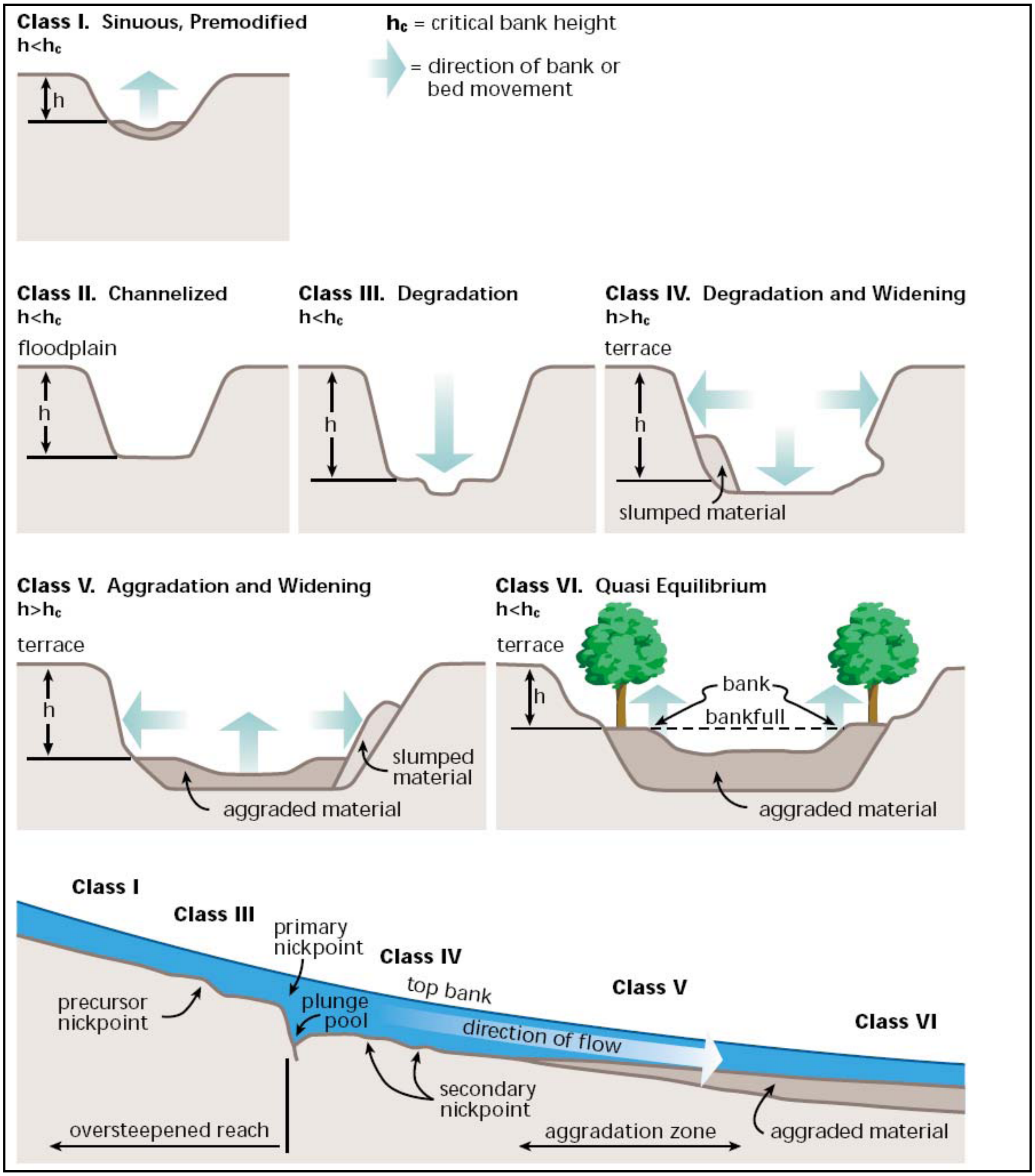
Dormant willow cuttings or posts are installed in the eroded bank area near the water's edge. Willow cuttings placed in the saturated zone root freely and grow quickly, holding bank soils in place while above-ground vegetative growth slows the speed of stream currents against the bank. This protects the bank against the erosive force of flowing water, allows other vegetation to gain a foothold, and can also cause sediment to be trapped and deposited on the bank.

Native trees, shrubs and grasses planted higher up on stream channel banks where soils are drier also stabilize streambanks. Native plant roots hold soil in place and provide vegetative cover that reduces the force of flowing water against the bank when stream flow is high. Vegetation is also able to regenerate naturally when damaged by floods, thus providing long-term protection of the streambank.

3.4.1.b Bank Re-shaping

Bank re-shaping is a manipulative form of streambank stabilization which requires the use of heavy earth-moving equipment. Steep, vertical banks are physically reshaped to a gentler slope which allows native trees, shrubs and grasses to be re-established.

Figure 21: Stages of channel evolution (24)



3.4.1.c Stone Toe Protection

Stone toe protection involves the placement of large rock at the base of the streambank in a line parallel to the bank. This provides protection of the base (the "toe") of the bank against undercutting by stream currents and reduces slumping. It also stabilizes the lower portion of the bank to allow vegetation (usually willows) to become established. Stone toe protection is typically installed at the base of re-shaped streambanks and used in conjunction with rock structures such as rock vanes or weirs.

3.4.1.d Rock Vanes and Weirs

Rock vanes and weirs are re-directive, in-stream rock structures constructed within the river channel and "keyed" into the streambank for stability. The structures are designed to become submerged when stream flows are high, and work by diverting the main force of stream currents away from the bank.

Figure 22: This streambank stabilization project was completed on the Delaware River in Atchison County in 2010.

The formerly vertical slope has been re-shaped to a more gentle slope and stone toe protection placed along the base of the bank. Note the rock vane in the foreground. Two more vanes are visible in the distance. Willows were planted at the base of the slope and other trees, shrubs and grasses planted up the remainder of the slope after this photo was taken.

Photo by Marlene Bosworth

3.4.2 Gully Erosion Control Practices In and Near Riparian Zones

Gully erosion control BMPs targeted for implementation in the Delaware River Watershed include grade stabilization and sediment retention practices that capture sediment just before it enters a stream. These practices are primarily structural in nature and are targeted to locations in close proximity to streams. The rationale behind controlling sediment sources in or near the riparian zone is that it allows retention of sediment concentrated from a large area at a single point. It is the last opportunity to intercept sediment before it enters a stream system. Controlling sediment originating from upland areas near the point of entry into a stream can be cost effective since retention is at a single point. Land treatment options such as terraces, waterways, tile terrace outlet systems are available through multiple conservation programs to address more diffuse sources of sediment on the landscape. By focusing on gully erosion control BMPs in riparian zones, WRAPS can address sediment loads that other programs do not. Primary gully erosion control BMPs are discussed below.

3.4.2.a Water and Sediment Debris Basins and Similar Retention Structures

A water and sediment debris basin is an earthen embankment that acts similar to a small dam and operates on the principle of runoff and sediment retention. Locating a sediment control basin near the entry point of concentrated flow into a stream provides grade stabilization, reducing gully erosion that frequently occurs where runoff exits a field or pasture. Eroded soil from upland areas is captured within the basin while water is released slowly either through infiltration or a pipe outlet. This allows trapped sediment to settle out of the water column. Other pollutants can also be reduced by these structures, depending on the retention time in the basin. Accumulated sediment must be removed periodically to maintain the retention capabilities of these structures.

3.4.2.b Diversions

A diversion is an earthen embankment similar to a large terrace. It is constructed across a slope to intercept water that is flowing downhill. Diversions are designed to collect water and divert it to a stable outlet such as a grassed waterway, piped outlet or a sediment control basin. The sediment load in runoff intercepted by a diversion is reduced as the runoff velocity and steepness of the path taken by water is reduced and sediment settles out of the water column. A grassed waterway outlet or retention of runoff within the diversion channel with a piped outlet traps additional sediment and reduces other pollutants as well.

3.4.2.c Constructed Wetlands

Constructed wetlands are shallow basins or depressions constructed to retain runoff. Their function in reduction of sediment loads is much like that of water and sediment control structures. However, since wetlands have a strong vegetative component, additional water quality benefits can be derived. Excess water entering a constructed wetland passes through thick wetland vegetation before exiting; this vegetation filters out sediment while also absorbing other pollutants in runoff water. Water that is captured and retained in the wetland undergoes physical, chemical and biological changes (nutrient uptake, denitrification, breakdown by sunlight, etc) that result in additional water quality benefits. Constructed wetlands may have a permanent pool of water throughout the growing season, but may also experience extended dry periods. In addition to surface water quality benefits, wetlands also replenish groundwater supplies and provide valuable habitat for wildlife.

3.4.3 Riparian Buffers

A riparian buffer is a linear strip of vegetation (trees, shrubs and/or native grasses) located alongside a stream. Buffers are specifically intended to remove sediment, nutrients, pesticides and other pollutants from runoff before it enters the stream by filtration, infiltration, absorption, adsorption, decomposition, and volatilization.

Riparian buffers have been shown to be very effective water quality protection practices. Some studies show that buffers can remove more than 90% of sediment, nutrients (especially nitrogen), bacteria and other contaminants (15). Buffer strips also provide wildlife habitat and impart aesthetic benefits. Because of the potential for buffers to effectively address major water quality issues, Delaware River WRAPS places heavy emphasis on increasing the adoption of buffer strip practices. Buffers are a relatively simple practice, do not require a large investment, and can be implemented almost anywhere with or without enrolling in a formal buffer program.

The Innovative Riparian Buffer Program initiated by Delaware River WRAPS was designed to supplement traditional riparian buffer programs available through the U.S. Department of Agriculture Continuous Conservation Reserve Program (CCRP). Although the CCRP program offers substantial financial incentives to landowners, some requirements of the program create a barrier to adoption. The most significant barrier identified by landowners in the watershed is the requirement to exclude livestock from buffers when adjacent cropland is grazed after crop harvest (this requirement can be waived under certain circumstances, but results in significant penalties).

In order to overcome this barrier and increase riparian buffer adoption, Delaware River WRAPS developed the Innovative Riparian Buffer Program in 2010. This Program allows landowners to enroll in a 10-year buffer program that has some similarities to CCRP. However, unlike the CCRP, buffers planted to native grasses under the WRAPS Buffer Program can be cut for hay and livestock are not required to be excluded from the strip when adjacent cropland is grazed after harvest (with some restrictions).

Delaware River WRAPS, in cooperation with Middle Kansas WRAPS, commissioned K-State Research & Extension to conduct a demonstration to examine the impact of incidental grazing on riparian native grass buffers (16). The study showed little if any negative impact on the functioning and re-growth of buffers when cattle grazed adjacent cropland stubble following fall harvest when the following conditions existed:

- Supplemental feed (hay) was made available at a location outside the buffer area
- A water supply other than the stream was available at a location outside the buffer area
- Shelter from the elements (especially wind) was available in a location outside the buffer zone

The full “Buffer Grazing Demo Report” may be found at www.delawarewraps.org/publications.html.

3.4.4 Livestock Waste Controls

The livestock industry is very important in the Delaware River Watershed. Large numbers of livestock are grown in unregulated and unregistered operations, often without any waste management practices, resulting in the high potential for animal wastes to enter into stream systems. Livestock wastes are considered a major source of bacterial contamination and nutrient enrichment of water resources in the watershed. Livestock can also contribute to sediment loading of water when allowed to degrade riparian vegetation and soils in riparian areas.

A variety of BMPs are available to reduce pollutant loads from livestock wastes. Unique conditions in each livestock operation require that different types of waste controls be applied. However, livestock BMPs can effectively protect water resources if they can accomplish one or more of the following: exclude livestock from riparian zones, cause livestock to spend less time in streams or riparian zones, filter runoff from areas where livestock are fed or otherwise concentrated, keep livestock dispersed and unconfined for greater lengths of time, or capture and retain runoff containing animal wastes.

A list of livestock waste controls that provide the greatest load reduction, cost effectiveness and that are likely to be accepted by livestock producers in the watershed was developed by the Delaware River WRAPS Stakeholder Leadership Team. From that list the following high priority BMPs were selected for implementation in the Delaware River Basin.

3.4.4.a Off-stream watering systems

Streams used as a source of water for livestock experience heavy waste loading because animals tend to spend a much time in and around the water. Wastes are deposited either directly in the water or in the surrounding riparian area. Off-stream water sources offer a phosphorus load reduction potential of 30-98%; greater efficiencies are for those that limit stream access. For this reason, fencing BMPs used to limit livestock access to water supplies is considered a component of off-stream watering systems.

Water sources in off-stream locations draw livestock and their wastes away from streams. Studies show that cattle will drink from a tank over a stream or pond 80% of the time (Josh Roe, Kansas State University, 2011). BMPs included in this category include solar pumps and tank systems, alternate water sources, pond developments and “hardened” watering points.

3.4.4.b Relocation of livestock feeding sites within pasture areas

Moving pasture feeding sites away from streams and other water sources can be accomplished by moving bale feeders or by using bale spreaders. This puts distance between concentrated waste deposited in feeding areas and streams. The installation of geotextile feed pads with properly located bale rings or bunks also make manure and waste feed removal easier and more efficient. This type of practice can lead to average phosphorus load reductions ranging from 30-80%.

3.4.4.c Relocation of livestock feedlots or feeding pens

The proper location of feedlots and pens is critical to protecting water resources. Confinement of animals results in the concentration of animal wastes which can contribute to heavy nutrient and bacteria loading of streams. Moving lots and pens away from streams puts distance between wastes and water resources. Like relocating feeding sites in pastures, relocating lots and pens can reduce phosphorus loads by 30-80%.

3.4.4.d Vegetative filter strips

Vegetative buffer strips are an area of vegetation (usually grasses) that receives runoff from animal feeding areas or lots. To be effective, the area of the strip should be equal to or greater than the drainage area from which runoff will be received. Periodic mowing and hay removal is required to maintain effectiveness of the filter.

Properly located filters trap solids and absorb waste-laden runoff, allow nutrient uptake by plants, increase denitrification and breakdown of bacteria by sunlight, and provide other benefits. Buffer strips must be located down-slope of feedlots, pens or other areas where livestock are concentrated, and may need to be graded to create sheet flow. Vegetative filters are often used in conjunction with other livestock waste reduction practices, and can provide a 50% average reduction in phosphorus loads.

3.4.4.e Rotational grazing systems

Rotational grazing systems can take many forms and can be customized to fit factors unique to a livestock operation. Rotational grazing involves frequently and systematically moving livestock between pasture lots, or paddocks, to maximize the quality and quantity of forage growth. Herds graze one portion of the pasture while allowing other areas to recover. Resting grazed lands allows vegetation to renew energy reserves and rebuild root systems, while spreading livestock wastes.

Rotational grazing results in greater forage production, livestock gains and water quality benefits but requires more time and management. Installation of cross-fencing and additional watering sites is also usually required. However, phosphorus reductions expected from rotational grazing systems can be significant, ranging from 50-75%.

3.4.5 Cropland BMPs

BMPs that address cropland runoff are most often associated with reduction of soil erosion, but many of these BMPs also significantly reduce nutrients like phosphorus because phosphorus tightly adheres to soil particles. The pending Eutrophication Total Maximum Daily Load (TMDL) for Perry Lake requires a reduction of nearly 71% in total phosphorus and 70% reduction in total nitrogen loading (see discussion in **Part 4**). This lofty goal cannot be achieved without reduction in the nutrient loads that can be gained from addressing runoff from cropland in the watershed. Cropland BMPs targeted for implementation to address nutrient loading are discussed below.

3.4.5.a Riparian vegetative buffers

Riparian buffers provide multiple water quality benefits and are easy to implement. See the discussion of buffers in **Section 3.4.3.** As a "rule of thumb", a one acre buffer will treat runoff from 15 acres of Kansas cropland. Buffers provide an average sediment and phosphorus reduction efficiency of 50%.

3.4.5.b Planting permanent vegetation (on cropland acres)

Planting whole or parts of crop fields to permanent vegetation (grass, shrubs or trees) significantly reduces nutrients in runoff and reduces all other potential water quality impairments such as sediment. Permanent vegetation provides continuous soil cover, eliminates soil disturbance, and lower fertilizer and chemical inputs. Increasing the amount of permanent vegetation in the watershed will be extremely beneficial for water quality. Converting cropland to permanent vegetation provides very high load reduction potential, reducing soil erosion by up to 95% while also providing 95% phosphorus reduction efficiency.

3.4.5.c Grassed waterways

Grassed waterways are a grass strip used as a stable outlet for terraces or other concentrated flow. Waterways benefit water resources by capturing silt, preventing gully formation and filtering runoff. As waterways age, accumulated sediment must be removed to maintain functionality. Currently, many waterways are being replaced by tile outlet systems because of the increasing size of farm equipment and desire to maximize crop production acres.

In Kansas, 1 acre of waterway on average will treat runoff from 10 acres of cropland. Sediment removal and soil erosion reduction efficiency averages 40% while phosphorus reduction also averages 40%.

3.4.5.d Water retention structures

See **Section 3.4.2** for a description of water retention structures. These structures trap sediment and nutrients before they leave the edge of the field. In terms of nutrient reduction, an average 50% phosphorus reduction can be expected.

3.4.5.e No-till cropping systems

No-till cropping systems reduce nutrient and sediment loads by eliminating tillage of the soil. In a continuous no-till system, the soil surface is not disturbed and residue remains on the surface at all times, reducing erosion by up to 75%. Runoff is also reduced and water infiltration is increased. Phosphorus reduction efficiency averages 40%.

Planting cover crops, while not limited exclusively to no-till systems, is considered as a component of no-till cropping systems for purposes of this plan. When cover crops are incorporated into a no-till cropping system, water quality benefits of reduced tillage can be boosted by increased organic matter levels in the soil, greater infiltration rates and water holding capacity of the soil. Cover crops have also been shown to reduce the amount of commercial fertilizer that may be required to maintain crop yields.

3.4.5.f Sub-surface fertilizer application

Applying fertilizer below the soil surface places fertilizer where it is less likely to be carried away by runoff. Injecting liquidized animal manure below the soil surface is an example of how this BMP can be practically applied. This BMP has little effect on soil erosion rates, but has an average phosphorus reduction efficiency of 50%.

3.5 BMP Needs for Watershed Target Areas

3.5.1 BMP Needs to Address Streambank Erosion

The assessment conducted by the Kansas Alliance for Wetlands and Stream (12) identified a total of 69 eroding streambank sites on the main stem of the Delaware River. At least 37 of these sites are located in the section of the River that was later targeted by stakeholders for implementation of streambank stabilization BMPs.

Eroding sites identified by the assessment represent a total of 43,266 linear feet of eroding streambank. Individual sites along the length of the river varied in length from approximately 225 lf to over 2,200 lf, with a mean length of 627 lf. The assessment did not specifically address BMP needs in the targeted reach of the river since it was completed prior to selection of priority areas. However, it is evident that the longest sites are located in the lower ½ of the river within the selected target area, and that the longest sites are located in Priority Area 1. Average length of eroding sites in the targeted reach is estimated to be 900 lf. Using this estimate, the total length of streambank stabilization needed to address streambank erosion in the target reach of the river is at least 33,300 lf.

3.5.2 BMP Needs to Address Gully Erosion

The 2010 assessment by the Kansas Water Office (KWO) identified gully erosion sites along all major streams in the Delaware River Watershed. As discussed earlier, five HUC-12 sub-watersheds were targeted for implementation of gully erosion control BMPs.

KWO assessment data identified a total of 57 individual gully erosion sites within these targeted sub-watersheds. Since this assessment was done remotely using GIS data and aerial photos, it is likely that the need for gully erosion control practices in the targeted region may be greater. However, this is the number of gully erosion sites that will be slated for BMP implementation in the targeted area.

3.5.3 BMP Needs to Address Livestock Sources of Nutrients

Stakeholders in the Delaware River Watershed selected five priority BMPs for implementation to address nutrient reduction needs and were described in **Section 3.4.4**. Keep in mind that in addition to the reduction of nutrient loads, these BMPs also address bacteria loading. These BMPs include:

- Alternative (off-stream) watering systems
- Relocate feeding sites in pastures
- Relocate feedlots and livestock pens
- Vegetative filter strip
- Rotational grazing

There is little comprehensive assessment data available that adequately estimates livestock-related BMP needs in the watershed. However, the Delaware River Rapid Watershed Assessment (6) estimated that there are 1,200 non-confined livestock operations in the watershed that "need treatment". This "treatment" consists of an assortment of management and structural practices that address manure storage, animal mortality facilities and fencing in addition to the five practices selected by the Delaware River Watershed SLT described above. In order to estimate livestock BMP needs, the SLT used its local knowledge of the livestock industry in the watershed.

Most unconfined, small livestock operations in the watershed could contribute to water quality improvement goals by implementing one or more livestock BMPs. Off-stream watering systems have been observed to be one of the greatest needs in the watershed, with rotational grazing being the lesser need. Based on general watershed knowledge and observations, stakeholders estimate the following livestock BMP needs:

A Note about Cropland and Livestock BMP Adoption Rates

The rate at which desirable BMPs for water resource protection are adopted varies from practice to practice. Adoption depends heavily on many factors including cost of implementation, incentives, economic conditions, commodity and land prices, technical assistance, cultural and societal perceptions of the practice(s). The Delaware River Watershed Rapid Watershed Assessment (NRCS 2006) used a future adoption rate of 59% for predicted scenarios for both cropland and livestock BMPs. Using this figure to predict adoption of BMPs over a 32-year implementation schedule provides a reasonable expectation of adoption rates of selected BMPS.

Table 12: Estimate of needs for priority Livestock BMPs

BMP Needed	Percentage of total small operations with this need	Estimated number required (% with need X 1,200 operations)
Off-stream watering systems	25%	300
Relocating feeding sites in pastures	20%	240
Relocating lots or feeding pens	10%	120
Vegetative filter strips	15%	180
Rotational grazing	5%	60

Because of the importance of the livestock industry in the watershed, and the lack of information on the actual impact of unconfined livestock operations on water resources, assessments or other data-gathering efforts regarding livestock in the watershed are needed to more accurately determine technical and financial requirements for meeting the needs of the livestock industry in the watershed.

3.5.4 BMPs Needed to Address Bacteria Load Reduction

In order to achieve bacteria load reduction goals, it will be necessary to implement best management practices that address livestock wastes management in unconfined livestock operations in the watershed. The same BMPs that address nutrient load reductions also decrease bacteria loads.

The ability to address bacteria load reductions were taken into consideration when selecting targeted nutrient control BMPs outlined earlier in this document. For this reason, all discussions of livestock BMP application goals and effectiveness is similarly applicable to both nutrient and bacteria. The application schedules, costs and targeting necessary to reduce livestock wastes will work toward achieving both nutrient enrichment and bacterial loading goals within the watershed.

3.5.5 BMP Needs to Address Cropland Sources of Sediment

Six high priority cropland BMPs targeted for implementation was developed. Based on modeling and economic analysis, a 32-year implementation schedule was developed to achieve sediment reduction goals. These same cropland BMPs also offer significant nutrient load reduction potential. Cropland BMPs targeted for implementation include:

- Permanent vegetation
- Vegetative Buffers
- Grassed Waterway (new or rebuilt)
- No-Till
- Subsurface Fertilizer Application
- Water Retention Structure

Table 13: Summary of Cropland BMPs, costs, and reduction efficiencies (Josh Roe, Kansas State University)

Best Management Practice	Cost Per Acre Treated	Available Cost Share	Erosion Reduction Efficiency	Phosphorous Reduction Efficiency	Nitrogen Reduction Efficiency
Permanent Vegetation	$150	50%	95%	95%	95%
Grassed Waterways	$160	50%	40%	40%	40%
No-Till	$78	39%	75%	40%	25%
Vegetative Buffers	$67	90%	50%	50%	25%
Subsurface Fertilizer App	$27	0%	0%	50%	70%
Water Retention Structures	$300	50%	50%	50%	25%

Watershed BMP needs discussed in the following sections were derived using data provided by the Natural Resources Conservation Service (NRCS "Needs Inventory Report") for each of the 5 counties in the Delaware River Watershed. Additional information for determining BMP needs was also obtained from the Delaware River Rapid Watershed Assessment (6). Costs and load reduction efficiencies were obtained from Josh Roe, Economist with K-State Research and Extension at Kansas State University.

3.5.5.a Waterways, Water/Sediment Retention, Permanent Vegetation and No-till Systems

Table 14 below illustrates the estimated need for waterways (new or rebuilt), water and sediment retention (grade stabilization or water & sediment control structures) practices, planting permanent vegetation, and acres where conservation tillage (assumed no-till) are needed. All denominations in the table are either number of acres for the practice (permanent vegetation or no-till) or number of acres treated by the practice (for waterways and water retention practices).

Table 14: Watershed needs for waterways, water retention structures, conversion to permanent vegetation and conservation tillage

Acres New Waterway Needed	Acres Rebuilt Waterway Needed	Grade Stabilization or Water & Sediment Control Structures needed (acres treated)	Acres Needing to be Converted to Permanent Vegetation	Acres cropland where Conservation Tillage(No-till) is needed
1,012	2,380	13,785	34,270	85,536

3.5.5.b Riparian Vegetative Buffers

Implementation of vegetative buffers is a high priority in the Delaware River Watershed. Buffers are effective at removing sediment, nutrients, bacteria and other pollutants because of their location at the field edge where runoff and pollutant loads are intercepted before leaving the field edge. There is unfortunately little data available as to the acres of riparian buffers needed in the watershed.

The assessment of the main stem Delaware River conducted by KAWS (12) examined land uses adjacent to riparian areas along the entire length of the Delaware River. Although this assessment was of the Delaware River only, vegetative buffers were also examined and data can be extrapolated to other major streams in the watershed.

The assessment's land use evaluation summary indicated that 16.7% of the riparian zone of the river (defined as land within 130 feet of the river) was in "need of restoration" (i.e. lacked riparian vegetation and was either developed or cultivated). 48.7% of the riparian area examined was determined to be in "need of management" (vegetated with grass, shrub/scrub and/or thin forest stands and were considered to transitory; the state of the riparian vegetation and its ability to provide riparian functions were not evaluated). The remaining 34.6% was determined to be in "need of protection" (forest cover was >40%).

There are 697 miles of classified streams in the Delaware River basin (17). In addition to classified streams, stakeholders estimate that there are approximately 3 times as many unclassified as classified streams (2,091 miles total). Estimating that the percentage of the riparian zone adjacent to all classified and unclassified streams in need of protection alone is similar to the percentages found in the 2009 KAWS assessment of the Delaware River, 465.6 miles of stream would be in need of protection (that is, in need of establishment of buffers) in the entire watershed area using the following formula:

(697 miles classified streams + 2,091 miles unclassified streams) X 16.7% = 465.6 miles of streams in need of restoration

To address the restoration of these riparian zone, an estimated **2,822 acres of vegetative buffer** would be required (assuming an average buffer width of 50 feet).

3.5.5.c Subsurface Fertilizer Application

Subsurface fertilizer application benefits water quality because nutrients are placed beneath the soil surface preventing loss to runoff and the amount of soil surface disturbance is much less. Knifing in anhydrous ammonia fertilizer is a very common subsurface fertilizer application method. Injecting liquid manure into the soil is another method of subsurface fertilizer application, although it is less common and requires specialized equipment.

It is estimated that 85% or more of the approximately 217,900 acres of cropland in the watershed currently receives anhydrous ammonia applications in the years when a non-legume crop is planted (acres planted to soybeans are not normally fertilized with anhydrous ammonia). The remaining 15%, or approximately 38,453 acres, receives surface-applied fertilizer (or on fertilizer at all). This 15% represents potential need for implementation of subsurface fertilizer application BMPs.

Part 4: Major Water Quality Impairments and Pollutant Load Reductions Needed to Achieve SLT Goals and Watershed TMDLs

4.1 Sediment

Although there is no TMDL for sedimentation of Perry Lake, stakeholders in the Delaware River Watershed consider sedimentation to be the highest priority issue in the watershed. The accelerated rate of sediment entering Perry and other lakes has a very negative impact on water supply, recreation, wildlife and aquatic species in the watershed. Sediment also transports other contaminants such as phosphorus, bacteria and pesticides that adhere to soil particles. Controlling sedimentation will therefore result in improved water quality not only because less sediment is delivered to lakes and streams, but because the concentration of other troublesome pollutants is also reduced.

Sedimentation in the Delaware River Watershed comes from two main sources: soil eroded from upland sources (cropland fields, pastures, road ditches, construction sites, etc.) and soil eroded from within or immediately adjacent to the stream channel itself (gully erosion in the riparian zone, unstable stream banks and degrading stream channels).

Because agriculture (cropland and livestock) is the most significant land use in the Delaware River Watershed, stakeholders in the watershed selected a variety of best management practices to reduce sediment loads from agricultural sources.

4.1.1 Impairment Sources

4.1.1.a Cropland

Physical properties of the land itself such as topography and geology affect erosion rates. For example, steeply sloping land has a higher erosion potential than flat bottomland, especially when the land is cultivated or overgrazed. Physical properties of the soil and rainfall factors also affect erosion rates. However, **land use** has the most significant impact on sediment loading of water bodies.

The Delaware River Watershed is 740,772 acres in size. Soils in the watershed are primarily glacial drift mantled with thick loess (loess is a fine-grained un-stratified clay and silt deposited by wind). Slopes in the region vary from nearly level to strongly sloping (>10% slopes). The soils are deep with high clay content and heavy rainfall events in spring and summer are common, all characteristics that contribute to soil erodibility. When the soil is disturbed or if continuous vegetative cover is lacking, soils become vulnerable to excessive erosion.

Prior to settlement, native grass prairies covered the uplands of northeast Kansas, with riparian forests predominant in the floodplains of creeks and rivers. Only a few remnants of this original land cover remain and the majority of the landscape now is used for crop production, grazing or hay production. Cropland that is conventionally tilled or that lacks properly maintained soil erosion control measures can contribute significantly to sediment loading of streams. For this reason, cropland requires special attention when trying to achieve the primary goal of reducing sedimentation.

Table 15 provides a breakdown of land uses and land cover characteristics of the watershed (6). 35% of the land area is used for **annual crop** production which typically involves frequent disturbance of the soil surface and long periods of time when fields are devoid of actively growing, permanent vegetation. Over grazing, poor plant health and gully erosion in pastures and hay fields also contribute to sedimentation in the watershed.

Table 15: Land Use/Land Cover Summary

Land Cover/Land Use	Acres	% of Total
Open Water	18,107	2
Residential	2,769	*
Commercial/Industrial/Transportation	2,408	*
Deciduous Forest	73,774	10
Evergreen or Mixed Forest	2,873	*
Shrubland	2,809	*
Grassland	82,987	11
Pasture/Hayland	292,145	39
Row Crops and Small Grains	256,354	35
Wetlands	5,191	1
Other	1,355	*
Totals	740,772	100%

*= Less than 1 percent of total acres

Totals are approximate due to rounding and small unknown acreages

- Small grains and row crops are predominant commodities grown in rotation on 35% of the watershed area
- Grassland, pasture and hayland totals approximately 50% of the watershed area
- Urban land comprises less than 1% of the watershed area

Source: "Kansas Rapid Watershed Assessment, Delaware River Watershed, Hydrologic Unit Code – 10270103", USDA Natural Resources Conservation Service, December 2006

Significant strides in cropland erosion control have been made in recent years. The passage of the 1985 Food Security Act established strict conservation compliance requirements that led to widespread implementation of conservation practices to bring erosion rates on Highly Erodible Land used to produce crops down to "T". While soil erosion rates on the majority of cropland acres in the watershed are estimated to be less than 5 tons/acres/year, approximately 75,000 acres are still eroding at rates greater than "T" (6). Despite the progress that has been made in soil conservation, soil erosion is still a major concern in the watershed and one that is still having an impact on water resources because soil erosion rates at "T" do not take into account water quality impacts.

> **What is "T"?**
>
> The soil loss tolerance ("T") of soils is the maximum amount of soil loss that can be tolerated while still economically sustaining a high level of crop production indefinitely. "T" values are expressed as tons per acre per year.
>
> "T" values are unique for different soil types. In northeast Kansas, most soils have "T" values that range from 3 to 5 tons/acre/year.
>
> "T" does not take into account any impacts on water resources from erosion. In fact, there is ample evidence that erosion rates well below "T" will have negative impacts on water quality and aquatic species.

4.1.1.b Stream and Riparian Areas

Healthy, functioning riparian areas of adequate width alongside streams are critical to the protection of water resources and reduction of sedimentation. Riparian forests adjacent to large streams protect stream banks against the ravages of floods and filter pollutants out of overland flow. On smaller streams, native grass buffers and riparian trees stabilize streambanks and remove pollutants from runoff. When permanent vegetation is removed from sensitive riparian areas, the lack of deep root systems and vegetative soil cover destabilizes streambanks making them prone to erosion. The filtering ability of the soil and vegetation is also reduced or eliminated.

In the Delaware River Watershed, the majority of the deep, fertile soils of floodplains adjacent to streams and rivers have been converted to agricultural use. This has resulted in the removal of most of the native riparian forests and grass buffers, causing significant destabilization of stream banks, especially on larger streams. In some cases, a narrow band of trees or grasses may be left on the edge of streams, but the width of these bands is often too narrow to protect against scouring of stream currents or provide any other water quality benefit.

Recently, streambank erosion rates on the Delaware River have been estimated to range from 2.0 to 5.5 tons/foot/year (11). Banks that are the most susceptible to streambank erosion are those located on the outside bend of stream meanders when there is little deep-rooted riparian vegetation present. On larger streams like the Delaware and other major tributaries, trees are necessary to provide adequate rooting depth to stabilize bank soils, whereas native grasses may provide sufficient rooting depth to protect smaller streams.

The channelization of the Delaware River and other streams in the watershed has also contributed to the instability of stream channels and banks. The goal of channelization was to maximize cropland acres and alleviate flooding. However, the increased grade of the stream channel that results from straightening, the subsequent down-cutting into the stream bed and the removal of trees have resulted in highly accelerated streambank erosion. Rivers and streams take many years to adjust to the drastic changes brought on by channelization. Although the Delaware River was channelized decades ago, the effects of this disturbance are still being seen as the river and its tributaries adjust to the changes and seek a new state of equilibrium in the surrounding floodplain.

4.1.1.c Gully Erosion in/near Riparian Zones

Frequent and heavy thunderstorms in northeast Kansas contribute to recurrent runoff events during spring and summer. Water that is not absorbed by the soil flows downhill, gaining velocity and volume as it flows. As runoff travels downhill it seldom travels over the land as sheet flow. Obstructions, variations in grade and surface roughness cause runoff to become concentrated in low areas and channels until it reaches and enters a stream. If the volume of runoff that becomes concentrated in a channel is large, there is a significant drop at the edge of the stream, the stream edge lacks protective vegetation, or appropriate conservation practices are lacking, gullies often form at the point where runoff enters the stream.

Sediment carried by overland flows and the soil eroded from streamside gullies contribute to the sediment load of streams. Retaining and/or detaining runoff at the point where these concentrated flows enter a stream can be a cost effective means of capturing and keeping sediment out of a stream system and can provide many other water quality benefits.

4.1.2 Sediment Load Reduction Goals for Perry Lake

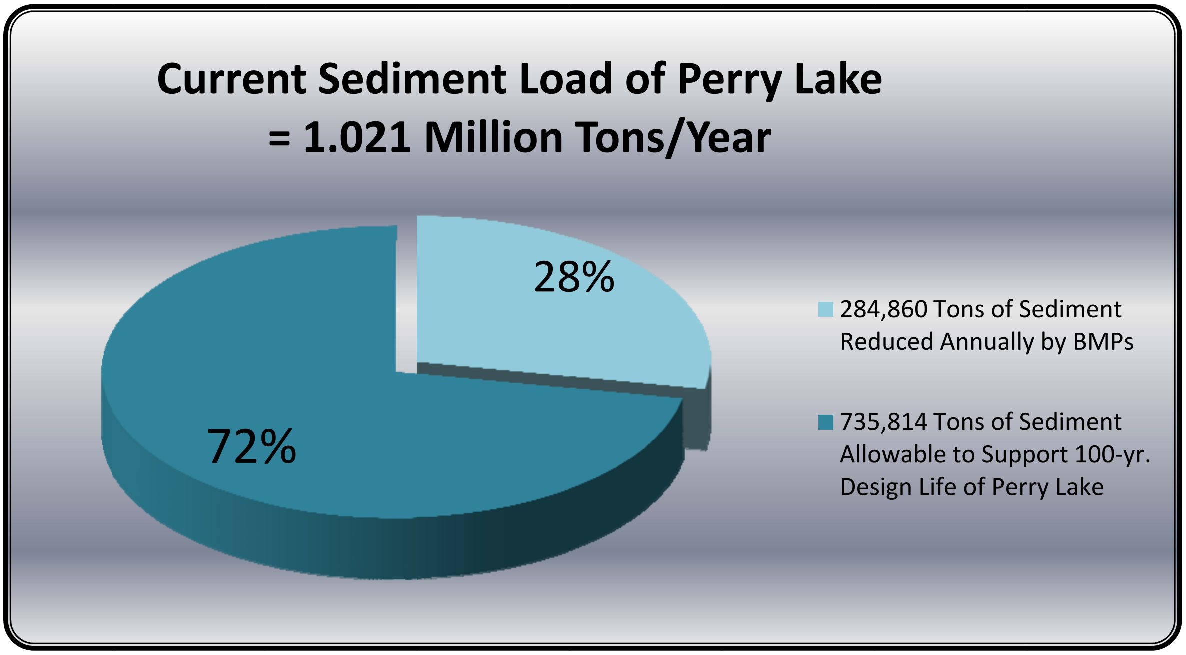
According to the Kansas Dept. of Health & Environment and the Kansas Water Office, the estimated sediment load reaching Perry Lake Reservoir from the watershed is 1.021 million tons/year (1,143 acre-feet/year). The estimated total load reduction needed to allow the reservoir to reach the desired 100-year Design Life for Sediment Storage is 284,860 tons/year (319 acre-feet/year), a 28% reduction (see **Figure 23**).

Sediment yield reductions necessary to achieve the protection goals for Perry Lake were broken down into BMP categories for Cropland, Streambank and Gully Erosion Control. The sediment load reduction needed from the BMPs in these categories is as follows:

Table 16: Sediment load reduction for Cropland, Streambank and Gully Control BMPs to meet the desired 100-year Design Life of Perry Lake

Best Management Practice Category	Total Load Reduction (tons)	% of Sediment Goal
Cropland	7,277	3%
Streambank	325,141	114%
Gullies	9,600	3%

Figure 23: Sediment Load Reduction Goal for Perry Lake



4.1.3 Sediment Load Reduction Goals for Mission Lake

A new high priority TMDL for Siltation was developed for Mission Lake in 2010 (18). The lake was dredged in 2010 at a cost of over $6,000,000 through the State Conservation Commission Water Supply Restoration Program. The rehabilitated lake will be used as a water supply for the city of Horton.

Bathymetric survey data collected by the Kansas Biological Survey in 2007 measured the pre-dredge surface area of Mission Lake in 2007 at 123 acres and the lake volume at 2,035 acre-feet. This represents a 45% reduction in original lake storage volume. Based on this information, the Kansas Water Office calculated that the annual sedimentation rate of the lake has been 10 acre-feet/year over the course of the lake's existence.

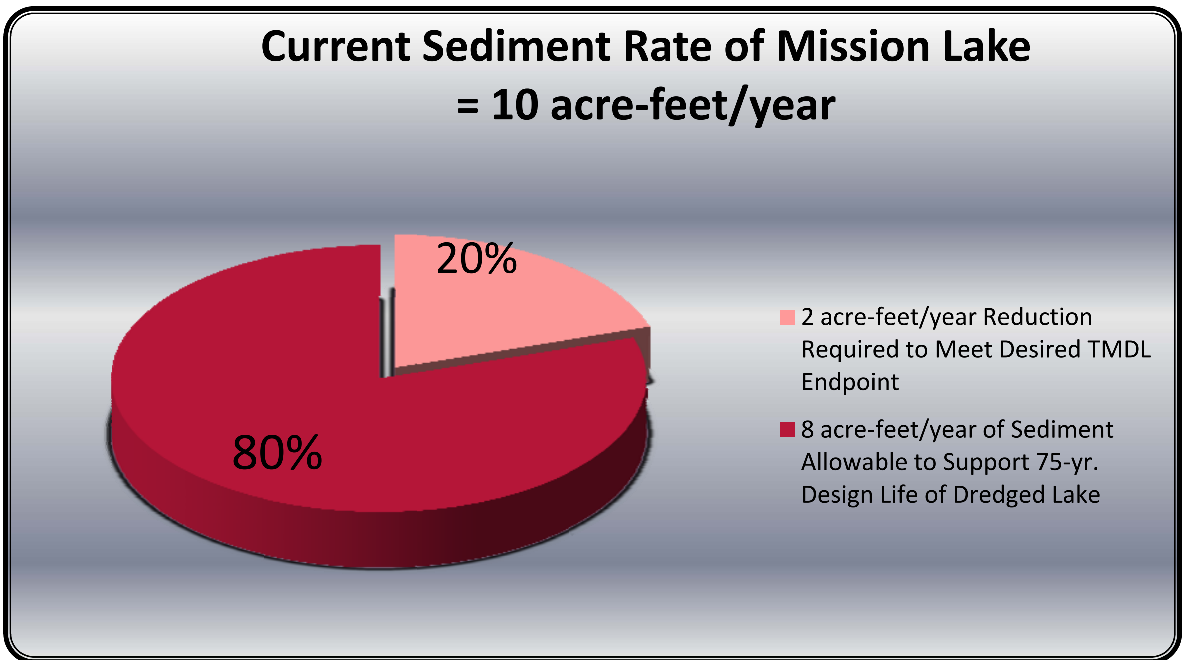
The 2010 dredging project removed approximately 1,000,000 cubic yards of sediment from Mission Lake, resulting in the restoration of 620 acre-feet of storage. The desired endpoint of the new Siltation TMDL was based on protecting the useful life of the lake for a minimum of 75 years. To meet this goal, it was calculated that the average sedimentation rate should not exceed more than 8 acre-feet/year. This represents a 20% reduction from the estimated current annual rate. At the desired sedimentation rate, the lake will take approximately 77 years to silt in to the pre-dredge condition (see **Figure 24).**

Sediment yield reductions necessary to achieve protection goals for Mission Lake were broken down into BMP Categories for cropland and streambank categories. The percent sediment load reduction needed from BMPs applied to Cropland and Streambanks to achieve these goals are as follows:

Table 17: Sediment load reduction from Cropland and Streambank BMPs to meet the desired 75-year Useable Life for Mission Lake

Best Management Practice Category	Total Load Reduction (tons)	% of Sediment TMDL
Cropland	103	6%
Streambank	1,700	96%
Total	**1,803**	**102%**
TMDL Reduction Goal = 1,774 Tons		

Figure 24: Sediment Load Reduction Goals to meet Siltation TMDL for Mission Lake



The drainage area for Mission Lake is relatively small (8.1 square miles) and wholly contained within a single HUC 12 area (HUC 102701030201). This HUC is located within the priority targeted area of Grasshopper Creek, a critical area for implementation of cropland and livestock BMPs. These BMPs are expected to reduce sediment and nutrient loading from non-point sources to Perry Lake, and will likewise provide the same benefit to the smaller Mission Lake. The close association of sediment with phosphorus will further result in reduction of algae bloom potential at Mission Lake. Atrazine levels in Mission Lake, the subject of a TMDL approved in 2000, will also be beneficially addressed by the implementation of BMPs designed to reduce sedimentation of Mission Lake.

4.1.4 Summary Tables for BMP Implementation to Address Sediment from Cropland Sources

Tables showing load reductions, implementation rates and costs for a 32-year plan implementation schedule of cropland BMPs to meet sediment goals for Perry Lake and Mission Lake are provided below.

Table 18: Summary of Cropland BMPs and implementation schedule fro the Cropland Targeted Areas (with associated load reductions) for Perry Lake

Perry Lake Annual Soil Erosion Reduction (tons), Cropland BMPs							
Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	13	19	89	95	0	12	**227**
2	27	38	177	189	0	24	**455**
3	40	57	266	284	0	35	**682**
4	54	76	355	378	0	47	**910**
5	67	95	443	473	0	59	**1,137**
6	81	113	532	567	0	71	**1,364**
7	94	132	620	662	0	83	**1,592**
8	108	151	709	756	0	95	**1,819**
9	121	170	798	851	0	106	**2,047**
10	135	189	886	946	0	118	**2,274**
11	148	208	975	1,040	0	130	**2,501**
12	162	227	1,064	1,135	0	142	**2,729**
13	175	246	1,152	1,229	0	154	**2,956**
14	189	265	1,241	1,324	0	165	**3,184**
15	202	284	1,330	1,418	0	177	**3,411**
16	216	303	1,418	1,513	0	189	**3,638**
17	229	321	1,507	1,607	0	201	**3,866**
18	243	340	1,596	1,702	0	213	**4,093**
19	256	359	1,684	1,796	0	225	**4,321**
20	269	378	1,773	1,891	0	236	**4,548**
21	283	397	1,861	1,986	0	248	**4,775**
22	296	416	1,950	2,080	0	260	**5,003**
23	310	435	2,039	2,175	0	272	**5,230**
24	323	454	2,127	2,269	0	284	**5,458**
25	337	473	2,216	2,364	0	295	**5,685**
26	350	492	2,305	2,458	0	307	**5,912**
27	364	511	2,393	2,553	0	319	**6,140**
28	377	529	2,482	2,647	0	331	**6,367**
29	391	548	2,571	2,742	0	343	**6,595**

Table 18 (continued): **Summary of cropland BMPs and implementation schedule for the cropland targeted areas (with associated load reductions) for Perry Lake**

Perry Lake Annual Soil Erosion Reduction (tons), Cropland BMPs							
Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
30	404	567	2,659	2,837	0	355	**6,822**
31	418	586	2,748	2,931	0	366	**7,049**
32	431	605	2,837	3,026	0	378	**7,277**

Sediment reduction goals for cropland BMPs met

Table 19: **Summary of Cropland BMPs and implementation schedule (with associated load reductions) to meet Mission Lake Siltation TMDL**

Mission Lake Annual Soil Erosion Reduction (tons), Cropland BMPs							
Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	0.19	0.27	1.26	1.34	0.00	0.17	**3.22**
2	0.38	0.54	2.51	2.68	0.00	0.34	**6.45**
3	0.57	0.80	3.77	4.02	0.00	0.50	**9.67**
4	0.76	1.07	5.03	5.36	0.00	0.67	**12.90**
5	0.96	1.34	6.29	6.70	0.00	0.84	**16.12**
6	1.15	1.61	7.54	8.05	0.00	1.01	**19.35**
7	1.34	1.88	8.80	9.39	0.00	1.17	**22.57**
8	1.53	2.15	10.06	10.73	0.00	1.34	**25.80**
9	1.72	2.41	11.31	12.07	0.00	1.51	**29.02**
10	1.91	2.68	12.57	13.41	0.00	1.68	**32.25**
11	2.10	2.95	13.83	14.75	0.00	1.84	**35.47**
12	2.29	3.22	15.09	16.09	0.00	2.01	**38.70**
13	2.48	3.49	16.34	17.43	0.00	2.18	**41.92**
14	2.68	3.75	17.60	18.77	0.00	2.35	**45.15**
15	2.87	4.02	18.86	20.11	0.00	2.51	**48.37**
16	3.06	4.29	20.11	21.45	0.00	2.68	**51.60**
17	3.25	4.56	21.37	22.80	0.00	2.85	**54.82**
18	3.44	4.83	22.63	24.14	0.00	3.02	**58.05**
19	3.63	5.10	23.88	25.48	0.00	3.18	**61.27**
20	3.82	5.36	25.14	26.82	0.00	3.35	**64.50**
21	4.01	5.63	26.40	28.16	0.00	3.52	**67.72**
22	4.20	5.90	27.66	29.50	0.00	3.69	**70.95**
23	4.39	6.17	28.91	30.84	0.00	3.86	**74.17**
24	4.59	6.44	30.17	32.18	0.00	4.02	**77.40**
25	4.78	6.70	31.43	33.52	0.00	4.19	**80.62**

Table 19 (continued): Summary of cropland BMPs and implementation schedule (with associated load reductions) to meet Mission Lake TMDL

Mission Lake Annual Soil Erosion Reduction (tons), Cropland BMPs							
Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
26	4.97	6.97	32.68	34.86	0.00	4.36	**83.85**
27	5.16	7.24	33.94	36.20	0.00	4.53	**87.07**
28	5.35	7.51	35.20	37.55	0.00	4.69	**90.30**
29	5.54	7.78	36.46	38.89	0.00	4.86	**93.52**
30	5.73	8.05	37.71	40.23	0.00	5.03	**96.75**
31	5.92	8.31	38.97	41.57	0.00	5.20	**99.97**
32	6.11	8.58	40.23	42.91	0.00	5.36	**103.20**

Sediment reduction goal for cropland BMPs has been met

Table 20: The 32-year Streambank Stabilization implementation scenario for priority areas based on sediment reduction goals established for Perry Lake by the Kansas Water Office. Note that Phase I and Phase II of the Delaware River Streambank Restoration Program and streambank stabilization projects completed through the Jackson Co. Conservation District in 2010 and 2011 are included in the first 3 lines of the table.

Delaware Watershed Annual Streambank Load Reductions and Cost for Perry Lake						
Year	Streambank Stabilization (feet)	Soil Load Reduction (tons)	Cumulative Erosion Reduction (tons)	Phosphorus Reduction (lbs)	Cumulative P Load Reduction (lbs)	Cost*
Phase I	6,283	23,310	23,310	1,399	1,399	$449,235
Phase II	7,300	27,083	50,393	1,625	3,024	$521,950
Jackson Co.	1,670	6,196	56,589	372	3,395	$119,405
1	2,262	8,392	64,981	504	3,899	$161,738
2	2,262	8,392	73,373	504	4,402	$166,590
3	2,262	8,392	81,765	504	4,906	$171,588
4	2,262	8,392	90,158	504	5,409	$176,735
5	2,262	8,392	98,550	504	5,913	$182,037
6	2,262	8,392	106,942	504	6,417	$187,498
7	2,262	8,392	115,335	504	6,920	$193,123
8	2,262	8,392	123,727	504	7,424	$198,917
9	2,262	8,392	132,119	504	7,927	$204,885
10	2,262	8,392	140,511	504	8,431	$211,031
11	2,262	8,392	148,904	504	8,934	$217,362

Table 20 (continued): Streambank stabilization scenario for Perry Lake

Delaware Watershed Annual Streambank Load Reductions and Cost for Perry Lake						
Year	Streambank Stabilization (feet)	Soil Load Reduction (tons)	Cumulative Erosion Reduction (tons)	Phosphorus Reduction (lbs)	Cumulative P Load Reduction (lbs)	Cost*
12	2,262	8,392	157,296	504	9,438	$223,883
13	2,262	8,392	165,688	504	9,941	$230,599
14	2,262	8,392	174,080	504	10,445	$237,517
15	2,262	8,392	182,473	504	10,948	$244,643
16	2,262	8,392	190,865	504	11,452	$251,982
17	2,262	8,392	199,257	504	11,955	$259,542
18	2,262	8,392	207,649	504	12,459	$267,328
19	2,262	8,392	216,042	504	12,963	$275,348
20	2,262	8,392	224,434	504	13,466	$283,608
21	2,262	8,392	232,826	504	13,970	$292,116
22	2,262	8,392	241,219	504	14,473	$300,880
23	2,262	8,392	249,611	504	14,977	$309,906
24	2,262	8,392	258,003	504	15,480	$319,203
25	2,262	8,392	266,395	504	15,984	$328,780
26	2,262	8,392	274,788	504	16,487	$338,643
27	2,262	8,392	283,180	504	16,991	$348,802
28	2,262	8,392	291,572	504	17,494	$359,266
29	2,262	8,392	299,964	504	17,998	$370,044
30	2,262	8,392	308,357	504	18,501	$381,146
31	2,262	8,392	316,749	504	19,005	$392,580
32	2,262	8,392	325,141	504	19,508	$404,357

*3% Inflation

Table 21: Streambank Stabilization implementation scenario based on TMDL sediment reduction goals for Mission Lake

Mission Lake Annual Streambank Load Reductions and Cost						
Year	Streambank Stabilization (feet)	Soil Load Reduction (tons)	Cumulative Erosion Reduction (tons)	Phosphorous Reduction (lbs)	Cumulative P Load Reduction (lbs)	Cost*
1	170	340	340	20	20	$12,155
2	170	340	680	20	41	$12,155
3	170	340	1,020	20	61	$12,155
4	170	340	1,360	20	82	$12,155
5	170	340	1,700	20	102	$12,155

*3% Inflation

Note: The streambank stabilization implementation scenario for Mission Lake illustrated in Table 21 is based on the following assumptions:

(1) Mitigation work in the watershed above Mission Lake that will be completed as a requirement of the lake dredging project will include in-channel or streambank stabilization practices

(2) Estimates are based on the statewide streambank erosion rate of 2 tons/foot/year.

Table 22: Combined sediment load reduction goals for Perry Lake from Cropland, Streambank Stabilization and Gully BMPs in the Delaware Watershed over a 32-year implementation schedule. Implementation of these BMPs in targeted areas will accomplish the SLT goal of allowing Perry Lake Reservoir to reach the desired 100-year Design Life for sediment storage.

Combined Sediment Reduction by Category for Perry Lake					
Year	Streambank Reduction (tons)	Cropland Reduction (tons)	Gully Reduction (tons)	Total Reduction (tons)	% of Goal
1	64,981	227	300	65,508	23%
2	73,373	455	600	74,428	26%
3	81,765	682	900	83,348	29%
4	90,158	910	1,200	92,267	32%
5	98,550	1,137	1,500	101,187	36%
6	106,942	1,364	1,800	110,107	39%
7	115,335	1,592	2,100	119,026	42%
8	123,727	1,819	2,400	127,946	45%
9	132,119	2,047	2,700	136,866	48%
10	140,511	2,274	3,000	145,785	51%
11	148,904	2,501	3,300	154,705	54%
12	157,296	2,729	3,600	163,625	57%
13	165,688	2,956	3,900	172,544	61%
14	174,080	3,184	4,200	181,464	64%
15	182,473	3,411	4,500	190,384	67%
16	190,865	3,638	4,800	199,303	70%
17	199,257	3,866	5,100	208,223	73%
18	207,649	4,093	5,400	217,143	76%
19	216,042	4,321	5,700	226,062	79%
20	224,434	4,548	6,000	234,982	82%
21	232,826	4,775	6,300	243,902	86%
22	241,219	5,003	6,600	252,821	89%
23	249,611	5,230	6,900	261,741	92%
24	258,003	5,458	7,200	270,661	95%
25	266,395	5,685	7,500	279,580	98%

Table 22 (continued): Combined sediment load reductions from BMPs for Perry Lake

Combined Sediment Reduction by Category for Perry Lake					
Year	Streambank Reduction (tons)	Cropland Reduction (tons)	Gully Reduction (tons)	Total Reduction (tons)	% of Goal
26	274,788	5,912	7,800	288,500	101%
27	283,180	6,140	8,100	297,420	104%
28	291,572	6,367	8,400	306,339	108%
29	299,964	6,595	8,700	315,259	111%
30	308,357	6,822	9,000	324,179	114%
31	316,749	7,049	9,300	333,098	117%
32	325,141	7,277	9,600	342,018	120%
Load Reduction to meet Sediment Goal:					284,860

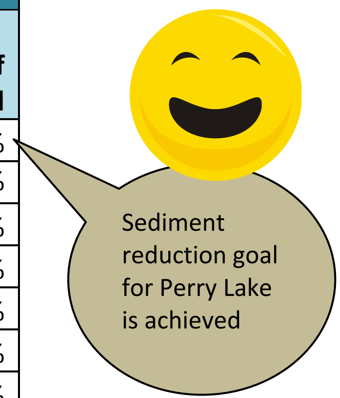


Table 23: Combined sediment load reductions for Mission Lake from Streambank stabilization and Cropland BMPs. Implementation of these BMPs will accomplish the TMDL desired endpoint that will allow Mission Lake to meet water quality standards and support designated uses for a minimum of 75 years.

Combined Sediment Reduction by Category for Mission Lake				
Year	Streambank Reduction (tons)	Cropland Reduction (tons)	Total Reduction (tons)	% of Goal
1	340	3	343	19%
2	680	6	686	39%
3	1,020	10	1,030	58%
4	1,360	13	1,373	77%
5	1,700	16	1,716	97%
6	1,700	19	1,719	97%
7	1,700	23	1,723	97%
8	1,700	26	1,726	97%
9	1,700	29	1,729	97%
10	1,700	32	1,732	98%
11	1,700	35	1,735	98%
12	1,700	39	1,739	98%
13	1,700	42	1,742	98%
14	1,700	45	1,745	98%
15	1,700	48	1,748	99%
16	1,700	52	1,752	99%

Table 23 (continued): Combined streambank sediment reductions for Mission Lake

Combined Sediment Reduction by Category for Mission Lake				
Year	Streambank Reduction (tons)	Cropland Reduction (tons)	Total Reduction (tons)	% of Goal
17	1,700	55	1,755	99%
18	1,700	58	1,758	99%
19	1,700	61	1,761	99%
20	1,700	64	1,764	99%
21	1,700	68	1,768	100%
22	1,700	71	1,771	100%
23	1,700	74	1,774	100%
24	1,700	77	1,777	100%
25	1,700	81	1,781	100%
26	1,700	84	1,784	101%
27	1,700	87	1,787	101%
28	1,700	90	1,790	101%
29	1,700	94	1,794	101%
30	1,700	97	1,797	101%
31	1,700	100	1,800	101%
32	1,700	103	1,803	102%
Load Reduction to meet Sedimentation TMDL:				1,774

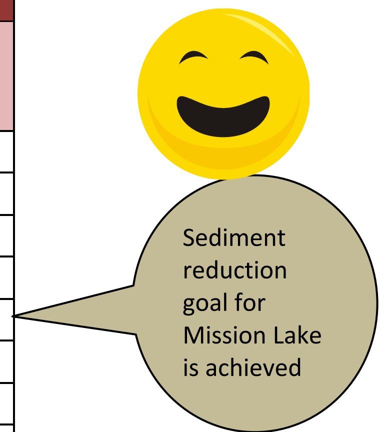


Table 24: Annual adoption rate of the 6 priority Cropland BMPs necessary to achieve load reduction goals for Perry Lake over a 32-year implementation period

Perry Lake Annual Adoption (treated acres), Cropland BMPs							
Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
1	73	244	611	977	415	122	2,444
2	73	244	611	977	415	122	2,444
3	73	244	611	977	415	122	2,444
4	73	244	611	977	415	122	2,444
5	73	244	611	977	415	122	2,444
6	73	244	611	977	415	122	2,444
7	73	244	611	977	415	122	2,444
8	73	244	611	977	415	122	2,444
9	73	244	611	977	415	122	2,444

Table 24 (continued): Annual adoption rate of priority Cropland BMPs to achieve sediment load reductions goals for Perry Lake

Perry Lake Annual Adoption (treated acres), Cropland BMPs							
Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
10	73	244	611	977	415	122	2,444
11	73	244	611	977	415	122	2,444
12	73	244	611	977	415	122	2,444
13	73	244	611	977	415	122	2,444
14	73	244	611	977	415	122	2,444
15	73	244	611	977	415	122	2,444
16	73	244	611	977	415	122	2,444
17	73	244	611	977	415	122	2,444
18	73	244	611	977	415	122	2,444
19	73	244	611	977	415	122	2,444
20	73	244	611	977	415	122	2,444
21	73	244	611	977	415	122	2,444
22	73	244	611	977	415	122	2,444
23	73	244	611	977	415	122	2,444
24	73	244	611	977	415	122	2,444
25	73	244	611	977	415	122	2,444
26	73	244	611	977	415	122	2,444
27	73	244	611	977	415	122	2,444
28	73	244	611	977	415	122	2,444
29	73	244	611	977	415	122	2,444
30	73	244	611	977	415	122	2,444
31	73	244	611	977	415	122	2,444
32	73	244	611	977	415	122	2,444

Table 25: Annual adoption rate of 6 priority Cropland BMPs to achieve sediment load reduction goals for Mission Lake over a 32-year implementation period

Mission Lake Annual Adoption (treated acres), Cropland BMPs							
Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
1	2.39	7.97	19.91	31.86	13.54	3.98	79.65
2	2.39	7.97	19.91	31.86	13.54	3.98	79.65
3	2.39	7.97	19.91	31.86	13.54	3.98	79.65
4	2.39	7.97	19.91	31.86	13.54	3.98	79.65

Table 25 (continued): Annual adoption rate of priority Cropland BMPs to achieve sediment load reductions goals for Mission Lake

Mission Lake Annual Adoption (treated acres), Cropland BMPs							
Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
5	2.39	7.97	19.91	31.86	13.54	3.98	79.65
6	2.39	7.97	19.91	31.86	13.54	3.98	79.65
7	2.39	7.97	19.91	31.86	13.54	3.98	79.65
8	2.39	7.97	19.91	31.86	13.54	3.98	79.65
9	2.39	7.97	19.91	31.86	13.54	3.98	79.65
10	2.39	7.97	19.91	31.86	13.54	3.98	79.65
11	2.39	7.97	19.91	31.86	13.54	3.98	79.65
12	2.39	7.97	19.91	31.86	13.54	3.98	79.65
13	2.39	7.97	19.91	31.86	13.54	3.98	79.65
14	2.39	7.97	19.91	31.86	13.54	3.98	79.65
15	2.39	7.97	19.91	31.86	13.54	3.98	79.65
16	2.39	7.97	19.91	31.86	13.54	3.98	79.65
17	2.39	7.97	19.91	31.86	13.54	3.98	79.65
18	2.39	7.97	19.91	31.86	13.54	3.98	79.65
19	2.39	7.97	19.91	31.86	13.54	3.98	79.65
20	2.39	7.97	19.91	31.86	13.54	3.98	79.65
21	2.39	7.97	19.91	31.86	13.54	3.98	79.65
22	2.39	7.97	19.91	31.86	13.54	3.98	79.65
23	2.39	7.97	19.91	31.86	13.54	3.98	79.65
24	2.39	7.97	19.91	31.86	13.54	3.98	79.65
25	2.39	7.97	19.91	31.86	13.54	3.98	79.65
26	2.39	7.97	19.91	31.86	13.54	3.98	79.65
27	2.39	7.97	19.91	31.86	13.54	3.98	79.65
28	2.39	7.97	19.91	31.86	13.54	3.98	79.65
29	2.39	7.97	19.91	31.86	13.54	3.98	79.65
30	2.39	7.97	19.91	31.86	13.54	3.98	79.65
31	2.39	7.97	19.91	31.86	13.54	3.98	79.65
32	2.39	7.97	19.91	31.86	13.54	3.98	79.65

4.2 Nutrients

Nutrient loading is a high priority water resource issue in the Delaware River Watershed. Impairment of Perry Lake Reservoir caused by excessive nutrient loading from the watershed has resulted in the creation of a high priority TMDL for Eutrophication for Perry Lake Reservoir in 2010 (19). A TMDL for Eutrophication for Mission Lake was also approved in January 2000 (20).

Nutrient-related pollutant problems include eutrophication (rapid lake aging and excessive algae growth), negative impacts on aquatic species and reduced recreational value of lakes. Algae blooms that result from high nutrient loads in lakes and streams may release toxins that are harmful to humans, livestock and other animals, cause taste and odor problems in drinking water and increase drinking water treatment costs. Heavy algae blooms can cause the depletion of oxygen levels in water leading to fish kills, and also impacts water pH levels. Although eutrophication is a natural process that occurs at some rate in all water bodies, human activity in the watershed that increases nutrient loads in streams and lakes typically accelerates the process.

4.2.1 Impairment Sources

Excessive nutrient (primarily nitrogen and phosphorus) enrichment is most troublesome for lakes and wetlands where nutrient-rich waters are impounded. Although nutrients can come from a variety of sources, major sources in the Delaware River Watershed include:

- Fertilizer runoff from cropland, pastures, lawns and other places where fertilizers are applied
- Runoff containing livestock manures, especially where livestock are in close proximity to water; wildlife wastes can be a contributing source although only in rare instances
- Streambank sources (primarily phosphorus that is attached to eroded streambank soils)
- Human wastes from failing septic systems or ineffective municipal wastewater treatment systems
- Phosphorus recycling within lakes from sediment deposits
- Atmospheric deposition

In order to address eutrophication, nutrient load reductions must take place in the watershed area above impacted lakes through the application of BMPs to address the watershed's most significant nutrient sources.

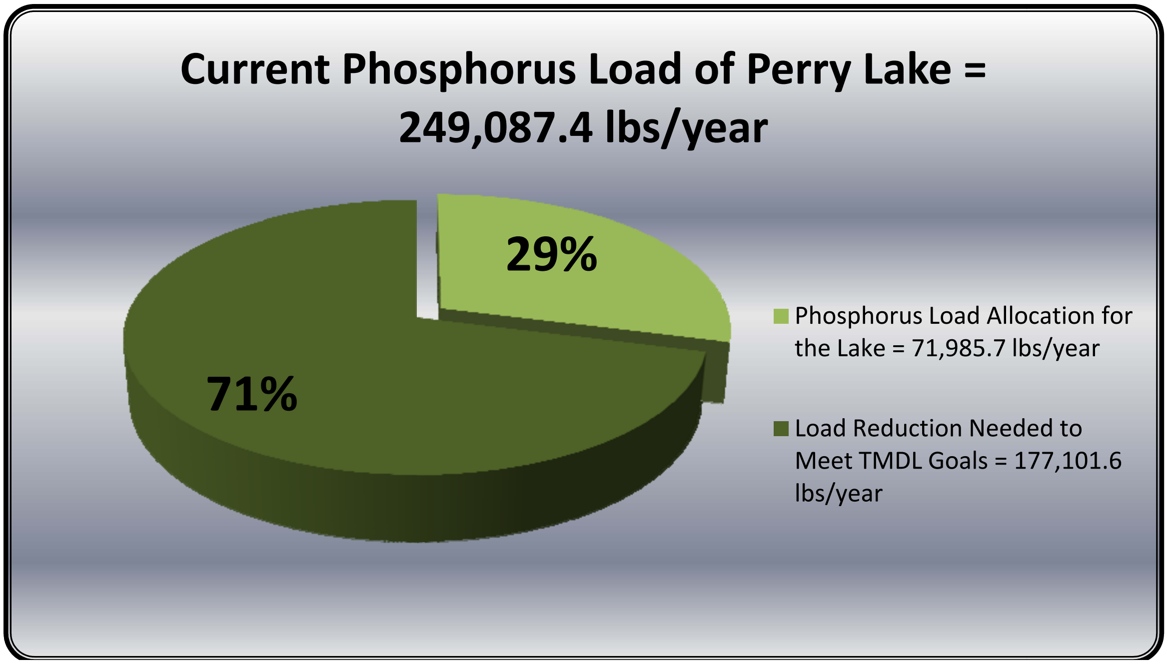
As with sediment, agricultural sources of nitrogen and phosphorus are of greatest concern. Fertilizers applied to cropland, pastures and hayland can move with runoff water into streams and lakes. Phosphorus, which attaches to soil particles, also impacts lakes when soil erosion washes sediment into stream and lakes. Livestock wastes are also a significant source of nitrogen and phosphorus. When the location of feeding sites or shelter causes livestock to concentrate in riparian areas, or when livestock utilize streams and ponds for water, nutrients in animal manures deposited directly in water and riparian areas are a major source of nutrients. For this reason, Delaware River WRAPS has placed a heavy emphasis on controlling livestock wastes as a means to achieving watershed goals related to nutrient load reductions.

4.2.2 Nutrient Load Reduction Goals – Perry Lake TMDL

4.2.2.a Phosphorus

The Kansas Dept. of Health & Environment estimates the phosphorus load reaching Perry Lake from the watershed and originating from non-point sources to be 249,087.4 lbs/year. The load allocation for the system (that is the maximum load of a pollutant a water body or system can absorb without adverse impact, as set forth in a TMDL) is 71,985.7 lbs/year. Therefore, to achieve the Eutrophicaton TMDL goal established for Perry Lake in 2010, a reduction of 177,101.6 lbs/year will be needed. This represents a **71% reduction** in phosphorus loading from the watershed (19).

Figure 25: Phosphorus Load Reduction Goal to meet Perry Lake Eutrophication TMDL



Phosphorus load reductions are achieved primarily through the application of cropland and livestock BMPs. Phosphorus yield reductions necessary to achieve the Eutrophication TMDL goals for Perry Lake were broken down into BMPs Categories for Cropland, Livestock, Gully and Streambank sources (to match BMP implementation categories). The percent load reduction of phosphorus for these BMP types are illustrated below:

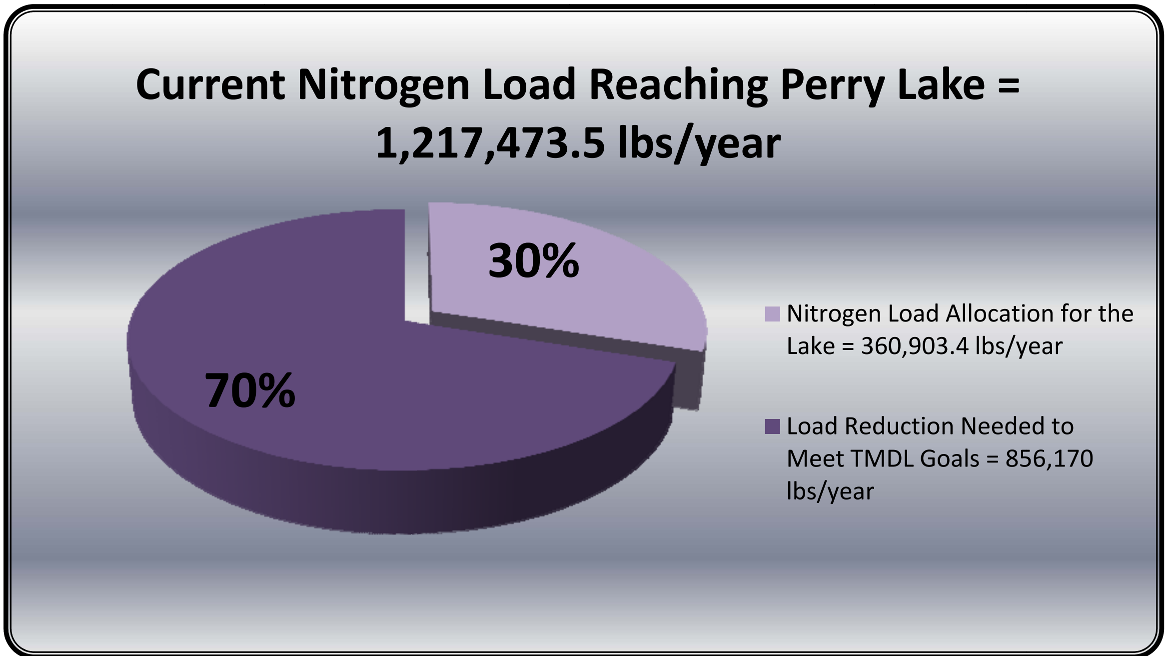
Table 26: Phosphorus load reduction goals from implementation of Cropland, Livestock, Gully Control and Streambank BMPs to meet the Eutrophication TMDL goals for Perry Lake

Best Management Practice Category	Total Load Reduction (pounds)	% of Phosphorous TMDL
Cropland	73,610	42%
Livestock	88,082	50%
Gullies	576	0.3%
Streambank	19,508	11%
Total	**181,776**	**103%**
TMDL Reduction Goal = 177,102 Pounds		

4.2.2.b Nitrogen

The estimated current nitrogen load reaching Perry Lake from the watershed from non-point sources is 1,217,473.5 lbs/year. The load allocation for the system (the maximum load of a pollutant a water body or system can absorb without adverse impact as set forth in a TMDL) is 360,903.4 lbs/year. Therefore, to achieve the Eutrophication TMDL goal for Perry Lake, a reduction of 856,570.1 lbs/year will be needed. This is a **70% reduction** in nitrogen loading from the watershed (19).

Figure 26: Nitrogen Load Reduction Goal to meet Perry Lake Eutrophication TMDL



Nitrogen load reductions are achieved primarily through the application of Cropland and Streambank BMPs. Load reductions achieved through application of selected BMPs are illustrated in **Table 4-13**.

Table 27: Nitrogen load reduction goals from implementation of Cropland, Livestock, Gully Control and Streambank BMPs to meet Eutrophication TMDL goals for Perry Lake

Best Management Practice Category	Total Load Reduction (pounds)	% of Nitrogen TMDL
Cropland	323,123	38%
Livestock	165,902	19%
Gullies	12,768	1%
Streambank	432,438	51%
Total	**934,231**	**109%**
TMDL Reduction Goal = 856,170 Lbs.		

4.2.2.c Impact of NPDES Facilities on Nutrients in the Watershed

There are several municipal and industrial wastewater facilities in the watershed that contribute regulated and permitted discharges of nutrients to streams. Discharging lagoon systems include the City of Holton and Oldham's LLC (located in Holton). Wasteload allocations for the City of Holton lagoon system has an average discharge of 2.04 mg/L of Total Phosphorus and 7.17mg/L of Total Nitrogen, discharging up to 0.66 MGD (Million Gallons/Day). Wasteload allocations for the lagoon system at Oldham's LLC has an average discharge of 1.35 mg/L of Total Phosphorus and 5.35 mg/L of Total Nitrogen, discharging up to 0.279 MGD. In addition, the wastewater treatment plant for the City of Sabetha discharges up to 0.75 MGD into the Delaware River, contributing an average of 2.69 mg/L total Phosphorus and 5.97 mg/L of Total Nitrogen. Since these wastewater facilities (point sources) are regulated and approved through the Kansas Department of Health and Environment NPDES permit system, they are not subject to load reduction activities associated with TMDL wasteload reduction goals. The 177,101 lbs/yr of phosphorus reduction and 856,170 lbs/yr of nitrogen needed to meet the Eutrophication TMDL endpoints for Perry Lake will be gained from other, nonpoint sources of pollution.

See **Table 7** for a list containing the wastewater facilities in the watershed that discharge nutrients into receiving streams in the watershed.

4.2.3 Summary Tables for BMP Implementation to Address Nutrients from Livestock Waste Sources

The following pages contain tables summarizing nutrient load reductions, implementation rates required and cost estimates for a 32-year plan implementation of priority livestock BMPs to meet load reduction goals.

Table 28: Phosphorus load reductions expected from implementation of Livestock BMPs with associated adoption rates needed to achieve TMDL endpoints over 32-year period

Annual Phosphorus Load Reductions (lbs)						
Year	**Vegetative Filter Strip**	**Relocate Feeding Pens**	**Relocate Pasture Feeding Site**	**Off Stream Watering System**	**Rotational Grazing**	**Annual Load Reduction**
1	1,276	957	152	228	140	**2,753**
2	2,552	1,914	304	456	280	**5,505**
3	3,827	2,870	456	684	420	**8,258**
4	5,103	3,827	608	912	560	**11,010**
5	6,379	4,784	760	1,140	700	**13,763**
6	7,655	5,741	912	1,368	840	**16,515**
7	8,930	6,698	1,064	1,596	980	**19,268**
8	10,206	7,655	1,216	1,824	1,120	**22,021**
9	11,482	8,611	1,368	2,052	1,260	**24,773**
10	12,758	9,568	1,520	2,280	1,400	**27,526**

Table 28 (continued): Phosphorus load reductions expected from implementation of livestock BMPs with associated adoption rates needed to achieve TMDL endpoints over 32-year period.

Annual Phosphorus Load Reductions (lbs)						
Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Annual Load Reduction
11	14,033	10,525	1,672	2,508	1,540	**30,278**
12	15,309	11,482	1,824	2,736	1,680	**33,031**
13	16,585	12,439	1,976	2,964	1,820	**35,783**
14	17,861	13,395	2,128	3,192	1,960	**38,536**
15	19,136	14,352	2,280	3,420	2,100	**41,288**
16	20,412	15,309	2,432	3,648	2,240	**44,041**
17	21,688	16,266	2,584	3,876	2,380	**46,794**
18	22,964	17,223	2,736	4,104	2,520	**49,546**
19	24,239	18,179	2,888	4,332	2,660	**52,299**
20	25,515	19,136	3,040	4,560	2,800	**55,051**
21	26,791	20,093	3,192	4,788	2,940	**57,804**
22	28,067	21,050	3,344	5,016	3,080	**60,556**
23	29,342	22,007	3,496	5,244	3,220	**63,309**
24	30,618	22,964	3,648	5,472	3,360	**66,062**
25	31,894	23,920	3,800	5,700	3,500	**68,814**
26	33,170	24,877	3,952	5,928	3,640	**71,567**
27	34,445	25,834	4,104	6,156	3,780	**74,319**
28	35,721	26,791	4,256	6,384	3,920	**77,072**
29	36,997	27,748	4,408	6,612	4,060	**79,824**
30	38,273	28,704	4,560	6,840	4,200	**82,577**
31	39,548	29,661	4,712	7,068	4,340	**85,329**
32	40,824	30,618	4,864	7,296	4,480	**88,082**

Phosphorus reduction goals for livestock BMPs achieved

Table 29: Nitrogen load reductions expected from implementation of Livestock BMPs with associated adoption rates needed to achieve TMDL endpoints over 32-year period

Annual Nitrogen Load Reduction (lbs)						
Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Annual Load Reduction
1	2,403	1,802	286	429	264	**5,184**
2	4,806	3,604	573	859	527	**10,369**
3	7,209	5,406	859	1,288	791	**15,553**
4	9,612	7,209	1,145	1,718	1,055	**20,738**
5	12,014	9,011	1,431	2,147	1,318	**25,922**
6	14,417	10,813	1,718	2,577	1,582	**31,107**
7	16,820	12,615	2,004	3,006	1,846	**36,291**
8	19,223	14,417	2,290	3,436	2,110	**41,476**
9	21,626	16,219	2,577	3,865	2,373	**46,660**
10	24,029	18,022	2,863	4,294	2,637	**51,845**
11	26,432	19,824	3,149	4,724	2,901	**57,029**
12	28,835	21,626	3,436	5,153	3,164	**62,213**
13	31,237	23,428	3,722	5,583	3,428	**67,398**
14	33,640	25,230	4,008	6,012	3,692	**72,582**
15	36,043	27,032	4,294	6,442	3,955	**77,767**
16	38,446	28,835	4,581	6,871	4,219	**82,951**
17	40,849	30,637	4,867	7,300	4,483	**88,136**
18	43,252	32,439	5,153	7,730	4,746	**93,320**
19	45,655	34,241	5,440	8,159	5,010	**98,505**
20	48,058	36,043	5,726	8,589	5,274	**103,689**
21	50,460	37,845	6,012	9,018	5,537	**108,873**
22	52,863	39,647	6,298	9,448	5,801	**114,058**
23	55,266	41,450	6,585	9,877	6,065	**119,242**
24	57,669	43,252	6,871	10,307	6,329	**124,427**
25	60,072	45,054	7,157	10,736	6,592	**129,611**
26	62,475	46,856	7,444	11,165	6,856	**134,796**
27	64,878	48,658	7,730	11,595	7,120	**139,980**
28	67,281	50,460	8,016	12,024	7,383	**145,165**
29	69,683	52,263	8,302	12,454	7,647	**150,349**
30	72,086	54,065	8,589	12,883	7,911	**155,534**
31	74,489	55,867	8,875	13,313	8,174	**160,718**
32	76,892	57,669	9,161	13,742	8,438	**165,902**

Nitrogen reduction goal for Livestock BMPs achieved

Table 30: Illustration of annual adoption rates of the 5 Priority Livestock BMPs needed to achieve nutrient load reductions goals over the 32-year implementation period

Annual Livestock BMP Adoption					
Year	**Vegetative Filter Strip**	**Relocate Feeding Pens**	**Relocate Pasture Feeding Site**	**Off Stream Watering System**	**Rotational Grazing**
1	2	1	2	3	1
2	2	1	2	3	1
3	2	1	2	3	1
4	2	1	2	3	1
5	2	1	2	3	1
6	2	1	2	3	1
7	2	1	2	3	1
8	2	1	2	3	1
9	2	1	2	3	1
10	2	1	2	3	1
11	2	1	2	3	1
12	2	1	2	3	1
13	2	1	2	3	1
14	2	1	2	3	1
15	2	1	2	3	1
16	2	1	2	3	1
17	2	1	2	3	1
18	2	1	2	3	1
19	2	1	2	3	1
20	2	1	2	3	1
21	2	1	2	3	1
22	2	1	2	3	1
23	2	1	2	3	1
24	2	1	2	3	1
25	2	1	2	3	1
26	2	1	2	3	1
27	2	1	2	3	1
28	2	1	2	3	1
29	2	1	2	3	1
30	2	1	2	3	1
31	2	1	2	3	1
32	2	1	2	3	1
Total	**64**	**32**	**64**	**96**	**32**

4.2.4 Summary Tables for Cropland BMP Implementation for Additional Nutrient Load Reduction from Cropland Sources

Cropland BMPs that reduce sedimentation also address nutrient load reductions. The following pages contain tables which summarize nutrient load reductions, adoption rates and cost estimates for a 32-year implementation schedule of cropland BMPs to help meet nutrient reduction goals.

Table 31: Phosphorus load reductions expected from implementation of Cropland BMPs with associated adoption rates needed to achieve TMDL endpoints over 32-year period for Perry Lake

Perry Lake Annual Phosphorous Reduction (pounds), Cropland BMPs							
Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	137	192	481	961	409	120	**2,300**
2	274	385	961	1,923	817	240	**4,601**
3	411	577	1,442	2,884	1,226	361	**6,901**
4	548	769	1,923	3,846	1,634	481	**9,201**
5	685	961	2,404	4,807	2,043	601	**11,502**
6	822	1,154	2,884	5,769	2,452	721	**13,802**
7	959	1,346	3,365	6,730	2,860	841	**16,102**
8	1,096	1,538	3,846	7,692	3,269	961	**18,402**
9	1,233	1,731	4,327	8,653	3,678	1,082	**20,703**
10	1,370	1,923	4,807	9,615	4,086	1,202	**23,003**
11	1,507	2,115	5,288	10,576	4,495	1,322	**25,303**
12	1,644	2,308	5,769	11,538	4,903	1,442	**27,604**
13	1,781	2,500	6,250	12,499	5,312	1,562	**29,904**
14	1,918	2,692	6,730	13,460	5,721	1,683	**32,204**
15	2,055	2,884	7,211	14,422	6,129	1,803	**34,505**
16	2,192	3,077	7,692	15,383	6,538	1,923	**36,805**
17	2,329	3,269	8,172	16,345	6,947	2,043	**39,105**
18	2,466	3,461	8,653	17,306	7,355	2,163	**41,405**
19	2,603	3,654	9,134	18,268	7,764	2,283	**43,706**
20	2,740	3,846	9,615	19,229	8,172	2,404	**46,006**
21	2,877	4,038	10,095	20,191	8,581	2,524	**48,306**
22	3,014	4,230	10,576	21,152	8,990	2,644	**50,607**
23	3,151	4,423	11,057	22,114	9,398	2,764	**52,907**
24	3,288	4,615	11,538	23,075	9,807	2,884	**55,207**
25	3,425	4,807	12,018	24,037	10,216	3,005	**57,508**
26	3,562	5,000	12,499	24,998	10,624	3,125	**59,808**
27	3,699	5,192	12,980	25,959	11,033	3,245	**62,108**

Table 31 (continued): Phosphorus load reductions expected from Implementation of Cropland BMPs with associated adoption rates necessary to achieve TMDL endpoints over 32-year period for Perry Lake.

Perry Lake Annual Phosphorous Reduction (pounds), Cropland BMPs							
Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
28	3,836	5,384	13,460	26,921	11,441	3,365	**64,408**
29	3,973	5,576	13,941	27,882	11,850	3,485	**66,709**
30	4,110	5,769	14,422	28,844	12,259	3,605	**69,009**
31	4,247	5,961	14,903	29,805	12,667	3,726	**71,309**
32	4,384	6,153	15,383	30,767	13,076	3,846	**73,610**

Phosphorus reduction goals for cropland BMPs achieved

Table 32: Nitrogen load reductions expected from implementation of Cropland BMPs with associated adoption rated needed to achieve TMDL endpoints over a 32-year implementation period for Perry Lake

Annual Nitrogen Reduction (pounds), Cropland BMPs							
Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	794	1,114	1,741	2,786	3,315	348	**10,098**
2	1,588	2,228	3,482	5,571	6,630	696	**20,195**
3	2,382	3,343	5,223	8,357	9,944	1,045	**30,293**
4	3,176	4,457	6,964	11,142	13,259	1,393	**40,390**
5	3,969	5,571	8,705	13,928	16,574	1,741	**50,488**
6	4,763	6,685	10,446	16,713	19,889	2,089	**60,586**
7	5,557	7,800	12,187	19,499	23,204	2,437	**70,683**
8	6,351	8,914	13,928	22,284	26,518	2,786	**80,781**
9	7,145	10,028	15,669	25,070	29,833	3,134	**90,878**
10	7,939	11,142	17,410	27,855	33,148	3,482	**100,976**
11	8,733	12,256	19,151	30,641	36,463	3,830	**111,074**
12	9,527	13,371	20,892	33,427	39,778	4,178	**121,171**
13	10,320	14,485	22,633	36,212	43,092	4,527	**131,269**
14	11,114	15,599	24,373	38,998	46,407	4,875	**141,366**
15	11,908	16,713	26,114	41,783	49,722	5,223	**151,464**
16	12,702	17,827	27,855	44,569	53,037	5,571	**161,561**
17	13,496	18,942	29,596	47,354	56,352	5,919	**171,659**
18	14,290	20,056	31,337	50,140	59,666	6,267	**181,757**
19	15,084	21,170	33,078	52,925	62,981	6,616	**191,854**
20	15,878	22,284	34,819	55,711	66,296	6,964	**201,952**

Table 32 (continued): Nitrogen load reductions expected from implementation of Cropland BMPs with associated adoption rates needed to achieve TMDL endpoints over 32-year period for Perry Lake.

Annual Nitrogen Reduction (pounds), Cropland BMPs							
Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
21	16,671	23,399	36,560	58,496	69,611	7,312	**212,049**
22	17,465	24,513	38,301	61,282	72,926	7,660	**222,147**
23	18,259	25,627	40,042	64,067	76,240	8,008	**232,245**
24	19,053	26,741	41,783	66,853	79,555	8,357	**242,342**
25	19,847	27,855	43,524	69,639	82,870	8,705	**252,440**
26	20,641	28,970	45,265	72,424	86,185	9,053	**262,537**
27	21,435	30,084	47,006	75,210	89,499	9,401	**272,635**
28	22,229	31,198	48,747	77,995	92,814	9,749	**282,733**
29	23,023	32,312	50,488	80,781	96,129	10,098	**292,830**
30	23,816	33,427	52,229	83,566	99,444	10,446	**302,928**
31	24,610	34,541	53,970	86,352	102,759	10,794	**313,025**
32	25,404	35,655	55,711	89,137	106,073	11,142	**323,123**

Nitrogen reduction goals for cropland BMPs achieved

4.2.5 Summary Tables for Streambank Stabilization and Gully Reduction BMP Implementation for Additional Nutrient Load Reduction from Streambank and Gully Erosion Sources

Streambank stabilization and gully erosion reduction practices discussed earlier (**Part 3)** not only effectively reduce soil erosion and sedimentation issues, but also address nutrient issues as well. This occurs as the amount of soil eroded from within the stream channel, the riparian zone and in near-riparian areas is reduced. Soil-attached nutrients are kept out of streams while nutrient-laden runoff is slowed and retained on the land, allowing an overall reduction in nutrient levels through filtration, absorption and other processes before runoff enters the stream system.

In order to meet the Eutrophication TMDL for Perry Lake, reductions from streambank and gully BMPs are necessary. In fact, at least 11% of the phosphorus load reduction and 54% of the nitrogen load reduction needed to accomplish TMDL endpoints are estimated to come from streambank and gully BMPs.

Following are two tables that summarize the load reductions expected over a 32-year implementation period for streambank stabilization and gully erosion reduction BMPs.

Table 33: Phosphorus load reductions from Streambank Stabilization and Gully Control BMPs in the Delaware River Watershed over a 32-year implementation period

Phosphorous			
Year	Streambank Reduction (lbs)	Gully Reduction (lbs)	Annual Load Reduction (lbs)
1	3,899	18	3,917
2	4,402	36	4,438
3	4,906	54	4,960
4	5,409	72	5,481
5	5,913	90	6,003
6	6,417	108	6,525
7	6,920	126	7,046
8	7,424	144	7,568
9	7,927	162	8,089
10	8,431	180	8,611
11	8,934	198	9,132
12	9,438	216	9,654
13	9,941	234	10,175
14	10,445	252	10,697
15	10,948	270	11,218
16	11,452	288	11,740
17	11,955	306	12,261
18	12,459	324	12,783
19	12,963	342	13,305
20	13,466	360	13,826
21	13,970	378	14,348
22	14,473	396	14,869
23	14,977	414	15,391
24	15,480	432	15,912
25	15,984	450	16,434
26	16,487	468	16,955
27	16,991	486	17,477
28	17,494	504	17,998
29	17,998	522	18,520
30	18,501	540	19,041
31	19,005	558	19,563
32	19,508	576	20,084

Phosphorus reduction goals for gully erosion and streambank BMPs achieved

Table 34: Nitrogen load reductions from Streambank Stabilization and Gully Control BMPs in the Delaware River Watershed over a 32-year implementation period

Nitrogen			
Year	Streambank Reduction (lbs)	Gully Reduction (lbs)	Annual Load Reduction (lbs)
1	86,425	399	86,824
2	97,586	798	98,384
3	108,748	1,197	109,945
4	119,910	1,596	121,506
5	131,071	1,995	133,066
6	142,233	2,394	144,627
7	153,395	2,793	156,188
8	164,557	3,192	167,749
9	175,718	3,591	179,309
10	186,880	3,990	190,870
11	198,042	4,389	202,431
12	209,203	4,788	213,991
13	220,365	5,187	225,552
14	231,527	5,586	237,113
15	242,689	5,985	248,674
16	253,850	6,384	260,234
17	265,012	6,783	271,795
18	276,174	7,182	283,356
19	287,335	7,581	294,916
20	298,497	7,980	306,477
21	309,659	8,379	318,038
22	320,821	8,778	329,599
23	331,982	9,177	341,159
24	343,144	9,576	352,720
25	354,306	9,975	364,281
26	365,467	10,374	375,841
27	376,629	10,773	387,402
28	387,791	11,172	398,963
29	398,953	11,571	410,524
30	410,114	11,970	422,084
31	421,276	12,369	433,645
32	432,438	12,768	445,206

Nitrogen reduction goals for gully erosion and streambank BMPs achieved

4.2.6 Summary Tables for Livestock, Cropland, Streambank and Gully Reduction BMP Implementation for Nutrient Load Reduction in the Delaware River Watershed

The following tables summarize the load reductions expected over a 32-year implementation period for all major targeted BMP types.

Table 35: Combined Phosphorus load reductions from all BMPS in the Delaware River Watershed over a32-year implementation schedule. Implementation of these BMPs in the critical target areas will accomplish the phosphorus load reduction goals set forth in the Eutrophication TMDL for Perry Lake

Phosphorus						
Year	Streambank Reduction (lbs)	Cropland Reduction (lbs)	Gully Reduction (lbs)	Livestock Reduction (lbs)	Total Reduction (lbs)	% of TMDL
1	3,899	2,300	18	2,753	8,970	5%
2	4,402	4,601	36	5,505	14,544	8%
3	4,906	6,901	54	8,258	20,119	11%
4	5,409	9,201	72	11,010	25,693	15%
5	5,913	11,502	90	13,763	31,267	18%
6	6,417	13,802	108	16,515	36,842	21%
7	6,920	16,102	126	19,268	42,416	24%
8	7,424	18,402	144	22,021	47,991	27%
9	7,927	20,703	162	24,773	53,565	30%
10	8,431	23,003	180	27,526	59,139	33%
11	8,934	25,303	198	30,278	64,714	37%
12	9,438	27,604	216	33,031	70,288	40%
13	9,941	29,904	234	35,783	75,862	43%
14	10,445	32,204	252	38,536	81,437	46%
15	10,948	34,505	270	41,288	87,011	49%
16	11,452	36,805	288	44,041	92,586	52%
17	11,955	39,105	306	46,794	98,160	55%
18	12,459	41,405	324	49,546	103,734	59%
19	12,963	43,706	342	52,299	109,309	62%
20	13,466	46,006	360	55,051	114,883	65%
21	13,970	48,306	378	57,804	120,458	68%
22	14,473	50,607	396	60,556	126,032	71%
23	14,977	52,907	414	63,309	131,606	74%
24	15,480	55,207	432	66,062	137,181	77%

Table 35 (continued): Combined P load reductions from all BMPs for Perry Lake

Phosphorus						
Year	Streambank Reduction (lbs)	Cropland Reduction (lbs)	Gully Reduction (lbs)	Livestock Reduction (lbs)	Total Reduction (lbs)	% of TMDL
25	15,984	57,508	450	68,814	142,755	81%
26	16,487	59,808	468	71,567	148,330	84%
27	16,991	62,108	486	74,319	153,904	87%
28	17,494	64,408	504	77,072	159,478	90%
29	17,998	66,709	522	79,824	165,053	93%
30	18,501	69,009	540	82,577	170,627	96%
31	19,005	71,309	558	85,329	176,202	99%
32	19,508	73,610	576	88,082	181,776	103%
Load Reduction to meet Phosphorus TMDL:						**177,102**

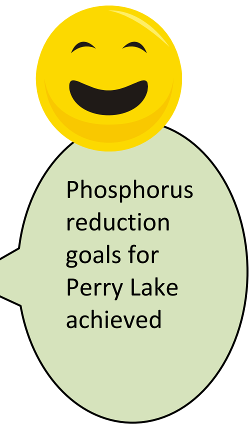
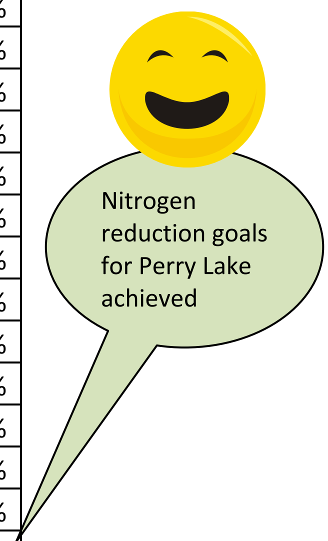


Table 36: Combined Nitrogen load reductions from all major BMP types in the Delaware River Watershed over a 32-year implementation schedule. Implemented of these BMPs in the critical target areas will accomplish the Nitrogen load reduction portion of the High Priority Eutrophication TMDL for Perry Lake

Nitrogen						
Year	Streambank Reduction (lbs)	Cropland Reduction (lbs)	Gully Reduction (lbs)	Livestock Reduction (lbs)	Total Reduction (lbs)	% of TMDL
1	86,425	10,098	399	5,184	102,106	12%
2	97,586	20,195	798	10,369	128,948	15%
3	108,748	30,293	1,197	15,553	155,791	18%
4	119,910	40,390	1,596	20,738	182,634	21%
5	131,071	50,488	1,995	25,922	209,477	24%
6	142,233	60,586	2,394	31,107	236,319	28%
7	153,395	70,683	2,793	36,291	263,162	31%
8	164,557	80,781	3,192	41,476	290,005	34%
9	175,718	90,878	3,591	46,660	316,848	37%
10	186,880	100,976	3,990	51,845	343,690	40%
11	198,042	111,074	4,389	57,029	370,533	43%
12	209,203	121,171	4,788	62,213	397,376	46%
13	220,365	131,269	5,187	67,398	424,219	50%
14	231,527	141,366	5,586	72,582	451,062	53%
15	242,689	151,464	5,985	77,767	477,904	56%

Table 36 (continued): Combined N reductions from all BMPs for Perry Lake

Nitrogen						
Year	Streambank Reduction (lbs)	Cropland Reduction (lbs)	Gully Reduction (lbs)	Livestock Reduction (lbs)	Total Reduction (lbs)	% of TMDL
16	253,850	161,561	6,384	82,951	504,747	59%
17	265,012	171,659	6,783	88,136	531,590	62%
18	276,174	181,757	7,182	93,320	558,433	65%
19	287,335	191,854	7,581	98,505	585,275	68%
20	298,497	201,952	7,980	103,689	612,118	71%
21	309,659	212,049	8,379	108,873	638,961	75%
22	320,821	222,147	8,778	114,058	665,804	78%
23	331,982	232,245	9,177	119,242	692,646	81%
24	343,144	242,342	9,576	124,427	719,489	84%
25	354,306	252,440	9,975	129,611	746,332	87%
26	365,467	262,537	10,374	134,796	773,175	90%
27	376,629	272,635	10,773	139,980	800,017	93%
28	387,791	282,733	11,172	145,165	826,860	97%
29	398,953	292,830	11,571	150,349	853,703	100%
30	410,114	302,928	11,970	155,534	880,546	103%
31	421,276	313,025	12,369	160,718	907,388	106%
32	432,438	323,123	12,768	165,902	934,231	109%
Load Reduction to meet Nitrogen TMDL:						**856,570**



4.3 Bacteria

There are two high priority TMDLs for Bacteria in the Delaware River Watershed. Both were approved in January, 2000 and together encompass approximately two-thirds of the land area and streams in the watershed (see **Figure 29**).

The first Bacteria TMDL is for the Delaware River Watershed above Perry Lake (21), and includes HUC 10 watershed numbers 1027010301, 1027010303, 1027010304, 1027010305, and 1027010306 (Muddy, Little Grasshopper, Negro, Straight, Mosquito, Elk, Banner, Unnamed, Bills, Catamount and Nebo Creeks). Baseline water quality conditions in these sub-watersheds only partially support designated uses, with exceedences of water quality standards for bacteria occurring in an average of 29% of the samples taken.

The second Bacteria TMDL is for Grasshopper Creek watershed (HUC 10 #1027010302) located in northeast Delaware River Watershed area (22). The Grasshopper Creek watershed encompasses parts of Atchison and Brown counties. Streams in this TMDL area include Grasshopper, Mission, Otter, Clear and Little Grasshopper Creeks. Baseline conditions in the TMDL area only partially support designated uses, with exceedences of water quality standards for bacteria occurring in an average of 24% of samples collected.

The Bacteria TMDLs were developed with the use of Fecal Coliform Bacteria (FCB) as indicator organisms. FCB are bacteria that can be found in the gastrointestinal systems of all warm-blooded animals; whenever FCB are detected in water, this indicates that fecal material from warm-blooded animals is present in the water. Although FCB themselves are not necessarily harmful, their presence indicates that other harmful organisms such as E. coli, protozoa and viruses may be present. Since the Bacteria TMDLs for the watershed were approved in 2000, the indicator organism used to gauge bacterial loading of water bodies has changed. E. coli bacteria (ECB) are now used as indicator organisms rather than FCB.

The nature of bacterial loading is very dynamic and complex. It is dependent on circumstances of runoff and flow as well as environmental conditions that vary daily and seasonally. Allocation and load reduction targets of the Bacteria TMDLs are difficult to define in simple terms. However, bacterial load reduction targets that indicate that bacteria loads are adequately decreasing and will eventually result in the "delisting" of water bodies in the watershed (that is, removal from the 303(d) list of impaired waters and subsequent removal of the Bacterial TMDL), are expected to be achieved through the application of BMPs that address sources of bacteria in the watershed.

To assess the impact of BMP implementation on bacterial loading, the frequency and magnitude of bacteria concentrations in streams are measured. KDHE utilizes a bacteria index to assess the frequency and magnitude of the bacteria concentrations at two monitoring sites in the watershed: KDHE sampling stations SC603 (on Grasshopper Creek) and SC554 (on the Delaware River near Half Mound). The bacteria index is a logarithmic calculation applied to bacteria concentrations found in samples collected at sampling locations during the April-October primary recreation season. Adequate water quality is indicated when a target index value below 1.0 at the upper decile (90^{th} percentile) is achieved.

The state of bacteria loads in the watershed in 2010 is illustrated in **Figures 27** and **28**. KDHE sampling at stations SC603 and SC554 was conducted in accordance with the water quality standard for three different intensive sampling events in 2010. Each intensive sampling event consisted of five E. coli bacteria (ECB) samples collected in a 30-day period. The calculated geometric mean of the five samples for each event were over the criterion for Grasshopper Creek (427 CFUs/100ml) for two of these intensive sampling events and also exceeded criteria for two of the three intensive sampling events for the Delaware River (262 CFUs/100ml).

4.3.1 Impact of NPDES Facilities on Bacteria Levels in the Watershed

The NPDES permitted wastewater treatment facilities discussed in **Section 4.2.2** (Cities of Holton and Sabetha and Oldham's LLC) and an additional 11 wastewater discharging facilities in the watershed contribute bacteria loads to rivers and streams in the Delaware River watershed. Bacteria levels in watershed resources need to be decreased in order to meet the Bacteria TMDL endpoints for the

Delaware River and tributaries and Grasshopper Creek. These facilities are point sources that are regulated and approved through the Kansas Department of Health and Environment NPDES system, and are not subject to load reduction activities associated with TMDL reductions. Since the NPDES discharging facilities are regulated by the state, TMDL wasteload reductions will need to be gained from nonpoint sources of pollution. See **Table 7** for a list of all discharging wastewater facilities in the watershed that release bacteria into receiving streams.

Figure 27: 2010 intensive sampling results for E. coli at station SC603, Grasshopper Creek

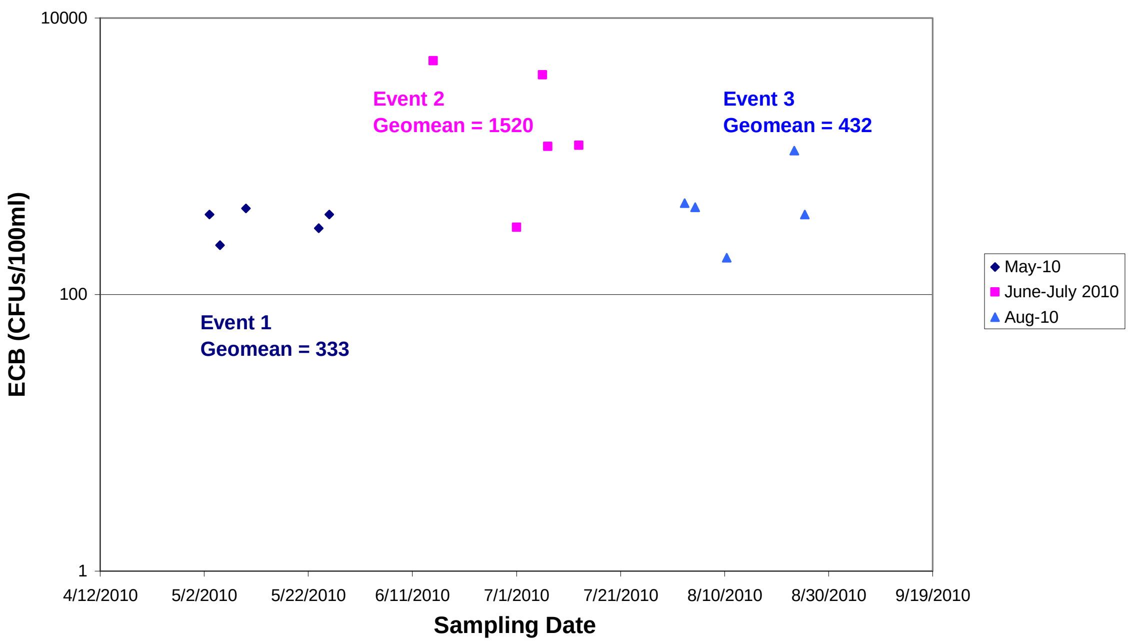


Figure 28: 2010 intensive sampling results for E. coli at station SC554, Delaware River

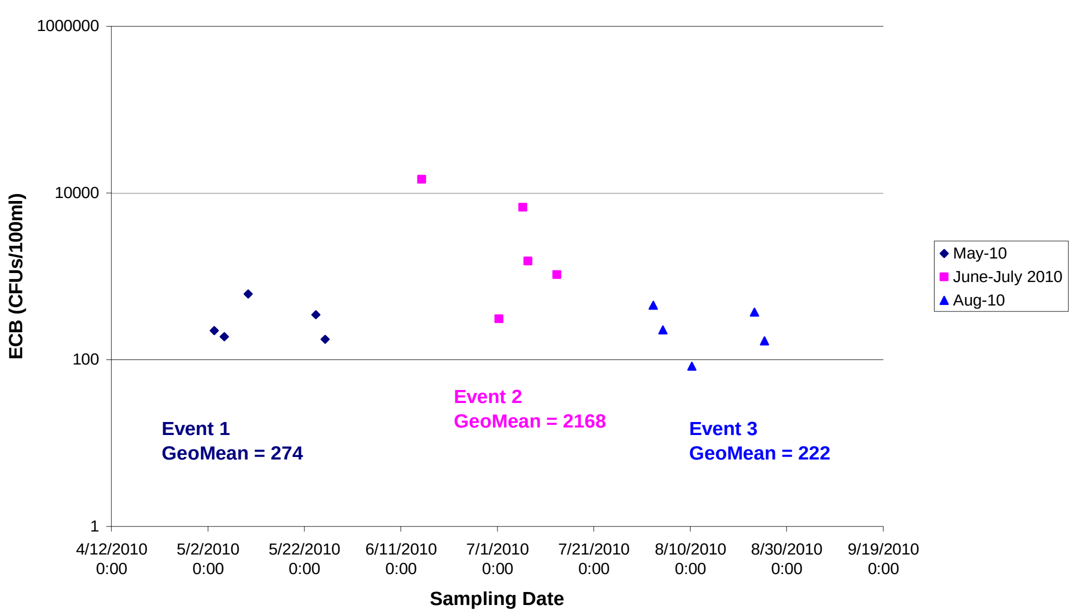
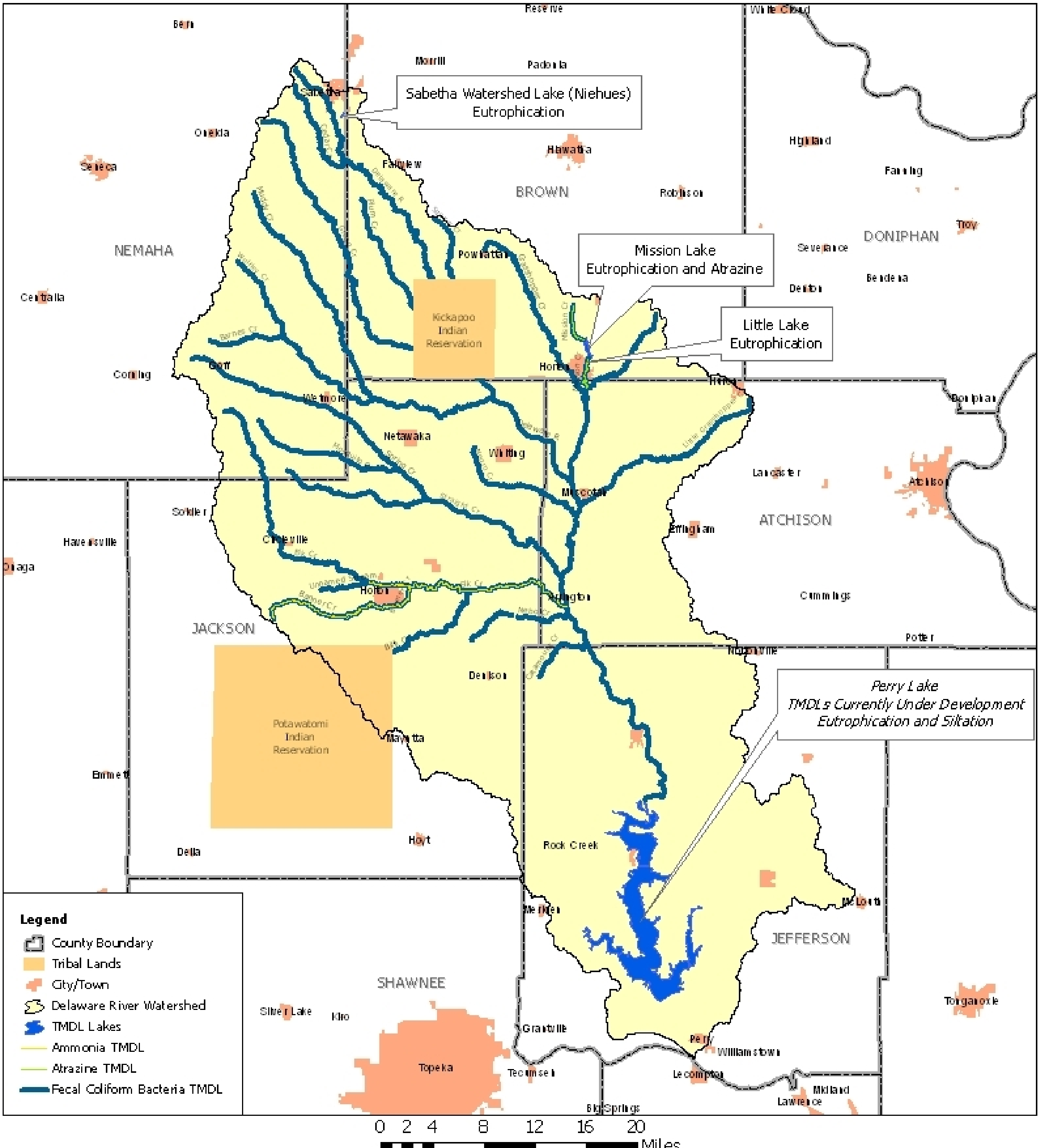


Figure 28: TMDL streams and lakes in the Delaware River Watershed



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

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4.3.2 Source of Impairment

Based on assessment data, the distribution of excursions from water quality standards and the relationship of high bacteria levels to runoff conditions, non-point pollution sources are the primary cause of water quality violations in the two Bacteria TMDL areas of the watershed. Small livestock operations in which livestock waste loading of streams occurs animal wastes are considered to be primary contributors to bacteria issues in watershed streams. Grazing density of livestock in the area is moderate to heavy (37 to 52 animal units/square mile). This factor along with low soil permeability (0.4 inches/hour, NRCS data) indicate that livestock wastes, especially those deposited in close proximity to streams have a high propensity to wash into streams and contribute to bacterial loading.

More than 60 livestock confined feeding facilities (CFFs) exist within the Bacteria TMDL area of the watershed. Since these facilities are registered, certified and/or permitted by KDHE, they are monitored by that agency. The majority also have waste control systems that are designed with capacity for a 25-year, 24-hour rainfall event. It is therefore unlikely that CFFs are a significant contributor to bacterial loading in the watershed.

Faulty on-site wastewater systems may contribute to bacteria loading. The rural nature of the watershed necessitates the use of on-site waste systems to dispose of household waste water. The fact that many of these systems are aging contributes to conditions where failing systems may impact water resources, especially where those systems are located close to receiving streams. However, an examination of the flow conditions and timing under which bacteria loads exceed acceptable water quality standards indicates that, although failing septic systems may be occasional contributors to bacteria loads, they are not likely to be a primary source of bacteria in the watershed.

There are 13 NPDES permitted wastewater system dischargers within the bacteria TMDL area of the watershed. Although NPDES facilities are a potential point source of bacteria, the nature of bacteria loads indicates that these facilities have minimal overall impact on bacteria levels. NPDES facilities are permitted by KDHE, equipped with multi-tiered treatment systems, are monitored closely, and treatment failures are rare. Furthermore, bacterial exceedences of water quality standards appear to be closely related to runoff conditions; that is, high bacteria concentrations occur when rainfall conditions create runoff that flows across the land and carries bacteria into receiving streams. If NPDES systems were significant contributors to bacterial loading, exceedences would occur even under low-flow conditions when NPDES effluent is a major source of baseline flows in streams.

4.3.3 Bacteria Load Reduction Goals

As discussed earlier, bacteria load reductions will result in **less frequent exceedences** of the nominal ECB criterion, and in **lowered magnitude of those exceedences**, at sampling stations above Perry Lake. The ECB criterion for the Delaware River sampling station Primary Recreation Class B is 262 Colony Forming Units (CFUs) per 100 ml (262 CFU/100 ml). Bacterial indices for the other tributaries within the watershed are based on the Primary Recreation Class C criterion of 427 CFUs/100 ml.

A logarithmic calculation of concentration of ECB found in water samples divided by the applicable recreation class criterion will be used to compare concentrations of bacteria found in water samples to desired endpoint goals.

As illustrated by sampling data collected and analyzed in 2010 discussed earlier, it is clear that ECB concentrations at the Delaware River sampling site near Half Mound and Grasshopper Creek sampling site exceed desired levels. The calculated geometric mean of the five samples were over the criterion for Grasshopper Creek (427 CFUs/100ml) for two of the intensive sampling events and for two of the three events for the Delaware River (262 CFUs/100ml).

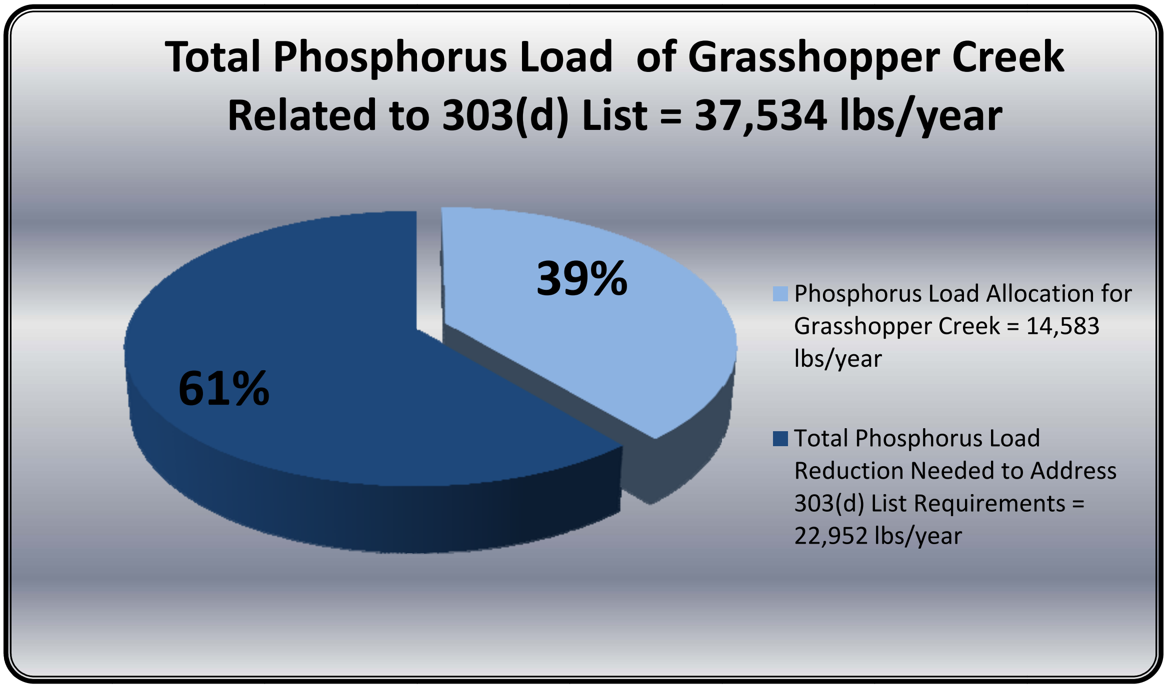
4.3.4 Bacteria Load Reduction Benefits from Targeted Nutrient Load Reduction Efforts in Grasshopper Creek Sub-watershed

Major sources of bacteria in the watershed, especially livestock sources, also contribute to nutrient loading of surface water. This plan details implementation plans for BMPs to address nutrient loading from livestock wastes in targeted areas of the watershed. The same BMPs that reduce nutrient loading from livestock sources also directly address bacteria loading and help to meet TMDL bacteria reduction goals.

The Grasshopper Creek sub-watershed area was selected for targeted implementation of livestock waste and cropland BMPs which will significantly reduce nutrient loading from these sources. These same BMPs also directly reduce bacteria loading from livestock sources in this sub-watershed area. This is significant because Grasshopper Creek is an impaired water body on the 303(d) List (see **Table 9**) for impairments related to total phosphorus and is the focus of a Bacteria TMDL. In addition, Grasshopper Creek is an important sub-watershed area contributing nutrients to Perry Lake for which there is a pending Eutrophication TMDL. According to the Perry Lake Eutrophication TMDL document, Grasshopper Creek contributes 16% of the current total phosphorus load that reaches Perry Lake (19).

Load reduction calculations specific for total phosphorus reduction in Grasshopper Creek are illustrated in **Figure 30**. Achieving the calculated reductions is necessary to address the 303(d) impairment for total phosphorus for Grasshopper Creek, aid in reaching the Eutrophication endpoints for Perry Lake, as well as achieve the bacteria load reductions needed to achieve Bacteria TMDL endpoints for this sub-watershed.

Figure 29: 303(d) List load reduction needed to address Phosphorus Impairment for Grasshopper Creek



4.4 Load Reduction Estimate Methodology

4.4.1 Cropland

Baseline loadings are calculated using the SWAT model delineated to the HUC 14 watershed scale. Best management practice (BMP) load reduction efficiencies are derived from K-State Research and Extension Publication MF-2572.[1] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

4.4.2 Livestock

Baseline nutrient loadings per animal unit are calculated using the Livestock Waste Facilities Handbook.[2] Livestock management practice load reduction efficiencies are derived from numerous sources including K-State Research and Extension Publication MF-2737 and MF-2454.[3] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

Available at: http://www.oznet.ksu.edu/library/h20ql2/mf2572.pdf
Available at: http://www.mwps.org/index.cfm?fuseaction=c_Categories.viewCategory&catID=719
MF-2737 Available at: http://www.oznet.ksu.edu/library/h20ql2/mf2737.pdf
MF-2454 Available at: http://www.oznet.ksu.edu/library/ageng2/mf2454.pdf

Part 5: Implementation Costs of Targeted BMPs; Potential Funding Sources and Technical Assistance Providers

The implementation of Best Management Practices (BMPs) to achieve TMDL endpoints and the goals set by the Delaware River Watershed SLT will require a technical and financial assistance. Technical assistance is required for planning, engineering and designing BMPs that meet practice standards and specifications, and can be provided by natural resource professionals in local, state or federal agencies, non-profit organizations or from the private sector. The finances needed to implement BMPs will come from a variety sources including cost share programs, grants and individual landowners.

5.1 Cost of BMP Implementation

The Delaware River Watershed SLT reviewed recommended BMPs and selected those that offer the greatest potential for accomplishing needed load reduction. Most of these BMPs are effective in reducing more than one category of impairment, which increases their efficiency. A detailed discussion of these BMPs is included in **Part 3** of this plan.

With assistance from Josh Roe, Watershed Economist at Kansas State University, costs for implementing each targeted BMP were estimated. The cost basis for each BMP and summary tables showing costs associated with each over the 32-year implementation period of this plan are presented in this section.

Table 37: Cost of individual practices used to derive BMP implementation cost estimates for the Delaware River Watershed

BMP	Unit	Acres Treated/Unit	Average Cost per Unit	Cost Share Available
Cropland BMPs				
Vegetative Riparian Buffers	Acre	15 acres of cropland/acre of buffer	$1,000/acre	Up to 90% c.s. (USDA, CD, WRAPS)
Planting Permanent Vegetation	Acre	1 acre	$150/acre	50% c.s (USDA)
Grassed Waterways	Acre	10 acres of cropland/acre of waterway	$1,600/acre	50% c.s. (USDA, CD)
Water Retention Structures	Each	Variable, average 40 each	$12,000/structure	70% c.s. (USDA, CD, WRAPS)
No-till	Acre	1 acre	$10/acre	50% c.s. (USDA)
Subsurface Fertilizer Application	Acre	1 acre	$3.50/acre	

Table 37 (continued): Costs of individual practices used to derive BMP implementation cost estimates for the Delaware River Watershed

BMP	Unit	Acres Treated/Unit	Average Cost per Unit	Cost Share Available
Livestock BMPs				
Off-stream Watering System	Each		$3,795 for solar powered system	50-70% c.s. (USDA, CD, WRAPS)
Relocate Feeding Sites in Pastures	Each		Highly variable, average $2,203 per unit	50-70% c.s. (USDA, CD, WRAPS)
Relocate Feeding Pens and Lots	Each		Highly Variable; average $6,600 per unit	50-70% c.s. (USDA, CD, WRAPS)
Vegetative Filter Strip	Acre	1 acre or less of feedlot area/acre of filter strip	$714/acre	50-70% c.s. (USDA, CD, WRAPS)
Rotational Grazing System			Variable; $7,000 per system; complex systems may be significantly more	50-70% c.s. (USDA, CD, WRAPS)
Streambank Stabilization BMPs				
Streambank manipulation, rock toe and vane, vegetative bank stabilization	Linear foot		$71.50/lf	50-95% c.s. (NRCS, SCC, WRAPS)
Gully Erosion BMPs				
Gully Erosion Control in or near Riparian Areas	Each	Variable	Highly Variable; $12,000/unit average	50-70% c.s. (USDA, CD, WRAPS)

A variety of cost share programs exist that can be used to assist landowners with the cost of implementation of many BMPs. These programs are offered through local, state and federal programs administered by natural resource agencies and other units of government. While not all BMPs have cost share programs available, some of these programs provide substantial cost share potential.

The following information illustrates annual costs expected for the implementation of **Livestock BMPs** targeted for implementation. **Table 38** shows expected annual costs of implementation of livestock BMPs ***before*** cost share funds are applied. **Table 39** shows the annual cost BMPs ***after*** cost share funds are utilized.

Table 38: Annual cost* of implementation of Livestock BMPs *before* cost share program funds are utilized

Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Annual Cost
1	$714	$3,311	$2,203	$5,693	$3,500	**$11,920**
2	$735	$3,410	$2,269	$5,863	$3,605	**$12,278**
3	$757	$3,512	$2,337	$6,039	$3,713	**$12,646**
4	$780	$3,617	$2,407	$6,220	$3,825	**$13,025**
5	$804	$3,726	$2,479	$6,407	$3,939	**$13,416**
6	$828	$3,838	$2,554	$6,599	$4,057	**$13,819**
7	$853	$3,953	$2,630	$6,797	$4,179	**$14,233**
8	$878	$4,071	$2,709	$7,001	$4,305	**$14,660**
9	$904	$4,194	$2,791	$7,211	$4,434	**$15,100**
10	$932	$4,319	$2,874	$7,427	$4,567	**$15,553**
11	$960	$4,449	$2,961	$7,650	$4,704	**$16,019**
12	$988	$4,583	$3,049	$7,880	$4,845	**$16,500**
13	$1,018	$4,720	$3,141	$8,116	$4,990	**$16,995**
14	$1,049	$4,862	$3,235	$8,360	$5,140	**$17,505**
15	$1,080	$5,007	$3,332	$8,610	$5,294	**$18,030**
16	$1,112	$5,158	$3,432	$8,869	$5,453	**$18,571**
17	$1,146	$5,312	$3,535	$9,135	$5,616	**$19,128**
18	$1,180	$5,472	$3,641	$9,409	$5,785	**$19,702**
19	$1,216	$5,636	$3,750	$9,691	$5,959	**$20,293**
20	$1,252	$5,805	$3,863	$9,982	$6,137	**$20,902**
21	$1,290	$5,979	$3,979	$10,281	$6,321	**$21,529**
22	$1,328	$6,159	$4,098	$10,590	$6,511	**$22,175**
23	$1,368	$6,343	$4,221	$10,907	$6,706	**$22,840**
24	$1,409	$6,534	$4,348	$11,235	$6,908	**$23,525**
25	$1,451	$6,730	$4,478	$11,572	$7,115	**$24,231**
26	$1,495	$6,931	$4,613	$11,919	$7,328	**$24,958**
27	$1,540	$7,139	$4,751	$12,276	$7,548	**$25,707**
28	$1,586	$7,354	$4,893	$12,645	$7,775	**$26,478**
29	$1,634	$7,574	$5,040	$13,024	$8,008	**$27,272**
30	$1,683	$7,801	$5,192	$13,415	$8,248	**$28,090**
31	$1,733	$8,035	$5,347	$13,817	$8,495	**$28,933**
32	$1,785	$8,277	$5,508	$14,232	$8,750	**$29,801**

3% Annual Cost Inflation

Table 39: Annual cost* of implementation of Livestock BMPs *after* cost share program funds are utilized

Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Annual Cost
1	$357	$1,655	$1,102	$2,846	$1,750	**$5,960**
2	$368	$1,705	$1,135	$2,932	$1,803	**$6,139**
3	$379	$1,756	$1,169	$3,020	$1,857	**$6,323**
4	$390	$1,809	$1,204	$3,110	$1,912	**$6,513**
5	$402	$1,863	$1,240	$3,203	$1,970	**$6,708**
6	$414	$1,919	$1,277	$3,300	$2,029	**$6,909**
7	$426	$1,976	$1,315	$3,399	$2,090	**$7,117**
8	$439	$2,036	$1,355	$3,501	$2,152	**$7,330**
9	$452	$2,097	$1,395	$3,606	$2,217	**$7,550**
10	$466	$2,160	$1,437	$3,714	$2,283	**$7,776**
11	$480	$2,225	$1,480	$3,825	$2,352	**$8,010**
12	$494	$2,291	$1,525	$3,940	$2,422	**$8,250**
13	$509	$2,360	$1,570	$4,058	$2,495	**$8,498**
14	$524	$2,431	$1,618	$4,180	$2,570	**$8,752**
15	$540	$2,504	$1,666	$4,305	$2,647	**$9,015**
16	$556	$2,579	$1,716	$4,434	$2,726	**$9,285**
17	$573	$2,656	$1,768	$4,567	$2,808	**$9,564**
18	$590	$2,736	$1,821	$4,704	$2,892	**$9,851**
19	$608	$2,818	$1,875	$4,846	$2,979	**$10,147**
20	$626	$2,902	$1,931	$4,991	$3,069	**$10,451**
21	$645	$2,990	$1,989	$5,141	$3,161	**$10,764**
22	$664	$3,079	$2,049	$5,295	$3,256	**$11,087**
23	$684	$3,172	$2,111	$5,454	$3,353	**$11,420**
24	$705	$3,267	$2,174	$5,617	$3,454	**$11,763**
25	$726	$3,365	$2,239	$5,786	$3,557	**$12,115**
26	$747	$3,466	$2,306	$5,959	$3,664	**$12,479**
27	$770	$3,570	$2,375	$6,138	$3,774	**$12,853**
28	$793	$3,677	$2,447	$6,322	$3,887	**$13,239**
29	$817	$3,787	$2,520	$6,512	$4,004	**$13,636**
30	$841	$3,901	$2,596	$6,707	$4,124	**$14,045**
31	$867	$4,018	$2,674	$6,909	$4,248	**$14,466**
32	$893	$4,138	$2,754	$7,116	$4,375	**$14,900**

3% Annual Cost Inflation

The following tables illustrate annual costs expected for implementing **Cropland BMPs**. **Tables 40 and 42** show the cost of implementing Cropland BMPs to address sediment load reduction for Perry Lake and Mission Lake, respectively, ***before*** cost share funding is utilized. **Tables 41 and 43** show the annual cost of implementation of Cropland BMPs to address sediment load reduction for Perry Lake and Mission Lake, respectively, ***after*** cost share funds are utilized.

Table 40: Annual cost* of implementing Cropland BMPs for sediment load reduction to Perry Lake *before* cost share funds are utilized

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$10,997	$39,099	$47,463	$65,165	$11,296	$36,656	**$210,675**
2	$11,327	$40,272	$48,887	$67,120	$11,634	$37,755	**$216,995**
3	$11,666	$41,480	$50,353	$69,134	$11,983	$38,888	**$223,505**
4	$12,016	$42,725	$51,864	$71,208	$12,343	$40,054	**$230,210**
5	$12,377	$44,006	$53,420	$73,344	$12,713	$41,256	**$237,117**
6	$12,748	$45,327	$55,022	$75,544	$13,095	$42,494	**$244,230**
7	$13,131	$46,686	$56,673	$77,811	$13,487	$43,769	**$251,557**
8	$13,524	$48,087	$58,373	$80,145	$13,892	$45,082	**$259,104**
9	$13,930	$49,530	$60,124	$82,549	$14,309	$46,434	**$266,877**
10	$14,348	$51,016	$61,928	$85,026	$14,738	$47,827	**$274,883**
11	$14,779	$52,546	$63,786	$87,577	$15,180	$49,262	**$283,130**
12	$15,222	$54,122	$65,700	$90,204	$15,636	$50,740	**$291,623**
13	$15,679	$55,746	$67,671	$92,910	$16,105	$52,262	**$300,372**
14	$16,149	$57,418	$69,701	$95,697	$16,588	$53,830	**$309,383**
15	$16,633	$59,141	$71,792	$98,568	$17,085	$55,445	**$318,665**
16	$17,132	$60,915	$73,945	$101,525	$17,598	$57,108	**$328,225**
17	$17,646	$62,743	$76,164	$104,571	$18,126	$58,821	**$338,071**
18	$18,176	$64,625	$78,449	$107,708	$18,670	$60,586	**$348,214**
19	$18,721	$66,564	$80,802	$110,940	$19,230	$62,404	**$358,660**
20	$19,283	$68,561	$83,226	$114,268	$19,807	$64,276	**$369,420**
21	$19,861	$70,618	$85,723	$117,696	$20,401	$66,204	**$380,502**
22	$20,457	$72,736	$88,295	$121,227	$21,013	$68,190	**$391,917**
23	$21,071	$74,918	$90,944	$124,864	$21,643	$70,236	**$403,675**
24	$21,703	$77,166	$93,672	$128,609	$22,293	$72,343	**$415,785**
25	$22,354	$79,481	$96,482	$132,468	$22,961	$74,513	**$428,259**
26	$23,025	$81,865	$99,376	$136,442	$23,650	$76,748	**$441,107**
27	$23,715	$84,321	$102,358	$140,535	$24,360	$79,051	**$454,340**
28	$24,427	$86,851	$105,429	$144,751	$25,091	$81,422	**$467,970**
29	$25,160	$89,456	$108,591	$149,094	$25,843	$83,865	**$482,009**
30	$25,914	$92,140	$111,849	$153,566	$26,619	$86,381	**$496,469**
31	$26,692	$94,904	$115,205	$158,173	$27,417	$88,973	**$511,363**
32	$27,493	$97,751	$118,661	$162,919	$28,240	$91,642	**$526,704**

Table 41: Annual cost* of implementing Cropland BMPs for sediment load reduction to Perry Lake *after* cost share

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$5,498	$19,550	$28,952	$6,517	$11,296	$18,328	**$90,140**
2	$5,663	$20,136	$29,821	$6,712	$11,634	$18,878	**$92,844**
3	$5,833	$20,740	$30,715	$6,913	$11,983	$19,444	**$95,630**
4	$6,008	$21,362	$31,637	$7,121	$12,343	$20,027	**$98,498**
5	$6,188	$22,003	$32,586	$7,334	$12,713	$20,628	**$101,453**
6	$6,374	$22,663	$33,564	$7,554	$13,095	$21,247	**$104,497**
7	$6,565	$23,343	$34,571	$7,781	$13,487	$21,884	**$107,632**
8	$6,762	$24,044	$35,608	$8,015	$13,892	$22,541	**$110,861**
9	$6,965	$24,765	$36,676	$8,255	$14,309	$23,217	**$114,187**
10	$7,174	$25,508	$37,776	$8,503	$14,738	$23,914	**$117,612**
11	$7,389	$26,273	$38,909	$8,758	$15,180	$24,631	**$121,141**
12	$7,611	$27,061	$40,077	$9,020	$15,636	$25,370	**$124,775**
13	$7,839	$27,873	$41,279	$9,291	$16,105	$26,131	**$128,518**
14	$8,074	$28,709	$42,517	$9,570	$16,588	$26,915	**$132,374**
15	$8,317	$29,571	$43,793	$9,857	$17,085	$27,722	**$136,345**
16	$8,566	$30,458	$45,107	$10,153	$17,598	$28,554	**$140,435**
17	$8,823	$31,371	$46,460	$10,457	$18,126	$29,411	**$144,648**
18	$9,088	$32,313	$47,854	$10,771	$18,670	$30,293	**$148,988**
19	$9,361	$33,282	$49,289	$11,094	$19,230	$31,202	**$153,457**
20	$9,641	$34,280	$50,768	$11,427	$19,807	$32,138	**$158,061**
21	$9,931	$35,309	$52,291	$11,770	$20,401	$33,102	**$162,803**
22	$10,229	$36,368	$53,860	$12,123	$21,013	$34,095	**$167,687**
23	$10,535	$37,459	$55,476	$12,486	$21,643	$35,118	**$172,718**
24	$10,851	$38,583	$57,140	$12,861	$22,293	$36,171	**$177,899**
25	$11,177	$39,740	$58,854	$13,247	$22,961	$37,257	**$183,236**
26	$11,512	$40,933	$60,620	$13,644	$23,650	$38,374	**$188,733**
27	$11,858	$42,160	$62,438	$14,053	$24,360	$39,525	**$194,395**
28	$12,213	$43,425	$64,311	$14,475	$25,091	$40,711	**$200,227**
29	$12,580	$44,728	$66,241	$14,909	$25,843	$41,933	**$206,234**
30	$12,957	$46,070	$68,228	$15,357	$26,619	$43,191	**$212,421**
31	$13,346	$47,452	$70,275	$15,817	$27,417	$44,486	**$218,793**
32	$13,746	$48,876	$72,383	$16,292	$28,240	$45,821	**$225,357**

**3% Inflation*

Table 42: Annual cost* of implementing Cropland BMPs for sediment load reduction to Mission Lake *before* cost share

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$358	$1,274	$1,547	$2,124	$368	$1,195	**$6,867**
2	$369	$1,313	$1,593	$2,188	$379	$1,231	**$7,073**
3	$380	$1,352	$1,641	$2,253	$391	$1,268	**$7,285**
4	$392	$1,393	$1,690	$2,321	$402	$1,306	**$7,503**
5	$403	$1,434	$1,741	$2,391	$414	$1,345	**$7,729**
6	$416	$1,477	$1,793	$2,462	$427	$1,385	**$7,960**
7	$428	$1,522	$1,847	$2,536	$440	$1,427	**$8,199**
8	$441	$1,567	$1,903	$2,612	$453	$1,469	**$8,445**
9	$454	$1,614	$1,960	$2,691	$466	$1,513	**$8,699**
10	$468	$1,663	$2,018	$2,771	$480	$1,559	**$8,960**
11	$482	$1,713	$2,079	$2,854	$495	$1,606	**$9,228**
12	$496	$1,764	$2,141	$2,940	$510	$1,654	**$9,505**
13	$511	$1,817	$2,206	$3,028	$525	$1,703	**$9,790**
14	$526	$1,871	$2,272	$3,119	$541	$1,755	**$10,084**
15	$542	$1,928	$2,340	$3,213	$557	$1,807	**$10,387**
16	$558	$1,985	$2,410	$3,309	$574	$1,861	**$10,698**
17	$575	$2,045	$2,482	$3,408	$591	$1,917	**$11,019**
18	$592	$2,106	$2,557	$3,511	$609	$1,975	**$11,350**
19	$610	$2,170	$2,634	$3,616	$627	$2,034	**$11,690**
20	$629	$2,235	$2,713	$3,724	$646	$2,095	**$12,041**
21	$647	$2,302	$2,794	$3,836	$665	$2,158	**$12,402**
22	$667	$2,371	$2,878	$3,951	$685	$2,223	**$12,774**
23	$687	$2,442	$2,964	$4,070	$705	$2,289	**$13,157**
24	$707	$2,515	$3,053	$4,192	$727	$2,358	**$13,552**
25	$729	$2,591	$3,145	$4,318	$748	$2,429	**$13,959**
26	$750	$2,668	$3,239	$4,447	$771	$2,502	**$14,377**
27	$773	$2,748	$3,336	$4,581	$794	$2,577	**$14,809**
28	$796	$2,831	$3,436	$4,718	$818	$2,654	**$15,253**
29	$820	$2,916	$3,539	$4,860	$842	$2,734	**$15,711**
30	$845	$3,003	$3,646	$5,005	$868	$2,816	**$16,182**
31	$870	$3,093	$3,755	$5,156	$894	$2,900	**$16,667**
32	$896	$3,186	$3,868	$5,310	$920	$2,987	**$17,167**

**3% Inflation*

Table 43: Annual cost* of implementing Cropland BMPs for sediment load reduction to Mission Lake *after* cost share

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$179	$637	$944	$212	$368	$597	**$2,938**
2	$185	$656	$972	$219	$379	$615	**$3,026**
3	$190	$676	$1,001	$225	$391	$634	**$3,117**
4	$196	$696	$1,031	$232	$402	$653	**$3,210**
5	$202	$717	$1,062	$239	$414	$672	**$3,307**
6	$208	$739	$1,094	$246	$427	$693	**$3,406**
7	$214	$761	$1,127	$254	$440	$713	**$3,508**
8	$220	$784	$1,161	$261	$453	$735	**$3,613**
9	$227	$807	$1,195	$269	$466	$757	**$3,722**
10	$234	$831	$1,231	$277	$480	$779	**$3,833**
11	$241	$856	$1,268	$285	$495	$803	**$3,948**
12	$248	$882	$1,306	$294	$510	$827	**$4,067**
13	$256	$908	$1,345	$303	$525	$852	**$4,189**
14	$263	$936	$1,386	$312	$541	$877	**$4,315**
15	$271	$964	$1,427	$321	$557	$904	**$4,444**
16	$279	$993	$1,470	$331	$574	$931	**$4,577**
17	$288	$1,023	$1,514	$341	$591	$959	**$4,715**
18	$296	$1,053	$1,560	$351	$609	$987	**$4,856**
19	$305	$1,085	$1,607	$362	$627	$1,017	**$5,002**
20	$314	$1,117	$1,655	$372	$646	$1,048	**$5,152**
21	$324	$1,151	$1,704	$384	$665	$1,079	**$5,306**
22	$333	$1,185	$1,756	$395	$685	$1,111	**$5,466**
23	$343	$1,221	$1,808	$407	$705	$1,145	**$5,630**
24	$354	$1,258	$1,862	$419	$727	$1,179	**$5,798**
25	$364	$1,295	$1,918	$432	$748	$1,214	**$5,972**
26	$375	$1,334	$1,976	$445	$771	$1,251	**$6,152**
27	$386	$1,374	$2,035	$458	$794	$1,288	**$6,336**
28	$398	$1,415	$2,096	$472	$818	$1,327	**$6,526**
29	$410	$1,458	$2,159	$486	$842	$1,367	**$6,722**
30	$422	$1,502	$2,224	$501	$868	$1,408	**$6,924**
31	$435	$1,547	$2,291	$516	$894	$1,450	**$7,131**
32	$448	$1,593	$2,359	$531	$920	$1,493	**$7,345**

**3% Inflation*

<u>Table 44</u>: Summary of annual costs of implementation for *all* Priority BMPs in the Delaware River Watershed *after* cost share over a 32-year implementation schedule

Year	Streambank	Cropland	Livestock	Gullies	Total Annual Cost
1	$449,235	$90,140	$5,960	$12,000	**$557,335**
2	$521,950	$92,844	$6,139	$12,360	**$633,293**
3	$119,405	$95,630	$6,323	$12,731	**$234,088**
4	$161,738	$98,498	$6,513	$13,113	**$279,862**
5	$166,590	$101,453	$6,708	$13,506	**$288,257**
6	$171,588	$104,497	$6,909	$13,911	**$296,905**
7	$176,735	$107,632	$7,117	$14,329	**$305,812**
8	$182,037	$110,861	$7,330	$14,758	**$314,987**
9	$187,498	$114,187	$7,550	$15,201	**$324,436**
10	$193,123	$117,612	$7,776	$15,657	**$334,169**
11	$198,917	$121,141	$8,010	$16,127	**$344,194**
12	$204,885	$124,775	$8,250	$16,611	**$354,520**
13	$211,031	$128,518	$8,498	$17,109	**$365,156**
14	$217,362	$132,374	$8,752	$17,622	**$376,111**
15	$223,883	$136,345	$9,015	$18,151	**$387,394**
16	$230,599	$140,435	$9,285	$18,696	**$399,016**
17	$237,517	$144,648	$9,564	$19,256	**$410,986**
18	$244,643	$148,988	$9,851	$19,834	**$423,316**
19	$251,982	$153,457	$10,147	$20,429	**$436,015**
20	$259,542	$158,061	$10,451	$21,042	**$449,096**
21	$267,328	$162,803	$10,764	$21,673	**$462,569**
22	$275,348	$167,687	$11,087	$22,324	**$476,446**
23	$283,608	$172,718	$11,420	$22,993	**$490,739**
24	$292,116	$177,899	$11,763	$23,683	**$505,461**
25	$300,880	$183,236	$12,115	$24,394	**$520,625**
26	$309,906	$188,733	$12,479	$25,125	**$536,244**
27	$319,203	$194,395	$12,853	$25,879	**$552,331**
28	$328,780	$200,227	$13,239	$26,655	**$568,901**
29	$338,643	$206,234	$13,636	$27,455	**$585,968**
30	$348,802	$212,421	$14,045	$28,279	**$603,547**
31	$359,266	$218,793	$14,466	$29,127	**$621,653**
32	$370,044	$225,357	$14,900	$30,001	**$640,303**

**3% Inflation*

5.2 Technical and Financial Assistance

Potential technical and financial assistance programs and sources are summarized in this section. **Table 45** summarizes potential funding sources for BMP implementation, listing agencies and specific programs. **Table 46** is a list of potential providers of technical assistance for different types of assistance for major targeted BMPs. **Table 47** provides a list of BMPs and potential sources of technical assistance for each along with associated costs.

Table 45: Potential funding sources and programs for BMP implementation

Funding Source	Funding Program Name (if applicable)
USDA (Natural Resources Conservation Service and Farm Services Agency	Environmental Quality Incentives Program (EQIP)
	Conservation Reserve Program (CRP)
	Continuous Conservation Reserve Program (CCRP)
	Wetland Reserve Program (WRP)
	Wildlife Habitat Incentive Program (WHIP)
	Forestland Enhancement Program (FLEP)
	State Acres for Wildlife Enhancement (SAFE)
	Grassland Reserve Program (GRP)
	Farmable Wetlands Program (FWP)
EPA and KDHE	Section 319 Clean Water Act funds
	State Revolving Fund (SRF)
	American Recovery and Reinvestment Act (ARRA)
	WRAPS Grants
Kansas Dept. of Wildlife & Parks	Partnering for Wildlife
	Wildlife Habitat Incentive Program (WHIP)
Kansas Alliance for Wetlands and Streams	Wetland and Riparian Program
State Conservation Commission	State Water Resources Cost Share Program (SWRCSP)
	Streambank Restoration funds
	Riparian and Wetland Protection Program (RWPP)
	Governor's Water Quality Buffer Initiative
	Landowner incentive funds for streambank restoration projects
Conservation Districts	Non-point Source Pollution Funds
	State Water Resources Cost Share Program (SWRCSP)
Kansas Forest Service	Rural Forestry Program
	Forestland Enhancement Program (FLEP)
Kansas Research & Extension Service	Variable
Kansas Rural Center	River Friendly Farms Program
Pheasants Forever, Quail Forever and other private non-profit organizations	Variable

Table 46: Potential providers of technical assistance for BMP implementation

BMP		Services Needed to Implement BMP		Service Provider
		Technical Assistance	Information and Education	
Cropland	Planting Permanent Vegetation	Design and cost share	Workshops, tours, field days	NRCS Farm Bill Biologist FSA KRC SCC KFS KSRE/Watershed Specialist Cons. Districts Buffer Coordinator KDWP KAWS WRAPS
	Riparian Buffers	Design and cost share	Workshops, tours, field days, publications	
	Grasses Waterways	Design and cost share	Workshops, tours, field days	
	Continuous No-till	Design and cost share	Workshops, tours, field days, publications	
	Subsurface Fertilizer Application	Design and cost share	Workshops, tours, field days	
	Water Retention Structures	Design and cost share	Workshops, tours, field days	
Livestock	Vegetative Filter Strips	Design and cost share	Workshops, tours, field days, publications	KSRE/Watershed Specialist NRCS Cons. Districts KAWS KRC WRAPS
	Relocation of Feeding Sites (pasture) and Relocating Lots and Pens	Design and cost share	Workshops, tours, field days, publications	
	Off-Stream Watering Systems	Design and cost share	Workshops, tours, field days, publications	
	Rotational Grazing	Design and cost share	Workshops, tours, field days, publications	
Streambank	Streambank Stabilization and Restoration	Design and cost share	Workshops, tours, field days, publications	NRCS Farm Bill Biologist SCC KFS KSRE/Watershed Specialist Cons. Districts Buffer Coordinator KDWP KAWS WRAPS
	Riparian Buffers	Design and cost share	Workshops, tours, field days, publications	

Table 46 (continued): Potential providers of technical assistance for BMP implementation

BMP		Services Needed to Implement BMP		Service Provider
		Technical Assistance	BMP	
Gullies	Water Retention Structures (grade stabilization, sediment debris basins and diversions)	Design and cost share	Workshops, tours, field days, publications	NRCS FSA SCC Cons. Districts Buffer Coordinator Farm Bill Biologist KFS WRAPS

Table 47: Technical assistance to implement priority BMPs with estimated costs

BMP		Technical Assistance	Projected Annual Cost
Cropland	Buffers	Buffer Coordinator Farm Bill Biologist WRAPS Coordinator River Friendly Farms Technician NRCS Personnel Kansas Forest Service	Buffer Coordinator - $30,000 WRAPS Coordinator - $40,000 Watershed Specialist - $17,500 KRC River Friendly Farms Technician - $20,000 Extension Agent - $10,000 KSRE/KSU - $15,000 NRCS Personnel - $30,000 Private Surveyor and Engineer - $12,000 per streambank site
Cropland	Grasses Waterways	WRAPS Coordinator NRCS Personnel	
Cropland	Continuous No-till	Extension Service Personnel KS Research & Ext. KSU WRAPS Coordinator River Friendly Farms Technician NRCS Personnel No-till on the Plains	
Cropland	Subsurface Fertilizer Application	Extension Agents KS Research & Ext./KSU	
Cropland	Water Retention Structures	NRCS Personnel WRAPS Coordinator	
Livestock	Vegetative Filter Strips	Watershed Specialist River Friendly Farms Technician NRCS Personnel Extension Service Personnel	

Table 47 (continued): Technical assistance to implement priority BMPs with estimated costs

	BMP	Technical Assistance	Projected Annual Cost
Livestock	Relocation of Feeding Sites	Watershed Specialist River Friendly Farms Technician NRCS Personnel	KAWS - $10,000 Kansas Forest Service - $17,500 Farm Bill Biologist - $10,000 No-till on the Plains - $4000-$12500
	Alternative (off-stream) Watering Systems	Watershed Specialist River Friendly Farms Technician NRCS Personnel	
	Rotational Grazing	Watershed Specialist River Friendly Farms Technician	
Streambank	Streambank Stabilization and Restoration	WRAPS Coordinator Buffer Coordinator Private Surveyor and Engineer NRCS Personnel KS Alliance for Wetlands & Streams (KAWS) Kansas Forest Service	
	Riparian Buffers	Buffer Coordinator Farm Bill Biologist WRAPS Coordinator River Friendly Farms Technician NRCS Personnel Kansas Forest Service	
Gullies	Water Retention Structures	WRAPS Coordinator NRCS Personnel	

Part 6: Information and Education to Support Implementation of BMPs

6.1 Information and Education

6.1.1 Information and Education Activities in Support of Targeted BMPs

Information and education (I&E) is important and integral components of a successful watershed plan, and involves more than just providing information. An effective I&E program increases the awareness of watershed issues and boosts recognition of the need to address those issues. Current water quality data, up-to-date information about the status of water resources and how individuals can work to benefit local water issues are important components of I&E programs. It must be an on-going effort that adapts to changes in the watershed while meeting the needs of specific audiences. Most importantly, an effective I&E program must support the adoption and implementation of Best Management Practices that address load reduction goals.

The following table lists specific activities, events and other elements of an Information & Education program developed by Delaware River WRAPS to support priority BMPs targeted for implementation.

Table 48: Information and Education activities and events to increase adoption of targeted Best Management Practices selected by the Stakeholder Leadership Team to address load reduction in the Delaware River Watershed

BMP	Target Audience	I&E Activity or Event	Time Frame	Sponsor/ Responsible Agency	Estimated Cost
Streambank BMP Implementation					
Streambank Stabilization Practices	Landowners along the Delaware River and major tributaries	Field day at a completed streambank project	Annual – late summer	Kansas Forest Service DOC, Cons. Districts KAWS WRAPS	$2,000 per field day
		One-on- one technical assistance	Annual and ongoing	Buffer Coordinator Conservation Districts Farm Bill Biologist Watershed Specialist KS Forest Service WRAPS	Included in TA for sponsors

Table 48 (continued): I&E activities and events to increase adoption of targeted Best Management Practices selected by the Stakeholder Leadership Team to address load reduction in the Delaware River Watershed

BMP	Target Audience	I&E Activity or Event	Time Frame	Sponsor/ Responsible Agency	Estimated Cost
Streambank BMP Implementation (continued)					
		News articles	Annual	WRAPS	No charge
Willow Cutting and other low-cost Stabilization Techniques	Landowners along smaller streams, watershed-wide	Field day at a completed streambank project	Annual – late summer	Kansas Forest Service Watershed Specialist WRAPS KAWS	$500 per field day
		One-on-one technical assistance	Annual and ongoing	Buffer Coordinator Conservation District Farm Bill Biologist Watershed Specialist Kansas Forest Service WRAPS	Included with TA for sponsors
		News articles	Annual	WRAPS	No charge
Riparian Forest and Native Grass Buffer Planting	Landowners along streams	Included as part of Field Day at stabilization projects	Annual –late summer	Kansas Forest Service SCC KAWS WRAPS	No charge
Livestock BMP Implementation					
Off-Stream Watering Systems	Small (non-CAFO) Livestock Producers	Demonstration Project	Annual	Watershed Specialist Extension Service Kansas Rural Center Conservation Districts/NRCS KAWS WRAPS	$5,000 per demo project
Relocate Winter Feeding Sites in Unconfined/Pasture Areas	Small (non-CAFO) Livestock Producers	Demonstration Project	Annual	Watershed Specialist Extension Service Kansas Rural Center Conservation Districts/NRCS KAWS WRAPS	$500 per demo project

Table 48 (continued): I&E activities and events to increase adoption of targeted Best Management Practices selected by the Stakeholder Leadership Team to address load reduction in the Delaware River Watershed

BMP	Target Audience	I&E Activity or Event	Time Frame	Sponsor/ Responsible Agency	Estimated Cost
Livestock BMP Implementation (continued)					
Relocate Feedlots or Feeding Pens	Small (non-CAFO) Livestock Producers	Demonstration Project	Annual	Watershed Specialist/Extension Kansas Rural Center Conservation Districts/NRCS KAWS WRAPS	$5,000 per demo project
Vegetative Filter Strips	Livestock Producers	Demonstration Project	Annual	Watershed Specialist/Extension Kansas Rural Center Conservation Districts/NRCS KAWS WRAPS	$500 per demo project
Rotational Grazing	Small (non-CAFO) Livestock Producers	Demonstration Project	Annual	Kansas Rural Center Watershed Specialist/Extension WRAPS	$5,000 per demo project
All Livestock BMPs	Livestock Producers	Livestock Producer Informational Email List	Bi-monthly	Watershed Specialist/Extension WRAPS	No charge
		Field day or tour	Annual	Watershed Specialist/Extension Kansas Rural Center Conservation Districts/NRCS KAWS WRAPS	$1000 per field day
		Livestock Producer Workshop	Annual – fall or winter		$500 per workshop
		Newspaper article	Biannual	WRAPS	No charge

Table 48 (continued): I&E activities and events to increase adoption of targeted Best Management Practices selected by the Stakeholder Leadership Team to address load reduction in the Delaware River Watershed

BMP	Target Audience	I&E Activity or Event	Time Frame	Sponsor/ Responsible Agency	Estimated Cost
Livestock BMP Implementation (continued)					
All Livestock BMPs	Livestock Producers	One-on-One Technical Assistance	Annual	Watershed Specialist Kansas Rural Center	Included with TA for sponsors
All Livestock BMPs	Livestock Producers	Small Group Livestock Producer Meetings	Annual	Watershed Specialist Kansas Rural Center KAWS WRAPS	Included in TA for sponsors
Cropland BMP Implementation					
Buffers	Landowners	Field day	Annual – summer or fall	Conservation District/NRCS FB Biologist Kansas Forest Service WRAPS	$500
		Newspaper article	Annual	WRAPS	No Cost
		Conservation District and Extension Newsletter articles	Annual - one per year in each CD and Extension newsletter	Conservation District Farm Bill Biologist Extension WRAPS	No Cost
		One-on-one meetings and consults with landowners	Annual - ongoing	Conservation Districts FB Biologist Kansas Forest Service WRAPS	Cost included in TA for Buffer Coordinator, FB Biologist & Kansas Forest Service
		Erect roadside signs highlighting riparian buffers	2012	Conservation Districts Farm Bill Biologist WRAPS	$500/sign
Plant Permanent Vegetation	Landowners	Field day or tour	Annual – summer or fall	Conservation Districts/NRCS FB Biologist Extension Service Watershed Specialist Kansas Rural Center	Hold in conjunction with other cropland BMP field day

Table 48 (continued): I&E activities and events to increase adoption of targeted Best Management Practices selected by the Stakeholder Leadership Team to address load reduction in the Delaware River Watershed

BMP	Target Audience	I&E Activity or Event	Time Frame	Sponsor/ Responsible Agency	Estimated Cost
Cropland BMP Implementation (continued)					
Plant Permanent Vegetation (continued)	Landowners (continued)	One-on-one meetings and consults with landowners	Annual - ongoing	Conservation Districts FB Biologist Kansas Forest Service Watershed Specialist	Cost included in TA for Buffer Coordinator, FB Biologist, KFS & Watershed Specialist
Grassed Waterways	Landowners with Cropland	Field day or tour	Annual – summer or fall	Conservation Districts/NRCS	Hold in conjunction with other cropland BMP field day
Water Retention Structures for Grade Stabilization	Landowners	Field day or tour	Annual – summer or fall	Conservation Districts/NRCS FB Biologist	Hold in conjunction with other cropland BMP field day
		One-on-one meetings and consults with landowners	Annual - ongoing	Conservation Districts/NRCS FB Biologist	Cost included in TA for Buffer Coordinator FB Biologist
No-till	Cropland Producers	Demonstration project utilizing cover crops in a no-till system	Annual	Extension Service Kansas Rural Center WRAPS	$300 per demo project
		Newspaper article	Annual	WRAPS	No charge
		Field day w/ soil pit, rainfall simulator, cover crop information, etc	Annual	Extension Service Kansas Rural Center WRAPS No-till on the Plains	$1,500
		One-on-one meetings and consults with crop producers	Annual – ongoing	Extension Service Kansas Rural Center	Cost included in TA
		Scholarships to Annual No-till Winter Conference	Annual – winter	Conservation Districts WRAPS	$1,500 ($150/person)

Table 48 (continued): I&E activities and events to increase adoption of targeted Best Management Practices selected by the Stakeholder Leadership Team to address load reduction in the Delaware River Watershed

BMP	Target Audience	I&E Activity or Event	Time Frame	Sponsor/ Responsible Agency	Estimated Cost
Cropland BMP Implementation (continued)					
No-till (continued	Cropland Producers (continued)	Conservation District and Extension Newsletter articles	Annual - one per year in each CD and each Extension District newsletter	Conservation Districts Extension Service WRAPS Kansas Rural Center	No Cost
Subsurface Fertilizer Application	Cropland Producers	Field day showing subsurface fertilizer application and equipment. Combine with	Annual – summer	Conservation Districts/NRCS Extension Service	Hold in conjunction with other cropland BMP field day
WRAPS I&E Program – Project Management	All as stated above	WRAPS involvement in programs and activities listed above	Annually	Glacial Hills RC&D	$6,000 annually

6.1.2 Watershed-Wide Information and Education Activities

Although a primary focus of I&E activities is to increase the adoption and implementation of BMPs, I&E programs should also reach out to other stakeholders in the watershed who may not be directly involved in implementation of BMPs in target areas. Helping to foster a knowledgeable, water resource savvy population in the watershed increases public support for BMP implementation, helps individuals to take personal responsibility for local water resources, and can result in implementation of BMPs in non-targeted areas which will benefit water quality overall.

The following table lists Watershed-wide I&E activities developed by the SLT to increase awareness of watershed issues among all residents in the watershed.

Table 49: Watershed-wide Information and Education activities and events to increase awareness of watershed issues and increase adoption of Best Management Practices in the Delaware River Watershed

BMP	Target Audience	I&E Activity or Event	Time Frame	Sponsor/ Responsible Agency	Estimated Cost
Watershed-Wide Information & Education					
WRAPS Website	Watershed Residents and Other Internet users	Maintain a Delaware River WRAPS website to provide watershed information, access for BMP applications, links to partnering agencies, etc	Annual – ongoing	WRAPS	$500/year
Announcements about watershed events and other watershed information	Television	Utilize local access channels to publicize events, meetings and other information	Annual – ongoing	WRAPS	No charge
	Radio	Utilize local radio stations to air announcements and information	Annual – ongoing	WRAPS	No charge
Announcements about watershed events and information (cont.)	Newspaper	Utilize local newspapers to publicize events and other information	Monthly	WRAPS	No charge
Educator Education	Educators, K-12	2-day Educator Workshops that offer graduate credit for attending	Annual	WRAPS KACEE Area Schools	$3000/workshop
		Sponsor teachers to attend Ag in the Classroom and other natural resource training	Annual - summer	Conservation Districts Kansas Foundation for Ag in the Classroom	$250/teacher

Table 49 (continued): Watershed-wide I&E activities and events to increase awareness of watershed issues and increase adoption of Best Management Practices in the Delaware River Watershed

BMP	Target Audience	I&E Activity or Event	Time Frame	Sponsor/ Responsible Agency	Estimated Cost
Watershed-Wide Information & Education (continued)					
Youth Education	Grades K-12	DVDs and other audio/visual materials with watershed topics	Annual – ongoing	Conservation Districts Area Schools WRAPS	$250/year
		Earth Day and other celebrations	Annual – ongoing	Conservation Districts Area Schools WRAPS	No charge
		Classroom Presentations	Annual – ongoing	Area Schools WRAPS	No charge
		Service learning projects	Annual – ongoing	Area Schools WRAPS	No charge
		Envirothon and other youth education events	Annual – spring	Conservation Districts Kansas Farm Bureau Extension Service	$250
		Conservation poster contest	Annual – winter	Conservation Districts Schools	No charge
	College Level	Service learning projects with students	Annual – ongoing	Kansas Universities/Colleges WRAPS	$5000/project
		Participate in career days activities in the area	Annual – ongoing	Kansas Universities/Colleges WRAPS	No charge
Adult Education	Adults in Watershed	WRAPS Newsletter	Annual – winter	WRAPS	$5000/newsletter
		River Friendly Farms producer meetings	Annual – ongoing	Kansas Rural Center	$150/meeting
		Media campaign to promote forestry practices	Annual – ongoing	Kansas Forest Service	$600

Table 49 (continued): Watershed-wide I&E activities and events to increase awareness of watershed issues and increase adoption of Best Management Practices in the Delaware River Watershed

BMP	Target Audience	I&E Activity or Event	Time Frame	Sponsor/ Responsible Agency	Estimated Cost
Watershed-Wide Information & Education (continued)					
Adult Education (continued)	Adults in Watershed (continued)	Presentations to conservation districts and other community groups	Annual – ongoing	WRAPS	No charge
		Watershed Tour highlighting water resource protection practices	Annual – fall	Conservation Districts/NRCS Watershed Specialist/Extension Kansas Rural Center Kansas Forest Service FB Biologist WRAPS	$1500
		Referral program provides info. and referral to technical assistance individuals	Annual – ongoing	NE KS Environmental Services JF Co. Health Dept. Conservation Districts	$5000
		Annual wastewater installers conference	Annual – winter	NE KS Environmental Services	$1000
		Monthly newspaper column	Monthly	WRAPS	No charge
		Abandoned well plugging demonstration	Annual – summer	Conservation Districts	$500
		Delaware River Watershed and BMP brochures	Annual	WRAPS	$1000
		Rain barrel/Rain garden workshop	Biannual – spring and late summer	Holtonians 4 Stormwater Solutions (H4SS) Conservation Districts WRAPS	$1000/workshop

Table 49 (continued): Watershed-wide I&E activities and events to increase awareness of watershed issues and increase adoption of Best Management Practices in the Delaware River Watershed

BMP	Target Audience	I&E Activity or Event	Time Frame	Sponsor/ Responsible Agency	Estimated Cost
Watershed-Wide Information & Education (continued)					
Adult Education (continued)	Adults in Watershed (continued)	"Urban" BMP field day or tour	Bi-annual	H4SS WRAPS	$500
		Absentee landowner newsletter	Annual	WRAPS	$1500
		"Human interest" articles related to watershed area and resources for local media	Annual	Local historical societies, museums and other historical groups WRAPS	No charge
		Local media stories about resource-friendly farming methods	Annual	Kansas Rural Center	Cost included in TA for Kansas Rural Center
		Household Hazardous Waste media campaign	Annual –ongoing	NE Kansas Region HHW Disposal Program (Jackson Co.) Jefferson Co. HHW Program Nemaha Co. HHW Program	$1000
BMP	**Target Audience**	**Information/ Education Activity/Event**	**Time Frame**	**Sponsor/ Responsible Agency**	**Estimated Cost**
Watershed-Wide Information & Education (cont.)					
Adult Education (continued)	Adults in Watershed (continued)	Promote Source Water Protection to public water suppliers	Annual – ongoing	Kansas Rural Water Association Public Water Suppliers KDHE WRAPS	No cost

6.2 Evaluating the Effectiveness of Information and Education Activities

I&E activities that are designed and conducted to meet objectives stated in this watershed plan will be required to include an evaluation component. This requirement applies to all I&E activities conducted by Delaware River WRAPS as well as those conducted by other service providers working in the watershed utilizing WRAPS funding. Evaluation methods are expected to vary somewhat depending on the type of activity and the target audience. However, evaluations should at a minimum be designed to derive the following information:

- ✓ Level of participant pre- and post- knowledge or understanding
- ✓ Feedback from participants rating the activity content, usefulness of the information, and quality of the presenters
- ✓ Any practice or behavioral changes participants expect to implement as a result of the activity
- ✓ Suggestions for additional activities or information that would be helpful
- ✓ The number of participants; participants should be asked to register or "sign-in" and provide their contact information whenever possible

Evaluation methods may include surveys or questionnaires taken at the end of an activity, follow-up interviews, questionnaires or surveys mailed to participants, or other methods as appropriate for the activity and the audience. Service providers who conduct I&E activities will be required to evaluate the activity themselves as well as share the results of participant evaluations with Delaware River WRAPS and the organization funding the activity.

<u>Part 7</u>: Plan and Water Quality Milestone Review Timeframe

Monitoring data in the Delaware River watershed will be used by the SLT to evaluate water quality progress. The schedule for informal review of monitoring data will be tied to the water quality milestones that have been developed as well as the frequency of the sampling data. Frequent reviews will allow the SLT to stay up-to-date with data that is available and any water quality trends. The SLT will request the assistance of KDHE, U.S. Corps of Engineers and other agencies from which this data will be available to assist in the analysis and review.

The BMP implementation schedule and water quality milestones for the Delaware River watershed extend through a 32 year plan implementation period, from 2011 to 2043. The impact of BMPs on water quality takes several years to become apparent and measureable. After the first 10 years of monitoring and BMP implementation, the SLT and KDHE will evaluate available water quality data to determine whether water quality improvements that meet the prescribed milestones have been achieved. The SLT, with assistance from KDHE, will address any necessary modifications or revisions to the plan based on this analysis, and every 5 years thereafter. In 2043, at the end of the 32-year implementation period, a final determination will be made as to whether water quality standards have been ultimately attained.

In addition, the SLT will conduct a formal review of the watershed plan and the extent to which the planned BMP implementation schedule has been met every 5 years. The first review of the watershed plan will therefore be conducted in 2016. Reviewing the watershed plan and BMP implementation every 5 years allows the SLT to make adjustments to the plan if needed, taking into account water quality trends, any new impairments and BMP implementation levels. In addition, TMDLs are reviewed in the Kansas-Lower Republican Basin every 5 years, with the next review scheduled for 2015. Thus a formal 5-year watershed plan review schedule following closely on the heels of the TMDL review in the watershed will allow the SLT to revise the plan as needed.

In the interim between planned reviews, the SLT maintains the option to formally amend the watershed plan in response to events or changes that could significantly alter watershed goals, BMP adoption or other conditions in the watershed. Examples of events that could lead to an unscheduled plan review and revision include regulations that drastically alter land use practices and wide events that extensively affect agricultural or cultural norms in the watershed. It is prudent to maintain this flexibility for stakeholders to the fullest extent possible. The 32-year implementation schedule is long and events outside the control of the SLT can significantly influence the culture and resources in the watershed, even within a shorter 5-year window. Although the likelihood of this need actually arising is small, the option to react in a timely manner to pressures and changes must be left open to stakeholder leaders.

In summary, water quality monitoring data will be analyzed and reviewed as it becomes available in order to stay abreast of water quality trends. The watershed plan and BMP implementation schedule will be reviewed on a 5-year basis beginning in 2016. An in-depth review of all data related to meeting water quality milestones for sediment, nutrients and bacteria impairments will be conducted after 10 years, beginning in 2021. The formal review and plan revision schedule will be followed to the extent possible. However, the SLT will maintain the freedom to review the plan, make changes or modify this review schedule in response to significant changes or events that would warrant such action.

Table 50: Watershed plan, BMP and water quality milestone review schedule for the Delaware River Watershed

Review Year	Plan Reviewed and BMP Implementation Evaluated	Sediment WQ Milestones Evaluated	Nutrient WQ Milestones Evaluated	Bacteria WQ Milestones Evaluated
2016	X			
2021	X	X	X	X
2026	X	X	X	X
2031	X	X	X	X
2036	X	X	X	X
2041	X	X	X	X
2043	X	X	X	X

Part 8: Measureable Water Quality and BMP Implementation Milestones

Measureable milestones have been set to help evaluate progress toward meeting BMP implementation and water quality goals. As BMPs are installed in targeted areas of the watershed, monitoring data should show water quality improvements over time. The Delaware River WRAPS SLT will formally evaluate progress and measure goal achievement every 5 years through a formal review of the watershed plan. If it is determined that sufficient progress is not being made toward planned BMP implementation and associated water quality goals, the SLT will readjust the implementation schedule, BMPs used or make other adjustments in order to achieve watershed goals by the end of the 32-year implementation schedule.

To aid the SLT in the task of evaluating achievement of implementation schedule and water quality goals, the 32-year BMP implementation schedule is broken into Short-Term (1 to 5 years) Medium-Term (6 to 10 years) and Long-Term (11 to 32 year) intervals.

8.1 Overview of Water Quality Milestones to Determine Water Quality Improvements

The goal of the Delaware River WRAPS plan is to protect and restore water quality so that water resources in the watershed will be capable of supporting their respective designated use(s). Protection and restoration efforts in this plan focus on three main water quality impairments that were identified by local stakeholders as being the highest priority issues for the watershed. These three priority issues are: sedimentation, nutrient enrichment and bacteria.

By focusing on these priority issues, the watershed plan also specifically addresses Total Maximum Daily Loads (TMDLs) that have been established for bodies of water in the watershed, including Grasshopper Creek, the Delaware River and tributaries, Perry Lake and Mission Lake. The TMDLs addressed include:

- High priority Bacteria TMDL for the Delaware River and tributaries above Perry Lake
- High priority Bacteria TMDL for Grasshopper Creek
- High priority Sediment TMDL for Mission Lake
- High priority Eutrophication TMDL for Perry Lake

In addition to the TMDLs listed above, high priority Eutrophication and Dissolved Oxygen TMDLs for Perry Lake Wildlife Area Wetlands and Atrazine TMDL for Grasshopper Creek have been developed and are pending final approval. While this plan does not directly address these impairments, it is expected that the water quality of these bodies of water will be positively affected by the implementation of BMPs as outlined in this plan.

In order to reach the load reduction goals associated with the TMDLs listed above, a BMP implementation schedule spanning 32 years has been developed (see **Part 4** for the implementation schedules of these BMPs). Separate water quality milestones have been developed for the Delaware

River, Grasshopper Creek, and Perry Lake and Mission Lake, along with additional indicators of water quality. The purpose of the milestones and indicators is to provide procedures to measure water quality improvements associated with the BMP implementation schedule contained in this plan.

Monitoring data in the Delaware River watershed will be used by the SLT to evaluate water quality progress. Monitoring data will be reviewed when it becomes available. .

The BMP implementation schedule and water quality milestones for the Delaware River watershed extend through a thirty-two year period, from 2011 to 2043. Throughout that time period, KDHE will continue to analyze and evaluate monitoring data that is collected. In addition to the planned review of the monitoring data and water quality milestones, the SLT with assistance from KDHE will revisit the plan in shorter time increments. This would allow the SLT to evaluate newly available information, respond to applicable TMDLs, or address any potential water quality indicators that might trigger immediate action.

8.2 Sediment Reduction Milestones

8.2.1 Sediment Reduction Milestones for Perry Lake

In order to reach the sediment and phosphorus reduction goals for Perry Lake, a BMP implementation schedule spanning 32 years has been developed, and water quality milestones and indicators have been developed for Perry Lake. In addition to water quality measures such as total phosphorus and secchi depth measurements, the sedimentation rate for Perry Lake will be utilized to determine the effectiveness of the BMPs as part of the sediment load reduction goals outlined in this plan.

The estimated sedimentation rates and future desired rate to meet the 100-year Design Life for Sediment Storage for Perry Lake were utilized to calculate sediment load reduction goals. The current sedimentation rate determined by the Kansas Water Office in 2010 is approximately 1,143 acre-feet/year. As part of the water quality assessment needed to measure water quality goal achievement, the sedimentation rate will continue to be analyzed throughout the life of this plan. A movement toward the desired sedimentation rate of 824 acre-feet/year is considered a water quality goal associated with the sediment load reductions goals of this plan.

Table 51: Milestone intervals for implementation of Cropland BMPs for Perry Lake

	Perry Lake Annual Adoption (treated acres), Cropland BMPs							
	Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
Short-Term	1	73	244	611	977	415	122	2,444
	2	73	244	611	977	415	122	2,444
	3	73	244	611	977	415	122	2,444
	4	73	244	611	977	415	122	2,444

Table 51 (continued): Milestone intervals for implementation of Cropland BMPs for Perry Lake

	Perry Lake Annual Adoption (treated acres), Cropland BMPs							
	Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
	5	73	244	611	977	415	122	2,444
	Total	*367*	*1,222*	*3,055*	*4,887*	*2,077*	*611*	*12,219*
Medium-Term	6	73	244	611	977	415	122	2,444
	7	73	244	611	977	415	122	2,444
	8	73	244	611	977	415	122	2,444
	9	73	244	611	977	415	122	2,444
	10	73	244	611	977	415	122	2,444
	Total	*733*	*2,444*	*6,109*	*9,775*	*4,154*	*1,222*	*24,437*
Long-Term	11	73	244	611	977	415	122	2,444
	12	73	244	611	977	415	122	2,444
	13	73	244	611	977	415	122	2,444
	14	73	244	611	977	415	122	2,444
	15	73	244	611	977	415	122	2,444
	16	73	244	611	977	415	122	2,444
	17	73	244	611	977	415	122	2,444
	18	73	244	611	977	415	122	2,444
	19	73	244	611	977	415	122	2,444
	20	73	244	611	977	415	122	2,444
	21	73	244	611	977	415	122	2,444
	22	73	244	611	977	415	122	2,444
	23	73	244	611	977	415	122	2,444
	24	73	244	611	977	415	122	2,444
	25	73	244	611	977	415	122	2,444
	26	73	244	611	977	415	122	2,444
	27	73	244	611	977	415	122	2,444
	28	73	244	611	977	415	122	2,444
	29	73	244	611	977	415	122	2,444
	30	73	244	611	977	415	122	2,444
	31	73	244	611	977	415	122	2,444
	32	73	244	611	977	415	122	2,444
	Total	*2,346*	*7,820*	*19,550*	*31,279*	*13,294*	*3,910*	*78,198*

Table 52: Milestone intervals for implementation of Livestock, Streambank Stabilization and Gully Control BMPs for Perry Lake

	Annual Livestock, Streambank and Gully BMP Adoption							
	Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Streambank (feet)	Gullies
Short-Term	1	2	1	2	3	1	2,262	1
	2	2	1	2	3	1	2,262	1
	3	2	1	2	3	1	2,262	1
	4	2	1	2	3	1	2,262	1
	5	2	1	2	3	1	2,262	1
	Total	*10*	*5*	*10*	*15*	*5*	*11,310*	*5*
Medium-Term	6	2	1	2	3	1	2,262	1
	7	2	1	2	3	1	2,262	1
	8	2	1	2	3	1	2,262	1
	9	2	1	2	3	1	2,262	1
	10	2	1	2	3	1	2,262	1
	Total	*20*	*10*	*20*	*30*	*10*	*22,620*	*10*
Long-Term	11	2	1	2	3	1	2,262	1
	12	2	1	2	3	1	2,262	1
	13	2	1	2	3	1	2,262	1
	14	2	1	2	3	1	2,262	1
	15	2	1	2	3	1	2,262	1
	16	2	1	2	3	1	2,262	1
	17	2	1	2	3	1	2,262	1
	18	2	1	2	3	1	2,262	1
	19	2	1	2	3	1	2,262	1
	20	2	1	2	3	1	2,262	1
	21	2	1	2	3	1	2,262	1
	22	2	1	2	3	1	2,262	1
	23	2	1	2	3	1	2,262	1
	24	2	1	2	3	1	2,262	1
	25	2	1	2	3	1	2,262	1
	26	2	1	2	3	1	2,262	1
	27	2	1	2	3	1	2,262	1
	28	2	1	2	3	1	2,262	1
	29	2	1	2	3	1	2,262	1
	30	2	1	2	3	1	2,262	1
	31	2	1	2	3	1	2,262	1
	32	2	1	2	3	1	2,262	1
	Total	*64*	*32*	*64*	*96*	*32*	*72,384*	*32*

8.2.2 Sediment Reduction Milestones for Mission Lake

Load reductions have been calculated, as described in earlier sections of this plan, in order to address the high priority Sediment TMDL for Mission Lake. BMP implementation targets the Mission Lake drainage area for sediment-reducing practices.

Mission Lake was dredged in 2010. In order to ensure that the lake maintains adequate storage capacity, future sediment loads must be managed. As part of the water quality assessment to determine the impact of BMP implementation, the sedimentation rate will continue to be analyzed throughout the life of this plan. To meet water quality goals and support designated uses, the lake should not exceed an average sedimentation rate of more than 8 acre-feet per year for the next 75 years to ensure that the restored capacity of Mission Lake is protected.

In addition to monitoring and maintaining an acceptable sedimentation rate for Mission Lake, the table below includes water quality goals for the secchi depth measured in Mission Lake.

Table 53: Water quality milestones for Mission Lake

Water Quality Milestones for Mission Lake			
		10-Year Goal	**Long Term Goal**
	Current Condition (1989 - 2009) Secchi (Avg)	**Improved Condition (2011 - 2021) Secchi (Avg)**	**Improved Condition Secchi (Avg)**
Sampling Site	Secchi (average of data collected during indicated period), m		
Mission Lake LM013601	0.35	0.65	Maintain Secchi depth > 1.0

Table 54: Milestone intervals for implementation of Cropland BMPs for Mission Lake

	Mission Lake Annual Adoption (treated acres), Cropland BMPs							
	Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
Short-Term	1	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	2	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	3	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	4	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	5	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	Total	11.95	39.83	99.56	159.30	67.70	19.91	398.25
Medium-Term	6	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	7	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	8	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	9	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	10	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	Total	23.90	79.65	199.13	318.60	135.41	39.83	796.50
Long-Term	11	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	12	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	13	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	14	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	15	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	16	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	17	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	18	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	19	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	20	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	21	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	22	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	23	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	24	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	25	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	26	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	27	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	28	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	29	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	30	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	31	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	32	2.39	7.97	19.91	31.86	13.54	3.98	79.65
	Total	76.46	254.88	637.20	1019.52	433.30	127.44	2548.80

8.3 Nutrient Reduction Milestones

Nutrient reduction water quality milestones will be measured at sampling stations on the Delaware River, Grasshopper Creek and in Perry Lake itself.

The table below includes 10-year and long term water quality goals for total phosphorus (TP) in the Delaware River and Grasshopper Creek. These milestones were determined by KDHE to be necessary to reach the desired endpoints related to nutrient reduction for the Eutrophication TMDL for Perry Lake.

Table 55: Total Phosphorus (TP) water quality milestones for the Delaware River and Grasshopper Creek above Perry Lake

Water Quality Milestones for Delaware River for Sampling Sites Above Perry Lake					
	Current Condition (2000 - 2009) Median TP	10-Year Goal		Long Term Goal	
		Improved Condition (2011 - 2021) Median TP	Total Reduction Needed	Improved Condition Median TP	Total Reduction Needed
Sampling Site	**Total Phosphorus (median of data collected during indicated period), ppb or %**				
Delaware River Near Half Mound SC554	205	200	**7**	144	**30%**
Grasshopper Creek SC603	235	200	**35**	165	**30%**

Table 56 illustrates the 10-year water quality goals and long term water quality goals for total phosphorus (TP), total nitrogen (TN), chlorophyll *a* (phosphorus indicators), and secchi depth (TSS indicator)that will be monitored in Perry Lake.

Because bacteria and nutrient impairments are closely related and originate from many of the same sources, the implementation of nutrient controlling BMPs will also result in water quality improvements related to bacteria.

Table 56: Total Phosphorus (TP) and Total Nitrogen (TN), Chlorophyll *a* and TSS (secchi depth) water quality milestones for Perry Lake

Water Quality Milestones for Perry Lake										
	Total Phosphorus					Total Nitrogen				
		10-Year Goal		Long Term Goal			10-Year Goal		Long Term Goal	
	Current Condition (1996 - 2010) Average TP	Improved Condition (2011 - 2021) Average TP	Total Reduction Needed	Improved Condition Average TP	Total Reduction Needed	Current Condition (1996 - 2010) Average TN	Improved Condition (2011 - 2021) Average TN	Total Reduction Needed	Improved Condition Average TN	Total Reduction Needed
Sampling Site	**Total Phosphorus (average of data collected during indicated period), ppb**					**Total Nitrogen (average of data collected during indicated period), ppm**				
Perry Lake LM029001	76	60	**16**	29	**47**	0.92	**0.75**	**0.17**	0.39	**0.53**

	Chlorophyll *a*					Total Suspended Solids (Secchi Depth)		
		10-Year Goal		Long Term Goal			10-Year Goal	Long Term Goal
	Current Condition (1996 - 2010) Chlorophyll *a*	Improved Condition (2011 - 2021) Chlorophyll *a*	Total Reduction Needed	Improved Condition Chlorophyll *a*	Total Reduction Needed	Current Condition (1996 - 2010) Secchi (Avg)	Improved Condition (2011 - 2021) Secchi (Avg)	Improved Condition Secchi (Avg)
Sampling Site	**Chlorophyll a (average of data collected during indicated period), ppb**					**Secchi (average of data collected during indicated period), m**		
Perry Lake LM029001	17.5	12	**5.5**	10	**7.5**	1.12	**Secchi depth > 1.5**	**Maintain Secchi depth > 1.5**

8.4 Bacteria Reduction Milestones

As noted previously, this plan addresses the high priority Bacteria TMDLs for both the Delaware River above Perry Lake and for Grasshopper Creek. To determine the effectiveness of BMPs designed to reduce bacteria impairments, bacteria concentrations in these streams must be measured. A bacteria index is then applied to the concentration data to gauge the relative frequency and magnitude of these bacteria concentrations at KDHE monitoring sites. Bacteria load reductions that result from the implementation of targeted BMPs should result in:

1) less frequent exceedences of the nominal *E. Coli* Bacteria (ECB) criterion (262 Colony Forming Units (CFUs)/100ml) for the sampling stations above Perry Lake
2) lowered magnitude of exceedences that do occur

The calculated bacteria index for the Delaware River at sampling station SC554 is the natural logarithm of each sample value taken during the April-October Primary Recreation season, divided by the natural logarithm of the bacteria criteria for Primary Recreation Class B [ln(262)].

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

The bacteria indices for other tributaries within the watershed are calculated in the same manner based on the Primary Recreation Class C criterion (427 CFUs/100ml).

Index = ln(ECB Count) / ln(427)

The indicator used will be the Upper Decile of the index values, with the desired target being that the calculated index is below 1.0 at the upper decile (90th percentile). Ultimately, compliance with water quality standards will require sampling 5 times within 30 days during several periods through the primary recreation season, and calculating the geometric mean of those samplings. Meeting the test will be justification for delisting the stream impairment.

KDHE sampling stations SC603 on Grasshopper Creek and SC554 on the Delaware River were sampled in accordance with the water quality standard for three different intensive sampling events in 2010. **Figures 30 through 33** show the bacteria index for the Delaware River as well as the results of the intensive sampling events that took place at SC554 and SC603. Each of the three intensive sampling events consisted of five ECB samples collected over a 30-day period. The calculated geometric mean of the five samples for each event was over the criterion for Grasshopper Creek (427 CFUs/100ml) for two of these sampling events and for two of the three events for the Delaware River (262 CFUs/100ml.

Figure 30: Bacteria Index for Delaware River Watershed to support Primary Contact Recreation B Use

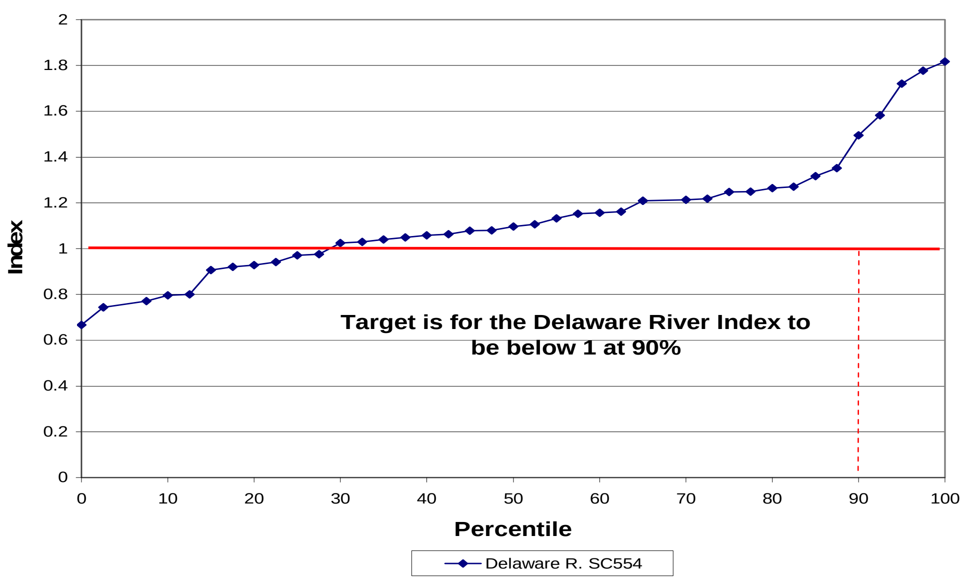


Figure 31: Bacteria Index for the Delaware River Watershed to support Primary Contact Recreation C

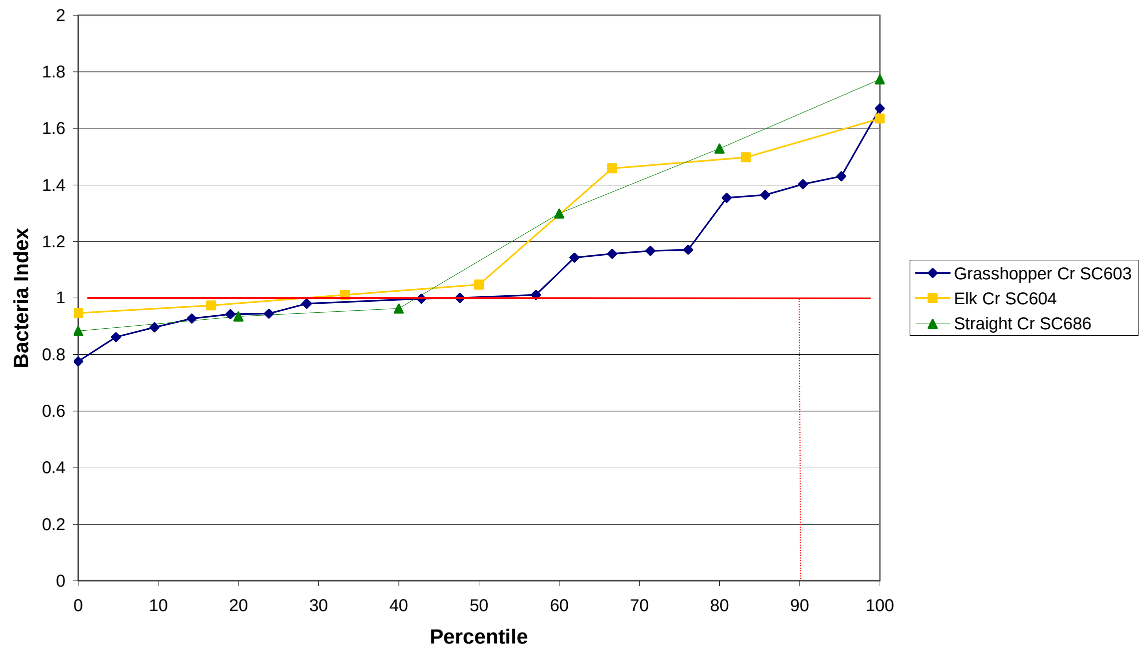


Figure 32: Bacteria Index Target for the Delaware River Watershed to support Primary Contact Recreation

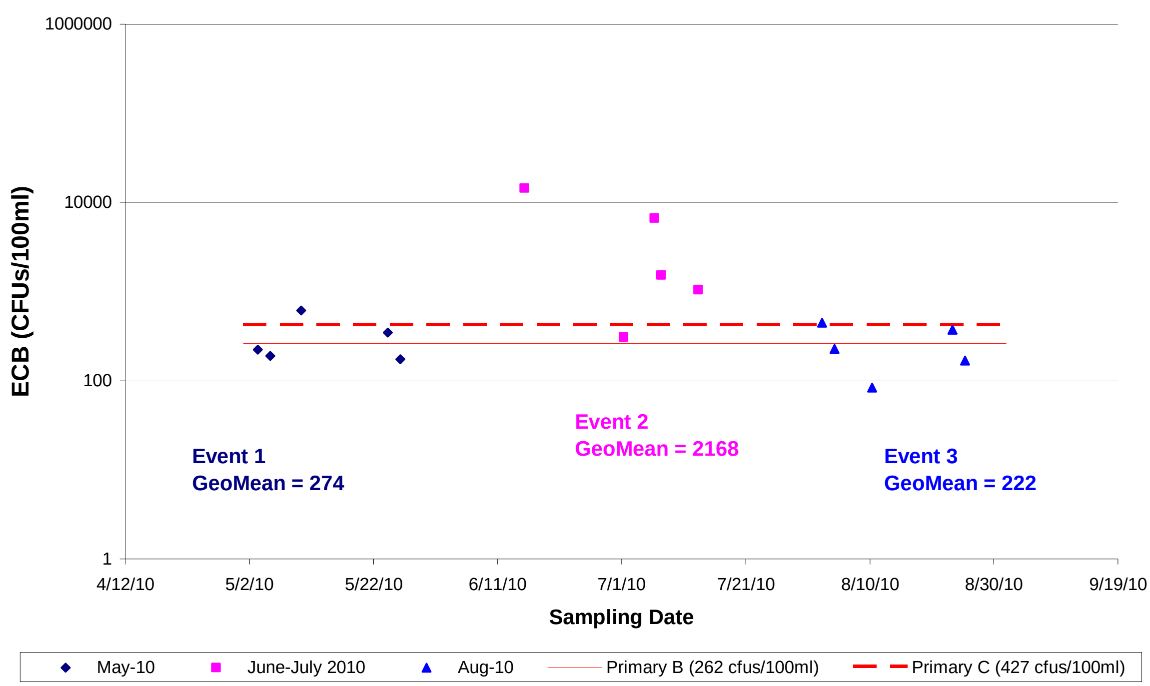
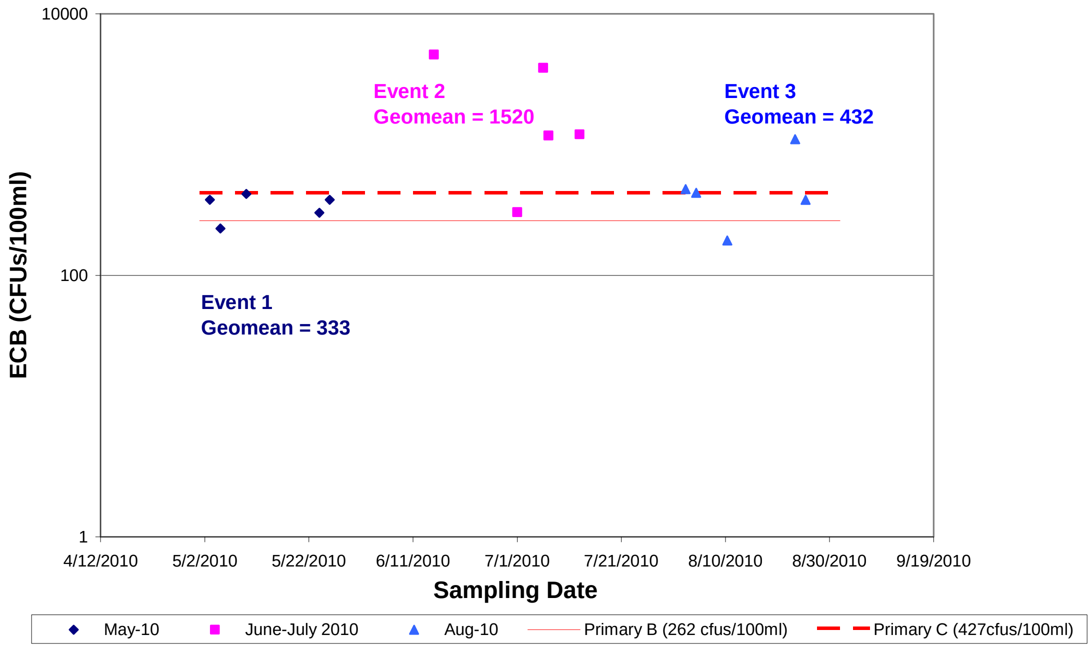


Figure 33: 2010 ECB intensive sampling results at Grasshopper Creek, Station SC602



The water quality goals for the bacteria impairments in the Delaware River and Grasshopper Creek are for at least 90% of the samples taken during April through October to be below the water quality criterion of 262 CFUs/100 ml and 427 CFUs/100 ml, respectively. The implementation of BMPs that address sources of bacteria are expected to result in attainment of these goals over the course of the implementation of this plan, as discussed in earlier sections.

8.4 Milestone Summary

The following tables illustrate BMP Milestones for all BMPs, first for Perry Lake and second for Mission Lake. The 32-year implementation period is broken down into 5-year intervals and the cumulative number of acres treated, acres, number or linear feet of each BMP are listed. *Please note that the numbers in the tables are cumulative totals.*

Table 57: BMP implementation milestones summary from 2011 to 2043 for Perry Lake (numbers are cumulative)

	Cropland (acres or acres treated)						Livestock (number of BMPs)					Streambank (linear feet)	Gully Erosion Control (no.)	Information & Education (no.)		
Milestone Review Year	Riparian Buffers (acres treated)	Permanent Vegetation (acres)	Grassed Waterways (acres treated)	Water Retention Structures (acres treated)	No-till (acres)	Sub-Surface Fertilizer Application (acres)	Off-Stream Watering Systems	Relocating Feeding Sites in Pastures	Relocating Feedlots and Pens	Vegetative Filter Strips	Rotational Grazing Systems	Streambank Restoration	Gully Erosion Control Structures in/near Riparian Areas	Workshops, Demos, Tours (number)	Newsletters, News Articles, Radio Spots, etc (number)	Contacts, Participants (number)
2016	4885	365	1220	610	3055	2075	15	10	5	10	5	26563	9	10	100	1250
2021	9770	730	2440	1220	6110	4150	30	20	10	20	10	37873	18	20	200	2500
2026	14655	1095	3660	1830	9163	6225	45	30	15	30	15	49183	27	30	300	3750
2031	19540	1460	4880	2440	12220	8300	60	40	20	40	20	60493	36	40	400	5000
2036	24425	1825	6100	3050	15275	10375	75	50	25	50	25	71803	45	50	500	6250
2041	29310	2190	7320	3660	18330	12450	90	60	30	60	30	83113	54	60	600	7500
2043	31264	2336	7808	3904	19552	13280	96	64	32	64	32	87637	57	64	640	8000

Table 58: BMP implementation milestones summary for 2011 to 2043 for Mission Lake (numbers are cumulative).

	Cropland (acres or acres treated)						Streambank (linear feet)
Milestone Review Year	Riparian Buffers (acres treated)	Permanent Vegetation (acres)	Grassed Waterways (acres treated)	Water Retention Structures (acres treated)	No-till (acres)	Sub-Surface Fertilizer Application (acres)	Streambank Restoration
2016	160	11.95	39.83	19.91	99.56	67.70	850
2021	320	23.90	79.65	39.83	199.13	135.41	850
2026	480	35.85	119.49	59.73	298.50	203.10	850
2031	640	47.80	159.32	79.64	398.24	270.80	850
2036	800	59.75	199.15	99.55	497.80	338.50	850
204	960	71.70	238.93	119.46	597.36	406.20	850
2043	1024	76.46	254.88	127.44	637.20	433.30	850

8.5 Additional Water Quality Indicators

In addition to water quality monitoring data and BMP project implementation, other water quality indicators can be utilized by the Delaware River Watershed SLT and KDHE to assess acute or short-term deviations from water quality standards. Such indicators include anecdotal information from stakeholders within the watershed or other social indicators.

Additional water quality indicators that will be considered include:

- Taste and odor problems in water supplies utilizing raw water from the Delaware River, Perry Lake and Mission Lake
- Algae blooms in watershed lakes, especially Perry Lake and Mission Lake
- Fish kills
- Skin rash outbreaks following contact with water in streams or lakes
- Visitor and boating traffic at Perry Lake (decrease in visitation levels can indicate water quality problems and have economic impacts on the region)
- Trends in quantity and quality of fishing in Perry Lake
- Beach closings or health advisories related to water contact and recreational activities

These indicators will act as trigger-points that will initiate modifications to the WRAPS plan and educational efforts, or warrant other action such as using a new BMP which can address the water quality issue causing the trigger. Specific action(s) will depend upon the severity and type of the issue that arises. In cases where there is a significant public health threat, Delaware WRAPS will take immediate action and work with KDHE, USACE or other agencies to quickly address the issue to the extent possible.

8.6 Evaluation of Monitoring Data

After the first ten years of monitoring and BMP implementation, the SLT and KDHE will evaluate the available water quality data to determine whether water quality milestones have been achieved. The SLT, with KDHE's assistance, may address any necessary modifications or revisions to the plan based on this data analysis. In 2043, at the end of the plan's 32-year implementation period, a determination will be made as to whether water quality standards have been ultimately attained.

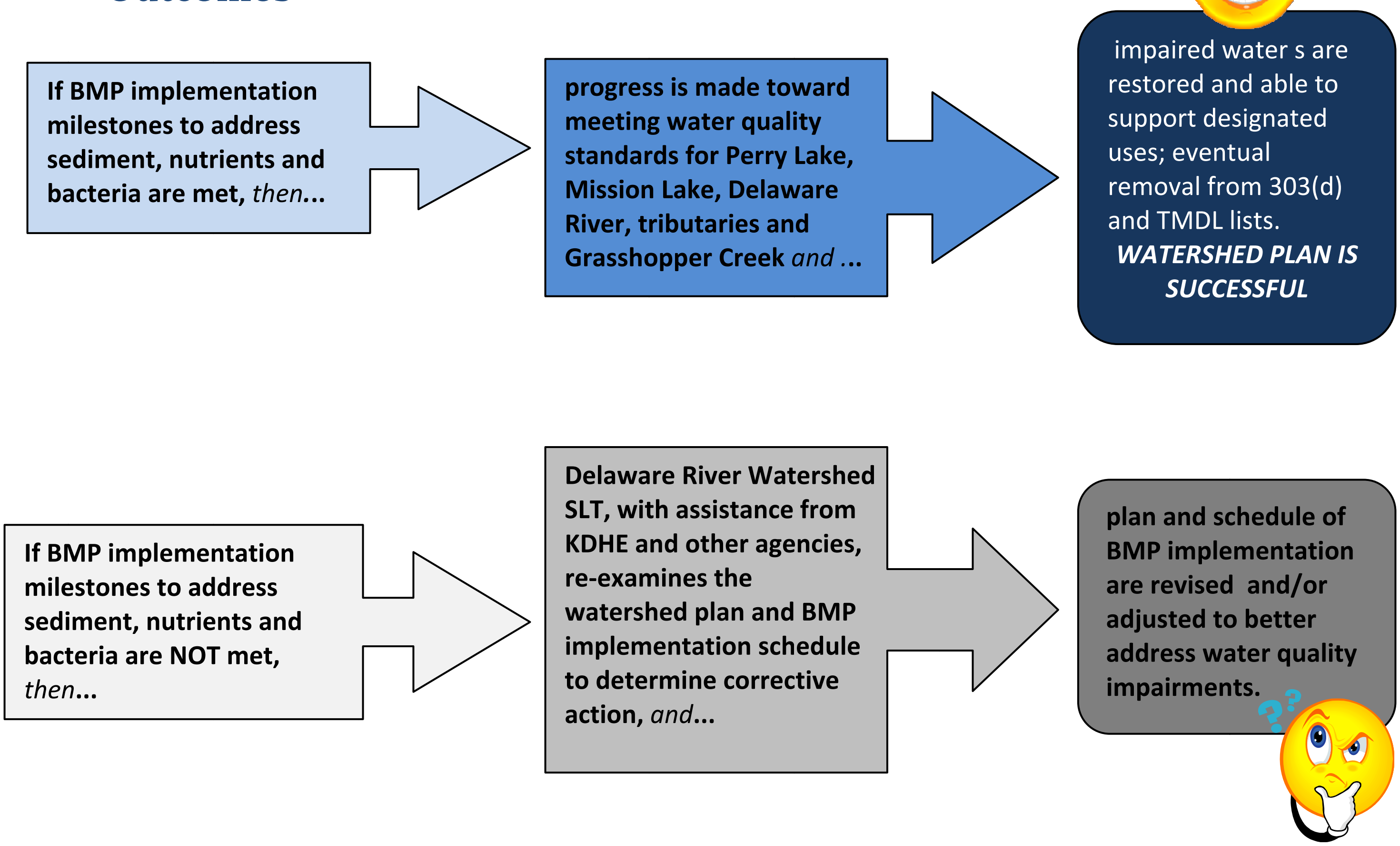
In addition to the planned review of the monitoring data and water quality milestones, the SLT will with assistance from KDHE revisit the plan in shorter time increments. This would allow the SLT to evaluate new information, incorporate any revisions to applicable TMDLs, or address any additional water quality indicators that might trigger more immediate review. See **Part 7** for a more detailed description of the Plan and BMP Implementation Review process.

8.7 Information & Education Related to Monitoring and Other Water Quality Data

Monitoring and other water quality data is an integral component of watershed information and education (I&E) efforts. It will be incorporated as appropriate in all I&E products (news articles, newsletters, signs, radio spots, etc) and activities (workshops, field days, etc.). This type of watershed-specific data helps keep the public informed about the status of local water resources, why BMP implementation is so important, and what water quality issues are being addressed. Monitoring data can help Delaware River WRAPS better illustrate local water issues and what can be done to improve them for the benefit of all stakeholders in the watershed. It can also help individual stakeholders understand better what they can do to benefit local water resources.

For this watershed plan to be successful, individuals must become interested in and care about what's happening in their watershed. Few things can be more effective in that regard than cold, hard facts gleaned from monitoring data. Since this data is based on science and is observable, it is hard to dismiss and hard to disregard. It is the kind of information that can prompt behavioral change or action to a greater degree than many other educational tools because it makes apparent to the individual the impairments that are affecting *their* water resources.

8.8 Diagram of Plan Review Process and Desired Outcomes

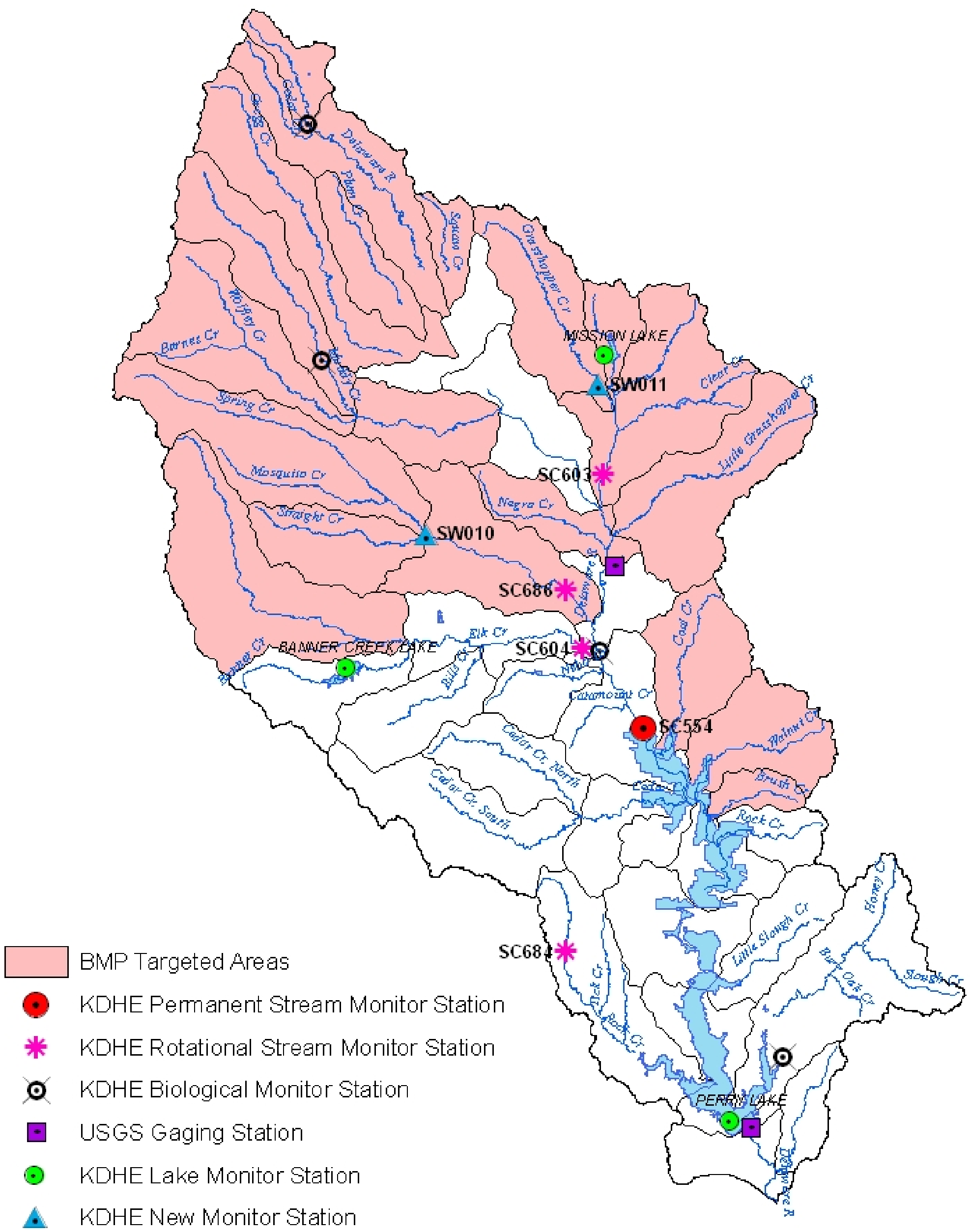


Part 9: Monitoring Water Quality Progress

9.1 KDHE Monitoring Program

KDHE monitors water quality in the Delaware River watershed by maintaining monitoring stations within the watershed. The map below shows the locations of KDHE monitoring sites within the Delaware River watershed. The shaded pink areas are the areas targeted for BMP implementation as discussed in previous sections of this plan.

Figure 34: KDHE Monitoring Sites in the Delaware River Watershed



KDHE stream monitoring stations are either ***permanent*** *or* ***rotational*** **s**ites. ***Permanent*** monitoring sites are continuously sampled, while ***rotational*** sites are typically sampled every four years. All sites are sampled for nutrients (nitrogen and phosphorus), *E. Coli* bacteria, chemicals, turbidity, alkalinity, dissolved oxygen, pH, ammonia and metals. However, the pollutant indicators at each site may vary somewhat depending on the season at collection time and other factors.

KDHE added two new stream monitoring sites (SW010 and SW011) in the watershed in 2010. The new sites include SW010 located in Spring Creek near the City of Netawaka, and SW011 located in Grasshopper Creek near the City of Horton. These sites are also identified **in Figure35.**

KDHE lake monitoring sites are typically sampled every 3 years. In addition to the parameters measured at stream sites, lake site monitoring also includes chlorophyll *a* measurements.

9.2 USACE Monitoring Program

Each year the U.S. Army Corps of Engineers (USACE) collects water samples at federal reservoirs throughout the Kansas City District, including Perry Lake. Sites at Perry Lake where the USACE collects samples have historically included three in-lake locations, one outflow location below the dam and two inflow locations (Rock Creek arm and Delaware River near Valley Falls). See **Figure 36**. One additional lake sampling site was added in the Slough Creek arm of the lake, and four more watershed inflow sites (Delaware River at Highway 9; Little Grasshopper Creek at Bourbon Road; Straight Creek at Allen Road; and Elk Creek at Allen Road) were added in 2008 at the request of the Delaware River WRAPS SLT. Samples are collected monthly from April through September. Nutrients, pesticides (notably atrazine and alachlor), secchi depth, chlorophyll *a*, dissolved oxygen, pH, conductivity and temperature are measured (23). Current funding for this level of testing is slated to be reduced after 2011.

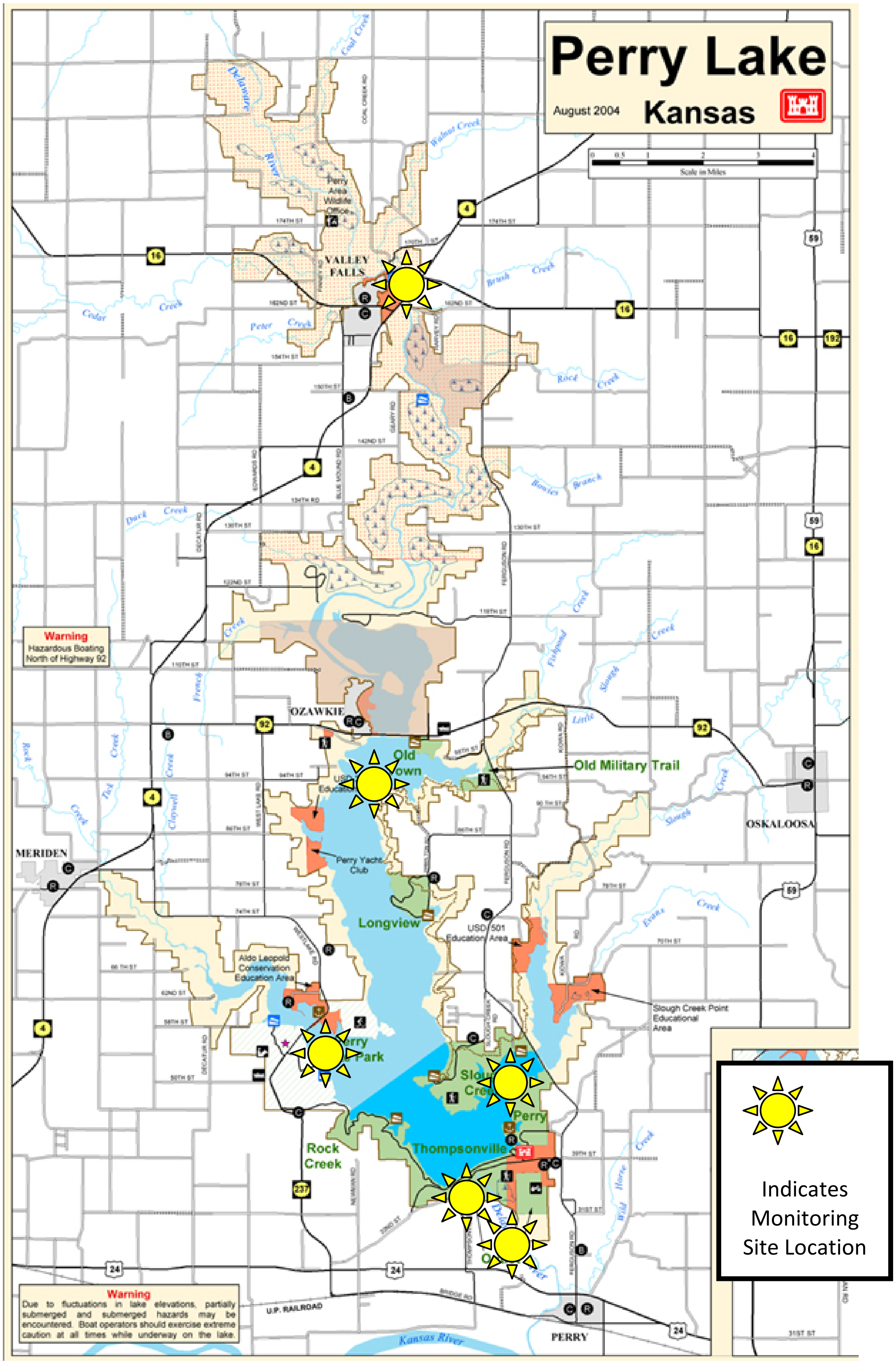
Because Perry Lake is located on the southern end of the watershed only a few miles away from the confluence of the Delaware with the Kansas River, it is a direct reflection of inputs from the watershed and acts like a barometer of water quality impacts from the watershed. For this reason, monitoring information from this program is especially vital to watershed evaluation efforts.

9.3 Monitoring and Assessment Needs

9.3.1 Additional Monitoring Sites

Although existing monitoring stations provide a great deal of information about watershed conditions, additional monitoring sites would be beneficial to this watershed protection effort because many of the larger tributaries in the western portions of the watershed are unmonitored and existing stations provide data from very large sections of the watershed. This makes it difficult to make accurate determinations as to the actual source of impairments and how effective BMP implementation is in addressing them.

<u>Figure 35</u>: U.S. Army Corps of Engineers sampling site locations on Perry Lake (23)



Capturing additional monitoring data from streams within the targeted areas of the watershed would aid in future targeting decisions, assessing the effectiveness of BMPs and refine impairment source identification. Additional monitoring sites at the following locations would accomplish these purposes:

- Elk Creek near confluence with Banner Creek (Jackson Co.)
- Muddy Creek near confluence with Wolfley Creek (Jackson Co.)
- Muddy Creek near confluence with Delaware River (Jackson Co.)
- Gregg Creek near confluence with Delaware River (Brown Co.)
- Upper Delaware River near confluence with Cedar Creek (Nemaha Co.)
- Upper Delaware River near Kickapoo Nation water supply intake (Brown Co.)
- Negro Creek near confluence with Delaware River (Atchison Co.)
- Clear Creek near confluence with Delaware River (Atchison Co.)
- Coal Creek near confluence with Delaware River (Jefferson Co.)
- Walnut Creek near confluence with Delaware River (Jefferson Co.)
- Brush Creek near confluence with Delaware River (Jefferson Co.)

The cost of monitoring is high, and adding additional sites may be cost prohibitive. If funding for state or federal agencies to establish additional monitoring becomes available, the location of new sites would be established based on priorities established by the SLT in consultation with KDHE, taking into account targeted areas, BMP implementation and cost efficiency. The SLT may also opt to fund monitoring activities in the watershed, utilizing organizations that offer this service. Cost for water quality sampling is estimated to be approximately $400/sample for basic water quality tests related to nutrients, bacteria and sediment, based on information received from the Kansas Alliance for Wetlands and Streams (email communication from John Bond, KAWS representative, July 2011). To adequately assess the water quality of a HUC 12 sub-watershed area for one year, at least 6 samples should be collected which would cost an estimated $2,400.

Larger tributaries in the western sections of the watershed would likely receive a higher priority for additional monitoring than smaller tributaries. In order to reduce costs, the water quality parameters sampled and testing frequency may be reduced, volunteers could collect samples for testing, or outside sources may be contracted in order to reduce costs.

9.3.2 Data Needs

The volume and complexity of water quality data collected over the years in the Delaware River Watershed is substantial. In order to be useful for planning, targeting, evaluation of BMP effectiveness and identification of impairment sources, large amounts of information must be assembled and analyzed. Although the USACE has compiled yearly reports summarizing the data collected at the Corps sites in the watershed, the large volume of KDHE monitoring data is much less accessible and useable. The SLT must rely on KDHE staff to provide the data, interpret what the data means and provide guidance on how to apply it. This makes it difficult for the SLT to understand water quality conditions, and in turn convey accurate information to other stakeholders. Obtaining stakeholder “buy-in”, which is necessary for BMP implementation and encouraging water-friendly behaviors, is made more difficult by a cumbersome system of complex and inaccessible information.

9.3.3 Other Assessment and Data Needs

Livestock waste issues are important in the Delaware River Watershed because of the impact the industry can have on nutrient and bacteria and sediment loading of water supplies. KDHE maintains information on the Confined Animal Feeding Operations (CAFOs) in the watershed. However, little is known about unconfined livestock numbers and operations in the watershed area. Local knowledge indicates that the number of unconfined livestock is greatest in Jackson, Nemaha and southwest Brown Counties, but exactly what waste management practices are being utilized, the impact these operations actually have on water resources, where livestock operations are located in relation to streams during the critical winter feeding period, and more, is largely lacking. Livestock location and feeding practices also vary greatly from season to season. A visual accounting of where livestock are in relation to streams, and what practices are in use that would have either a negative OR positive impact on water resources would aid in targeting resources for BMP implementation and educational outreach.

Sedimentation is an important issue in the watershed and is closely related to other water quality issues. Delaware River WRAPS has successfully implemented a large streambank restoration program on the Delaware River which has included riparian tree-planting in adjacent floodplain areas to address a major source of sediment to Perry Lake. The success of this effort has been possible because of assistance and funding from several state and federal agencies as well as the cooperation and financial investment of landowners along the river. In light of the substantial investment in streambank restoration, an assessment of the impact on sedimentation rates at Perry Lake is needed. Such an assessment should include water quality monitoring above and below streambank stabilization project sites and other study to determine whether the projects are justified in terms of soil savings and costs.

Assessment of watershed conditions can often be done remotely using aerial assessment techniques. The KAWS assessment of the main stem Delaware River in 2008 and 2009 provided useful information that was later used to implement the Delaware River Streambank Restoration Program. Similar assessments of stream stability, riparian vegetation and land uses adjacent to streams would be useful for targeting BMP implementation and location of future monitoring sites. The cost of this type of assessment for one HUC 12 sub-watershed area is estimated to be $15,000 (email communication from John Bond, KAWS representative, July 2011). The Delaware River Watershed SLT may utilize this type of service in the future for targeting purposes.

Other information needs include refinement of data that has been collected through on-the-ground field verification. For example, the Kansas Water Office gully and streambank erosion assessment completed in 2010 was conducted using aerial photography and GIS data. Verifying the accuracy of this information and refining the “hot-spots” the identification process with on-the-ground observation would aid targeting efforts and lead to more efficient application of BMPs. This type of on-the-ground field verification can be time-consuming and expensive.

Table 59 provides a summary of a "wish list" of additional monitoring, data analysis and assessment needs identified by the Delaware River Watershed SLT.

Table 59: Summary of major monitoring, data analysis and assessment needs in the Delaware River Watershed

Assessment Project Description	Technical Assistance Needs	Sponsor/ Service Provider(s)
Stream monitoring – locate new monitoring sites on large tributaries not currently being sampled	Monitoring Program	KDHE KAWS
Data Analysis and Data Sharing – compilation and reporting (in usable form) of existing water quality data	Compilation and reporting water quality data in understandable and accessible format	KDHE Other state agencies USACE
Livestock Assessment - determine location, waste management practices and actual water quality impacts of unconfined livestock operations	Physical, on-the-ground survey and aerial assessments of livestock target areas	KSRE Watershed Specialist Kansas Rural Center
Streambank Stabilization Sediment Assessment – monitor sediment load of the Delaware River above and below streambank stabilization sites to determine effect on sediment load of the river	Monitoring program	USACE KWO
Aerial Assessment of HUC 12 Sub-watershed areas – identification of land use and riparian areas adjacent to streams to improve targeting and BMP implementation efficiencies	Aerial assessment	KAWS

Part 10: Appendix

10.1 Service Provider Information

Table 60: Potential service provider listing

Organization	Programs	Purpose	Technical or Financial Assistance	Website Address
U.S. Environmental Protection Agency (EPA)	*Clean Water Act (CWA) Section 319 Funds *State Revolving Fund (SRF) Program *American Recovery and Reinvestment Act (ARRA) Funds	CWA provides grant funds for water protection activities SRF and ARRA provide loans for water pollution control activities and green infrastructure	Financial	www.epa.gov
Kansas Dept. of Health & Environment (KSHE)	*Watershed Restoration and Protection Strategy (WRAPS) *State Revolving Fund *Nonpoint Source Pollution Program *Watershed Management Programs *National Pollutant Discharge Elimination System (NPDES) Program *Livestock operation certification and permitting *Local Environmental Protection Program (LEPP)	Funding for programs to reduce nonpoint source pollution Funding for local watershed projects and coordination (WRAPS) Low cost and "forgivable" loans for BMPs and green infrastructure projects Compliance monitoring	Technical and Financial	www.kdheks.gov
Kansas Alliance for Wetlands and Streams (KAWS)	*Streambank Stabilization *Wetland Restoration *Cost share programs *Riparian and streambank assessment	KAWS is a non-profit, non-governmental organization organized in 1996 to promote the protection, enhancement and restoration of wetlands and streams in Kansas	Technical and Financial	www.kaws.org

Table 60 (continued): Potential service provider listing

Organization	Programs	Purpose	Technical or Financial Assistance	Website Address
Kansas Forest Service (KFS)	*Forest Stewardship Program *Rural Forestry Program *Riparian Forestry Programs	Assist private landowners with the management of woodlands and windbreaks through education, planning and on-site assistance from professional foresters	Technical and Financial	www.kansasforests.org
Kansas Dept. of Wildlife, Parks & Tourism (KDWPT)	*Land and Water Cons. Funding *Conservation Easements *Wildlife Habitat Improvement Program *Walk-in Hunting Program *North American Waterfowl Cons. Act *Work with non-profits such as Ducks Unlimited, Pheasants Forever and other state and federal agencies to promote wildlife habitat	Supervises the fisheries, wildlife, law enforcement, and state parks in Kansas. Also works with nongame, threatened and endangered species programs. Educational programs and landowner assistance to promote enhanced wildlife habitat. Manage lands associated with state parks, wetlands and other conservation areas.	Technical and Financial	www.kdwp.state.ks.us
Kansas Dept. of Agriculture (KDA)	*Watershed Structures *Water Appropriation *Permitting	Deal with water resource management for the benefit of all Kansans, permitting, minimum desirable stream flow, dam safety and regulation. The Division of Conservation, formerly the State Conservation Commission, is now a department within KDA	Technical and Financial	www.ksda.gov
Kansas Rural Center (KRC)	*Clean Water Farms Project *Grazing Management	KRC is a non-profit, non-governmental organization organized in 1979 to promote long-term health of the land and its people through research, education, and advocacy; KRC promotes family farming and stewardship of soil and water	Technical and Financial	www.kansasruralcenter.org

Table 60 (continued): Potential service provider listing

Organization	Programs	Purpose	Technical or Financial Assistance	Website Address
Kansas State Research & Extension (KSRE)	*Watershed Specialist Program *County Extension Offices *Kansas Public Healthy Ecosystems Healthy Communities Program *Citizen Science Kansas Center for Ag Resources and Environment (KCARE)	Provide education, information and technical assistance to build awareness of water quality issues, identify sources of water quality impairment and demonstrate, promote and implement BMPs for water quality improvement and protection	Technical	www.ksre.ksu.edu
Kansas Association for Conservation and Environmental Education (KACEE)	*Facilitation and Educational Workshops related to Environmental Education	KACEE is a non-profit, non-governmental organization that promotes and provides non-biased and science-based environmental education	Technical	www.kacee.org
Natural Resources Conservation Service (NRCS)	*Environmental Quality Incentive Program *Conservation Planning and Compliance Program *Multiple USDA Conservation Programs administered directly by NRCS or in partnership with the Farm Service Agency such as CRP, WRP and others	**NRCS** is a Federal agency that works in partnership with the landowners to benefit the soil, water, air, plants, and animals for productive lands and healthy ecosystems through conservation planning and assistance. NRCS maintains field offices at USDA Service Centers in nearly every county in Kansas	Technical and Financial	www.nrcs.usda.gov

Table 60 (continued): Potential service provider listing

Organization	Programs	Purpose	Technical or Financial Assistance	Website Address
Northeast Kansas Environmental Services (NEKES)	*Wastewater Management Program *Local Environmental Protection Program *Enforcement of state laws and sanitary codes especially as related to on-site wastewater, private wells and waste disposal issues	NEKES is an environmental coalition of five county governments in Northeast Kansas that provides enforcement of local, state and federal laws, regulations and codes that address environmental issues in the affiliated counties. The counties are Atchison, Brown, Doniphan, Jackson and Nemaha. NEKES reports to the five County Commissions and is administrated by the Directors of the five County Health Departments	Technical	www.nekes.org
County Conservation Districts (CD)	*State Water Resources Cost Share Program *Nonpoint Source Pollution Programs *Works with local NRCS field office staff, FSA and other conservation agencies	CDs are the primary local unit of government responsible for the conservation of soil, water, and related natural resources within a county's boundary; they are political subdivisions of state government utilizing funding from county and state allocations co-located with the local NRCS field office	Technical and Financial	http://scc.ks.gov/node/18
Division of Conservation (formerly the State Conservation Commission)	*Aid to CDs * Water Resources Cost Share Program *Non-Point Source Pollution Control Program * Riparian and Wetland Protection Program * Kansas Water Quality Buffer Initiative * Watershed Dam Program * Multipurpose Small Lakes Program *Other Water Supply/Rights Programs	SCC works with 105 local conservation districts, 88 organized watershed districts, other special purpose districts, and state and federal agencies to administer programs to improve water quality, reduce soil erosion, conserve water, reduce flooding and provide local water supply. The SCC has responsibility to administer the Conservation Districts Law, the Watershed District Act and other statutes.	Technical and Financial	www.ksda.gov/doc

Table 60 (continued): Potential service provider listing

Organization	Programs	Purpose	Technical or Financial Assistance	Website Address
Kansas Water Office (KWO)	*Water planning, policy, coordination and marketing for the state	KWO coordinates the Kansas water planning process in cooperation with the Kansas Water Authority (KWA). KWA's 24 members include representatives from diverse water use interest groups and leaders of the state's natural resource agencies. Advice on policy development comes from Basin Advisory Committees (BACs) in each of the state's 12 river basins and other local stakeholders. KWA in turn advises the Governor and Legislature on water issues to be considered for policy enactment	Technical	www.kwo.org
Kansas Rural Water Association (KRWA)	*Assist public water supplies with Source Water Protection Planning *Educate system operators	Provide leadership, education, and technical assistance to public water and wastewater utilities.	Technical	www.krwa.net
No-till on the Plains	*Field days, workshops, technical consulting	A non-profit educational organization providing information to farmers on adopting no-till and other sustainable production methods	Technical	www.notill.org
U.S. Geological Survey (USGS)	* WaterWatch (streamflow conditions) * National Streamflow Information Program *Flood Inundation and mapping *Groundwater Resources Program *National Water Quality Assessment Program	Scientific organization that provides stream flow data and conducts research related to water resources	Technical	www.usgs.gov
U.S. Army Corps of Engineers (USACE)	*Water Quality Program (collects monitoring for Perry Lake) *Reservoir Management	Manages federal reservoirs in Kansas and operates a water quality program	Technical	www.usace.army.mil

10.2 BMP Definitions

10.2.1 Cropland BMP Definitions

Permanent Vegetation

-Planting a portion of or an entire field to grass.

-95% erosion reduction efficiency, 95% phosphorous reduction efficiency.

-$150 an acre, 50% cost-share available from NRCS.

Vegetative Buffer

-Area of field maintained in permanent vegetation to help reduce nutrient and sediment loss from agricultural fields, improve runoff water quality, and provide habitat for wildlife.

-On average for Kansas fields, 1 acre buffer treats 15 acres of cropland.

-50% erosion reduction efficiency, 50% phosphorous reduction efficiency

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

Grassed Waterway

-Grassed strip used as an outlet to prevent silt and gully formation.

-Can also be used as outlets for water from terraces.

-On average for Kansas fields, 1 acre waterway will treat 10 acres of cropland.

-40% erosion reduction efficiency, 40% phosphorous reduction efficiency.

-$1,600 an acre, 50% cost-share available from NRCS.

No-Till

-A management system in which chemicals may be used for weed control and seedbed preparation.

-The soil surface is never disturbed except for planting or drilling operations in a 100% no-till system.

-75% erosion reduction efficiency, 40% phosphorous reduction efficiency.

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

-For greatest water quality benefit, cover crops (average cost $30/acre) are considered a component of a no-till system for the watershed

Subsurface Fertilizer Application

-Placing or injecting fertilizer beneath the soil surface.

-Reduces fertilizer runoff.

-0% soil and 50% P reduction efficiency.

-$3.50 an acre for 10 years, no cost-share.

-WRAPS groups and KSU Ag Economists have decided $3.50 an acre for 10 years is an adequate payment to entice producers to convert.

Water Retention Structure

-Water impoundment made by constructing an earthen dam.

-Traps sediment and nutrients from leaving edge of field.

-Provides source of water.
-50% P Reduction.
-Approximately $12,000

10.2.2 Livestock BMP Definitions

Vegetative Filter Strip
-A vegetated area that receives runoff during rainfall from an animal feeding operation.
-Often require a land area equal to or greater than the drainage area (needs to be as large as the feedlot).
-10 year lifespan, requires periodic mowing or haying, average P reduction: 50%.
-$714 an acre

Relocate Feeding Sites
-Feeding Pens- Move feedlot or pens away from a stream, waterway, or body of water to increase filtration and waste removal of manure.Highly variable in price, average of $6,600 per unit.
-Pasture- Move feeding site that is in a pasture away from a stream, waterway, or body of water to increase the filtration and waste removal (eg. move bale feeders away from stream).Highly variable in price, average of $2,203 per unit.
-Average P reduction: 30-80%

Alternative (Off-Stream) Watering System
-Watering system so that livestock do not enter stream or body of water.
-Studies show cattle will drink from tank over a stream or pond 80% of the time.
-10-25 year lifespan, average P reduction: 30-98% with greater efficiencies for limited stream access.
-$3,795 installed for solar system, including present value of maintenance costs.

Rotational Grazing
-Rotating livestock within a pasture to spread manure more uniformly and allow grass to regenerate.
-May involve significant cross fencing and additional watering sites.
-50-75% P Reduction.
-Approximately $7,000 with complex systems significantly more expensive.
Average Stocking Rates for Delaware Watershed: One pair on 7 acres of native grass; average grazing dates: April 20-October 15.

10.2.3 Other BMP Definitions

Streambank BMPs: Average cost $71.50 per linear foot as determined by The Watershed Institute

Gully Repair: $1,000 per gully from data derived by fixing gullies in Greenwood County, Kansas

10.3 Additional Tables

Tables in this section illustrate sediment, phosphorus and nitrogen load reductions for implemented Cropland in targeted sub-watersheds. For ease of reference, each sub-watershed was assigned a one or two digit number as shown in **Figure 37** below.

Figure 36: Sub-watershed targeted for implementation of Cropland BMPs (use as a KEY to identify sub-watersheds referenced in Table Sets 61 thru 67)

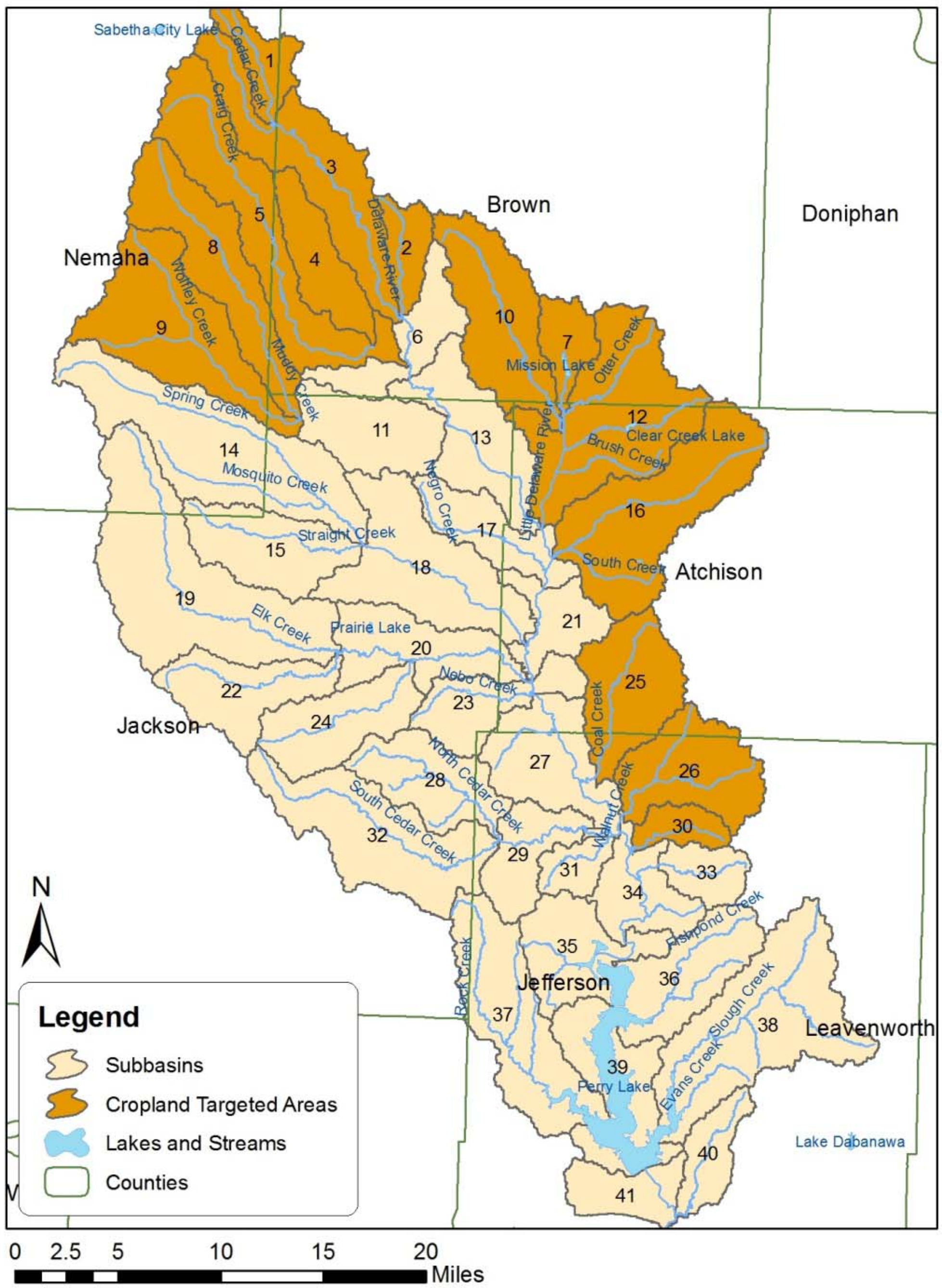


Table Set 61: Set of tables showing sediment load reductions for Cropland BMPs implemented in targeted sub-watersheds

Sub-Watershed #1 Annual Sediment Reduction (tons), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	0.4	0.5	2.3	2.5	0.0	0.3	**6**
2	1	1	5	5	0	1	**12**
3	1	1	7	7	0	1	**18**
4	1	2	9	10	0	1	**24**
5	2	2	12	12	0	2	**30**
6	2	3	14	15	0	2	**36**
7	2	3	16	17	0	2	**42**
8	3	4	19	20	0	2	**48**
9	3	4	21	22	0	3	**54**
10	4	5	23	25	0	3	**60**
11	4	5	26	27	0	3	**66**
12	4	6	28	30	0	4	**72**
13	5	6	30	32	0	4	**78**
14	5	7	33	35	0	4	**84**
15	5	7	35	37	0	5	**90**
16	6	8	37	40	0	5	**96**
17	6	8	40	42	0	5	**102**
18	6	9	42	45	0	6	**108**
19	7	9	44	47	0	6	**114**
20	7	10	47	50	0	6	**120**
21	7	10	49	52	0	7	**125**
22	8	11	51	55	0	7	**131**
23	8	11	54	57	0	7	**137**
24	8	12	56	60	0	7	**143**
25	9	12	58	62	0	8	**149**
26	9	13	61	65	0	8	**155**
27	10	13	63	67	0	8	**161**
28	10	14	65	70	0	9	**167**
29	10	14	68	72	0	9	**173**
30	11	15	70	75	0	9	**179**
31	11	15	72	77	0	10	**185**
32	11	16	75	80	0	10	**191**

Sub-Watershed #2 **Annual Sediment Reduction (tons), Cropland BMPs**

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	0.1	0.1	0.5	0.5	0.0	0.1	**1**
2	0.1	0.2	0.9	1.0	0.0	0.1	**2**
3	0.2	0.3	1.4	1.5	0.0	0.2	**4**
4	0.3	0.4	1.8	2.0	0.0	0.2	**5**
5	0.3	0.5	2.3	2.4	0.0	0.3	**6**
6	0.4	0.6	2.7	2.9	0.0	0.4	**7**
7	0.5	0.7	3.2	3.4	0.0	0.4	**8**
8	0.6	0.8	3.7	3.9	0.0	0.5	**9**
9	0.6	0.9	4.1	4.4	0.0	0.5	**11**
10	0.7	1.0	4.6	4.9	0.0	0.6	**12**
11	0.8	1.1	5.0	5.4	0.0	0.7	**13**
12	0.8	1.2	5.5	5.9	0.0	0.7	**14**
13	0.9	1.3	6.0	6.4	0.0	0.8	**15**
14	1.0	1.4	6.4	6.8	0.0	0.9	**16**
15	1.0	1.5	6.9	7.3	0.0	0.9	**18**
16	1.1	1.6	7.3	7.8	0.0	1.0	**19**
17	1.2	1.7	7.8	8.3	0.0	1.0	**20**
18	1.3	1.8	8.2	8.8	0.0	1.1	**21**
19	1.3	1.9	8.7	9.3	0.0	1.2	**22**
20	1.4	2.0	9.2	9.8	0.0	1.2	**24**
21	1.5	2.1	9.6	10.3	0.0	1.3	**25**
22	1.5	2.2	10.1	10.8	0.0	1.3	**26**
23	1.6	2.2	10.5	11.2	0.0	1.4	**27**
24	1.7	2.3	11.0	11.7	0.0	1.5	**28**
25	1.7	2.4	11.5	12.2	0.0	1.5	**29**
26	1.8	2.5	11.9	12.7	0.0	1.6	**31**
27	1.9	2.6	12.4	13.2	0.0	1.6	**32**
28	2.0	2.7	12.8	13.7	0.0	1.7	**33**
29	2.0	2.8	13.3	14.2	0.0	1.8	**34**
30	2.1	2.9	13.7	14.7	0.0	1.8	**35**
31	2.2	3.0	14.2	15.2	0.0	1.9	**36**
32	2.2	3.1	14.7	15.6	0.0	2.0	**38**

Sub-Watershed #3 **Annual Sediment Reduction (tons), Cropland BMPs**

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	3.0	4.2	19.7	21.0	0.0	2.6	**51**
2	6	8	39	42	0	5	**101**

3	9	13	59	63	0	8	**152**
4	12	17	79	84	0	11	**202**
5	15	21	99	105	0	13	**253**
6	18	25	118	126	0	16	**304**
7	21	29	138	147	0	18	**354**
8	24	34	158	168	0	21	**405**
9	27	38	178	189	0	24	**455**
10	30	42	197	210	0	26	**506**
11	33	46	217	231	0	29	**557**
12	36	51	237	253	0	32	**607**
13	39	55	256	274	0	34	**658**
14	42	59	276	295	0	37	**709**
15	45	63	296	316	0	39	**759**
16	48	67	316	337	0	42	**810**
17	51	72	335	358	0	45	**860**
18	54	76	355	379	0	47	**911**
19	57	80	375	400	0	50	**962**
20	60	84	395	421	0	53	**1,012**
21	63	88	414	442	0	55	**1,063**
22	66	93	434	463	0	58	**1,113**
23	69	97	454	484	0	61	**1,164**
24	72	101	473	505	0	63	**1,215**
25	75	105	493	526	0	66	**1,265**
26	78	109	513	547	0	68	**1,316**
27	81	114	533	568	0	71	**1,366**
28	84	118	552	589	0	74	**1,417**
29	87	122	572	610	0	76	**1,468**
30	90	126	592	631	0	79	**1,518**
31	93	130	612	652	0	82	**1,569**
32	96	135	631	673	0	84	**1,620**

Sub-Watershed #4 Annual Sediment Reduction (tons), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	0.5	0.7	3.4	3.6	0.0	0.5	**9**
2	1	1	7	7	0	1	**17**
3	2	2	10	11	0	1	**26**
4	2	3	14	14	0	2	**35**
5	3	4	17	18	0	2	**43**
6	3	4	20	22	0	3	**52**
7	4	5	24	25	0	3	**61**
8	4	6	27	29	0	4	**69**

9	5	6	30	32	0	4	**78**
10	5	7	34	36	0	5	**87**
11	6	8	37	40	0	5	**96**
12	6	9	41	43	0	5	**104**
13	7	9	44	47	0	6	**113**
14	7	10	47	51	0	6	**122**
15	8	11	51	54	0	7	**130**
16	8	12	54	58	0	7	**139**
17	9	12	58	61	0	8	**148**
18	9	13	61	65	0	8	**156**
19	10	14	64	69	0	9	**165**
20	10	14	68	72	0	9	**174**
21	11	15	71	76	0	9	**182**
22	11	16	74	79	0	10	**191**
23	12	17	78	83	0	10	**200**
24	12	17	81	87	0	11	**208**
25	13	18	85	90	0	11	**217**
26	13	19	88	94	0	12	**226**
27	14	19	91	97	0	12	**234**
28	14	20	95	101	0	13	**243**
29	15	21	98	105	0	13	**252**
30	15	22	102	108	0	14	**260**
31	16	22	105	112	0	14	**269**
32	16	23	108	116	0	14	**278**

Sub-Watershed #5 Annual Sediment Reduction (tons), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	2.7	3.8	17.6	18.8	0.0	2.3	**45**
2	5	8	35	38	0	5	**90**
3	8	11	53	56	0	7	**136**
4	11	15	70	75	0	9	**181**
5	13	19	88	94	0	12	**226**
6	16	23	106	113	0	14	**271**
7	19	26	123	132	0	16	**316**
8	21	30	141	150	0	19	**362**
9	24	34	159	169	0	21	**407**
10	27	38	176	188	0	23	**452**
11	29	41	194	207	0	26	**497**
12	32	45	211	226	0	28	**543**
13	35	49	229	244	0	31	**588**
14	38	53	247	263	0	33	**633**

15	40	56	264	282	0	35	**678**
16	43	60	282	301	0	38	**723**
17	46	64	300	320	0	40	**769**
18	48	68	317	338	0	42	**814**
19	51	71	335	357	0	45	**859**
20	54	75	352	376	0	47	**904**
21	56	79	370	395	0	49	**949**
22	59	83	388	414	0	52	**995**
23	62	86	405	432	0	54	**1,040**
24	64	90	423	451	0	56	**1,085**
25	67	94	441	470	0	59	**1,130**
26	70	98	458	489	0	61	**1,176**
27	72	102	476	508	0	63	**1,221**
28	75	105	493	526	0	66	**1,266**
29	78	109	511	545	0	68	**1,311**
30	80	113	529	564	0	70	**1,356**
31	83	117	546	583	0	73	**1,402**
32	86	120	564	602	0	75	**1,447**

Sub-Watershed #7 Annual Sediment Reduction (tons), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	0.2	0.3	1.3	1.3	0.0	0.2	**3**
2	0.4	0.5	2.5	2.7	0.0	0.3	**6**
3	1	1	4	4	0	1	**10**
4	1	1	5	5	0	1	**13**
5	1	1	6	7	0	1	**16**
6	1	2	8	8	0	1	**19**
7	1	2	9	9	0	1	**23**
8	2	2	10	11	0	1	**26**
9	2	2	11	12	0	2	**29**
10	2	3	13	13	0	2	**32**
11	2	3	14	15	0	2	**35**
12	2	3	15	16	0	2	**39**
13	2	3	16	17	0	2	**42**
14	3	4	18	19	0	2	**45**
15	3	4	19	20	0	3	**48**
16	3	4	20	21	0	3	**52**
17	3	5	21	23	0	3	**55**
18	3	5	23	24	0	3	**58**
19	4	5	24	25	0	3	**61**
20	4	5	25	27	0	3	**64**

21	4	6	26	28	0	4	**68**
22	4	6	28	29	0	4	**71**
23	4	6	29	31	0	4	**74**
24	5	6	30	32	0	4	**77**
25	5	7	31	34	0	4	**81**
26	5	7	33	35	0	4	**84**
27	5	7	34	36	0	5	**87**
28	5	8	35	38	0	5	**90**
29	6	8	36	39	0	5	**94**
30	6	8	38	40	0	5	**97**
31	6	8	39	42	0	5	**100**
32	6	9	40	43	0	5	**103**

Sub-Watershed #8 Annual Sediment Reduction (tons), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	0.7	0.9	4.4	4.7	0.0	0.6	**11**
2	1	2	9	9	0	1	**23**
3	2	3	13	14	0	2	**34**
4	3	4	18	19	0	2	**45**
5	3	5	22	24	0	3	**57**
6	4	6	27	28	0	4	**68**
7	5	7	31	33	0	4	**80**
8	5	8	35	38	0	5	**91**
9	6	9	40	43	0	5	**102**
10	7	9	44	47	0	6	**114**
11	7	10	49	52	0	6	**125**
12	8	11	53	57	0	7	**136**
13	9	12	58	61	0	8	**148**
14	9	13	62	66	0	8	**159**
15	10	14	66	71	0	9	**170**
16	11	15	71	76	0	9	**182**
17	11	16	75	80	0	10	**193**
18	12	17	80	85	0	11	**204**
19	13	18	84	90	0	11	**216**
20	13	19	89	94	0	12	**227**
21	14	20	93	99	0	12	**239**
22	15	21	97	104	0	13	**250**
23	15	22	102	109	0	14	**261**
24	16	23	106	113	0	14	**273**
25	17	24	111	118	0	15	**284**
26	18	25	115	123	0	15	**295**

27	18	26	120	128	0	16	**307**
28	19	26	124	132	0	17	**318**
29	20	27	128	137	0	17	**329**
30	20	28	133	142	0	18	**341**
31	21	29	137	146	0	18	**352**
32	22	30	142	151	0	19	**364**

Sub-Watershed #10 Annual Sediment Reduction (tons), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	1.8	2.5	11.7	12.4	0.0	1.6	**30**
2	4	5	23	25	0	3	**60**
3	5	7	35	37	0	5	**90**
4	7	10	47	50	0	6	**120**
5	9	12	58	62	0	8	**150**
6	11	15	70	75	0	9	**180**
7	12	17	82	87	0	11	**209**
8	14	20	93	100	0	12	**239**
9	16	22	105	112	0	14	**269**
10	18	25	117	124	0	16	**299**
11	20	27	128	137	0	17	**329**
12	21	30	140	149	0	19	**359**
13	23	32	152	162	0	20	**389**
14	25	35	163	174	0	22	**419**
15	27	37	175	187	0	23	**449**
16	28	40	187	199	0	25	**479**
17	30	42	198	212	0	26	**509**
18	32	45	210	224	0	28	**539**
19	34	47	222	236	0	30	**568**
20	35	50	233	249	0	31	**598**
21	37	52	245	261	0	33	**628**
22	39	55	257	274	0	34	**658**
23	41	57	268	286	0	36	**688**
24	43	60	280	299	0	37	**718**
25	44	62	292	311	0	39	**748**
26	46	65	303	323	0	40	**778**
27	48	67	315	336	0	42	**808**
28	50	70	327	348	0	44	**838**
29	51	72	338	361	0	45	**868**
30	53	75	350	373	0	47	**898**
31	55	77	362	386	0	48	**928**
32	57	80	373	398	0	50	**957**

Sub-Watershed #12 Annual Sediment Reduction (tons), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	2.4	3.4	15.8	16.9	0.0	2.1	**41**
2	5	7	32	34	0	4	**81**
3	7	10	47	51	0	6	**122**
4	10	13	63	67	0	8	**162**
5	12	17	79	84	0	11	**203**
6	14	20	95	101	0	13	**243**
7	17	24	111	118	0	15	**284**
8	19	27	126	135	0	17	**324**
9	22	30	142	152	0	19	**365**
10	24	34	158	169	0	21	**405**
11	26	37	174	185	0	23	**446**
12	29	40	190	202	0	25	**487**
13	31	44	205	219	0	27	**527**
14	34	47	221	236	0	30	**568**
15	36	51	237	253	0	32	**608**
16	38	54	253	270	0	34	**649**
17	41	57	269	287	0	36	**689**
18	43	61	285	303	0	38	**730**
19	46	64	300	320	0	40	**770**
20	48	67	316	337	0	42	**811**
21	50	71	332	354	0	44	**852**
22	53	74	348	371	0	46	**892**
23	55	78	364	388	0	48	**933**
24	58	81	379	405	0	51	**973**
25	60	84	395	422	0	53	**1,014**
26	62	88	411	438	0	55	**1,054**
27	65	91	427	455	0	57	**1,095**
28	67	94	443	472	0	59	**1,135**
29	70	98	458	489	0	61	**1,176**
30	72	101	474	506	0	63	**1,216**
31	74	105	490	523	0	65	**1,257**
32	77	108	506	540	0	67	**1,298**

Sub-Watershed #16 Annual Sediment Reduction (tons), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	1.0	1.5	6.8	7.3	0.0	0.9	**17**
2	2	3	14	15	0	2	**35**

3	3	4	20	22	0	3	**52**
4	4	6	27	29	0	4	**70**
5	5	7	34	36	0	5	**87**
6	6	9	41	44	0	5	**105**
7	7	10	48	51	0	6	**122**
8	8	12	54	58	0	7	**140**
9	9	13	61	65	0	8	**157**
10	10	15	68	73	0	9	**174**
11	11	16	75	80	0	10	**192**
12	12	17	82	87	0	11	**209**
13	13	19	88	94	0	12	**227**
14	14	20	95	102	0	13	**244**
15	16	22	102	109	0	14	**262**
16	17	23	109	116	0	15	**279**
17	18	25	116	123	0	15	**297**
18	19	26	122	131	0	16	**314**
19	20	28	129	138	0	17	**331**
20	21	29	136	145	0	18	**349**
21	22	30	143	152	0	19	**366**
22	23	32	150	160	0	20	**384**
23	24	33	156	167	0	21	**401**
24	25	35	163	174	0	22	**419**
25	26	36	170	181	0	23	**436**
26	27	38	177	189	0	24	**454**
27	28	39	184	196	0	24	**471**
28	29	41	190	203	0	25	**488**
29	30	42	197	210	0	26	**506**
30	31	44	204	218	0	27	**523**
31	32	45	211	225	0	28	**541**
32	33	46	218	232	0	29	**558**

Sub-Watershed #25 Annual Sediment Reduction (tons), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	0.3	0.4	2.0	2.1	0.0	0.3	**5**
2	1	1	4	4	0	1	**10**
3	1	1	6	6	0	1	**15**
4	1	2	8	8	0	1	**20**
5	2	2	10	11	0	1	**25**
6	2	3	12	13	0	2	**30**
7	2	3	14	15	0	2	**36**
8	2	3	16	17	0	2	**41**

9	3	4	18	19	0	2	**46**
10	3	4	20	21	0	3	**51**
11	3	5	22	23	0	3	**56**
12	4	5	24	25	0	3	**61**
13	4	5	26	27	0	3	**66**
14	4	6	28	30	0	4	**71**
15	5	6	30	32	0	4	**76**
16	5	7	32	34	0	4	**81**
17	5	7	34	36	0	4	**86**
18	5	8	36	38	0	5	**91**
19	6	8	38	40	0	5	**96**
20	6	8	40	42	0	5	**102**
21	6	9	42	44	0	6	**107**
22	7	9	44	46	0	6	**112**
23	7	10	46	49	0	6	**117**
24	7	10	47	51	0	6	**122**
25	8	11	49	53	0	7	**127**
26	8	11	51	55	0	7	**132**
27	8	11	53	57	0	7	**137**
28	8	12	55	59	0	7	**142**
29	9	12	57	61	0	8	**147**
30	9	13	59	63	0	8	**152**
31	9	13	61	65	0	8	**157**
32	10	14	63	68	0	8	**162**

Sub-Watershed #26 Annual Sediment Reduction (tons), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	0.4	0.6	2.9	3.1	0.0	0.4	**8**
2	1	1	6	6	0	1	**15**
3	1	2	9	9	0	1	**23**
4	2	3	12	13	0	2	**30**
5	2	3	15	16	0	2	**38**
6	3	4	18	19	0	2	**45**
7	3	4	21	22	0	3	**53**
8	4	5	24	25	0	3	**60**
9	4	6	26	28	0	4	**68**
10	4	6	29	31	0	4	**75**
11	5	7	32	35	0	4	**83**
12	5	8	35	38	0	5	**91**
13	6	8	38	41	0	5	**98**
14	6	9	41	44	0	5	**106**

15	7	9	44	47	0	6	**113**
16	7	10	47	50	0	6	**121**
17	8	11	50	53	0	7	**128**
18	8	11	53	56	0	7	**136**
19	8	12	56	60	0	7	**143**
20	9	13	59	63	0	8	**151**
21	9	13	62	66	0	8	**159**
22	10	14	65	69	0	9	**166**
23	10	14	68	72	0	9	**174**
24	11	15	71	75	0	9	**181**
25	11	16	74	78	0	10	**189**
26	12	16	77	82	0	10	**196**
27	12	17	79	85	0	11	**204**
28	13	18	82	88	0	11	**211**
29	13	18	85	91	0	11	**219**
30	13	19	88	94	0	12	**226**
31	14	19	91	97	0	12	**234**
32	14	20	94	100	0	13	**242**

Sub-Watershed #30 Annual Sediment Reduction (tons), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	0.0	0.1	0.2	0.3	0.0	0.0	**1**
2	0	0	0	1	0	0	**1**
3	0	0	1	1	0	0	**2**
4	0	0	1	1	0	0	**2**
5	0	0	1	1	0	0	**3**
6	0	0	1	2	0	0	**4**
7	0	0	2	2	0	0	**4**
8	0	0	2	2	0	0	**5**
9	0	0	2	2	0	0	**6**
10	0	1	2	3	0	0	**6**
11	0	1	3	3	0	0	**7**
12	0	1	3	3	0	0	**7**
13	0	1	3	3	0	0	**8**
14	1	1	3	4	0	0	**9**
15	1	1	4	4	0	0	**9**
16	1	1	4	4	0	1	**10**
17	1	1	4	4	0	1	**10**
18	1	1	4	5	0	1	**11**
19	1	1	5	5	0	1	**12**
20	1	1	5	5	0	1	**12**

21	1	1	5	5	0	1	**13**
22	1	1	5	6	0	1	**14**
23	1	1	6	6	0	1	**14**
24	1	1	6	6	0	1	**15**
25	1	1	6	6	0	1	**15**
26	1	1	6	7	0	1	**16**
27	1	1	6	7	0	1	**17**
28	1	1	7	7	0	1	**17**
29	1	1	7	7	0	1	**18**
30	1	2	7	8	0	1	**19**
31	1	2	7	8	0	1	**19**
32	1	2	8	8	0	1	**20**

Table Set 62: Set of Tables showing Phosphorus load reductions for Cropland BMPs implemented in targeted sub-watersheds

Sub-Watershed #1 Annual Phosphorous Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	6	9	22	43	18	5	**104**
2	12	17	43	87	37	11	**208**
3	19	26	65	130	55	16	**312**
4	25	35	87	174	74	22	**415**
5	31	43	109	217	92	27	**519**
6	37	52	130	260	111	33	**623**
7	43	61	152	304	129	38	**727**
8	49	69	174	347	148	43	**831**
9	56	78	195	391	166	49	**935**
10	62	87	217	434	184	54	**1,038**
11	68	95	239	477	203	60	**1,142**
12	74	104	260	521	221	65	**1,246**
13	80	113	282	564	240	71	**1,350**
14	87	122	304	608	258	76	**1,454**
15	93	130	326	651	277	81	**1,558**
16	99	139	347	694	295	87	**1,661**
17	105	148	369	738	314	92	**1,765**
18	111	156	391	781	332	98	**1,869**
19	118	165	412	825	350	103	**1,973**
20	124	174	434	868	369	109	**2,077**
21	130	182	456	911	387	114	**2,181**
22	136	191	477	955	406	119	**2,285**

23	142	200	499	998	424	125	**2,388**
24	148	208	521	1,042	443	130	**2,492**
25	155	217	543	1,085	461	136	**2,596**
26	161	226	564	1,128	480	141	**2,700**
27	167	234	586	1,172	498	146	**2,804**
28	173	243	608	1,215	516	152	**2,908**
29	179	252	629	1,259	535	157	**3,011**
30	186	260	651	1,302	553	163	**3,115**
31	192	269	673	1,346	572	168	**3,219**
32	198	278	694	1,389	590	174	**3,323**

Sub-Watershed #2 Annual Phosphorous Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	3	4	9	19	8	2	**45**
2	5	7	19	37	16	5	**90**
3	8	11	28	56	24	7	**134**
4	11	15	37	75	32	9	**179**
5	13	19	47	94	40	12	**224**
6	16	22	56	112	48	14	**269**
7	19	26	66	131	56	16	**314**
8	21	30	75	150	64	19	**359**
9	24	34	84	169	72	21	**403**
10	27	37	94	187	80	23	**448**
11	29	41	103	206	88	26	**493**
12	32	45	112	225	96	28	**538**
13	35	49	122	244	104	30	**583**
14	37	52	131	262	111	33	**628**
15	40	56	141	281	119	35	**672**
16	43	60	150	300	127	37	**717**
17	45	64	159	319	135	40	**762**
18	48	67	169	337	143	42	**807**
19	51	71	178	356	151	45	**852**
20	53	75	187	375	159	47	**897**
21	56	79	197	394	167	49	**941**
22	59	82	206	412	175	52	**986**
23	61	86	215	431	183	54	**1,031**
24	64	90	225	450	191	56	**1,076**
25	67	94	234	468	199	59	**1,121**
26	69	97	244	487	207	61	**1,166**
27	72	101	253	506	215	63	**1,210**
28	75	105	262	525	223	66	**1,255**

29	77	109	272	543	231	68	**1,300**
30	80	112	281	562	239	70	**1,345**
31	83	116	290	581	247	73	**1,390**
32	85	120	300	600	255	75	**1,435**

Sub-Watershed #3 Annual Phosphorous Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	27	39	96	193	82	24	**461**
2	55	77	193	386	164	48	**923**
3	82	116	289	579	246	72	**1,384**
4	110	154	386	772	328	96	**1,846**
5	137	193	482	964	410	121	**2,307**
6	165	231	579	1,157	492	145	**2,769**
7	192	270	675	1,350	574	169	**3,230**
8	220	309	772	1,543	656	193	**3,692**
9	247	347	868	1,736	738	217	**4,153**
10	275	386	964	1,929	820	241	**4,615**
11	302	424	1,061	2,122	902	265	**5,076**
12	330	463	1,157	2,315	984	289	**5,538**
13	357	501	1,254	2,507	1,066	313	**5,999**
14	385	540	1,350	2,700	1,148	338	**6,461**
15	412	579	1,447	2,893	1,230	362	**6,922**
16	440	617	1,543	3,086	1,312	386	**7,383**
17	467	656	1,639	3,279	1,394	410	**7,845**
18	495	694	1,736	3,472	1,476	434	**8,306**
19	522	733	1,832	3,665	1,558	458	**8,768**
20	550	772	1,929	3,858	1,639	482	**9,229**
21	577	810	2,025	4,050	1,721	506	**9,691**
22	605	849	2,122	4,243	1,803	530	**10,152**
23	632	887	2,218	4,436	1,885	555	**10,614**
24	660	926	2,315	4,629	1,967	579	**11,075**
25	687	964	2,411	4,822	2,049	603	**11,537**
26	715	1,003	2,507	5,015	2,131	627	**11,998**
27	742	1,042	2,604	5,208	2,213	651	**12,460**
28	770	1,080	2,700	5,401	2,295	675	**12,921**
29	797	1,119	2,797	5,594	2,377	699	**13,383**
30	825	1,157	2,893	5,786	2,459	723	**13,844**
31	852	1,196	2,990	5,979	2,541	747	**14,305**
32	880	1,234	3,086	6,172	2,623	772	**14,767**

Sub-Watershed #4 Annual Phosphorous Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	13	18	45	90	38	11	**214**
2	26	36	90	179	76	22	**429**
3	38	54	134	269	114	34	**643**
4	51	72	179	358	152	45	**858**
5	64	90	224	448	190	56	**1,072**
6	77	108	269	538	229	67	**1,286**
7	89	125	314	627	267	78	**1,501**
8	102	143	358	717	305	90	**1,715**
9	115	161	403	807	343	101	**1,930**
10	128	179	448	896	381	112	**2,144**
11	140	197	493	986	419	123	**2,358**
12	153	215	538	1,075	457	134	**2,573**
13	166	233	582	1,165	495	146	**2,787**
14	179	251	627	1,255	533	157	**3,002**
15	192	269	672	1,344	571	168	**3,216**
16	204	287	717	1,434	609	179	**3,430**
17	217	305	762	1,523	647	190	**3,645**
18	230	323	807	1,613	686	202	**3,859**
19	243	341	851	1,703	724	213	**4,074**
20	255	358	896	1,792	762	224	**4,288**
21	268	376	941	1,882	800	235	**4,502**
22	281	394	986	1,971	838	246	**4,717**
23	294	412	1,031	2,061	876	258	**4,931**
24	306	430	1,075	2,151	914	269	**5,146**
25	319	448	1,120	2,240	952	280	**5,360**
26	332	466	1,165	2,330	990	291	**5,574**
27	345	484	1,210	2,420	1,028	302	**5,789**
28	358	502	1,255	2,509	1,066	314	**6,003**
29	370	520	1,299	2,599	1,104	325	**6,218**
30	383	538	1,344	2,688	1,143	336	**6,432**
31	396	556	1,389	2,778	1,181	347	**6,646**
32	409	574	1,434	2,868	1,219	358	**6,861**

Sub-Watershed #5 Annual Phosphorous Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	24	34	84	169	72	21	**404**

2	48	68	169	338	144	42	**808**
3	72	101	253	507	215	63	**1,212**
4	96	135	338	676	287	84	**1,617**
5	120	169	422	845	359	106	**2,021**
6	144	203	507	1,014	431	127	**2,425**
7	168	236	591	1,182	503	148	**2,829**
8	193	270	676	1,351	574	169	**3,233**
9	217	304	760	1,520	646	190	**3,637**
10	241	338	845	1,689	718	211	**4,041**
11	265	372	929	1,858	790	232	**4,446**
12	289	405	1,014	2,027	861	253	**4,850**
13	313	439	1,098	2,196	933	274	**5,254**
14	337	473	1,182	2,365	1,005	296	**5,658**
15	361	507	1,267	2,534	1,077	317	**6,062**
16	385	541	1,351	2,703	1,149	338	**6,466**
17	409	574	1,436	2,872	1,220	359	**6,870**
18	433	608	1,520	3,041	1,292	380	**7,275**
19	457	642	1,605	3,209	1,364	401	**7,679**
20	481	676	1,689	3,378	1,436	422	**8,083**
21	505	709	1,774	3,547	1,508	443	**8,487**
22	530	743	1,858	3,716	1,579	465	**8,891**
23	554	777	1,943	3,885	1,651	486	**9,295**
24	578	811	2,027	4,054	1,723	507	**9,699**
25	602	845	2,112	4,223	1,795	528	**10,104**
26	626	878	2,196	4,392	1,867	549	**10,508**
27	650	912	2,280	4,561	1,938	570	**10,912**
28	674	946	2,365	4,730	2,010	591	**11,316**
29	698	980	2,449	4,899	2,082	612	**11,720**
30	722	1,014	2,534	5,068	2,154	633	**12,124**
31	746	1,047	2,618	5,237	2,226	655	**12,528**
32	770	1,081	2,703	5,405	2,297	676	**12,933**

Sub-Watershed #7 Annual Phosphorous Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	3	5	12	24	10	3	**57**
2	6.8	9.5	23.7	47.5	20.2	5.9	**114**
3	10	14	36	71	30	9	**170**
4	14	19	47	95	40	12	**227**
5	17	24	59	119	50	15	**284**
6	20	28	71	142	61	18	**341**
7	24	33	83	166	71	21	**397**

8	27	38	95	190	81	24	**454**
9	30	43	107	214	91	27	**511**
10	34	47	119	237	101	30	**568**
11	37	52	131	261	111	33	**625**
12	41	57	142	285	121	36	**681**
13	44	62	154	309	131	39	**738**
14	47	66	166	332	141	42	**795**
15	51	71	178	356	151	45	**852**
16	54	76	190	380	161	47	**909**
17	57	81	202	403	171	50	**965**
18	61	85	214	427	182	53	**1,022**
19	64	90	225	451	192	56	**1,079**
20	68	95	237	475	202	59	**1,136**
21	71	100	249	498	212	62	**1,192**
22	74	104	261	522	222	65	**1,249**
23	78	109	273	546	232	68	**1,306**
24	81	114	285	570	242	71	**1,363**
25	85	119	297	593	252	74	**1,420**
26	88	123	309	617	262	77	**1,476**
27	91	128	320	641	272	80	**1,533**
28	95	133	332	665	282	83	**1,590**
29	98	138	344	688	293	86	**1,647**
30	101	142	356	712	303	89	**1,704**
31	105	147	368	736	313	92	**1,760**
32	108	152	380	760	323	95	**1,817**

Sub-Watershed #8 Annual Phosphorous Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	14	19	48	95	41	12	**228**
2	27	38	95	191	81	24	**457**
3	41	57	143	286	122	36	**685**
4	54	76	191	382	162	48	**914**
5	68	95	239	477	203	60	**1,142**
6	82	115	286	573	244	72	**1,371**
7	95	134	334	668	284	84	**1,599**
8	109	153	382	764	325	95	**1,828**
9	122	172	430	859	365	107	**2,056**
10	136	191	477	955	406	119	**2,285**
11	150	210	525	1,050	446	131	**2,513**
12	163	229	573	1,146	487	143	**2,742**
13	177	248	621	1,241	528	155	**2,970**

14	191	267	668	1,337	568	167	**3,199**
15	204	286	716	1,432	609	179	**3,427**
16	218	306	764	1,528	649	191	**3,656**
17	231	325	812	1,623	690	203	**3,884**
18	245	344	859	1,719	731	215	**4,113**
19	259	363	907	1,814	771	227	**4,341**
20	272	382	955	1,910	812	239	**4,570**
21	286	401	1,003	2,005	852	251	**4,798**
22	299	420	1,050	2,101	893	263	**5,026**
23	313	439	1,098	2,196	933	275	**5,255**
24	327	458	1,146	2,292	974	286	**5,483**
25	340	477	1,194	2,387	1,015	298	**5,712**
26	354	497	1,241	2,483	1,055	310	**5,940**
27	367	516	1,289	2,578	1,096	322	**6,169**
28	381	535	1,337	2,674	1,136	334	**6,397**
29	395	554	1,385	2,769	1,177	346	**6,626**
30	408	573	1,432	2,865	1,218	358	**6,854**
31	422	592	1,480	2,960	1,258	370	**7,083**
32	435	611	1,528	3,056	1,299	382	**7,311**

Sub-Watershed #10 Annual Phosphorous Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	16	22	56	111	47	14	**267**
2	32	45	111	223	95	28	**533**
3	48	67	167	334	142	42	**800**
4	64	89	223	446	189	56	**1,066**
5	79	111	279	557	237	70	**1,333**
6	95	134	334	669	284	84	**1,599**
7	111	156	390	780	331	97	**1,866**
8	127	178	446	891	379	111	**2,133**
9	143	201	501	1,003	426	125	**2,399**
10	159	223	557	1,114	474	139	**2,666**
11	175	245	613	1,226	521	153	**2,932**
12	191	267	669	1,337	568	167	**3,199**
13	206	290	724	1,449	616	181	**3,466**
14	222	312	780	1,560	663	195	**3,732**
15	238	334	836	1,671	710	209	**3,999**
16	254	357	891	1,783	758	223	**4,265**
17	270	379	947	1,894	805	237	**4,532**
18	286	401	1,003	2,006	852	251	**4,798**
19	302	423	1,059	2,117	900	265	**5,065**

20	318	446	1,114	2,228	947	279	**5,332**
21	333	468	1,170	2,340	994	292	**5,598**
22	349	490	1,226	2,451	1,042	306	**5,865**
23	365	513	1,281	2,563	1,089	320	**6,131**
24	381	535	1,337	2,674	1,137	334	**6,398**
25	397	557	1,393	2,786	1,184	348	**6,665**
26	413	579	1,449	2,897	1,231	362	**6,931**
27	429	602	1,504	3,008	1,279	376	**7,198**
28	445	624	1,560	3,120	1,326	390	**7,464**
29	460	646	1,616	3,231	1,373	404	**7,731**
30	476	669	1,671	3,343	1,421	418	**7,997**
31	492	691	1,727	3,454	1,468	432	**8,264**
32	508	713	1,783	3,566	1,515	446	**8,531**

Sub-Watershed #12 Annual Phosphorous Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	17	23	59	117	50	15	**280**
2	33	47	117	234	100	29	**561**
3	50	70	176	352	149	44	**841**
4	67	94	234	469	199	59	**1,121**
5	83	117	293	586	249	73	**1,402**
6	100	141	352	703	299	88	**1,682**
7	117	164	410	820	349	103	**1,962**
8	134	187	469	937	398	117	**2,243**
9	150	211	527	1,055	448	132	**2,523**
10	167	234	586	1,172	498	146	**2,804**
11	184	258	644	1,289	548	161	**3,084**
12	200	281	703	1,406	598	176	**3,364**
13	217	305	762	1,523	647	190	**3,645**
14	234	328	820	1,641	697	205	**3,925**
15	250	352	879	1,758	747	220	**4,205**
16	267	375	937	1,875	797	234	**4,486**
17	284	398	996	1,992	847	249	**4,766**
18	301	422	1,055	2,109	896	264	**5,046**
19	317	445	1,113	2,226	946	278	**5,327**
20	334	469	1,172	2,344	996	293	**5,607**
21	351	492	1,230	2,461	1,046	308	**5,887**
22	367	516	1,289	2,578	1,096	322	**6,168**
23	384	539	1,348	2,695	1,145	337	**6,448**
24	401	562	1,406	2,812	1,195	352	**6,728**
25	417	586	1,465	2,929	1,245	366	**7,009**

26	434	609	1,523	3,047	1,295	381	**7,289**
27	451	633	1,582	3,164	1,345	395	**7,570**
28	468	656	1,641	3,281	1,394	410	**7,850**
29	484	680	1,699	3,398	1,444	425	**8,130**
30	501	703	1,758	3,515	1,494	439	**8,411**
31	518	727	1,816	3,633	1,544	454	**8,691**
32	534	750	1,875	3,750	1,594	469	**8,971**

Sub-Watershed #16 Annual Phosphorous Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	7	10	25	51	22	6	**121**
2	14	20	51	101	43	13	**243**
3	22	30	76	152	65	19	**364**
4	29	41	101	203	86	25	**485**
5	36	51	127	253	108	32	**606**
6	43	61	152	304	129	38	**728**
7	51	71	177	355	151	44	**849**
8	58	81	203	406	172	51	**970**
9	65	91	228	456	194	57	**1,092**
10	72	101	253	507	215	63	**1,213**
11	79	112	279	558	237	70	**1,334**
12	87	122	304	608	259	76	**1,456**
13	94	132	330	659	280	82	**1,577**
14	101	142	355	710	302	89	**1,698**
15	108	152	380	760	323	95	**1,819**
16	116	162	406	811	345	101	**1,941**
17	123	172	431	862	366	108	**2,062**
18	130	183	456	913	388	114	**2,183**
19	137	193	482	963	409	120	**2,305**
20	144	203	507	1,014	431	127	**2,426**
21	152	213	532	1,065	452	133	**2,547**
22	159	223	558	1,115	474	139	**2,669**
23	166	233	583	1,166	496	146	**2,790**
24	173	243	608	1,217	517	152	**2,911**
25	181	253	634	1,267	539	158	**3,032**
26	188	264	659	1,318	560	165	**3,154**
27	195	274	684	1,369	582	171	**3,275**
28	202	284	710	1,420	603	177	**3,396**
29	210	294	735	1,470	625	184	**3,518**
30	217	304	760	1,521	646	190	**3,639**
31	224	314	786	1,572	668	196	**3,760**

32	231	324	811	1,622	690	203	**3,882**

Sub-Watershed #25 Annual Phosphorous Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	3	4	10	21	9	3	**50**
2	6	8	21	41	18	5	**99**
3	9	12	31	62	26	8	**149**
4	12	17	41	83	35	10	**198**
5	15	21	52	104	44	13	**248**
6	18	25	62	124	53	16	**297**
7	21	29	73	145	62	18	**347**
8	24	33	83	166	70	21	**397**
9	27	37	93	186	79	23	**446**
10	30	41	104	207	88	26	**496**
11	32	46	114	228	97	28	**545**
12	35	50	124	249	106	31	**595**
13	38	54	135	269	114	34	**644**
14	41	58	145	290	123	36	**694**
15	44	62	155	311	132	39	**743**
16	47	66	166	331	141	41	**793**
17	50	70	176	352	150	44	**843**
18	53	75	186	373	158	47	**892**
19	56	79	197	394	167	49	**942**
20	59	83	207	414	176	52	**991**
21	62	87	218	435	185	54	**1,041**
22	65	91	228	456	194	57	**1,090**
23	68	95	238	476	203	60	**1,140**
24	71	99	249	497	211	62	**1,190**
25	74	104	259	518	220	65	**1,239**
26	77	108	269	539	229	67	**1,289**
27	80	112	280	559	238	70	**1,338**
28	83	116	290	580	247	73	**1,388**
29	86	120	300	601	255	75	**1,437**
30	89	124	311	622	264	78	**1,487**
31	92	128	321	642	273	80	**1,537**
32	94	133	331	663	282	83	**1,586**

Sub-Watershed #26 Annual Phosphorous Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	3	5	12	24	10	3	**58**

2	7	10	24	49	21	6	**117**
3	10	15	37	73	31	9	**175**
4	14	20	49	98	42	12	**234**
5	17	24	61	122	52	15	**292**
6	21	29	73	147	62	18	**351**
7	24	34	85	171	73	21	**409**
8	28	39	98	195	83	24	**467**
9	31	44	110	220	93	27	**526**
10	35	49	122	244	104	31	**584**
11	38	54	134	269	114	34	**643**
12	42	59	147	293	125	37	**701**
13	45	63	159	317	135	40	**760**
14	49	68	171	342	145	43	**818**
15	52	73	183	366	156	46	**876**
16	56	78	195	391	166	49	**935**
17	59	83	208	415	176	52	**993**
18	63	88	220	440	187	55	**1,052**
19	66	93	232	464	197	58	**1,110**
20	70	98	244	488	208	61	**1,169**
21	73	103	256	513	218	64	**1,227**
22	77	107	269	537	228	67	**1,285**
23	80	112	281	562	239	70	**1,344**
24	84	117	293	586	249	73	**1,402**
25	87	122	305	611	259	76	**1,461**
26	90	127	317	635	270	79	**1,519**
27	94	132	330	659	280	82	**1,578**
28	97	137	342	684	291	85	**1,636**
29	101	142	354	708	301	89	**1,694**
30	104	147	366	733	311	92	**1,753**
31	108	151	379	757	322	95	**1,811**
32	111	156	391	782	332	98	**1,870**

Sub-Watershed #30 Annual Phosphorous Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	1	1	2	4	2	1	**10**
2	1	2	4	8	4	1	**20**
3	2	3	6	13	5	2	**30**
4	2	3	8	17	7	2	**41**
5	3	4	11	21	9	3	**51**
6	4	5	13	25	11	3	**61**
7	4	6	15	30	13	4	**71**

8	5	7	17	34	14	4	**81**
9	5	8	19	38	16	5	**91**
10	6	8	21	42	18	5	**101**
11	7	9	23	47	20	6	**111**
12	7	10	25	51	22	6	**122**
13	8	11	28	55	23	7	**132**
14	8	12	30	59	25	7	**142**
15	9	13	32	64	27	8	**152**
16	10	14	34	68	29	8	**162**
17	10	14	36	72	31	9	**172**
18	11	15	38	76	32	10	**182**
19	11	16	40	80	34	10	**193**
20	12	17	42	85	36	11	**203**
21	13	18	44	89	38	11	**213**
22	13	19	47	93	40	12	**223**
23	14	19	49	97	41	12	**233**
24	14	20	51	102	43	13	**243**
25	15	21	53	106	45	13	**253**
26	16	22	55	110	47	14	**264**
27	16	23	57	114	49	14	**274**
28	17	24	59	119	50	15	**284**
29	18	25	61	123	52	15	**294**
30	18	25	64	127	54	16	**304**
31	19	26	66	131	56	16	**314**
32	19	27	68	136	58	17	**324**

Table Set 63: Set of tables showing Nitrogen load reductions for Cropland BMPs implemented in targeted sub-watersheds

Sub-Watershed #1 Annual Nitrogen Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	28	40	62	100	119	12	**362**
2	57	80	125	200	238	25	**725**
3	85	120	187	300	357	37	**1,087**
4	114	160	250	400	476	50	**1,449**
5	142	200	312	500	595	62	**1,811**
6	171	240	375	600	714	75	**2,174**
7	199	280	437	700	833	87	**2,536**
8	228	320	500	800	951	100	**2,898**
9	256	360	562	900	1,070	112	**3,261**
10	285	400	625	999	1,189	125	**3,623**

11	313	440	687	1,099	1,308	137	**3,985**
12	342	480	750	1,199	1,427	150	**4,348**
13	370	520	812	1,299	1,546	162	**4,710**
14	399	560	875	1,399	1,665	175	**5,072**
15	427	600	937	1,499	1,784	187	**5,434**
16	456	640	999	1,599	1,903	200	**5,797**
17	484	680	1,062	1,699	2,022	212	**6,159**
18	513	720	1,124	1,799	2,141	225	**6,521**
19	541	760	1,187	1,899	2,260	237	**6,884**
20	570	800	1,249	1,999	2,379	250	**7,246**
21	598	840	1,312	2,099	2,498	262	**7,608**
22	627	880	1,374	2,199	2,617	275	**7,971**
23	655	919	1,437	2,299	2,735	287	**8,333**
24	684	959	1,499	2,399	2,854	300	**8,695**
25	712	999	1,562	2,499	2,973	312	**9,057**
26	741	1,039	1,624	2,599	3,092	325	**9,420**
27	769	1,079	1,687	2,699	3,211	337	**9,782**
28	798	1,119	1,749	2,798	3,330	350	**10,144**
29	826	1,159	1,811	2,898	3,449	362	**10,507**
30	855	1,199	1,874	2,998	3,568	375	**10,869**
31	883	1,239	1,936	3,098	3,687	387	**11,231**
32	911	1,279	1,999	3,198	3,806	400	**11,594**

Sub-Watershed #2 Annual Nitrogen Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	17	24	38	60	72	8	**218**
2	34	48	75	120	143	15	**436**
3	51	72	113	181	215	23	**655**
4	69	96	150	241	287	30	**873**
5	86	120	188	301	358	38	**1,091**
6	103	144	226	361	430	45	**1,309**
7	120	169	263	421	501	53	**1,527**
8	137	193	301	482	573	60	**1,746**
9	154	217	339	542	645	68	**1,964**
10	172	241	376	602	716	75	**2,182**
11	189	265	414	662	788	83	**2,400**
12	206	289	451	722	860	90	**2,618**
13	223	313	489	783	931	98	**2,837**
14	240	337	527	843	1,003	105	**3,055**
15	257	361	564	903	1,074	113	**3,273**
16	274	385	602	963	1,146	120	**3,491**

17	292	409	640	1,023	1,218	128	**3,710**
18	309	433	677	1,084	1,289	135	**3,928**
19	326	457	715	1,144	1,361	143	**4,146**
20	343	482	752	1,204	1,433	150	**4,364**
21	360	506	790	1,264	1,504	158	**4,582**
22	377	530	828	1,324	1,576	166	**4,801**
23	395	554	865	1,384	1,648	173	**5,019**
24	412	578	903	1,445	1,719	181	**5,237**
25	429	602	941	1,505	1,791	188	**5,455**
26	446	626	978	1,565	1,862	196	**5,673**
27	463	650	1,016	1,625	1,934	203	**5,892**
28	480	674	1,053	1,685	2,006	211	**6,110**
29	498	698	1,091	1,746	2,077	218	**6,328**
30	515	722	1,129	1,806	2,149	226	**6,546**
31	532	746	1,166	1,866	2,221	233	**6,764**
32	549	770	1,204	1,926	2,292	241	**6,983**

Sub-Watershed #3 Annual Nitrogen Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	142	199	311	497	591	62	**1,802**
2	283	398	621	994	1,183	124	**3,603**
3	425	596	932	1,491	1,774	186	**5,405**
4	567	795	1,243	1,988	2,366	249	**7,207**
5	708	994	1,553	2,485	2,957	311	**9,008**
6	850	1,193	1,864	2,982	3,549	373	**10,810**
7	992	1,392	2,174	3,479	4,140	435	**12,612**
8	1,133	1,590	2,485	3,976	4,732	497	**14,414**
9	1,275	1,789	2,796	4,473	5,323	559	**16,215**
10	1,416	1,988	3,106	4,970	5,915	621	**18,017**
11	1,558	2,187	3,417	5,467	6,506	683	**19,819**
12	1,700	2,386	3,728	5,964	7,097	746	**21,620**
13	1,841	2,584	4,038	6,461	7,689	808	**23,422**
14	1,983	2,783	4,349	6,958	8,280	870	**25,224**
15	2,125	2,982	4,660	7,455	8,872	932	**27,025**
16	2,266	3,181	4,970	7,952	9,463	994	**28,827**
17	2,408	3,380	5,281	8,449	10,055	1,056	**30,629**
18	2,550	3,579	5,591	8,946	10,646	1,118	**32,430**
19	2,691	3,777	5,902	9,443	11,238	1,180	**34,232**
20	2,833	3,976	6,213	9,940	11,829	1,243	**36,034**
21	2,975	4,175	6,523	10,437	12,420	1,305	**37,835**
22	3,116	4,374	6,834	10,934	13,012	1,367	**39,637**

23	3,258	4,573	7,145	11,431	13,603	1,429	**41,439**
24	3,400	4,771	7,455	11,928	14,195	1,491	**43,241**
25	3,541	4,970	7,766	12,425	14,786	1,553	**45,042**
26	3,683	5,169	8,077	12,922	15,378	1,615	**46,844**
27	3,825	5,368	8,387	13,419	15,969	1,677	**48,646**
28	3,966	5,567	8,698	13,916	16,561	1,740	**50,447**
29	4,108	5,765	9,008	14,414	17,152	1,802	**52,249**
30	4,249	5,964	9,319	14,911	17,744	1,864	**54,051**
31	4,391	6,163	9,630	15,408	18,335	1,926	**55,852**
32	4,533	6,362	9,940	15,905	18,926	1,988	**57,654**

Sub-Watershed #4 Annual Nitrogen Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	85	119	186	298	354	37	**1,079**
2	170	238	372	595	708	74	**2,158**
3	254	357	558	893	1,063	112	**3,237**
4	339	476	744	1,191	1,417	149	**4,316**
5	424	595	930	1,488	1,771	186	**5,395**
6	509	714	1,116	1,786	2,125	223	**6,473**
7	594	833	1,302	2,083	2,479	260	**7,552**
8	679	952	1,488	2,381	2,833	298	**8,631**
9	763	1,071	1,674	2,679	3,188	335	**9,710**
10	848	1,191	1,860	2,976	3,542	372	**10,789**
11	933	1,310	2,046	3,274	3,896	409	**11,868**
12	1,018	1,429	2,232	3,572	4,250	446	**12,947**
13	1,103	1,548	2,418	3,869	4,604	484	**14,026**
14	1,188	1,667	2,604	4,167	4,958	521	**15,105**
15	1,272	1,786	2,790	4,464	5,313	558	**16,184**
16	1,357	1,905	2,976	4,762	5,667	595	**17,262**
17	1,442	2,024	3,162	5,060	6,021	632	**18,341**
18	1,527	2,143	3,348	5,357	6,375	670	**19,420**
19	1,612	2,262	3,534	5,655	6,729	707	**20,499**
20	1,696	2,381	3,720	5,953	7,084	744	**21,578**
21	1,781	2,500	3,906	6,250	7,438	781	**22,657**
22	1,866	2,619	4,092	6,548	7,792	818	**23,736**
23	1,951	2,738	4,278	6,845	8,146	856	**24,815**
24	2,036	2,857	4,464	7,143	8,500	893	**25,894**
25	2,121	2,976	4,650	7,441	8,854	930	**26,973**
26	2,205	3,095	4,836	7,738	9,209	967	**28,052**
27	2,290	3,214	5,022	8,036	9,563	1,004	**29,130**
28	2,375	3,333	5,209	8,334	9,917	1,042	**30,209**

29	2,460	3,452	5,395	8,631	10,271	1,079	**31,288**
30	2,545	3,572	5,581	8,929	10,625	1,116	**32,367**
31	2,630	3,691	5,767	9,226	10,980	1,153	**33,446**
32	2,714	3,810	5,953	9,524	11,334	1,191	**34,525**

Sub-Watershed #5 Annual Nitrogen Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	127	179	279	447	532	56	**1,621**
2	255	358	559	894	1,064	112	**3,241**
3	382	537	838	1,341	1,596	168	**4,862**
4	510	715	1,118	1,788	2,128	224	**6,483**
5	637	894	1,397	2,235	2,660	279	**8,103**
6	765	1,073	1,677	2,683	3,192	335	**9,724**
7	892	1,252	1,956	3,130	3,724	391	**11,345**
8	1,019	1,431	2,235	3,577	4,256	447	**12,966**
9	1,147	1,610	2,515	4,024	4,788	503	**14,586**
10	1,274	1,788	2,794	4,471	5,320	559	**16,207**
11	1,402	1,967	3,074	4,918	5,852	615	**17,828**
12	1,529	2,146	3,353	5,365	6,384	671	**19,448**
13	1,656	2,325	3,633	5,812	6,916	727	**21,069**
14	1,784	2,504	3,912	6,259	7,448	782	**22,690**
15	1,911	2,683	4,191	6,706	7,981	838	**24,310**
16	2,039	2,861	4,471	7,153	8,513	894	**25,931**
17	2,166	3,040	4,750	7,601	9,045	950	**27,552**
18	2,294	3,219	5,030	8,048	9,577	1,006	**29,173**
19	2,421	3,398	5,309	8,495	10,109	1,062	**30,793**
20	2,548	3,577	5,589	8,942	10,641	1,118	**32,414**
21	2,676	3,756	5,868	9,389	11,173	1,174	**34,035**
22	2,803	3,934	6,147	9,836	11,705	1,229	**35,655**
23	2,931	4,113	6,427	10,283	12,237	1,285	**37,276**
24	3,058	4,292	6,706	10,730	12,769	1,341	**38,897**
25	3,186	4,471	6,986	11,177	13,301	1,397	**40,517**
26	3,313	4,650	7,265	11,624	13,833	1,453	**42,138**
27	3,440	4,829	7,545	12,071	14,365	1,509	**43,759**
28	3,568	5,007	7,824	12,518	14,897	1,565	**45,380**
29	3,695	5,186	8,103	12,966	15,429	1,621	**47,000**
30	3,823	5,365	8,383	13,413	15,961	1,677	**48,621**
31	3,950	5,544	8,662	13,860	16,493	1,732	**50,242**
32	4,077	5,723	8,942	14,307	17,025	1,788	**51,862**

Sub-Watershed #7 Annual Nitrogen Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	23	32	49	79	94	10	**287**
2	45.1	63.3	98.9	158.3	188.3	19.8	**574**
3	68	95	148	237	282	30	**861**
4	90	127	198	317	377	40	**1,147**
5	113	158	247	396	471	49	**1,434**
6	135	190	297	475	565	59	**1,721**
7	158	222	346	554	659	69	**2,008**
8	180	253	396	633	753	79	**2,295**
9	203	285	445	712	847	89	**2,582**
10	226	317	495	791	942	99	**2,868**
11	248	348	544	870	1,036	109	**3,155**
12	271	380	593	950	1,130	119	**3,442**
13	293	411	643	1,029	1,224	129	**3,729**
14	316	443	692	1,108	1,318	138	**4,016**
15	338	475	742	1,187	1,412	148	**4,303**
16	361	506	791	1,266	1,507	158	**4,589**
17	383	538	841	1,345	1,601	168	**4,876**
18	406	570	890	1,424	1,695	178	**5,163**
19	428	601	940	1,503	1,789	188	**5,450**
20	451	633	989	1,583	1,883	198	**5,737**
21	474	665	1,039	1,662	1,977	208	**6,024**
22	496	696	1,088	1,741	2,072	218	**6,310**
23	519	728	1,137	1,820	2,166	227	**6,597**
24	541	760	1,187	1,899	2,260	237	**6,884**
25	564	791	1,236	1,978	2,354	247	**7,171**
26	586	823	1,286	2,057	2,448	257	**7,458**
27	609	855	1,335	2,136	2,542	267	**7,745**
28	631	886	1,385	2,216	2,637	277	**8,031**
29	654	918	1,434	2,295	2,731	287	**8,318**
30	677	950	1,484	2,374	2,825	297	**8,605**
31	699	981	1,533	2,453	2,919	307	**8,892**
32	722	1,013	1,583	2,532	3,013	317	**9,179**

Sub-Watershed #8 Annual Nitrogen Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction

1	70	98	153	244	291	31	**886**
2	139	196	305	489	582	61	**1,772**
3	209	293	458	733	872	92	**2,658**
4	279	391	611	978	1,163	122	**3,544**
5	348	489	764	1,222	1,454	153	**4,430**
6	418	587	916	1,466	1,745	183	**5,315**
7	488	684	1,069	1,711	2,036	214	**6,201**
8	557	782	1,222	1,955	2,327	244	**7,087**
9	627	880	1,375	2,200	2,617	275	**7,973**
10	697	978	1,527	2,444	2,908	305	**8,859**
11	766	1,075	1,680	2,688	3,199	336	**9,745**
12	836	1,173	1,833	2,933	3,490	367	**10,631**
13	905	1,271	1,986	3,177	3,781	397	**11,517**
14	975	1,369	2,138	3,421	4,072	428	**12,403**
15	1,045	1,466	2,291	3,666	4,362	458	**13,289**
16	1,114	1,564	2,444	3,910	4,653	489	**14,175**
17	1,184	1,662	2,597	4,155	4,944	519	**15,061**
18	1,254	1,760	2,749	4,399	5,235	550	**15,946**
19	1,323	1,857	2,902	4,643	5,526	580	**16,832**
20	1,393	1,955	3,055	4,888	5,816	611	**17,718**
21	1,463	2,053	3,208	5,132	6,107	642	**18,604**
22	1,532	2,151	3,360	5,377	6,398	672	**19,490**
23	1,602	2,248	3,513	5,621	6,689	703	**20,376**
24	1,672	2,346	3,666	5,865	6,980	733	**21,262**
25	1,741	2,444	3,819	6,110	7,271	764	**22,148**
26	1,811	2,542	3,971	6,354	7,561	794	**23,034**
27	1,881	2,639	4,124	6,599	7,852	825	**23,920**
28	1,950	2,737	4,277	6,843	8,143	855	**24,806**
29	2,020	2,835	4,430	7,087	8,434	886	**25,692**
30	2,090	2,933	4,582	7,332	8,725	916	**26,577**
31	2,159	3,030	4,735	7,576	9,016	947	**27,463**
32	2,229	3,128	4,888	7,821	9,306	978	**28,349**

Sub-Watershed #10 Annual Nitrogen Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	102	144	224	359	427	45	**1,302**
2	205	287	449	718	855	90	**2,604**
3	307	431	673	1,077	1,282	135	**3,905**
4	409	575	898	1,436	1,709	180	**5,207**
5	512	718	1,122	1,796	2,137	224	**6,509**
6	614	862	1,347	2,155	2,564	269	**7,811**

7	716	1,005	1,571	2,514	2,991	314	**9,112**
8	819	1,149	1,796	2,873	3,419	359	**10,414**
9	921	1,293	2,020	3,232	3,846	404	**11,716**
10	1,023	1,436	2,244	3,591	4,273	449	**13,018**
11	1,126	1,580	2,469	3,950	4,701	494	**14,319**
12	1,228	1,724	2,693	4,309	5,128	539	**15,621**
13	1,330	1,867	2,918	4,668	5,555	584	**16,923**
14	1,433	2,011	3,142	5,027	5,983	628	**18,225**
15	1,535	2,155	3,367	5,387	6,410	673	**19,526**
16	1,638	2,298	3,591	5,746	6,837	718	**20,828**
17	1,740	2,442	3,816	6,105	7,265	763	**22,130**
18	1,842	2,586	4,040	6,464	7,692	808	**23,432**
19	1,945	2,729	4,264	6,823	8,119	853	**24,733**
20	2,047	2,873	4,489	7,182	8,547	898	**26,035**
21	2,149	3,016	4,713	7,541	8,974	943	**27,337**
22	2,252	3,160	4,938	7,900	9,401	988	**28,639**
23	2,354	3,304	5,162	8,259	9,829	1,032	**29,940**
24	2,456	3,447	5,387	8,619	10,256	1,077	**31,242**
25	2,559	3,591	5,611	8,978	10,683	1,122	**32,544**
26	2,661	3,735	5,835	9,337	11,111	1,167	**33,846**
27	2,763	3,878	6,060	9,696	11,538	1,212	**35,148**
28	2,866	4,022	6,284	10,055	11,965	1,257	**36,449**
29	2,968	4,166	6,509	10,414	12,393	1,302	**37,751**
30	3,070	4,309	6,733	10,773	12,820	1,347	**39,053**
31	3,173	4,453	6,958	11,132	13,247	1,392	**40,355**
32	3,275	4,597	7,182	11,491	13,675	1,436	**41,656**

Sub-Watershed #12 Annual Nitrogen Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	105	148	231	370	440	46	**1,341**
2	211	296	462	740	880	92	**2,682**
3	316	444	693	1,110	1,320	139	**4,022**
4	422	592	925	1,479	1,761	185	**5,363**
5	527	740	1,156	1,849	2,201	231	**6,704**
6	632	888	1,387	2,219	2,641	277	**8,045**
7	738	1,036	1,618	2,589	3,081	324	**9,385**
8	843	1,184	1,849	2,959	3,521	370	**10,726**
9	949	1,332	2,080	3,329	3,961	416	**12,067**
10	1,054	1,479	2,312	3,699	4,401	462	**13,408**
11	1,160	1,627	2,543	4,069	4,842	509	**14,748**
12	1,265	1,775	2,774	4,438	5,282	555	**16,089**

13	1,370	1,923	3,005	4,808	5,722	601	**17,430**
14	1,476	2,071	3,236	5,178	6,162	647	**18,771**
15	1,581	2,219	3,467	5,548	6,602	693	**20,111**
16	1,687	2,367	3,699	5,918	7,042	740	**21,452**
17	1,792	2,515	3,930	6,288	7,482	786	**22,793**
18	1,897	2,663	4,161	6,658	7,923	832	**24,134**
19	2,003	2,811	4,392	7,027	8,363	878	**25,475**
20	2,108	2,959	4,623	7,397	8,803	925	**26,815**
21	2,214	3,107	4,854	7,767	9,243	971	**28,156**
22	2,319	3,255	5,086	8,137	9,683	1,017	**29,497**
23	2,424	3,403	5,317	8,507	10,123	1,063	**30,838**
24	2,530	3,551	5,548	8,877	10,563	1,110	**32,178**
25	2,635	3,699	5,779	9,247	11,004	1,156	**33,519**
26	2,741	3,847	6,010	9,617	11,444	1,202	**34,860**
27	2,846	3,995	6,241	9,986	11,884	1,248	**36,201**
28	2,952	4,143	6,473	10,356	12,324	1,295	**37,541**
29	3,057	4,290	6,704	10,726	12,764	1,341	**38,882**
30	3,162	4,438	6,935	11,096	13,204	1,387	**40,223**
31	3,268	4,586	7,166	11,466	13,644	1,433	**41,564**
32	3,373	4,734	7,397	11,836	14,085	1,479	**42,904**

Sub-Watershed #16 Annual Nitrogen Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	47	66	103	165	196	21	**598**
2	94	132	206	330	393	41	**1,197**
3	141	198	310	495	589	62	**1,795**
4	188	264	413	660	786	83	**2,394**
5	235	330	516	825	982	103	**2,992**
6	282	396	619	990	1,179	124	**3,590**
7	329	462	722	1,155	1,375	144	**4,189**
8	376	528	825	1,321	1,571	165	**4,787**
9	423	594	929	1,486	1,768	186	**5,385**
10	470	660	1,032	1,651	1,964	206	**5,984**
11	517	726	1,135	1,816	2,161	227	**6,582**
12	565	792	1,238	1,981	2,357	248	**7,181**
13	612	858	1,341	2,146	2,554	268	**7,779**
14	659	924	1,444	2,311	2,750	289	**8,377**
15	706	990	1,548	2,476	2,947	310	**8,976**
16	753	1,056	1,651	2,641	3,143	330	**9,574**
17	800	1,122	1,754	2,806	3,339	351	**10,172**
18	847	1,189	1,857	2,971	3,536	371	**10,771**

19	894	1,255	1,960	3,136	3,732	392	**11,369**
20	941	1,321	2,063	3,301	3,929	413	**11,968**
21	988	1,387	2,167	3,466	4,125	433	**12,566**
22	1,035	1,453	2,270	3,632	4,322	454	**13,164**
23	1,082	1,519	2,373	3,797	4,518	475	**13,763**
24	1,129	1,585	2,476	3,962	4,714	495	**14,361**
25	1,176	1,651	2,579	4,127	4,911	516	**14,960**
26	1,223	1,717	2,682	4,292	5,107	536	**15,558**
27	1,270	1,783	2,786	4,457	5,304	557	**16,156**
28	1,317	1,849	2,889	4,622	5,500	578	**16,755**
29	1,364	1,915	2,992	4,787	5,697	598	**17,353**
30	1,411	1,981	3,095	4,952	5,893	619	**17,951**
31	1,458	2,047	3,198	5,117	6,089	640	**18,550**
32	1,505	2,113	3,301	5,282	6,286	660	**19,148**

Sub-Watershed #25 Annual Nitrogen Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	19	27	42	67	80	8	**243**
2	38	54	84	134	159	17	**485**
3	57	80	126	201	239	25	**728**
4	76	107	167	268	319	33	**971**
5	95	134	209	335	398	42	**1,213**
6	114	161	251	402	478	50	**1,456**
7	134	187	293	469	558	59	**1,699**
8	153	214	335	535	637	67	**1,941**
9	172	241	377	602	717	75	**2,184**
10	191	268	418	669	797	84	**2,426**
11	210	295	460	736	876	92	**2,669**
12	229	321	502	803	956	100	**2,912**
13	248	348	544	870	1,036	109	**3,154**
14	267	375	586	937	1,115	117	**3,397**
15	286	402	628	1,004	1,195	126	**3,640**
16	305	428	669	1,071	1,274	134	**3,882**
17	324	455	711	1,138	1,354	142	**4,125**
18	343	482	753	1,205	1,434	151	**4,368**
19	362	509	795	1,272	1,513	159	**4,610**
20	382	535	837	1,339	1,593	167	**4,853**
21	401	562	879	1,406	1,673	176	**5,096**
22	420	589	920	1,473	1,752	184	**5,338**
23	439	616	962	1,540	1,832	192	**5,581**
24	458	643	1,004	1,606	1,912	201	**5,823**

25	477	669	1,046	1,673	1,991	209	**6,066**
26	496	696	1,088	1,740	2,071	218	**6,309**
27	515	723	1,130	1,807	2,151	226	**6,551**
28	534	750	1,171	1,874	2,230	234	**6,794**
29	553	776	1,213	1,941	2,310	243	**7,037**
30	572	803	1,255	2,008	2,390	251	**7,279**
31	591	830	1,297	2,075	2,469	259	**7,522**
32	610	857	1,339	2,142	2,549	268	**7,765**

Sub-Watershed #26 Annual Nitrogen Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	24	33	52	83	99	10	**300**
2	47	66	104	166	197	21	**600**
3	71	99	155	248	296	31	**900**
4	94	132	207	331	394	41	**1,201**
5	118	166	259	414	493	52	**1,501**
6	142	199	311	497	591	62	**1,801**
7	165	232	362	580	690	72	**2,101**
8	189	265	414	662	788	83	**2,401**
9	212	298	466	745	887	93	**2,701**
10	236	331	518	828	985	104	**3,002**
11	260	364	569	911	1,084	114	**3,302**
12	283	397	621	994	1,182	124	**3,602**
13	307	431	673	1,076	1,281	135	**3,902**
14	330	464	725	1,159	1,380	145	**4,202**
15	354	497	776	1,242	1,478	155	**4,502**
16	378	530	828	1,325	1,577	166	**4,803**
17	401	563	880	1,408	1,675	176	**5,103**
18	425	596	932	1,490	1,774	186	**5,403**
19	448	629	983	1,573	1,872	197	**5,703**
20	472	662	1,035	1,656	1,971	207	**6,003**
21	496	696	1,087	1,739	2,069	217	**6,303**
22	519	729	1,139	1,822	2,168	228	**6,604**
23	543	762	1,190	1,905	2,266	238	**6,904**
24	566	795	1,242	1,987	2,365	248	**7,204**
25	590	828	1,294	2,070	2,463	259	**7,504**
26	614	861	1,346	2,153	2,562	269	**7,804**
27	637	894	1,397	2,236	2,661	279	**8,104**
28	661	927	1,449	2,319	2,759	290	**8,405**
29	684	961	1,501	2,401	2,858	300	**8,705**
30	708	994	1,553	2,484	2,956	311	**9,005**

31	732	1,027	1,604	2,567	3,055	321	**9,305**
32	755	1,060	1,656	2,650	3,153	331	**9,605**

Sub-Watershed #30 Annual Nitrogen Reduction (pounds), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Load Reduction
1	5	7	10	16	19	2	**59**
2	9	13	20	33	39	4	**119**
3	14	20	31	49	58	6	**178**
4	19	26	41	65	78	8	**237**
5	23	33	51	82	97	10	**297**
6	28	39	61	98	117	12	**356**
7	33	46	72	115	136	14	**415**
8	37	52	82	131	156	16	**475**
9	42	59	92	147	175	18	**534**
10	47	65	102	164	195	20	**593**
11	51	72	113	180	214	23	**653**
12	56	79	123	196	234	25	**712**
13	61	85	133	213	253	27	**771**
14	65	92	143	229	273	29	**831**
15	70	98	153	245	292	31	**890**
16	75	105	164	262	312	33	**949**
17	79	111	174	278	331	35	**1,009**
18	84	118	184	295	351	37	**1,068**
19	89	124	194	311	370	39	**1,127**
20	93	131	205	327	390	41	**1,187**
21	98	137	215	344	409	43	**1,246**
22	103	144	225	360	428	45	**1,305**
23	107	151	235	376	448	47	**1,364**
24	112	157	245	393	467	49	**1,424**
25	117	164	256	409	487	51	**1,483**
26	121	170	266	426	506	53	**1,542**
27	126	177	276	442	526	55	**1,602**
28	131	183	286	458	545	57	**1,661**
29	135	190	297	475	565	59	**1,720**
30	140	196	307	491	584	61	**1,780**
31	145	203	317	507	604	63	**1,839**
32	149	209	327	524	623	65	**1,898**

Table Set 64: Set of tables showing annual adoption rates for Cropland BMPs in targeted sub-watersheds

Sub-Watershed #1 Annual Adoption (treated acres), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
1	2	8	20	32	14	4	81
2	2	8	20	32	14	4	81
3	2	8	20	32	14	4	81
4	2	8	20	32	14	4	81
5	2	8	20	32	14	4	81
6	2	8	20	32	14	4	81
7	2	8	20	32	14	4	81
8	2	8	20	32	14	4	81
9	2	8	20	32	14	4	81
10	2	8	20	32	14	4	81
11	2	8	20	32	14	4	81
12	2	8	20	32	14	4	81
13	2	8	20	32	14	4	81
14	2	8	20	32	14	4	81
15	2	8	20	32	14	4	81
16	2	8	20	32	14	4	81
17	2	8	20	32	14	4	81
18	2	8	20	32	14	4	81
19	2	8	20	32	14	4	81
20	2	8	20	32	14	4	81
21	2	8	20	32	14	4	81
22	2	8	20	32	14	4	81
23	2	8	20	32	14	4	81
24	2	8	20	32	14	4	81
25	2	8	20	32	14	4	81
26	2	8	20	32	14	4	81
27	2	8	20	32	14	4	81
28	2	8	20	32	14	4	81
29	2	8	20	32	14	4	81
30	2	8	20	32	14	4	81
31	2	8	20	32	14	4	81
32	2	8	20	32	14	4	81

Sub-Watershed #2 Annual Adoption (treated acres), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
1	2	7	18	29	12	4	73
2	2	7	18	29	12	4	73
3	2	7	18	29	12	4	73
4	2	7	18	29	12	4	73
5	2	7	18	29	12	4	73
6	2	7	18	29	12	4	73
7	2	7	18	29	12	4	73
8	2	7	18	29	12	4	73
9	2	7	18	29	12	4	73
10	2	7	18	29	12	4	73
11	2	7	18	29	12	4	73
12	2	7	18	29	12	4	73
13	2	7	18	29	12	4	73
14	2	7	18	29	12	4	73
15	2	7	18	29	12	4	73
16	2	7	18	29	12	4	73
17	2	7	18	29	12	4	73
18	2	7	18	29	12	4	73
19	2	7	18	29	12	4	73
20	2	7	18	29	12	4	73
21	2	7	18	29	12	4	73
22	2	7	18	29	12	4	73
23	2	7	18	29	12	4	73
24	2	7	18	29	12	4	73
25	2	7	18	29	12	4	73
26	2	7	18	29	12	4	73
27	2	7	18	29	12	4	73
28	2	7	18	29	12	4	73
29	2	7	18	29	12	4	73
30	2	7	18	29	12	4	73
31	2	7	18	29	12	4	73
32	2	7	18	29	12	4	73

Sub-Watershed #3 Annual Adoption (treated acres), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption

1	10	33	81	130	55	16	325
2	10	33	81	130	55	16	325
3	10	33	81	130	55	16	325
4	10	33	81	130	55	16	325
5	10	33	81	130	55	16	325
6	10	33	81	130	55	16	325
7	10	33	81	130	55	16	325
8	10	33	81	130	55	16	325
9	10	33	81	130	55	16	325
10	10	33	81	130	55	16	325
11	10	33	81	130	55	16	325
12	10	33	81	130	55	16	325
13	10	33	81	130	55	16	325
14	10	33	81	130	55	16	325
15	10	33	81	130	55	16	325
16	10	33	81	130	55	16	325
17	10	33	81	130	55	16	325
18	10	33	81	130	55	16	325
19	10	33	81	130	55	16	325
20	10	33	81	130	55	16	325
21	10	33	81	130	55	16	325
22	10	33	81	130	55	16	325
23	10	33	81	130	55	16	325
24	10	33	81	130	55	16	325
25	10	33	81	130	55	16	325
26	10	33	81	130	55	16	325
27	10	33	81	130	55	16	325
28	10	33	81	130	55	16	325
29	10	33	81	130	55	16	325
30	10	33	81	130	55	16	325
31	10	33	81	130	55	16	325
32	10	33	81	130	55	16	325

Sub-Watershed #4 Annual Adoption (treated acres), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
1	5	15	38	61	26	8	152
2	5	15	38	61	26	8	152
3	5	15	38	61	26	8	152
4	5	15	38	61	26	8	152
5	5	15	38	61	26	8	152

6	5	15	38	61	26	8	152
7	5	15	38	61	26	8	152
8	5	15	38	61	26	8	152
9	5	15	38	61	26	8	152
10	5	15	38	61	26	8	152
11	5	15	38	61	26	8	152
12	5	15	38	61	26	8	152
13	5	15	38	61	26	8	152
14	5	15	38	61	26	8	152
15	5	15	38	61	26	8	152
16	5	15	38	61	26	8	152
17	5	15	38	61	26	8	152
18	5	15	38	61	26	8	152
19	5	15	38	61	26	8	152
20	5	15	38	61	26	8	152
21	5	15	38	61	26	8	152
22	5	15	38	61	26	8	152
23	5	15	38	61	26	8	152
24	5	15	38	61	26	8	152
25	5	15	38	61	26	8	152
26	5	15	38	61	26	8	152
27	5	15	38	61	26	8	152
28	5	15	38	61	26	8	152
29	5	15	38	61	26	8	152
30	5	15	38	61	26	8	152
31	5	15	38	61	26	8	152
32	5	15	38	61	26	8	152

Sub-Watershed #5 Annual Adoption (treated acres), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
1	9	31	79	126	53	16	314
2	9	31	79	126	53	16	314
3	9	31	79	126	53	16	314
4	9	31	79	126	53	16	314
5	9	31	79	126	53	16	314
6	9	31	79	126	53	16	314
7	9	31	79	126	53	16	314
8	9	31	79	126	53	16	314
9	9	31	79	126	53	16	314
10	9	31	79	126	53	16	314

11	9	31	79	126	53	16	314
12	9	31	79	126	53	16	314
13	9	31	79	126	53	16	314
14	9	31	79	126	53	16	314
15	9	31	79	126	53	16	314
16	9	31	79	126	53	16	314
17	9	31	79	126	53	16	314
18	9	31	79	126	53	16	314
19	9	31	79	126	53	16	314
20	9	31	79	126	53	16	314
21	9	31	79	126	53	16	314
22	9	31	79	126	53	16	314
23	9	31	79	126	53	16	314
24	9	31	79	126	53	16	314
25	9	31	79	126	53	16	314
26	9	31	79	126	53	16	314
27	9	31	79	126	53	16	314
28	9	31	79	126	53	16	314
29	9	31	79	126	53	16	314
30	9	31	79	126	53	16	314
31	9	31	79	126	53	16	314
32	9	31	79	126	53	16	314

Sub-Watershed #7 Annual Adoption (treated acres), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
1	2	8	20	32	14	4	80
2	2	8	20	32	14	4	80
3	2	8	20	32	14	4	80
4	2	8	20	32	14	4	80
5	2	8	20	32	14	4	80
6	2	8	20	32	14	4	80
7	2	8	20	32	14	4	80
8	2	8	20	32	14	4	80
9	2	8	20	32	14	4	80
10	2	8	20	32	14	4	80
11	2	8	20	32	14	4	80
12	2	8	20	32	14	4	80
13	2	8	20	32	14	4	80
14	2	8	20	32	14	4	80
15	2	8	20	32	14	4	80

16	2	8	20	32	14	4	80
17	2	8	20	32	14	4	80
18	2	8	20	32	14	4	80
19	2	8	20	32	14	4	80
20	2	8	20	32	14	4	80
21	2	8	20	32	14	4	80
22	2	8	20	32	14	4	80
23	2	8	20	32	14	4	80
24	2	8	20	32	14	4	80
25	2	8	20	32	14	4	80
26	2	8	20	32	14	4	80
27	2	8	20	32	14	4	80
28	2	8	20	32	14	4	80
29	2	8	20	32	14	4	80
30	2	8	20	32	14	4	80
31	2	8	20	32	14	4	80
32	2	8	20	32	14	4	80

Sub-Watershed #8 Annual Adoption (treated acres), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
1	5	17	43	68	29	9	171
2	5	17	43	68	29	9	171
3	5	17	43	68	29	9	171
4	5	17	43	68	29	9	171
5	5	17	43	68	29	9	171
6	5	17	43	68	29	9	171
7	5	17	43	68	29	9	171
8	5	17	43	68	29	9	171
9	5	17	43	68	29	9	171
10	5	17	43	68	29	9	171
11	5	17	43	68	29	9	171
12	5	17	43	68	29	9	171
13	5	17	43	68	29	9	171
14	5	17	43	68	29	9	171
15	5	17	43	68	29	9	171
16	5	17	43	68	29	9	171
17	5	17	43	68	29	9	171
18	5	17	43	68	29	9	171
19	5	17	43	68	29	9	171
20	5	17	43	68	29	9	171

21	5	17	43	68	29	9	171
22	5	17	43	68	29	9	171
23	5	17	43	68	29	9	171
24	5	17	43	68	29	9	171
25	5	17	43	68	29	9	171
26	5	17	43	68	29	9	171
27	5	17	43	68	29	9	171
28	5	17	43	68	29	9	171
29	5	17	43	68	29	9	171
30	5	17	43	68	29	9	171
31	5	17	43	68	29	9	171
32	5	17	43	68	29	9	171

Sub-Watershed #10 Annual Adoption (treated acres), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
1	9	29	73	116	49	15	291
2	9	29	73	116	49	15	291
3	9	29	73	116	49	15	291
4	9	29	73	116	49	15	291
5	9	29	73	116	49	15	291
6	9	29	73	116	49	15	291
7	9	29	73	116	49	15	291
8	9	29	73	116	49	15	291
9	9	29	73	116	49	15	291
10	9	29	73	116	49	15	291
11	9	29	73	116	49	15	291
12	9	29	73	116	49	15	291
13	9	29	73	116	49	15	291
14	9	29	73	116	49	15	291
15	9	29	73	116	49	15	291
16	9	29	73	116	49	15	291
17	9	29	73	116	49	15	291
18	9	29	73	116	49	15	291
19	9	29	73	116	49	15	291
20	9	29	73	116	49	15	291
21	9	29	73	116	49	15	291
22	9	29	73	116	49	15	291
23	9	29	73	116	49	15	291
24	9	29	73	116	49	15	291
25	9	29	73	116	49	15	291

26	9	29	73	116	49	15	291
27	9	29	73	116	49	15	291
28	9	29	73	116	49	15	291
29	9	29	73	116	49	15	291
30	9	29	73	116	49	15	291
31	9	29	73	116	49	15	291
32	9	29	73	116	49	15	291

Sub-Watershed #12 Annual Adoption (treated acres), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
1	11	36	90	144	61	18	361
2	11	36	90	144	61	18	361
3	11	36	90	144	61	18	361
4	11	36	90	144	61	18	361
5	11	36	90	144	61	18	361
6	11	36	90	144	61	18	361
7	11	36	90	144	61	18	361
8	11	36	90	144	61	18	361
9	11	36	90	144	61	18	361
10	11	36	90	144	61	18	361
11	11	36	90	144	61	18	361
12	11	36	90	144	61	18	361
13	11	36	90	144	61	18	361
14	11	36	90	144	61	18	361
15	11	36	90	144	61	18	361
16	11	36	90	144	61	18	361
17	11	36	90	144	61	18	361
18	11	36	90	144	61	18	361
19	11	36	90	144	61	18	361
20	11	36	90	144	61	18	361
21	11	36	90	144	61	18	361
22	11	36	90	144	61	18	361
23	11	36	90	144	61	18	361
24	11	36	90	144	61	18	361
25	11	36	90	144	61	18	361
26	11	36	90	144	61	18	361
27	11	36	90	144	61	18	361
28	11	36	90	144	61	18	361
29	11	36	90	144	61	18	361
30	11	36	90	144	61	18	361

31	11	36	90	144	61	18	361
32	11	36	90	144	61	18	361

Sub-Watershed #16 Annual Adoption (treated acres), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
1	8	27	67	107	46	13	268
2	8	27	67	107	46	13	268
3	8	27	67	107	46	13	268
4	8	27	67	107	46	13	268
5	8	27	67	107	46	13	268
6	8	27	67	107	46	13	268
7	8	27	67	107	46	13	268
8	8	27	67	107	46	13	268
9	8	27	67	107	46	13	268
10	8	27	67	107	46	13	268
11	8	27	67	107	46	13	268
12	8	27	67	107	46	13	268
13	8	27	67	107	46	13	268
14	8	27	67	107	46	13	268
15	8	27	67	107	46	13	268
16	8	27	67	107	46	13	268
17	8	27	67	107	46	13	268
18	8	27	67	107	46	13	268
19	8	27	67	107	46	13	268
20	8	27	67	107	46	13	268
21	8	27	67	107	46	13	268
22	8	27	67	107	46	13	268
23	8	27	67	107	46	13	268
24	8	27	67	107	46	13	268
25	8	27	67	107	46	13	268
26	8	27	67	107	46	13	268
27	8	27	67	107	46	13	268
28	8	27	67	107	46	13	268
29	8	27	67	107	46	13	268
30	8	27	67	107	46	13	268
31	8	27	67	107	46	13	268
32	8	27	67	107	46	13	268

Sub-Watershed #25 **Annual Adoption (treated acres), Cropland BMPs**

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
1	4	12	31	50	21	6	124
2	4	12	31	50	21	6	124
3	4	12	31	50	21	6	124
4	4	12	31	50	21	6	124
5	4	12	31	50	21	6	124
6	4	12	31	50	21	6	124
7	4	12	31	50	21	6	124
8	4	12	31	50	21	6	124
9	4	12	31	50	21	6	124
10	4	12	31	50	21	6	124
11	4	12	31	50	21	6	124
12	4	12	31	50	21	6	124
13	4	12	31	50	21	6	124
14	4	12	31	50	21	6	124
15	4	12	31	50	21	6	124
16	4	12	31	50	21	6	124
17	4	12	31	50	21	6	124
18	4	12	31	50	21	6	124
19	4	12	31	50	21	6	124
20	4	12	31	50	21	6	124
21	4	12	31	50	21	6	124
22	4	12	31	50	21	6	124
23	4	12	31	50	21	6	124
24	4	12	31	50	21	6	124
25	4	12	31	50	21	6	124
26	4	12	31	50	21	6	124
27	4	12	31	50	21	6	124
28	4	12	31	50	21	6	124
29	4	12	31	50	21	6	124
30	4	12	31	50	21	6	124
31	4	12	31	50	21	6	124
32	4	12	31	50	21	6	124

Sub-Watershed #26 **Annual Adoption (treated acres), Cropland BMPs**

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
1	5	15	38	61	26	8	152
2	5	15	38	61	26	8	152
3	5	15	38	61	26	8	152
4	5	15	38	61	26	8	152
5	5	15	38	61	26	8	152
6	5	15	38	61	26	8	152
7	5	15	38	61	26	8	152
8	5	15	38	61	26	8	152
9	5	15	38	61	26	8	152
10	5	15	38	61	26	8	152
11	5	15	38	61	26	8	152
12	5	15	38	61	26	8	152
13	5	15	38	61	26	8	152
14	5	15	38	61	26	8	152
15	5	15	38	61	26	8	152
16	5	15	38	61	26	8	152
17	5	15	38	61	26	8	152
18	5	15	38	61	26	8	152
19	5	15	38	61	26	8	152
20	5	15	38	61	26	8	152
21	5	15	38	61	26	8	152
22	5	15	38	61	26	8	152
23	5	15	38	61	26	8	152
24	5	15	38	61	26	8	152
25	5	15	38	61	26	8	152
26	5	15	38	61	26	8	152
27	5	15	38	61	26	8	152
28	5	15	38	61	26	8	152
29	5	15	38	61	26	8	152
30	5	15	38	61	26	8	152
31	5	15	38	61	26	8	152
32	5	15	38	61	26	8	152

Sub-Watershed #30 Annual Adoption (treated acres), Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
1	2	5	13	21	9	3	52
2	2	5	13	21	9	3	52
3	2	5	13	21	9	3	52
4	2	5	13	21	9	3	52
5	2	5	13	21	9	3	52
6	2	5	13	21	9	3	52
7	2	5	13	21	9	3	52
8	2	5	13	21	9	3	52
9	2	5	13	21	9	3	52
10	2	5	13	21	9	3	52
11	2	5	13	21	9	3	52
12	2	5	13	21	9	3	52
13	2	5	13	21	9	3	52
14	2	5	13	21	9	3	52
15	2	5	13	21	9	3	52
16	2	5	13	21	9	3	52
17	2	5	13	21	9	3	52
18	2	5	13	21	9	3	52
19	2	5	13	21	9	3	52
20	2	5	13	21	9	3	52
21	2	5	13	21	9	3	52
22	2	5	13	21	9	3	52
23	2	5	13	21	9	3	52
24	2	5	13	21	9	3	52
25	2	5	13	21	9	3	52
26	2	5	13	21	9	3	52
27	2	5	13	21	9	3	52
28	2	5	13	21	9	3	52
29	2	5	13	21	9	3	52
30	2	5	13	21	9	3	52
31	2	5	13	21	9	3	52
32	2	5	13	21	9	3	52

<u>Table Set 65</u>: Set of tables showing Short, Medium and Long-term adoption rates for Cropland BMPs implemented in targeted sub-watersheds

Sub-Watershed #1 Annual Adoption (treated acres), Cropland BMPs

	Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
Short-Term	1	2	8	20	32	14	4	81
	2	2	8	20	32	14	4	81
	3	2	8	20	32	14	4	81
	4	2	8	20	32	14	4	81
	5	2	8	20	32	14	4	81
	Total	*12*	*41*	*101*	*162*	*69*	*20*	*405*
Medium-Term	6	2	8	20	32	14	4	81
	7	2	8	20	32	14	4	81
	8	2	8	20	32	14	4	81
	9	2	8	20	32	14	4	81
	10	2	8	20	32	14	4	81
	Total	*24*	*81*	*203*	*324*	*138*	*41*	*810*
Long-Term	11	2	8	20	32	14	4	81
	12	2	8	20	32	14	4	81
	13	2	8	20	32	14	4	81
	14	2	8	20	32	14	4	81
	15	2	8	20	32	14	4	81
	16	2	8	20	32	14	4	81
	17	2	8	20	32	14	4	81
	18	2	8	20	32	14	4	81
	19	2	8	20	32	14	4	81
	20	2	8	20	32	14	4	81
	21	2	8	20	32	14	4	81
	22	2	8	20	32	14	4	81
	23	2	8	20	32	14	4	81
	24	2	8	20	32	14	4	81
	25	2	8	20	32	14	4	81
	26	2	8	20	32	14	4	81
	27	2	8	20	32	14	4	81
	28	2	8	20	32	14	4	81
	29	2	8	20	32	14	4	81
	30	2	8	20	32	14	4	81
	31	2	8	20	32	14	4	81
	32	2	8	20	32	14	4	81
	Total	*78*	*259*	*648*	*1,037*	*441*	*130*	*2,592*

Sub-Watershed #2 **Annual Adoption (treated acres), Cropland BMPs**

	Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
Short-Term	1	2	7	18	29	12	4	73
	2	2	7	18	29	12	4	73
	3	2	7	18	29	12	4	73
	4	2	7	18	29	12	4	73
	5	2	7	18	29	12	4	73
	Total	*11*	*36*	*91*	*146*	*62*	*18*	*364*
Medium-Term	6	2	7	18	29	12	4	73
	7	2	7	18	29	12	4	73
	8	2	7	18	29	12	4	73
	9	2	7	18	29	12	4	73
	10	2	7	18	29	12	4	73
	Total	*22*	*73*	*182*	*291*	*124*	*36*	*728*
Long-Term	11	2	7	18	29	12	4	73
	12	2	7	18	29	12	4	73
	13	2	7	18	29	12	4	73
	14	2	7	18	29	12	4	73
	15	2	7	18	29	12	4	73
	16	2	7	18	29	12	4	73
	17	2	7	18	29	12	4	73
	18	2	7	18	29	12	4	73
	19	2	7	18	29	12	4	73
	20	2	7	18	29	12	4	73
	21	2	7	18	29	12	4	73
	22	2	7	18	29	12	4	73
	23	2	7	18	29	12	4	73
	24	2	7	18	29	12	4	73
	25	2	7	18	29	12	4	73
	26	2	7	18	29	12	4	73
	27	2	7	18	29	12	4	73
	28	2	7	18	29	12	4	73
	29	2	7	18	29	12	4	73
	30	2	7	18	29	12	4	73
	31	2	7	18	29	12	4	73
	32	2	7	18	29	12	4	73
	Total	*70*	*233*	*582*	*932*	*396*	*116*	*2,329*

Sub-Watershed #3 **Annual Adoption (treated acres), Cropland BMPs**

	Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
Short-Term	1	10	33	81	130	55	16	325
	2	10	33	81	130	55	16	325
	3	10	33	81	130	55	16	325
	4	10	33	81	130	55	16	325
	5	10	33	81	130	55	16	325
	Total	*49*	*163*	*406*	*650*	*276*	*81*	*1,625*
Medium-Term	6	10	33	81	130	55	16	325
	7	10	33	81	130	55	16	325
	8	10	33	81	130	55	16	325
	9	10	33	81	130	55	16	325
	10	10	33	81	130	55	16	325
	Total	*98*	*325*	*813*	*1,300*	*553*	*163*	*3,250*
Long-Term	11	10	33	81	130	55	16	325
	12	10	33	81	130	55	16	325
	13	10	33	81	130	55	16	325
	14	10	33	81	130	55	16	325
	15	10	33	81	130	55	16	325
	16	10	33	81	130	55	16	325
	17	10	33	81	130	55	16	325
	18	10	33	81	130	55	16	325
	19	10	33	81	130	55	16	325
	20	10	33	81	130	55	16	325
	21	10	33	81	130	55	16	325
	22	10	33	81	130	55	16	325
	23	10	33	81	130	55	16	325
	24	10	33	81	130	55	16	325
	25	10	33	81	130	55	16	325
	26	10	33	81	130	55	16	325
	27	10	33	81	130	55	16	325
	28	10	33	81	130	55	16	325
	29	10	33	81	130	55	16	325
	30	10	33	81	130	55	16	325
	31	10	33	81	130	55	16	325
	32	10	33	81	130	55	16	325
	Total	*312*	*1,040*	*2,600*	*4,160*	*1,768*	*520*	*10,400*

Sub-Watershed #4 **Annual Adoption (treated acres), Cropland BMPs**

	Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
Short-Term	1	5	15	38	61	26	8	152
	2	5	15	38	61	26	8	152
	3	5	15	38	61	26	8	152
	4	5	15	38	61	26	8	152
	5	5	15	38	61	26	8	152
	Total	*23*	*76*	*190*	*303*	*129*	*38*	*759*
Medium-Term	6	5	15	38	61	26	8	152
	7	5	15	38	61	26	8	152
	8	5	15	38	61	26	8	152
	9	5	15	38	61	26	8	152
	10	5	15	38	61	26	8	152
	Total	*46*	*152*	*379*	*607*	*258*	*76*	*1,517*
Long-Term	11	5	15	38	61	26	8	152
	12	5	15	38	61	26	8	152
	13	5	15	38	61	26	8	152
	14	5	15	38	61	26	8	152
	15	5	15	38	61	26	8	152
	16	5	15	38	61	26	8	152
	17	5	15	38	61	26	8	152
	18	5	15	38	61	26	8	152
	19	5	15	38	61	26	8	152
	20	5	15	38	61	26	8	152
	21	5	15	38	61	26	8	152
	22	5	15	38	61	26	8	152
	23	5	15	38	61	26	8	152
	24	5	15	38	61	26	8	152
	25	5	15	38	61	26	8	152
	26	5	15	38	61	26	8	152
	27	5	15	38	61	26	8	152
	28	5	15	38	61	26	8	152
	29	5	15	38	61	26	8	152
	30	5	15	38	61	26	8	152
	31	5	15	38	61	26	8	152
	32	5	15	38	61	26	8	152
	Total	*146*	*486*	*1,214*	*1,942*	*825*	*243*	*4,855*

Sub-Watershed #5 **Annual Adoption (treated acres), Cropland BMPs**

	Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
Short-Term	1	9	31	79	126	53	16	314
	2	9	31	79	126	53	16	314
	3	9	31	79	126	53	16	314
	4	9	31	79	126	53	16	314
	5	9	31	79	126	53	16	314
	Total	*47*	*157*	*393*	*629*	*267*	*79*	*1,572*
Medium-Term	6	9	31	79	126	53	16	314
	7	9	31	79	126	53	16	314
	8	9	31	79	126	53	16	314
	9	9	31	79	126	53	16	314
	10	9	31	79	126	53	16	314
	Total	*94*	*314*	*786*	*1,257*	*534*	*157*	*3,143*
Long-Term	11	9	31	79	126	53	16	314
	12	9	31	79	126	53	16	314
	13	9	31	79	126	53	16	314
	14	9	31	79	126	53	16	314
	15	9	31	79	126	53	16	314
	16	9	31	79	126	53	16	314
	17	9	31	79	126	53	16	314
	18	9	31	79	126	53	16	314
	19	9	31	79	126	53	16	314
	20	9	31	79	126	53	16	314
	21	9	31	79	126	53	16	314
	22	9	31	79	126	53	16	314
	23	9	31	79	126	53	16	314
	24	9	31	79	126	53	16	314
	25	9	31	79	126	53	16	314
	26	9	31	79	126	53	16	314
	27	9	31	79	126	53	16	314
	28	9	31	79	126	53	16	314
	29	9	31	79	126	53	16	314
	30	9	31	79	126	53	16	314
	31	9	31	79	126	53	16	314
	32	9	31	79	126	53	16	314
	Total	*302*	*1,006*	*2,514*	*4,023*	*1,710*	*503*	*10,058*

Sub-Watershed #7 Annual Adoption (treated acres), Cropland BMPs

	Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
Short-Term	1	2	8	20	32	14	4	80
	2	2	8	20	32	14	4	80
	3	2	8	20	32	14	4	80
	4	2	8	20	32	14	4	80
	5	2	8	20	32	14	4	80
	Total	*12*	*40*	*100*	*159*	*68*	*20*	*398*
Medium-Term	6	2	8	20	32	14	4	80
	7	2	8	20	32	14	4	80
	8	2	8	20	32	14	4	80
	9	2	8	20	32	14	4	80
	10	2	8	20	32	14	4	80
	Total	*24*	*80*	*199*	*319*	*135*	*40*	*797*
Long-Term	11	2	8	20	32	14	4	80
	12	2	8	20	32	14	4	80
	13	2	8	20	32	14	4	80
	14	2	8	20	32	14	4	80
	15	2	8	20	32	14	4	80
	16	2	8	20	32	14	4	80
	17	2	8	20	32	14	4	80
	18	2	8	20	32	14	4	80
	19	2	8	20	32	14	4	80
	20	2	8	20	32	14	4	80
	21	2	8	20	32	14	4	80
	22	2	8	20	32	14	4	80
	23	2	8	20	32	14	4	80
	24	2	8	20	32	14	4	80
	25	2	8	20	32	14	4	80
	26	2	8	20	32	14	4	80
	27	2	8	20	32	14	4	80
	28	2	8	20	32	14	4	80
	29	2	8	20	32	14	4	80
	30	2	8	20	32	14	4	80
	31	2	8	20	32	14	4	80
	32	2	8	20	32	14	4	80
	Total	*76*	*255*	*637*	*1,020*	*433*	*127*	*2,549*

Sub-Watershed #8 Annual Adoption (treated acres), Cropland BMPs

	Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
Short-Term	1	5	17	43	68	29	9	171
	2	5	17	43	68	29	9	171
	3	5	17	43	68	29	9	171
	4	5	17	43	68	29	9	171
	5	5	17	43	68	29	9	171
	Total	*26*	*86*	*214*	*342*	*145*	*43*	*856*
Medium-Term	6	5	17	43	68	29	9	171
	7	5	17	43	68	29	9	171
	8	5	17	43	68	29	9	171
	9	5	17	43	68	29	9	171
	10	5	17	43	68	29	9	171
	Total	*51*	*171*	*428*	*685*	*291*	*86*	*1,712*
Long-Term	11	5	17	43	68	29	9	171
	12	5	17	43	68	29	9	171
	13	5	17	43	68	29	9	171
	14	5	17	43	68	29	9	171
	15	5	17	43	68	29	9	171
	16	5	17	43	68	29	9	171
	17	5	17	43	68	29	9	171
	18	5	17	43	68	29	9	171
	19	5	17	43	68	29	9	171
	20	5	17	43	68	29	9	171
	21	5	17	43	68	29	9	171
	22	5	17	43	68	29	9	171
	23	5	17	43	68	29	9	171
	24	5	17	43	68	29	9	171
	25	5	17	43	68	29	9	171
	26	5	17	43	68	29	9	171
	27	5	17	43	68	29	9	171
	28	5	17	43	68	29	9	171
	29	5	17	43	68	29	9	171
	30	5	17	43	68	29	9	171
	31	5	17	43	68	29	9	171
	32	5	17	43	68	29	9	171
	Total	*164*	*548*	*1,369*	*2,191*	*931*	*274*	*5,477*

Sub-Watershed #10 Annual Adoption (treated acres), Cropland BMPs

	Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
Short-Term	1	9	29	73	116	49	15	291
	2	9	29	73	116	49	15	291
	3	9	29	73	116	49	15	291
	4	9	29	73	116	49	15	291
	5	9	29	73	116	49	15	291
	Total	*44*	*145*	*363*	*581*	*247*	*73*	*1,453*
Medium-Term	6	9	29	73	116	49	15	291
	7	9	29	73	116	49	15	291
	8	9	29	73	116	49	15	291
	9	9	29	73	116	49	15	291
	10	9	29	73	116	49	15	291
	Total	*87*	*291*	*726*	*1,162*	*494*	*145*	*2,906*
Long-Term	11	9	29	73	116	49	15	291
	12	9	29	73	116	49	15	291
	13	9	29	73	116	49	15	291
	14	9	29	73	116	49	15	291
	15	9	29	73	116	49	15	291
	16	9	29	73	116	49	15	291
	17	9	29	73	116	49	15	291
	18	9	29	73	116	49	15	291
	19	9	29	73	116	49	15	291
	20	9	29	73	116	49	15	291
	21	9	29	73	116	49	15	291
	22	9	29	73	116	49	15	291
	23	9	29	73	116	49	15	291
	24	9	29	73	116	49	15	291
	25	9	29	73	116	49	15	291
	26	9	29	73	116	49	15	291
	27	9	29	73	116	49	15	291
	28	9	29	73	116	49	15	291
	29	9	29	73	116	49	15	291
	30	9	29	73	116	49	15	291
	31	9	29	73	116	49	15	291
	32	9	29	73	116	49	15	291
	Total	*279*	*930*	*2,325*	*3,719*	*1,581*	*465*	*9,298*

Sub-Watershed #12 Annual Adoption (treated acres), Cropland BMPs

	Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
Short-Term	1	11	36	90	144	61	18	361
	2	11	36	90	144	61	18	361
	3	11	36	90	144	61	18	361
	4	11	36	90	144	61	18	361
	5	11	36	90	144	61	18	361
	Total	*54*	*181*	*451*	*722*	*307*	*90*	*1,805*
Medium-Term	6	11	36	90	144	61	18	361
	7	11	36	90	144	61	18	361
	8	11	36	90	144	61	18	361
	9	11	36	90	144	61	18	361
	10	11	36	90	144	61	18	361
	Total	*108*	*361*	*903*	*1,444*	*614*	*181*	*3,610*
Long-Term	11	11	36	90	144	61	18	361
	12	11	36	90	144	61	18	361
	13	11	36	90	144	61	18	361
	14	11	36	90	144	61	18	361
	15	11	36	90	144	61	18	361
	16	11	36	90	144	61	18	361
	17	11	36	90	144	61	18	361
	18	11	36	90	144	61	18	361
	19	11	36	90	144	61	18	361
	20	11	36	90	144	61	18	361
	21	11	36	90	144	61	18	361
	22	11	36	90	144	61	18	361
	23	11	36	90	144	61	18	361
	24	11	36	90	144	61	18	361
	25	11	36	90	144	61	18	361
	26	11	36	90	144	61	18	361
	27	11	36	90	144	61	18	361
	28	11	36	90	144	61	18	361
	29	11	36	90	144	61	18	361
	30	11	36	90	144	61	18	361
	31	11	36	90	144	61	18	361
	32	11	36	90	144	61	18	361
	Total	*347*	*1,155*	*2,888*	*4,621*	*1,964*	*578*	*11,553*

Sub-Watershed #16 Annual Adoption (treated acres), Cropland BMPs

	Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
Short-Term	1	8	27	67	107	46	13	268
	2	8	27	67	107	46	13	268
	3	8	27	67	107	46	13	268
	4	8	27	67	107	46	13	268
	5	8	27	67	107	46	13	268
	Total	*40*	*134*	*335*	*537*	*228*	*67*	*1,342*
Medium-Term	6	8	27	67	107	46	13	268
	7	8	27	67	107	46	13	268
	8	8	27	67	107	46	13	268
	9	8	27	67	107	46	13	268
	10	8	27	67	107	46	13	268
	Total	*80*	*268*	*671*	*1,073*	*456*	*134*	*2,683*
Long-Term	11	8	27	67	107	46	13	268
	12	8	27	67	107	46	13	268
	13	8	27	67	107	46	13	268
	14	8	27	67	107	46	13	268
	15	8	27	67	107	46	13	268
	16	8	27	67	107	46	13	268
	17	8	27	67	107	46	13	268
	18	8	27	67	107	46	13	268
	19	8	27	67	107	46	13	268
	20	8	27	67	107	46	13	268
	21	8	27	67	107	46	13	268
	22	8	27	67	107	46	13	268
	23	8	27	67	107	46	13	268
	24	8	27	67	107	46	13	268
	25	8	27	67	107	46	13	268
	26	8	27	67	107	46	13	268
	27	8	27	67	107	46	13	268
	28	8	27	67	107	46	13	268
	29	8	27	67	107	46	13	268
	30	8	27	67	107	46	13	268
	31	8	27	67	107	46	13	268
	32	8	27	67	107	46	13	268
	Total	*258*	*859*	*2,146*	*3,434*	*1,460*	*429*	*8,586*

Sub-Watershed #25 Annual Adoption (treated acres), Cropland BMPs

	Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
Short-Term	1	4	12	31	50	21	6	124
	2	4	12	31	50	21	6	124
	3	4	12	31	50	21	6	124
	4	4	12	31	50	21	6	124
	5	4	12	31	50	21	6	124
	Total	*19*	*62*	*155*	*248*	*106*	*31*	*621*
Medium-Term	6	4	12	31	50	21	6	124
	7	4	12	31	50	21	6	124
	8	4	12	31	50	21	6	124
	9	4	12	31	50	21	6	124
	10	4	12	31	50	21	6	124
	Total	*37*	*124*	*310*	*497*	*211*	*62*	*1,242*
Long-Term	11	4	12	31	50	21	6	124
	12	4	12	31	50	21	6	124
	13	4	12	31	50	21	6	124
	14	4	12	31	50	21	6	124
	15	4	12	31	50	21	6	124
	16	4	12	31	50	21	6	124
	17	4	12	31	50	21	6	124
	18	4	12	31	50	21	6	124
	19	4	12	31	50	21	6	124
	20	4	12	31	50	21	6	124
	21	4	12	31	50	21	6	124
	22	4	12	31	50	21	6	124
	23	4	12	31	50	21	6	124
	24	4	12	31	50	21	6	124
	25	4	12	31	50	21	6	124
	26	4	12	31	50	21	6	124
	27	4	12	31	50	21	6	124
	28	4	12	31	50	21	6	124
	29	4	12	31	50	21	6	124
	30	4	12	31	50	21	6	124
	31	4	12	31	50	21	6	124
	32	4	12	31	50	21	6	124
	Total	*119*	*397*	*993*	*1,589*	*676*	*199*	*3,974*

Sub-Watershed #26 Annual Adoption (treated acres), Cropland BMPs

	Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
Short-Term	1	5	15	38	61	26	8	152
	2	5	15	38	61	26	8	152
	3	5	15	38	61	26	8	152
	4	5	15	38	61	26	8	152
	5	5	15	38	61	26	8	152
	Total	*23*	*76*	*190*	*304*	*129*	*38*	*760*
Medium-Term	6	5	15	38	61	26	8	152
	7	5	15	38	61	26	8	152
	8	5	15	38	61	26	8	152
	9	5	15	38	61	26	8	152
	10	5	15	38	61	26	8	152
	Total	*46*	*152*	*380*	*608*	*259*	*76*	*1,521*
Long-Term	11	5	15	38	61	26	8	152
	12	5	15	38	61	26	8	152
	13	5	15	38	61	26	8	152
	14	5	15	38	61	26	8	152
	15	5	15	38	61	26	8	152
	16	5	15	38	61	26	8	152
	17	5	15	38	61	26	8	152
	18	5	15	38	61	26	8	152
	19	5	15	38	61	26	8	152
	20	5	15	38	61	26	8	152
	21	5	15	38	61	26	8	152
	22	5	15	38	61	26	8	152
	23	5	15	38	61	26	8	152
	24	5	15	38	61	26	8	152
	25	5	15	38	61	26	8	152
	26	5	15	38	61	26	8	152
	27	5	15	38	61	26	8	152
	28	5	15	38	61	26	8	152
	29	5	15	38	61	26	8	152
	30	5	15	38	61	26	8	152
	31	5	15	38	61	26	8	152
	32	5	15	38	61	26	8	152
	Total	*146*	*487*	*1,217*	*1,947*	*827*	*243*	*4,866*

Sub-Watershed #30 Annual Adoption (treated acres), Cropland BMPs

	Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Adoption
Short-Term	1	2	5	13	21	9	3	52
	2	2	5	13	21	9	3	52
	3	2	5	13	21	9	3	52
	4	2	5	13	21	9	3	52
	5	2	5	13	21	9	3	52
	Total	*8*	*26*	*65*	*104*	*44*	*13*	*260*
Medium-Term	6	2	5	13	21	9	3	52
	7	2	5	13	21	9	3	52
	8	2	5	13	21	9	3	52
	9	2	5	13	21	9	3	52
	10	2	5	13	21	9	3	52
	Total	*16*	*52*	*130*	*208*	*88*	*26*	*520*
Long-Term	11	2	5	13	21	9	3	52
	12	2	5	13	21	9	3	52
	13	2	5	13	21	9	3	52
	14	2	5	13	21	9	3	52
	15	2	5	13	21	9	3	52
	16	2	5	13	21	9	3	52
	17	2	5	13	21	9	3	52
	18	2	5	13	21	9	3	52
	19	2	5	13	21	9	3	52
	20	2	5	13	21	9	3	52
	21	2	5	13	21	9	3	52
	22	2	5	13	21	9	3	52
	23	2	5	13	21	9	3	52
	24	2	5	13	21	9	3	52
	25	2	5	13	21	9	3	52
	26	2	5	13	21	9	3	52
	27	2	5	13	21	9	3	52
	28	2	5	13	21	9	3	52
	29	2	5	13	21	9	3	52
	30	2	5	13	21	9	3	52
	31	2	5	13	21	9	3	52
	32	2	5	13	21	9	3	52
	Total	*50*	*166*	*416*	*665*	*283*	*83*	*1,662*

Table Set 66: Set of tables showing annual cost estimates for implementation of Cropland BMPs in targeted sub-watersheds *before* cost share

Sub-Watershed #1 Annual Cost* Before Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$365	$1,296	$1,573	$2,160	$374	$1,215	**$6,983**
2	$375	$1,335	$1,620	$2,225	$386	$1,251	**$7,193**
3	$387	$1,375	$1,669	$2,292	$397	$1,289	**$7,408**
4	$398	$1,416	$1,719	$2,360	$409	$1,328	**$7,631**
5	$410	$1,459	$1,771	$2,431	$421	$1,367	**$7,860**
6	$423	$1,502	$1,824	$2,504	$434	$1,409	**$8,095**
7	$435	$1,547	$1,879	$2,579	$447	$1,451	**$8,338**
8	$448	$1,594	$1,935	$2,657	$460	$1,494	**$8,588**
9	$462	$1,642	$1,993	$2,736	$474	$1,539	**$8,846**
10	$476	$1,691	$2,053	$2,818	$489	$1,585	**$9,111**
11	$490	$1,742	$2,114	$2,903	$503	$1,633	**$9,385**
12	$505	$1,794	$2,178	$2,990	$518	$1,682	**$9,666**
13	$520	$1,848	$2,243	$3,080	$534	$1,732	**$9,956**
14	$535	$1,903	$2,310	$3,172	$550	$1,784	**$10,255**
15	$551	$1,960	$2,380	$3,267	$566	$1,838	**$10,563**
16	$568	$2,019	$2,451	$3,365	$583	$1,893	**$10,879**
17	$585	$2,080	$2,525	$3,466	$601	$1,950	**$11,206**
18	$602	$2,142	$2,600	$3,570	$619	$2,008	**$11,542**
19	$621	$2,206	$2,678	$3,677	$637	$2,068	**$11,888**
20	$639	$2,273	$2,759	$3,788	$657	$2,131	**$12,245**
21	$658	$2,341	$2,841	$3,901	$676	$2,194	**$12,612**
22	$678	$2,411	$2,927	$4,018	$697	$2,260	**$12,991**
23	$698	$2,483	$3,014	$4,139	$717	$2,328	**$13,380**
24	$719	$2,558	$3,105	$4,263	$739	$2,398	**$13,782**
25	$741	$2,635	$3,198	$4,391	$761	$2,470	**$14,195**
26	$763	$2,714	$3,294	$4,523	$784	$2,544	**$14,621**
27	$786	$2,795	$3,393	$4,658	$807	$2,620	**$15,060**
28	$810	$2,879	$3,495	$4,798	$832	$2,699	**$15,512**
29	$834	$2,965	$3,599	$4,942	$857	$2,780	**$15,977**
30	$859	$3,054	$3,707	$5,090	$882	$2,863	**$16,456**
31	$885	$3,146	$3,819	$5,243	$909	$2,949	**$16,950**
32	$911	$3,240	$3,933	$5,400	$936	$3,038	**$17,458**

**3% Inflation*

Sub-Watershed #2 Annual Cost* Before Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$327	$1,164	$1,413	$1,941	$336	$1,092	**$6,274**
2	$337	$1,199	$1,456	$1,999	$346	$1,124	**$6,462**
3	$347	$1,235	$1,500	$2,059	$357	$1,158	**$6,656**
4	$358	$1,272	$1,545	$2,121	$368	$1,193	**$6,856**
5	$369	$1,311	$1,591	$2,184	$379	$1,229	**$7,061**
6	$380	$1,350	$1,639	$2,250	$390	$1,265	**$7,273**
7	$391	$1,390	$1,688	$2,317	$402	$1,303	**$7,492**
8	$403	$1,432	$1,738	$2,387	$414	$1,343	**$7,716**
9	$415	$1,475	$1,791	$2,458	$426	$1,383	**$7,948**
10	$427	$1,519	$1,844	$2,532	$439	$1,424	**$8,186**
11	$440	$1,565	$1,900	$2,608	$452	$1,467	**$8,432**
12	$453	$1,612	$1,957	$2,686	$466	$1,511	**$8,685**
13	$467	$1,660	$2,015	$2,767	$480	$1,556	**$8,945**
14	$481	$1,710	$2,076	$2,850	$494	$1,603	**$9,214**
15	$495	$1,761	$2,138	$2,935	$509	$1,651	**$9,490**
16	$510	$1,814	$2,202	$3,023	$524	$1,701	**$9,775**
17	$526	$1,869	$2,268	$3,114	$540	$1,752	**$10,068**
18	$541	$1,925	$2,336	$3,208	$556	$1,804	**$10,370**
19	$558	$1,982	$2,406	$3,304	$573	$1,858	**$10,681**
20	$574	$2,042	$2,479	$3,403	$590	$1,914	**$11,002**
21	$591	$2,103	$2,553	$3,505	$608	$1,972	**$11,332**
22	$609	$2,166	$2,629	$3,610	$626	$2,031	**$11,672**
23	$627	$2,231	$2,708	$3,719	$645	$2,092	**$12,022**
24	$646	$2,298	$2,790	$3,830	$664	$2,154	**$12,382**
25	$666	$2,367	$2,873	$3,945	$684	$2,219	**$12,754**
26	$686	$2,438	$2,959	$4,063	$704	$2,286	**$13,136**
27	$706	$2,511	$3,048	$4,185	$725	$2,354	**$13,531**
28	$727	$2,586	$3,140	$4,311	$747	$2,425	**$13,936**
29	$749	$2,664	$3,234	$4,440	$770	$2,498	**$14,355**
30	$772	$2,744	$3,331	$4,573	$793	$2,572	**$14,785**
31	$795	$2,826	$3,431	$4,711	$817	$2,650	**$15,229**
32	$819	$2,911	$3,534	$4,852	$841	$2,729	**$15,686**

**3% Inflation*

Sub-Watershed #3 Annual Cost* Before Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$1,463	$5,200	$6,312	$8,667	$1,502	$4,875	**$28,019**
2	$1,506	$5,356	$6,502	$8,927	$1,547	$5,021	**$28,859**
3	$1,552	$5,517	$6,697	$9,194	$1,594	$5,172	**$29,725**
4	$1,598	$5,682	$6,898	$9,470	$1,642	$5,327	**$30,617**
5	$1,646	$5,853	$7,105	$9,754	$1,691	$5,487	**$31,535**
6	$1,695	$6,028	$7,318	$10,047	$1,742	$5,651	**$32,481**
7	$1,746	$6,209	$7,537	$10,348	$1,794	$5,821	**$33,456**
8	$1,799	$6,395	$7,763	$10,659	$1,848	$5,996	**$34,459**
9	$1,853	$6,587	$7,996	$10,979	$1,903	$6,176	**$35,493**
10	$1,908	$6,785	$8,236	$11,308	$1,960	$6,361	**$36,558**
11	$1,965	$6,988	$8,483	$11,647	$2,019	$6,552	**$37,655**
12	$2,024	$7,198	$8,738	$11,997	$2,079	$6,748	**$38,784**
13	$2,085	$7,414	$9,000	$12,357	$2,142	$6,951	**$39,948**
14	$2,148	$7,636	$9,270	$12,727	$2,206	$7,159	**$41,146**
15	$2,212	$7,865	$9,548	$13,109	$2,272	$7,374	**$42,381**
16	$2,279	$8,101	$9,834	$13,502	$2,340	$7,595	**$43,652**
17	$2,347	$8,344	$10,129	$13,907	$2,411	$7,823	**$44,962**
18	$2,417	$8,595	$10,433	$14,325	$2,483	$8,058	**$46,311**
19	$2,490	$8,853	$10,746	$14,754	$2,557	$8,299	**$47,700**
20	$2,565	$9,118	$11,069	$15,197	$2,634	$8,548	**$49,131**
21	$2,641	$9,392	$11,401	$15,653	$2,713	$8,805	**$50,605**
22	$2,721	$9,674	$11,743	$16,123	$2,795	$9,069	**$52,123**
23	$2,802	$9,964	$12,095	$16,606	$2,878	$9,341	**$53,687**
24	$2,886	$10,263	$12,458	$17,104	$2,965	$9,621	**$55,297**
25	$2,973	$10,571	$12,832	$17,618	$3,054	$9,910	**$56,956**
26	$3,062	$10,888	$13,217	$18,146	$3,145	$10,207	**$58,665**
27	$3,154	$11,214	$13,613	$18,690	$3,240	$10,513	**$60,425**
28	$3,249	$11,551	$14,021	$19,251	$3,337	$10,829	**$62,238**
29	$3,346	$11,897	$14,442	$19,829	$3,437	$11,154	**$64,105**
30	$3,446	$12,254	$14,875	$20,424	$3,540	$11,488	**$66,028**
31	$3,550	$12,622	$15,322	$21,036	$3,646	$11,833	**$68,009**
32	$3,656	$13,000	$15,781	$21,667	$3,756	$12,188	**$70,049**

**3% Inflation*

Sub-Watershed #4 **Annual Cost* Before Cost-Share, Cropland BMPs**

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$683	$2,428	$2,947	$4,046	$701	$2,276	**$13,080**
2	$703	$2,500	$3,035	$4,167	$722	$2,344	**$13,473**
3	$724	$2,575	$3,126	$4,292	$744	$2,414	**$13,877**
4	$746	$2,653	$3,220	$4,421	$766	$2,487	**$14,293**
5	$768	$2,732	$3,317	$4,554	$789	$2,562	**$14,722**
6	$792	$2,814	$3,416	$4,690	$813	$2,638	**$15,164**
7	$815	$2,899	$3,519	$4,831	$837	$2,718	**$15,619**
8	$840	$2,986	$3,624	$4,976	$863	$2,799	**$16,087**
9	$865	$3,075	$3,733	$5,125	$888	$2,883	**$16,570**
10	$891	$3,167	$3,845	$5,279	$915	$2,970	**$17,067**
11	$918	$3,262	$3,960	$5,437	$943	$3,059	**$17,579**
12	$945	$3,360	$4,079	$5,601	$971	$3,150	**$18,106**
13	$973	$3,461	$4,202	$5,769	$1,000	$3,245	**$18,650**
14	$1,003	$3,565	$4,328	$5,942	$1,030	$3,342	**$19,209**
15	$1,033	$3,672	$4,457	$6,120	$1,061	$3,442	**$19,785**
16	$1,064	$3,782	$4,591	$6,304	$1,093	$3,546	**$20,379**
17	$1,096	$3,896	$4,729	$6,493	$1,125	$3,652	**$20,990**
18	$1,129	$4,012	$4,871	$6,687	$1,159	$3,762	**$21,620**
19	$1,162	$4,133	$5,017	$6,888	$1,194	$3,875	**$22,269**
20	$1,197	$4,257	$5,167	$7,095	$1,230	$3,991	**$22,937**
21	$1,233	$4,385	$5,322	$7,308	$1,267	$4,110	**$23,625**
22	$1,270	$4,516	$5,482	$7,527	$1,305	$4,234	**$24,333**
23	$1,308	$4,652	$5,647	$7,753	$1,344	$4,361	**$25,063**
24	$1,347	$4,791	$5,816	$7,985	$1,384	$4,492	**$25,815**
25	$1,388	$4,935	$5,990	$8,225	$1,426	$4,626	**$26,590**
26	$1,430	$5,083	$6,170	$8,471	$1,468	$4,765	**$27,388**
27	$1,472	$5,235	$6,355	$8,726	$1,512	$4,908	**$28,209**
28	$1,517	$5,392	$6,546	$8,987	$1,558	$5,055	**$29,055**
29	$1,562	$5,554	$6,742	$9,257	$1,605	$5,207	**$29,927**
30	$1,609	$5,721	$6,945	$9,535	$1,653	$5,363	**$30,825**
31	$1,657	$5,892	$7,153	$9,821	$1,702	$5,524	**$31,750**
32	$1,707	$6,069	$7,367	$10,115	$1,753	$5,690	**$32,702**

**3% Inflation*

Sub-Watershed #5 Annual Cost* Before Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$1,414	$5,029	$6,104	$8,381	$1,453	$4,715	**$27,096**
2	$1,457	$5,180	$6,288	$8,633	$1,496	$4,856	**$27,909**
3	$1,500	$5,335	$6,476	$8,892	$1,541	$5,002	**$28,746**
4	$1,545	$5,495	$6,671	$9,159	$1,588	$5,152	**$29,609**
5	$1,592	$5,660	$6,871	$9,433	$1,635	$5,306	**$30,497**
6	$1,640	$5,830	$7,077	$9,716	$1,684	$5,465	**$31,412**
7	$1,689	$6,005	$7,289	$10,008	$1,735	$5,629	**$32,354**
8	$1,739	$6,185	$7,508	$10,308	$1,787	$5,798	**$33,325**
9	$1,792	$6,370	$7,733	$10,617	$1,840	$5,972	**$34,325**
10	$1,845	$6,561	$7,965	$10,936	$1,896	$6,151	**$35,354**
11	$1,901	$6,758	$8,204	$11,264	$1,952	$6,336	**$36,415**
12	$1,958	$6,961	$8,450	$11,602	$2,011	$6,526	**$37,508**
13	$2,017	$7,170	$8,704	$11,950	$2,071	$6,722	**$38,633**
14	$2,077	$7,385	$8,965	$12,308	$2,133	$6,923	**$39,792**
15	$2,139	$7,607	$9,234	$12,678	$2,197	$7,131	**$40,986**
16	$2,204	$7,835	$9,511	$13,058	$2,263	$7,345	**$42,215**
17	$2,270	$8,070	$9,796	$13,450	$2,331	$7,565	**$43,482**
18	$2,338	$8,312	$10,090	$13,853	$2,401	$7,792	**$44,786**
19	$2,408	$8,561	$10,392	$14,269	$2,473	$8,026	**$46,130**
20	$2,480	$8,818	$10,704	$14,697	$2,547	$8,267	**$47,513**
21	$2,554	$9,083	$11,025	$15,138	$2,624	$8,515	**$48,939**
22	$2,631	$9,355	$11,356	$15,592	$2,703	$8,770	**$50,407**
23	$2,710	$9,636	$11,697	$16,060	$2,784	$9,033	**$51,919**
24	$2,791	$9,925	$12,048	$16,541	$2,867	$9,304	**$53,477**
25	$2,875	$10,223	$12,409	$17,038	$2,953	$9,584	**$55,081**
26	$2,961	$10,529	$12,781	$17,549	$3,042	$9,871	**$56,734**
27	$3,050	$10,845	$13,165	$18,075	$3,133	$10,167	**$58,436**
28	$3,142	$11,170	$13,560	$18,617	$3,227	$10,472	**$60,189**
29	$3,236	$11,506	$13,967	$19,176	$3,324	$10,786	**$61,994**
30	$3,333	$11,851	$14,386	$19,751	$3,424	$11,110	**$63,854**
31	$3,433	$12,206	$14,817	$20,344	$3,526	$11,443	**$65,770**
32	$3,536	$12,572	$15,262	$20,954	$3,632	$11,787	**$67,743**

**3% Inflation*

Sub-Watershed #7 Annual Cost* Before Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$358	$1,274	$1,547	$2,124	$368	$1,195	**$6,867**
2	$369	$1,313	$1,593	$2,188	$379	$1,231	**$7,073**
3	$380	$1,352	$1,641	$2,253	$391	$1,268	**$7,285**
4	$392	$1,393	$1,690	$2,321	$402	$1,306	**$7,503**
5	$403	$1,434	$1,741	$2,391	$414	$1,345	**$7,729**
6	$416	$1,477	$1,793	$2,462	$427	$1,385	**$7,960**
7	$428	$1,522	$1,847	$2,536	$440	$1,427	**$8,199**
8	$441	$1,567	$1,903	$2,612	$453	$1,469	**$8,445**
9	$454	$1,614	$1,960	$2,691	$466	$1,513	**$8,699**
10	$468	$1,663	$2,018	$2,771	$480	$1,559	**$8,960**
11	$482	$1,713	$2,079	$2,854	$495	$1,606	**$9,228**
12	$496	$1,764	$2,141	$2,940	$510	$1,654	**$9,505**
13	$511	$1,817	$2,206	$3,028	$525	$1,703	**$9,790**
14	$526	$1,871	$2,272	$3,119	$541	$1,755	**$10,084**
15	$542	$1,928	$2,340	$3,213	$557	$1,807	**$10,387**
16	$558	$1,985	$2,410	$3,309	$574	$1,861	**$10,698**
17	$575	$2,045	$2,482	$3,408	$591	$1,917	**$11,019**
18	$592	$2,106	$2,557	$3,511	$609	$1,975	**$11,350**
19	$610	$2,170	$2,634	$3,616	$627	$2,034	**$11,690**
20	$629	$2,235	$2,713	$3,724	$646	$2,095	**$12,041**
21	$647	$2,302	$2,794	$3,836	$665	$2,158	**$12,402**
22	$667	$2,371	$2,878	$3,951	$685	$2,223	**$12,774**
23	$687	$2,442	$2,964	$4,070	$705	$2,289	**$13,157**
24	$707	$2,515	$3,053	$4,192	$727	$2,358	**$13,552**
25	$729	$2,591	$3,145	$4,318	$748	$2,429	**$13,959**
26	$750	$2,668	$3,239	$4,447	$771	$2,502	**$14,377**
27	$773	$2,748	$3,336	$4,581	$794	$2,577	**$14,809**
28	$796	$2,831	$3,436	$4,718	$818	$2,654	**$15,253**
29	$820	$2,916	$3,539	$4,860	$842	$2,734	**$15,711**
30	$845	$3,003	$3,646	$5,005	$868	$2,816	**$16,182**
31	$870	$3,093	$3,755	$5,156	$894	$2,900	**$16,667**
32	$896	$3,186	$3,868	$5,310	$920	$2,987	**$17,167**

**3% Inflation*

Sub-Watershed #8 Annual Cost* Before Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$770	$2,738	$3,324	$4,564	$791	$2,567	**$14,755**
2	$793	$2,821	$3,424	$4,701	$815	$2,644	**$15,198**
3	$817	$2,905	$3,527	$4,842	$839	$2,724	**$15,654**
4	$842	$2,992	$3,632	$4,987	$864	$2,805	**$16,123**
5	$867	$3,082	$3,741	$5,137	$890	$2,889	**$16,607**
6	$893	$3,175	$3,854	$5,291	$917	$2,976	**$17,105**
7	$920	$3,270	$3,969	$5,450	$945	$3,065	**$17,618**
8	$947	$3,368	$4,088	$5,613	$973	$3,157	**$18,147**
9	$976	$3,469	$4,211	$5,782	$1,002	$3,252	**$18,691**
10	$1,005	$3,573	$4,337	$5,955	$1,032	$3,350	**$19,252**
11	$1,035	$3,680	$4,467	$6,134	$1,063	$3,450	**$19,830**
12	$1,066	$3,791	$4,601	$6,318	$1,095	$3,554	**$20,424**
13	$1,098	$3,904	$4,739	$6,507	$1,128	$3,660	**$21,037**
14	$1,131	$4,021	$4,882	$6,702	$1,162	$3,770	**$21,668**
15	$1,165	$4,142	$5,028	$6,903	$1,197	$3,883	**$22,318**
16	$1,200	$4,266	$5,179	$7,111	$1,233	$4,000	**$22,988**
17	$1,236	$4,394	$5,334	$7,324	$1,269	$4,120	**$23,678**
18	$1,273	$4,526	$5,494	$7,544	$1,308	$4,243	**$24,388**
19	$1,311	$4,662	$5,659	$7,770	$1,347	$4,371	**$25,120**
20	$1,351	$4,802	$5,829	$8,003	$1,387	$4,502	**$25,873**
21	$1,391	$4,946	$6,004	$8,243	$1,429	$4,637	**$26,649**
22	$1,433	$5,094	$6,184	$8,490	$1,472	$4,776	**$27,449**
23	$1,476	$5,247	$6,369	$8,745	$1,516	$4,919	**$28,272**
24	$1,520	$5,404	$6,561	$9,007	$1,561	$5,067	**$29,120**
25	$1,566	$5,567	$6,757	$9,278	$1,608	$5,219	**$29,994**
26	$1,613	$5,734	$6,960	$9,556	$1,656	$5,375	**$30,894**
27	$1,661	$5,906	$7,169	$9,843	$1,706	$5,537	**$31,821**
28	$1,711	$6,083	$7,384	$10,138	$1,757	$5,703	**$32,775**
29	$1,762	$6,265	$7,605	$10,442	$1,810	$5,874	**$33,759**
30	$1,815	$6,453	$7,834	$10,755	$1,864	$6,050	**$34,771**
31	$1,869	$6,647	$8,069	$11,078	$1,920	$6,231	**$35,814**
32	$1,925	$6,846	$8,311	$11,410	$1,978	$6,418	**$36,889**

**3% Inflation*

Sub-Watershed #10 Annual Cost* Before Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$1,308	$4,649	$5,644	$7,749	$1,343	$4,359	**$25,051**
2	$1,347	$4,789	$5,813	$7,981	$1,383	$4,489	**$25,802**
3	$1,387	$4,932	$5,987	$8,221	$1,425	$4,624	**$26,576**
4	$1,429	$5,080	$6,167	$8,467	$1,468	$4,763	**$27,374**
5	$1,472	$5,233	$6,352	$8,721	$1,512	$4,906	**$28,195**
6	$1,516	$5,390	$6,543	$8,983	$1,557	$5,053	**$29,041**
7	$1,561	$5,551	$6,739	$9,252	$1,604	$5,204	**$29,912**
8	$1,608	$5,718	$6,941	$9,530	$1,652	$5,361	**$30,809**
9	$1,656	$5,889	$7,149	$9,816	$1,701	$5,521	**$31,734**
10	$1,706	$6,066	$7,364	$10,110	$1,752	$5,687	**$32,686**
11	$1,757	$6,248	$7,585	$10,414	$1,805	$5,858	**$33,666**
12	$1,810	$6,436	$7,812	$10,726	$1,859	$6,033	**$34,676**
13	$1,864	$6,629	$8,047	$11,048	$1,915	$6,214	**$35,717**
14	$1,920	$6,828	$8,288	$11,379	$1,972	$6,401	**$36,788**
15	$1,978	$7,032	$8,537	$11,721	$2,032	$6,593	**$37,892**
16	$2,037	$7,243	$8,793	$12,072	$2,093	$6,791	**$39,028**
17	$2,098	$7,461	$9,056	$12,434	$2,155	$6,994	**$40,199**
18	$2,161	$7,684	$9,328	$12,807	$2,220	$7,204	**$41,405**
19	$2,226	$7,915	$9,608	$13,192	$2,287	$7,420	**$42,647**
20	$2,293	$8,152	$9,896	$13,587	$2,355	$7,643	**$43,927**
21	$2,362	$8,397	$10,193	$13,995	$2,426	$7,872	**$45,245**
22	$2,432	$8,649	$10,499	$14,415	$2,499	$8,108	**$46,602**
23	$2,505	$8,908	$10,814	$14,847	$2,574	$8,352	**$48,000**
24	$2,581	$9,176	$11,138	$15,293	$2,651	$8,602	**$49,440**
25	$2,658	$9,451	$11,472	$15,751	$2,730	$8,860	**$50,923**
26	$2,738	$9,734	$11,817	$16,224	$2,812	$9,126	**$52,451**
27	$2,820	$10,026	$12,171	$16,711	$2,897	$9,400	**$54,025**
28	$2,905	$10,327	$12,536	$17,212	$2,983	$9,682	**$55,645**
29	$2,992	$10,637	$12,912	$17,728	$3,073	$9,972	**$57,315**
30	$3,081	$10,956	$13,300	$18,260	$3,165	$10,271	**$59,034**
31	$3,174	$11,285	$13,699	$18,808	$3,260	$10,580	**$60,805**
32	$3,269	$11,623	$14,110	$19,372	$3,358	$10,897	**$62,629**

**3% Inflation*

Sub-Watershed #12 **Annual Cost* Before Cost-Share, Cropland BMPs**

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$1,625	$5,776	$7,012	$9,627	$1,669	$5,415	**$31,124**
2	$1,673	$5,950	$7,222	$9,916	$1,719	$5,578	**$32,058**
3	$1,724	$6,128	$7,439	$10,214	$1,770	$5,745	**$33,020**
4	$1,775	$6,312	$7,662	$10,520	$1,824	$5,918	**$34,011**
5	$1,829	$6,501	$7,892	$10,836	$1,878	$6,095	**$35,031**
6	$1,883	$6,696	$8,129	$11,161	$1,935	$6,278	**$36,082**
7	$1,940	$6,897	$8,373	$11,496	$1,993	$6,466	**$37,164**
8	$1,998	$7,104	$8,624	$11,840	$2,052	$6,660	**$38,279**
9	$2,058	$7,317	$8,883	$12,196	$2,114	$6,860	**$39,428**
10	$2,120	$7,537	$9,149	$12,561	$2,177	$7,066	**$40,610**
11	$2,183	$7,763	$9,424	$12,938	$2,243	$7,278	**$41,829**
12	$2,249	$7,996	$9,706	$13,326	$2,310	$7,496	**$43,084**
13	$2,316	$8,236	$9,997	$13,726	$2,379	$7,721	**$44,376**
14	$2,386	$8,483	$10,297	$14,138	$2,451	$7,953	**$45,707**
15	$2,457	$8,737	$10,606	$14,562	$2,524	$8,191	**$47,079**
16	$2,531	$8,999	$10,924	$14,999	$2,600	$8,437	**$48,491**
17	$2,607	$9,269	$11,252	$15,449	$2,678	$8,690	**$49,946**
18	$2,685	$9,548	$11,590	$15,913	$2,758	$8,951	**$51,444**
19	$2,766	$9,834	$11,937	$16,390	$2,841	$9,219	**$52,987**
20	$2,849	$10,129	$12,296	$16,882	$2,926	$9,496	**$54,577**
21	$2,934	$10,433	$12,664	$17,388	$3,014	$9,781	**$56,214**
22	$3,022	$10,746	$13,044	$17,910	$3,104	$10,074	**$57,901**
23	$3,113	$11,068	$13,436	$18,447	$3,198	$10,376	**$59,638**
24	$3,206	$11,400	$13,839	$19,000	$3,293	$10,688	**$61,427**
25	$3,303	$11,742	$14,254	$19,570	$3,392	$11,008	**$63,270**
26	$3,402	$12,094	$14,682	$20,157	$3,494	$11,339	**$65,168**
27	$3,504	$12,457	$15,122	$20,762	$3,599	$11,679	**$67,123**
28	$3,609	$12,831	$15,576	$21,385	$3,707	$12,029	**$69,136**
29	$3,717	$13,216	$16,043	$22,027	$3,818	$12,390	**$71,211**
30	$3,829	$13,612	$16,524	$22,687	$3,933	$12,762	**$73,347**
31	$3,943	$14,021	$17,020	$23,368	$4,051	$13,145	**$75,547**
32	$4,062	$14,441	$17,531	$24,069	$4,172	$13,539	**$77,814**

**3% Inflation*

Sub-Watershed #16 **Annual Cost* Before Cost-Share, Cropland BMPs**

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$1,207	$4,293	$5,211	$7,155	$1,240	$4,025	**$23,131**
2	$1,244	$4,422	$5,367	$7,369	$1,277	$4,145	**$23,824**
3	$1,281	$4,554	$5,528	$7,590	$1,316	$4,270	**$24,539**
4	$1,319	$4,691	$5,694	$7,818	$1,355	$4,398	**$25,275**
5	$1,359	$4,832	$5,865	$8,053	$1,396	$4,530	**$26,034**
6	$1,400	$4,977	$6,041	$8,294	$1,438	$4,665	**$26,815**
7	$1,442	$5,126	$6,222	$8,543	$1,481	$4,805	**$27,619**
8	$1,485	$5,280	$6,409	$8,799	$1,525	$4,950	**$28,448**
9	$1,529	$5,438	$6,601	$9,063	$1,571	$5,098	**$29,301**
10	$1,575	$5,601	$6,799	$9,335	$1,618	$5,251	**$30,180**
11	$1,623	$5,769	$7,003	$9,615	$1,667	$5,409	**$31,086**
12	$1,671	$5,942	$7,213	$9,904	$1,717	$5,571	**$32,018**
13	$1,721	$6,121	$7,430	$10,201	$1,768	$5,738	**$32,979**
14	$1,773	$6,304	$7,653	$10,507	$1,821	$5,910	**$33,968**
15	$1,826	$6,493	$7,882	$10,822	$1,876	$6,087	**$34,987**
16	$1,881	$6,688	$8,119	$11,147	$1,932	$6,270	**$36,037**
17	$1,937	$6,889	$8,362	$11,481	$1,990	$6,458	**$37,118**
18	$1,996	$7,095	$8,613	$11,826	$2,050	$6,652	**$38,231**
19	$2,055	$7,308	$8,871	$12,180	$2,111	$6,851	**$39,378**
20	$2,117	$7,527	$9,138	$12,546	$2,175	$7,057	**$40,560**
21	$2,181	$7,753	$9,412	$12,922	$2,240	$7,269	**$41,776**
22	$2,246	$7,986	$9,694	$13,310	$2,307	$7,487	**$43,030**
23	$2,313	$8,225	$9,985	$13,709	$2,376	$7,711	**$44,320**
24	$2,383	$8,472	$10,284	$14,120	$2,448	$7,943	**$45,650**
25	$2,454	$8,726	$10,593	$14,544	$2,521	$8,181	**$47,020**
26	$2,528	$8,988	$10,911	$14,980	$2,597	$8,426	**$48,430**
27	$2,604	$9,258	$11,238	$15,430	$2,675	$8,679	**$49,883**
28	$2,682	$9,536	$11,575	$15,893	$2,755	$8,940	**$51,380**
29	$2,762	$9,822	$11,923	$16,369	$2,837	$9,208	**$52,921**
30	$2,845	$10,116	$12,280	$16,860	$2,923	$9,484	**$54,509**
31	$2,931	$10,420	$12,649	$17,366	$3,010	$9,769	**$56,144**
32	$3,018	$10,732	$13,028	$17,887	$3,101	$10,062	**$57,828**

**3% Inflation*

Sub-Watershed #25 **Annual Cost* Before Cost-Share, Cropland BMPs**

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$559	$1,987	$2,412	$3,311	$574	$1,863	**$10,705**
2	$576	$2,046	$2,484	$3,411	$591	$1,919	**$11,026**
3	$593	$2,108	$2,559	$3,513	$609	$1,976	**$11,357**
4	$611	$2,171	$2,635	$3,618	$627	$2,035	**$11,698**
5	$629	$2,236	$2,714	$3,727	$646	$2,096	**$12,049**
6	$648	$2,303	$2,796	$3,839	$665	$2,159	**$12,410**
7	$667	$2,372	$2,880	$3,954	$685	$2,224	**$12,783**
8	$687	$2,444	$2,966	$4,073	$706	$2,291	**$13,166**
9	$708	$2,517	$3,055	$4,195	$727	$2,360	**$13,561**
10	$729	$2,592	$3,147	$4,321	$749	$2,430	**$13,968**
11	$751	$2,670	$3,241	$4,450	$771	$2,503	**$14,387**
12	$773	$2,750	$3,338	$4,584	$795	$2,578	**$14,819**
13	$797	$2,833	$3,439	$4,721	$818	$2,656	**$15,263**
14	$821	$2,918	$3,542	$4,863	$843	$2,735	**$15,721**
15	$845	$3,005	$3,648	$5,009	$868	$2,817	**$16,193**
16	$871	$3,095	$3,757	$5,159	$894	$2,902	**$16,679**
17	$897	$3,188	$3,870	$5,314	$921	$2,989	**$17,179**
18	$924	$3,284	$3,986	$5,473	$949	$3,079	**$17,694**
19	$951	$3,382	$4,106	$5,637	$977	$3,171	**$18,225**
20	$980	$3,484	$4,229	$5,806	$1,006	$3,266	**$18,772**
21	$1,009	$3,588	$4,356	$5,981	$1,037	$3,364	**$19,335**
22	$1,040	$3,696	$4,487	$6,160	$1,068	$3,465	**$19,915**
23	$1,071	$3,807	$4,621	$6,345	$1,100	$3,569	**$20,512**
24	$1,103	$3,921	$4,760	$6,535	$1,133	$3,676	**$21,128**
25	$1,136	$4,039	$4,903	$6,731	$1,167	$3,786	**$21,762**
26	$1,170	$4,160	$5,050	$6,933	$1,202	$3,900	**$22,415**
27	$1,205	$4,285	$5,201	$7,141	$1,238	$4,017	**$23,087**
28	$1,241	$4,413	$5,357	$7,355	$1,275	$4,137	**$23,780**
29	$1,278	$4,546	$5,518	$7,576	$1,313	$4,262	**$24,493**
30	$1,317	$4,682	$5,684	$7,803	$1,353	$4,389	**$25,228**
31	$1,356	$4,822	$5,854	$8,037	$1,393	$4,521	**$25,985**
32	$1,397	$4,967	$6,030	$8,279	$1,435	$4,657	**$26,764**

**3% Inflation*

Sub-Watershed #26 Annual Cost* Before Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$684	$2,433	$2,954	$4,055	$703	$2,281	**$13,111**
2	$705	$2,506	$3,042	$4,177	$724	$2,350	**$13,504**
3	$726	$2,581	$3,134	$4,302	$746	$2,420	**$13,909**
4	$748	$2,659	$3,228	$4,431	$768	$2,493	**$14,326**
5	$770	$2,739	$3,324	$4,564	$791	$2,567	**$14,756**
6	$793	$2,821	$3,424	$4,701	$815	$2,644	**$15,199**
7	$817	$2,905	$3,527	$4,842	$839	$2,724	**$15,655**
8	$842	$2,993	$3,633	$4,988	$865	$2,805	**$16,124**
9	$867	$3,082	$3,742	$5,137	$890	$2,890	**$16,608**
10	$893	$3,175	$3,854	$5,291	$917	$2,976	**$17,106**
11	$920	$3,270	$3,969	$5,450	$945	$3,066	**$17,620**
12	$947	$3,368	$4,089	$5,614	$973	$3,158	**$18,148**
13	$976	$3,469	$4,211	$5,782	$1,002	$3,252	**$18,693**
14	$1,005	$3,573	$4,338	$5,955	$1,032	$3,350	**$19,253**
15	$1,035	$3,680	$4,468	$6,134	$1,063	$3,450	**$19,831**
16	$1,066	$3,791	$4,602	$6,318	$1,095	$3,554	**$20,426**
17	$1,098	$3,905	$4,740	$6,508	$1,128	$3,661	**$21,039**
18	$1,131	$4,022	$4,882	$6,703	$1,162	$3,770	**$21,670**
19	$1,165	$4,142	$5,028	$6,904	$1,197	$3,883	**$22,320**
20	$1,200	$4,267	$5,179	$7,111	$1,233	$4,000	**$22,990**
21	$1,236	$4,395	$5,335	$7,324	$1,270	$4,120	**$23,679**
22	$1,273	$4,526	$5,495	$7,544	$1,308	$4,244	**$24,390**
23	$1,311	$4,662	$5,660	$7,770	$1,347	$4,371	**$25,121**
24	$1,351	$4,802	$5,829	$8,004	$1,387	$4,502	**$25,875**
25	$1,391	$4,946	$6,004	$8,244	$1,429	$4,637	**$26,651**
26	$1,433	$5,095	$6,184	$8,491	$1,472	$4,776	**$27,451**
27	$1,476	$5,247	$6,370	$8,746	$1,516	$4,919	**$28,274**
28	$1,520	$5,405	$6,561	$9,008	$1,561	$5,067	**$29,122**
29	$1,566	$5,567	$6,758	$9,278	$1,608	$5,219	**$29,996**
30	$1,613	$5,734	$6,961	$9,557	$1,657	$5,376	**$30,896**
31	$1,661	$5,906	$7,169	$9,843	$1,706	$5,537	**$31,823**
32	$1,711	$6,083	$7,384	$10,139	$1,757	$5,703	**$32,778**

**3% Inflation*

Sub-Watershed #30 Annual Cost* Before Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$234	$831	$1,009	$1,385	$240	$779	**$4,479**
2	$241	$856	$1,039	$1,427	$247	$803	**$4,613**
3	$248	$882	$1,070	$1,470	$255	$827	**$4,751**
4	$255	$908	$1,103	$1,514	$262	$852	**$4,894**
5	$263	$936	$1,136	$1,559	$270	$877	**$5,041**
6	$271	$964	$1,170	$1,606	$278	$903	**$5,192**
7	$279	$992	$1,205	$1,654	$287	$930	**$5,348**
8	$288	$1,022	$1,241	$1,704	$295	$958	**$5,508**
9	$296	$1,053	$1,278	$1,755	$304	$987	**$5,673**
10	$305	$1,085	$1,317	$1,808	$313	$1,017	**$5,844**
11	$314	$1,117	$1,356	$1,862	$323	$1,047	**$6,019**
12	$324	$1,151	$1,397	$1,918	$332	$1,079	**$6,200**
13	$333	$1,185	$1,439	$1,975	$342	$1,111	**$6,386**
14	$343	$1,221	$1,482	$2,034	$353	$1,144	**$6,577**
15	$354	$1,257	$1,526	$2,095	$363	$1,179	**$6,774**
16	$364	$1,295	$1,572	$2,158	$374	$1,214	**$6,978**
17	$375	$1,334	$1,619	$2,223	$385	$1,250	**$7,187**
18	$386	$1,374	$1,668	$2,290	$397	$1,288	**$7,403**
19	$398	$1,415	$1,718	$2,358	$409	$1,327	**$7,625**
20	$410	$1,458	$1,769	$2,429	$421	$1,366	**$7,853**
21	$422	$1,501	$1,822	$2,502	$434	$1,407	**$8,089**
22	$435	$1,546	$1,877	$2,577	$447	$1,450	**$8,332**
23	$448	$1,593	$1,933	$2,654	$460	$1,493	**$8,582**
24	$461	$1,640	$1,991	$2,734	$474	$1,538	**$8,839**
25	$475	$1,690	$2,051	$2,816	$488	$1,584	**$9,104**
26	$489	$1,740	$2,113	$2,901	$503	$1,632	**$9,377**
27	$504	$1,793	$2,176	$2,988	$518	$1,681	**$9,659**
28	$519	$1,846	$2,241	$3,077	$533	$1,731	**$9,948**
29	$535	$1,902	$2,309	$3,170	$549	$1,783	**$10,247**
30	$551	$1,959	$2,378	$3,265	$566	$1,836	**$10,554**
31	$567	$2,018	$2,449	$3,363	$583	$1,891	**$10,871**
32	$584	$2,078	$2,523	$3,463	$600	$1,948	**$11,197**

**3% Inflation*

Table Set 67: Set of tables showing annual cost estimates for implementation of Cropland BMPs in targeted sub-watersheds *after* cost share

Sub-Watershed #1 Annual Cost* After Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$182	$648	$960	$216	$374	$608	**$2,988**
2	$188	$667	$988	$222	$386	$626	**$3,077**
3	$193	$687	$1,018	$229	$397	$644	**$3,170**
4	$199	$708	$1,049	$236	$409	$664	**$3,265**
5	$205	$729	$1,080	$243	$421	$684	**$3,363**
6	$211	$751	$1,113	$250	$434	$704	**$3,464**
7	$218	$774	$1,146	$258	$447	$725	**$3,568**
8	$224	$797	$1,180	$266	$460	$747	**$3,675**
9	$231	$821	$1,216	$274	$474	$770	**$3,785**
10	$238	$845	$1,252	$282	$489	$793	**$3,898**
11	$245	$871	$1,290	$290	$503	$816	**$4,015**
12	$252	$897	$1,328	$299	$518	$841	**$4,136**
13	$260	$924	$1,368	$308	$534	$866	**$4,260**
14	$268	$952	$1,409	$317	$550	$892	**$4,388**
15	$276	$980	$1,452	$327	$566	$919	**$4,519**
16	$284	$1,010	$1,495	$337	$583	$946	**$4,655**
17	$292	$1,040	$1,540	$347	$601	$975	**$4,795**
18	$301	$1,071	$1,586	$357	$619	$1,004	**$4,938**
19	$310	$1,103	$1,634	$368	$637	$1,034	**$5,087**
20	$320	$1,136	$1,683	$379	$657	$1,065	**$5,239**
21	$329	$1,170	$1,733	$390	$676	$1,097	**$5,396**
22	$339	$1,205	$1,785	$402	$697	$1,130	**$5,558**
23	$349	$1,242	$1,839	$414	$717	$1,164	**$5,725**
24	$360	$1,279	$1,894	$426	$739	$1,199	**$5,897**
25	$370	$1,317	$1,951	$439	$761	$1,235	**$6,074**
26	$382	$1,357	$2,009	$452	$784	$1,272	**$6,256**
27	$393	$1,397	$2,070	$466	$807	$1,310	**$6,444**
28	$405	$1,439	$2,132	$480	$832	$1,349	**$6,637**
29	$417	$1,483	$2,196	$494	$857	$1,390	**$6,836**
30	$429	$1,527	$2,262	$509	$882	$1,432	**$7,041**
31	$442	$1,573	$2,329	$524	$909	$1,475	**$7,252**
32	$456	$1,620	$2,399	$540	$936	$1,519	**$7,470**

3% inflation

Sub-Watershed #2 Annual Cost* After Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$164	$582	$862	$194	$336	$546	**$2,684**
2	$169	$600	$888	$200	$346	$562	**$2,765**
3	$174	$618	$915	$206	$357	$579	**$2,848**
4	$179	$636	$942	$212	$368	$596	**$2,933**
5	$184	$655	$970	$218	$379	$614	**$3,021**
6	$190	$675	$1,000	$225	$390	$633	**$3,112**
7	$196	$695	$1,030	$232	$402	$652	**$3,205**
8	$201	$716	$1,060	$239	$414	$671	**$3,302**
9	$207	$738	$1,092	$246	$426	$691	**$3,401**
10	$214	$760	$1,125	$253	$439	$712	**$3,503**
11	$220	$782	$1,159	$261	$452	$734	**$3,608**
12	$227	$806	$1,194	$269	$466	$756	**$3,716**
13	$233	$830	$1,229	$277	$480	$778	**$3,827**
14	$240	$855	$1,266	$285	$494	$802	**$3,942**
15	$248	$881	$1,304	$294	$509	$826	**$4,060**
16	$255	$907	$1,343	$302	$524	$850	**$4,182**
17	$263	$934	$1,384	$311	$540	$876	**$4,308**
18	$271	$962	$1,425	$321	$556	$902	**$4,437**
19	$279	$991	$1,468	$330	$573	$929	**$4,570**
20	$287	$1,021	$1,512	$340	$590	$957	**$4,707**
21	$296	$1,052	$1,557	$351	$608	$986	**$4,848**
22	$305	$1,083	$1,604	$361	$626	$1,015	**$4,994**
23	$314	$1,116	$1,652	$372	$645	$1,046	**$5,144**
24	$323	$1,149	$1,702	$383	$664	$1,077	**$5,298**
25	$333	$1,183	$1,753	$394	$684	$1,110	**$5,457**
26	$343	$1,219	$1,805	$406	$704	$1,143	**$5,621**
27	$353	$1,256	$1,859	$419	$725	$1,177	**$5,789**
28	$364	$1,293	$1,915	$431	$747	$1,212	**$5,963**
29	$375	$1,332	$1,973	$444	$770	$1,249	**$6,142**
30	$386	$1,372	$2,032	$457	$793	$1,286	**$6,326**
31	$397	$1,413	$2,093	$471	$817	$1,325	**$6,516**
32	$409	$1,456	$2,156	$485	$841	$1,365	**$6,711**

**3% Inflation*

Sub-Watershed #3 Annual Cost* After Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$731	$2,600	$3,851	$867	$1,502	$2,438	**$11,988**
2	$753	$2,678	$3,966	$893	$1,547	$2,511	**$12,348**
3	$776	$2,758	$4,085	$919	$1,594	$2,586	**$12,718**
4	$799	$2,841	$4,208	$947	$1,642	$2,664	**$13,100**
5	$823	$2,926	$4,334	$975	$1,691	$2,743	**$13,493**
6	$848	$3,014	$4,464	$1,005	$1,742	$2,826	**$13,898**
7	$873	$3,105	$4,598	$1,035	$1,794	$2,911	**$14,315**
8	$899	$3,198	$4,736	$1,066	$1,848	$2,998	**$14,744**
9	$926	$3,294	$4,878	$1,098	$1,903	$3,088	**$15,186**
10	$954	$3,392	$5,024	$1,131	$1,960	$3,180	**$15,642**
11	$983	$3,494	$5,175	$1,165	$2,019	$3,276	**$16,111**
12	$1,012	$3,599	$5,330	$1,200	$2,079	$3,374	**$16,594**
13	$1,043	$3,707	$5,490	$1,236	$2,142	$3,475	**$17,092**
14	$1,074	$3,818	$5,655	$1,273	$2,206	$3,580	**$17,605**
15	$1,106	$3,933	$5,824	$1,311	$2,272	$3,687	**$18,133**
16	$1,139	$4,051	$5,999	$1,350	$2,340	$3,798	**$18,677**
17	$1,173	$4,172	$6,179	$1,391	$2,411	$3,911	**$19,238**
18	$1,209	$4,297	$6,364	$1,432	$2,483	$4,029	**$19,815**
19	$1,245	$4,426	$6,555	$1,475	$2,557	$4,150	**$20,409**
20	$1,282	$4,559	$6,752	$1,520	$2,634	$4,274	**$21,021**
21	$1,321	$4,696	$6,954	$1,565	$2,713	$4,402	**$21,652**
22	$1,360	$4,837	$7,163	$1,612	$2,795	$4,534	**$22,302**
23	$1,401	$4,982	$7,378	$1,661	$2,878	$4,671	**$22,971**
24	$1,443	$5,131	$7,599	$1,710	$2,965	$4,811	**$23,660**
25	$1,486	$5,285	$7,827	$1,762	$3,054	$4,955	**$24,369**
26	$1,531	$5,444	$8,062	$1,815	$3,145	$5,104	**$25,101**
27	$1,577	$5,607	$8,304	$1,869	$3,240	$5,257	**$25,854**
28	$1,624	$5,775	$8,553	$1,925	$3,337	$5,414	**$26,629**
29	$1,673	$5,949	$8,810	$1,983	$3,437	$5,577	**$27,428**
30	$1,723	$6,127	$9,074	$2,042	$3,540	$5,744	**$28,251**
31	$1,775	$6,311	$9,346	$2,104	$3,646	$5,916	**$29,098**
32	$1,828	$6,500	$9,627	$2,167	$3,756	$6,094	**$29,971**

**3% Inflation*

Sub-Watershed #4 Annual Cost* After Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$341	$1,214	$1,798	$405	$701	$1,138	**$5,597**
2	$352	$1,250	$1,852	$417	$722	$1,172	**$5,765**
3	$362	$1,288	$1,907	$429	$744	$1,207	**$5,937**
4	$373	$1,326	$1,964	$442	$766	$1,243	**$6,116**
5	$384	$1,366	$2,023	$455	$789	$1,281	**$6,299**
6	$396	$1,407	$2,084	$469	$813	$1,319	**$6,488**
7	$408	$1,449	$2,146	$483	$837	$1,359	**$6,683**
8	$420	$1,493	$2,211	$498	$863	$1,400	**$6,883**
9	$432	$1,538	$2,277	$513	$888	$1,442	**$7,090**
10	$445	$1,584	$2,345	$528	$915	$1,485	**$7,302**
11	$459	$1,631	$2,416	$544	$943	$1,529	**$7,521**
12	$473	$1,680	$2,488	$560	$971	$1,575	**$7,747**
13	$487	$1,731	$2,563	$577	$1,000	$1,622	**$7,979**
14	$501	$1,783	$2,640	$594	$1,030	$1,671	**$8,219**
15	$516	$1,836	$2,719	$612	$1,061	$1,721	**$8,465**
16	$532	$1,891	$2,801	$630	$1,093	$1,773	**$8,719**
17	$548	$1,948	$2,885	$649	$1,125	$1,826	**$8,981**
18	$564	$2,006	$2,971	$669	$1,159	$1,881	**$9,250**
19	$581	$2,066	$3,060	$689	$1,194	$1,937	**$9,528**
20	$599	$2,128	$3,152	$709	$1,230	$1,995	**$9,814**
21	$617	$2,192	$3,247	$731	$1,267	$2,055	**$10,108**
22	$635	$2,258	$3,344	$753	$1,305	$2,117	**$10,411**
23	$654	$2,326	$3,444	$775	$1,344	$2,180	**$10,724**
24	$674	$2,396	$3,548	$799	$1,384	$2,246	**$11,045**
25	$694	$2,467	$3,654	$822	$1,426	$2,313	**$11,377**
26	$715	$2,541	$3,764	$847	$1,468	$2,383	**$11,718**
27	$736	$2,618	$3,877	$873	$1,512	$2,454	**$12,070**
28	$758	$2,696	$3,993	$899	$1,558	$2,528	**$12,432**
29	$781	$2,777	$4,113	$926	$1,605	$2,604	**$12,805**
30	$804	$2,860	$4,236	$953	$1,653	$2,682	**$13,189**
31	$829	$2,946	$4,363	$982	$1,702	$2,762	**$13,584**
32	$853	$3,035	$4,494	$1,012	$1,753	$2,845	**$13,992**

**3% Inflation*

Sub-Watershed #5 Annual Cost* After Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$707	$2,514	$3,724	$838	$1,453	$2,357	**$11,593**
2	$728	$2,590	$3,835	$863	$1,496	$2,428	**$11,941**
3	$750	$2,668	$3,951	$889	$1,541	$2,501	**$12,300**
4	$773	$2,748	$4,069	$916	$1,588	$2,576	**$12,669**
5	$796	$2,830	$4,191	$943	$1,635	$2,653	**$13,049**
6	$820	$2,915	$4,317	$972	$1,684	$2,733	**$13,440**
7	$844	$3,002	$4,446	$1,001	$1,735	$2,815	**$13,843**
8	$870	$3,092	$4,580	$1,031	$1,787	$2,899	**$14,259**
9	$896	$3,185	$4,717	$1,062	$1,840	$2,986	**$14,686**
10	$923	$3,281	$4,859	$1,094	$1,896	$3,076	**$15,127**
11	$950	$3,379	$5,004	$1,126	$1,952	$3,168	**$15,581**
12	$979	$3,481	$5,155	$1,160	$2,011	$3,263	**$16,048**
13	$1,008	$3,585	$5,309	$1,195	$2,071	$3,361	**$16,530**
14	$1,039	$3,692	$5,468	$1,231	$2,133	$3,462	**$17,025**
15	$1,070	$3,803	$5,632	$1,268	$2,197	$3,566	**$17,536**
16	$1,102	$3,917	$5,801	$1,306	$2,263	$3,673	**$18,062**
17	$1,135	$4,035	$5,976	$1,345	$2,331	$3,783	**$18,604**
18	$1,169	$4,156	$6,155	$1,385	$2,401	$3,896	**$19,162**
19	$1,204	$4,281	$6,339	$1,427	$2,473	$4,013	**$19,737**
20	$1,240	$4,409	$6,530	$1,470	$2,547	$4,133	**$20,329**
21	$1,277	$4,541	$6,725	$1,514	$2,624	$4,257	**$20,939**
22	$1,316	$4,678	$6,927	$1,559	$2,703	$4,385	**$21,567**
23	$1,355	$4,818	$7,135	$1,606	$2,784	$4,517	**$22,214**
24	$1,396	$4,962	$7,349	$1,654	$2,867	$4,652	**$22,881**
25	$1,438	$5,111	$7,570	$1,704	$2,953	$4,792	**$23,567**
26	$1,481	$5,265	$7,797	$1,755	$3,042	$4,936	**$24,274**
27	$1,525	$5,423	$8,031	$1,808	$3,133	$5,084	**$25,002**
28	$1,571	$5,585	$8,272	$1,862	$3,227	$5,236	**$25,752**
29	$1,618	$5,753	$8,520	$1,918	$3,324	$5,393	**$26,525**
30	$1,667	$5,925	$8,775	$1,975	$3,424	$5,555	**$27,321**
31	$1,716	$6,103	$9,038	$2,034	$3,526	$5,722	**$28,140**
32	$1,768	$6,286	$9,310	$2,095	$3,632	$5,893	**$28,985**

**3% Inflation*

Sub-Watershed #7 Annual Cost* After Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$179	$637	$944	$212	$368	$597	**$2,938**
2	$185	$656	$972	$219	$379	$615	**$3,026**
3	$190	$676	$1,001	$225	$391	$634	**$3,117**
4	$196	$696	$1,031	$232	$402	$653	**$3,210**
5	$202	$717	$1,062	$239	$414	$672	**$3,307**
6	$208	$739	$1,094	$246	$427	$693	**$3,406**
7	$214	$761	$1,127	$254	$440	$713	**$3,508**
8	$220	$784	$1,161	$261	$453	$735	**$3,613**
9	$227	$807	$1,195	$269	$466	$757	**$3,722**
10	$234	$831	$1,231	$277	$480	$779	**$3,833**
11	$241	$856	$1,268	$285	$495	$803	**$3,948**
12	$248	$882	$1,306	$294	$510	$827	**$4,067**
13	$256	$908	$1,345	$303	$525	$852	**$4,189**
14	$263	$936	$1,386	$312	$541	$877	**$4,315**
15	$271	$964	$1,427	$321	$557	$904	**$4,444**
16	$279	$993	$1,470	$331	$574	$931	**$4,577**
17	$288	$1,023	$1,514	$341	$591	$959	**$4,715**
18	$296	$1,053	$1,560	$351	$609	$987	**$4,856**
19	$305	$1,085	$1,607	$362	$627	$1,017	**$5,002**
20	$314	$1,117	$1,655	$372	$646	$1,048	**$5,152**
21	$324	$1,151	$1,704	$384	$665	$1,079	**$5,306**
22	$333	$1,185	$1,756	$395	$685	$1,111	**$5,466**
23	$343	$1,221	$1,808	$407	$705	$1,145	**$5,630**
24	$354	$1,258	$1,862	$419	$727	$1,179	**$5,798**
25	$364	$1,295	$1,918	$432	$748	$1,214	**$5,972**
26	$375	$1,334	$1,976	$445	$771	$1,251	**$6,152**
27	$386	$1,374	$2,035	$458	$794	$1,288	**$6,336**
28	$398	$1,415	$2,096	$472	$818	$1,327	**$6,526**
29	$410	$1,458	$2,159	$486	$842	$1,367	**$6,722**
30	$422	$1,502	$2,224	$501	$868	$1,408	**$6,924**
31	$435	$1,547	$2,291	$516	$894	$1,450	**$7,131**
32	$448	$1,593	$2,359	$531	$920	$1,493	**$7,345**

**3% Inflation*

Sub-Watershed #8 Annual Cost* After Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$385	$1,369	$2,028	$456	$791	$1,284	**$6,313**
2	$397	$1,410	$2,089	$470	$815	$1,322	**$6,503**
3	$409	$1,453	$2,151	$484	$839	$1,362	**$6,698**
4	$421	$1,496	$2,216	$499	$864	$1,403	**$6,899**
5	$433	$1,541	$2,282	$514	$890	$1,445	**$7,106**
6	$446	$1,587	$2,351	$529	$917	$1,488	**$7,319**
7	$460	$1,635	$2,421	$545	$945	$1,533	**$7,538**
8	$474	$1,684	$2,494	$561	$973	$1,579	**$7,764**
9	$488	$1,734	$2,569	$578	$1,002	$1,626	**$7,997**
10	$502	$1,786	$2,646	$595	$1,032	$1,675	**$8,237**
11	$518	$1,840	$2,725	$613	$1,063	$1,725	**$8,484**
12	$533	$1,895	$2,807	$632	$1,095	$1,777	**$8,739**
13	$549	$1,952	$2,891	$651	$1,128	$1,830	**$9,001**
14	$566	$2,011	$2,978	$670	$1,162	$1,885	**$9,271**
15	$582	$2,071	$3,067	$690	$1,197	$1,942	**$9,549**
16	$600	$2,133	$3,159	$711	$1,233	$2,000	**$9,836**
17	$618	$2,197	$3,254	$732	$1,269	$2,060	**$10,131**
18	$636	$2,263	$3,352	$754	$1,308	$2,122	**$10,435**
19	$656	$2,331	$3,452	$777	$1,347	$2,185	**$10,748**
20	$675	$2,401	$3,556	$800	$1,387	$2,251	**$11,070**
21	$696	$2,473	$3,662	$824	$1,429	$2,318	**$11,402**
22	$716	$2,547	$3,772	$849	$1,472	$2,388	**$11,744**
23	$738	$2,624	$3,885	$875	$1,516	$2,460	**$12,097**
24	$760	$2,702	$4,002	$901	$1,561	$2,533	**$12,460**
25	$783	$2,783	$4,122	$928	$1,608	$2,609	**$12,833**
26	$806	$2,867	$4,246	$956	$1,656	$2,688	**$13,218**
27	$830	$2,953	$4,373	$984	$1,706	$2,768	**$13,615**
28	$855	$3,041	$4,504	$1,014	$1,757	$2,851	**$14,023**
29	$881	$3,133	$4,639	$1,044	$1,810	$2,937	**$14,444**
30	$907	$3,227	$4,778	$1,076	$1,864	$3,025	**$14,877**
31	$935	$3,323	$4,922	$1,108	$1,920	$3,116	**$15,324**
32	$963	$3,423	$5,070	$1,141	$1,978	$3,209	**$15,783**

**3% Inflation*

Sub-Watershed #10 Annual Cost* After Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$654	$2,325	$3,443	$775	$1,343	$2,179	**$10,718**
2	$673	$2,394	$3,546	$798	$1,383	$2,245	**$11,040**
3	$694	$2,466	$3,652	$822	$1,425	$2,312	**$11,371**
4	$714	$2,540	$3,762	$847	$1,468	$2,381	**$11,712**
5	$736	$2,616	$3,875	$872	$1,512	$2,453	**$12,064**
6	$758	$2,695	$3,991	$898	$1,557	$2,526	**$12,426**
7	$781	$2,776	$4,111	$925	$1,604	$2,602	**$12,798**
8	$804	$2,859	$4,234	$953	$1,652	$2,680	**$13,182**
9	$828	$2,945	$4,361	$982	$1,701	$2,761	**$13,578**
10	$853	$3,033	$4,492	$1,011	$1,752	$2,844	**$13,985**
11	$879	$3,124	$4,627	$1,041	$1,805	$2,929	**$14,405**
12	$905	$3,218	$4,765	$1,073	$1,859	$3,017	**$14,837**
13	$932	$3,314	$4,908	$1,105	$1,915	$3,107	**$15,282**
14	$960	$3,414	$5,056	$1,138	$1,972	$3,200	**$15,740**
15	$989	$3,516	$5,207	$1,172	$2,032	$3,296	**$16,212**
16	$1,019	$3,622	$5,364	$1,207	$2,093	$3,395	**$16,699**
17	$1,049	$3,730	$5,524	$1,243	$2,155	$3,497	**$17,200**
18	$1,081	$3,842	$5,690	$1,281	$2,220	$3,602	**$17,716**
19	$1,113	$3,957	$5,861	$1,319	$2,287	$3,710	**$18,247**
20	$1,146	$4,076	$6,037	$1,359	$2,355	$3,821	**$18,795**
21	$1,181	$4,198	$6,218	$1,399	$2,426	$3,936	**$19,359**
22	$1,216	$4,324	$6,404	$1,441	$2,499	$4,054	**$19,939**
23	$1,253	$4,454	$6,596	$1,485	$2,574	$4,176	**$20,537**
24	$1,290	$4,588	$6,794	$1,529	$2,651	$4,301	**$21,154**
25	$1,329	$4,725	$6,998	$1,575	$2,730	$4,430	**$21,788**
26	$1,369	$4,867	$7,208	$1,622	$2,812	$4,563	**$22,442**
27	$1,410	$5,013	$7,424	$1,671	$2,897	$4,700	**$23,115**
28	$1,452	$5,164	$7,647	$1,721	$2,983	$4,841	**$23,809**
29	$1,496	$5,319	$7,877	$1,773	$3,073	$4,986	**$24,523**
30	$1,541	$5,478	$8,113	$1,826	$3,165	$5,136	**$25,258**
31	$1,587	$5,642	$8,356	$1,881	$3,260	$5,290	**$26,016**
32	$1,635	$5,812	$8,607	$1,937	$3,358	$5,448	**$26,797**

**3% Inflation*

Sub-Watershed #12 **Annual Cost* After Cost-Share, Cropland BMPs**

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$812	$2,888	$4,277	$963	$1,669	$2,708	**$13,317**
2	$837	$2,975	$4,406	$992	$1,719	$2,789	**$13,717**
3	$862	$3,064	$4,538	$1,021	$1,770	$2,873	**$14,128**
4	$888	$3,156	$4,674	$1,052	$1,824	$2,959	**$14,552**
5	$914	$3,251	$4,814	$1,084	$1,878	$3,048	**$14,988**
6	$942	$3,348	$4,959	$1,116	$1,935	$3,139	**$15,438**
7	$970	$3,449	$5,107	$1,150	$1,993	$3,233	**$15,901**
8	$999	$3,552	$5,261	$1,184	$2,052	$3,330	**$16,378**
9	$1,029	$3,659	$5,418	$1,220	$2,114	$3,430	**$16,870**
10	$1,060	$3,768	$5,581	$1,256	$2,177	$3,533	**$17,376**
11	$1,092	$3,881	$5,748	$1,294	$2,243	$3,639	**$17,897**
12	$1,124	$3,998	$5,921	$1,333	$2,310	$3,748	**$18,434**
13	$1,158	$4,118	$6,098	$1,373	$2,379	$3,861	**$18,987**
14	$1,193	$4,241	$6,281	$1,414	$2,451	$3,976	**$19,556**
15	$1,229	$4,369	$6,470	$1,456	$2,524	$4,096	**$20,143**
16	$1,266	$4,500	$6,664	$1,500	$2,600	$4,218	**$20,747**
17	$1,304	$4,635	$6,864	$1,545	$2,678	$4,345	**$21,370**
18	$1,343	$4,774	$7,070	$1,591	$2,758	$4,475	**$22,011**
19	$1,383	$4,917	$7,282	$1,639	$2,841	$4,610	**$22,671**
20	$1,424	$5,064	$7,500	$1,688	$2,926	$4,748	**$23,351**
21	$1,467	$5,216	$7,725	$1,739	$3,014	$4,890	**$24,052**
22	$1,511	$5,373	$7,957	$1,791	$3,104	$5,037	**$24,774**
23	$1,556	$5,534	$8,196	$1,845	$3,198	$5,188	**$25,517**
24	$1,603	$5,700	$8,442	$1,900	$3,293	$5,344	**$26,282**
25	$1,651	$5,871	$8,695	$1,957	$3,392	$5,504	**$27,071**
26	$1,701	$6,047	$8,956	$2,016	$3,494	$5,669	**$27,883**
27	$1,752	$6,229	$9,224	$2,076	$3,599	$5,839	**$28,719**
28	$1,804	$6,416	$9,501	$2,139	$3,707	$6,015	**$29,581**
29	$1,858	$6,608	$9,786	$2,203	$3,818	$6,195	**$30,468**
30	$1,914	$6,806	$10,080	$2,269	$3,933	$6,381	**$31,382**
31	$1,972	$7,010	$10,382	$2,337	$4,051	$6,572	**$32,324**
32	$2,031	$7,221	$10,694	$2,407	$4,172	$6,769	**$33,294**

**3% Inflation*

Sub-Watershed #16 **Annual Cost* After Cost-Share, Cropland BMPs**

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$604	$2,146	$3,179	$715	$1,240	$2,012	**$9,897**
2	$622	$2,211	$3,274	$737	$1,277	$2,073	**$10,194**
3	$640	$2,277	$3,372	$759	$1,316	$2,135	**$10,499**
4	$660	$2,345	$3,474	$782	$1,355	$2,199	**$10,814**
5	$679	$2,416	$3,578	$805	$1,396	$2,265	**$11,139**
6	$700	$2,488	$3,685	$829	$1,438	$2,333	**$11,473**
7	$721	$2,563	$3,796	$854	$1,481	$2,403	**$11,817**
8	$742	$2,640	$3,909	$880	$1,525	$2,475	**$12,172**
9	$765	$2,719	$4,027	$906	$1,571	$2,549	**$12,537**
10	$788	$2,801	$4,148	$934	$1,618	$2,626	**$12,913**
11	$811	$2,885	$4,272	$962	$1,667	$2,704	**$13,300**
12	$836	$2,971	$4,400	$990	$1,717	$2,785	**$13,699**
13	$861	$3,060	$4,532	$1,020	$1,768	$2,869	**$14,110**
14	$887	$3,152	$4,668	$1,051	$1,821	$2,955	**$14,534**
15	$913	$3,247	$4,808	$1,082	$1,876	$3,044	**$14,970**
16	$941	$3,344	$4,952	$1,115	$1,932	$3,135	**$15,419**
17	$969	$3,444	$5,101	$1,148	$1,990	$3,229	**$15,881**
18	$998	$3,548	$5,254	$1,183	$2,050	$3,326	**$16,358**
19	$1,028	$3,654	$5,412	$1,218	$2,111	$3,426	**$16,848**
20	$1,059	$3,764	$5,574	$1,255	$2,175	$3,528	**$17,354**
21	$1,090	$3,877	$5,741	$1,292	$2,240	$3,634	**$17,875**
22	$1,123	$3,993	$5,913	$1,331	$2,307	$3,743	**$18,411**
23	$1,157	$4,113	$6,091	$1,371	$2,376	$3,856	**$18,963**
24	$1,191	$4,236	$6,274	$1,412	$2,448	$3,971	**$19,532**
25	$1,227	$4,363	$6,462	$1,454	$2,521	$4,090	**$20,118**
26	$1,264	$4,494	$6,656	$1,498	$2,597	$4,213	**$20,721**
27	$1,302	$4,629	$6,855	$1,543	$2,675	$4,340	**$21,343**
28	$1,341	$4,768	$7,061	$1,589	$2,755	$4,470	**$21,983**
29	$1,381	$4,911	$7,273	$1,637	$2,837	$4,604	**$22,643**
30	$1,423	$5,058	$7,491	$1,686	$2,923	$4,742	**$23,322**
31	$1,465	$5,210	$7,716	$1,737	$3,010	$4,884	**$24,022**
32	$1,509	$5,366	$7,947	$1,789	$3,101	$5,031	**$24,743**

**3% Inflation*

Sub-Watershed #25 **Annual Cost* After Cost-Share, Cropland BMPs**

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$279	$993	$1,471	$331	$574	$931	**$4,580**
2	$288	$1,023	$1,515	$341	$591	$959	**$4,718**
3	$296	$1,054	$1,561	$351	$609	$988	**$4,859**
4	$305	$1,086	$1,608	$362	$627	$1,018	**$5,005**
5	$314	$1,118	$1,656	$373	$646	$1,048	**$5,155**
6	$324	$1,152	$1,706	$384	$665	$1,080	**$5,310**
7	$334	$1,186	$1,757	$395	$685	$1,112	**$5,469**
8	$344	$1,222	$1,809	$407	$706	$1,145	**$5,633**
9	$354	$1,258	$1,864	$419	$727	$1,180	**$5,802**
10	$365	$1,296	$1,920	$432	$749	$1,215	**$5,976**
11	$375	$1,335	$1,977	$445	$771	$1,252	**$6,156**
12	$387	$1,375	$2,036	$458	$795	$1,289	**$6,340**
13	$398	$1,416	$2,098	$472	$818	$1,328	**$6,531**
14	$410	$1,459	$2,160	$486	$843	$1,368	**$6,726**
15	$423	$1,503	$2,225	$501	$868	$1,409	**$6,928**
16	$435	$1,548	$2,292	$516	$894	$1,451	**$7,136**
17	$448	$1,594	$2,361	$531	$921	$1,494	**$7,350**
18	$462	$1,642	$2,432	$547	$949	$1,539	**$7,571**
19	$476	$1,691	$2,505	$564	$977	$1,585	**$7,798**
20	$490	$1,742	$2,580	$581	$1,006	$1,633	**$8,032**
21	$505	$1,794	$2,657	$598	$1,037	$1,682	**$8,273**
22	$520	$1,848	$2,737	$616	$1,068	$1,733	**$8,521**
23	$535	$1,903	$2,819	$634	$1,100	$1,784	**$8,777**
24	$551	$1,961	$2,904	$654	$1,133	$1,838	**$9,040**
25	$568	$2,019	$2,991	$673	$1,167	$1,893	**$9,311**
26	$585	$2,080	$3,080	$693	$1,202	$1,950	**$9,590**
27	$603	$2,142	$3,173	$714	$1,238	$2,008	**$9,878**
28	$621	$2,207	$3,268	$736	$1,275	$2,069	**$10,174**
29	$639	$2,273	$3,366	$758	$1,313	$2,131	**$10,480**
30	$658	$2,341	$3,467	$780	$1,353	$2,195	**$10,794**
31	$678	$2,411	$3,571	$804	$1,393	$2,261	**$11,118**
32	$699	$2,484	$3,678	$828	$1,435	$2,328	**$11,451**

**3% Inflation*

Sub-Watershed #26 Annual Cost* After Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$342	$1,217	$1,802	$406	$703	$1,141	**$5,610**
2	$352	$1,253	$1,856	$418	$724	$1,175	**$5,778**
3	$363	$1,291	$1,911	$430	$746	$1,210	**$5,951**
4	$374	$1,329	$1,969	$443	$768	$1,246	**$6,130**
5	$385	$1,369	$2,028	$456	$791	$1,284	**$6,314**
6	$397	$1,410	$2,089	$470	$815	$1,322	**$6,503**
7	$409	$1,453	$2,151	$484	$839	$1,362	**$6,698**
8	$421	$1,496	$2,216	$499	$865	$1,403	**$6,899**
9	$433	$1,541	$2,282	$514	$890	$1,445	**$7,106**
10	$446	$1,587	$2,351	$529	$917	$1,488	**$7,319**
11	$460	$1,635	$2,421	$545	$945	$1,533	**$7,539**
12	$474	$1,684	$2,494	$561	$973	$1,579	**$7,765**
13	$488	$1,735	$2,569	$578	$1,002	$1,626	**$7,998**
14	$502	$1,787	$2,646	$596	$1,032	$1,675	**$8,238**
15	$518	$1,840	$2,725	$613	$1,063	$1,725	**$8,485**
16	$533	$1,895	$2,807	$632	$1,095	$1,777	**$8,739**
17	$549	$1,952	$2,891	$651	$1,128	$1,830	**$9,002**
18	$566	$2,011	$2,978	$670	$1,162	$1,885	**$9,272**
19	$583	$2,071	$3,067	$690	$1,197	$1,942	**$9,550**
20	$600	$2,133	$3,159	$711	$1,233	$2,000	**$9,836**
21	$618	$2,197	$3,254	$732	$1,270	$2,060	**$10,131**
22	$637	$2,263	$3,352	$754	$1,308	$2,122	**$10,435**
23	$656	$2,331	$3,452	$777	$1,347	$2,185	**$10,748**
24	$675	$2,401	$3,556	$800	$1,387	$2,251	**$11,071**
25	$696	$2,473	$3,663	$824	$1,429	$2,319	**$11,403**
26	$716	$2,547	$3,772	$849	$1,472	$2,388	**$11,745**
27	$738	$2,624	$3,886	$875	$1,516	$2,460	**$12,097**
28	$760	$2,702	$4,002	$901	$1,561	$2,534	**$12,460**
29	$783	$2,783	$4,122	$928	$1,608	$2,610	**$12,834**
30	$806	$2,867	$4,246	$956	$1,657	$2,688	**$13,219**
31	$831	$2,953	$4,373	$984	$1,706	$2,768	**$13,616**
32	$855	$3,042	$4,505	$1,014	$1,757	$2,851	**$14,024**

**3% Inflation*

Sub-Watershed #30 Annual Cost* After Cost-Share, Cropland BMPs

Year	Permanent Vegetation	Grassed Waterways	No-Till	Vegetative Buffers	Subsurface Fertilizer Application	Water Retention Structures	Total Cost
1	$117	$416	$615	$139	$240	$390	**$1,916**
2	$120	$428	$634	$143	$247	$401	**$1,974**
3	$124	$441	$653	$147	$255	$413	**$2,033**
4	$128	$454	$673	$151	$262	$426	**$2,094**
5	$132	$468	$693	$156	$270	$439	**$2,157**
6	$136	$482	$714	$161	$278	$452	**$2,221**
7	$140	$496	$735	$165	$287	$465	**$2,288**
8	$144	$511	$757	$170	$295	$479	**$2,357**
9	$148	$526	$780	$175	$304	$494	**$2,427**
10	$153	$542	$803	$181	$313	$508	**$2,500**
11	$157	$559	$827	$186	$323	$524	**$2,575**
12	$162	$575	$852	$192	$332	$539	**$2,653**
13	$167	$593	$878	$198	$342	$556	**$2,732**
14	$172	$610	$904	$203	$353	$572	**$2,814**
15	$177	$629	$931	$210	$363	$589	**$2,899**
16	$182	$647	$959	$216	$374	$607	**$2,985**
17	$188	$667	$988	$222	$385	$625	**$3,075**
18	$193	$687	$1,017	$229	$397	$644	**$3,167**
19	$199	$708	$1,048	$236	$409	$663	**$3,262**
20	$205	$729	$1,079	$243	$421	$683	**$3,360**
21	$211	$751	$1,112	$250	$434	$704	**$3,461**
22	$217	$773	$1,145	$258	$447	$725	**$3,565**
23	$224	$796	$1,179	$265	$460	$747	**$3,672**
24	$231	$820	$1,215	$273	$474	$769	**$3,782**
25	$238	$845	$1,251	$282	$488	$792	**$3,895**
26	$245	$870	$1,289	$290	$503	$816	**$4,012**
27	$252	$896	$1,327	$299	$518	$840	**$4,133**
28	$260	$923	$1,367	$308	$533	$865	**$4,257**
29	$267	$951	$1,408	$317	$549	$891	**$4,384**
30	$275	$979	$1,450	$326	$566	$918	**$4,516**
31	$284	$1,009	$1,494	$336	$583	$946	**$4,651**
32	$292	$1,039	$1,539	$346	$600	$974	**$4,791**

**3% Inflation*

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