Cheney Lake Watershed Restoration and Protection Strategies (WRAPS) Plan

2019

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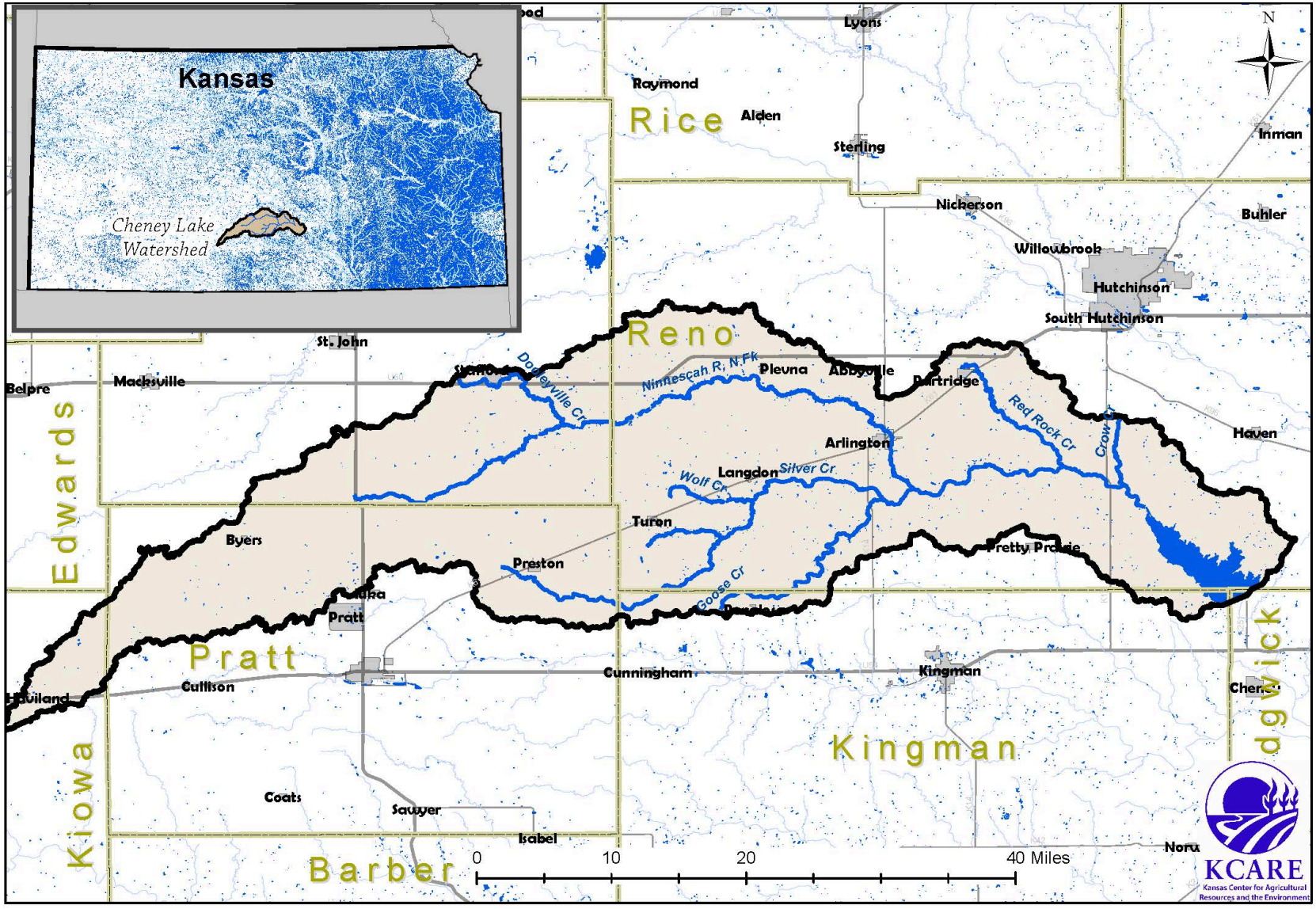
Cheney Lake Watershed



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Glossary of Terms and Acronyms

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

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

Biota: Plant and animal life of a particular region.

Chlorophyll a: Common pigment used in photosynthesis, found in algae and other aquatic plants. Can be used for measurement of eutrophication in a water body.

Citizens' Management Committee (CMC): The governing body of the non-profit organization, Cheney Lake Watershed, Inc. This group also serves in an advisory capacity to the Reno County Conservation District. *This group serves the same purpose as the Stakeholder Leadership Team in other WRAPS groups.*

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

***E. coli* bacteria (ECB):** Bacteria normally found in gastrointestinal tracts of animals. Some strains cause diarrheal diseases and are pathogenic to humans.

Eutrophication (E): Excess of mineral and organic nutrients that promote a proliferation of plant life in lakes and ponds.

Fecal coliform bacteria (FCB): Bacteria originating in the intestines of all warm-blooded animals.

Hydrologic Unit Code (HUC): An identification system using numerical digits for watersheds. The smaller the watershed, the more digits a HUC will have.

KDHE: Kansas Department of Health and Environment.

Municipal water system: A water system serving at least 10 service connections or regularly serving an average of at least 25 individuals daily, at least 60 days out of the year.

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

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

Nitrogen (N): Element essential for plants and animals.

Nonpoint sources (NPS): Any activity not required to have a NPDES permit and results in the release of pollutants to waters of the state. This release may result from precipitation runoff, aerial drift and deposition from the air, or the release of subsurface brine or other contaminated groundwaters to surface waters of the state.

Nutrients: Nitrogen and/or phosphorus in a water source.

Phosphorus (P): Element in water that, in excess, can lead to increased biological activity which may cause eutrophication.

Point sources (PS): Any discernible, confined and discrete conveyance from which pollutants are or could be discharged.

RAC: Regional Advisory Committee.

Riparian zone: Areas of interchange between land and water alongside bodies of water.

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

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

Stakeholder Leadership Team (SLT): Organization of watershed residents, landowners, farmers, ranchers, agency personnel and any other persons with an interest in water quality. *This is just another name for the CMC in the Cheney Lake Watershed.*

Total Maximum Daily Load (TMDL): Maximum amount of pollutant that a specific body of water can receive without violating surface water-quality standards which results in failure to support their designated uses.

Total Nitrogen (TN): A chemical measurement of all nitrogen forms in a water sample.

Total Phosphorus (TP): A chemical measurement of all phosphorus forms in a water sample.

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

WRAPS: Watershed Restoration and Protection Strategy.

1. Preface and Plan Update

The purpose of this Watershed Restoration and Protection Strategy (WRAPS) report for the **Cheney Lake Watershed** is to outline a plan of restoration and protection goals and actions for this watershed's surface waters. Watershed goals can be characterized as either "restoration" or "protection." Watershed restoration refers to surface waters that fail to meet water quality standards and for areas of the watershed that need improvement in habitat, land management, or other attributes. Watershed protection refers to surface waters currently meeting water quality standards but requiring protection from future degradation.

In the WRAPS process, local communities and governmental agencies work together toward the common goal of a healthy environment. Local participants, or stakeholders, provide valuable grass-roots leadership, responsibility, and management of resources in this process. Because they have the most at stake, these community members work together to ensure that their lands' water quality is protected. Agencies bring science-based information, communication, and technical and financial assistance to the table. By working as a WRAPS team, communities can take several steps toward watershed restoration and protection. Within the watershed, the team works to build awareness and education, to engage local leadership and to monitor and evaluate watershed conditions; they also assess, plan and implement the WRAPS process at the local level.

Other crucial objectives for the WRAPS process are to maintain recreational opportunities and biodiversity while protecting the environment from flooding and the negative effects of urbanization and industrial production. Final watershed goals are to provide a sustainable water source for drinking and domestic use while preserving food, fiber, and timber production. The ultimate WRAPS goal is a restored and protected watershed: "local hands caring for local lands" in partnership with government agencies to improve the environment for everyone.

This plan is intended to serve as a guide for the WRAPS efforts in the protection and restoration of the North Fork Ninnescah River and the Cheney Reservoir by its watershed citizens, and partners in the City of Wichita, state, and federal agencies. This WRAPS project is guided by a commitment to citizen leadership, voluntary participation in conservation work, partnerships with other interested stakeholders, and the watershed citizens actively working toward clean water. At the end of the WRAPS process, the Citizens' Management Committee (CMC) will have the capability and capacity to make decisions to restore and to protect the water quality and watershed conditions of the Cheney Lake Watershed.

Plan Update: The original Cheney Lake Watershed management plan was written in 1994 with minor revisions in subsequent years. In 2011, the management plan was updated to follow the Kansas Department of Health and Environment's (KDHE) WRAPS guidelines, which included a more specific strategy for achieving watershed goals. A TMDL revision by KDHE resulted in the need for an updated WRAPS plan and implementation goals. Therefore, the Cheney Lake Watershed WRAPS plan was updated and revised in 2019 by Kansas State University staff and KDHE, with the guidance of the Cheney Lake Watershed CMC.

2. Cheney Lake Watershed WRAPS Introduction

This section includes a discussion about the importance of a WRAPS plan as well as a description of the key collaborators who strive to make it effective. There is a special focus on the specifics of the Cheney Lake Watershed's location and stakeholders.

A. What Is a Watershed?

A watershed is an area of land that catches precipitation and funnels it to a particular creek, stream, river, and so on, until the water drains into an ocean. In the case of the Cheney Lake Watershed, all the water drains into the Cheney Reservoir. A watershed has distinct elevation boundaries that do not follow county, state, or international borders. Watersheds come in all shapes and sizes, with some covering an area of only a few acres, while others encompass thousands of square miles.

B. What Is a Watershed Restoration and Protection Strategy (WRAPS)?

WRAPS is a planning and management framework built to engage local citizen-stakeholders within a particular watershed. It is a process used to **identify** restoration and protection needs, to **establish** management goals for the watershed community, to **create** an action plan to achieve those goals, and to **implement** the action plan.

The acronym "WRAPS" originated from KDHE in response to the 1998 Clean Water Action Plan issued by the Clinton Administration. The Clean Water Action Plan directed the state environmental agency and the state conservationist of every state to complete a "unified watershed assessment." Upon completion of the assessment, states were directed to develop "watershed restoration action strategies" (WRAS).

The state of Kansas contends that restoring damage to a watershed is not enough because it addresses only part of the need; action to protect water is a necessity, hence the new term WRAPS. Historically, "WRAPS" refers to the development of action plans that address nonpoint source pollution sources on a watershed basis. WRAPS projects are initiated by watershed stakeholders and receive financial support from KDHE to address Total Maximum Daily Loads (TMDLs) and related water quality concerns.

The WRAPS initiative intends to address priority issues identified in the basin sections of the Kansas Water Plan through the development and implementation of WRAPS projects in priority watersheds.

C. Watershed Location

There are 12 river basins in Kansas. The scope of this WRAPS project is the Cheney Lake Watershed, located in the Lower Arkansas River Basin (**Figure 1**). The Cheney Lake Watershed is located in south-central Kansas and overlays portions of five counties (**Figure**

2). The majority of the Cheney Lake Watershed and Cheney reservoir are located in Reno County. The watershed also is located in south-eastern Stafford County, northern Pratt County and northeast Kiowa County. Two small portions of the watershed are located in two separate areas in northern Kingman County, while very small portions of the reservoir are located in Kingman and Sedgwick Counties.

The Cheney Lake Watershed and the North Fork Ninnescah River Watershed are the same watershed. However, there is a portion of the North Fork Ninnescah River Watershed below the dam that is not targeted; therefore, the targeted area for this plan was called the Cheney Lake Watershed.

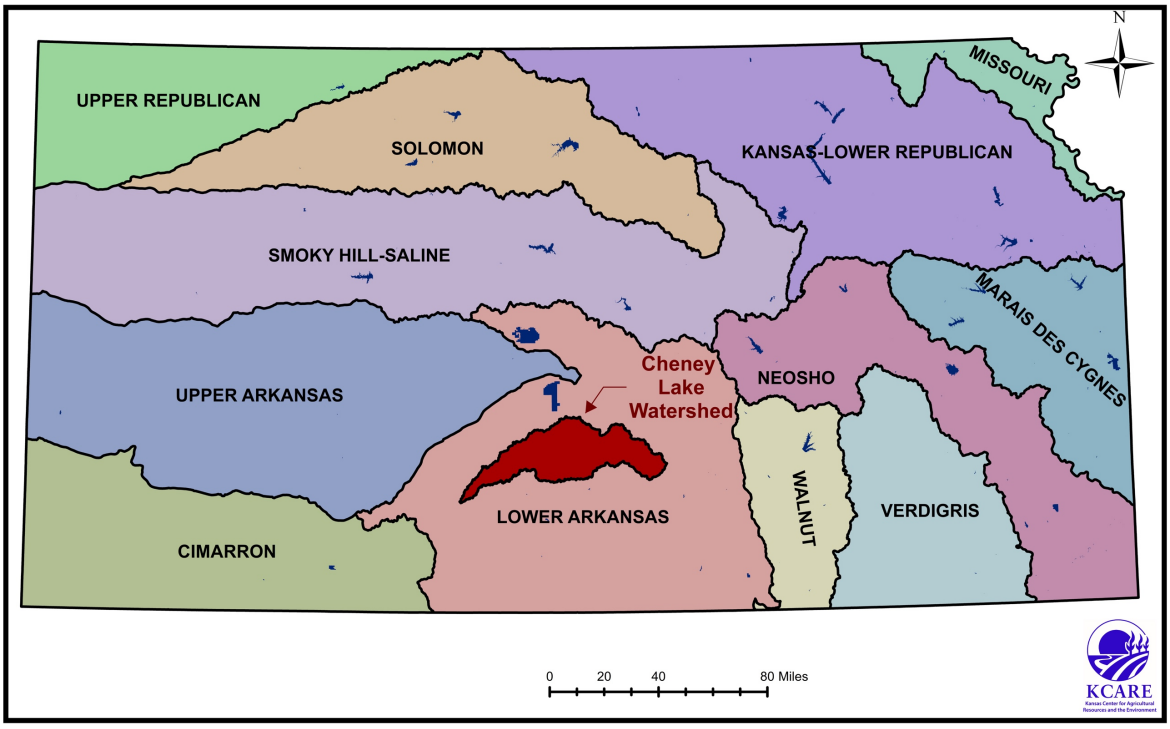


Figure 1. The 12 River Basins of Kansas, Highlighting the Cheney Lake Watershed

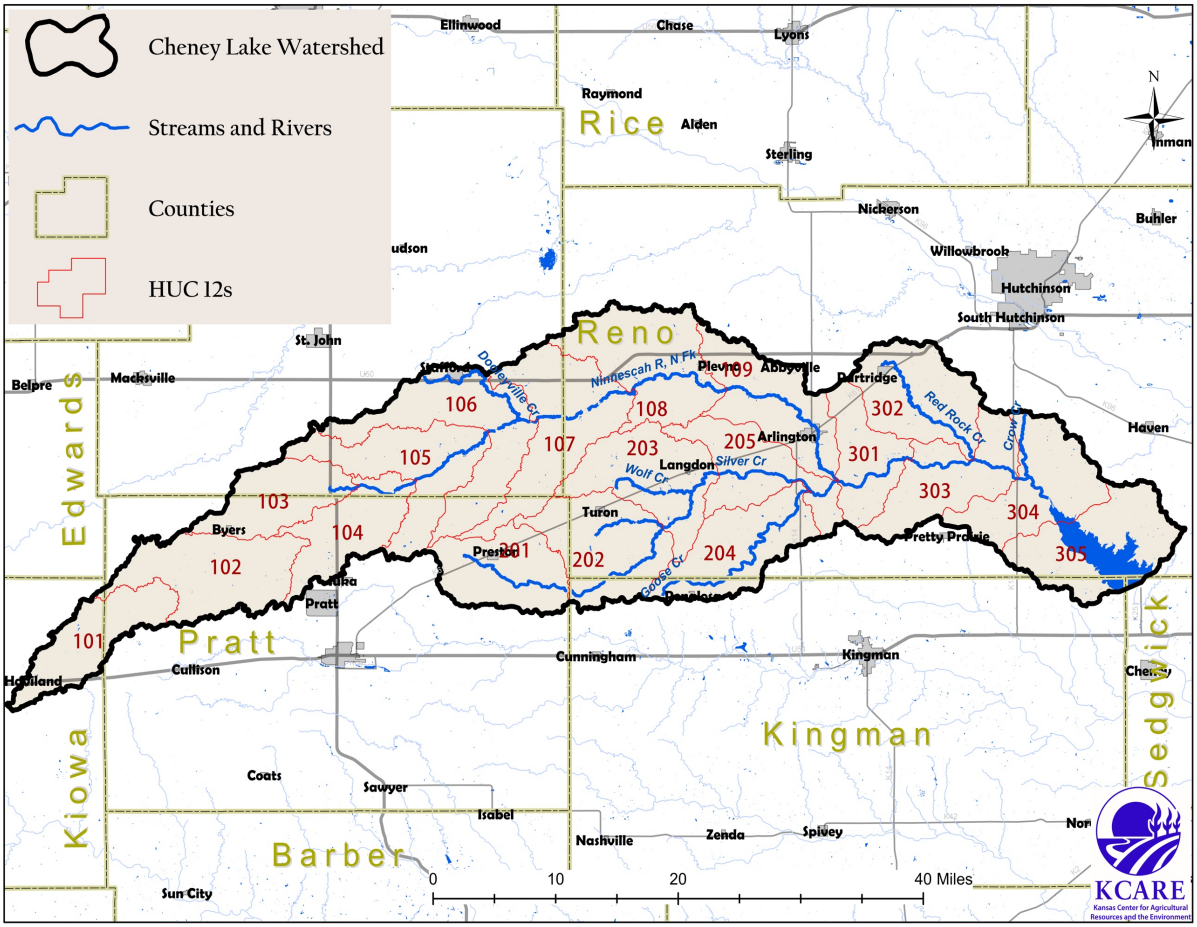


Figure 2. Cheney Lake Watershed

D. Overview of the Cheney Lake Watershed

The Cheney Lake Watershed covers 633,934 acres, which equates to 991 square miles. The Cheney Lake Watershed contains numerous creeks and tributaries, including the North Fork Ninnescah River, Goose Creek, Silver Creek, Red Rock Creek and Crow Creek to name a few. All surface waters in the watershed drain into the Cheney Reservoir, although the geography and topography of the area is such that runoff water is captured generally as groundwater instead of creating concentrated streamflow into the Ninnescah River. Specific information about land use within the watershed, as well as specific population information, can be found in **Section 3** of this report.

The Cheney Reservoir was designed and constructed in 1962-1965 by the Bureau of Reclamation as part of a water supply system for the City of Wichita. The reservoir was designed as a 100-year multipurpose project to act as a water supply, flood control and wildlife area. The City of Wichita currently draws 70% of its daily water supply from the reservoir. This water supply also is marketed to the cities of Valley Center, Andover, Derby, Rose Hill, Eastborough, Bentley, Benton, Bel Aire, Park City and Kechi, as well as several rural water districts.

The Cheney Reservoir is located 20 miles west of Wichita and 25 miles south of Hutchinson. The reservoir lies primarily in Reno County with a very small portion located in Kingman County; part of the dam is in Sedgwick County. The reservoir is the sixth largest in Kansas and is 6,800 acres in size.

Cheney State Park is 1,913 acres. It is divided by the reservoir which splits the park into two areas: the East Shore and West Shore. The park is home to two marinas, including a full-service marina on the East Shore. Cheney Reservoir is popular with water-skiers and anglers, and it is noted as one of the best lakes in the nation for sailing. The park offers primitive and modern camping sites. In addition to camping, Cheney State Park offers plenty of outdoor recreational space for sightseeing, picnicking and hiking and even offers a "free to the public" shooting range. There are three swimming beaches along the reservoir, two on the West Shore and one on the East Shore. The area also is home to many different species of birds, animals and fish. Bald eagles, white-tailed deer, Canada geese and wild turkey can be found at Cheney Reservoir. Some of the fishing species in the lake are crappie, bass, walleye and channel catfish. The lake's fish and wildlife resources provide sightseers, fishermen and hunters ample opportunities for their sports.

Adjacent to Cheney State Park is another 5,200 acres of land and 4,100 acres of water. This area is utilized for conservation and management of migratory birds and other wildlife. Part of this land is leased to local producers with guidance from KDWPT on proper crop rotations and land management.

E. Elevation of the Cheney Lake Watershed

Elevation determines watershed boundaries. As shown in **Figure 3**, the lower end of the Cheney Lake Watershed at Cheney Reservoir has an elevation of approximately 1,420 feet. The watershed elevation rises to the west with a final elevation southwest of the town of Byers of approximately 2,164 feet.

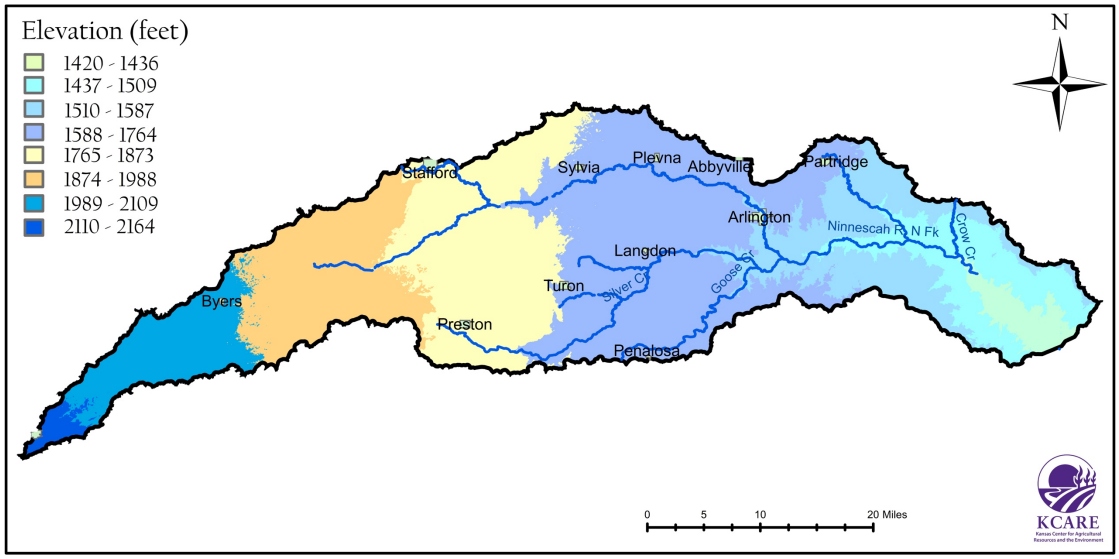


Figure 3. Elevation Relief Map of the Cheney Lake Watershed

F. What is a Hydrologic Unit Code (HUC)?

HUC is an acronym for **H**ydrologic **U**nit **C**ode; HUCs act as an identification system for watersheds. Each watershed is assigned a unique HUC number, in addition to a common name.

The HUC for the Cheney Lake Watershed (also referred to as the North Fork Ninnescah River Watershed) is composed of the HUC 8 (meaning an 8-digit identifier code) numbered **11030014**. The first two numbers in the HUC code refer to the drainage region, the second two digits refer to the drainage sub-region, the third two digits refer to the accounting unit, and the fourth pair of digits is the cataloging unit. For example:

- **11**030014: Region drainage of the Arkansas, White and Red River Basins above the points of highest backwater effect of the Mississippi River (245,500 square miles).
- 11**03**0014: Sub-region drainage of the Middle Arkansas; the Arkansas River Basin below its intersect with the Colorado-Kansas state line to and including the Walnut River Basin (20,200 square miles).
- 1103**00**14: Accounting unit drainage of the Middle Arkansas River Basin in Kansas and Colorado (20,200 square miles).
- 11030014: Cataloging unit drainage of the section of the North Fork Ninnescah River (941 square miles).

As watersheds become smaller, the HUC number becomes larger. HUC 8s can be split into smaller watersheds that are given HUC 10 numbers, and HUC 10 watersheds can be divided into smaller HUC 12 watersheds. The Cheney Lake Watershed consists of the HUC 10s-numbered 1103001**401**, 1103001**402** and 1103001**403**, indicating the drainage area into Cheney Reservoir. The Cheney Lake Watershed can be divided even further into 19 HUC 12 delineations, including the following numbers: 110300140**101**, 110300140**102**, 110300140**103**, 110300140**104**, 110300140**105**, 110300140**106**, 110300140**107**, 110300140**108**, 110300140**109**, 110300140**201**, 110300140**202**, 110300140**203**, 110300140**204**, 110300140**205**, 110300140**301**, 110300140**302**, 110300140**303**, 110300140**304**, and 110300140**305** (**Figure 4**).

Targeting for BMP implementation within the Cheney Lake Watershed will be according to HUC 12 sub-watersheds. *Please note that maps throughout this plan will refer primarily to these HUC 12s by their last three digits.*

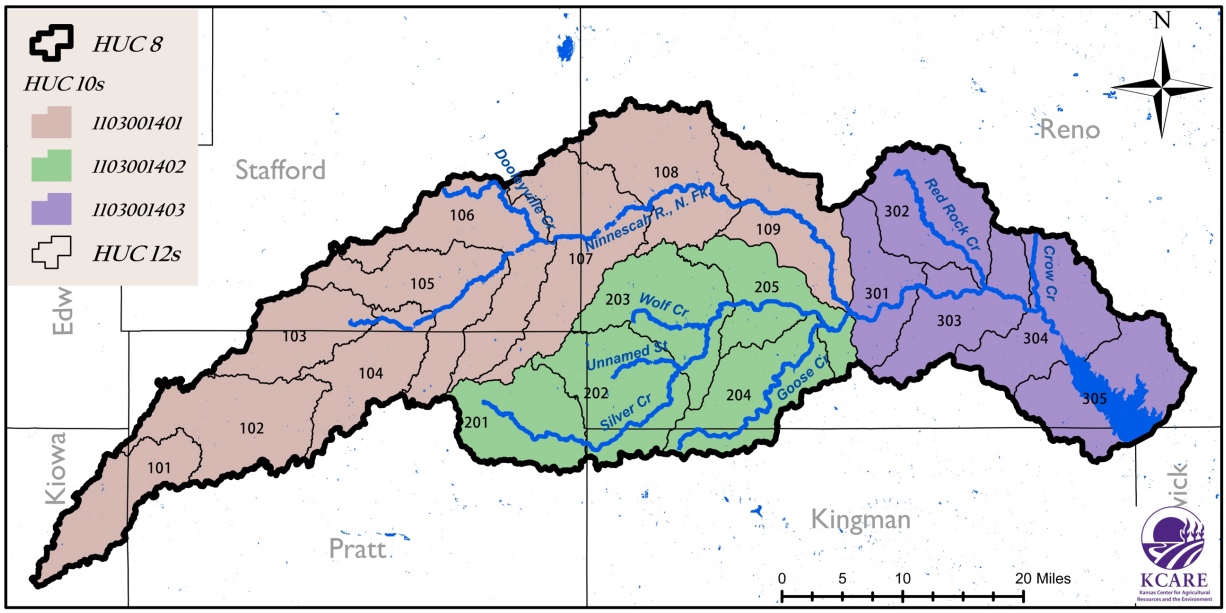


Figure 4. HUC 8, 10, and 12 Delineations in the Cheney Lake Watershed

G. Cheney Lake Watershed WRAPS History

According to the 1999 Kansas Unified Watershed Assessment prepared by KDHE and the National Resources Conservation Service (NRCS), the Cheney Lake Watershed (then referred to as the North Fork Ninnescah) is rated as a Category I watershed. This means that the watershed needs restoration and protection to sustain water quality. A Category I watershed either does not meet state water quality standards or fails to achieve aquatic system goals related to habitat and ecosystem health. Category I watersheds also are assigned a priority for restoration. The Cheney Lake Watershed is ranked 7th out of 92 watersheds in the state for restoration priority.

H. Who Are the Stakeholders?

Beginning in the early 1990s, Cheney Reservoir began experiencing algae blooms significant enough to result in taste and odor problems in the final water product, which supplies the City of Wichita. These problems in the treated water during and after algae blooms created significant problems for Wichita consumers. The two primary pollutants identified in the reservoir's water were phosphorus and sediment, which affected both the quality and quantity of the water in the reservoir. Cheney Reservoir was then and remains listed by the Kansas Department of Health and Environment for having high-priority total maximum daily loads for eutrophication and siltation.

In l992, a task force was formed to identify and alleviate potential sources of pollution in the watershed and in Cheney Reservoir. The task force was comprised of local landowners and representatives of the Reno County Conservation District, Sedgwick County Conservation District, Reno County Farm Service Agency (FSA), Reno County Health Department, Wichita Water and Sewer Department, Reno County Extension Service, Kansas Department of Wildlife and Parks and Tourism (KDWPT), KDHE, NRCS, Bureau of Reclamation, US Fish and

Wildlife, US Geological Survey (USGS), Environmental Protection Agency (EPA), Kansas Water Office (KWO) other local, state, and federal agencies.

The task force prepared a master plan to alleviate the degradation of the reservoir and to double its life. Implementation of the plan began in July l994 under the leadership of the Citizens' Management Committee (CMC) which operates as a subcommittee of the Reno County Conservation District. Cheney Lake Watershed, Inc. received status as a 501(c)(3) non-profit corporation on July 14, 1998. The Board of Directors, or CMC, is composed of seven people who own or manage land in the watershed. This board actively engages in the promotion of the project goals. WRAPS groups across the state may refer to this group of dedicated individuals as their *stakeholder leadership team* or *SLT*. The Cheney Lake Watershed will continue to refer to this group as the *CMC*, as it was a functioning body long before WRAPS groups began creating and using SLTs.

One of the most significant aspects of the Cheney Reservoir Watershed WRAPS project is the partnership of rural-urban stakeholders. Because the City of Wichita recognized the value of correcting pollution problems prior to water entering the reservoir, the City agreed to help farmers pay to implement conservation practices. Voluntary implementation of conservation work has been initiated successfully by the program through one-on-one contacts with neighbors of CMC members. CMC members also promote the project in small, informal meetings with local groups of farmers.

The CMC renamed, rewrote, and resubmitted their original 1994 watershed plan to KDHE in 2011. The 2011 version included the new KDHE WRAPS standards, and the plan was titled the *Cheney Lake Watershed Restoration and Protection Plan*.

I. Goals of the Cheney Lake Citizens' Management Committee (CMC)

Responsibility for restoration and protection of the watershed rests primarily in the hands of local stakeholders. In cooperation with these local stakeholders, federal and state agencies provide technical and financial assistance for education activities and implementation of BMPs.

The main pollutants for the Cheney Lake Watershed are sediment and nutrients (phosphorus and nitrogen). The CMC has identified specific goals to achieve watershed improvements. It is believed that implementation of BMPs as well as financial incentives and cost-share programs will, over time, lead to decreases in surface- and groundwater pollutants. This will subsequently result in the reduction of water quality impairments in the Cheney Reservoir.

The **watershed goals** of the CMC are to:

1. restore degraded water quality in the Cheney Reservoir by achieving TMDLs, and
2. educate the watershed community about water quality practices and benefits.

The CMC will work to restore water quality in the Cheney Reservoir and achieve TMDLs by focusing on these priority issues:

- protect and restore water quality throughout the watershed;

- reduce erosion on cropland;
- reduce nutrient and bacteria runoff from livestock operations;
- protect eroding streambanks and degraded riparian areas;
- control flooding; and
- reduce bacteria contamination from failing septic systems.

The CMC will educate the community about water quality BMPs and benefits. They will focus educational efforts and funding in the most vulnerable acres of the watershed with the most efficient practices for reducing sediment and nutrient loading. These include practices such as reduced tillage, nutrient management, cover crops, grass plantings, relocation of livestock feeding areas, and a strong emphasis on soil health in both cropland and rangeland.

The CMC also believes in the importance of working to reduce or eliminate the proliferation of invasive species, even if it does not have a direct impact on water quality.

The CMC hopes that these efforts will protect the productivity of agricultural lands throughout the watershed while improving water quality in nearby streams and in the Cheney Reservoir.

J. Regional Advisory Committee (RAC)

In 2013, the governor of Kansas issued a call to action to develop a 50-Year Vision Plan for incorporation into the Kansas Water Plan. Regional Advisory Committees (RACs) were developed in 2015 to work in concert with the 50-Year Vision Plan. The Cheney Lake Watershed is part of the **Equus-Walnut RAC**.[1] The Equus-Walnut RAC developed the following seven goals for the future of the river basin. *Even though some of the goals and action steps of the Equus-Walnut RAC are time sensitive and outdated in respect to this document, it is important to view them all to understand the intent of the RAC in coordination with the 50-Year Vision Plan.*

1. Achieve and maintain sustainable balance of groundwater withdrawals with annual recharge in the Equus Beds Aquifer by 2020. Ensure that safe yield and recharge rate calculations for the Equus Beds Aquifer are accurate through a district-wide integrated groundwater and surface water model by 2018.
2. Each public water supplier in the region will develop a long-term water supply plan and revise it every five years to meet their individual forecasted needs. Water suppliers should consider alternative uses of non-potable water and existing water supplies before developing any new water supply projects.
3. Implement and maintain watershed protection activities to maintain regional reservoir storage capacity for an additional 100 years beyond the design life.
4. Maintain or reduce the rate of sedimentation and nutrient loading through the encouragement of BMPs on 50% of the high-priority acres in the watershed above water

[1] Kansas Water Vision, Regional Goal Action Plans Section. http://kwo.ks.gov/docs/default-source/water-vision-water-plan/vision/rpt-vision-regional-goal-action-plans-section.pdf?sfvrsn=4

supply reservoirs. Ensure practices are sustained and maintained for the long-term and priorities are reassessed every five years.

5. Allocate necessary resources ($1-5 million) within five years to identify and prioritize current contamination issues impacting the Equus Beds Aquifer and develop a plan to manage and mitigate the contamination. Review existing studies and emerging technologies to develop a new conceptual plan with estimated costs. Begin implementation of the plan within 10 years of completing the study.
6. Coordinate with public/private research and development programs to develop and promote fewer water-and nutrient-intensive crops. Provide incentives for operators to implement irrigation efficiency improvements immediately. Increase efforts to implement water-conserving agricultural production practices such as no-till methods, cover cropping systems and a rangeland cedar tree management program. While focused on the preservation of our water resources, agricultural water users will double the value of irrigation-based production over the next 50 years.
7. Encourage municipal, commercial, and industrial users of water to increase the efficiency of net water use by reducing the volume of water used per unit of measure by 5% per decade. Provide incentives for users to implement water efficiency improvements.

The RAC goals are closely aligned with the WRAPS process; to meet these goals, the RAC developed **Action Steps**. These steps are outlined below. Even though some of the goals of the Equus-Walnut RAC are time-sensitive and outdated in respect to this document, it is important to view them all to understand the intent of the RAC in coordination with the 50-Year Vision Plan.

Goal 1: Action Steps

- Complete ongoing KGS modeling effort currently scheduled for completion during 2016.
- Utilize the model results to support refinement of aquifer recharge rates.
- Consider application of the revised recharge rates to support safe yield calculations within modeled boundaries.
- Complete expansion of existing USGS Equus Beds MODFLOW Model to cover all of GMD2.
- Continue to encourage communication and collaboration among all responsible agencies and organizations tasked to implement this action.
- Utilize modeling results to inventory areas of over-appropriation or within the Equus Beds Aquifer.
- Consider implementation of management strategies for over-appropriated areas identified by model within the Equus-Walnut Region.

Goal 2: Action Steps

- The KWO will coordinate with the KDHE Bureau of Water and Kansas Department of Agriculture-Division of Water Resources (KDA-DWR) on a database of all public water suppliers within the RAC that includes contact information and chief responsible staff person and chief governance person for each supplier by December 31, 2016. *The database will be updated every 1-3 years.*

- The KWO will develop a survey document to ascertain the current state, practice, and plans of each public water supplier regarding their long-term water supply plan, including their consideration of non-potable water and existing water supplies by March 31, 2017. The results of this survey document will be made available to each public water supplier within the Equus-Walnut Planning Region.
- The KWO will communicate the planning survey to each public water supplier by June 30, 2017.
- The RAC will work with the KWO to prepare a report to the Kansas Water Authority (KWA) that conveys the results of the survey and identifies any further actions that may be necessary in pursuit of the goal.
- KWA will establish a five-year frequency for submitting updated water plans by the end of 2017.
- Promote a regulatory framework for the use of graywater both on-site and off-site.
- Review recommendations for water suppliers' use of surface water and groundwater by KWA to prioritize the use of excess surface water before the use of ground water, depending on local conditions, by 2018. Incentives should be in alignment with water resource conservation philosophy.
- The Equus-Walnut RAC, in conjunction with the KWA, will develop an over-arching water resource conservation strategy that prioritizes how water resources will be allocated.

Goal 3 and 4 Action Steps

- Identify market-based funding sources.
- Increase Information & Education activities which keep in mind human nature.
- Re-establish a Kansas buffer initiative program.
- Compensate property owners for use of their property for implementation of BMPs through existing or enhanced conservation programs. Discourage shotgun approach to BMP implementation.
- Continue maintenance payments for upkeep of conservation practices beyond their contract life.
- Demonstrate practices which reduce sediment runoff using Conservation Farms.
- Allow Corps of Engineers (COE) Water Storage Contract Holders use Operations & Maintenance (O&M) money for watershed practices to help reduce sedimentation.
- Add additional fees to water bills to be used for BMP implementation in watersheds.
- Increase partnerships between NRCS, KDHE, KDA-DOC and Kansas State Research and Extension (KSRE) to improve efficiency of BMP implementation.
- Determine/define high priority areas. *Establish a "Streambank Stabilization Initiative" for priority areas.*
- Continue to focus on BMPs as highlighted within the WRAPS 9-Element Watershed Plans as well as streambank stabilization and erosion control dams.
- Ensure revisions to WRAPS 9-Element Watershed Plans covering areas above regional water supply reservoirs to implement BMPs which lead to regional reservoir storage capacity for an additional 100 years beyond the design life.
- Conduct sediment source analysis within watersheds above regional water supply reservoirs. Results of this analysis can lead to modifications of BMP implementation types (i.e. streambank stabilization or cropland/upland areas of focus).

Goal 5 Action Steps

- Develop an inventory of known contamination sites within the Equus Beds Aquifer. *GMD2 to lead effort, anticipated completion by 12/2017*
- Identify data gaps associated with inventoried sites; this could include lack of definition regarding vertical or horizontal extent of contamination, concentration of contaminants or the source of contamination of an identified site. This identification will be concurrent with development of contamination site inventory. *GMD2 to lead effort alongside collaboration with KCC and KDHE.*
- Prioritize sites for additional investigation, utilizing development of prioritization criteria.
- Utilize and refine existing groundwater models to address site-specific data needs associated with the performance of additional investigations.
- Install additional monitoring wells and piezometers as necessary to collect data where needs are identified.
- Complete a remediation feasibility study for the top three prioritized sites.
- Complete pilot studies as required to facilitate groundwater remediation feasibility.
- Develop a process to address the contaminated sites within the Equus-Walnut Region.

Goal 6 Action Steps

- Preserve water resources and coordinate programs to develop less water-intensive crops. - *Develop four water demonstration farms which compare less water intensive crops.*
- Coordinate public/private research and development for development of viable drought tolerant crops. - *Invest in Center for Sorghum Improvement.*
- Identification and development of markets for alternative crops.
- Establish a technology farm within the Equus-Walnut Region where no-till, cover cropping systems and a rangeland management program can be evaluated. Rely on expertise of state and local experts to identify an appropriate location for technology farm within the Equus-Walnut Region.
- Provide and support workshops and field days starting in February/March 2017 in advance of annual burn season for fire management of invasive vegetation for improved rangeland management. - *Outcome of these efforts and previously mentioned technology farm would be improved soil health, improved moisture holding capacity of soils, and increased groundwater recharge potential through increased education and awareness in area residence.*

Goal 7 Action Steps

- Discuss the regional vs. statewide nature of this goal. If this discussion supports pursuing the goal on an Equus-Walnut RAC basis, rather than a statewide basis, that will dictate a significantly different approach to outreach. This process needs to be completed before any further development of an action plan for this goal. Place this question on the May Equus-Walnut RAC meeting agenda for discussion and possible message to the KWA.
- Identify a comprehensive list of major water users in each of the three categories (municipal, commercial, and industrial) for the RAC by Q1 2017. Will need to decide on how small to go on commercial users.

- Communicate with all of the targeted entities in each category to determine if they would be willing to attend a "brainstorming session" for this goal, and how it might be effectively and efficiently implemented. Consider as a special session during the annual Governor's Water Conference in November 2017.
- Request entities that have recently implemented water efficiency projects present their success to the attendees of the "brainstorming session".
- Analyze the results from Step 2 to determine a plan forward.
- Integrate action items of Goal 7 with Goal 2.
- Consider incentives that have been successful in other parts of the country that encourage water efficiency projects.
- By the end of 2017, ask major water users to include a 5% improvement in water use efficiency per decade in their annual goals.

In summary, the RAC will work in cooperation and coordination with local WRAPS groups, conservation districts, producers and municipalities. Partnerships will execute goals by leveraging existing financial resources and finding new funding sources, implementing new conservation practices, and providing education and awareness of water quality and quantity issues in the watershed.

3. Watershed Review

This watershed review is an in-depth description of the Cheney Lake Watershed. This section includes descriptions and data about the watershed's land cover and use, special water designations, annual rainfall, aquifers, population, public water supplies and permitted waste water facilities.

A. Land Cover and Land Uses

Land use activities have a significant impact on the types and quantity of nutrient and sediment pollutants in the Cheney Lake Watershed. Over 99% of the watershed is used for agricultural purposes. The two major land uses in the Cheney Lake Watershed are cropland (50%) and grassland (41%). Cultivated crops (cropland) is the main source of sediment and nutrient runoff from overland flow. Nutrients attach to sediment during runoff events and end up in nearby streams and, eventually, the reservoir. In addition, agricultural cropland under conventional tillage practices and a lack of maintenance of agricultural BMP structures can have cumulative effects on land transformation through sheet and rill erosion. Often, grassland uses can contribute livestock manure to streams and ponds, resulting in nutrient and *E. coli* runoff, in addition to sediment runoff from cattle trails and gullies in pastures. **Table 1** lists the remaining land uses in the watershed, including: urban open space (4%), water (2%), deciduous forest (1%) and wetlands (1%); urban areas, herbaceous wetlands, pasture/hay, shrubland and not actively managed lands each represent less than 1%.

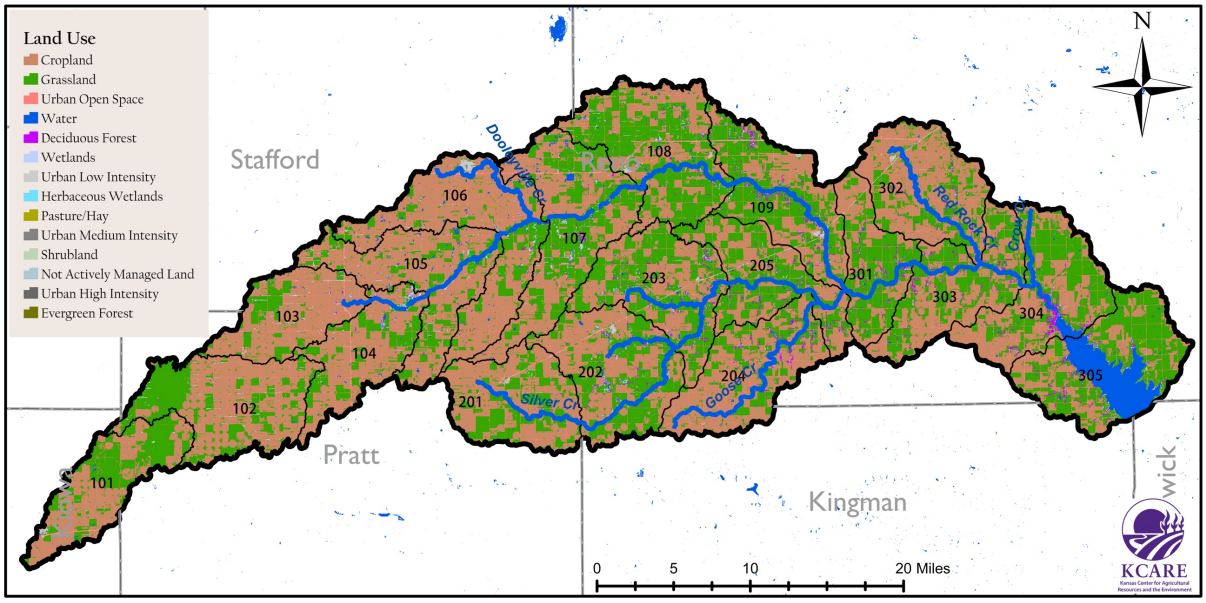


Figure 5. Land Cover and Land Use in the Cheney Lake Watershed[2]

[2] U.S. Geological Survey National Land Cover Database, 2011.
https://www.mrlc.gov/data/legends/national-land-cover-database-2011-nlcd2011-legend

Table 1. Land Use in the Cheney Lake Watershed

Land Use in the Cheney Lake Watershed															
HUC 11030014	Land Use (Acres)														Acres in each Sub-watershed
	Cropland	Grassland	Urban Open Space	Water	Deciduous Forest	Wetlands	Urban Low Intensity	Herbaceous Wetlands	Pasture / Hay	Urban Medium Intensity	Shrub-land	Not Actively Managed	Urban High Intensity	Ever-green Forest	
101	13,979	11,418	915	67	6	61	154	0	0	39	0	1	11	0	26,650
102	22,537	13,790	996	30	18	365	18	0	0	5	2	1	0	0	37,763
103	18,395	5,029	1,095	67	78	320	82	3	0	3	1	3	0	0	25,076
104	16,429	7,812	1,074	192	108	428	33	93	0	3	10	0	0	0	26,184
105	23,935	9,360	1,267	375	138	451	69	136	0	2	3	0	0	0	35,736
106	31,251	8,502	1,694	513	98	320	433	46	27	70	3	5	7	0	42,969
107	19,819	19,108	1,834	519	292	603	89	54	0	0	21	5	0	0	42,344
108	14,227	23,081	1,886	279	393	456	251	86	38	12	11	4	1	0	40,726
109	11,482	18,562	1,689	342	890	332	357	10	9	24	14	0	2	13	33,725
201	17,187	10,662	1,109	41	65	149	155	5	0	9	22	0	1	0	29,406
202	17,295	16,516	1,290	197	492	434	208	78	0	17	23	0	3	0	36,555
203	13,479	18,517	1,425	253	672	378	195	28	0	9	19	2	0	0	34,976
204	20,524	9,872	1,412	104	804	123	44	6	0	9	5	0	0	0	32,903
205	11,047	15,001	1,166	93	586	156	101	1	24	4	4	1	0	0	28,186
301	7,689	12,682	982	225	551	106	52	3	0	2	0	4	0	0	22,295
302	21,676	9,090	1,483	115	419	93	275	2	30	18	2	5	2	0	33,210
303	14,136	14,388	1,293	257	863	110	23	2	53	0	0	4	0	0	31,128
304	15,131	15,291	1,456	977	1,119	173	27	7	77	0	0	1	0	0	34,259
305	9,362	18,123	1,354	9,715	708	202	202	5	149	18	4	0	0	0	39,842
Total Acres	319,580	256,805	25,418	14,361	8,302	5,259	2,769	565	406	247	145	36	28	13	633,934
% of Watershed	50%	41%	4%	2%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	100%

B. Designated Uses

The streams and lakes in the Cheney Lake Watershed have many designated uses according to the Kansas Surface Water Register, which is prepared and maintained by KDHE's Division of Environment, Bureau of Water. Designated uses in the Cheney Lake Watershed include domestic water supply use, food procurement, ground water recharge, industrial water supply, irrigation, and livestock watering. The Cheney Reservoir is a general-purpose water body also designated for aquatic life use and contact recreational use (primarily swimming and boating). These "designated uses" are defined and assigned to specific water bodies in the Kansas Surface Water Register, 2013, issued by KDHE (**Table 3**).

Table 2. Designated Water Uses Abbreviation Key

Designated Uses Abbreviation Key			
AL	Aquatic Life Use	GR	Ground Water Recharge Use
CR	Contact Recreational Use	IW	Industrial Water Supply Use
DS	Domestic Water Supply Use	IR	Irrigation Use
FP	Food Procurement Use	LW	Livestock Water Use
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.
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.
E	Expected aquatic life use water.	S	Special aquatic life use water.
O	Referenced stream segment does not support the indicated designated use.	X	Referenced stream segment is assigned the indicated designated use.

Table 3. Designated Water Uses in the Cheney Lake Watershed[3]

Designated Water Uses: Cheney Lake Watershed - 11030014									
Waterbody	**Segment**	**AL**	**CR**	**DS**	**FP**	**GR**	**IW**	**IR**	**LW**
Cheney Reservoir	**N/A**	**E***	**A**	**X***	**X**	**X**	**X***	**X**	**X**
Crow Creek	11	E	b	X	O	X	X	X	X
Dooleyville Creek	8	E	b	O	X	X	O	X	X
Goose Creek	10	S	b	O	X	X	O	X	X
North Fork Ninnescah River	**1**	**S***	**C**	**X**	**X**	**X**	**X**	**X**	**X**
North Fork Ninnescah River	**5**	**S***	**b**	**X**	**X**	**X**	**X**	**X**	**X**
North Fork Ninnescah River	**6**	**S***	**b**	**X**	**X**	**X**	**X**	**X**	**X**
Red Rock Creek	12	S	b	X	X	X	X	X	X
Silver Creek	7	S	b	X	X	X	X	X	X
Unnamed Stream	289	S	b	O	O	X	O	X	X
Wolf Creek	9	S	b	X	O	X	X	X	X

*Waterbodies in bold will be directly affected by implementation of this 9-Element Watershed plan. *Asterisks refer to a violation of designated use and a TMDL has been written.*

[3] Kansas Surface Water Register, 2013. Kansas Department of Health and Environment. https://www.epa.gov/sites/production/files/2014-12/documents/kswqs-register-2009.pdf

C. Special Aquatic Life Use Waters[4]

Special Aquatic Life Use (SALU) waters are defined as "surface waters that contain combinations of habitat types and indigenous biota not found commonly in the state, or surface waters that contain representative populations of threatened or endangered species." The SALU waters in the Cheney Lake Watershed include: North Fork Ninnescah River, Red Rock Creek, Silver Creek and an unnamed tributary to Silver Creek (**Figure 6**).

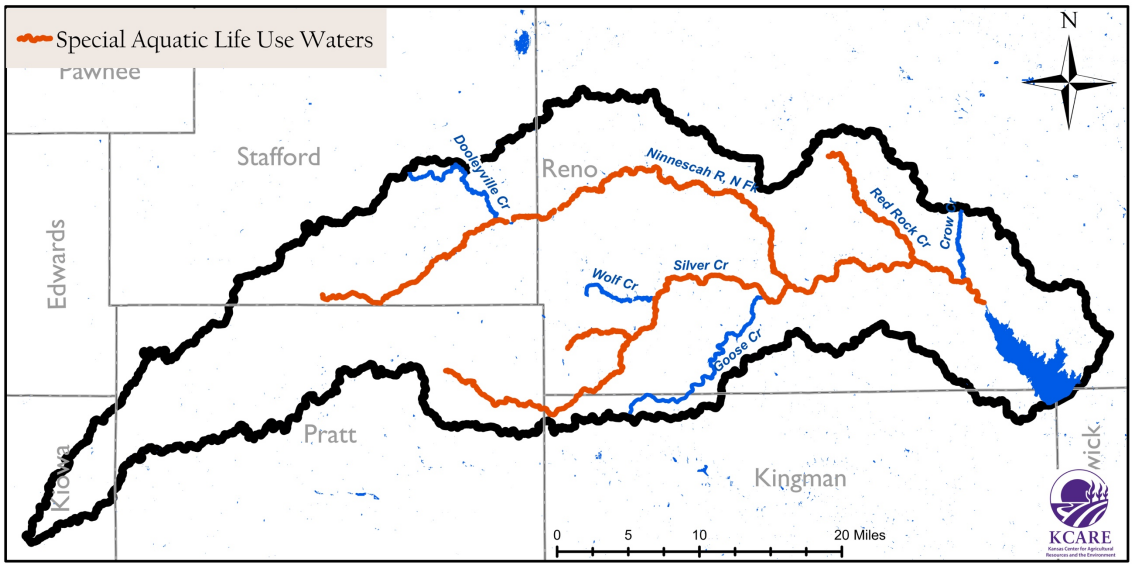


Figure 6. Special Aquatic Life Use Waters in the Cheney Lake Watershed

D. Exceptional State Waters[3]

Exceptional State Waters (ESW) are defined as "any of the surface waters or surface water segments that are of remarkable quality or of significant recreational or ecological value." There are no ESW-listed waters in the Cheney Lake Watershed.

E. Outstanding National Resource Waters[3]

Outstanding National Resource Waters (ONRW) are defined as "any of the surface waters or surface water segments of extraordinary recreational or ecological significance." The Cheney Lake Watershed does not contain any ONRW-listed waters.

F. Rainfall and Runoff

Rainfall amounts and duration affect sediment and nutrient runoff during high-intensity rainfall events, most of which occur in late spring and early summer. These time frames may coincide

[4] Kansas Surface Water Quality Standards K.A.R. 28-16-28. http://www.kdheks.gov/tmdl/download/Unofficial_Copy_SURFACE_WATER_QUALITY_STANDARDS_04.11.18.pdf

with planting periods when cropland has little or no crop residue; likewise, grasses are short and do not catch runoff. Both of these situations can lead to pollutants entering the waterways.

Using climate data for the cities of Hutchinson, Pratt, and Wichita (**Figure 7**), it was determined that the Cheney Lake Watershed averages 28 inches of rainfall annually (**Figure 8**). These cities are each 20-25 miles outside the watershed on the north (Hutchinson), southwest (Pratt), and east (Wichita), sides of the Cheney Lake Watershed. Therefore, average rainfall within the actual watershed boundaries may vary from the amounts shown here.

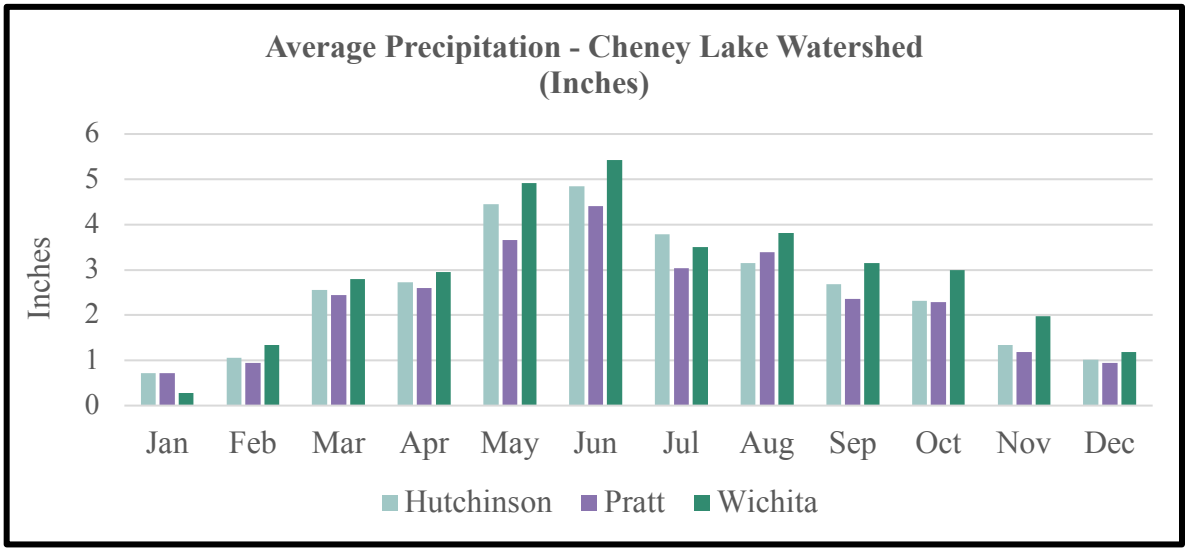


Figure 7. Cheney Lake Watershed Monthly Average Precipitation[5]

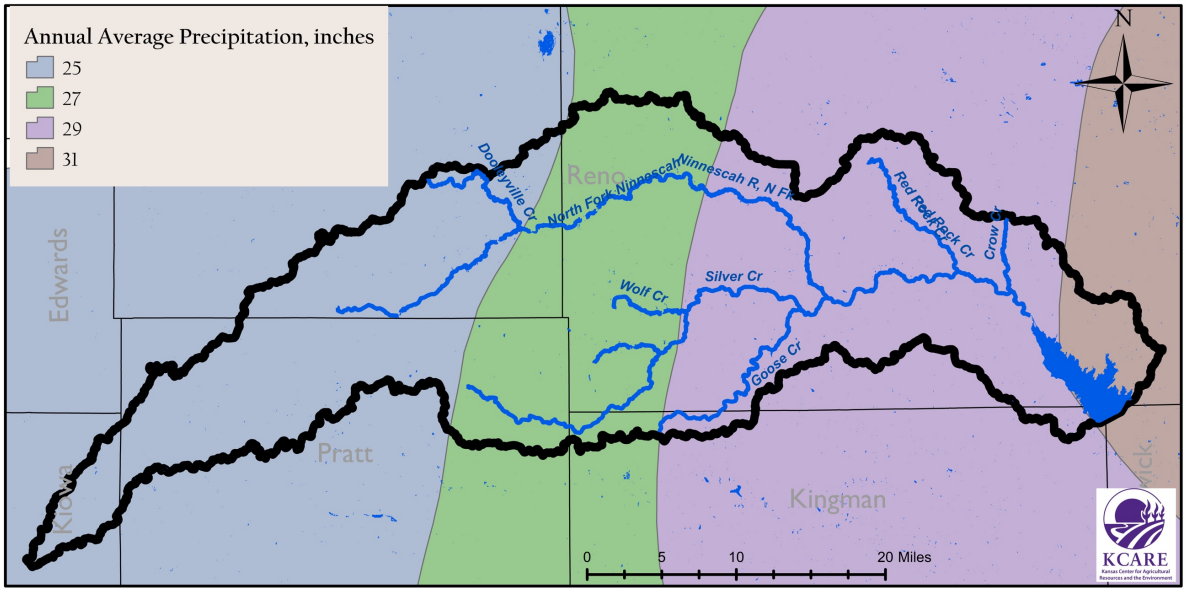


Figure 8. Annual Precipitation in the Cheney Lake Watershed

[5] U.S. Climate Data. https://USClimatedata.com

G. Population and Wastewater Systems

Most of the Cheney Lake Watershed is considered below-average population, and no major urban areas are located in the watershed (**Figure 9**). In fact, 99% of the watershed is used for agriculture. The total population for the Cheney Lake Watershed is estimated to be 7,534 (**Table 4**).

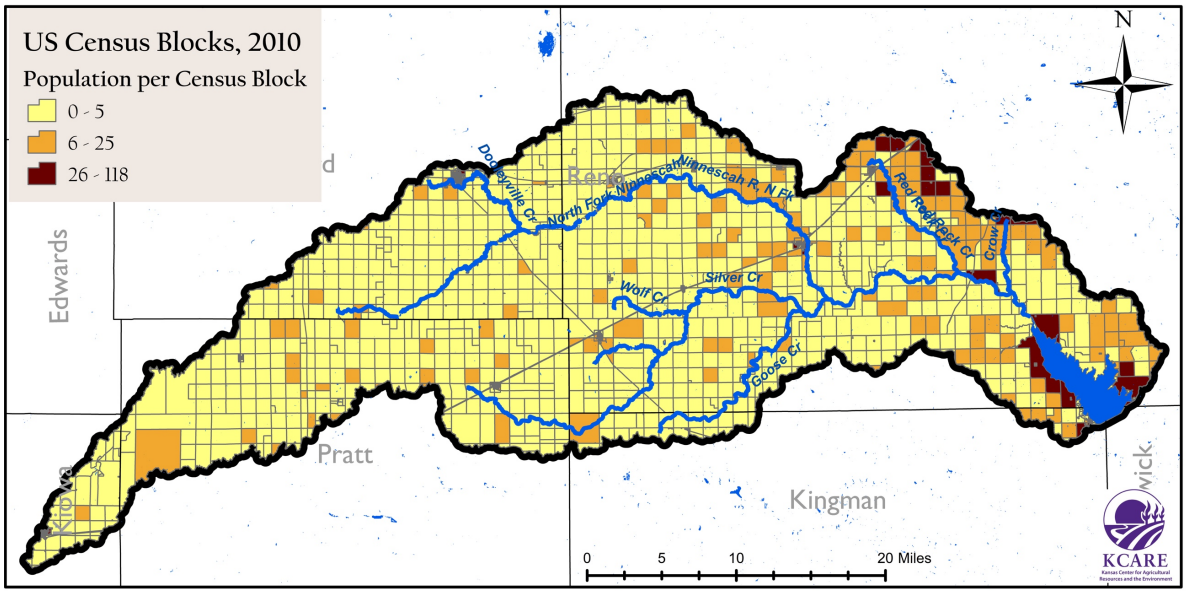


Figure 9. Cheney Lake Watershed Population Map

Table 4. Rural and Urban Populations Used to Determine Wastewater Systems

Cheney Lake Watershed Rural and Urban Populations		
Township	**2010**	**2018**
Abbyville	87	87
Arlington	473	453
Byers	35	35
Haviland	701	677
Langdon	42	40
Partridge	248	242
Penalosa	17	18
Plevna	98	97
Preston	158	150
Stafford	1,042	968
Sylvia	218	207
Turon	387	373
TOTAL URBAN POPULATION	3,506	3,347
TOTAL RURAL POPULATION	4,028	
Cheney Lake Watershed: TOTAL POPULATION	**7,534**	

*Numbers from 2018 listed in **Table 4** are estimates from the League of Kansas Municipalities, and are for informational purposes only. The 2010 U.S. Census data was utilized to calculate current population and wastewater systems in the watershed.*

The number of wastewater treatment systems is directly tied to population, particularly in rural areas without access to municipal wastewater treatment facilities. The lack of onsite wastewater systems, or systems that are failing or improperly installed, can lead to Fecal Coliform Bacteria (FCB) or other nutrients from untreated sewage leaking or draining into the watershed. Even though all the counties in the watershed have county sanitary codes, there is no way of knowing how many failing or improperly constructed systems exist in this watershed. Using a rural population of 4,028 and an estimated 2.29 people per rural Kansas household, it can be determined that there are approximately 1,759 onsite wastewater treatment systems installed in the watershed with a failure rate of roughly 20%.[6]

H. Aquifers

There are three aquifers associated with the Cheney Lake Watershed (**Figure 10**). Alluvial aquifers of the Ninnescah River and its tributaries exist throughout the Cheney Lake Watershed. Alluvial aquifers provide the primary water source for many public water supplies located within the watershed. Water quality in alluvial aquifers is generally good; however, nitrates, minerals, pesticides, and bacteria can be pollutant concerns. Portions of the Dakota Aquifer exist in the western portion of the Cheney Lake Watershed. Water from this aquifer is used for irrigation, public use, and rural-domestic water supply. Water from the Dakota Aquifer is good; however, chloride and sodium content increase with depth. The majority of the Cheney Lake Watershed overlays the High Plains Aquifer. Water from this aquifer is often used for irrigation. This water is typically high in mineral content, but in good condition with no dominating pollutants.

[6] Cooperative Extension Service, University of Kentucky, College of Agriculture. http://www2.ca.uky.edu/agcomm/pubs/HENV/HENV502/HENV502.pdf

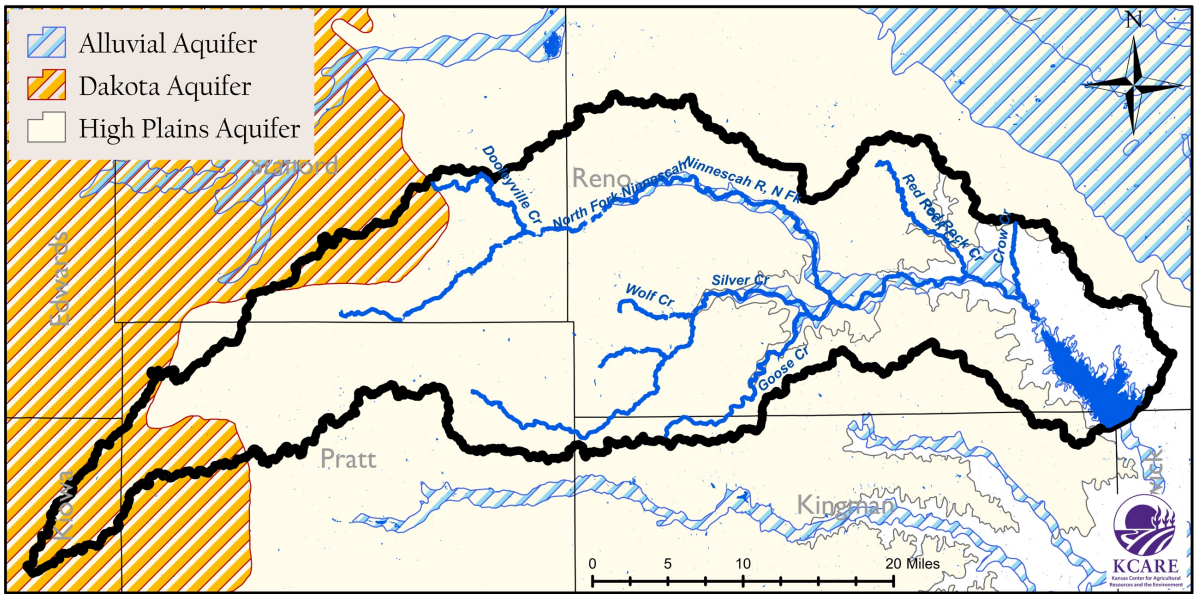


Figure 10. Aquifers in the Cheney Lake Watershed[7]

I. Public Water Supplies

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

Cheney Reservoir serves as the primary water supply for the City of Wichita and other communities that purchase water from Wichita. More than 430,000 people depend on this surface water source for at least 70% of their water supply (**Table 5**). The reservoir is impaired by siltation and eutrophication (excess nutrient loading), and both are a threat to the suitability of the sources as a public water supply.

The Cheney Lake Watershed is also the location for public water source wells for a number of small cities and public facilities. In Kansas, a public water supply system is defined by Kansas Statutes Annotated (K.S.A.) 65-162a and Kansas Administrative Regulations (K.A.R.) 28-15a-2 as a "system for delivery to the public of piped water for human consumption that has at least 10 service connections or regularly serves at least 25 individuals daily at least 60 days out of the year." These systems are regulated by the state's Public Water Supply Supervision (PWSS) program to assure safe and pathogen-free drinking water for citizens. Private domestic/residential groundwater wells are not considered a public water supply system and are not regulated by the PWSS.

[7] Kansas Geological Survey. http://www.kgs.ku.edu/HighPlains/atlas/atgws.htm

Source Water Protection

In 1996, every state was required to conduct a Source Water Assessment (SWA) on all public water supplies. In order to protect their source of drinking water, public water supplies were then encouraged by KDHE to develop a Source Water Protection Plan (SWPP). The Cheney Lake Watershed has 15 active PWS sites. Fourteen public water suppliers within the Cheney Lake Watershed were required to develop a SWA[8] in 2003; all 14 scored "low" to "moderate" Susceptibility Likelihood Scores (SLS) for each contaminant of concern category. These include the cities of Arlington (moderate), Cheney (low), Dutch Kitchen (low-moderate), Garden Plain (low), Haviland (low-moderate), Preston (low-moderate), Stafford (low-moderate), Sylvia (moderate), Turon (moderate) and Wichita (low-moderate). Other scores included Camp Kanza (low), Cheney State Park M & M Point (low), Fairfield High School (low-moderate) and Pilgrim Christian School (low-moderate).

Table 5. Cheney Lake Watershed Public Water Suppliers[9]

Public Water Suppliers	County	Population
Arlington, City of	Reno	453
Camp Kanza	Reno	
Cheney, City of	Sedgwick	2,170
Cheney State Park, M & M Point	Reno	
Cheney State Park, Marina	Reno	
Dutch Kitchen	Reno	
Fairfield High School	Reno	
Garden Plain, City of	Sedgwick	898
Haviland, City of	Kiowa	677
Pilgrim Christian School	Reno	
Preston, City of	Pratt	150
Stafford, City of	Stafford	968
Sylvia, City of	Reno	207
Turon, City of	Reno	373
Wichita, City of	Sedgwick	366,046
Wichita, City of - Consumers		
Andover	Sedgwick	13,111
Bentley	Sedgwick	525
Benton	Butler	873
Derby	Sedgwick	23,673
Eastborough	Sedgwick	754
Kechi	Sedgwick	2,007
Park City	Sedgwick	7,729
Rose Hill	Butler	3,980
Valley Center	Sedgwick	7,300
Total Population Served		**431,894**

[8] Kansas Department of Health and Environment, Source Water Assessment Reports. http://www.kdheks.gov/nps/swap/SWreports.html

[9] Kansas Department of Health and Environment, April 4, 2019

J. National Pollutant Discharge Elimination System (NPDES)

The National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources (PS) that discharge pollutants into surface waters and is regulated by KDHE. Individual homes that connect to a municipal system, use a septic system, or do not have a surface discharge, do not require a NPDES permit. However, industrial, municipal, and other facilities must obtain permits if their discharge goes directly to surface waters. Any pollutant discharge from PS allowed by the state is considered to be a wasteload allocation. Having these PS located on streams or rivers may impact water quality in the waterways.

Municipal wastewater can contain suspended solids, biological pollutants that reduce oxygen in the water column, inorganic compounds, or bacteria. Treatment of municipal waste water is similar across the country; wastewater treatment facilities remove solids and organic materials, disinfect water to kill bacteria and viruses, and discharge water to surface waterways.

Industrial point sources also can contribute toxic chemicals or heavy metals to waterways. Treatment of industrial wastewater is specific to the industry and the pollutant discharged. There are currently 18 permitted NPDES facilities in the Cheney Lake Watershed (**Table 6**).

Table 6. NPDES Permitted Facilities in the Cheney Lake Watershed[10]

NPDES Permitted Facilities in the Cheney Lake Watershed				
Facility Name	**Facility Type**	**Description**	**City**	**County**
Abbyville, City of	3 Cell Lagoon	Waste-Stabilization Pond	Abbyville	Reno
Arlington, City of	3 Cell Lagoon	Waste-Stabilization Pond	Arlington	Reno
Fairview Service Center	2 Cell Lagoon	Waste-Stabilization Pond	N/A	Reno
Haviland, City of	2 Cell Lagoon	Waste-Stabilization Pond	Haviland	Kiowa
KDWPT - Cheney Oxidation Pond #3	2 Cell Lagoon	Waste-Stabilization Pond	N/A	Reno
KDWPT - Cheney East Shore	3 Cell Lagoon	Waste-Stabilization Pond	N/A	Reno
KDWPT - Cheney West Shore	3 Cell Lagoon	Waste-Stabilization Pond	N/A	Kingman
KDWPT - Cheney State Park - Heimerman Point	2 Cell Lagoon	Waste-Stabilization Pond	N/A	Reno
Partridge, City of	3 Cell Lagoon	Waste-Stabilization Pond	Partridge	Reno
Plevna, City of	2 Cell Lagoon	Waste-Stabilization Pond	Plevna	Reno
Preston, City of	3 Cell Lagoon	Waste-Stabilization Pond	Preston	Pratt
Reno County Sewer Disrict #1	2 Cell Lagoon	Waste-Stabilization Pond	N/A	Reno
Southern Star Central Gas	Business Site	Industrial Wastewater	N/A	Stafford
St. Joseph Church	1 Cell Lagoon	Waste-Stabilization Pond	N/A	Reno
Stafford, City of	3 Cell Lagoon	Waste-Stabilization Pond	Stafford	Stafford
Sylvia, City of	3 Cell Lagoon	Waste-Stabilization Pond	Sylvia	Reno
Turon, City of	3 Cell Lagoon	Waste-Stabilization Pond	Turon	Reno
Unified Schoool District #310	1 Cell Lagoon	Waste-Stabilization Pond	N/A	Reno
** Kansas Department of Wildlife, Parks and Tourism (KDWPT)*				

[10] Kansas Department of Health and Environment, April 4, 2019

K. Livestock Operations in the Cheney Lake Watershed

1. Confined livestock

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

Table 7. Permitted Livestock Facilities in the Cheney Lake Watershed

Permitted Livestock Facilities	
County	**Quantity of Facilities**
Reno	23
Pratt	7
Kingman	4
Stafford	3
Kiowa	1
Total	38

Table 7 shows 38 active permitted livestock facilities in the five counties that house the Cheney Lake Watershed. Permitted facilities are required to have a management plan for containing and utilizing manure and lot runoff. Livestock waste facilities can be useful tools for managing livestock waste, but waste material must be land-applied from the containment facilities in a manner that does not jeopardize water resources. Within the Cheney Lake Watershed, producers should apply livestock waste by matching the phosphorus content of the waste with soil test recommendations to avoid over-application of phosphorus in areas prone to runoff.

2. Unconfined livestock

Unconfined areas of animal concentration such as watering areas, loafing areas or feeding areas also can pose a pollution potential if not managed properly. These are potential sources of nutrient, sediment and bacteria pollution. Management practices for these areas can include alternative water supplies, rotational grazing, proper mineral and feed placement, and proper manure application to cropland.

4. Impaired Waters in the Cheney Lake Watershed

Water quality in the Cheney Lake Watershed is monitored at four different sites (**Figure 11**). These sites include two USGS real-time monitoring stations, and two KDHE stations. The first of the USGS sites is located on the North Fork Ninnescah River above Cheney Reservoir, near the convergence point of Red Rock Creek with the North Fork Ninnescah River. There is a third USGS station located at the base of the reservoir. The KDHE monitoring sites consist of one permanent station near the convergence of the North Fork Ninnescah River and Crow Creek above the reservoir and also a lake monitoring station at the base of the reservoir.

Water samples from these monitoring sites are analyzed for nutrients, metals, ammonia, solid fractions, turbidity, alkalinity, chlorophyll, pH, dissolved oxygen, *E. coli* bacteria and chemicals. Sample analysis determines if the water contains an unacceptable level of the previously mentioned pollutants. If analysis determines that any one pollutant exceeds acceptable limits, the water segment then becomes "impaired" by that pollutant and is reported as a 303d-listed impairment. If the water segment affected by the pollutant is in dire need of reduction and is considered "high priority," it is then listed as a Total Maximum Daily Load (TMDL).

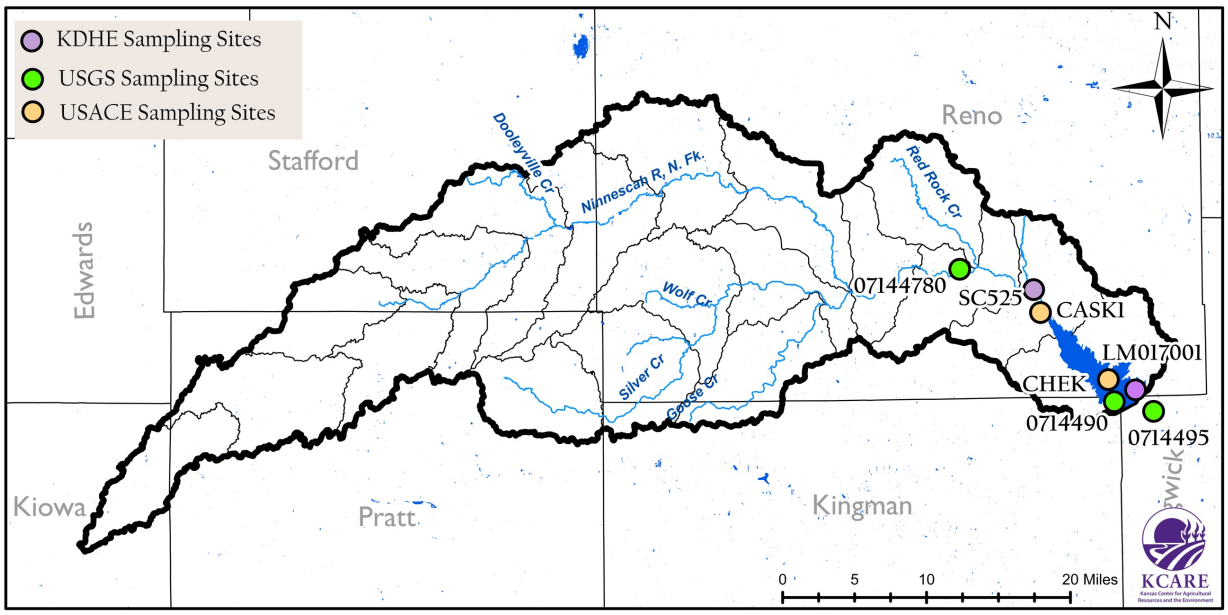


Figure 11. Cheney Lake Watershed Monitoring Sites

A. 303d List of Impaired Waters in the Cheney Lake Watershed

KDHE develops a "303d list" of impaired waters biennially and submits it to EPA. To be included on the 303d list, samples taken during the KDHE monitoring program must show that water quality standards are not met, which also means that designated uses are not met. **At this time, there are no 303d-listed waters in the Cheney Lake Watershed.**

B. Total Maximum Daily Loads (TMDL)

1. What is a TMDL?

A TMDL designation sets the maximum amount of pollutant that a specific body of water can receive without violating the surface water-quality standards, which would result in a failure to support their designated uses. TMDLs in Kansas may be established on a watershed basis and may use a pollutant-by-pollutant approach, a biomonitoring approach, or both as appropriate. TMDL establishment means that a draft TMDL has been completed, there has been public notice and comment on the TMDL, there has been consideration of the public comment, any necessary revisions to the TMDL have been made, and the TMDL has been submitted to EPA for approval. In a TMDL, the desired outcome of the process is indicated, using the current situation as the baseline. Deviations from the water quality standards will be documented. The TMDL will state its objective in meeting the appropriate water quality standard by quantifying the degree of pollution reduction expected over time.

In summary, TMDLs provide a tool to target and reduce point and nonpoint pollution sources. The goal of the WRAPS process is to address high-priority TMDLs. KDHE reviews TMDLs assigned in each of the 12 Kansas basins every five years on a rotational schedule. The Cheney Lake Watershed is part of the Lower Arkansas River Basin and was reviewed in 2018. It is scheduled for review again in 2023.

2. Cheney Lake Watershed TMDLs

To be issued a TMDL, water samples taken during the KDHE monitoring program indicate that water quality standards are not met. This in turn means that designated uses are not met.

The Cheney Lake Watershed has three TMDLs. Cheney Reservoir holds high-priority eutrophication and siltation TMDLs, while the North Fork Ninnescah River has a low-priority pH TMDL (**Table 8)**.

Table 8. TMDLs in the Cheney Lake Watershed[11]

TMDLs in the Cheney Lake Watershed				
Water Segment	**Impairment**	**Priority**	**Goal of TMDL**	**Sampling Station**
Cheney Reservoir	Siltation	High	Secchi Disc Depth ≥ 0.61 m	LM017001
Cheney Reservoir	Eutrophication	High	Summer Chlorophyll *a* ≤ 10 µg/L	LM017001
North Fork Ninnescah River	pH	Low	reading of 6.5 to 8.5	SC525

[11] Kansas Department of Health and Environment, 2018.
http://www.kdheks.gov/tmdl/2018/Approved_2018_303_d)_List_of_All_Impaired_Waters.pdf

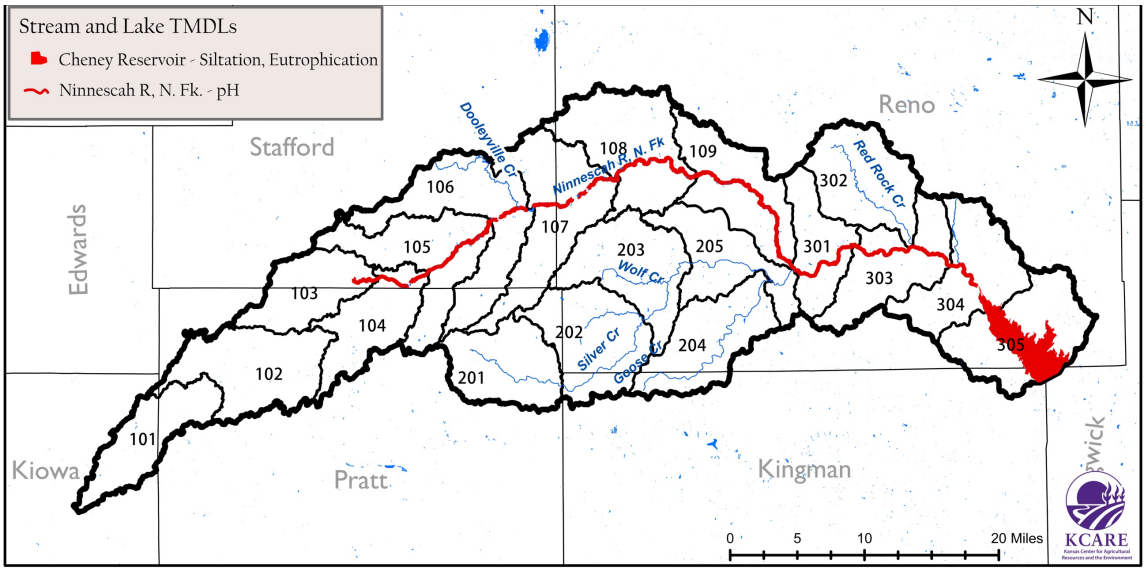


Figure 12. Waters with a TMDL in the Cheney Lake Watershed

5. Watershed Impairments to be Addressed

The Cheney Lake Watershed CMC acknowledges all TMDL water segments in the watershed. All goals and BMPs will be aimed at protecting the Cheney Lake Watershed from further degradation (**Table 9**). The CMC will focus this plan on three key TMDL-listed impairments:

- Silt (Sediment)
- Eutrophication (E): nitrogen and phosphorus
- pH

Table 9. Cheney Lake Watershed TMDL Impairment Loads and Goals

Load Allocations for the Cheney Lake Watershed				
Impairment/TMDL		**Current Load/year**	**Allowed Load/year**	**Required Reduction/year**
Silt/Sediment		226,500	203,850	22,650 tons
Eutrophication	**Nitrogen**	787,566	509,607	277,959 pounds
	Phosphorus	129,008	88,824	40,184 pounds
pH	**Nitrogen**	1.0 mg/L	1 mg/L	Unknown. Meeting the TMDL goal for E should have a positive effect on pH.
	Phosphorus	0.16 mg/L	0.14 mg/L	

Although pH will not be targeted directly by this WRAPS plan, it is expected that the North Fork Ninnescah River's pH TMDL will be impacted positively by nutrient and sediment BMP implementation in the targeted areas.

A. Sediment

The Cheney Lake Watershed has a "high" priority TMDL for the impairment of **siltation**[12] **(sedimentation)** in the Cheney Reservoir. Siltation refers to the deposition of sediment in the reservoir and the suspension of sediment within the reservoir's water. Based on KDHE's analysis of sediment data from USGS, approximately 235 acre-feet of sediment are deposited annually. Siltation reduces the reservoir's capacity for water storage. A decrease in storage in the reservoir affects domestic and industrial uses of the water. Since Cheney is a federal reservoir that serves a considerable portion of Kansas' population for recreational purposes and water supply, this TMDL has been designated as High Priority for implementation.

Suspended sediment makes the water cloudy or murky, which impacts water quality for aquatic life, recreational purposes and drinking water treatment. Suspended solids concentrations at the KDHE monitoring station LM017001 average 16.06 mg/L, with a range of 3.00 to 62.00 mg/L. Generally, it is desired to maintain TSS concentrations below 100 mg/L. The average turbidity is 24.5 (formazin turbidity unit), and the average transparency (Secchi disc depth) is 1.3 feet. To improve the quality of the water column and an implied reduction in loading, the

[12] Kansas Department of Health and Environment. http://www.kdheks.gov/tmdl/la/CheneySILT.pdf

goal set by KDHE would be to increase the average transparency as measured by the Secchi disc to two feet.

There are no point sources contributing sediment, therefore 100% of the load is allocated to non-point sources such as runoff from agricultural land. Sediment can originate from streambank erosion and sloughing of streambanks due to erosion and a lack of riparian cover. Sheet and rill erosion from cropping and pasture systems contribute sediment into the ecosystem as well. Therefore, reducing erosion is necessary to reduce sediment in Cheney Reservoir. In addition, nutrient pollutants, such as nitrogen and phosphorus, can attach to sediment particles or become dissolved in runoff water, causing higher than normal concentrations and accelerating eutrophication in Cheney Reservoir. The CMC hopes that the sediment BMPs incorporated in the watershed will reduce excess sediment and improve water clarity in the lake. *BMP implementation and load reductions in this report will refer to sediment and sedimentation, while the TMDL will refer to siltation.*

1. Sources of the impairment

Land-based activities affect sediment transported downstream to reservoirs. Physical components of the terrain, such as slope, propensity to generate runoff and soil type are important to sediment movement. Sediment transfer also can originate from alteration of stream channels, streambank erosion and sloughing of the sides of rivers and streambanks. A lack of riparian cover can cause washing on the banks of streams or rivers and enhance erosion. Animal movement, such as livestock regularly crossing a stream, can cause pathways that will erode. Silt is another source of sediment present in streams from past activities which gradually moves downstream with each high-intensity rainfall event. Maintenance and replacement of roads and bridges is also a source of impairment.

Land use

Land use activities have a significant impact on the types and quantity of sediment transfer in the watershed. Construction projects can leave disturbed areas of soil and unvegetated roadside ditches that can erode during a rainfall event. In addition, agricultural cropland using conventional tillage practices and lacking maintenance from agricultural BMP structures can have cumulative effects on land transformation through sheet and rill erosion. Sediment transfer also can be caused by degraded pastureland or streambank sloughing. Primary land uses in the areas this WRAPS plan will target for BMP implementation (see Section 6), are cropland (50%) and grassland (41%). Reducing erosion in these areas is necessary for a reduction in sediment loading.

Agricultural BMPs such as such as no-till, cover crops/forage crops, wetlands, grassed waterways, terraces and permanent vegetation will reduce erosion and improve water quality.

Soil erosion by wind and/or water

NRCS has established a “T factor” in evaluating soil erosion, where T represents the soil loss tolerance factor. It is defined as the maximum amount of erosion at which soil quality as a medium for plant growth can be maintained. It is assigned to soils without respect to

land use or cover and ranges from one ton per acre for shallow soils, to five tons per acre for deep soils that are not as affected by loss of productivity by erosion. T factors represent the goal for maximum annual soil loss in sustaining the productivity of land use.[13]

Riparian quality

An adequately functioning and healthy riparian area will reduce sediment flow from cropland and rangeland. Riparian areas can be vulnerable to runoff and erosion from livestock-induced activities in pastureland and overland flow from bare soil on cropland. Buffers and filter strips, along with additional vegetated riparian areas, can be used to impede erosion and streambank sloughing. Livestock restriction along the stream will prevent livestock from entering streams and degrading the banks. Cropland requires permanent vegetation adjacent to streams in order to impede the sediment flow from fields.

This WRAPS project will target the riparian corridor (one-quarter mile on each side of the water segment) of Crow, Dooleyville, Goose, Red Rock, Silver, and Wolf Creeks, as well as the North Fork Ninnescah River for BMP implementation.

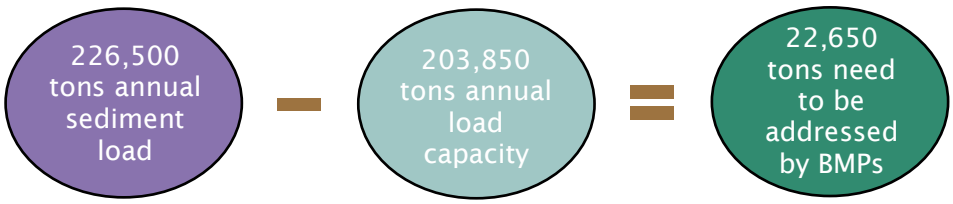
In the targeted areas, predominant land use in riparian areas is cropland (50%). This is the land that can be most vulnerable to runoff and erosion. Conservation tillage, such as no-till practices, are effective for slowing the flow of rainwater off of crop fields. The use of permanent vegetative buffers and wetland placement can impede erosion and streambank sloughing. As a result, the CMC decided to incorporate these BMPs into this WRAPS plan.

Rainfall and runoff

Rainfall amounts and the subsequent runoff can affect the sediment runoff from both agricultural and urban areas into streams and into Cheney Reservoir. In addition, high rainfall events can cause cropland erosion and sloughing of streambanks, adding sediment to streams and rivers that will flow ultimately into the reservoir.

2. Pollutant loads

The current estimated sediment load in the Cheney Lake Watershed is 226,500 tons per year, according to the TMDL section of KDHE. The total load reduction needed to meet the sediment TMDL is 22,650 tons of sediment, a reduction of 10%. **If all BMPs have been implemented by the end of this 25-year WRAPS plan, a reduction of 71,629 tons per year of sediment will have been saved.** This exceeds the TMDL goal by 316%.



[13] NRCS T factor. http://www.nrcs.usda.gov/technical/NRI/1997/summary_report/glossary.html and https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/kansas/KS155/0/Reno_KS.pdf

3. Which BMPs will be implemented to meet the TMDL?

The CMC has identified specific cropland and livestock BMPs which will result in significant nutrient pollutant reductions and are acceptable to watershed residents. Each agricultural BMP, such as no-till, cover crops/forage crops, nutrient management plan development, wetlands, grassed waterways, terraces and permanent vegetation will improve water quality by reducing nutrient runoff and attachment to soil. Providing alternate watering sites, relocating pasture feeding sites and pens away from streams, and the implementing rotational grazing will work to reduce nutrient loading from livestock areas. Specific acreages or projects requiring annual implementation have been determined through modeling and economic analysis and have been approved by the CMC (**Table 10**).

Table 10. BMPs to Prevent or Reduce Sediment Runoff and Erosion

BMPs to Reduce Sediment Runoff and Erosion		
Protection Measures	**Best Management Practices**	**Acres or Feet Treated Annually**
Prevention of sediment contribution from **cropland**	No-Till	378 acres
	Cover Crops	378 acres
	Nutrient Management	378 acres
	Wetlands	47 acres
	Grassed Waterways	473 acres
	Terraces	473 acres
	Permanent Vegetation	95 acres

Implementation of cropland BMPs in support of the sediment TMDL also works to reduce nitrogen and phosphorus leaching and pollutant loading, thereby positively impacting the eutrophication TMDL.

B. Eutrophication: Nitrogen and Phosphorus

The Cheney Lake Watershed has a "high" priority TMDL for the impairment of **eutrophication**[14] in Cheney Reservoir. Excess nutrient loading (primarily nitrogen and phosphorus) causes eutrophication which creates conditions favorable for algal blooms and aquatic plant growth. The algal blooms can lead to low dissolved oxygen and an unpleasant taste and odor, even in treated water. Taste and odor problems are of special concern for the City of Wichita and its residents. Although the City has completed construction of an ozone treatment plant to reduce taste and odor problems in raw water, treatment levels and the resulting expenses can be reduced through management of phosphorus entering the reservoir.

Since Cheney Reservoir is a federal reservoir serving a considerable portion of Kansas' population for recreational purposes and water supply, this TMDL has been designated as High Priority for implementation.

[14] Kansas Department of Health and Environment. http://www.kdheks.gov/tmdl/2015/Cheney_Eu.pdf

Excess nutrients originate from fertilizer and manure runoff in rural and urban areas. In the Cheney Lake Watershed, agricultural land use, and small livestock operations all contribute excess nutrients to the watershed system.

The USGS sampling data from the reservoir indicates a rise in chlorophyll *a* during summer and fall months with an average of 12.5 µg/L (2001 -2014). Desired levels are less than or equal to 10 µg/L. Increases of chlorophyll *a* can be accredited to nutrients that attach to sediment which in turn run into water segments during runoff events. This water ultimately ends up in the reservoir. Increased chlorophyll *a* can result in algal blooms and aquatic plant growth. This growth may increase oxygen levels temporarily, but the bloom will die off eventually after nutrients become scarce. During this die-off, there are reduced dissolved oxygen levels in the water because algal decomposition utilizes the oxygen. This results in an unfavorable habitat for aquatic life. Desirable criteria for healthy water dictate dissolved oxygen rates greater than 5 mg/L and biological oxygen demand (BOD) less than 3 mg/L.

1. Sources of the impairment

Nutrient loading can originate in both rural and urban areas and can be caused by both point and nonpoint sources. This plan focuses primarily on agricultural nonpoint source contributions, even though other possible sources will be included as part of the discussion.

Land Use

Land use activities can affect nutrient runoff into streams. Fertilizer or manure applied to frozen ground or cropland prior to a rainfall event can be transported easily downstream. Livestock allowed access to streams to drink or loaf will contribute manure directly into the stream. Overgrazed pastures do not provide adequate biomass to trap manure runoff.

Agricultural BMPs that will help reduce nutrient runoff include: no-till, cover crops/forage crops, nutrient management plan development, wetlands, grassed waterways, terraces, permanent vegetation on cropland, providing off-stream watering sites with fenced streams and ponds, relocating pasture feeding sites away from streams, relocating feeding pens away from streams, and implementing rotational grazing on land used for livestock.

Wastewater treatment facilities

KDHE permits and regulates wastewater treatment facilities. National Pollutant Discharge Elimination System (NPDES) permits specify the maximum amount of pollutants allowed to be discharged to surface waters. There are 21 NPDES facilities in the watershed at the time of this document's publication.

Population

Watershed population can affect nutrient runoff. There are roughly 1,759 wastewater systems estimated in the Cheney Lake Watershed, mainly in rural areas. Although the functional condition of these systems is generally unknown, it is projected that nearly 20% may be failing; onsite wastewater could be an area of possible pollution contribution for evaluation over time.

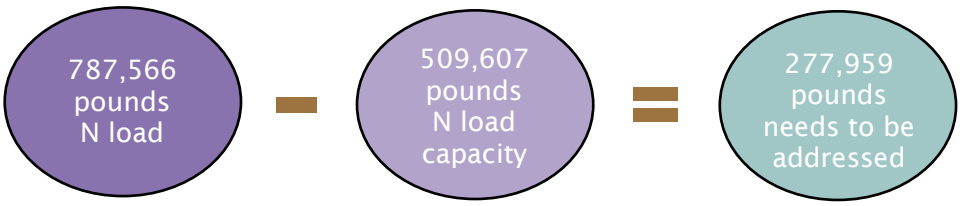
Confined Animal Feeding Operations
In Kansas, animal feeding operations (AFOs) with greater than 300 animal units (AUs) and less than 1,000 AUs must register with KDHE. An AU is an equal standard for all animals based on size and manure production. For example: one AU equals one animal weighing 1,000 pounds. Confined animal feeding operations (CAFOs) are those with more than 999 AUs, and they must be federally permitted. There are certified or permitted AFOs and CAFOs spread throughout the watershed. There are also numerous small livestock farms (below 300 AUs) that contribute to the nutrient loads.

Grazing density
Approximately 41% of the watershed is grasslands. Grassland in this area of Kansas is a highly productive forage source for beef cattle. Grazing density affects grass cover and potential manure runoff: an overgrazed pasture will not have the needed forage biomass to trap and hold manure in a high rainfall event. Also, allowing cattle to drink and loaf in streams increases the occurrence of nutrients and *E. coli* bacteria in the waterway. Grazing density ranges from 12.5 to 14.3 cattle per 100 acres across the watershed.[15] This is considered to be medium density when compared with statewide density numbers.

Rainfall and runoff
Rainfall amounts and subsequent runoff affect nutrient runoff from agricultural and urban areas into streams and Cheney Reservoir. The amount and timing of rainfall events affects manure runoff from livestock that are allowed access to streams, or manure applied before a rainfall or on frozen ground. Therefore, it is important to maintain adequate grass density to slow the runoff of manure over pastures.

2. Pollutant loads

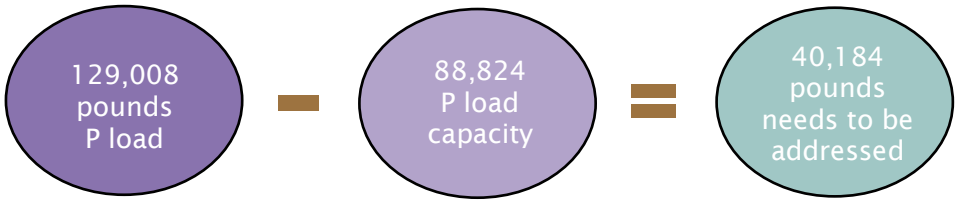
Nitrogen
The annual current estimated nitrogen load in the Cheney Lake Watershed is 787,566 pounds, according to the TMDL section of KDHE.[16] The amount of nitrogen (N) in the watershed contributes to the eutrophication TMDL. It has been determined that a 65% N reduction is necessary to meet the TMDL, which equates to an annual reduction of 277,959 pounds. **If all BMPs have been implemented, it will reduce 119,540 pounds of N from the watershed by the end of this 25-year plan.** This equates to meeting 43% of the TMDL goal.



[15] National Agricultural Statistics Service, United States Department of Agriculture, 2002.
[16] Kansas Department of Health and Environment. March 2019.

Phosphorus

The current estimated phosphorus (P) load in the Cheney Lake Watershed is 129,008 pounds per year, according to the TMDL section of KDHE.[17] The amount of P in the watershed contributes to the eutrophication TMDL. The total load reduction needed to meet the phosphorus TMDL is 40,184 pounds of phosphorus per year, a reduction of 69%. **If all BMPs have been implemented, it will reduce 71,415 pounds of P from the watershed by the end of this 25-year plan.** This exceeds the required reduction goal by 178%.



3. What BMPs will be implemented to meet the TMDL?

The CMC has identified specific cropland and livestock BMPs which will result in significant nutrient pollutant reductions and are acceptable to watershed residents. Each agricultural BMP, such as no-till, cover crops/forage crops, nutrient management plan development, wetlands, grassed waterways, terraces and permanent vegetation will improve water quality by reducing nutrient runoff and loading. Providing alternate watering sites, relocating pasture feeding sites and pens away from streams, and implementing rotational grazing also will work to reduce nutrient loading from livestock areas. Specific acreages or projects needing annual implementation have been determined through modeling and economic analysis and have been approved by the CMC (**Table 11**).

Table 11. BMPs to Prevent and/or Reduce Nutrient Runoff and Loading

BMPs to Reduce Nutrient Loading		
Protection Measures	**Best Management Practices**	**Acres or Feet Treated Annually**
Prevention of nutrient contribution from **cropland**	No-Till	378 acres
	Cover Crops	378 acres
	Nutrient Management	378 acres
	Wetlands	47 acres
	Grassed Waterways	473 acres
	Terraces	473 acres
	Permanent Vegetation	95 acres
Prevention of nutrient contribution from **livestock areas**	Relocate Pasture Feeding Sites	1 project per year
	Off-Stream Watering System	3 projects per year
	Rotational Grazing	2 projects per year
	Relocate Feeding Pens	1 project every other year

[17] Kansas Department of Health and Environment. March 2019.

Implementation of cropland BMPs in support of the sediment TMDL also works to reduce nitrogen and phosphorus leaching and loading. This will impact the watershed in a positive way by reducing pollutant loads.

C. pH[18]

The North Fork Ninnescah River has a "low" priority TMDL for **pH**. A pH measurement indicates whether a solution is acidic or alkaline as measured on a scale of 0 to 14. A reading of 7 is neutral; lower numbers indicate increasing acidity, and higher numbers indicate alkalinity. Water quality standards for the State of Kansas indicate that artificial sources of pollution shall not cause the pH of any surface water outside of a zone of initial dilution to be below 6.5 and above 8.5 (KAR 28-16-28e(c)(2)(C)). These standards are established as "fully supporting aquatic life," as most aquatic life is adapted to a specific range of pH levels. Extreme pH can have a negative impact on fish, aquatic insects and other aquatic life. High pH may also increase the toxicity of other substances.

The main stem of the North Fork Ninnescah River (from the reservoir and to a point near Stafford) and the tributaries of Goose, Red Rock and Silver Creeks have consistent pH readings above 8.5 during the spring, summer and early fall. These streams are clear, shallow and wide with a sandy substrate allowing for light penetration and warming of the water. When sufficient nutrients are available, these conditions support the growth of phytoplankton primarily during the spring, summer, and early fall.

When phytoplankton take up carbon dioxide and release oxygen during photosynthesis, it results in a pH increase that peaks in the afternoon, when the greatest amount of radiant energy reaches the river. The pH impairment in the North Fork Ninnescah River is linked to nitrate and phosphorus levels. Algae can be active beyond the growing season, as well. A look at other USGS data indicates periods in winter where pH levels jump over 8.5, indicating some photosynthesis is occurring. Although this is predominantly a summertime event, it is not strictly seasonal to the exclusion of occurrences during other months according to the Watershed Planning Section of KDHE.

KDHE has set an interim management goal for this TMDL to reduce nitrate and phosphorus averages from 1.0 mg/L and 0.16 mg/L to 1.0 mg/L and 0.14 mg/L, respectively. The load allocation from point sources (municipal waste treatment facilities) is 3.2 pounds/day for nitrate and 0.45 pounds/day for phosphorus. The load allocation from non-point sources (agricultural runoff, animal waste and household septic systems) is 27-432 pounds/day for nitrate and 3.8-60 pounds/day for phosphorus. It is anticipated that a reduction in nutrient availability, as set forth in this plan by the nutrient load reduction goals, will indirectly reduce spikes in pH levels. KDHE has stated that this TMDL's desired condition is for less than 10% of future samples to have a pH greater than 8.5.

Nutrient BMPs listed to improve the eutrophication TMDL also will serve to reduce the nitrogen and phosphorus entering the North Fork Ninnescah River, which causes high pH

[18] Kansas Department of Health and Environment. http://www.kdheks.gov/tmdl/la/NFNinnescah.pdf

levels in the stream. Implemented sediment BMPs will result in a decrease in nutrient leaching which will subsequently improve the pH TMDL.

D. Soil Health in the Cheney Lake Watershed

In addition to the implementation of traditional conservation practices, the Cheney Lake Watershed WRAPS plan and CMC will emphasize soil health principles that build soil structure, increase infiltration and provide for living roots in the soil as much as possible.

Water-induced soil erosion and the resulting loss of nutrients cannot be addressed solely with conventional conservation practices such as terraces and waterways. The 2017 USGS publication states that "substantial suspended-sediment loads have been delivered to Cheney Reservoir during very short time periods with extreme hydrological condition. Forty-one percent of the sediment load transported to Cheney Reservoir during 1966-2013 was delivered during 8 days (Stone and others, 2015)."[19]

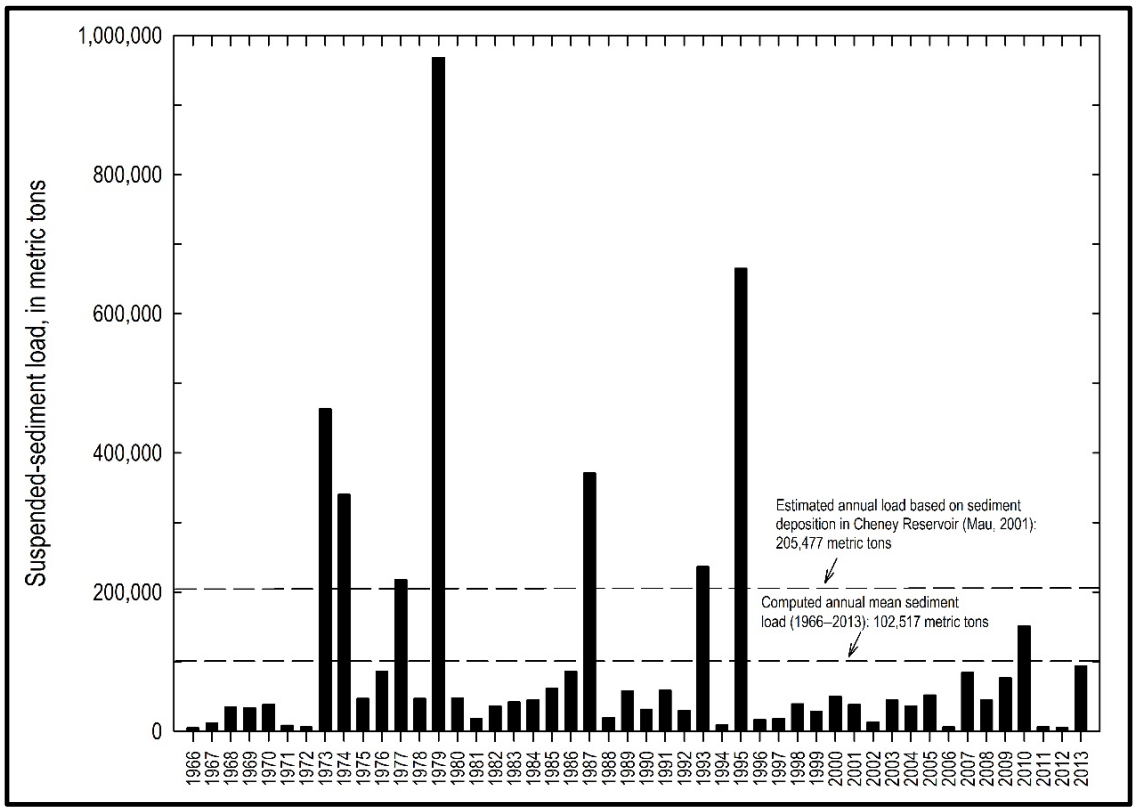


Figure 13. Suspended Sediment Load from 1966 to 2013[20]

[19] USGS Publication: *Twenty Years of Water-Quality Studies in the Cheney Reservoir Watershed, Kansas, 1996-2016, 2017.*

[20] Computed annual suspended-sediment loads using the suspended-sediment concentrations from the daily streamflow-only mode (that was based on 1970-2-12 data) at the North Fork Ninnescah River, upstream from the Cheney Reservoir (USGS Station 07144780), south central Kansas, during 1966 through 2013. 2017 USGS publication: *Twenty Years of Water-Quality Studies in the Cheney Reservoir Watershed, Kansas, 1996-2016.*

If predicted climatological changes lead to more frequent and extreme hydrologic events, then it becomes even more important for watershed management strategies to address these large, infrequent events.

The Cheney Lake Watershed WRAPS plan identifies several practices that may be implemented including no-till farming with cover crops, the restoration or creation of wetlands, traditional structural practices, and the conversion of cropland to permanent vegetation. However, the farmer or landowner should be encouraged to employ a farming system that incorporates many practices that build soil health: reduced tillage, living roots in the soil, diversity of crops and cover crops, soil that is covered, and the integration of livestock into the cropping system whenever possible.

Tillage destroys soil structure because it breaks soil aggregates into smaller and smaller particles with limited pore space to allow for air and water infiltration. Tillage also disrupts biological life within the soil; these are the very source of the substances acting as glue for aggregate stability. No-till farming must be accompanied by practices that cover the soil and provide living roots as much as possible. Crop residue and cover crops provide protection from rain, wind, run-off water and extreme temperatures. Living roots increase soil stability and enhance the biological component of living soils.

By integrating livestock into a diverse cropping system, landowners can build diversity of soil microorganisms, beneficial insects and other aspects of the biological community. By placing livestock within a cropping system, the land manager also can reduce the accumulation of manure in pens and lots, decrease the use of fossil fuels used for feeding and hauling waste, reduce the impact on native and planted pastures, enhance nutrient cycling, and, perhaps, improve farm profitability.

E. Other Concerns in the Cheney Lake Watershed

The CMC is concerned with some watershed issues not directly related to impaired waters. KDWPT personnel at the Cheney Reservoir and Wildlife Area cite major concerns including shoreline erosion, control of invasive species (sericea lespedeza, eastern red cedar, Russian olive, white perch, zebra mussels, etc.), and road maintenance. These are issues that the CMC would like to address if funding becomes available in the future.

Please note that no cost analysis has been completed for these actions. Potential partners to achieve the goals might include: KDWPT, Bureau of Reclamation, City of Wichita, Cheney Lake Watershed, Ninnescah Sailing Association, the State of Kansas and the Cheney Lake Association.

1. Shoreline erosion

The overarching goal is to minimize water quality impacts to the reservoir from KDWPT land adjacent to the reservoir. The objectives are to reduce erosion, siltation, and nutrient loading from KDWPT land. Methods to achieve these objectives could include the following measures:

- Stabilize eroding shorelines with riprap or other structures that protect the shoreline.
- Reduce tillage and increase residue or living crops (cover crops) on cropland.

Figure 14. Shoreline Erosion at Cheney Reservoir

2. Invasive species in the Cheney Lake Watershed

The CMC would like to reduce the expansion of certain varieties of plant and animal life that tend to be *invasive* and have a negative effect on biodiversity.

Invasive species are defined as any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem and whose introduction does or is likely to cause economic or environmental harm, or harm to human health. Invasive species can come from other regions of the U.S., or another country. They become problematic because they are beyond their natural range with no natural predators to control their population growth.[21] Once established, an invasive plant species can alter the soil structure permanently, disrupt native plant communities, reduce dependent wildlife populations, and impact long-term productivity.

a. Sericea lespedeza

The legislature declared sericea lespedeza, or Chinese bush clover, a state-wide noxious weed on July 1, 2000. Noxious weed control, especially sericea lespedeza control, is an ongoing fight for landowners in the Cheney Lake Watershed. The watershed has 256,824 acres of grass/pasture/hay. An increasing number of these acres have sericea lespedeza present.

[21] Kansas Forest Service. https://www.kansasforests.org/forest_health/invasivespecies.html

Individual stems of a sericea lespedeza plant can produce in excess of 1,000 seeds which can remain viable in the soil for 20 years or longer. Established sericea plants will reduce or eliminate competing vegetation. Sericea requires more water to produce foliage than other warm-season plants, creating a "drought" for competing vegetation. In addition to competing for light, water and nutrients, sericea plants also produce allelopathic chemicals which inhibit seed germination and growth of some plants, such as big bluestem, Indian grass, Kentucky bluegrass, bermudagrass, fescue, and ryegrass.

Invasive plant species will not be addressed directly by this WRAPS plan, as the plan focuses on high-priority TMDLs and water quality issues. However, the CMC does view invasive plants as a major concern in the watershed and would like to address this in the future should another source of funding become available.

The CMC would like to provide an incentive to landowners to control sericea lespedeza and leave their land in grass. It is hoped that providing an incentive for landowners to maintain their land in grass will lead to fewer acres converted to cropland. Land in grass provides better sediment control than cropland, thereby protecting nearby streams and lakes from sediment erosion and nutrient leaching.

b. Eastern red cedar[22]

During the Dust Bowl drought of the 1930s, the Prairie States Forest Project encouraged farmers to plant eastern red cedars in shelterbelts (windbreaks) throughout the Great Plains. It has since invaded virtually all of Kansas' plant communities. In the absence of fire, eastern red cedar thrives and may eventually dominate the prairie vegetation.

Research has shown that red cedar is a dominant factor in displacing grassland birds and songbirds from the native prairie, and as few as three red cedar per acre will displace some birds (prairie chickens) from their habitat. Red cedars can provide some value to wildlife, but the value is generally not unique and often can be fulfilled by other vegetation. As cedars invade, vegetation that supplies food and nesting cover for quail and mast (acorns) for turkey and deer are forced out. Turkeys routinely abandon roost sites that have grown up into red cedars. Areas infested with cedars often attract raccoons, opossums, skunks and snakes, which displace bobwhite quail coveys and turkeys mainly through nest predation.

Eastern red cedar has spread aggressively in poorly managed rangeland due to the lack of prescribed fire management, as well as a lack of appreciation for prairie and shrubland ecosystems and indigenous wildlife. Eastern red cedars are likely to continue their expansion as a result of urban development and landscape fragmentation, but mostly due to the exclusion of prescribed burning. Prescribed fire management

[22] Natural Resources Conservation Service.
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ks/newsroom/features/?cid=nrcseprd468806

promotes plants preferred by wildlife for food and habitat. The cost of doing nothing to control red cedar increases every year, therefore prescribed burning should be a method utilized to prevent the red cedar from taking over rangelands.
This WRAPS plan does not provide funding to reduce the red cedar population. Federal funding is available to incentivize prescribed burning and for the mechanical and chemical control of invasive tree species. The City of Wichita provides some funding for these practices through the Cheney Lake Watershed. In addition, Cheney Lake Watershed provides support for local Prescribed Burn Associations to execute prescribed burns and to educate landowners.

c. White perch

White perch are native to the Atlantic coast region and it is not known how they were introduced to Kansas. According to KAR 115-18-10, it is illegal to possess live white perch. It is also illegal to release the fish from one water body into another. White perch are a problem and considered a nuisance because they have been associated with declines in crappie, walleye and white bass populations as they destroy the spawning efforts of these fish. They feed heavily on baitfish utilized by other species. White perch can out-compete native fish for food and space, and they hybridize with white bass.

White perch are spread easily by illegal release. It is illegal to release fish taken from one body of water into another. Angler harvest can be an effective way to control white perch. When a white perch is caught, they should not be released, but rather eaten or disposed of properly.[23]

This WRAPS plan does not provide funding to reduce the white perch population in Cheney Reservoir. Therefore, if alternate funding should become available, the CMC could use it to increase awareness and provide education on the white perch and how to limit their procreation.

d. Zebra mussels

Zebra mussels are native to the Black and Caspian Seas in Europe. They were introduced into the Great Lakes in 1988 from the ballast water of ships. Zebra mussels have become widespread throughout the midwestern US.

Zebra mussels look like small clams, usually less than an inch long with a D-shaped shell. Usually the shell is yellowish-brown with alternating dark and light stripes. Zebra mussels use sticky byssal threads to attach tightly to any hard surface.

[23] Kansas Department of Wildlife, Parks and Tourism. https://ksoutdoors.com/Fishing/Aquatic-Nuisance-Species/Aquatic-Nuisance-Species-List/White-Perch

They are a problem because they filter water (up to a liter a day) to eat plankton. Although this filtering action may clear up the water, clear water does NOT mean clean water; the clear water zebra mussels leave behind will often lead to algal blooms that are harmful to people. The clear water can also allow UV rays to damage fish eggs laid during the spawn. Larval fish and native mussels rely on the same plankton consumed by zebra mussels to survive. Zebra mussels also clog pipes by forming colonies inside of the pipes, which impedes water flow. Nationwide expenditures to control zebra mussels in electric generating plants are estimated at $145 million annually.

Contrary to some beliefs, zebra mussels are not spread by birds. Transport by people, even though it is illegal, is the primary vector for the spread of zebra mussels to unconnected waters. Zebra mussels will attach to a solid substrate and can be transported easily on recreational equipment. Their larvae (veligers) are so small they cannot be seen without a microscope. The veliger floats in a water column for one to five weeks. As it grows, it begins to sink and search for a hard surface on which to live and grow.

Zebra mussels cannot be controlled in the wild. Chemicals can be used to kill zebra mussels, but if these chemicals were used in an open lake or reservoir, they would affect fish and native mussels. The first successful eradication of zebra mussels in the wild took place in Virginia. It was costly and detrimental to native mussels. To prevent the spread of zebra mussels, drain all of the water from boats, live wells, and bait wells. Lake visitors and boaters should inspect their boat's hull and trailer thoroughly for any zebra mussels and remove them. Boating, skiing and swimming equipment should be washed with 140-degree water and left to sit for five days.[24]

The Cheney Lake Watershed WRAPS plan does not provide funding to control or prevent zebra mussels in the reservoir. However, if alternate funding should become available, the CMC could use it to provide education on how to prevent the spread of these invasive mussels.

3. Road maintenance

The overarching goal is to minimize water quality impacts to the reservoir from KDWPT land adjacent to the reservoir. The objectives are to reduce erosion, siltation and nutrient loading from KDWPT land. One way of accomplishing this could be to stabilize and maintain roadways, prevent off-road traffic and close unnecessary roads.

[24] Kansas Department of Wildlife, Parks and Tourism. https://ksoutdoors.com/Fishing/Aquatic-Nuisance-Species/Aquatic-Nuisance-Species-List/Zebra-Mussels

6. Targeted Areas

Implementing BMPs is a necessity for improving a watershed's water quality. All fields, pastures and feed lots are susceptible to runoff waters to some degree; these can contribute sediment and nutrients to nearby water segments. However, some crop fields, pastures, and feed lots are more susceptible than others: these include areas with close proximity to streams, soils more prone to erosion and nutrient leaching, high water flow areas along streams, etc. Areas such as these are considered "high priority" and are targeted for BMP implementation. It has been determined that focusing BMP implementation in high-priority areas offers greater improvement in water quality since these areas are generally the major contributors to non-point source pollution and, ultimately, 303d and TMDL listings.

A. Studies Conducted to Determine Targeted Areas

1. Soil and Water Assessment Tool (SWAT): Kansas State University

The SWAT is a physically based, deterministic and continuous watershed-scale simulation model. It was developed by USDA-ARS from numerous equations and relationships evolved from years of runoff and erosion research in combination with other models used to estimate pollutant loads from animal feedlots, fertilizer and agrochemical applications, etc. The SWAT model has been tested for a wide range of regions, conditions, practices, and time scales; an evaluation of monthly and annual streamflow and pollutant outputs indicate that SWAT functioned well in a wide range of watersheds.

The model directly accounts for many types of common agricultural conservation practices. These include terraces and small ponds; management practices, including fertilizer applications; and common landscape features, including grass waterways. It incorporates various grazing management practices by specifying the amount of manure applied to pasture or grassland, grazing periods and amount of biomass consumed or trampled daily by livestock. Septic systems as well as NPDES discharges and other point sources are considered combined point sources and applied to inlets of sub-watersheds. Evaluation of monthly and annual streamflow and pollutant outputs indicate SWAT functioned well in a wide range of watersheds and is a good tool for assessing rural watersheds in Kansas.

The Cheney Lake Watershed was assessed in 2009 using SWAT by Kansas State University's Department of Biological and Agricultural Engineering. The SWAT was used as an assessment tool to estimate annual average pollutant loadings such as nutrients and sediment that flow from land into streams. At the end of simulation runs, the average annual loads were calculated for each sub-watershed. Some areas had higher loads than the others. Based on experience and technical knowledge, the areas or sub-watersheds with the top 20-30% of the highest loads among all areas within the watershed were selected as critical (targeted) areas for cropland and livestock BMPs implementation.

ArcSWAT version 2009.93.5 with the ArcGIS version 9.3 interface was used. This version uses spatially distributed data on topography, soils, land cover, land management, and weather to predict water, sediment, nutrient, and pesticide yields. A modeled watershed is divided spatially into sub-watersheds using digital elevation data according to the drainage area specified by the user. Sub-watersheds are modeled as having non-uniform slope, uniform climatic conditions determined from the nearest weather station, and they are further subdivided into lumped, non-spatial hydrologic response units (HRUs) consisting of all areas within the sub-watershed having similar soil, land use, and slope characteristics. The use of HRUs allows slope, soil, and land-use heterogeneity to be simulated within each sub-watershed but ignores pollutant attenuation between the source area and stream and limits spatial representation of wetlands, buffers, and other conservation practices within a sub-watershed.

The model includes sub-basin, reservoir, and channel routing components:

- The **sub-basin component** simulates runoff and erosion processes, soil water movement, evapotranspiration, crop growth and yield, soil nutrient and carbon cycling, and pesticide and bacteria degradation and transport. It allows simulation of a wide array of agricultural structures and practices, including tillage, fertilizer and manure application, subsurface drainage, irrigation, ponds and wetlands, and edge-of-field buffers. Sediment yield is estimated for each sub-basin with the Modified Universal Soil Loss Equation (MUSLE). The hydrology model provides estimates of runoff volume and peak runoff rates. The crop management factor is evaluated as a function of above-ground biomass, residue on the surface, and the minimum C factor for the crop.
- The **reservoir component** detains water, sediments, and pollutants, and degrades nutrients, pesticides and bacteria during detention. This component was not used during the simulations.
- The **channel component** routes flows, settles and entrains sediment, and degrades nutrients, pesticides and bacteria during transport. SWAT produces daily results for every sub-watershed outlet, each of which can be summarized to provide daily, monthly, and annual load estimates. The sediment deposition component is based on fall velocity, and the sediment degradation component is based on Bagnold's stream power concepts. Bed degradation is adjusted by the USLE soil erodibility and cover factors of the channel and the floodplain. The sediment deposition was utilized in the simulations, but the channel degradation and nutrient degradation components were not.

Data for the Cheney Lake Watershed SWAT model were collected from a variety of reliable online and printed data sources and knowledgeable agency personnel within the watershed. Input data and their online sources are:

- 30-meter DEM (USGS National Elevation Dataset);

- 30-m USDA National Crop Data Layer from 2006, 2007, 2008, and 2009 were combined to produce spatially distributed cropping system information (USDA-NRCS);
- Soil Survey Geographic (SSURGO) soil dataset (USDA-NRCS);
- NCDC NOAA daily weather data (NOAA National Climatic Data Center);
- Point sources from KDHE were assessed based on permitted discharges and interviews with discharge system operators. The discharges were minimal relative to other watershed features and were therefore not included in the model;
- Crop rotations based on multi-year analysis of the USDA NCDL and local knowledge of farming practices; and
- Grazing management practices (local knowledge).

2. Conservation Effects Assessment Project (CEAP) using AnnAGNPS: NRCS

In 2005-2009, the Cheney Lake Watershed participated in a Conservation Effects Assessment Project (CEAP) study to estimate the effects of U.S. Department of Agriculture (USDA) conservation practices implemented in the Cheney Lake Watershed. This study, conducted by the Natural Resources Conservation Service (NRCS), began by synthesizing and reporting information from previous assessments completed between 1994 and 2004. These assessments were based on land use data and conservation practices implemented within that time frame. The primary emphasis of the CEAP study was to use the Annualized Agricultural Non-Point Source (AnnAGNPS) computer model to estimate the effects that conservation practices had on the water, sediment loadings and nutrient loadings to Cheney Reservoir from all upstream sources and all types of erosion.

Eight scenarios were developed to assess the potential impact to runoff, sediments, and nutrients with the implementation of a conservation practice across the entire watershed. The scenarios included implementation of mulch till on all crop acres (at least 30% residue); removal of existing conservation practices; removal of Conservation Reserve Program (CRP) acres with a return to conventionally tilled cropping on all crop acres; removal of existing livestock waste systems; treatment of all ephemeral gullies in cropland; use of no-till farming on all crop acres; all crop acres planted to native grass; and a reduction of soil moisture in irrigated systems from 70% of field capacity to 50% of field capacity before irrigation was triggered. Not all of the scenarios were completed before the end of the CEAP study, but several have given useful guidance for future conservation efforts with regard to sediment.

The CEAP study provided some useful tools for identifying areas most vulnerable to soil loss. By comparing the benchmark scenario representing 1997 conditions with the scenario representing treatment of all ephemeral gullies, a ratio of sediment load by each 200-acre cell can be established. **Figure 15** illustrates this relationship showing that approximately 20% of the 200-acre cells in the watershed contribute roughly 74% of the sediment load to the watershed outlet at Cheney Reservoir. If it is impractical to expect treatment for every ephemeral gully, then a good strategy for implementation would be to address the most

vulnerable areas that contribute the greatest load.

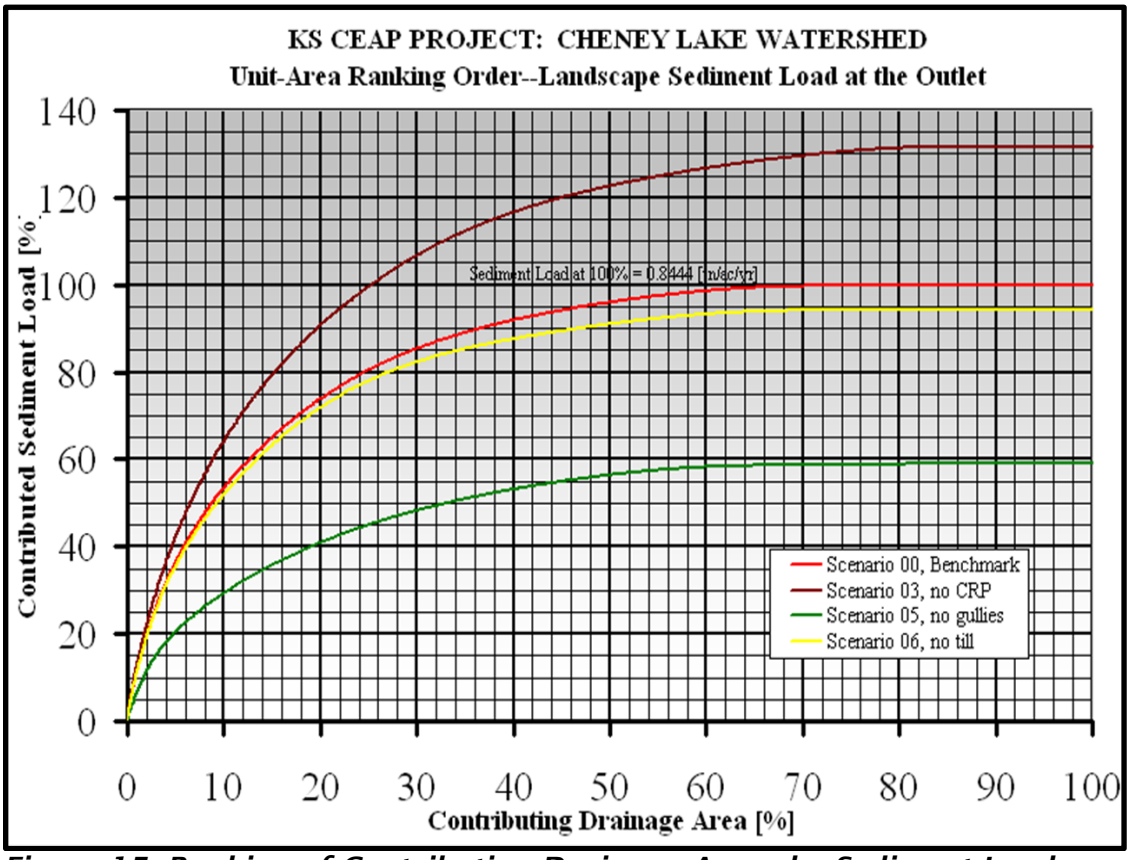


Figure 15. Ranking of Contributing Drainage Areas by Sediment Load

Figure 15 shows the sediment load delivered to the watershed outlet at Cheney Reservoir according to the percentage of the drainage area that is contributing the sediment. Those areas contributing the highest sediment load are ranked first and shown as a percentage of the total drainage area. The red arc represents the benchmark condition. The brown arc shows the predicted increase in loading if all CRP acres are returned to conventional cropping practices. The yellow arc illustrates the predicted reduction in loading if all crop acres are converted to no-till cropping practices. The green arc indicates the predicted reduction in loading if all ephemeral gullies are treated with grassed waterways. In all instances, top-ranked contributing areas (10-20% of the total area) contribute a disproportionate amount of the load. At benchmark conditions, 20% of the watershed contributes 74% of the sediment load delivered to the watershed outlet.

The relationship between sediment load at the watershed outlet and the contributing cells is illustrated spatially with a series of watershed maps. The purple-shaded areas in **Figure 16**, based on the AnnAGNPS watershed model estimates, make up the 20% of the watershed that contributes 74% of the sediment. The green-shaded areas are those that contribute less than the highest percent but are still above the mean contribution.

The same type of analysis was done for each scenario to determine the optimum locations for various conservation treatments. Since these maps are based on 200-acre cells, they

cannot be used to pinpoint a single field, but rather they provide guidance to areas that may be more vulnerable.

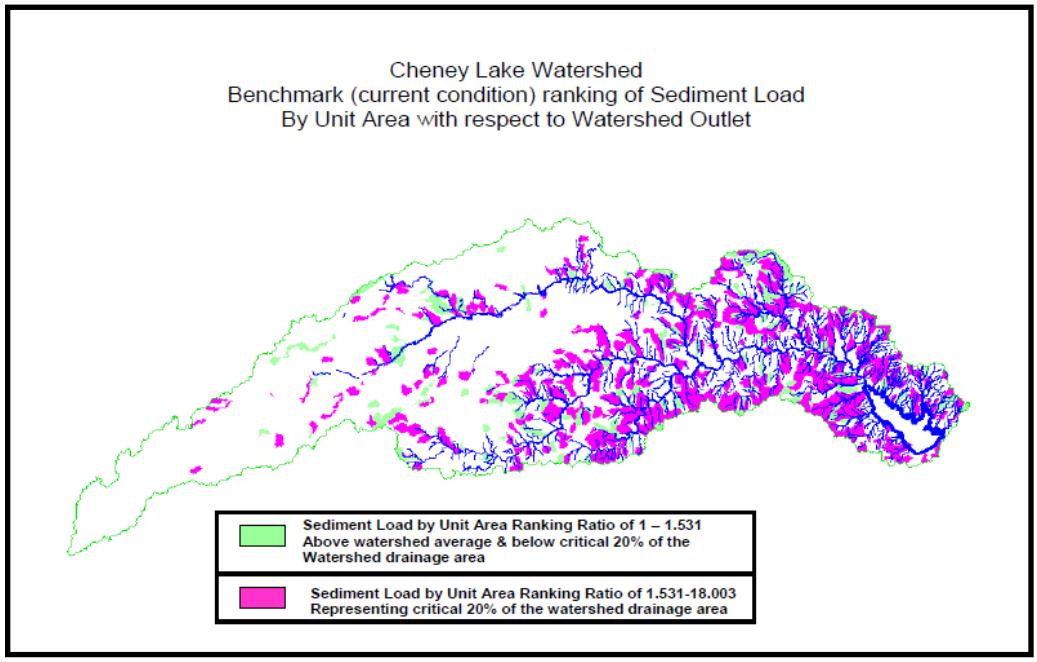


Figure 16. Benchmark Condition - Ranking Sediment Load by Unit Area

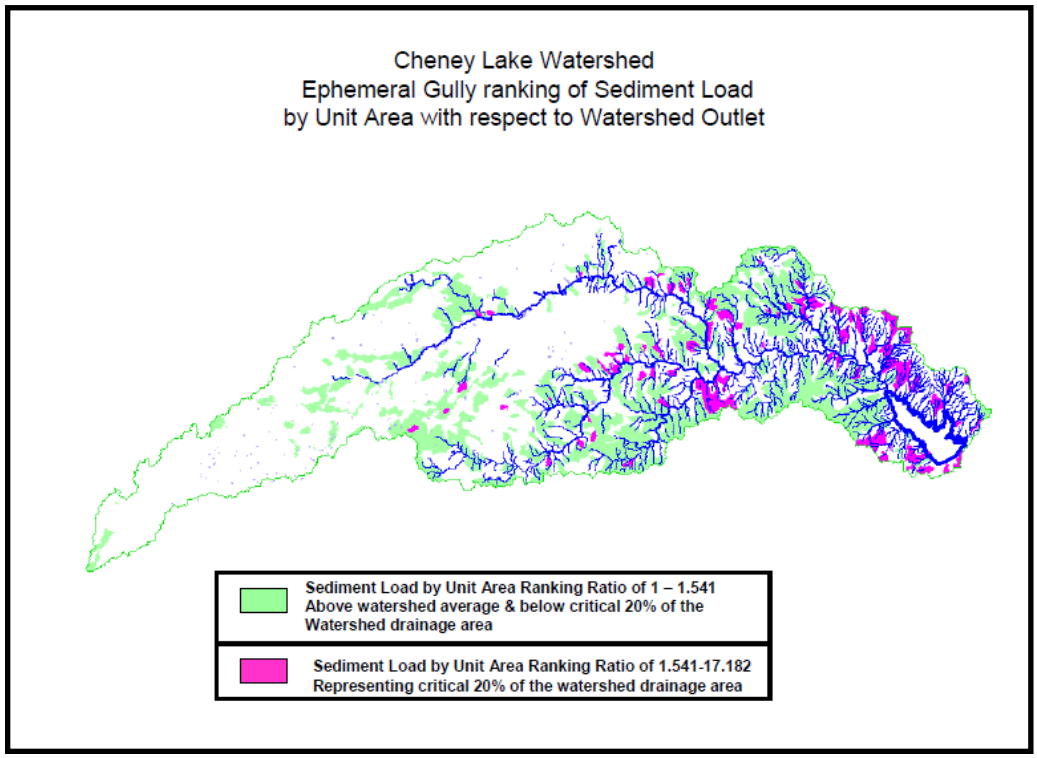


Figure 17. Ranking Sediment Load from Ephemeral Gullies by Contributing Area

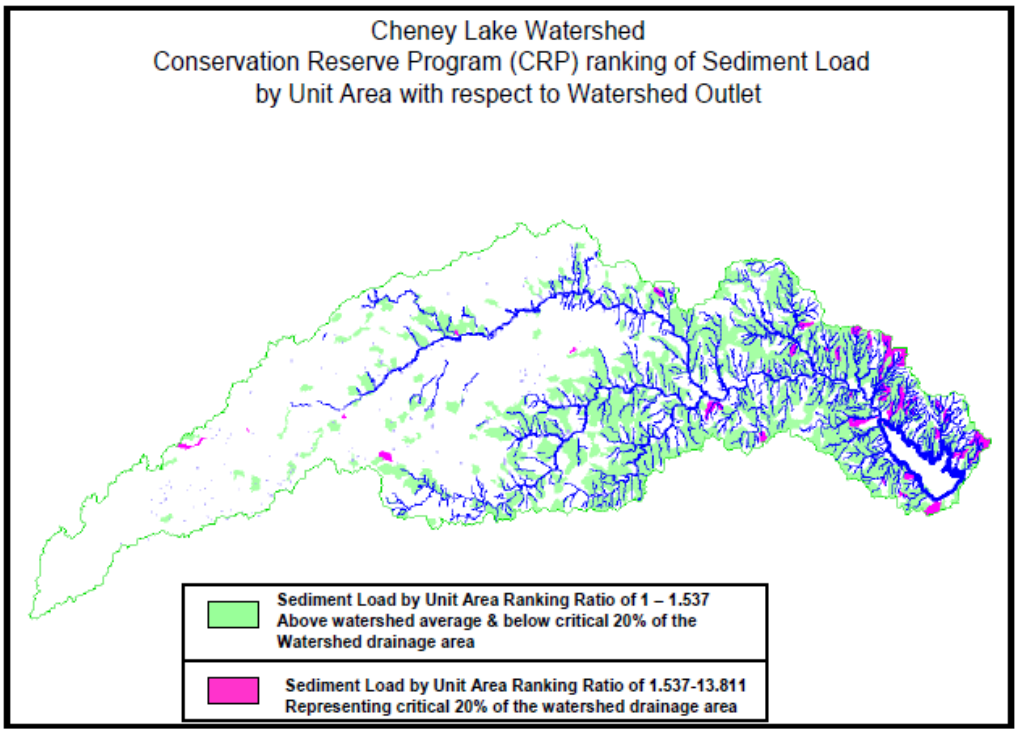


Figure 18. Ranking of Potential Sediment Load by Contributing Area Currently in CRP

3. Conservation Effects Assessment Project (CEAP) using USLE: Kansas State University

Similar maps were generated by a second Conservation Effects Assessment Project (CEAP) study at Kansas State University. Using the Universal Soil Loss Equation (USLE), the study generated maps that showed areas in the watershed most vulnerable to erosion. Unlike the AnnAGNPS-generated maps, they did not illustrate delivery of sediment to the reservoir, just soil losses. However, the maps are similar and would indicate comparable priority areas.

K-State did use the Soil and Water Assessment Tool (SWAT) model to estimate loading information for use in this plan. Maps generated with the SWAT watershed model show similar results to the AnnAGNPS-generated maps and are included below.

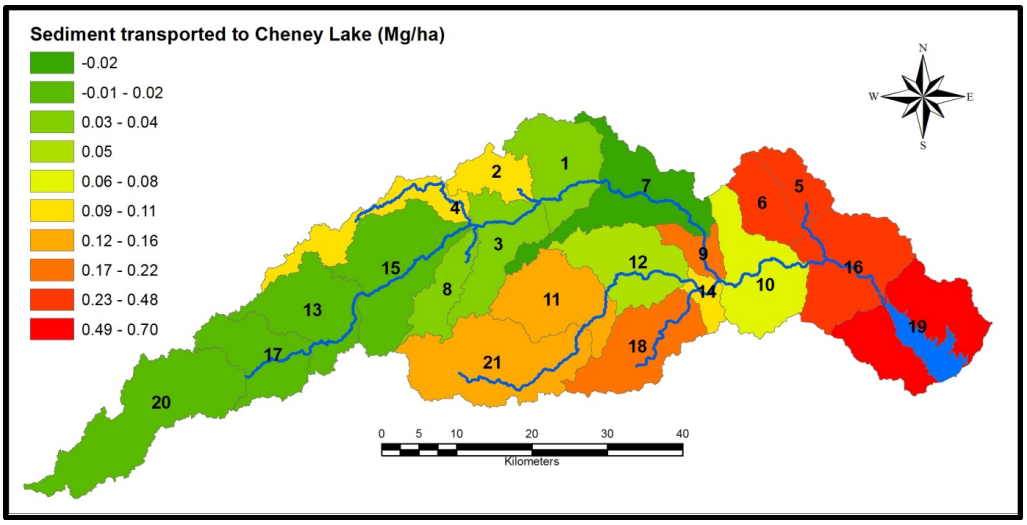


Figure 19. Sediment Transported to Cheney Reservoir, Projected by SWAT

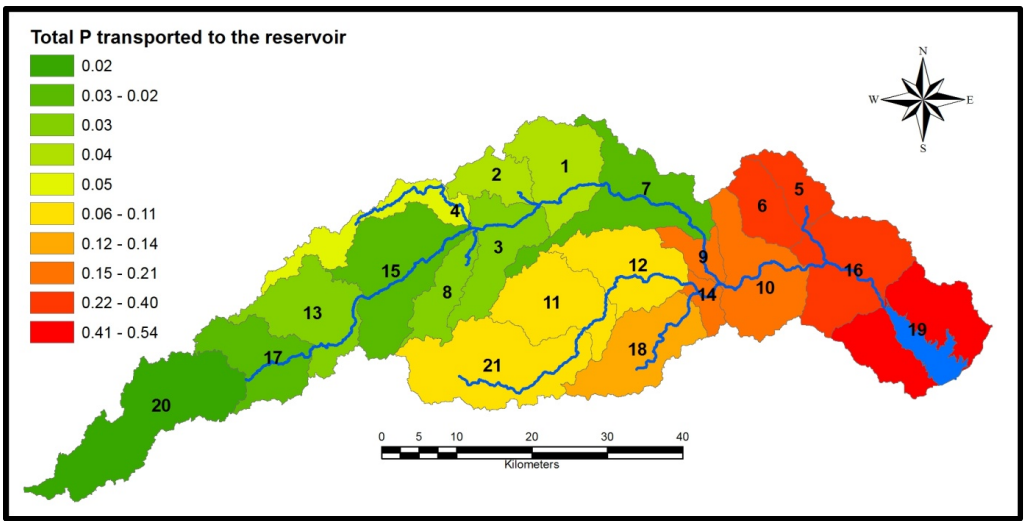


Figure 20. Total P Transported from Cheney Lake Watershed, Projected by SWAT

4. Streambank erosion using ArcGIS: Kansas Water Office

In May 2011, the Kansas Water Office completed a draft report on streambank erosion using ArcGIS® to conduct a comparison study of aerial photography from 1991 and 2008 to determine bank losses on the main stem of the North Fork Ninnescah River. A total of 41 erosion sites were identified, covering 33,336 feet of unstable streambank. (Only those erosion sites covering an area greater than or equal to 1,500 sq. feet were identified.) Bank erosion was analyzed by stream reach and Hydrologic Unit Code. Analysis indicated that a substantial portion of identified eroded sediment in the watershed is transported annually from the mainstem Reach Two (NFN2) and Reach Three (NFN3) as identified in **Figure 21**. These represent roughly 52% and 22%, respectively, of the sediment load from the main stem.

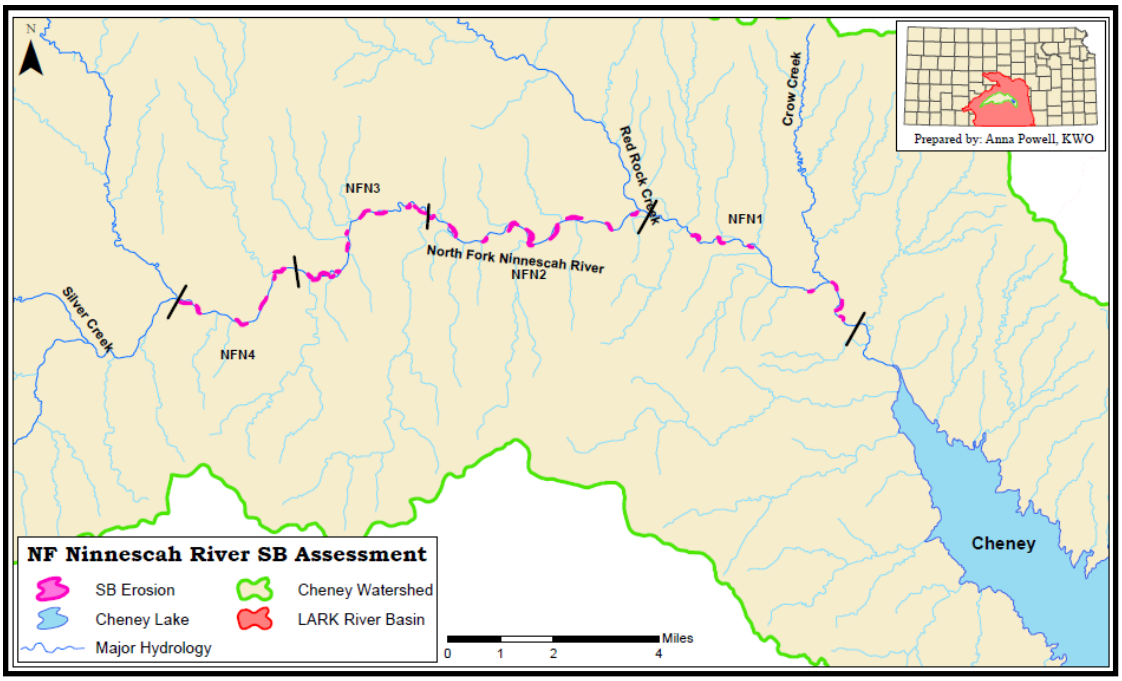


Figure 21. Mainstem North Fork Ninnescah River Streambank Assessment

5. Aerial assessment: KDHE

KDHE analyzed aerial images and determined areas of interest (**Figure 22**), either in close proximity to a stream or those areas that have been degraded over time. These are crop fields and livestock areas in the Cheney Lake Watershed with moderate to severe degradation.

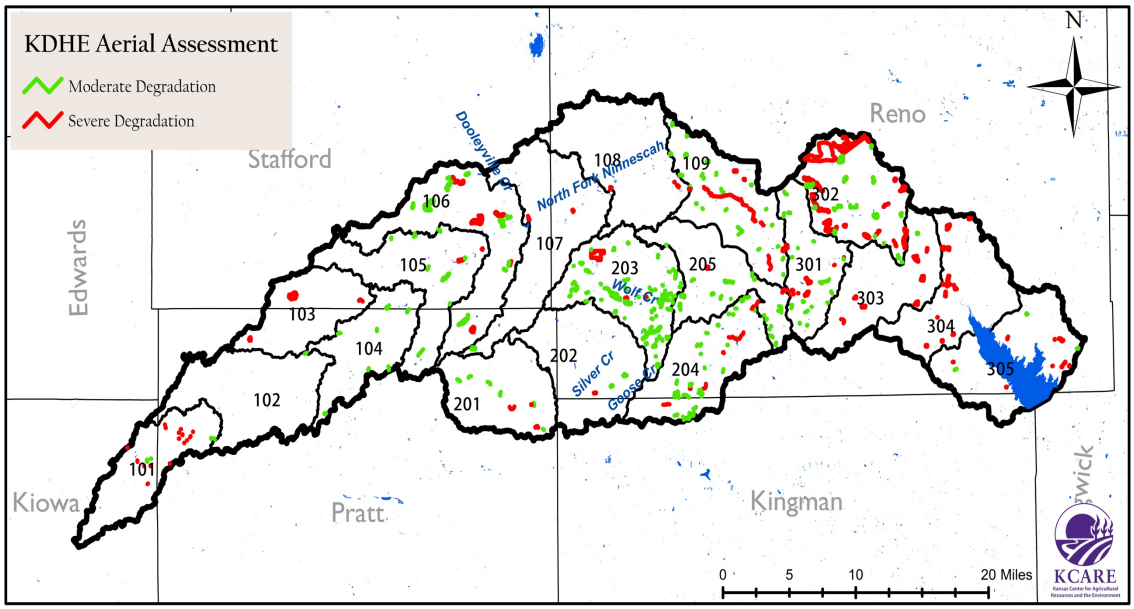


Figure 22. Aerial Assessment in the Cheney Lake Watershed

B. Targeted Areas

Watersheds get a better value for their money by focusing BMP placement rather than randomly applying BMPs throughout the watershed. Every watershed has specific locations that contribute a greater pollutant load due to soil type, proximity to streams and land use practices. By focusing BMPs in these areas, pollutants can be reduced at a more efficient rate.

The SWAT, AnnAGNPS and USLE models in conjunction with ArcGIS mapping and KDHE's aerial assessment provided data used to determine the targeted areas for the Cheney Lake Watershed WRAPS plan. Final targeting assessment results were presented to and considered by the CMC. Using TMDL and targeting guidance from KDHE, the CMC decided to target seven HUC 12s which lie along the North Fork of the Ninnescah River, Silver Creek, Red Rock Creek, and a portion of Goose Creek, as well as the area surrounding and draining into Cheney Reservoir. Focusing on cropland, livestock and riparian corridors in these areas will positively impact all watershed TMDLs. Targeted areas are shown below in **Figure 23**.

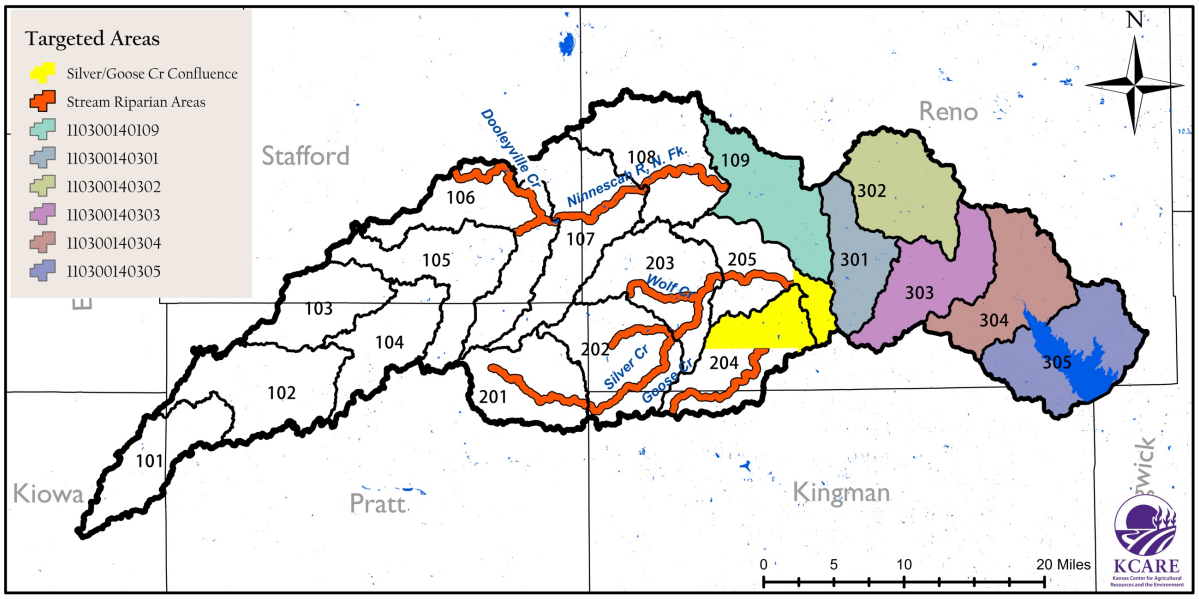


Figure 23. Targeted Areas in the Cheney Lake Watershed

The HUC 12s targeted in the Cheney Lake Watershed include:

- 110300140**109**
- 110300140**204**, northern portion
- 110300140**205**, southern portion

} Silver/Goose Creek Confluence

- 110300140**301**
- 110300140**302**
- 110300140**303**
- 110300140**304**
- 110300140**305**

In addition to the HUC 12s listed above, stream riparian corridors will also be targeted. **Riparian Corridors** consist of 0.25 mile on both sides of a stream or creek. The following HUC 12s in the Cheney Lake Watershed will be targeted:

- 110300140**106**
- 110300140**107**
- 110300140**108**
- 110300140**201**
- 110300140**202**
- 110300140**203**
- 110300140**204**, southern portion
- 110300140**205**, northern portion

The CMC will focus BMP placement for sediment and nutrient runoff in the HUC 12s listed above and will target the following land use areas:

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

Load reductions will be estimated for the pollutants addressed in each area to measure success toward meeting TMDL goals.

C. Load Reduction Estimate Methodology

1. Cropland

Baseline loadings are calculated using the AnnAGNPS model delineated to the HUC 12 watershed scale. BMP load reduction efficiencies are derived from K-State Research and Extension Publication MF-2572.[25] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

2. Livestock

Baseline nutrient loadings per animal unit are calculated using the Livestock Waste Facilities Handbook.[26] Livestock management practice load reduction efficiencies are derived from numerous sources, including K-State Research and Extension Publication MF-2737 and MF-2454.[27] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies. Stocking rates in the Cheney Lake Watershed average 12.5 to 14.3 cattle per 100 acres.

[25] https://www.bookstore.ksre.ksu.edu/pubs/MF2572.pdf
[26] https://www-mwps.sws.iastate.edu/catalog/manure-management/livestock-waste-facilities-handbook
[27] MF-2737 Available at: https://www.bookstore.ksre.ksu.edu/pubs/mf2737.pdf
MF-2454 Available at: https://www.bookstore.ksre.ksu.edu/pubs/MF2454.pdf

7. Implementation

As mentioned in the previous section, BMP implementation in the Cheney Lake Watershed will take place in high-priority areas where TMDL's can be positively impacted. Cropland and livestock areas will be targeted in the areas listed below in an effort to effectively improve the following TMDL impairments:

- **Sediment: cropland**
- **Eutrophication - nutrients (nitrogen and phosphorus): cropland and livestock areas**
  The pH TMDL for the North Fork Ninnescah River is not targeted directly but will be impacted positively by BMPs utilized to reduce nutrient runoff and attachment.

Cropland and livestock areas in the following HUC 12s will be targeted in their entirety to reduce sediment erosion/runoff and nutrient loading in the Cheney Lake Watershed:

- 110300140**109**
- 110300140**204** – northern portion } Silver/Goose Creek Confluence
- 110300140**205** – southern portion } Silver/Goose Creek Confluence
- 110300140**301**
- 110300140**302**
- 110300140**303**
- 110300140**304**
- 110300140**305**

The northern portion of HUC 110300140204 and the southern portion of 110300140205 will be referred to as "Silver/Goose Creek Confluence" throughout the remainder of this WRAPS plan.

Riparian corridors will also be targeted for cropland and livestock BMP implementation. The following HUC 12s will be targeted along the riparian corridors for sediment erosion and nutrient runoff:

- 110300140**106**
- 110300140**107**
- 110300140**108**
- 110300140**201**
- 110300140**202**
- 110300140**203**
- 110300140**204** – southern portion
- 110300140**205** – northern portion

The eight HUC 12 areas listed above will be referred to as "riparian corridors" for the remainder of this WRAPS plan.

A. Sediment Loss Reductions in the Cheney Lake Watershed

The Cheney Lake Watershed has a "high" TMDL ranking for sediment in the reservoir and will target **cropland** for sediment loss reductions. Adoption and implementation of sediment BMPs will result in a total sediment load reduction (soil saved) of **71,629 tons** at the conclusion of this 25-year WRAPS plan, exceeding the sediment TMDL goal.

There are 97,788 cultivated cropland acres in the targeted areas for sediment in Cheney Lake Watershed (**Table 12**). Land use in the area targeted for sediment does make a difference in the amount of sediment entering the waterways. Cropland, local streambanks and riparian areas are all highly susceptible to runoff and erosion during rainfall events.

Table 12. Land Use in the Sediment Targeted Areas

Sediment Targeted Area Land Use in the Cheney Lake Watershed										
Land Use	Acres in Targetd HUC 12: 110300140...								Total Acres	% of Targeted Area
	109	301	302	303	304	305	Silver/Goose Creek Confluence	Riparian Corridors		
Cropland	11,482	7,689	21,676	14,136	15,131	9,362	9,857	8,456	97,788	40.21%
Grassland	18,562	12,682	9,090	14,388	15,291	18,123	8,232	17,095	113,463	46.65%
Urban Open Space	1,689	982	1,483	1,293	1,456	1,354	863	1,202	10,321	4.24%
Water	342	225	115	257	977	9,715	74	508	12,214	5.02%
Deciduous Forest	890	551	419	863	1,119	708	749	666	5,964	2.45%
Wetlands	332	106	93	110	173	202	129	512	1,657	0.68%
Urban Low Intensity	357	52	275	23	27	202	37	207	1,180	0.49%
Herbaceous Wetlands	10	3	2	2	7	5	0	108	136	0.06%
Pasture/Hay	9	0	30	53	77	149	0	0	317	0.13%
Urban Medium Intensity	24	2	18	0	0	18	0	29	92	0.04%
Shrubland	14	0	2	0	0	4	1	7	28	0.01%
Not Actively Managed	0	4	5	4	1	0	1	1	16	0.01%
Urban High Intensity	2	0	2	0	0	0	0	4	8	0.00%
Evergreen Forest	13	0	0	0	0	0	0	0	13	0.01%
Totals	**33,725**	**22,295**	**33,210**	**31,128**	**34,259**	**39,842**	**19,943**	**28,795**	**243,198**	**100.00%**

1. Sediment BMP implementation in the Cheney Lake Watershed

a. Targeted cropland areas for sediment reductions

Cropland BMPs will be implemented to reduce sediment loss in the Cheney Lake Watershed to protect local streams and, ultimately, the Cheney Reservoir.

Cropland BMPs will be implemented in the following areas:

- 110300140**109**
- 110300140**301**
- 110300140**302**
- 110300140**303**

- 110300140**304**
- 110300140**305**
- Silver/Goose Creek Confluence
- Riparian corridors

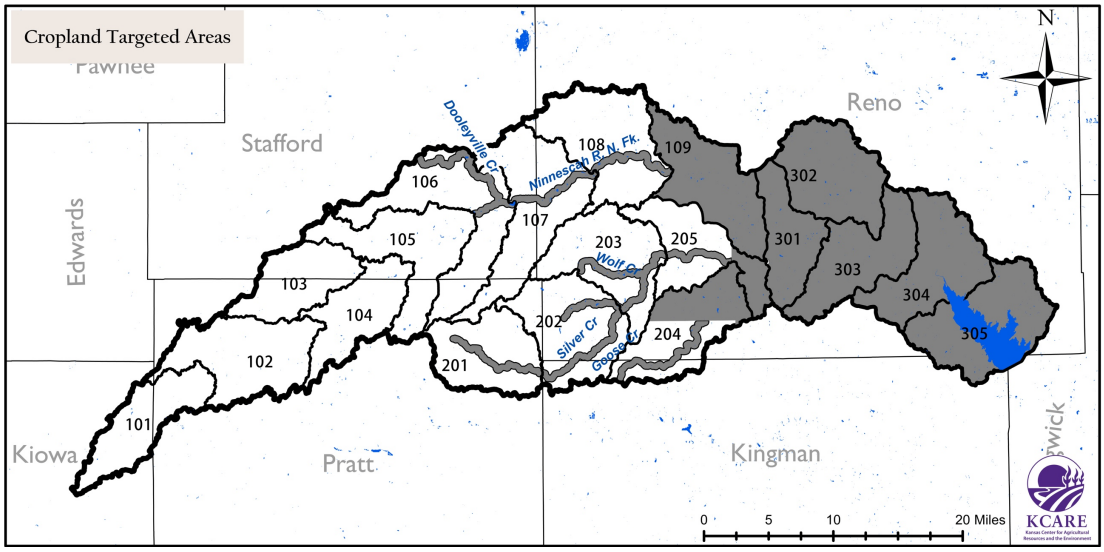


Figure 24. Cropland Targeted Areas in the Cheney Lake Watershed

b. Cropland BMPs for sediment reductions in the Cheney Lake Watershed

Within the targeted areas listed in the previous section, the following BMPs will be implemented to reduce soil erosion and sediment loss from crop fields:

- adopt no-till cultivation;
- utilize cover crops;
- create nutrient management plans;
- establish wetlands;
- establish grassed waterways;
- build new and/or revamp terraces; and
- establish permanent vegetation.

Table 13. Cropland BMPs to Reduce Sediment Loss

BMPs to Reduce Sediment Runoff and Erosion			
Protection Measures	**Best Management Practices**	**Adoption Rate Goal**	**Acres Needing BMPs (Annually)**
Cropland	No-Till	8%	378
	Cover Crops	8%	378
	Nutrient Management	8%	378
	Wetlands	1%	47
	Grassed Waterways	10%	473
	Terraces	10%	473
	Permanent Vegetation	2%	95

Table 14. Adoption Rates for Cropland BMPs to Address Sediment

Total Annual Adoption (treated acres), Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Adoption
1	378	378	378	47	473	473	95	2,221
2	378	378	378	47	473	473	95	2,221
3	378	378	378	47	473	473	95	2,221
4	378	378	378	47	473	473	95	2,221
5	378	378	378	47	473	473	95	2,221
6	378	378	378	47	473	473	95	2,221
7	378	378	378	47	473	473	95	2,221
8	378	378	378	47	473	473	95	2,221
9	378	378	378	47	473	473	95	2,221
10	378	378	378	47	473	473	95	2,221
11	378	378	378	47	473	473	95	2,221
12	378	378	378	47	473	473	95	2,221
13	378	378	378	47	473	473	95	2,221
14	378	378	378	47	473	473	95	2,221
15	378	378	378	47	473	473	95	2,221
16	378	378	378	47	473	473	95	2,221
17	378	378	378	47	473	473	95	2,221
18	378	378	378	47	473	473	95	2,221
19	378	378	378	47	473	473	95	2,221
20	378	378	378	47	473	473	95	2,221
21	378	378	378	47	473	473	95	2,221
22	378	378	378	47	473	473	95	2,221
23	378	378	378	47	473	473	95	2,221
24	378	378	378	47	473	473	95	2,221
25	378	378	378	47	473	473	95	2,221
Total	**9,450**	**9,450**	**9,450**	**1,181**	**11,813**	**11,813**	**2,363**	**55,521**

2. Sediment load reductions from cropland BMP implementation

The implementation of cropland BMPs on 2,221 acres per year in the targeted areas will result in a load reduction of 71,629 tons of soil saved at the end of this 25-year WRAPS plan (**Table 15**).

Table 15. Sediment Load Reductions from Cropland BMPs

Total Annual Soil Erosion Reduction, Cropland BMPs (tons)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	843	449	281	42	562	421	267	2,865
2	1,685	899	562	84	1,124	843	534	5,730
3	2,528	1,348	843	126	1,685	1,264	801	8,596
4	3,371	1,798	1,124	169	2,247	1,685	1,067	11,461
5	4,213	2,247	1,404	211	2,809	2,107	1,334	14,326
6	5,056	2,697	1,685	253	3,371	2,528	1,601	17,191
7	5,899	3,146	1,966	295	3,933	2,949	1,868	20,056
8	6,742	3,596	2,247	337	4,494	3,371	2,135	22,921
9	7,584	4,045	2,528	379	5,056	3,792	2,402	25,787
10	8,427	4,494	2,809	421	5,618	4,213	2,669	28,652
11	9,270	4,944	3,090	463	6,180	4,635	2,935	31,517
12	10,112	5,393	3,371	506	6,742	5,056	3,202	34,382
13	10,955	5,843	3,652	548	7,303	5,478	3,469	37,247
14	11,798	6,292	3,933	590	7,865	5,899	3,736	40,112
15	12,640	6,742	4,213	632	8,427	6,320	4,003	42,978
16	13,483	7,191	4,494	674	8,989	6,742	4,270	45,843
17	14,326	7,640	4,775	716	9,551	7,163	4,537	48,708
18	15,169	8,090	5,056	758	10,112	7,584	4,803	51,573
19	16,011	8,539	5,337	801	10,674	8,006	5,070	54,438
20	16,854	8,989	5,618	843	11,236	8,427	5,337	57,304
21	17,697	9,438	5,899	885	11,798	8,848	5,604	60,169
22	18,539	9,888	6,180	927	12,360	9,270	5,871	63,034
23	19,382	10,337	6,461	969	12,921	9,691	6,138	65,899
24	20,225	10,787	6,742	1,011	13,483	10,112	6,405	68,764
25	21,067	11,236	7,022	1,053	14,045	10,534	6,671	71,629

3. Meeting the siltation/sediment TMDL in the Cheney Lake Watershed

Adoption and implementation of sediment BMPs on cropland will result in a total sediment load reduction (soil saved) of **71,629 tons** at the conclusion of this 25-year WRAPS plan. The load reduction goal to meet the sediment TMDL is a reduction of 22,650 tons, therefore the implementation of all sediment BMPs will exceed the goal (**Table 16**).

Table 16. Sediment TMDL: Reductions in the Cheney Lake Watershed

Meeting the Sediment TMDL		
Year	Total Load Reductions: Cropland (tons)	% of TMDL
1	2,865	13%
2	5,730	25%
3	8,596	38%
4	11,461	51%
5	14,326	63%
6	17,191	76%
7	20,056	89%
8	22,921	101%
9	25,787	114%
10	28,652	126%
11	31,517	139%
12	34,382	152%
13	37,247	164%
14	40,112	177%
15	42,978	190%
16	45,843	202%
17	48,708	215%
18	51,573	228%
19	54,438	240%
20	57,304	253%
21	60,169	266%
22	63,034	278%
23	65,899	291%
24	68,764	304%
25	71,629	316%
Load Reduction to meet Sediment TMDL (tons):		22,650

B. Nutrient Load Reductions in the Cheney Lake Watershed

The Cheney Lake Watershed has a "high" TMDL ranking for eutrophication (nitrogen and phosphorus) in Cheney Reservoir. The Cheney Lake Watershed targets **cropland** and **livestock** areas for BMP implementation to reduce nutrient loading. Adoption and implementation of nutrient BMPs will result in total nutrient load reductions of **71,415 pounds of nitrogen** and **119,540 pounds of phosphorus** at the conclusion of this 25-year WRAPS plan.

There are 97,788 cultivated cropland acres and 113,780 grassland/pasture/hay acres in the areas targeted for nutrients in the Cheney Lake Watershed (**Table 17**). Land use in the nutrient targeted area makes a difference in the amount of nitrogen and phosphorus entering the water because cropland and livestock areas are both highly susceptible to runoff and erosion during rainfall events. Nutrients attach to these soil particles and enter nearby water segments. The significant acreage – 40% of land used is as cropland and 47% of land is used for grassland, pasture and hay – make both cropland and livestock areas major contributors of nutrient loading in this watershed.

Table 17. Land Use in the Nutrient Targeted Areas

Nutrient Targeted Area Land Use in the Cheney Lake Watershed										
Land Use	Acres in Targetd HUC 12: 110300140...								Total Acres	% of Targeted Area
	109	301	302	303	304	305	Silver/Goose Creek Confluence	Riparian Corridors		
Cropland	11,482	7,689	21,676	14,136	15,131	9,362	9,857	8,456	97,788	40.21%
Grassland	18,562	12,682	9,090	14,388	15,291	18,123	8,232	17,095	113,463	46.65%
Urban Open Space	1,689	982	1,483	1,293	1,456	1,354	863	1,202	10,321	4.24%
Water	342	225	115	257	977	9,715	74	508	12,214	5.02%
Deciduous Forest	890	551	419	863	1,119	708	749	666	5,964	2.45%
Wetlands	332	106	93	110	173	202	129	512	1,657	0.68%
Urban Low Intensity	357	52	275	23	27	202	37	207	1,180	0.49%
Herbaceous Wetlands	10	3	2	2	7	5	0	108	136	0.06%
Pasture/Hay	9	0	30	53	77	149	0	0	317	0.13%
Urban Medium Intensity	24	2	18	0	0	18	0	29	92	0.04%
Shrubland	14	0	2	0	0	4	1	7	28	0.01%
Not Actively Managed	0	4	5	4	1	0	1	1	16	0.01%
Urban High Intensity	2	0	2	0	0	0	0	4	8	0.00%
Evergreen Forest	13	0	0	0	0	0	0	0	13	0.01%
Totals	**33,725**	**22,295**	**33,210**	**31,128**	**34,259**	**39,842**	**19,943**	**28,795**	**243,198**	**100.00%**

1. Nutrient BMP implementation in the Cheney Lake Watershed

a. Targeted cropland and livestock areas for nutrient reductions

Cropland and livestock BMPs will be implemented in the Cheney Lake Watershed to protect streams and Cheney Reservoir by reducing nutrient leaching and loading.

Cropland and livestock BMPs will be implemented in the following areas:

- 110300140**109**
- 110300140**301**
- 110300140**302**
- 110300140**303**
- 110300140**304**
- 110300140**305**
- Silver/Goose Creek Confluence
- Riparian corridors

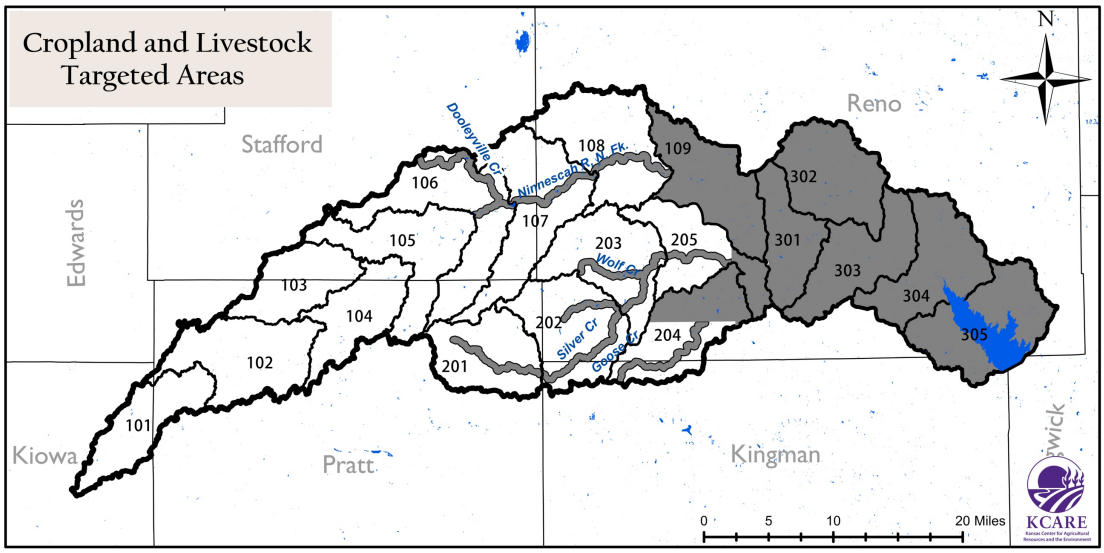


Figure 25. Cropland and Livestock Targeted Areas in the Cheney Lake Watershed

b. Cropland BMPs for nutrient reductions in the Cheney Lake Watershed

Within the targeted areas, the following BMPs will be implemented to reduce nutrient loading from crop fields:

- adopt no-till cultivation;
- utilize cover crops;
- create nutrient management plans;
- establish wetlands;
- establish grassed waterways;
- build new and/or restore terraces; and
- establish permanent vegetation.

Table 18. Cropland BMPs to Reduce Nutrient Loading

BMPs to Reduce Sediment Loss and Nutrient Loading			
Protection Measures	**Best Management Practices**	**Adoption Rate Goal**	**Acres Needing BMPs (Annually)**
Cropland	No-Till	8%	378
	Cover Crops	8%	378
	Nutrient Management	8%	378
	Wetlands	1%	47
	Grassed Waterways	10%	473
	Terraces	10%	473
	Permanent Vegetation	2%	95

Table 19. Adoption Rates for Cropland BMPs to Address Nutrients

Total Annual Adoption (treated acres), Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Adoption
1	378	378	378	47	473	473	95	2,221
2	378	378	378	47	473	473	95	2,221
3	378	378	378	47	473	473	95	2,221
4	378	378	378	47	473	473	95	2,221
5	378	378	378	47	473	473	95	2,221
6	378	378	378	47	473	473	95	2,221
7	378	378	378	47	473	473	95	2,221
8	378	378	378	47	473	473	95	2,221
9	378	378	378	47	473	473	95	2,221
10	378	378	378	47	473	473	95	2,221
11	378	378	378	47	473	473	95	2,221
12	378	378	378	47	473	473	95	2,221
13	378	378	378	47	473	473	95	2,221
14	378	378	378	47	473	473	95	2,221
15	378	378	378	47	473	473	95	2,221
16	378	378	378	47	473	473	95	2,221
17	378	378	378	47	473	473	95	2,221
18	378	378	378	47	473	473	95	2,221
19	378	378	378	47	473	473	95	2,221
20	378	378	378	47	473	473	95	2,221
21	378	378	378	47	473	473	95	2,221
22	378	378	378	47	473	473	95	2,221
23	378	378	378	47	473	473	95	2,221
24	378	378	378	47	473	473	95	2,221
25	378	378	378	47	473	473	95	2,221
Total	**9,450**	**9,450**	**9,450**	**1,181**	**11,813**	**11,813**	**2,363**	**55,521**

c. Livestock BMPs for nutrient reductions in the Cheney Lake Watershed

Within the targeted areas, the following BMPs will be implemented to reduce nutrient loading from crop fields:

- relocate pasture feeding sites;
- promote alternative watering sites away from streams;
- establish rotational grazing regimen; and
- relocate feeding pens away from streams.

Table 20. Livestock BMPs to Reduce Nutrient Loading

BMPs to Reduce Nutrient Loading		
Protection Measures	**Best Management Practices**	**Acres or Feet Treated Annually**
Livestock	Relocate Pasture Feeding Sites	1 project per year
	Off-Stream Watering System	3 projects per year
	Rotational Grazing	2 projects per year
	Relocate Feeding Pens	1 project every other year

Table 21. Adoption Rates for Livestock BMPs to Address Nutrients

Annual Livestock BMP Adoption				
Year	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Relocate Feeding Pens
1	1	3	2	1
2	1	3	2	0
3	1	3	2	1
4	1	3	2	0
5	1	3	2	1
6	1	3	2	0
7	1	3	2	1
8	1	3	2	0
9	1	3	2	1
10	1	3	2	0
11	1	3	2	1
12	1	3	2	0
13	1	3	2	1
14	1	3	2	0
15	1	3	2	1
16	1	3	2	0
17	1	3	2	1
18	1	3	2	0
19	1	3	2	1
20	1	3	2	0
21	1	3	2	1
22	1	3	2	0
23	1	3	2	1
24	1	3	2	0
25	1	3	2	1
Total	**25**	**75**	**50**	**13**

2. Nutrient load reductions from BMP implementation

a. Nutrient load reductions from cropland BMP implementation

The implementation of cropland BMPs on 1,225 acres per year in the Cheney Lake Watershed's targeted areas will result in a nitrogen load reduction of 68,621 pounds and a phosphorus reduction of 44,330 pounds at the end of this 25-year WRAPS plan (**Tables 22 and 23**).

Table 22. Nitrogen Load Reductions from Cropland BMP Implementation

Total Annual Nitrogen Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	362	362	362	45	725	544	344	2,745
2	725	725	725	91	1,449	1,087	688	5,490
3	1,087	1,087	1,087	136	2,174	1,631	1,033	8,234
4	1,449	1,449	1,449	181	2,899	2,174	1,377	10,979
5	1,812	1,812	1,812	226	3,624	2,718	1,721	13,724
6	2,174	2,174	2,174	272	4,348	3,261	2,065	16,469
7	2,536	2,536	2,536	317	5,073	3,805	2,410	19,214
8	2,899	2,899	2,899	362	5,798	4,348	2,754	21,959
9	3,261	3,261	3,261	408	6,522	4,892	3,098	24,703
10	3,624	3,624	3,624	453	7,247	5,435	3,442	27,448
11	3,986	3,986	3,986	498	7,972	5,979	3,787	30,193
12	4,348	4,348	4,348	544	8,696	6,522	4,131	32,938
13	4,711	4,711	4,711	589	9,421	7,066	4,475	35,683
14	5,073	5,073	5,073	634	10,146	7,609	4,819	38,428
15	5,435	5,435	5,435	679	10,871	8,153	5,164	41,172
16	5,798	5,798	5,798	725	11,595	8,696	5,508	43,917
17	6,160	6,160	6,160	770	12,320	9,240	5,852	46,662
18	6,522	6,522	6,522	815	13,045	9,784	6,196	49,407
19	6,885	6,885	6,885	861	13,769	10,327	6,540	52,152
20	7,247	7,247	7,247	906	14,494	10,871	6,885	54,896
21	7,609	7,609	7,609	951	15,219	11,414	7,229	57,641
22	7,972	7,972	7,972	996	15,944	11,958	7,573	60,386
23	8,334	8,334	8,334	1,042	16,668	12,501	7,917	63,131
24	8,696	8,696	8,696	1,087	17,393	13,045	8,262	65,876
25	9,059	9,059	9,059	1,132	18,118	13,588	8,606	68,621

Table 23. Phosphorus Load Reductions from Cropland BMP Implementation

Total Annual Phosphorus Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	308	385	193	29	385	289	183	1,773
2	617	771	385	58	771	578	366	3,546
3	925	1,156	578	87	1,156	867	549	5,320
4	1,234	1,542	771	116	1,542	1,156	732	7,093
5	1,542	1,927	964	145	1,927	1,446	916	8,866
6	1,850	2,313	1,156	173	2,313	1,735	1,099	10,639
7	2,159	2,698	1,349	202	2,698	2,024	1,282	12,413
8	2,467	3,084	1,542	231	3,084	2,313	1,465	14,186
9	2,775	3,469	1,735	260	3,469	2,602	1,648	15,959
10	3,084	3,855	1,927	289	3,855	2,891	1,831	17,732
11	3,392	4,240	2,120	318	4,240	3,180	2,014	19,505
12	3,701	4,626	2,313	347	4,626	3,469	2,197	21,279
13	4,009	5,011	2,506	376	5,011	3,758	2,380	23,052
14	4,317	5,397	2,698	405	5,397	4,048	2,563	24,825
15	4,626	5,782	2,891	434	5,782	4,337	2,747	26,598
16	4,934	6,168	3,084	463	6,168	4,626	2,930	28,371
17	5,243	6,553	3,277	491	6,553	4,915	3,113	30,145
18	5,551	6,939	3,469	520	6,939	5,204	3,296	31,918
19	5,859	7,324	3,662	549	7,324	5,493	3,479	33,691
20	6,168	7,710	3,855	578	7,710	5,782	3,662	35,464
21	6,476	8,095	4,048	607	8,095	6,071	3,845	37,238
22	6,784	8,481	4,240	636	8,481	6,360	4,028	39,011
23	7,093	8,866	4,433	665	8,866	6,650	4,211	40,784
24	7,401	9,252	4,626	694	9,252	6,939	4,394	42,557
25	7,710	9,637	4,819	723	9,637	7,228	4,578	44,330

b. Nutrient load reductions from livestock BMP implementation

The implementation of 6.5 livestock BMP projects per year (a continued pattern of 7 one year and 6 the next) in the targeted areas in the Cheney Lake Watershed will result in a nitrogen load reduction of 50,919 pounds and a phosphorus load reduction of 27,085 pounds at the end of this 25-year WRAPS plan (**Tables 24 and 25**).

Table 24. Nitrogen Reductions from Livestock BMP Implementation

Total Annual Nitrogen Load Reduction, Livestock BMPs					
Year	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Relocate Feeding Pens	Total
1	144	431	526	1,799	2,900
2	287	862	1,053	1,799	4,002
3	431	1,293	1,579	3,598	6,902
4	575	1,724	2,106	3,598	8,003
5	719	2,156	2,632	5,397	10,904
6	862	2,587	3,158	5,397	12,005
7	1,006	3,018	3,685	7,197	14,905
8	1,150	3,449	4,211	7,197	16,006
9	1,293	3,880	4,738	8,996	18,907
10	1,437	4,311	5,264	8,996	20,008
11	1,581	4,742	5,790	10,795	22,908
12	1,724	5,173	6,317	10,795	24,009
13	1,868	5,604	6,843	12,594	26,910
14	2,012	6,035	7,370	12,594	28,011
15	2,156	6,467	7,896	14,393	30,911
16	2,299	6,898	8,422	14,393	32,013
17	2,443	7,329	8,949	16,192	34,913
18	2,587	7,760	9,475	16,192	36,014
19	2,730	8,191	10,002	17,992	38,915
20	2,874	8,622	10,528	17,992	40,016
21	3,018	9,053	11,054	19,791	42,916
22	3,161	9,484	11,581	19,791	44,017
23	3,305	9,915	12,107	21,590	46,918
24	3,449	10,347	12,634	21,590	48,019
25	3,593	10,778	13,160	23,389	50,919

Table 25. Phosphorus Reductions from Livestock BMP Implementation

Total Annual Phosphorous Load Reduction, Livestock BMPs					
Year	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Relocate Feeding Pens	Total Load Reduction
1	76	229	280	957	1,543
2	153	459	560	957	2,128
3	229	688	840	1,914	3,671
4	306	917	1,120	1,914	4,257
5	382	1,147	1,400	2,871	5,800
6	459	1,376	1,680	2,871	6,385
7	535	1,605	1,960	3,828	7,928
8	611	1,834	2,240	3,828	8,514
9	688	2,064	2,520	4,785	10,057
10	764	2,293	2,800	4,785	10,642
11	841	2,522	3,080	5,742	12,185
12	917	2,752	3,360	5,742	12,771
13	994	2,981	3,640	6,699	14,314
14	1,070	3,210	3,920	6,699	14,899
15	1,147	3,440	4,200	7,656	16,442
16	1,223	3,669	4,480	7,656	17,028
17	1,299	3,898	4,760	8,613	18,571
18	1,376	4,128	5,040	8,613	19,156
19	1,452	4,357	5,320	9,570	20,699
20	1,529	4,586	5,600	9,570	21,285
21	1,605	4,816	5,880	10,527	22,828
22	1,682	5,045	6,160	10,527	23,413
23	1,758	5,274	6,440	11,484	24,956
24	1,834	5,503	6,720	11,484	25,542
25	1,911	5,733	7,000	12,441	27,085

3. Meeting the eutrophication/nutrient TMDL in the Cheney Lake Watershed

Adoption and implementation of nutrient BMPs on cropland and in livestock areas will result in a total nitrogen load reduction of **119,540 pounds** at the conclusion of this 25-year WRAPS plan. The load reduction goal to meet the nutrient TMDL is 277,959 pounds of nitrogen, therefore the implementation of all nutrient BMPs will meet 43% of the TMDL goal (**Table 26**).

Adoption and implementation of these BMPs also will result in a total phosphorus load reduction of **71,415 pounds** at the conclusion of this 25-year WRAPS plan. The load reduction goal to meet the nutrient TMDL is 40,184 pounds of phosphorus, therefore the implementation of all nutrient BMPs will exceed the goal at 178% (**Table 27**).

Table 26. The Cheney Lake Watershed Nutrient Goal: Nitrogen

The Eutrophication/Nutrient TMDL: Nitrogen		
Best Management Practice Type	**Total Load Reduction**	**% of Nitrogen Reduction**
Cropland	68,621	25%
Livestock	50,919	18%
Total	119,540	43%
Nitrogen Reduction Goal: 277,959 pounds		

Table 27. The Cheney Lake Watershed Nutrient Goal: Phosphorus

The Eutrophication/Nutrient TMDL: Phosphorus		
Best Management Practice Type	**Total Load Reduction**	**% of Phosphorus Reduction**
Cropland	44,330	111%
Livestock	27,085	67%
Total	71,415	178%
Phosphorus Reduction Goal: 40,184 pounds		

Table 28. Nutrient TMDL: Load Reductions by Targeted Area

Attempt at Meeting the Nitrogen TMDL				
Year	**Cropland (pounds)**	**Livestock (pounds)**	**Total Load Reductions**	**% of TMDL**
1	2,745	2,900	5,645	2%
2	5,490	4,002	9,491	3%
3	8,234	6,902	15,136	5%
4	10,979	8,003	18,982	7%
5	13,724	10,904	24,628	9%
6	16,469	12,005	28,474	10%
7	19,214	14,905	34,119	12%
8	21,959	16,006	37,965	14%
9	24,703	18,907	43,610	16%
10	27,448	20,008	47,456	17%
11	30,193	22,908	53,101	19%
12	32,938	24,009	56,947	20%
13	35,683	26,910	62,593	23%
14	38,428	28,011	66,439	24%
15	41,172	30,911	72,084	26%
16	43,917	32,013	75,930	27%
17	46,662	34,913	81,575	29%
18	49,407	36,014	85,421	31%
19	52,152	38,915	91,066	33%
20	54,896	40,016	94,912	34%
21	57,641	42,916	100,557	36%
22	60,386	44,017	104,403	38%
23	63,131	46,918	110,049	40%
24	65,876	48,019	113,895	41%
25	68,621	50,919	119,540	43%
Load Reduction to meet Nitrogen TMDL (pounds):				**277,959**

Table 29. Phosphorus TMDL: Load Reductions by Targeted Area

Meeting the Phosphorous TMDL				
Year	**Cropland (pounds)**	**Livestock (pounds)**	**Total Load Reductions**	**% of TMDL**
1	1,773	1,543	3,316	8%
2	3,546	2,128	5,675	14%
3	5,320	3,671	8,991	22%
4	7,093	4,257	11,350	28%
5	8,866	5,800	14,666	36%
6	10,639	6,385	17,025	42%
7	12,413	7,928	20,341	51%
8	14,186	8,514	22,700	56%
9	15,959	10,057	26,016	65%
10	17,732	10,642	28,375	71%
11	19,505	12,185	31,691	79%
12	21,279	12,771	34,050	85%
13	23,052	14,314	37,366	93%
14	24,825	14,899	39,725	99%
15	26,598	16,442	43,040	107%
16	28,371	17,028	45,399	113%
17	30,145	18,571	48,715	121%
18	31,918	19,156	51,074	127%
19	33,691	20,699	54,390	135%
20	35,464	21,285	56,749	141%
21	37,238	22,828	60,065	149%
22	39,011	23,413	62,424	155%
23	40,784	24,956	65,740	164%
24	42,557	25,542	68,099	169%
25	44,330	27,085	71,415	178%
Load Reduction to meet Phosphorous TMDL (pounds):				**40,184**

*It is worth noting that while **pH** will not be targeted directly with BMP implementation, it is expected that the North Fork Ninnescah River's pH TMDL will be impacted positively by sediment and nutrient BMP implementation in the targeted areas outlined by this WRAPS plan.*

8. Information and Education

The CMC has determined which Information and Education (I&E) activities are needed in the Cheney Lake Watershed. These activities are important because they provide watershed residents with a higher awareness of local watershed issues which leads to increased adoption rates of BMPs. All I&E activities and events are evaluated based on productivity, attendance, and achievement of objectives.

A. I&E Activities and Events Scheduled in the Cheney Lake Watershed

Listed below are the I&E activities and events along with costs and possible sponsoring agencies. If all listed I&E events and activities take place, the total cost will be **$26,100**. *It is understood that funding from different sources can be utilized for these activities.*

Table 30. I&E: Cropland BMP Implementation

Cropland Conservation Practices					
BMP	**Targeted Audience**	**Information/Education Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/ Responsible Agency**
No-till farming and cover crops	Landowner/ operator	Soil health workshops	3-4 each winter	$800 each or $3,200 total	Cheney Lake WRAPS
No-till farming and cover crops	Landowner/ operator	Soil health field day	August	$6,000	Cheney Lake WRAPS
No-till farming and cover crops	Landowner/ operator in targeted areas	Scholarships to conferences on Soil Health	January - April	$1,200	Cheney Lake WRAPS
No-till farming and cover crops	Landowner/ operator	Demonstration farm for soil health principles	Year-round	$5,000	Cheney Lake WRAPS
No-till farming and cover crops	Landowner/ operator	Soil health discussion group	December - March	$1,000	Cheney Lake WRAPS
Integrate livestock into cropping system	Livestock and crop producers	Field day	Annually	Staff time	Cheney Lake WRAPS
Integrate livestock into cropping system	Livestock and crop producers	Winter workshop speaker on grazing crops	Winter	$2,000	Cheney Lake WRAPS
Nutrient management	Crop advisors, co-ops, landowners, operators, Agencies	Review existing programs and current practices to address gaps or inconsistencies	Summer/fall	Staff time	Cheney Lake WRAPS
Nutrient management	Dairy and beef operations	Soil health workshops including manure management	Spring	$200	Cheney Lake WRAPS
Wetland creation and management	Hunting groups and landowners who manage wetlands	Field day	As opportunity arises to promote completed projects	Staff time; $200	Cheney Lake WRAPS
Cropland converted to permanent vegetation	Landowner/ operator	Promote cost share and incentives with signs, news articles, brochures	Ongoing	Staff time; general watershed education expenses	Cheney Lake WRAPS
Cropland converted to permanent vegetation	Landowner/ operator	Field day	As opportunity arises to promote completed projects	Staff time; $200	Cheney Lake WRAPS
Cropland converted to permanent vegetation	Landowner/ operator	Winter workshop speaker	Winter	$200	Cheney Lake WRAPS
Cropland converted to permanent vegetation	FSA; State Tech Committee	Participate in State Technical Committee meetings to maintain CRP priority areas in Cheney	Annually	$300 for travel	Cheney Lake WRAPS

Table 31. I&E: Livestock BMP Implementation

Livestock Conservation Practices					
BMP	**Targeted Audience**	**Information/Education Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/ Responsible Agency**
Alternative water sites	Livestock producers with stream water on property	Workshop on water systems, rotational grazing	Winter	$1,000	Cheney Lake WRAPS
Alternative water sites	Livestock producers with stream water on property	Field day	Summer	$1,000	Cheney Lake WRAPS
Relocate winter feeding sites away from streams	Cow-calf producers	One-on-one visits	On-going	Staff time	Cheney Lake WRAPS
Relocate winter feeding sites away from streams	Cow-calf producers	Newsletter articles	Winter	Staff time	Cheney Lake WRAPS
Relocate winter feeding sites away from streams	Cow-calf producers	Field day	Mid-late Winter	Staff time	Cheney Lake WRAPS
Rotational grazing	Livestock producers	Rotational grazing workshop speaker	Winter	$2,000	Cheney Lake WRAPS
Rotational grazing	Livestock producers	Field day	Summer	$500	Cheney Lake WRAPS
Integrate livestock into cropping system	Livestock producers	Field day	Annually	Staff time	Cheney Lake WRAPS
Integrate livestock into cropping system	Livestock producers	Winter workshop speaker on grazing crops	Winter	$2,000	Cheney Lake WRAPS

Table 32. I&E: Cheney Lake Watershed Resident Education - Adults

Adult Education				
Targeted Audience	**Educational Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/Responsible Agency**
General public	Website, facebook page	Ongoing	Staff time; $200/year	Cheney Lake WRAPS
Watershed landowners/operators	Newsletter	4 issues/year	$750/year	Cheney Lake WRAPS
Watershed landowners/operators	Brochures - general, grass incentives, cover crops, fence CRP	Reprint as needed	$50/year	Cheney Lake WRAPS
Watershed landowners/operators	One-on-one outreach	Ongoing	Staff time	Cheney Lake WRAPS
Watershed landowners/operators	Signs identifying successful projects	8/year	$100/year for mileage, letters	Cheney Lake WRAPS
Watershed residents	Conservation awards	Annual - January	No WRAPS costs	Conservation Districts

Table 33. I&E: Cheney Lake Watershed Resident Education - Youth

Youth Education				
Targeted Audience	**Educational Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/Responsible Agency**
4th Grade Students	Water Festival	Annual - winter	Staff Time	Reno County Conservation District
Elementary classrooms in watershed (3 schools)	Classroom presentations, stream workshops	1-3/year	$500	Cheney Lake WRAPS
3rd Grade students	Farm2U	Annual - spring	Staff Time	Cheney Lake WRAPS
K-12 Students	Poster and essay contests on conservation themes	Annual	No WRAPS Cost	Conservation Districts
FFA or High School science classes	Classroom presentations, stream workshops	Annual	$500	Cheney Lake WRAPS

B. Evaluation of Information and Education Activities

All service providers conducting I&E activities funded through the Cheney Lake Watershed WRAPS will be required to include an evaluation component in their project implementation proposals. Evaluation methods will vary based on the activity. All service providers will be required to submit a brief written evaluation of their I&E activity, summarizing how successful the activity was in achieving the learning objectives, and how the activity contributed to achieving the long-term WRAPS goals and/or objectives for pollutant load reductions.

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

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

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

The ultimate success of the information and education program for the watershed is measured by the implementation of conservation practices and changes in management that protect water quality. Conservation practices implemented in the watershed using cost share from the City of Wichita are tracked by the WRAPS project. This database includes location, cost, funding sources, and project type. With assistance from KDHE, BMPs implemented can be translated into an estimate of load reduction. Some practices can be identified by ground-truthing through tillage practice surveys, periodic surveys of changes in management practices, and/or participation in incentive programs for conservation practices through the conservation districts, the Farm Service Agency and/or NRCS.

9. Cost of Implementing BMPs and Funding Sources

The CMC reviewed all recommended BMPs listed in this WRAPS plan for each individual impairment and determined which BMPs will receive implementation funding in each category (cropland and livestock). An added benefit is that most of the targeted BMPs will be advantageous to more than one impairment. Below are expenses before and after cost share for implementing cropland and livestock BMPs. Cost derivations are located in the appendix.

A. Cropland BMP Implementation Costs

Table 34. Cropland BMP Implementation Costs: Before Cost Share

Total Annual Cost* Before Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$29,368	$21,547	$28,351	$215,467	$30,241	$75,886	$14,175	$415,035
2	$30,249	$22,193	$29,201	$221,931	$31,148	$78,163	$14,601	$427,486
3	$31,156	$22,859	$30,078	$228,589	$32,083	$80,508	$15,039	$440,311
4	$32,091	$23,545	$30,980	$235,447	$33,045	$82,923	$15,490	$453,520
5	$33,054	$24,251	$31,909	$242,510	$34,037	$85,410	$15,955	$467,126
6	$34,045	$24,979	$32,867	$249,786	$35,058	$87,973	$16,433	$481,140
7	$35,067	$25,728	$33,853	$257,279	$36,109	$90,612	$16,926	$495,574
8	$36,119	$26,500	$34,868	$264,998	$37,193	$93,330	$17,434	$510,441
9	$37,202	$27,295	$35,914	$272,948	$38,308	$96,130	$17,957	$525,754
10	$38,318	$28,114	$36,992	$281,136	$39,458	$99,014	$18,496	$541,527
11	$39,468	$28,957	$38,101	$289,570	$40,641	$101,985	$19,051	$557,773
12	$40,652	$29,826	$39,244	$298,257	$41,861	$105,044	$19,622	$574,506
13	$41,871	$30,720	$40,422	$307,205	$43,116	$108,195	$20,211	$591,741
14	$43,128	$31,642	$41,634	$316,421	$44,410	$111,441	$20,817	$609,493
15	$44,421	$32,591	$42,883	$325,914	$45,742	$114,784	$21,442	$627,778
16	$45,754	$33,569	$44,170	$335,691	$47,115	$118,228	$22,085	$646,612
17	$47,127	$34,576	$45,495	$345,762	$48,528	$121,775	$22,747	$666,010
18	$48,541	$35,613	$46,860	$356,135	$49,984	$125,428	$23,430	$685,990
19	$49,997	$36,682	$48,266	$366,819	$51,483	$129,191	$24,133	$706,570
20	$51,497	$37,782	$49,714	$377,823	$53,028	$133,067	$24,857	$727,767
21	$53,042	$38,916	$51,205	$389,158	$54,619	$137,059	$25,602	$749,600
22	$54,633	$40,083	$52,741	$400,833	$56,257	$141,170	$26,371	$772,088
23	$56,272	$41,286	$54,323	$412,858	$57,945	$145,406	$27,162	$795,251
24	$57,960	$42,524	$55,953	$425,243	$59,683	$149,768	$27,977	$819,108
25	$59,699	$43,800	$57,632	$438,001	$61,474	$154,261	$28,816	$843,681
*3% Inflation							Total	$15,131,884

Table 35. Cropland BMP Implementation Costs: After Cost Share

Total Annual Cost* After Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$24,669	$13,574	$5,670	$86,187	$12,096	$30,354	$142	$172,693
2	$25,409	$13,982	$5,840	$88,773	$12,459	$31,265	$146	$177,874
3	$26,171	$14,401	$6,016	$91,436	$12,833	$32,203	$150	$183,210
4	$26,956	$14,833	$6,196	$94,179	$13,218	$33,169	$155	$188,706
5	$27,765	$15,278	$6,382	$97,004	$13,615	$34,164	$160	$194,368
6	$28,598	$15,736	$6,573	$99,914	$14,023	$35,189	$164	$200,199
7	$29,456	$16,209	$6,771	$102,912	$14,444	$36,245	$169	$206,205
8	$30,340	$16,695	$6,974	$105,999	$14,877	$37,332	$174	$212,391
9	$31,250	$17,196	$7,183	$109,179	$15,323	$38,452	$180	$218,762
10	$32,187	$17,712	$7,398	$112,454	$15,783	$39,606	$185	$225,325
11	$33,153	$18,243	$7,620	$115,828	$16,257	$40,794	$191	$232,085
12	$34,148	$18,790	$7,849	$119,303	$16,744	$42,018	$196	$239,048
13	$35,172	$19,354	$8,084	$122,882	$17,247	$43,278	$202	$246,219
14	$36,227	$19,935	$8,327	$126,568	$17,764	$44,577	$208	$253,606
15	$37,314	$20,533	$8,577	$130,365	$18,297	$45,914	$214	$261,214
16	$38,433	$21,149	$8,834	$134,276	$18,846	$47,291	$221	$269,050
17	$39,586	$21,783	$9,099	$138,305	$19,411	$48,710	$227	$277,122
18	$40,774	$22,436	$9,372	$142,454	$19,994	$50,171	$234	$285,435
19	$41,997	$23,110	$9,653	$146,727	$20,593	$51,676	$241	$293,998
20	$43,257	$23,803	$9,943	$151,129	$21,211	$53,227	$249	$302,818
21	$44,555	$24,517	$10,241	$155,663	$21,847	$54,823	$256	$311,903
22	$45,892	$25,252	$10,548	$160,333	$22,503	$56,468	$264	$321,260
23	$47,268	$26,010	$10,865	$165,143	$23,178	$58,162	$272	$330,898
24	$48,686	$26,790	$11,191	$170,097	$23,873	$59,907	$280	$340,825
25	$50,147	$27,594	$11,526	$175,200	$24,590	$61,704	$288	$351,050
*3% Inflation							Total	$6,296,264

B. Livestock BMP Implementation Costs

Table 36. Livestock BMP Implementation: Before Cost Share

Total Annual Cost Before Cost Share, Livestock BMPs					
Year	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Relocate Feeding Pens	Total
1	$2,203	$18,000	$14,000	$7,000	$41,203
2	$2,269	$18,540	$14,420	$0	$35,229
3	$2,337	$19,096	$14,853	$7,426	$43,712
4	$2,407	$19,669	$15,298	$0	$37,375
5	$2,479	$20,259	$15,757	$7,879	$46,374
6	$2,554	$20,867	$16,230	$0	$39,651
7	$2,630	$21,493	$16,717	$8,358	$49,199
8	$2,709	$22,138	$17,218	$0	$42,065
9	$2,791	$22,802	$17,735	$8,867	$52,195
10	$2,874	$23,486	$18,267	$0	$44,627
11	$2,961	$24,190	$18,815	$9,407	$55,373
12	$3,049	$24,916	$19,379	$0	$47,345
13	$3,141	$25,664	$19,961	$9,980	$58,746
14	$3,235	$26,434	$20,559	$0	$50,228
15	$3,332	$27,227	$21,176	$10,588	$62,323
16	$3,432	$28,043	$21,812	$0	$53,287
17	$3,535	$28,885	$22,466	$11,233	$66,119
18	$3,641	$29,751	$23,140	$0	$56,532
19	$3,750	$30,644	$23,834	$11,917	$70,145
20	$3,863	$31,563	$24,549	$0	$59,975
21	$3,979	$32,510	$25,286	$12,643	$74,417
22	$4,098	$33,485	$26,044	$0	$63,628
23	$4,221	$34,490	$26,825	$13,413	$78,949
24	$4,348	$35,525	$27,630	$0	$67,503
25	$4,478	$36,590	$28,459	$14,230	$83,757
*3% Inflation				Total	$1,379,958

Table 37. Livestock BMP Implementation: After Cost Share

Total Annual Cost After Cost Share, Livestock BMPs					
Year	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Relocate Feeding Pens	Total
1	$1,102	$9,000	$7,000	$3,500	$20,602
2	$1,135	$9,270	$7,210	$0	$17,615
3	$1,169	$9,548	$7,426	$3,713	$21,856
4	$1,204	$9,835	$7,649	$0	$18,687
5	$1,240	$10,130	$7,879	$3,939	$23,187
6	$1,277	$10,433	$8,115	$0	$19,825
7	$1,315	$10,746	$8,358	$4,179	$24,599
8	$1,355	$11,069	$8,609	$0	$21,033
9	$1,395	$11,401	$8,867	$4,434	$26,097
10	$1,437	$11,743	$9,133	$0	$22,314
11	$1,480	$12,095	$9,407	$4,704	$27,687
12	$1,525	$12,458	$9,690	$0	$23,672
13	$1,570	$12,832	$9,980	$4,990	$29,373
14	$1,618	$13,217	$10,280	$0	$25,114
15	$1,666	$13,613	$10,588	$5,294	$31,162
16	$1,716	$14,022	$10,906	$0	$26,644
17	$1,768	$14,442	$11,233	$5,616	$33,059
18	$1,821	$14,876	$11,570	$0	$28,266
19	$1,875	$15,322	$11,917	$5,959	$35,073
20	$1,931	$15,782	$12,275	$0	$29,988
21	$1,989	$16,255	$12,643	$6,321	$37,209
22	$2,049	$16,743	$13,022	$0	$31,814
23	$2,111	$17,245	$13,413	$6,706	$39,475
24	$2,174	$17,762	$13,815	$0	$33,751
25	$2,239	$18,295	$14,230	$7,115	$41,879
*3% Inflation				Total	$689,979

C. Total Costs for BMP Implementation and Education

Table 38. BMP Implementation and Education Costs: After Cost Share

Total Annual WRAPS Cost after Cost-Share by Category				
Year	Cropland	Livestock	I&E	Total Annual Cost
1	$172,693	$20,602	$21,600	$214,895
2	$177,874	$17,615	$22,248	$217,737
3	$183,210	$21,856	$22,915	$227,982
4	$188,706	$18,687	$23,603	$230,996
5	$194,368	$23,187	$24,311	$241,866
6	$200,199	$19,825	$25,040	$245,064
7	$206,205	$24,599	$25,792	$256,595
8	$212,391	$21,033	$26,565	$259,989
9	$218,762	$26,097	$27,362	$272,222
10	$225,325	$22,314	$28,183	$275,822
11	$232,085	$27,687	$29,029	$288,801
12	$239,048	$23,672	$29,899	$292,619
13	$246,219	$29,373	$30,796	$306,389
14	$253,606	$25,114	$31,720	$310,440
15	$261,214	$31,162	$32,672	$325,048
16	$269,050	$26,644	$33,652	$329,346
17	$277,122	$33,059	$34,662	$344,842
18	$285,435	$28,266	$35,702	$349,403
19	$293,998	$35,073	$36,773	$365,844
20	$302,818	$29,988	$37,876	$370,682
21	$311,903	$37,209	$39,012	$388,124
22	$321,260	$31,814	$40,182	$393,256
23	$330,898	$39,475	$41,388	$411,761
24	$340,825	$33,751	$42,629	$417,205
25	$351,050	$41,879	$43,908	$436,837
3% inflation				**$7,773,765**

10. Technical Assistance and Funding Sources

Technical assistance and various funding sources may be required to implement the BMPs and watershed education programs listed in the Cheney Lake Watershed WRAPS plan. Possible technical assistance providers and funding sources are presented in **Tables 39** and **40**.

Table 39. Potential Technical Assistance Providers for Plan Implementation

Technical Assistance to Aid in BMP Implementation		
BMPs To Be Implemented		**Technical Assistance**
Cropland	No-Till	DOC, FSA, KAWS, KDWPT, KFS, KSRE, NRCS and Watershed Specialist
	Cover Crops/Forage Crops	
	Nutrient Management Plans	
	Wetlands	
	Grassed Waterways	
	Terraces	
	Permanent Vegetation	
Livestock	Alternative Off Stream Watering Sites	
	Relocate Pasture Feeding Sites	
	Relocate Feeding Pens	
	Rotational Grazing	

Table 40. Potential Funding Sources for Plan Implementation

Potential BMP Funding Sources	
Potential Funding Sources	**Potential Funding Programs**
City of Wichita	
Division of Conservation/Conservation Districts	State Cost Share Programs
Ducks Unlimited	
EPA/KDHE	319 Funding Grants
Farm Service Agency	Conservation Reserve Program (CRP)
Kansas Alliance for Wetlands and Streams	
Kansas Department of Wildlife, Parks and Tourism	Partnering for Wildlife
Kansas Forest Service	
Kansas Wildlife Department	Kansas Reservoir Protection Initiative
Natural Resources Conservation Service (NRCS)	CRP
	Environmental Quality Incentives Program (EQIP)
	Farmable Wetlands Program (FWP)
	Forestland Enhancement Program (FLEP)
	Grassland Reserve Program (GRP)
	State Acres for Wildlife Enhancement (SAFE)
	Regional Conservation Partnership Program (RCPP)
	Wetland Reserve Program (WRP)
	Wildlife Habitat Incentive Program (WHIP)
No-till on the Plains	
Pheasants Forever	
Stumps Trust	
US Fish and Wildlife	

11. Measurable Milestones

The goal of this Cheney Lake Watershed WRAPS plan is to restore water quality for uses that support aquatic life, domestic water supply and recreation for Cheney Reservoir. The plan specifically addresses the high-priority eutrophication and siltation TMDLs for the reservoir. In order to reach the load reduction goals associated with the Cheney Lake Watershed impairments, an implementation schedule for conservation practices spanning 25 years has been developed.

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

In order to provide additional water quality information associated with this plan, separate water quality milestones also are included for the North Fork Ninnescah River. These water quality indicators will enable KDHE and the Cheney Lake Watershed WRAPS to measure water quality improvements within the watershed above the reservoir, which then should affect the water quality of the lake itself.

It is estimated that the **siltation TMDL** in the Cheney Lake Watershed will be attained at year eight of this WRAPS plan. After the sediment TMDL is achieved, the process will become one of protection rather than restoration.

The **nitrogen portion of the eutrophication TMDL** in Cheney Lake Watershed will not be met during the 25 years of this WRAPS plan. However, the **phosphorus portion of the eutrophication TMDL** in the watershed will be met in year 15 of the plan. After the nitrogen and phosphorus goals are achieved, the process will become one of protection instead of restoration.

Implementing the BMPs outlined in this plan to achieve the siltation and eutrophication on TMDLs subsequently will address the pH TMDL in the North Fork Ninnescah River.

A. Measurable Milestones for BMP Implementation

Milestones will be determined at the end of every five years by the following: number of acres treated, projects installed, contacts made to watershed residents, and water quality parameters. The CMC will examine these criteria to determine if adequate progress has been made on BMP implementations to date. If they determine that adequate progress has not been made, they will readjust the implementation projects in order to achieve the TMDL by the end of 25 years, as stipulated in this WRAPS plan.

Table 41. Short-, Medium-, and Long-Term Goals for Cropland BMP Adoption

Cheney Targeted Area Cropland BMP Adoption Milestones, acres									
	Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Adoption
Short-Term	1	378	378	378	47	473	473	95	2,221
	2	378	378	378	47	473	473	95	2,221
	3	378	378	378	47	473	473	95	2,221
	4	378	378	378	47	473	473	95	2,221
	5	378	378	378	47	473	473	95	2,221
	Subtotal	*1,890*	*1,890*	*1,890*	*236*	*2,363*	*2,363*	*473*	*11,104*
Medium-Term	6	378	378	378	47	473	473	95	2,221
	7	378	378	378	47	473	473	95	2,221
	8	378	378	378	47	473	473	95	2,221
	9	378	378	378	47	473	473	95	2,221
	10	378	378	378	47	473	473	95	2,221
	Subtotal	*3,780*	*3,780*	*3,780*	*473*	*4,725*	*4,725*	*945*	*22,208*
Long-Term	11	378	378	378	47	473	473	95	2,221
	12	378	378	378	47	473	473	95	2,221
	13	378	378	378	47	473	473	95	2,221
	14	378	378	378	47	473	473	95	2,221
	15	378	378	378	47	473	473	95	2,221
	Subtotal	*5,670*	*5,670*	*5,670*	*709*	*7,088*	*7,088*	*1,418*	*33,312*
	16	378	378	378	47	473	473	95	2,221
	17	378	378	378	47	473	473	95	2,221
	18	378	378	378	47	473	473	95	2,221
	19	378	378	378	47	473	473	95	2,221
	20	378	378	378	47	473	473	95	2,221
	Subtotal	*7,560*	*7,560*	*7,560*	*945*	*9,450*	*9,450*	*1,890*	*44,417*
	21	378	378	378	47	473	473	95	2,221
	22	378	378	378	47	473	473	95	2,221
	23	378	378	378	47	473	473	95	2,221
	24	378	378	378	47	473	473	95	2,221
	25	378	378	378	47	473	473	95	2,221
	Total	**9,450**	**9,450**	**9,450**	**1,181**	**11,813**	**11,813**	**2,363**	**55,521**

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

Annual Livestock BMP Adoption Milestones						
	Year	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Relocate Feeding Pens	Total Adoption
Short-Term	1	1	3	2	1	7
	2	1	3	2	0	6
	3	1	3	2	1	7
	4	1	3	2	0	6
	5	1	3	2	1	7
	Subtotal	*5*	*15*	*10*	*3*	*33*
Medium-Term	6	1	3	2	0	6
	7	1	3	2	1	7
	8	1	3	2	0	6
	9	1	3	2	1	7
	10	1	3	2	0	6
	Subtotal	*10*	*30*	*20*	*5*	*65*
Long-Term	11	1	3	2	1	7
	12	1	3	2	0	6
	13	1	3	2	1	7
	14	1	3	2	0	6
	15	1	3	2	1	7
	Subtotal	*15*	*45*	*30*	*8*	*98*
	16	1	3	2	0	6
	17	1	3	2	1	7
	18	1	3	2	0	6
	19	1	3	2	1	7
	20	1	3	2	0	6
	Subtotal	*20*	*60*	*40*	*10*	*130*
	21	1	3	2	1	7
	22	1	3	2	0	6
	23	1	3	2	1	7
	24	1	3	2	0	6
	25	1	3	2	1	7
	Total	**25**	**75**	**50**	**13**	**163**

B. Benchmarks to Measure Water Quality and Social Progress

Over a 10- to 25-year time frame, the Cheney Lake Watershed WRAPS plan hopes to improve water quality throughout the watershed and in Cheney Reservoir. To monitor these improvements, measurements taken at Cheney Reservoir are important because the reservoir

is the drainage endpoint of the watershed. Social indicators of success also will be examined by tracking traffic in the reservoir and Cheney State Park. A good example of a healthy reservoir ecosystem is frequent visits by the public to enjoy outdoor recreation at the reservoir and park.

After reviewing the criteria listed in **Table 43**, the CMC will assess and revise the overall strategy plan for the watershed every five years. New goals will be set, and new BMPs will be implemented in order to achieve improved water quality if necessary. Coordination with KDHE TMDL staff, Water Plan staff and the CMC will be held every five years to discuss benchmarks and TMDL update plans. Using data obtained by KDHE, Kansas State University or the Army Corps of Engineers, the following indicator and parameter criteria shall be used to assess progress toward successful implementation to abate pollutant loads.

Table 43. Benchmarks to Measure Water Quality Progress

Benchmarks to Measure Water Quality Progress		
Impairment Addressed	**Criteria to Measure Water Quality Progress**	**Information Source**
Sediment	**Cheney Reservoir:** TSS < 100 mg/L Secchi disc transparency increased to 2 feet.	KDHE
	Cheney Reservoir: Secchi Disc Depth > 0.61m	KDHE
	Fewer high event stream flow rates indicating better retention and slower release of storm water above the reservoir	USGS
Nutrients	**Cheney Reservoir:** Summer chlorophyll α concentration ≤ 10 µg/l	KDHE
	North Fork Ninnescah River: Maintain pH concentrations with readings between 6.5 to 8.5. Less than 10% of samples with a > 8.5 pH.	KDHE
Impairment Addressed	**Social Indicators to Measure Water Quality Progress**	**Information Source**
Sediment/ Nutrients	Visitor traffic to the Cheney Reservoir	KDWPT
	Boating traffic in the Cheney Reservoir	KDWPT
	Trends of quantity and quality of fishing in Cheney Reservoir	KDWPT
	Beach closings at Cheney Reservoir	KDHE
	Taste and odor issues in public water supply from the Cheney Reservoir	KDHE
	Occurrence of algal blooms in the Cheney Reservoir	KDHE
	No fish kills in the North Fork Ninnescah River	KDHE
	Economic indicators demonstrating the effect of the Cheney Lake Watershed's impact on local businesses	County Economic Development Organizations
	Survey of water quality issues to determine whether information and education programs are having an effect on public perception	KSRE
	Number of attendees at tours and field days	KSRE
	Number of acres of wetlands, grassed waterways and terraces installed in the cropland targeted areas	NRCS

The goals of the Cheney Lake Watershed WRAPS plan will be to restore water quality for uses that support aquatic life, primary contact recreation and public water supply for the Cheney

Reservoir and the North Fork Ninnescah River and its tributaries. This restoration plan will take 25 years of BMP implementation.

C. Water Quality Milestones Used to Determine Improvements

This plan specifically addresses the high-priority siltation and eutrophication TMDLs for the Cheney Lake Watershed, specifically in Cheney Reservoir. In order to reach the load reduction goals associated with the Cheney Reservoir impairments, a BMP implementation schedule spanning 25 years has been developed.

The BMPs included in this plan will be implemented throughout the targeted areas within the Cheney Lake Watershed, including the North Fork Ninnescah River and the sub-watersheds located above the reservoir. While the North Fork Ninnescah River has a low-priority pH TMDL that this plan does not address specifically, it is anticipated that the water quality impairments will be affected positively by the BMP implementation plan developed as part of this WRAPS plan.

Water quality milestones have been developed for Cheney Reservoir, along with additional indicators of water quality. The purpose of the milestones and indicators is to measure water quality improvements associated with the BMP implementation schedule contained in this plan. These water quality indicators will enable KDHE and the Cheney Lake Watershed CMC and WRAPS groups to measure water quality improvements within the watershed above Cheney Reservoir, which then should affect the water quality in the reservoir itself.

D. Water Quality Milestones for Cheney Reservoir

As previously stated, in order to reach the load reduction goals for the Cheney Lake Watershed, specifically Cheney Reservoir, a BMP implementation schedule spanning 25 years has been developed, including several water quality milestones and indicators for Cheney Reservoir. In addition to water quality measures such as concentrations of total nitrogen and phosphorus and Secchi depth measurements, the lake sedimentation rate for the reservoir will determine the effectiveness of the BMPs implemented as part of the sediment load reduction goals outlined in the plan.

As included in the siltation TMDL for Cheney Reservoir, the estimated sedimentation rate, as provided by the Kansas Water Office in 2000, was approximately 235 acre-feet/year. As part of the water quality assessment, the sedimentation rate will continue to be analyzed throughout the life of this plan. A movement toward the desired sedimentation rate of 210 acre-feet/year, or a 10% reduction, is considered a water quality goal associated with the sediment load reduction goals of this plan.

The eutrophication TMDL requires decreased nitrogen and phosphorus loading into the reservoir. While BMP implementation will result in reductions by nutrient pounds per year, monitoring will measure parts per billion (ppb) in the water column.

Tables 44, 45 and 46 include 10-year water quality goals, as well as long-term water quality goals for the sediment and nutrient TMDLs and related parameters monitored in Cheney Reservoir.

Table 44. Cheney Reservoir Milestones for Sediment TMDL

Water Quality Milestones: Cheney Reservoir - Sediment			
Sampling Site	Secchi (average of data collected during indicated period)		
	Current Condition (1990 - 2008) Secchi (Avg)	10-Year Goal Improved Condition (2011 - 2021) Secchi (Avg)	Long Term Goal Improved Condition Secchi (Avg)
Cheney Reservoir (USGS Site)	0.58 m	Secchi depth > 0.61m	Maintain Average Secchi depth > 1.0 m

Table 45. Cheney Reservoir Milestones for Eutrophication TMDL - Phosphorus

Water Quality Milestones: Cheney Reservoir - Nutrients -> Phosphorus					
Sampling Site	Total Phosphorus (TP) (median of data collected during indicated period), ppb				
	Current Condition (2001-2010) Median TP	10-Year Goal		Long Term Goal	
		Improved Condition (2011 - 2021) Median TP	Total Reduction Needed	Improved Condition Median TP	Total Reduction Needed
Cheney Reservoir (USGS Site)	100	90	10	80	20

There are no available data for the nitrogen portion of the eutrophication TMDL in Cheney Reservoir, therefore a table similar to **Table 45** for nitrogen cannot be included in this plan.

Chlorophyll *a* is a measurement of chlorophyll in the water column. High chlorophyll levels will result in algal growth. The presence of nutrients and chlorophyll are directly correlated. Therefore, any decrease in chlorophyll indicates a decrease in nutrients.

Table 46. Milestones for Eutrophication in the Cheney Reservoir - Chlorophyll a

Water Quality Milestones: Cheney Reservoir - Nutrients -> Chlorophyll *a*				
Sampling Site	Chlorophyll *a* (average of data collected during indicated period), ppb			
	Current Condition (1990-2008) Chlorophyll *a*	10-Year Goal		Long Term Goal
		Improved Condition (2011 - 2021) Chlorophyll *a*	Total Reduction Needed	Improved Condition Chlorophyll *a*
Cheney Reservoir LM017001	18.6	13	5.6	Maintain Average: Chlorophyll *a* ≤ 10 ppb

Current conditions for sediment and phosphorus were calculated by utilizing USGS water quality data for samples taken from 2001 through 2010[28].

E. Water Quality Milestones for the North Fork Ninnescah River

While the primary focus of this plan is the high-priority siltation and eutrophication TMDLs for Cheney Reservoir, it is anticipated that the implementation plan for targeted areas within the watershed also will improve water quality, such as pH, in the North Fork Ninnescah River.

[28] Lisa French, 2011 Cheney Lake WRAPS Plan, page 65.

Table 47. Milestones for Eutrophication in the North Fork Ninnescah River

Eutrophication Milestones						
Stream	**Station**	**Parameter**	**Average Flow (cfs)**	**Current Non-point Load (pounds/year)**	**Target Annual Non-point Source Load Reductions (pounds/year)**	**% Reduction in Non-point Source Load**
Phase I						
North Fork Ninnescah River	SC525	Total Nitrogen	149	718,593	327,673	43%
North Fork Ninnescah River	SC525	Total Phosphorus	149	129,008	56,163	41%
Phase II						
North Fork Ninnescah River	SC525	Total Nitrogen	149	718,593	537,403	*65%*
North Fork Ninnescah River	SC525	Total Phosphorus	149	129,008	92,843	69%

Table 47 includes water quality nutrient milestones in the North Fork Ninnescah River which will improve pH conditions in the water segment.

Table 48. North Fork Ninnescah River pH TMDL Milestones

Water Quality Milestones: North Fork Ninnescah River - pH		
Sampling Sites	**Current Condition (2001 - 2010) % Samples with pH > 8.5**	**Long Term Goal**
		Improved Condition (% Samples pH > 8.5)
North Fork Ninnescah River (USGS Site)	13%	Less than 10%

Current conditions for pH were calculated using sampling data from the KDHE monitoring station at the North Fork Ninnescah River from 2001 to 2010[29].

[29] Lisa French, 2011 Cheney Lake WRAPS Plan, page 66.

12. Monitoring Water Quality

KDHE continues to monitor water quality in the Cheney Lake Watershed by maintaining the monitoring stations located within the watershed.

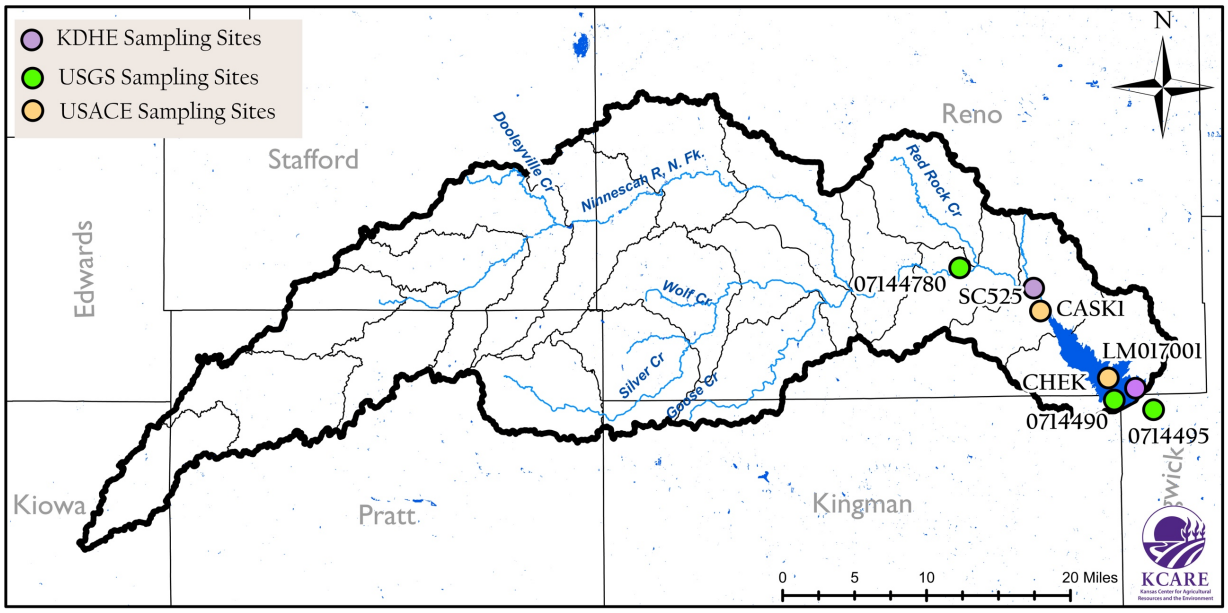


Figure 26. Monitoring Stations in the Cheney Lake Watershed

Cheney Lake Watershed water monitoring sites as shown in **Figure 26** include:

1. Stream chemistry monitoring sites:
   - KDHE station SC525, located on the North Fork Ninnescah River at a bridge on K17 Highway, 1 mile northeast and 1.5 miles south of Castleton; period of record 1990 to present.
   - USGS 07144780 located on the North Fork Ninnescah River, above Cheney Reservoir; period of record 1998 to present.
   - U.S. Army Corps of Engineers (USACE), Station CASK1, Ninnescah River above Cheney Reservoir.
2. Lake monitoring sites:
   - KDHE station LM017001, located near the Cheney Reservoir dam; period of record 2001 to present.
   - USGS station 07144790, located near the Cheney Reservoir dam; period of record 2001 to present.
   - USACE, Station CHEK, North Fork Ninnescah River at the Cheney Reservoir dam.

Figure 26 shows the permanent KDHE monitoring station (SC525) located within the Cheney Lake Watershed, which is above the reservoir on the North Fork Ninnescah River. The KDHE permanent monitoring sites are sampled continuously for nutrients, *E. coli* bacteria, chemicals, turbidity, alkalinity, dissolved oxygen, pH, ammonia and metals. The pollutant indicators tested for each site may vary depending on the season at collection time and other factors. The CMC will

request KDHE to review analyzed data from all monitoring sources on an annual basis. Data collected in the targeted HUC 12s will be of special interest. Monitoring data will be used to direct the CMC in their evaluation of water quality progress. Also shown is the KDHE lake monitoring station (LM017001) near the dam of the reservoir. This site is sampled typically every three years between April and October.

Also indicated in **Figure 26** are two U. S. Geological Survey (USGS) monitoring stations. One is located in the reservoir (07144790), and one is on the North Fork Ninnescah River (07144780). Both of these stations have real-time data collection for 15- to 60-minute intervals; the data collection includes temperature, specific conductance, dissolved oxygen, pH, turbidity, chlorophyll fluorescence (reservoir site only) and phycocyanin fluorescence (reservoir site only). The data are stored onsite and then transmitted to USGS offices hourly. These types of data assure flow, runoff and daily fluxes are accounted for, thus minimizing data interpretation and assumptions. Fewer interpretation and assumptions result in more accurate analysis, which in turn leads to more realistic conclusions and decisions. Monitoring on the North Fork Ninnescah River may also help identify responses to BMP implementation as the lake site measurements would have a much longer lag time for response to implementation due to in-lake loading. The current funding sources for USGS monitoring in this watershed are the City of Wichita (50%) and USGS (50%). This joint funding agreement is in effect through September 2020.

Stream flow data also is collected by the USGS. Samples are taken automatically every 15 minutes. Reviewing the data will indicate whether runoff events in the upper reaches of the watershed have been slowed by BMPs such as no-till or terraces. Stream flow monitoring sites include:

- USGS station 07144780, located on the North Fork Ninnescah River, above Cheney Reservoir; period of record, 1990 to present.
- USGS station 07144795, located on the North Fork Ninnescah River, below Cheney Reservoir (outside the Cheney Lake Watershed); period of record, 1990 to present.

USACE conducts regular monitoring in the Cheney Lake Watershed as well. Typically, monitoring takes place from May through September. Sampling data include temperature, DO, pH, conductivity and turbidity, nitrogen, phosphorus, chlorophyll α, iron, Secchi disc depth and atrazine. USACE has two sampling points to include:

- Station CASK1, North Fork Ninnescah River above the Cheney Reservoir; and
- Station CHEK, North Fork Ninnescah River at the Cheney Reservoir dam.

Much of the evaluative information can be obtained through the existing networks and sampling plans of KDHE, USGS, USACE and Kansas State University. In addition to the monitoring data, other water quality indicators can be utilized by KDHE and the CMC. Such indicators may include anecdotal information from the CMC and other citizen groups within the watershed (e.g., skin rash outbreaks, fish kills, nuisance odors), which can be used to assess short-term deviations from water quality standards. These additional indicators can act as trigger points that might initiate further revisions or modifications to the WRAPS plan by KDHE and the CMC. Public engagement can be obtained through observations of the reservoir, reservoir clarity, ease of boating, and/or the physical appearance of the reservoir.

Future Monitoring Needs

Additional monitoring in high-priority sub-watersheds would provide useful data. Existing watershed studies indicate that this type of monitoring needs to be conducted on small scale watersheds in order to detect water quality trends. Previous USGS studies (1996-2000) indicated that Red Rock Creek had the largest nutrient concentrations and yields of any sub-watershed area within the Cheney Lake Watershed. Resumption of monitoring at the Red Rock and Goose Creek sites previously monitored by USGS would be useful; however, a paired watershed study within one of these sub-watersheds would hold the greatest potential to document water quality improvements.

The CMC proposes a three- to five-year study of paired watersheds within either the Goose Creek or Red Rock Creek sub-watershed, with intensive implementation of conservation work in one drainage area during the monitoring period. Monitoring would include total phosphorus, total nitrogen, bacteria, atrazine (for Red Rock sub-watershed), and other chemical constituents. The high nutrient levels found by USGS in the late 1990s makes Red Rock a top choice for implementation and monitoring in a paired watershed study.

The key to creating a robust dataset on water quality trends is good research design and analysis. The CMC does not believe that volunteer or student-run projects would provide the quality of data that would justify the expense of monitoring. USGS conducted the original monitoring studies, and the CMC would prefer for USGS to conduct any future studies to ensure consistency in quality of data collection and analysis.

Whether or not this study is initiated in the Cheney Lake Watershed, the CMC believes that such a study in Kansas would help demonstrate the potential for water quality improvement with focused voluntary implementation of conservation work. Such a project also would provide insight into the strategies needed to transition from random conservation work to focused implementation.

Evaluation of Monitoring Data

Monitoring data in the Cheney Lake Watershed will be used to determine water quality progress, track water quality milestones, and to determine the effectiveness of the implementation of conservation practices outlined in this plan. The schedule of review for the monitoring data will be tied to the water quality milestones already developed, as well as the frequency of the sampling data. It should be noted that the current TMDLs for Cheney Lake Watershed are scheduled to be reviewed by KDHE in 2024. Monitoring data will be utilized at that time to determine necessary modifications to the TMDL.

13. Review of the WRAPS Plan

In the year 2024, the Cheney Lake Watershed WRAPS plan will be reviewed and revised according to results acquired from monitoring data. The CMC will request a report from KDHE on the milestone achievements for sediment, nitrogen and phosphorus load reductions. At that time, the CMC will review the following criteria in addition to any other concerns that may occur at the plan's future review:

1. Reports from KDHE on current and desired endpoints for water quality in the Cheney Reservoir.

    - **Sediment:** Based on analysis of sediment data from USGS, approximately 235 acre-feet of sediment are deposited into Cheney Reservoir annually. The Cheney Reservoir sedimentation rate must be reduced by 10%, or 22,650 tons/year. At the current sedimentation rate, the area weighted Secchi depth is 0.398 meters (1.3 feet). A water quality-based target to meet the TMDL is a Secchi depth of 0.61 meters (2 feet) which constitutes a 35% increase. This will indicate a reduction in TSS in the water column which equates to a reduction in sediment loading.[30]

    - **Eutrophication:** The desired outcome is to maintain summer chlorophyll *a* average concentrations below 10 µg/L, corresponding to a Carlson Trophic State Index of 53.2, with reductions focused on nitrogen and phosphorus. Based on the BATHTUB reservoir eutrophication model, the total nitrogen and total phosphorus entering Cheney Reservoir must be reduced. **Nitrogen** must be reduced to 277,959 pounds per year, which is a reduction of 65%. Meanwhile, **phosphorus** must be reduced to 40,184 pounds per year, which is a 69% reduction.[31]

2. Reports from KDHE concerning watershed TMDL revisions, including possible nutrient and/or sediment criteria, revised load allocations, and new wasteload allocations defined for the point sources.

3. Reports from KDHE, USGS, and USACE on trends in water quality above, below, and in the Cheney Reservoir.

In turn, the CMC will provide various reports when necessary. These include:
1. progress toward achieving the benchmarks listed in this nine-element plan;
2. progress toward achieving the BMP adoption rates in this plan; and
3. discussion of necessary adjustments and revisions needed for the targets listed in this plan.

[30] Kansas Department of Health and Environment, TMDL Section. http://www.kdheks.gov/tmdl/la/CheneySILT.pdf
[31] Kansas Department of Health and Environment, TMDL Section. http://www.kdheks.gov/tmdl/2015/Cheney_Eu.pdf

14. Appendix

A. Potential Service Providers

Table 49. Service Provider List

Organization	Programs	Purpose	Technical or Financial Assistance	Phone	Website address
Environmental Protection Agency	Clean Water State Revolving Fund Program	Provides low cost loans to communities for water pollution control activities.	Financial	913-551-7003	www.epa.gov
	Watershed Protection	Assist with holistic strategies for restoring and protecting aquatic resources based on hydrology rather than political boundaries.			
Kansas Alliance for Wetlands and Streams	Streambank Stabilization, Wetland Restoration	The Kansas Alliance for Wetlands and Streams (KAWS) was organized in 1996 to promote the protection, enhancement, restoration and establishment wetlands and streams in Kansas.	Technical	785-210-0040	www.kaws.org
Kansas Department of Agriculture - Division of Water Resources	Stream and Floodplain Permits	Permitting for stream obstructions such as stream crossings, dams, culverts, etc. and for channel changes in designated streams.	Technical	620-234-5311 (Stafford Field Office)	https://agriculture.ks.gov/divisions-programs/dwr/stream-and-floodplain-permits
	Groundwater appropriations	Administration of laws regarding ground water use.	Technical	620-234-5311 (Stafford Field Office)	https://agriculture.ks.gov/divisions-programs/dwr/water-appropriation
Kansas Department of Health and Environment	Nonpoint Source Pollution Program	Provide funds for projects that will reduce nonpoint source pollution.	Technical and Financial	785-296-1500	www.kdheks.gov
	Livestock waste Municipal waste	Compliance monitoring.			
	State Revolving Loan Fund	Makes low interest loans for projects to improve and protect water quality.			
Kansas Department of Wildlife, Parks and Tourism	Land and Water Conservation Funds	Provides funds to preserve develop and assure access to outdoor recreation.	Financial	620-672-5911	www.kdwp.state.ks.us/about/grants.html
	Conservation Easements for Riparian and Wetland Areas	To provide easements to secure and enhance quality areas in the state.		785-296-2780	
	Wildlife Habitat Improvement Program	To provide limited assistance for development of wildlife habitat.		620-672-5911	
	North American Waterfowl Conservation Act	To provide up to 50 percent cost share for the purchase and/or development of wetlands and wildlife habitat.		620-342-0658	
	MARSH program in coordination with Ducks Unlimited	May provide up to 100 percent of funding for small wetland projects.		620-672-5911	
	Chickadee Checkoff	Projects help with eagles, songbirds, threatened and endangered species, turtles, lizards, butterflies, and stream darters. Funding is an optional donation line item on the KS income tax form.			
	Walk In Hunting Program	Landowners receive a payment incentive to allow public hunting on their property.			
	F.I.S.H. Program	Landowners receive a payment incentive to allow public fishing access to their ponds and streams.			

Service Provider List, Continued

Organization	Programs	Purpose	Technical or Financial Assistance	Phone	Website address
Kansas Forest Service	Riparian and Wetland Protection Program	Work closely with other agencies to promote and assist with establishment of riparian forestland and manage existing stands.	Technical and Financial	785-532-3310	kansasforests.org
Kansas Rural Center	Community Food Solutions; Women and Conservation; Pollinators and Habitat Conservation; Tunnel to Table	The Center is committed to economically viable, environmentally sound and socially sustainable rural culture.	Technical and Education	785-873-3431	www.kansasruralcenter.org
Kansas Rural Water Association	Technical assistance for Water Systems with Source Water Protection Planning	Provide education, technical assistance and leadership to public water and wastewater utilities to enhance the public health and to sustain Kansas' communities.	Technical	785-336-3760	www.krwa.net
Kansas State Research and Extension	Kansas Center for Agricultural Resources and Environment (KCARE)	Provide programs, expertise and educational materials that relate to minimizing the impact of rural and urban activities on water quality.		785532-7108	www.kcare.ksu.edu
Kansas Water Office	Public Information and Education	Provide information and education to the public on Kansas Water Resources.	Technical and Financial	785-296-3185	www.kwo.org
No-Till on the Plains	Field days, seasonal meetings, tours and technical consulting.	Provide information and assistance concerning continuous no-till farming practices.	Technical	888-330-5142	www.notill.org
Division of Conservation, Conservation Districts and Kansas Association of Conservation Districts (KACD)	Water Resources Cost Share Program	Provide cost share assistance to landowners for establishment of water conservation practices.	Technical and Financial	Reno County Conservation District 620-669-8161	agriculture.ks.gov/divisions-programs/division-of-conservation
	Nonpoint Source Pollution Control Fund	Provides financial assistance for nonpoint pollution control projects which help restore water quality.		Kingman County Conservation District 620-532-5731	
	Kansas Water Quality Buffer Initiative	Compliments Conservation Reserve Program by offering additional financial incentives for grass filters and riparian forest buffers.		Stafford County Conservation District 620-549-3480	www.kacdnet.org/
	Watershed district and multipurpose lakes	Programs are available for watershed district and multipurpose small lakes.		Pratt County Conservation District 620-672-7449	
US Army Corps of Engineers	Planning Assistance to states	Assistance in development of plans for development, utilization and conservation of water and related land resources of drainage.	Technical	816-983-3157	www.usace.army.mil
	Environmental Restoration	Funding assistance for aquatic ecosystem restoration.		816-983-3157	
US Fish and and Wildife	Fish and Wildlife Enhancement Program	Supports field operations which include technical assistance on wetland design.	Technical	785-539-3474	www.fws.gov
	Private Lands Program	Contracts to restore, enhance, or create wetlands.		785-539-3474	

Service Provider List, Continued

Organization	Programs	Purpose	Technical or Financial Assistance	Phone	Website address
USDA Natural Resources Conservation Service (NRCS) and Farm Service Agency (FSA)	Conservation Compliance	Primarily for the technical assistance to develop conservation plans on cropland.	Technical and Financial	Reno County Conservation District 620-669-8161	www.ks.nrcs.usda.gov
	Conservation Operations	To provide technical assistance on private land for development and application of Resource Management Plans.		Kingman County Conservation District 620-532-5731	
	Grassland Reserve Program, Environmental Quality Incentives Program and Conservation Reserve Program	Improve and protect rangeland resources with cost-sharing practices, rental agreements, and easement purchases.		Stafford County Conservation District 620-549-3480	
				Pratt County Conservation District 620-672-7449	
City of Wichita	Public Works and Utilities - Water Production	Provides financial assistance for watershed outreach and education; cost share and incentives for water quality protection measures on watershed farms	Financial	620-269-4760	www.wichita.gov/PWU/
Groundwater Mangement District 2 (Equus Beds)	Groundwater appropriations	Administration of laws regarding ground water use	Technical	316-835-2224	www.gmd2.org
Groundwater Mangement District 5	Groundwater appropriations	Administration of laws regarding ground water use	Technical	620-234-5352	https://gmd5.org
Ninnescah Valley Prescribed Burn Association	Cooperative effort for the use of prescribed fire	Provide the tools, training, education, and resources to its members to conduct prescribed burns in a safe and effective manner. enables the members to better manage their grassland resources and control invasive species.	Technical	nvpbamembers@gmail.com	www.facebook.com/NVPBA/

B. BMP Definitions

1. Cropland BMPs

a. No-till

- A management system in which chemicals may be used instead of tillage 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 and 40% phosphorous reduction efficiency.

b. Cover crops

- A cover crop is a crop of a specific plant grown primarily for the benefit of the soil rather than the crop yield.
- Cover crops commonly are used to suppress weeds, manage soil erosion, help build and improve soil fertility and quality, and control diseases and pests.
- Cover crops are typically legumes or grasses but may be comprised of other green plants.
- Cover crops can reduce erosion from wind and water, sequester carbon in plant biomass and soils to increase soil organic matter content, capture and recycle excess nutrients in the soil profile, promote biological nitrogen fixation, increase biodiversity, promote weed suppression, provide supplemental forage, promote soil moisture management, and reduce particulate emissions into the atmosphere.[32]
- 40% erosion reduction efficiency and 50% phosphorus reduction efficiency.

c. Nutrient management plan

- Management for the amount, source, placement, form and timing of the application of nutrients and soil amendments.
- Intensive soil testing.
- 40% erosion reduction efficiency and 50% phosphorus reduction efficiency.

d. Wetlands

- Establish wetlands coming off crop fields on sites where there is expected to be high erosion rates and ground level is low.
- Wetlands can capture and slow crop field runoff, thereby catching sediment and nutrients in the wetland, keeping these pollutants from entering a nearby stream segment.
- It is assumed that one acre of wetland treats 10 acres of cropland.
- 30% erosion reduction efficiency and 30% phosphorus reduction efficiency.

e. Grassed waterways

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

[32] Kansas Department of Health and Environment.
http://www.kdheks.gov/nps/downloads/AnnualReport2006.pdf

- They also can be used as outlets for water from terraces.
- On average for Kansas fields, a one-acre waterway will treat 10 acres of cropland.
- 40% erosion reduction efficiency and 40% phosphorous reduction efficiency.

f. Terraces

- An earth embankment and/or channel constructed across the slope to intercept runoff water and trap soil.
- They are one of the oldest/most common BMPs.
- 30% erosion reduction efficiency and 30% phosphorous reduction efficiency.

g. Establish permanent vegetation

- Establishing permanent vegetation on sites that have or are expected to have high erosion rates, and on sites that have physical, chemical, or biological conditions that prevent the establishment of vegetation using normal practices;
- Establishing permanent vegetation can stabilize areas with existing or expected high rates of soil erosion by water and wind; and
- Establishing permanent vegetation can restore degraded sites that cannot be stabilized through normal methods.
- 95% erosion reduction efficiency and 95% phosphorus reduction efficiency.

2. Livestock BMPs

a. Relocate feeding sites

- Move **feedlot** or pens away from a stream, waterway, or body of water to increase filtration and waste removal of manure.
- Move **pasture** feeding sites to a pasture away from a stream, waterway, or body of water to increase the filtration and waste removal (i.e., move bale feeders away from the stream).
- Average P reduction: 30-80%

b. Alternative (off-stream) watering systems

- Watering systems designed 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.
- They have a 10- to 25-year lifespan, with an average P reduction of 30-98%, with greater efficiencies for limited stream access.

c. Rotational Grazing

- A grazing system that involves rotating livestock within a pasture to spread manure more uniformly and allow grass adequate rest to regenerate.
- Expenses may involve significant cross fencing and additional watering sites.
- 40-60% P Reduction efficiency.

C. Budget Derivations

1. Cropland

Summarized derivation of cropland BMP cost estimates

- No-till: $78 per treated acre with 16% cost share.
- Cover crops: $75 per treated acre with 80% cost share.
- Nutrient management plan $57 per treated acre with 37% cost share.
- Establish wetlands: $1,606 per treated acre with 60% cost share.
- Grassed waterway: $64 per treated acre with 60% cost share.
- Terraces: $457 per treated acre with 60% cost share.
- Establish permanent vegetation: $150 per treated acre with 99% cost share.

2. Livestock

Summarized derivation of livestock BMP cost estimates

- Relocated feeding lot: $2,203 with 60% cost share. Cost includes the cost of building ¼ mile of fence, a permeable surface, and labor.
- Off-stream watering system: $6,000 with 60% cost share. Cost includes supplies and labor.
- Rotational Grazing: $7,000 with 60% cost share. Cost includes fencing and labor.
- Relocated feeding pens: $7,000 with 60% cost share. Cost includes the fencing, a new watering system, concrete, and labor.

D. 25-year Project Tables by Sub-watershed

1. Cropland BMP implementation in the Cheney Lake Watershed

HUC 109 Annual Adoption (treated acres), Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Adoption
1	37	37	37	5	46	46	9	216
2	37	37	37	5	46	46	9	216
3	37	37	37	5	46	46	9	216
4	37	37	37	5	46	46	9	216
5	37	37	37	5	46	46	9	216
6	37	37	37	5	46	46	9	216
7	37	37	37	5	46	46	9	216
8	37	37	37	5	46	46	9	216
9	37	37	37	5	46	46	9	216
10	37	37	37	5	46	46	9	216
11	37	37	37	5	46	46	9	216
12	37	37	37	5	46	46	9	216
13	37	37	37	5	46	46	9	216
14	37	37	37	5	46	46	9	216
15	37	37	37	5	46	46	9	216
16	37	37	37	5	46	46	9	216
17	37	37	37	5	46	46	9	216
18	37	37	37	5	46	46	9	216
19	37	37	37	5	46	46	9	216
20	37	37	37	5	46	46	9	216
21	37	37	37	5	46	46	9	216
22	37	37	37	5	46	46	9	216
23	37	37	37	5	46	46	9	216
24	37	37	37	5	46	46	9	216
25	37	37	37	5	46	46	9	216

HUC 301 Annual Adoption (treated acres), Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Adoption
1	25	25	25	3	31	31	6	145
2	25	25	25	3	31	31	6	145
3	25	25	25	3	31	31	6	145
4	25	25	25	3	31	31	6	145
5	25	25	25	3	31	31	6	145
6	25	25	25	3	31	31	6	145
7	25	25	25	3	31	31	6	145
8	25	25	25	3	31	31	6	145
9	25	25	25	3	31	31	6	145
10	25	25	25	3	31	31	6	145
11	25	25	25	3	31	31	6	145
12	25	25	25	3	31	31	6	145
13	25	25	25	3	31	31	6	145
14	25	25	25	3	31	31	6	145
15	25	25	25	3	31	31	6	145
16	25	25	25	3	31	31	6	145
17	25	25	25	3	31	31	6	145
18	25	25	25	3	31	31	6	145
19	25	25	25	3	31	31	6	145
20	25	25	25	3	31	31	6	145
21	25	25	25	3	31	31	6	145
22	25	25	25	3	31	31	6	145
23	25	25	25	3	31	31	6	145
24	25	25	25	3	31	31	6	145
25	25	25	25	3	31	31	6	145

HUC 302 Annual Adoption (treated acres), Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Adoption
1	69	69	69	9	87	87	17	408
2	69	69	69	9	87	87	17	408
3	69	69	69	9	87	87	17	408
4	69	69	69	9	87	87	17	408
5	69	69	69	9	87	87	17	408
6	69	69	69	9	87	87	17	408
7	69	69	69	9	87	87	17	408
8	69	69	69	9	87	87	17	408
9	69	69	69	9	87	87	17	408
10	69	69	69	9	87	87	17	408
11	69	69	69	9	87	87	17	408
12	69	69	69	9	87	87	17	408
13	69	69	69	9	87	87	17	408
14	69	69	69	9	87	87	17	408
15	69	69	69	9	87	87	17	408
16	69	69	69	9	87	87	17	408
17	69	69	69	9	87	87	17	408
18	69	69	69	9	87	87	17	408
19	69	69	69	9	87	87	17	408
20	69	69	69	9	87	87	17	408
21	69	69	69	9	87	87	17	408
22	69	69	69	9	87	87	17	408
23	69	69	69	9	87	87	17	408
24	69	69	69	9	87	87	17	408
25	69	69	69	9	87	87	17	408

HUC 303 Annual Adoption (treated acres), Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Adoption
1	45	45	45	6	57	57	11	266
2	45	45	45	6	57	57	11	266
3	45	45	45	6	57	57	11	266
4	45	45	45	6	57	57	11	266
5	45	45	45	6	57	57	11	266
6	45	45	45	6	57	57	11	266
7	45	45	45	6	57	57	11	266
8	45	45	45	6	57	57	11	266
9	45	45	45	6	57	57	11	266
10	45	45	45	6	57	57	11	266
11	45	45	45	6	57	57	11	266
12	45	45	45	6	57	57	11	266
13	45	45	45	6	57	57	11	266
14	45	45	45	6	57	57	11	266
15	45	45	45	6	57	57	11	266
16	45	45	45	6	57	57	11	266
17	45	45	45	6	57	57	11	266
18	45	45	45	6	57	57	11	266
19	45	45	45	6	57	57	11	266
20	45	45	45	6	57	57	11	266
21	45	45	45	6	57	57	11	266
22	45	45	45	6	57	57	11	266
23	45	45	45	6	57	57	11	266
24	45	45	45	6	57	57	11	266
25	45	45	45	6	57	57	11	266

HUC 304 Annual Adoption (treated acres), Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Adoption
1	48	48	48	6	61	61	12	284
2	48	48	48	6	61	61	12	284
3	48	48	48	6	61	61	12	284
4	48	48	48	6	61	61	12	284
5	48	48	48	6	61	61	12	284
6	48	48	48	6	61	61	12	284
7	48	48	48	6	61	61	12	284
8	48	48	48	6	61	61	12	284
9	48	48	48	6	61	61	12	284
10	48	48	48	6	61	61	12	284
11	48	48	48	6	61	61	12	284
12	48	48	48	6	61	61	12	284
13	48	48	48	6	61	61	12	284
14	48	48	48	6	61	61	12	284
15	48	48	48	6	61	61	12	284
16	48	48	48	6	61	61	12	284
17	48	48	48	6	61	61	12	284
18	48	48	48	6	61	61	12	284
19	48	48	48	6	61	61	12	284
20	48	48	48	6	61	61	12	284
21	48	48	48	6	61	61	12	284
22	48	48	48	6	61	61	12	284
23	48	48	48	6	61	61	12	284
24	48	48	48	6	61	61	12	284
25	48	48	48	6	61	61	12	284

HUC 305 Annual Adoption (treated acres), Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Adoption
1	30	30	30	4	37	37	7	176
2	30	30	30	4	37	37	7	176
3	30	30	30	4	37	37	7	176
4	30	30	30	4	37	37	7	176
5	30	30	30	4	37	37	7	176
6	30	30	30	4	37	37	7	176
7	30	30	30	4	37	37	7	176
8	30	30	30	4	37	37	7	176
9	30	30	30	4	37	37	7	176
10	30	30	30	4	37	37	7	176
11	30	30	30	4	37	37	7	176
12	30	30	30	4	37	37	7	176
13	30	30	30	4	37	37	7	176
14	30	30	30	4	37	37	7	176
15	30	30	30	4	37	37	7	176
16	30	30	30	4	37	37	7	176
17	30	30	30	4	37	37	7	176
18	30	30	30	4	37	37	7	176
19	30	30	30	4	37	37	7	176
20	30	30	30	4	37	37	7	176
21	30	30	30	4	37	37	7	176
22	30	30	30	4	37	37	7	176
23	30	30	30	4	37	37	7	176
24	30	30	30	4	37	37	7	176
25	30	30	30	4	37	37	7	176

Silver/Goose Creek Confluence Annual Adoption (treated acres), Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Adoption
1	32	32	32	4	39	39	8	185
2	32	32	32	4	39	39	8	185
3	32	32	32	4	39	39	8	185
4	32	32	32	4	39	39	8	185
5	32	32	32	4	39	39	8	185
6	32	32	32	4	39	39	8	185
7	32	32	32	4	39	39	8	185
8	32	32	32	4	39	39	8	185
9	32	32	32	4	39	39	8	185
10	32	32	32	4	39	39	8	185
11	32	32	32	4	39	39	8	185
12	32	32	32	4	39	39	8	185
13	32	32	32	4	39	39	8	185
14	32	32	32	4	39	39	8	185
15	32	32	32	4	39	39	8	185
16	32	32	32	4	39	39	8	185
17	32	32	32	4	39	39	8	185
18	32	32	32	4	39	39	8	185
19	32	32	32	4	39	39	8	185
20	32	32	32	4	39	39	8	185
21	32	32	32	4	39	39	8	185
22	32	32	32	4	39	39	8	185
23	32	32	32	4	39	39	8	185
24	32	32	32	4	39	39	8	185
25	32	32	32	4	39	39	8	185

Riparian Corridors Annual Adoption (treated acres), Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Buffers	Permanent Vegetation	Total Adoption
1	92	92	92	12	115	115	23	541
2	92	92	92	12	115	115	23	541
3	92	92	92	12	115	115	23	541
4	92	92	92	12	115	115	23	541
5	92	92	92	12	115	115	23	541
6	92	92	92	12	115	115	23	541
7	92	92	92	12	115	115	23	541
8	92	92	92	12	115	115	23	541
9	92	92	92	12	115	115	23	541
10	92	92	92	12	115	115	23	541
11	92	92	92	12	115	115	23	541
12	92	92	92	12	115	115	23	541
13	92	92	92	12	115	115	23	541
14	92	92	92	12	115	115	23	541
15	92	92	92	12	115	115	23	541
16	92	92	92	12	115	115	23	541
17	92	92	92	12	115	115	23	541
18	92	92	92	12	115	115	23	541
19	92	92	92	12	115	115	23	541
20	92	92	92	12	115	115	23	541
21	92	92	92	12	115	115	23	541
22	92	92	92	12	115	115	23	541
23	92	92	92	12	115	115	23	541
24	92	92	92	12	115	115	23	541
25	92	92	92	12	115	115	23	541

2. Cropland BMP implementation: Sediment loss reductions

HUC 109 Annual Soil Erosion Reduction, Cropland BMPs (tons)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	33	18	11	2	22	17	11	113
2	67	36	22	3	44	33	21	227
3	100	53	33	5	67	50	32	340
4	133	71	44	7	89	67	42	453
5	167	89	56	8	111	83	53	566
6	200	107	67	10	133	100	63	680
7	233	124	78	12	156	117	74	793
8	267	142	89	13	178	133	84	906
9	300	160	100	15	200	150	95	1,020
10	333	178	111	17	222	167	106	1,133
11	367	195	122	18	244	183	116	1,246
12	400	213	133	20	267	200	127	1,360
13	433	231	144	22	289	217	137	1,473
14	467	249	156	23	311	233	148	1,586
15	500	267	167	25	333	250	158	1,699
16	533	284	178	27	355	267	169	1,813
17	566	302	189	28	378	283	179	1,926
18	600	320	200	30	400	300	190	2,039
19	633	338	211	32	422	317	200	2,153
20	666	355	222	33	444	333	211	2,266
21	700	373	233	35	467	350	222	2,379
22	733	391	244	37	489	367	232	2,492
23	766	409	255	38	511	383	243	2,606
24	800	427	267	40	533	400	253	2,719
25	833	444	278	42	555	417	264	2,832

HUC 301 Annual Soil Erosion Reduction, Cropland BMPs (tons)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	38	20	13	2	25	19	12	130
2	76	41	25	4	51	38	24	260
3	115	61	38	6	76	57	36	390
4	153	81	51	8	102	76	48	519
5	191	102	64	10	127	95	60	649
6	229	122	76	11	153	115	73	779
7	267	143	89	13	178	134	85	909
8	305	163	102	15	204	153	97	1,039
9	344	183	115	17	229	172	109	1,169
10	382	204	127	19	255	191	121	1,298
11	420	224	140	21	280	210	133	1,428
12	458	244	153	23	305	229	145	1,558
13	496	265	165	25	331	248	157	1,688
14	535	285	178	27	356	267	169	1,818
15	573	305	191	29	382	286	181	1,948
16	611	326	204	31	407	305	193	2,077
17	649	346	216	32	433	325	206	2,207
18	687	367	229	34	458	344	218	2,337
19	726	387	242	36	484	363	230	2,467
20	764	407	255	38	509	382	242	2,597
21	802	428	267	40	535	401	254	2,727
22	840	448	280	42	560	420	266	2,856
23	878	468	293	44	586	439	278	2,986
24	916	489	305	46	611	458	290	3,116
25	955	509	318	48	636	477	302	3,246

HUC 302 Annual Soil Erosion Reduction, Cropland BMPs (tons)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	166	88	55	8	110	83	52	563
2	331	177	110	17	221	166	105	1,127
3	497	265	166	25	331	249	157	1,690
4	663	354	221	33	442	331	210	2,254
5	829	442	276	41	552	414	262	2,817
6	994	530	331	50	663	497	315	3,380
7	1,160	619	387	58	773	580	367	3,944
8	1,326	707	442	66	884	663	420	4,507
9	1,491	795	497	75	994	746	472	5,071
10	1,657	884	552	83	1,105	829	525	5,634
11	1,823	972	608	91	1,215	911	577	6,197
12	1,988	1,061	663	99	1,326	994	630	6,761
13	2,154	1,149	718	108	1,436	1,077	682	7,324
14	2,320	1,237	773	116	1,547	1,160	735	7,888
15	2,486	1,326	829	124	1,657	1,243	787	8,451
16	2,651	1,414	884	133	1,768	1,326	840	9,014
17	2,817	1,502	939	141	1,878	1,408	892	9,578
18	2,983	1,591	994	149	1,988	1,491	945	10,141
19	3,148	1,679	1,049	157	2,099	1,574	997	10,704
20	3,314	1,768	1,105	166	2,209	1,657	1,049	11,268
21	3,480	1,856	1,160	174	2,320	1,740	1,102	11,831
22	3,645	1,944	1,215	182	2,430	1,823	1,154	12,395
23	3,811	2,033	1,270	191	2,541	1,906	1,207	12,958
24	3,977	2,121	1,326	199	2,651	1,988	1,259	13,521
25	4,143	2,209	1,381	207	2,762	2,071	1,312	14,085

HUC 303 Annual Soil Erosion Reduction, Cropland BMPs (tons)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	123	66	41	6	82	62	39	420
2	247	132	82	12	165	123	78	840
3	370	198	123	19	247	185	117	1,260
4	494	263	165	25	329	247	156	1,679
5	617	329	206	31	412	309	196	2,099
6	741	395	247	37	494	370	235	2,519
7	864	461	288	43	576	432	274	2,939
8	988	527	329	49	659	494	313	3,359
9	1,111	593	370	56	741	556	352	3,779
10	1,235	659	412	62	823	617	391	4,199
11	1,358	724	453	68	906	679	430	4,619
12	1,482	790	494	74	988	741	469	5,038
13	1,605	856	535	80	1,070	803	508	5,458
14	1,729	922	576	86	1,153	864	547	5,878
15	1,852	988	617	93	1,235	926	587	6,298
16	1,976	1,054	659	99	1,317	988	626	6,718
17	2,099	1,120	700	105	1,400	1,050	665	7,138
18	2,223	1,186	741	111	1,482	1,111	704	7,558
19	2,346	1,251	782	117	1,564	1,173	743	7,977
20	2,470	1,317	823	123	1,647	1,235	782	8,397
21	2,593	1,383	864	130	1,729	1,297	821	8,817
22	2,717	1,449	906	136	1,811	1,358	860	9,237
23	2,840	1,515	947	142	1,894	1,420	899	9,657
24	2,964	1,581	988	148	1,976	1,482	939	10,077
25	3,087	1,647	1,029	154	2,058	1,544	978	10,497

HUC 304 Annual Soil Erosion Reduction, Cropland BMPs (tons)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	189	101	63	9	126	95	60	643
2	378	202	126	19	252	189	120	1,287
3	568	303	189	28	378	284	180	1,930
4	757	404	252	38	505	378	240	2,573
5	946	505	315	47	631	473	300	3,217
6	1,135	605	378	57	757	568	360	3,860
7	1,325	706	442	66	883	662	419	4,503
8	1,514	807	505	76	1,009	757	479	5,147
9	1,703	908	568	85	1,135	851	539	5,790
10	1,892	1,009	631	95	1,261	946	599	6,433
11	2,081	1,110	694	104	1,388	1,041	659	7,077
12	2,271	1,211	757	114	1,514	1,135	719	7,720
13	2,460	1,312	820	123	1,640	1,230	779	8,363
14	2,649	1,413	883	132	1,766	1,325	839	9,007
15	2,838	1,514	946	142	1,892	1,419	899	9,650
16	3,027	1,615	1,009	151	2,018	1,514	959	10,293
17	3,217	1,716	1,072	161	2,144	1,608	1,019	10,937
18	3,406	1,816	1,135	170	2,271	1,703	1,079	11,580
19	3,595	1,917	1,198	180	2,397	1,798	1,138	12,223
20	3,784	2,018	1,261	189	2,523	1,892	1,198	12,867
21	3,974	2,119	1,325	199	2,649	1,987	1,258	13,510
22	4,163	2,220	1,388	208	2,775	2,081	1,318	14,153
23	4,352	2,321	1,451	218	2,901	2,176	1,378	14,797
24	4,541	2,422	1,514	227	3,027	2,271	1,438	15,440
25	4,730	2,523	1,577	237	3,154	2,365	1,498	16,083

HUC 305 Annual Soil Erosion Reduction, Cropland BMPs (tons)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	184	98	61	9	123	92	58	627
2	369	197	123	18	246	184	117	1,254
3	553	295	184	28	369	277	175	1,882
4	738	394	246	37	492	369	234	2,509
5	922	492	307	46	615	461	292	3,136
6	1,107	590	369	55	738	553	351	3,763
7	1,291	689	430	65	861	646	409	4,391
8	1,476	787	492	74	984	738	467	5,018
9	1,660	886	553	83	1,107	830	526	5,645
10	1,845	984	615	92	1,230	922	584	6,272
11	2,029	1,082	676	101	1,353	1,015	643	6,900
12	2,214	1,181	738	111	1,476	1,107	701	7,527
13	2,398	1,279	799	120	1,599	1,199	759	8,154
14	2,583	1,377	861	129	1,722	1,291	818	8,781
15	2,767	1,476	922	138	1,845	1,384	876	9,409
16	2,952	1,574	984	148	1,968	1,476	935	10,036
17	3,136	1,673	1,045	157	2,091	1,568	993	10,663
18	3,321	1,771	1,107	166	2,214	1,660	1,052	11,290
19	3,505	1,869	1,168	175	2,337	1,753	1,110	11,917
20	3,690	1,968	1,230	184	2,460	1,845	1,168	12,545
21	3,874	2,066	1,291	194	2,583	1,937	1,227	13,172
22	4,059	2,165	1,353	203	2,706	2,029	1,285	13,799
23	4,243	2,263	1,414	212	2,829	2,122	1,344	14,426
24	4,428	2,361	1,476	221	2,952	2,214	1,402	15,054
25	4,612	2,460	1,537	231	3,075	2,306	1,460	15,681

Silver/Goose Creek Confluence Annual Soil Erosion Reduction, Cropland BMPs (tons)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	48	25	16	2	32	24	15	163
2	96	51	32	5	64	48	30	325
3	143	76	48	7	96	72	45	488
4	191	102	64	10	127	96	61	650
5	239	127	80	12	159	120	76	813
6	287	153	96	14	191	143	91	975
7	335	178	112	17	223	167	106	1,138
8	382	204	127	19	255	191	121	1,300
9	430	229	143	22	287	215	136	1,463
10	478	255	159	24	319	239	151	1,625
11	526	280	175	26	351	263	167	1,788
12	574	306	191	29	382	287	182	1,950
13	621	331	207	31	414	311	197	2,113
14	669	357	223	33	446	335	212	2,275
15	717	382	239	36	478	359	227	2,438
16	765	408	255	38	510	382	242	2,600
17	813	433	271	41	542	406	257	2,763
18	860	459	287	43	574	430	272	2,925
19	908	484	303	45	605	454	288	3,088
20	956	510	319	48	637	478	303	3,250
21	1,004	535	335	50	669	502	318	3,413
22	1,052	561	351	53	701	526	333	3,575
23	1,099	586	366	55	733	550	348	3,738
24	1,147	612	382	57	765	574	363	3,901
25	1,195	637	398	60	797	598	378	4,063

Riparian Corridors Annual Soil Erosion Reduction, Cropland BMPs (tons)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	60	32	20	3	40	30	19	206
2	121	65	40	6	81	60	38	411
3	181	97	60	9	121	91	57	617
4	242	129	81	12	161	121	77	823
5	302	161	101	15	202	151	96	1,028
6	363	194	121	18	242	181	115	1,234
7	423	226	141	21	282	212	134	1,440
8	484	258	161	24	323	242	153	1,646
9	544	290	181	27	363	272	172	1,851
10	605	323	202	30	403	302	192	2,057
11	665	355	222	33	444	333	211	2,263
12	726	387	242	36	484	363	230	2,468
13	786	419	262	39	524	393	249	2,674
14	847	452	282	42	565	423	268	2,880
15	907	484	302	45	605	454	287	3,085
16	968	516	323	48	645	484	307	3,291
17	1,028	549	343	51	686	514	326	3,497
18	1,089	581	363	54	726	544	345	3,702
19	1,149	613	383	57	766	575	364	3,908
20	1,210	645	403	60	807	605	383	4,114
21	1,270	678	423	64	847	635	402	4,320
22	1,331	710	444	67	887	665	421	4,525
23	1,391	742	464	70	928	696	441	4,731
24	1,452	774	484	73	968	726	460	4,937
25	1,512	807	504	76	1,008	756	479	5,142

3. Cropland BMP implementation: Nitrogen load reductions

HUC 109 Annual Nitrogen Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	17	17	17	2	33	25	16	127
2	33	33	33	4	67	50	32	254
3	50	50	50	6	100	75	48	380
4	67	67	67	8	134	100	64	507
5	84	84	84	10	167	125	79	634
6	100	100	100	13	201	151	95	761
7	117	117	117	15	234	176	111	887
8	134	134	134	17	268	201	127	1,014
9	151	151	151	19	301	226	143	1,141
10	167	167	167	21	335	251	159	1,268
11	184	184	184	23	368	276	175	1,394
12	201	201	201	25	402	301	191	1,521
13	218	218	218	27	435	326	207	1,648
14	234	234	234	29	469	351	223	1,775
15	251	251	251	31	502	376	238	1,901
16	268	268	268	33	535	402	254	2,028
17	284	284	284	36	569	427	270	2,155
18	301	301	301	38	602	452	286	2,282
19	318	318	318	40	636	477	302	2,408
20	335	335	335	42	669	502	318	2,535
21	351	351	351	44	703	527	334	2,662
22	368	368	368	46	736	552	350	2,789
23	385	385	385	48	770	577	366	2,915
24	402	402	402	50	803	602	382	3,042
25	418	418	418	52	837	627	397	3,169

HUC 301 Annual Nitrogen Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	18	18	18	2	36	27	17	138
2	36	36	36	5	73	54	35	275
3	54	54	54	7	109	82	52	413
4	73	73	73	9	145	109	69	550
5	91	91	91	11	182	136	86	688
6	109	109	109	14	218	163	104	826
7	127	127	127	16	254	191	121	963
8	145	145	145	18	291	218	138	1,101
9	163	163	163	20	327	245	155	1,238
10	182	182	182	23	363	272	173	1,376
11	200	200	200	25	400	300	190	1,513
12	218	218	218	27	436	327	207	1,651
13	236	236	236	30	472	354	224	1,789
14	254	254	254	32	509	381	242	1,926
15	272	272	272	34	545	409	259	2,064
16	291	291	291	36	581	436	276	2,201
17	309	309	309	39	618	463	293	2,339
18	327	327	327	41	654	490	311	2,477
19	345	345	345	43	690	518	328	2,614
20	363	363	363	45	727	545	345	2,752
21	381	381	381	48	763	572	362	2,889
22	400	400	400	50	799	599	380	3,027
23	418	418	418	52	835	627	397	3,164
24	436	436	436	54	872	654	414	3,302
25	454	454	454	57	908	681	431	3,440

HUC 302 Annual Nitrogen Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	98	98	98	12	197	148	94	746
2	197	197	197	25	394	295	187	1,492
3	295	295	295	37	591	443	281	2,238
4	394	394	394	49	788	591	374	2,984
5	492	492	492	62	985	739	468	3,730
6	591	591	591	74	1,182	886	561	4,476
7	689	689	689	86	1,379	1,034	655	5,222
8	788	788	788	98	1,576	1,182	748	5,968
9	886	886	886	111	1,773	1,329	842	6,714
10	985	985	985	123	1,970	1,477	936	7,460
11	1,083	1,083	1,083	135	2,167	1,625	1,029	8,206
12	1,182	1,182	1,182	148	2,363	1,773	1,123	8,952
13	1,280	1,280	1,280	160	2,560	1,920	1,216	9,698
14	1,379	1,379	1,379	172	2,757	2,068	1,310	10,444
15	1,477	1,477	1,477	185	2,954	2,216	1,403	11,190
16	1,576	1,576	1,576	197	3,151	2,363	1,497	11,936
17	1,674	1,674	1,674	209	3,348	2,511	1,590	12,682
18	1,773	1,773	1,773	222	3,545	2,659	1,684	13,428
19	1,871	1,871	1,871	234	3,742	2,807	1,778	14,174
20	1,970	1,970	1,970	246	3,939	2,954	1,871	14,920
21	2,068	2,068	2,068	259	4,136	3,102	1,965	15,665
22	2,167	2,167	2,167	271	4,333	3,250	2,058	16,411
23	2,265	2,265	2,265	283	4,530	3,398	2,152	17,157
24	2,363	2,363	2,363	295	4,727	3,545	2,245	17,903
25	2,462	2,462	2,462	308	4,924	3,693	2,339	18,649

HUC 303 Annual Nitrogen Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	51	51	51	6	102	76	48	386
2	102	102	102	13	204	153	97	772
3	153	153	153	19	306	229	145	1,157
4	204	204	204	25	407	306	194	1,543
5	255	255	255	32	509	382	242	1,929
6	306	306	306	38	611	458	290	2,315
7	356	356	356	45	713	535	339	2,700
8	407	407	407	51	815	611	387	3,086
9	458	458	458	57	917	687	435	3,472
10	509	509	509	64	1,019	764	484	3,858
11	560	560	560	70	1,120	840	532	4,243
12	611	611	611	76	1,222	917	581	4,629
13	662	662	662	83	1,324	993	629	5,015
14	713	713	713	89	1,426	1,069	677	5,401
15	764	764	764	95	1,528	1,146	726	5,786
16	815	815	815	102	1,630	1,222	774	6,172
17	866	866	866	108	1,731	1,299	822	6,558
18	917	917	917	115	1,833	1,375	871	6,944
19	968	968	968	121	1,935	1,451	919	7,329
20	1,019	1,019	1,019	127	2,037	1,528	968	7,715
21	1,069	1,069	1,069	134	2,139	1,604	1,016	8,101
22	1,120	1,120	1,120	140	2,241	1,681	1,064	8,487
23	1,171	1,171	1,171	146	2,343	1,757	1,113	8,872
24	1,222	1,222	1,222	153	2,444	1,833	1,161	9,258
25	1,273	1,273	1,273	159	2,546	1,910	1,209	9,644

HUC 304 Annual Nitrogen Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	73	73	73	9	147	110	70	555
2	147	147	147	18	293	220	139	1,110
3	220	220	220	27	440	330	209	1,665
4	293	293	293	37	586	440	278	2,220
5	366	366	366	46	733	550	348	2,775
6	440	440	440	55	879	659	418	3,330
7	513	513	513	64	1,026	769	487	3,886
8	586	586	586	73	1,172	879	557	4,441
9	659	659	659	82	1,319	989	627	4,996
10	733	733	733	92	1,466	1,099	696	5,551
11	806	806	806	101	1,612	1,209	766	6,106
12	879	879	879	110	1,759	1,319	835	6,661
13	953	953	953	119	1,905	1,429	905	7,216
14	1,026	1,026	1,026	128	2,052	1,539	975	7,771
15	1,099	1,099	1,099	137	2,198	1,649	1,044	8,326
16	1,172	1,172	1,172	147	2,345	1,759	1,114	8,881
17	1,246	1,246	1,246	156	2,491	1,869	1,183	9,436
18	1,319	1,319	1,319	165	2,638	1,978	1,253	9,991
19	1,392	1,392	1,392	174	2,785	2,088	1,323	10,546
20	1,466	1,466	1,466	183	2,931	2,198	1,392	11,102
21	1,539	1,539	1,539	192	3,078	2,308	1,462	11,657
22	1,612	1,612	1,612	202	3,224	2,418	1,532	12,212
23	1,685	1,685	1,685	211	3,371	2,528	1,601	12,767
24	1,759	1,759	1,759	220	3,517	2,638	1,671	13,322
25	1,832	1,832	1,832	229	3,664	2,748	1,740	13,877

HUC 305 Annual Nitrogen Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	60	60	60	7	120	90	57	454
2	120	120	120	15	240	180	114	909
3	180	180	180	22	360	270	171	1,363
4	240	240	240	30	480	360	228	1,817
5	300	300	300	37	600	450	285	2,272
6	360	360	360	45	720	540	342	2,726
7	420	420	420	52	840	630	399	3,181
8	480	480	480	60	960	720	456	3,635
9	540	540	540	67	1,080	810	513	4,089
10	600	600	600	75	1,200	900	570	4,544
11	660	660	660	82	1,320	990	627	4,998
12	720	720	720	90	1,440	1,080	684	5,452
13	780	780	780	97	1,560	1,170	741	5,907
14	840	840	840	105	1,680	1,260	798	6,361
15	900	900	900	112	1,799	1,350	855	6,816
16	960	960	960	120	1,919	1,440	912	7,270
17	1,020	1,020	1,020	127	2,039	1,530	969	7,724
18	1,080	1,080	1,080	135	2,159	1,620	1,026	8,179
19	1,140	1,140	1,140	142	2,279	1,710	1,083	8,633
20	1,200	1,200	1,200	150	2,399	1,799	1,140	9,087
21	1,260	1,260	1,260	157	2,519	1,889	1,197	9,542
22	1,320	1,320	1,320	165	2,639	1,979	1,254	9,996
23	1,380	1,380	1,380	172	2,759	2,069	1,311	10,450
24	1,440	1,440	1,440	180	2,879	2,159	1,368	10,905
25	1,500	1,500	1,500	187	2,999	2,249	1,425	11,359

Silver/Goose Creek Confluence Annual Nitrogen Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	19	19	19	2	39	29	18	147
2	39	39	39	5	78	58	37	294
3	58	58	58	7	116	87	55	441
4	78	78	78	10	155	116	74	588
5	97	97	97	12	194	146	92	735
6	116	116	116	15	233	175	111	882
7	136	136	136	17	272	204	129	1,029
8	155	155	155	19	310	233	147	1,176
9	175	175	175	22	349	262	166	1,323
10	194	194	194	24	388	291	184	1,470
11	213	213	213	27	427	320	203	1,617
12	233	233	233	29	466	349	221	1,764
13	252	252	252	32	504	378	240	1,911
14	272	272	272	34	543	407	258	2,058
15	291	291	291	36	582	437	277	2,205
16	310	310	310	39	621	466	295	2,352
17	330	330	330	41	660	495	313	2,499
18	349	349	349	44	699	524	332	2,646
19	369	369	369	46	737	553	350	2,793
20	388	388	388	49	776	582	369	2,940
21	407	407	407	51	815	611	387	3,087
22	427	427	427	53	854	640	406	3,234
23	446	446	446	56	893	669	424	3,381
24	466	466	466	58	931	699	442	3,528
25	485	485	485	61	970	728	461	3,675

Riparian Corridors Annual Nitrogen Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	25	25	25	3	51	38	24	192
2	51	51	51	6	102	76	48	385
3	76	76	76	10	152	114	72	577
4	102	102	102	13	203	152	96	769
5	127	127	127	16	254	190	121	962
6	152	152	152	19	305	229	145	1,154
7	178	178	178	22	355	267	169	1,346
8	203	203	203	25	406	305	193	1,539
9	229	229	229	29	457	343	217	1,731
10	254	254	254	32	508	381	241	1,923
11	279	279	279	35	559	419	265	2,116
12	305	305	305	38	609	457	289	2,308
13	330	330	330	41	660	495	314	2,500
14	355	355	355	44	711	533	338	2,693
15	381	381	381	48	762	571	362	2,885
16	406	406	406	51	812	609	386	3,077
17	432	432	432	54	863	647	410	3,270
18	457	457	457	57	914	686	434	3,462
19	482	482	482	60	965	724	458	3,654
20	508	508	508	63	1,016	762	482	3,846
21	533	533	533	67	1,066	800	507	4,039
22	559	559	559	70	1,117	838	531	4,231
23	584	584	584	73	1,168	876	555	4,423
24	609	609	609	76	1,219	914	579	4,616
25	635	635	635	79	1,269	952	603	4,808

4. Cropland BMP implementation: Phosphorus load reductions

HUC 109 Annual Phosphorous Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	14	18	9	1	18	13	8	82
2	28	36	18	3	36	27	17	164
3	43	53	27	4	53	40	25	246
4	57	71	36	5	71	53	34	328
5	71	89	45	7	89	67	42	409
6	85	107	53	8	107	80	51	491
7	100	125	62	9	125	93	59	573
8	114	142	71	11	142	107	68	655
9	128	160	80	12	160	120	76	737
10	142	178	89	13	178	134	85	819
11	157	196	98	15	196	147	93	901
12	171	214	107	16	214	160	101	983
13	185	231	116	17	231	174	110	1,064
14	199	249	125	19	249	187	118	1,146
15	214	267	134	20	267	200	127	1,228
16	228	285	142	21	285	214	135	1,310
17	242	303	151	23	303	227	144	1,392
18	256	320	160	24	320	240	152	1,474
19	271	338	169	25	338	254	161	1,556
20	285	356	178	27	356	267	169	1,638
21	299	374	187	28	374	280	178	1,720
22	313	392	196	29	392	294	186	1,801
23	328	409	205	31	409	307	194	1,883
24	342	427	214	32	427	320	203	1,965
25	356	445	223	33	445	334	211	2,047

HUC 301 Annual Phosphorous Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	15	19	10	1	19	14	9	89
2	31	39	19	3	39	29	18	178
3	46	58	29	4	58	43	28	267
4	62	77	39	6	77	58	37	356
5	77	97	48	7	97	72	46	444
6	93	116	58	9	116	87	55	533
7	108	135	68	10	135	101	64	622
8	124	155	77	12	155	116	73	711
9	139	174	87	13	174	130	83	800
10	155	193	97	14	193	145	92	889
11	170	213	106	16	213	159	101	978
12	185	232	116	17	232	174	110	1,067
13	201	251	126	19	251	188	119	1,155
14	216	271	135	20	271	203	128	1,244
15	232	290	145	22	290	217	138	1,333
16	247	309	155	23	309	232	147	1,422
17	263	328	164	25	328	246	156	1,511
18	278	348	174	26	348	261	165	1,600
19	294	367	184	28	367	275	174	1,689
20	309	386	193	29	386	290	184	1,778
21	325	406	203	30	406	304	193	1,867
22	340	425	213	32	425	319	202	1,955
23	356	444	222	33	444	333	211	2,044
24	371	464	232	35	464	348	220	2,133
25	386	483	242	36	483	362	229	2,222

HUC 302 Annual Phosphorous Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	84	105	52	8	105	79	50	482
2	168	210	105	16	210	157	100	964
3	251	314	157	24	314	236	149	1,446
4	335	419	210	31	419	314	199	1,928
5	419	524	262	39	524	393	249	2,410
6	503	629	314	47	629	471	299	2,891
7	587	733	367	55	733	550	348	3,373
8	670	838	419	63	838	629	398	3,855
9	754	943	471	71	943	707	448	4,337
10	838	1,048	524	79	1,048	786	498	4,819
11	922	1,152	576	86	1,152	864	547	5,301
12	1,006	1,257	629	94	1,257	943	597	5,783
13	1,090	1,362	681	102	1,362	1,021	647	6,265
14	1,173	1,467	733	110	1,467	1,100	697	6,747
15	1,257	1,571	786	118	1,571	1,179	746	7,229
16	1,341	1,676	838	126	1,676	1,257	796	7,711
17	1,425	1,781	890	134	1,781	1,336	846	8,193
18	1,509	1,886	943	141	1,886	1,414	896	8,674
19	1,592	1,991	995	149	1,991	1,493	945	9,156
20	1,676	2,095	1,048	157	2,095	1,571	995	9,638
21	1,760	2,200	1,100	165	2,200	1,650	1,045	10,120
22	1,844	2,305	1,152	173	2,305	1,729	1,095	10,602
23	1,928	2,410	1,205	181	2,410	1,807	1,145	11,084
24	2,011	2,514	1,257	189	2,514	1,886	1,194	11,566
25	2,095	2,619	1,310	196	2,619	1,964	1,244	12,048

HUC 303 Annual Phosphorous Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	43	54	27	4	54	41	26	249
2	87	108	54	8	108	81	51	498
3	130	163	81	12	163	122	77	748
4	173	217	108	16	217	163	103	997
5	217	271	135	20	271	203	129	1,246
6	260	325	163	24	325	244	154	1,495
7	303	379	190	28	379	284	180	1,744
8	347	433	217	33	433	325	206	1,994
9	390	488	244	37	488	366	232	2,243
10	433	542	271	41	542	406	257	2,492
11	477	596	298	45	596	447	283	2,741
12	520	650	325	49	650	488	309	2,991
13	563	704	352	53	704	528	335	3,240
14	607	758	379	57	758	569	360	3,489
15	650	813	406	61	813	609	386	3,738
16	693	867	433	65	867	650	412	3,987
17	737	921	460	69	921	691	437	4,237
18	780	975	488	73	975	731	463	4,486
19	823	1,029	515	77	1,029	772	489	4,735
20	867	1,084	542	81	1,084	813	515	4,984
21	910	1,138	569	85	1,138	853	540	5,233
22	953	1,192	596	89	1,192	894	566	5,483
23	997	1,246	623	93	1,246	935	592	5,732
24	1,040	1,300	650	98	1,300	975	618	5,981
25	1,084	1,354	677	102	1,354	1,016	643	6,230

HUC 304 Annual Phosphorous Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	62	78	39	6	78	58	37	359
2	125	156	78	12	156	117	74	717
3	187	234	117	18	234	175	111	1,076
4	249	312	156	23	312	234	148	1,434
5	312	390	195	29	390	292	185	1,793
6	374	468	234	35	468	351	222	2,152
7	437	546	273	41	546	409	259	2,510
8	499	624	312	47	624	468	296	2,869
9	561	702	351	53	702	526	333	3,227
10	624	780	390	58	780	585	370	3,586
11	686	858	429	64	858	643	407	3,945
12	748	935	468	70	935	702	444	4,303
13	811	1,013	507	76	1,013	760	481	4,662
14	873	1,091	546	82	1,091	819	518	5,020
15	935	1,169	585	88	1,169	877	555	5,379
16	998	1,247	624	94	1,247	935	592	5,737
17	1,060	1,325	663	99	1,325	994	629	6,096
18	1,123	1,403	702	105	1,403	1,052	667	6,455
19	1,185	1,481	741	111	1,481	1,111	704	6,813
20	1,247	1,559	780	117	1,559	1,169	741	7,172
21	1,310	1,637	819	123	1,637	1,228	778	7,530
22	1,372	1,715	858	129	1,715	1,286	815	7,889
23	1,434	1,793	896	134	1,793	1,345	852	8,248
24	1,497	1,871	935	140	1,871	1,403	889	8,606
25	1,559	1,949	974	146	1,949	1,462	926	8,965

HUC 305 Annual Phosphorous Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	51	64	32	5	64	48	30	294
2	102	128	64	10	128	96	61	587
3	153	191	96	14	191	144	91	881
4	204	255	128	19	255	191	121	1,174
5	255	319	160	24	319	239	152	1,468
6	306	383	191	29	383	287	182	1,761
7	357	447	223	34	447	335	212	2,055
8	408	510	255	38	510	383	242	2,348
9	459	574	287	43	574	431	273	2,642
10	510	638	319	48	638	479	303	2,935
11	562	702	351	53	702	526	333	3,229
12	613	766	383	57	766	574	364	3,522
13	664	830	415	62	830	622	394	3,816
14	715	893	447	67	893	670	424	4,109
15	766	957	479	72	957	718	455	4,403
16	817	1,021	510	77	1,021	766	485	4,697
17	868	1,085	542	81	1,085	814	515	4,990
18	919	1,149	574	86	1,149	861	546	5,284
19	970	1,212	606	91	1,212	909	576	5,577
20	1,021	1,276	638	96	1,276	957	606	5,871
21	1,072	1,340	670	101	1,340	1,005	637	6,164
22	1,123	1,404	702	105	1,404	1,053	667	6,458
23	1,174	1,468	734	110	1,468	1,101	697	6,751
24	1,225	1,531	766	115	1,531	1,149	727	7,045
25	1,276	1,595	798	120	1,595	1,196	758	7,338

Silver/Goose Creek Confluence Annual Phosphorous Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	17	21	10	2	21	15	10	95
2	33	41	21	3	41	31	20	190
3	50	62	31	5	62	46	29	285
4	66	83	41	6	83	62	39	380
5	83	103	52	8	103	77	49	475
6	99	124	62	9	124	93	59	570
7	116	144	72	11	144	108	69	665
8	132	165	83	12	165	124	78	760
9	149	186	93	14	186	139	88	855
10	165	206	103	15	206	155	98	950
11	182	227	114	17	227	170	108	1,044
12	198	248	124	19	248	186	118	1,139
13	215	268	134	20	268	201	127	1,234
14	231	289	144	22	289	217	137	1,329
15	248	310	155	23	310	232	147	1,424
16	264	330	165	25	330	248	157	1,519
17	281	351	175	26	351	263	167	1,614
18	297	372	186	28	372	279	176	1,709
19	314	392	196	29	392	294	186	1,804
20	330	413	206	31	413	310	196	1,899
21	347	433	217	33	433	325	206	1,994
22	363	454	227	34	454	341	216	2,089
23	380	475	237	36	475	356	226	2,184
24	396	495	248	37	495	372	235	2,279
25	413	516	258	39	516	387	245	2,374

Riparian Corridors Annual Phosphorous Reduction, Cropland BMPs (pounds)								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Load Reduction
1	22	27	14	2	27	20	13	124
2	43	54	27	4	54	41	26	248
3	65	81	41	6	81	61	38	373
4	86	108	54	8	108	81	51	497
5	108	135	68	10	135	101	64	621
6	130	162	81	12	162	122	77	745
7	151	189	95	14	189	142	90	870
8	173	216	108	16	216	162	103	994
9	194	243	122	18	243	182	115	1,118
10	216	270	135	20	270	203	128	1,242
11	238	297	149	22	297	223	141	1,367
12	259	324	162	24	324	243	154	1,491
13	281	351	176	26	351	263	167	1,615
14	303	378	189	28	378	284	180	1,739
15	324	405	203	30	405	304	192	1,864
16	346	432	216	32	432	324	205	1,988
17	367	459	230	34	459	344	218	2,112
18	389	486	243	36	486	365	231	2,236
19	411	513	257	38	513	385	244	2,361
20	432	540	270	41	540	405	257	2,485
21	454	567	284	43	567	425	269	2,609
22	475	594	297	45	594	446	282	2,733
23	497	621	311	47	621	466	295	2,858
24	519	648	324	49	648	486	308	2,982
25	540	675	338	51	675	506	321	3,106

5. Cropland BMP implementation: Costs before cost share

HUC 109 Annual Cost* Before Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$2,855	$2,094	$2,756	$20,943	$2,939	$7,376	$1,378	$40,341
2	$2,940	$2,157	$2,838	$21,571	$3,028	$7,597	$1,419	$41,551
3	$3,028	$2,222	$2,924	$22,219	$3,118	$7,825	$1,462	$42,798
4	$3,119	$2,289	$3,011	$22,885	$3,212	$8,060	$1,506	$44,082
5	$3,213	$2,357	$3,102	$23,572	$3,308	$8,302	$1,551	$45,404
6	$3,309	$2,428	$3,195	$24,279	$3,408	$8,551	$1,597	$46,766
7	$3,408	$2,501	$3,290	$25,007	$3,510	$8,807	$1,645	$48,169
8	$3,511	$2,576	$3,389	$25,757	$3,615	$9,072	$1,695	$49,614
9	$3,616	$2,653	$3,491	$26,530	$3,724	$9,344	$1,745	$51,103
10	$3,724	$2,733	$3,596	$27,326	$3,835	$9,624	$1,798	$52,636
11	$3,836	$2,815	$3,703	$28,146	$3,950	$9,913	$1,852	$54,215
12	$3,951	$2,899	$3,815	$28,990	$4,069	$10,210	$1,907	$55,841
13	$4,070	$2,986	$3,929	$29,860	$4,191	$10,516	$1,964	$57,517
14	$4,192	$3,076	$4,047	$30,756	$4,317	$10,832	$2,023	$59,242
15	$4,318	$3,168	$4,168	$31,678	$4,446	$11,157	$2,084	$61,019
16	$4,447	$3,263	$4,293	$32,629	$4,579	$11,492	$2,147	$62,850
17	$4,581	$3,361	$4,422	$33,608	$4,717	$11,836	$2,211	$64,735
18	$4,718	$3,462	$4,555	$34,616	$4,858	$12,191	$2,277	$66,677
19	$4,860	$3,565	$4,691	$35,654	$5,004	$12,557	$2,346	$68,678
20	$5,005	$3,672	$4,832	$36,724	$5,154	$12,934	$2,416	$70,738
21	$5,156	$3,783	$4,977	$37,826	$5,309	$13,322	$2,489	$72,860
22	$5,310	$3,896	$5,126	$38,960	$5,468	$13,722	$2,563	$75,046
23	$5,470	$4,013	$5,280	$40,129	$5,632	$14,133	$2,640	$77,297
24	$5,634	$4,133	$5,439	$41,333	$5,801	$14,557	$2,719	$79,616
25	$5,803	$4,257	$5,602	$42,573	$5,975	$14,994	$2,801	$82,005
*3% Inflation								$1,470,801

HUC 301 Annual Cost* Before Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$1,912	$1,402	$1,845	$14,025	$1,968	$4,939	$923	$27,015
2	$1,969	$1,445	$1,901	$14,445	$2,027	$5,088	$950	$27,825
3	$2,028	$1,488	$1,958	$14,879	$2,088	$5,240	$979	$28,660
4	$2,089	$1,533	$2,016	$15,325	$2,151	$5,397	$1,008	$29,520
5	$2,151	$1,578	$2,077	$15,785	$2,215	$5,559	$1,038	$30,405
6	$2,216	$1,626	$2,139	$16,259	$2,282	$5,726	$1,070	$31,317
7	$2,282	$1,675	$2,203	$16,746	$2,350	$5,898	$1,102	$32,257
8	$2,351	$1,725	$2,270	$17,249	$2,421	$6,075	$1,135	$33,225
9	$2,421	$1,777	$2,338	$17,766	$2,493	$6,257	$1,169	$34,221
10	$2,494	$1,830	$2,408	$18,299	$2,568	$6,445	$1,204	$35,248
11	$2,569	$1,885	$2,480	$18,848	$2,645	$6,638	$1,240	$36,305
12	$2,646	$1,941	$2,554	$19,414	$2,725	$6,837	$1,277	$37,395
13	$2,725	$2,000	$2,631	$19,996	$2,806	$7,042	$1,316	$38,516
14	$2,807	$2,060	$2,710	$20,596	$2,891	$7,254	$1,355	$39,672
15	$2,891	$2,121	$2,791	$21,214	$2,977	$7,471	$1,396	$40,862
16	$2,978	$2,185	$2,875	$21,850	$3,067	$7,695	$1,438	$42,088
17	$3,067	$2,251	$2,961	$22,506	$3,159	$7,926	$1,481	$43,350
18	$3,159	$2,318	$3,050	$23,181	$3,253	$8,164	$1,525	$44,651
19	$3,254	$2,388	$3,142	$23,876	$3,351	$8,409	$1,571	$45,991
20	$3,352	$2,459	$3,236	$24,592	$3,452	$8,661	$1,618	$47,370
21	$3,452	$2,533	$3,333	$25,330	$3,555	$8,921	$1,666	$48,791
22	$3,556	$2,609	$3,433	$26,090	$3,662	$9,189	$1,716	$50,255
23	$3,663	$2,687	$3,536	$26,873	$3,772	$9,464	$1,768	$51,763
24	$3,773	$2,768	$3,642	$27,679	$3,885	$9,748	$1,821	$53,316
25	$3,886	$2,851	$3,751	$28,509	$4,001	$10,041	$1,876	$54,915
*3% Inflation								$984,932

HUC 302 Annual Cost* Before Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$5,389	$3,954	$5,202	$39,537	$5,549	$13,925	$2,601	$76,157
2	$5,550	$4,072	$5,358	$40,723	$5,716	$14,342	$2,679	$78,441
3	$5,717	$4,194	$5,519	$41,945	$5,887	$14,773	$2,760	$80,795
4	$5,889	$4,320	$5,685	$43,203	$6,064	$15,216	$2,842	$83,218
5	$6,065	$4,450	$5,855	$44,499	$6,246	$15,672	$2,928	$85,715
6	$6,247	$4,583	$6,031	$45,834	$6,433	$16,143	$3,015	$88,286
7	$6,435	$4,721	$6,212	$47,209	$6,626	$16,627	$3,106	$90,935
8	$6,628	$4,863	$6,398	$48,626	$6,825	$17,126	$3,199	$93,663
9	$6,826	$5,008	$6,590	$50,084	$7,029	$17,639	$3,295	$96,473
10	$7,031	$5,159	$6,788	$51,587	$7,240	$18,169	$3,394	$99,367
11	$7,242	$5,313	$6,991	$53,134	$7,457	$18,714	$3,496	$102,348
12	$7,459	$5,473	$7,201	$54,728	$7,681	$19,275	$3,601	$105,419
13	$7,683	$5,637	$7,417	$56,370	$7,912	$19,853	$3,709	$108,581
14	$7,914	$5,806	$7,640	$58,061	$8,149	$20,449	$3,820	$111,839
15	$8,151	$5,980	$7,869	$59,803	$8,393	$21,062	$3,934	$115,194
16	$8,396	$6,160	$8,105	$61,597	$8,645	$21,694	$4,052	$118,650
17	$8,647	$6,345	$8,348	$63,445	$8,905	$22,345	$4,174	$122,209
18	$8,907	$6,535	$8,599	$65,349	$9,172	$23,015	$4,299	$125,875
19	$9,174	$6,731	$8,856	$67,309	$9,447	$23,706	$4,428	$129,652
20	$9,449	$6,933	$9,122	$69,328	$9,730	$24,417	$4,561	$133,541
21	$9,733	$7,141	$9,396	$71,408	$10,022	$25,149	$4,698	$137,547
22	$10,025	$7,355	$9,678	$73,551	$10,323	$25,904	$4,839	$141,674
23	$10,326	$7,576	$9,968	$75,757	$10,633	$26,681	$4,984	$145,924
24	$10,635	$7,803	$10,267	$78,030	$10,952	$27,482	$5,134	$150,302
25	$10,954	$8,037	$10,575	$80,371	$11,280	$28,306	$5,288	$154,811
*3% Inflation								$2,776,615

HUC 303 Annual Cost* Before Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$3,514	$2,578	$3,393	$25,784	$3,619	$9,081	$1,696	$49,666
2	$3,620	$2,656	$3,494	$26,558	$3,727	$9,353	$1,747	$51,156
3	$3,728	$2,735	$3,599	$27,354	$3,839	$9,634	$1,800	$52,690
4	$3,840	$2,817	$3,707	$28,175	$3,954	$9,923	$1,854	$54,271
5	$3,955	$2,902	$3,818	$29,020	$4,073	$10,221	$1,909	$55,899
6	$4,074	$2,989	$3,933	$29,891	$4,195	$10,527	$1,966	$57,576
7	$4,196	$3,079	$4,051	$30,788	$4,321	$10,843	$2,025	$59,303
8	$4,322	$3,171	$4,173	$31,711	$4,451	$11,168	$2,086	$61,082
9	$4,452	$3,266	$4,298	$32,662	$4,584	$11,503	$2,149	$62,915
10	$4,585	$3,364	$4,427	$33,642	$4,722	$11,849	$2,213	$64,802
11	$4,723	$3,465	$4,559	$34,652	$4,863	$12,204	$2,280	$66,746
12	$4,865	$3,569	$4,696	$35,691	$5,009	$12,570	$2,348	$68,749
13	$5,011	$3,676	$4,837	$36,762	$5,160	$12,947	$2,419	$70,811
14	$5,161	$3,786	$4,982	$37,865	$5,314	$13,336	$2,491	$72,936
15	$5,316	$3,900	$5,132	$39,001	$5,474	$13,736	$2,566	$75,124
16	$5,475	$4,017	$5,286	$40,171	$5,638	$14,148	$2,643	$77,377
17	$5,639	$4,138	$5,444	$41,376	$5,807	$14,572	$2,722	$79,699
18	$5,809	$4,262	$5,608	$42,617	$5,981	$15,009	$2,804	$82,090
19	$5,983	$4,390	$5,776	$43,896	$6,161	$15,460	$2,888	$84,552
20	$6,162	$4,521	$5,949	$45,213	$6,346	$15,924	$2,975	$87,089
21	$6,347	$4,657	$6,127	$46,569	$6,536	$16,401	$3,064	$89,701
22	$6,538	$4,797	$6,311	$47,966	$6,732	$16,893	$3,156	$92,393
23	$6,734	$4,940	$6,501	$49,405	$6,934	$17,400	$3,250	$95,164
24	$6,936	$5,089	$6,696	$50,887	$7,142	$17,922	$3,348	$98,019
25	$7,144	$5,241	$6,897	$52,414	$7,356	$18,460	$3,448	$100,960
*3% Inflation								$1,810,769

HUC 304 Annual Cost* Before Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$3,762	$2,760	$3,631	$27,599	$3,874	$9,720	$1,816	$53,161
2	$3,875	$2,843	$3,740	$28,427	$3,990	$10,012	$1,870	$54,756
3	$3,991	$2,928	$3,853	$29,280	$4,109	$10,312	$1,926	$56,399
4	$4,110	$3,016	$3,968	$30,158	$4,233	$10,621	$1,984	$58,091
5	$4,234	$3,106	$4,087	$31,063	$4,360	$10,940	$2,044	$59,834
6	$4,361	$3,199	$4,210	$31,995	$4,490	$11,268	$2,105	$61,629
7	$4,492	$3,295	$4,336	$32,955	$4,625	$11,606	$2,168	$63,477
8	$4,626	$3,394	$4,466	$33,943	$4,764	$11,955	$2,233	$65,382
9	$4,765	$3,496	$4,600	$34,962	$4,907	$12,313	$2,300	$67,343
10	$4,908	$3,601	$4,738	$36,010	$5,054	$12,683	$2,369	$69,364
11	$5,055	$3,709	$4,880	$37,091	$5,206	$13,063	$2,440	$71,444
12	$5,207	$3,820	$5,027	$38,203	$5,362	$13,455	$2,513	$73,588
13	$5,363	$3,935	$5,178	$39,349	$5,523	$13,859	$2,589	$75,795
14	$5,524	$4,053	$5,333	$40,530	$5,688	$14,274	$2,666	$78,069
15	$5,690	$4,175	$5,493	$41,746	$5,859	$14,703	$2,746	$80,411
16	$5,861	$4,300	$5,658	$42,998	$6,035	$15,144	$2,829	$82,824
17	$6,036	$4,429	$5,827	$44,288	$6,216	$15,598	$2,914	$85,308
18	$6,217	$4,562	$6,002	$45,617	$6,402	$16,066	$3,001	$87,868
19	$6,404	$4,699	$6,182	$46,985	$6,594	$16,548	$3,091	$90,504
20	$6,596	$4,839	$6,368	$48,395	$6,792	$17,044	$3,184	$93,219
21	$6,794	$4,985	$6,559	$49,847	$6,996	$17,556	$3,279	$96,015
22	$6,998	$5,134	$6,756	$51,342	$7,206	$18,082	$3,378	$98,896
23	$7,208	$5,288	$6,958	$52,882	$7,422	$18,625	$3,479	$101,863
24	$7,424	$5,447	$7,167	$54,469	$7,645	$19,184	$3,583	$104,919
25	$7,647	$5,610	$7,382	$56,103	$7,874	$19,759	$3,691	$108,066
*3% Inflation								$1,938,225

HUC 305 Annual Cost* Before Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
2	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
3	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
4	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
5	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
6	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
7	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
8	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
9	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
10	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
11	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
12	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
13	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
14	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
15	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
16	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
17	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
18	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
19	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
20	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
21	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
22	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
23	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
24	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
25	$2,327	$1,708	$2,247	$17,076	$2,397	$6,014	$1,123	$32,893
*3% Inflation								$822,313

Silver/Goose Creek Confluence Annual Cost* Before Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
2	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
3	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
4	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
5	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
6	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
7	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
8	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
9	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
10	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
11	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
12	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
13	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
14	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
15	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
16	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
17	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
18	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
19	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
20	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
21	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
22	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
23	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
24	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
25	$2,451	$1,798	$2,366	$17,979	$2,523	$6,332	$1,183	$34,632
*3% Inflation								$865,792

Riparian Corridors Annual Cost* Before Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
2	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
3	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
4	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
5	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
6	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
7	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
8	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
9	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
10	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
11	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
12	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
13	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
14	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
15	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
16	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
17	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
18	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
19	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
20	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
21	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
22	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
23	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
24	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
25	$7,159	$5,252	$6,911	$52,524	$7,372	$18,499	$3,456	$101,172
*3% Inflation								$2,529,302

6. Cropland BMP implementation: Costs after cost share

HUC 109 Annual Cost* After Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$2,398	$1,319	$551	$8,377	$1,176	$2,950	$14	$16,786
2	$2,470	$1,359	$568	$8,629	$1,211	$3,039	$14	$17,289
3	$2,544	$1,400	$585	$8,887	$1,247	$3,130	$15	$17,808
4	$2,620	$1,442	$602	$9,154	$1,285	$3,224	$15	$18,342
5	$2,699	$1,485	$620	$9,429	$1,323	$3,321	$16	$18,892
6	$2,780	$1,530	$639	$9,712	$1,363	$3,420	$16	$19,459
7	$2,863	$1,575	$658	$10,003	$1,404	$3,523	$16	$20,043
8	$2,949	$1,623	$678	$10,303	$1,446	$3,629	$17	$20,644
9	$3,037	$1,671	$698	$10,612	$1,489	$3,737	$17	$21,263
10	$3,129	$1,722	$719	$10,930	$1,534	$3,850	$18	$21,901
11	$3,222	$1,773	$741	$11,258	$1,580	$3,965	$19	$22,558
12	$3,319	$1,826	$763	$11,596	$1,628	$4,084	$19	$23,235
13	$3,419	$1,881	$786	$11,944	$1,676	$4,207	$20	$23,932
14	$3,521	$1,938	$809	$12,302	$1,727	$4,333	$20	$24,650
15	$3,627	$1,996	$834	$12,671	$1,778	$4,463	$21	$25,390
16	$3,736	$2,056	$859	$13,052	$1,832	$4,597	$21	$26,151
17	$3,848	$2,117	$884	$13,443	$1,887	$4,735	$22	$26,936
18	$3,963	$2,181	$911	$13,846	$1,943	$4,877	$23	$27,744
19	$4,082	$2,246	$938	$14,262	$2,002	$5,023	$23	$28,576
20	$4,205	$2,314	$966	$14,690	$2,062	$5,174	$24	$29,434
21	$4,331	$2,383	$995	$15,130	$2,124	$5,329	$25	$30,317
22	$4,461	$2,455	$1,025	$15,584	$2,187	$5,489	$26	$31,226
23	$4,594	$2,528	$1,056	$16,052	$2,253	$5,653	$26	$32,163
24	$4,732	$2,604	$1,088	$16,533	$2,320	$5,823	$27	$33,128
25	$4,874	$2,682	$1,120	$17,029	$2,390	$5,998	$28	$34,122
*3% Inflation								$611,989

HUC 301 Annual Cost* After Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$1,606	$884	$369	$5,610	$787	$1,976	$9	$11,241
2	$1,654	$910	$380	$5,778	$811	$2,035	$10	$11,578
3	$1,703	$937	$392	$5,952	$835	$2,096	$10	$11,925
4	$1,755	$965	$403	$6,130	$860	$2,159	$10	$12,283
5	$1,807	$994	$415	$6,314	$886	$2,224	$10	$12,651
6	$1,861	$1,024	$428	$6,503	$913	$2,290	$11	$13,031
7	$1,917	$1,055	$441	$6,699	$940	$2,359	$11	$13,422
8	$1,975	$1,087	$454	$6,899	$968	$2,430	$11	$13,824
9	$2,034	$1,119	$468	$7,106	$997	$2,503	$12	$14,239
10	$2,095	$1,153	$482	$7,320	$1,027	$2,578	$12	$14,666
11	$2,158	$1,187	$496	$7,539	$1,058	$2,655	$12	$15,106
12	$2,223	$1,223	$511	$7,765	$1,090	$2,735	$13	$15,560
13	$2,289	$1,260	$526	$7,998	$1,123	$2,817	$13	$16,026
14	$2,358	$1,298	$542	$8,238	$1,156	$2,901	$14	$16,507
15	$2,429	$1,336	$558	$8,485	$1,191	$2,989	$14	$17,002
16	$2,502	$1,377	$575	$8,740	$1,227	$3,078	$14	$17,512
17	$2,577	$1,418	$592	$9,002	$1,263	$3,171	$15	$18,038
18	$2,654	$1,460	$610	$9,272	$1,301	$3,266	$15	$18,579
19	$2,734	$1,504	$628	$9,550	$1,340	$3,364	$16	$19,136
20	$2,816	$1,549	$647	$9,837	$1,381	$3,465	$16	$19,710
21	$2,900	$1,596	$667	$10,132	$1,422	$3,568	$17	$20,302
22	$2,987	$1,644	$687	$10,436	$1,465	$3,676	$17	$20,911
23	$3,077	$1,693	$707	$10,749	$1,509	$3,786	$18	$21,538
24	$3,169	$1,744	$728	$11,072	$1,554	$3,899	$18	$22,184
25	$3,264	$1,796	$750	$11,404	$1,601	$4,016	$19	$22,850
*3% Inflation								$409,823

HUC 302 Annual Cost* After Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$4,527	$2,491	$1,040	$15,815	$2,220	$5,570	$26	$31,688
2	$4,662	$2,566	$1,072	$16,289	$2,286	$5,737	$27	$32,639
3	$4,802	$2,643	$1,104	$16,778	$2,355	$5,909	$28	$33,618
4	$4,946	$2,722	$1,137	$17,281	$2,425	$6,086	$28	$34,627
5	$5,095	$2,803	$1,171	$17,800	$2,498	$6,269	$29	$35,665
6	$5,248	$2,888	$1,206	$18,334	$2,573	$6,457	$30	$36,735
7	$5,405	$2,974	$1,242	$18,884	$2,650	$6,651	$31	$37,837
8	$5,567	$3,063	$1,280	$19,450	$2,730	$6,850	$32	$38,972
9	$5,734	$3,155	$1,318	$20,034	$2,812	$7,056	$33	$40,142
10	$5,906	$3,250	$1,358	$20,635	$2,896	$7,267	$34	$41,346
11	$6,083	$3,347	$1,398	$21,254	$2,983	$7,485	$35	$42,586
12	$6,266	$3,448	$1,440	$21,891	$3,072	$7,710	$36	$43,864
13	$6,454	$3,551	$1,483	$22,548	$3,165	$7,941	$37	$45,180
14	$6,647	$3,658	$1,528	$23,225	$3,260	$8,180	$38	$46,535
15	$6,847	$3,768	$1,574	$23,921	$3,357	$8,425	$39	$47,931
16	$7,052	$3,881	$1,621	$24,639	$3,458	$8,678	$41	$49,369
17	$7,264	$3,997	$1,670	$25,378	$3,562	$8,938	$42	$50,850
18	$7,482	$4,117	$1,720	$26,139	$3,669	$9,206	$43	$52,376
19	$7,706	$4,240	$1,771	$26,924	$3,779	$9,482	$44	$53,947
20	$7,937	$4,368	$1,824	$27,731	$3,892	$9,767	$46	$55,565
21	$8,176	$4,499	$1,879	$28,563	$4,009	$10,060	$47	$57,232
22	$8,421	$4,634	$1,936	$29,420	$4,129	$10,362	$48	$58,949
23	$8,673	$4,773	$1,994	$30,303	$4,253	$10,672	$50	$60,718
24	$8,934	$4,916	$2,053	$31,212	$4,381	$10,993	$51	$62,539
25	$9,202	$5,063	$2,115	$32,148	$4,512	$11,322	$53	$64,416
*3% Inflation								$1,155,329

HUC 303 Annual Cost* After Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$2,952	$1,624	$679	$10,314	$1,448	$3,632	$17	$20,665
2	$3,041	$1,673	$699	$10,623	$1,491	$3,741	$17	$21,285
3	$3,132	$1,723	$720	$10,942	$1,536	$3,854	$18	$21,924
4	$3,226	$1,775	$741	$11,270	$1,582	$3,969	$19	$22,582
5	$3,323	$1,828	$764	$11,608	$1,629	$4,088	$19	$23,259
6	$3,422	$1,883	$787	$11,956	$1,678	$4,211	$20	$23,957
7	$3,525	$1,940	$810	$12,315	$1,728	$4,337	$20	$24,676
8	$3,631	$1,998	$835	$12,684	$1,780	$4,467	$21	$25,416
9	$3,740	$2,058	$860	$13,065	$1,834	$4,601	$21	$26,178
10	$3,852	$2,119	$885	$13,457	$1,889	$4,739	$22	$26,964
11	$3,967	$2,183	$912	$13,861	$1,945	$4,882	$23	$27,773
12	$4,086	$2,249	$939	$14,276	$2,004	$5,028	$23	$28,606
13	$4,209	$2,316	$967	$14,705	$2,064	$5,179	$24	$29,464
14	$4,335	$2,385	$996	$15,146	$2,126	$5,334	$25	$30,348
15	$4,465	$2,457	$1,026	$15,600	$2,190	$5,494	$26	$31,258
16	$4,599	$2,531	$1,057	$16,068	$2,255	$5,659	$26	$32,196
17	$4,737	$2,607	$1,089	$16,550	$2,323	$5,829	$27	$33,162
18	$4,879	$2,685	$1,122	$17,047	$2,393	$6,004	$28	$34,157
19	$5,026	$2,765	$1,155	$17,558	$2,464	$6,184	$29	$35,182
20	$5,176	$2,848	$1,190	$18,085	$2,538	$6,369	$30	$36,237
21	$5,332	$2,934	$1,225	$18,628	$2,614	$6,560	$31	$37,324
22	$5,492	$3,022	$1,262	$19,186	$2,693	$6,757	$32	$38,444
23	$5,656	$3,113	$1,300	$19,762	$2,774	$6,960	$33	$39,597
24	$5,826	$3,206	$1,339	$20,355	$2,857	$7,169	$33	$40,785
25	$6,001	$3,302	$1,379	$20,965	$2,943	$7,384	$34	$42,009
*3% Inflation								$753,447

HUC 304 Annual Cost* After Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$3,160	$1,739	$726	$11,040	$1,549	$3,888	$18	$22,120
2	$3,255	$1,791	$748	$11,371	$1,596	$4,005	$19	$22,784
3	$3,352	$1,845	$771	$11,712	$1,644	$4,125	$19	$23,467
4	$3,453	$1,900	$794	$12,063	$1,693	$4,249	$20	$24,171
5	$3,556	$1,957	$817	$12,425	$1,744	$4,376	$20	$24,896
6	$3,663	$2,016	$842	$12,798	$1,796	$4,507	$21	$25,643
7	$3,773	$2,076	$867	$13,182	$1,850	$4,643	$22	$26,412
8	$3,886	$2,138	$893	$13,577	$1,906	$4,782	$22	$27,205
9	$4,003	$2,203	$920	$13,985	$1,963	$4,925	$23	$28,021
10	$4,123	$2,269	$948	$14,404	$2,022	$5,073	$24	$28,862
11	$4,247	$2,337	$976	$14,836	$2,082	$5,225	$24	$29,727
12	$4,374	$2,407	$1,005	$15,281	$2,145	$5,382	$25	$30,619
13	$4,505	$2,479	$1,036	$15,740	$2,209	$5,543	$26	$31,538
14	$4,640	$2,553	$1,067	$16,212	$2,275	$5,710	$27	$32,484
15	$4,780	$2,630	$1,099	$16,698	$2,344	$5,881	$27	$33,459
16	$4,923	$2,709	$1,132	$17,199	$2,414	$6,057	$28	$34,462
17	$5,071	$2,790	$1,165	$17,715	$2,486	$6,239	$29	$35,496
18	$5,223	$2,874	$1,200	$18,247	$2,561	$6,426	$30	$36,561
19	$5,379	$2,960	$1,236	$18,794	$2,638	$6,619	$31	$37,658
20	$5,541	$3,049	$1,274	$19,358	$2,717	$6,818	$32	$38,788
21	$5,707	$3,140	$1,312	$19,939	$2,798	$7,022	$33	$39,951
22	$5,878	$3,235	$1,351	$20,537	$2,882	$7,233	$34	$41,150
23	$6,055	$3,332	$1,392	$21,153	$2,969	$7,450	$35	$42,384
24	$6,236	$3,432	$1,433	$21,788	$3,058	$7,673	$36	$43,656
25	$6,423	$3,534	$1,476	$22,441	$3,150	$7,904	$37	$44,966
*3% Inflation								$806,481

HUC 305 Annual Cost* After Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
2	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
3	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
4	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
5	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
6	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
7	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
8	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
9	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
10	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
11	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
12	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
13	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
14	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
15	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
16	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
17	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
18	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
19	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
20	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
21	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
22	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
23	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
24	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
25	$1,955	$1,076	$449	$6,831	$959	$2,406	$11	$13,686
*3% Inflation								$342,158

Silver/Goose Creek Confluence Annual Cost* After Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
2	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
3	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
4	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
5	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
6	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
7	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
8	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
9	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
10	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
11	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
12	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
13	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
14	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
15	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
16	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
17	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
18	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
19	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
20	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
21	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
22	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
23	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
24	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
25	$2,058	$1,133	$473	$7,192	$1,009	$2,533	$12	$14,410
*3% Inflation								$360,249

Riparian Corridors Annual Cost* After Cost-Share, Cropland BMPs								
Year	No-Till	Cover Crops	Nutrient Management Plans	Wetlands	Waterways	Terraces	Permanent Vegetation	Total Cost
1	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
2	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
3	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
4	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
5	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
6	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
7	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
8	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
9	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
10	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
11	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
12	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
13	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
14	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
15	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
16	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
17	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
18	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
19	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
20	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
21	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
22	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
23	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
24	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
25	$6,013	$3,309	$1,382	$21,010	$2,949	$7,399	$35	$42,097
*3% Inflation								$1,052,424