Marion Lake WRAPS – 9 Element Watershed Plan Summary
Flint Hills RC&D

<u>Impairments to be addressed</u>

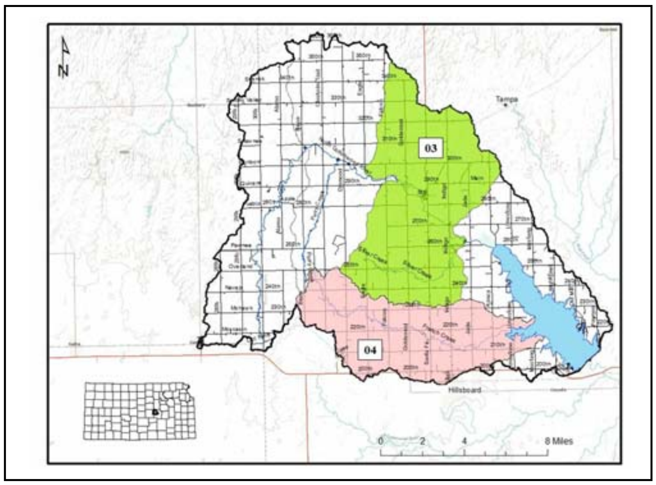
Directly addressing:

Marion Lake – Eutrophication

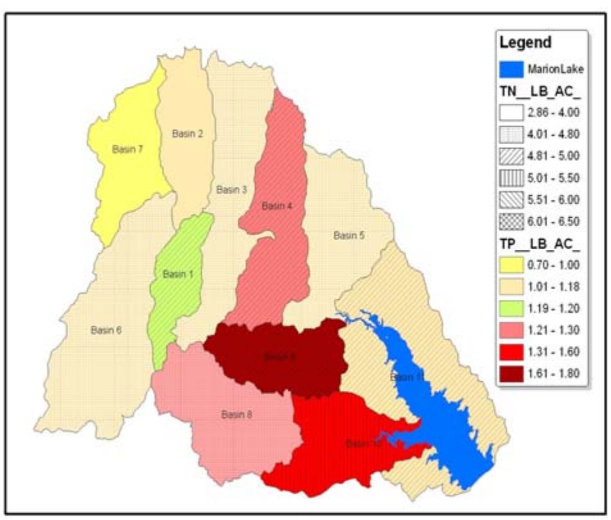
Positively Effecting:

French Creek– DO

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



Targeting Considerations:



- Cropland Targeted areas were identified after reviewing the Marion Lake GWLF, Rusle2 and BATHTUB Watershed models and gaining local knowledge, the Marion SLT choose three priority areas for Cropland BMP Implementation.
- Livestock Targeted areas were identified after reviewing a Marion Lake watershed CAFO map and local knowledge.
- Grade stabilization structures will be targeted based on the Watershed Institute streambank assessment.

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Best Management Practices and Load Reduction Goals

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

Phosphorus Reducing Cropland BMPs

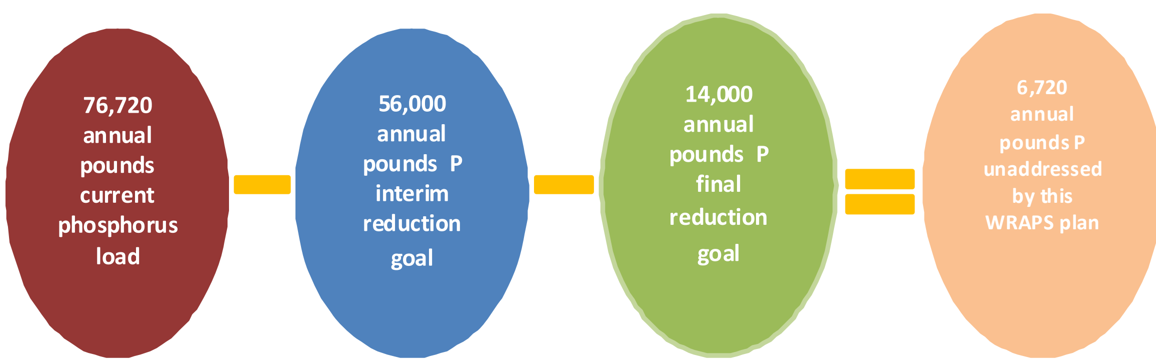
- Vegetative Buffers
- Grassed Waterway
- No-Till
- Terraces
- Cover Crops
- Wetlands
- Grade Stabilization Structures

Phosphorus Reducing Livestock BMPs

- Rangeland Management
- Alternative (Off-Stream) Watering System

Load reduction needed

- The focus of the Marion 9 element plan will be the phosphours load reduction. 70,000 lbs/yr of P is the end goal of the plan. Implementing BMP's directed at the phosphorus load reduction should also reduce nitrogen and sediment loads entering Marion Lake.



Gates on Marion Lake Dam

Marion Lake

Watershed Restoration And Protection Strategy

Cottonwood River (North Branch) French Creek Silver Creek

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

K-STATE Research and Extension

Marion WRAPS

K-State Research and Extension Project Staff

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Stakeholder Leadership Team

Landowners:

Herb Bartel, Mike Meisinger, Scott David, Dale Klassen, Jim Enns

Local Homeowner and Businesses:

Norman Epp, Terry Olsen, Kevin Sunderman, Max Terman, Lloyd Davies

City, County, State and Federal:

Peggy Blackman (WRAPS Coordinator), Ann D'Alfonso (KDHE Advisor), Tonya Richards (Public Health), Morgan Marlar (Hillsboro Water Dept.), Rickey Roberts (County Ag. Agent), Grover DePriest (NRCS), Kyle J. Manwaring (Lake Ranger), Marion County Commission, Dan Holub (County Commissioner), Marvin Peterson (KDWP), Bryan Sorensen (KDWP), Jon Stein (KDWP), Bill Holderman (Marion City Councilman), Mary Olsen(Marion City Mayor), Warren Kreutziger (President of the Lake Association), Teresa Huffman (Marion EcoDevelopment), Rick Sellers (Marion Lake Manager U S Army Corps), Randy Crawford Marion County Road and Bridge Supervisor

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1.0 Preface

The purpose of this Watershed Restoration and Protection Strategy (WRAPS) report for Marion Lake is to outline a plan of restoration and protection goals and actions for the surface waters of the watershed. Watershed goals are characterized as “restoration” or “protection”. Watershed restoration is for surface waters that do not meet water quality standards, and for areas of the watershed that need improvement in habitat, land management, or other attributes. Watershed protection is needed for surface waters that currently meet water quality standards, but are in need of protection from future degradation.

The WRAPS development process involves local communities and governmental agencies working together toward the common goal of a healthy environment. Local participants or stakeholders provide valuable grass roots leadership, responsibility and management of resources in the process. They have the most “at stake” in ensuring the water quality existing on their land is protected. Agencies bring science-based information, communication, and technical and financial assistance to the table. Together, several steps can be taken towards watershed restoration and protection. These steps involve building awareness and education, engaging local leadership, monitoring and evaluation of watershed conditions, in addition to assessment, planning, and implementation of the WRAPS process at the local level. Final goals for the watershed at the end of the WRAPS process are to provide a sustainable water source for drinking and domestic use while preserving food, fiber, and timber production. Other crucial objectives are to maintain recreational opportunities and biodiversity while protecting the environment from flooding, and negative effects of urbanization and industrial production. The ultimate goal is watershed restoration and protection that will be “locally led and driven” in conjunction with government agencies in order to better the environment for everyone.

This plan is intended to serve as an overall strategy to guide watershed restoration and protection efforts by individuals, local, state, and federal agencies and organizations. At the end of the WRAPS process, the Stakeholder Leadership Team (SLT) will have the capability, capacity and confidence to make decisions that will restore and protect the water quality and watershed conditions in the drainage into Marion Lake and actions that may be taken on the Lake itself to restore conditions in the Lake water.

2.0 Development of the Stakeholder Leadership Team

In 1997, a task force representing cities, government agencies, concerned individuals, businesses, organizations, and Tabor College met to determine if there was a need to identify potential pollutants in Marion Lake, and to develop a proposal to protect and enhance water quality in the lake and its tributaries. Marion County Conservation District coordinated the planning effort and developed the project proposal submitted to the Kansas Department of Health and Environment to obtain 319 Nonpoint Source Water Quality Project funds. On approval, the District contracted with the U.S. Department of the Interior, U. S. Geological Survey (USGS) to conduct the Water-Resources Report 99-4158. In 1998 the USGS Investigative Report sampled 25 stream sites during low flow conditions to evaluate spatial variability in concentrations of dissolved solids, major ions, nutrients, selected pesticides and fecal coliform bacteria. The report summary identified:

• high concentration of dissolved solids
• areas of excessive levels of nitrite, plus nitrate
• areas of total excessive phosphorus levels exceeding USEPA guidelines
• areas of excessive atrazine and
• areas of fecal coliform bacteria

The nonpoint pollutant sources occurred throughout the entire watershed. Following the recommendations of the Task Force and applying the information determined by the USGS Report, Marion County Conservation District developed a watershed plan for Marion Reservoir and received nonpoint source Financial Assistance, in 2002, through a 319 Nonpoint Source Water Quality Grant. Implementation of “best management practices” (BMPs) and information and education activities have been conducted, each year through November 2005 and continuing in 2006, adhering to all the goals, objectives and milestones established in the original watershed plan. The goal and objectives of the original Marion Reservoir Water Quality Protection Plan are listed below;

• Goal: To maintain and enhance the quality of water in Marion Reservoir and its tributaries.

• Objectives:
A. Develop and implement a water quality information and education program for all land and water users in the Marion Reservoir Watershed Area utilizing the following:

1. One-on-one contacts with landowners, land users, and people living in the watershed
2. Provide technical assistance, directly or by referral
3. Organize tours, field days and meetings
4. Develop and publish newsletters
5. Work with and keep project stakeholders informed.

B. Install and/or adopt pollution control practices to improve the water quality in the Marion Reservoir watershed.

1. Develop plans with individual landowners and water users in the Marion Reservoir Watershed. Utilize Watershed Restoration and Protection Strategy program, EQIP and all available programs to install desired practices.

   a. Develop plans and reduce soil loss on 12,000 acres of eroding cropland from current levels to tolerable (“T”) erosion levels.

   b. Install filter strips and/or riparian buffers along 15 miles of streams, including cropland near the reservoir shoreline

   c. Install adequate pollution control systems at 10 livestock facilities (beef confined feedlot, dairy, swine, etc.): upgrade 15 failing septic systems.

   d. Prepare and implement comprehensive nutrient and pesticide management plans on 20,000 acres of cropland to reduce nutrient, pesticide and related contaminant levels in Marion Reservoir and its tributaries to state maximum acceptable concentrations.

   e. Ensure development around Marion Reservoir is done according to sound land use policy.

   f. Research and demonstrate suitable bioengineering techniques and practices for cost and feasibility on selected shoreline sites; educate public about proper shoreline use. (Bioengineering or environmental engineering is the application of scientific and engineering principals to assess, manage and design sustainable environmental systems for the protection of ecological health.)

   g. Develop plans and implement practices to improve the quality of water runoff from grasslands by applying proper grazing use, using rotational grazing, developing alternative water sources and installing other practices on 15,000 acres.

C. Evaluate water quality trends through analysis of existing and future water sampling data.

1. Utilize Tabor College to periodically sample and analyze runoff from selected sites
2. Review Tabor College, USACE, City of Marion, City of Hillsboro, and other sources water test data to monitor trends.

Taste and odor problems have plagued the water treatment plants of Hillsboro and Marion through out the years. The cities began using the reservoir as their public water supply in 1982. Beginning in the summer of 2003, in late May and early June, a phenomenon occurred. USACE Rangers saw a remarkable depth of clarity in a normally highly turbid reservoir. Visitors to the reservoir enjoyed the clear, beautiful color of the water. Within a few days blue-green algae was found among the rocks and shallow areas of certain coves. Within days clumps of blue-green algae were easy to spot within the waters of the reservoir. The water treatment facilities had more intense problems with taste and odor in their public water supply. Hillsboro hauled water for their community throughout most of the summer of 2003. Marion was fortunate to have an alternative water source to supply their need and did not use water from Marion Reservoir during this time. Water quality tests showed blue-green algae related toxins in the finished water. The summer of 2004 began the same way as 2003, only the blue-green algae were much worse. The shallow waters of the coves were deep forest green in color and algae were so thick the water looked like green paint. Boats leaving the waters were left with a residue line of green from the algae. The summer of 2005 began similar to 2003 and 2004. A river of algae was located by the

USACE over 2 miles in length and approximately 100 feet wide. Heavy rains that began in late May and continued through out the summer curtailed the excessive growth of the algae.

Although the Conservation District had addressed the potential of poor water quality, beginning in 1998, the cities and general public had not shown much interest. Now, activities to improve water quality in the watershed and reservoir have become a major concern to the public at large. An immediate “fix” was sought, but none was found. Public meetings were held to look at possible treatment to remove blue-green algae from reservoir waters were held. The conclusion was, there was no easy fix to the problem. These meetings emphasized the need to continue BMP implementation in the watershed to alleviate sediment and nutrient load in reservoir waters.

3.0 Description of the Watershed

Marion Lake is located between the cities of Marion and Hillsboro in central Kansas (Figure 1). It was constructed by the U.S. Army Corps of Engineers (USACE) in 1968. The reservoir was created by damming the North Cottonwood River to control flooding and reached its conservation pool level in 1969. Marion Lake (mean depth 3.4 m, maximum depth 9.0 m) is a multiple-use and relatively young reservoir that serves as the major source of drinking water for people in Marion County and surrounding communities. Normal pool surface area is 2,509 ha (6,200 acres) that can extend to 3,716 ha (9,183 acres) during flood control operations.

Marion Lake lies within a 52,836-ha (204-sq. mile) watershed that is predominantly cultivated crop land (43%) and grassland (40%). The North Cottonwood River drains 82% of the watershed while French Creek watershed comprises 18% of the remaining drainage area.

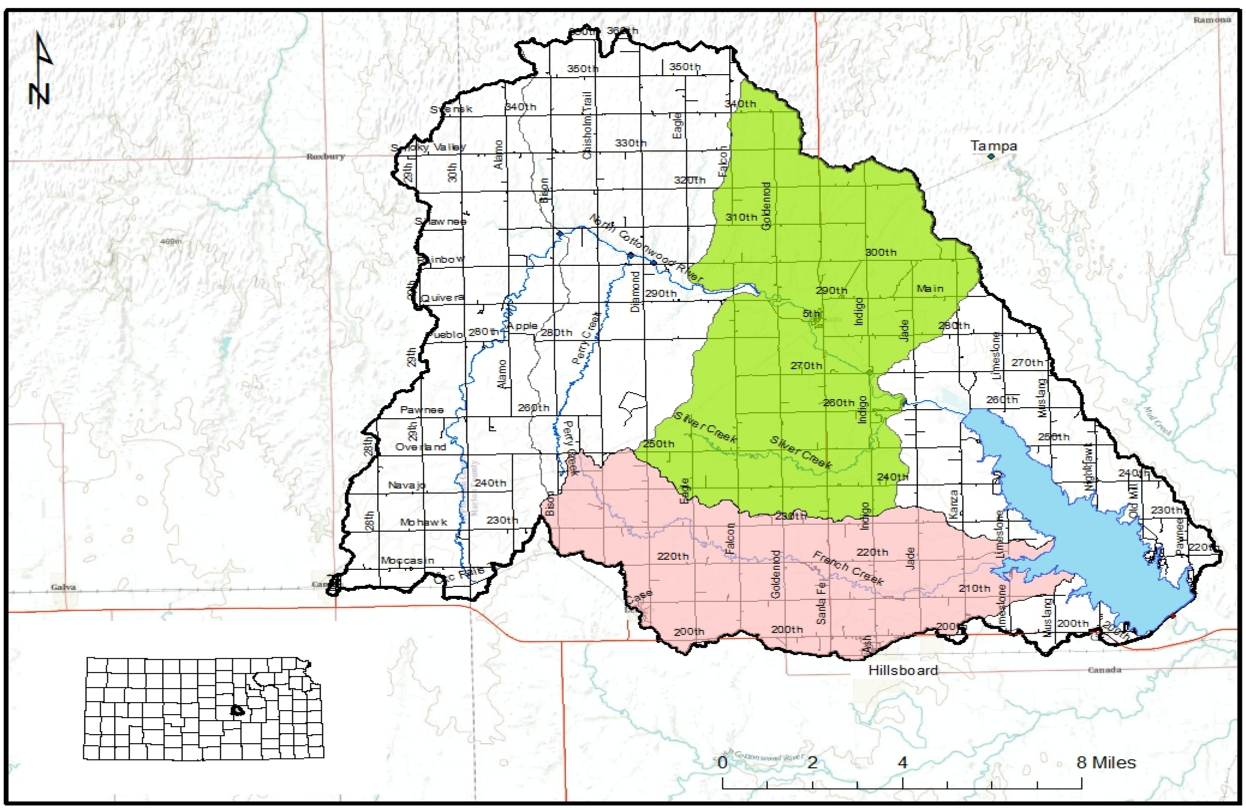


Figure 1. Map of Marion County showing Marion Lake and the watersheds flowing into the Lake.

Marion Lake frequently experiences cyanobacterial blooms in the recent years. In July 2003, total algal cell count [*Anabaena* sp. (121,647 cells/ml) and *Microcystis* sp. (33,765,339 cells/ml)] in drinking water intake far exceeded the World Health Organization's recommended guidelines of very high risk level (100,000 cells/ml).

The trophic conditions of Marion Lake were compared to other federal reservoirs. Typically, Marion Lake has higher trophic levels than other reservoirs in the state and has much higher nutrients and Chlorophyll *a* concentrations than the nutrient benchmarks proposed by the state.

Cultural eutrophication is an important water-quality problem in Marion Lake and reservoirs throughout the Midwest. Although eutrophication occurs naturally, cultural eutrophication causes a reservoir to become more productive or eutrophic due to excessive nutrient additions from their associated watersheds.

One of the most detrimental consequences of eutrophication is the development of nuisance cyanobacteria blooms. Cyanobacteria, also referred to as blue-green algae, are photosynthetic prokaryotes that frequently dominate the phytoplankton communities of lakes and reservoirs that receive high nutrient loads from their surrounding watersheds. Abundant cyanobacteria blooms and the resulting appearance of dense surface accumulations are not only aesthetically unappealing, but they can also have negative effects on water quality conditions. Many taxa produce objectionable odor substances (e.g., geosmin) when they die and decay and/or chemicals that are toxic to humans or animals.

Low TN:TP ratios and warm, dry weather, accompanying the prolonged dissolved oxygen (DO) stratification, create favorable conditions for excessive cyanobacteria blooms. More specifically, extensive agricultural activities (e.g., animal feeding operations) cause an imbalance nutrient export (i.e., increased TP levels in conjunction with decreased TN level) from the watershed. Soil test results from Kansas State University indicated that on average the top 6″ soil in Marion County had 36 mg/L of available P. Because Marion Lake has a long hydrological residence time (2.2 years) and approximately 93% of the TP load is retained annually in the lake, internal P released from lake sediment may play the important role of fueling the undesired algal blooms when the lake undergoes extensive DO stratification. A recent study conducted by the Kansas Biological Survey revealed that the average internal P releasing rate was 21 mg/m2/day, ranging from 17 to 24 mg/m2/day. Understanding what environmental factors contribute to cultural eutrophication and the subsequent appearance of algal blooms has been at the center of total watershed management. Specifically, nutrient loading, thermal stratification, hydrological condition (e.g., residence times and flushing rates), and land use/land cover patterns have all been identified as important factors contributing to water quality problems that occur in Marion Lake.

Eleven sub watersheds were modeled using Generalized Watershed Loading Function (GWLF) (Figure 2, page 13), and the 10-yr modeling results indicated that in average of 263 tons of TN and 67 tons of TP are exported annually from the watershed to the lake. GWLF is a mid-range watershed loading model developed to assess non-point source flow and sediment and nutrient loading from urban and rural watersheds. The GWLF model provides the ability to simulate runoff, sediment, and nutrient loadings (N and P) from a watershed given variable-size source areas (e.g., agricultural, forested, and developed land). It also has algorithms for calculating septic system loads, and allows for the inclusion of point source discharge data. It is a continuous simulation model, which uses daily time steps for weather data and water balance calculations.

GWLF is considered to be a combined distributed/lumped parameter watershed model. Of which, about 81% of the TN (213 tons) and 80% of the TP (54 tons) come from the North Cottonwood River whereas the French Creek (Basins 9 and 10) exports the remaining nutrient loads. Two municipal wastewater treatment plants (Canton and Lehigh) together contribute 1.4 tons of TN and 0.4 tons of TP per year. Nutrient losses from streambank erosion only contribute about 1% of the total watershed nutrient loads. Among the 11 sub watersheds, Basins 9, 10, 1, 4 and 11 are the top five sub watersheds having a higher TN load per unit of area. Similarly, Basins 9 10, 8, 4, and 1 are the top five subwatershed that have a higher TP load per unit of area.

To improve water quality, a 70% nutrient reduction (TN and TP) is required in order to reach the desired designated Primary Contact Recreation Use (chlorophyll *a* = 12 μg/L). However, an 85% nutrient reduction is needed if only managing TP load. Additional reductions are necessary to reach 10 μg/L of chlorophyll *a.*

The results of a 10-yr BATHTUB simulation (a steady-state lake model designed by the U. S. Corps of Engineers, Walker, 1996) show that the internal nutrients from the sediment are an important source of causing algal blooms in the lake. The BATHTUB model is designed to facilitate application of empirical eutrophication models to morphometrically complex reservoirs. The program performs water and nutrient balance calculations in a steady-state, spatially segmented hydraulic network that accounts for advective transport, diffusive transport, and nutrient sedimentation. Eutrophication-related water quality conditions (expressed in terms of total phosphorus, total nitrogen, chlorophyll a, transparency, organic nitrogen, nonortho-phosphorus, and hypo limnetic oxygen depletion rate) are predicted using empirical relationships previously developed and tested for reservoir applications. The BATHTUB model is designed to facilitate application of empirical eutrophication models to test for reservoir applications. This is because excess P is released into the water column, which lowers the TN:TP ratio. As a result, algal species shifts to cyanobacteria that can fix N from the atmosphere, and can out compete the more desired algae.

For future perspective in terms of changes in water quality, the U.S. Global Change Research Program indicates that possible future climate changes in the Central Great Plains region are higher temperatures with much drier growing seasons, but warmer and wetter winter and spring months, and higher intensity rainfall events. Therefore, predicted changes in the future climate are very likely to accelerate the eutrophication of this specific aquatic ecosystem and increase the possibility of the occurrence of cyanobacteria dominance.

To minimize water quality problems, there are several recommended agricultural practices: (1) Apply nutrient best management practices (BMPs) to reduce nutrient additions from excess fertilization; (2) Promote and adopt continuous no-till cultivation to minimize soil erosion and nutrient transports; (3) Install grass buffer strips along streams; (4) Reduce activities within riparian areas; (5) Setback both confined and non-confined animal feeding operation sites; (6) Evaluate a lake application of chelating agents to bond phosphorus to sediments; and (7) Construct ponds/detention basins, erosion control structures and/or wetlands to reduce soil erosion and to trap sediment and lower peak runoff rates. In addition, a watershed management team needs to work with research agencies and/or institutes to develop new technologies to effectively and efficiently remove P from the watershed.

4.0 Watershed Review

Marion Lake WRAPS Classified Waters are shown in Figure 3 (page 14). The SLT has selected the lower part of the North Fork of the Cottonwood River and French Creek as the priority sub watersheds to implement practices to meet the Marion Lake TMDL for eutrophication. Table 1 presents the designated uses of these waters.

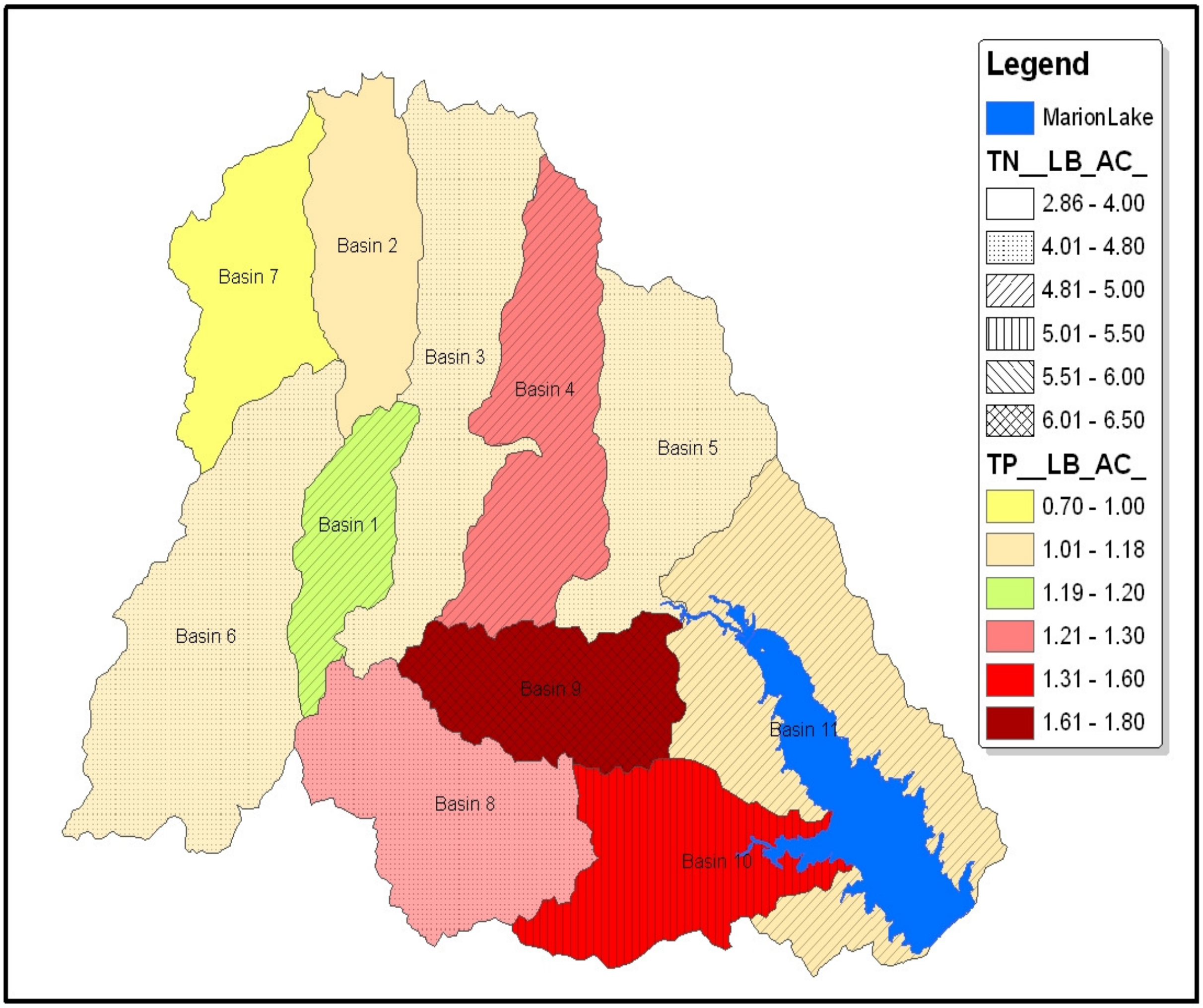


Figure 2. GWLF modeled sub watersheds draining into Marion Lake (Watershed Planning and TMDL Section, KDHE).

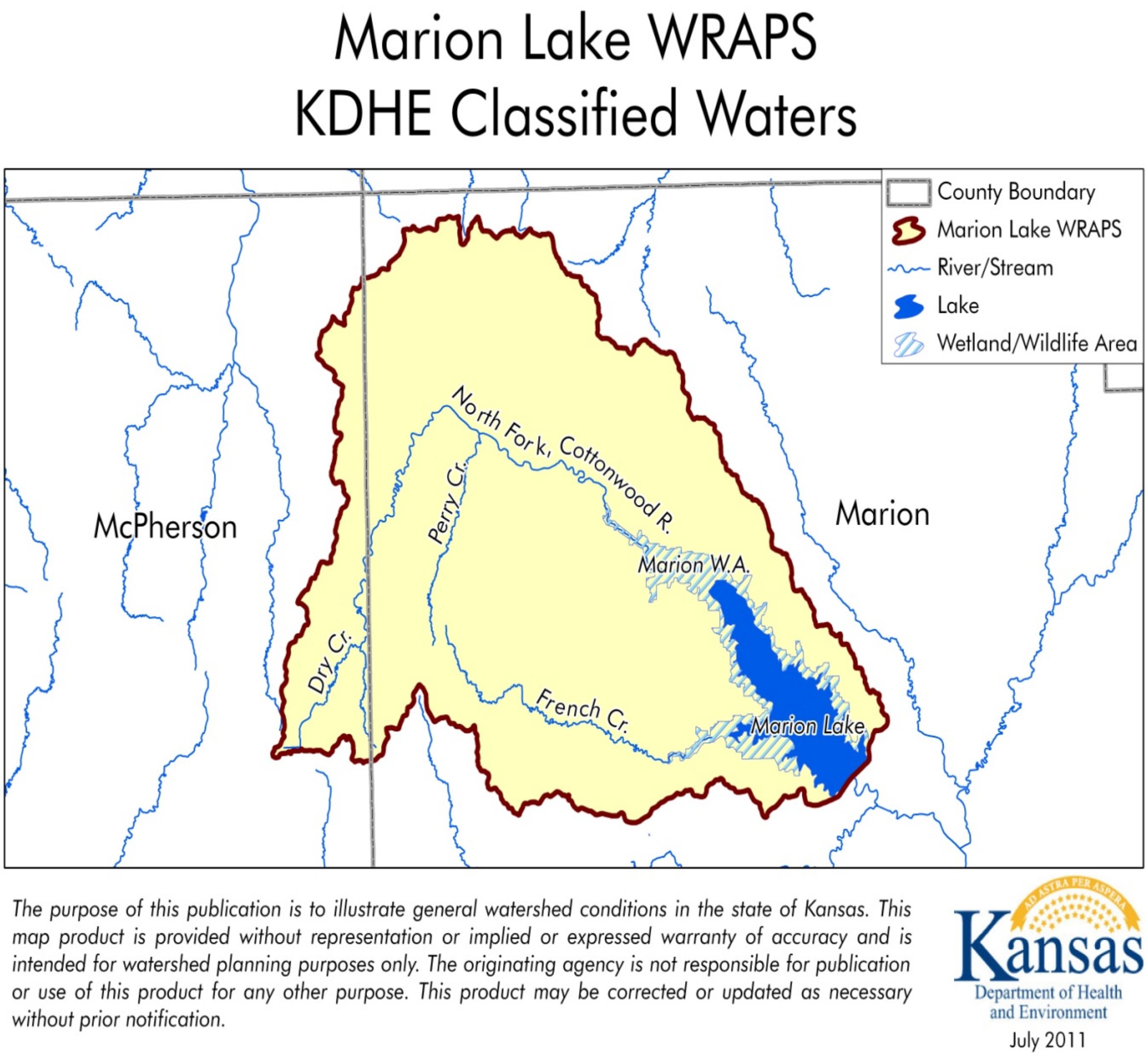


Figure 3. Marion Lake WRAPS KDHE Classified Waters.

Table 1. KDHE Designated Uses for Classified Waters

Lake/Stream Name	CUSEGA	CLASS	AL	CR	FP	DS	GR	IW	IR	LW
Cottonwood River, North	1107020214	GP	E	C	X	X	X	X	X	X
French Creek	1107020216	GP	E	b	X	X				
Perry Creek	1107020223	GP	E	b	X	O	O	O	X	X
Dry Creek	11070202401	GP	E	b	O	O	X	O	O	O
Marion Wildlife Area	N/A	GP	E	B	X	X	X	X	X	X
Marion Lake	N/A	GP	E	A	X	X	X	X	X	X

Key for Designated Uses

CUSEGA	=	channel unit segment
CLASS	=	antidegradation category
GP	=	general purpose waters
AL	=	designated for aquatic life use
E	=	expected aquatic life use water
CR	=	designated for contact recreational use
A	=	Primary contact recreation stream segment/lake that is a public swimming area/has a posted public swimming area
B	=	Primary contact recreation stream segment/lake that is by law or written permission of the landowner open to and accessible by the public
C	=	Primary contact recreation stream segment/lake that is not open to and accessible by the public under Kansas law
b	=	Secondary contact recreation stream segment/lake that is not open to and accessible by the public under Kansas law
FP	=	designated for food procurement use
DS	=	designated for domestic water supply
GR	=	designated for ground water recharge
IW	=	designated for industrial water supply use
IR	=	designated for irrigation use
LW	=	designated for livestock watering use
X	=	referenced stream segment/lake is assigned the indicated designated use
O	=	referenced stream segment/lake does not support the indicated designated use
blank	=	capacity of the referenced stream segment/lake to support the indicated designated use has not been determined by use attainability analysis

The surface waters in Marion Lake Watershed are generally used for aquatic life support, food procurement, domestic water supply, recreational use, groundwater recharge, industrial water supply, irrigation and livestock watering. Surface waters are given certain “designated uses” based on what the waters will be used for as stated in the Kansas Surface Water Register, 2009, issued by KDHE. For example, water that will come into contact with human skin should be of higher quality than water used for watering livestock. Therefore, each “designated use” category has a different water quality standard associated with it. When water does not meet its “designated use” water quality standard then the water is considered “impaired”.

4.1 Rapid Assessment map of the Marion Lake priority watersheds.

ArcGIS was used to map the Marion Lake watershed. The USDA Revised Universal Soil Loss Equation Version 2 (RUSLE2) program was used to estimate the erosion potentaial in the watershed. The original map was made assuming no conservation practices had been implemented in the watershed. All the fields in the watershed were then surveyed by visual inspections to assess practices used on each field used in the NRCS rapid assessment. If questions arose from this survey, the local conservation district and WRAPS coordinator was contacted about practices that had been installed on the fields in question.

RUSLE2 was developed primarily to guide conservation planning, inventory erosion rates and estimate sediment delivery. Values computed by RUSLE2 are supported by accepted scientific knowledge and technical judgment, are consistent with sound principles of conservation planning, and result in good conservation plans. RUSLE2 is based on science and judgment.
RUSLE2 has evolved from a series of previous erosion prediction technologies. The USLE was entirely an empirically based equation and was limited in its application to conditions where experimental data were available for deriving factor values. A major advancement in revised model was the use of sub factor relationships to compute C factor values from basic features of cover-management systems. While the revised model retained the basic structure of the USLE, process-based relationships were added where empirical data and relationships were inadequate, such as computing the effect of strip cropping for modern conservation tillage systems.

While RUSLE2 uses the USLE basic formulation of the unit plot, the mathematics of RUSLE2 is on a daily basis. Improved cover-management sub factor relationships are used in RUSLE2, a new ridge sub factor has been added, and the deposition equations have been extended to consider sediment characteristics and how deposition changes these characteristics. It includes new relationships for handling residue, including resurfacing of residue by implements like field cultivators.

The major visible change in RUSLE2 is its new, modern graphical user interface. It makes the model easy to use, but is extremely powerful in the information that it displays and the types of situations that it can represent. RUSLE2 is a very powerful model yet it uses very simple, easy to obtain inputs. Table 2 shows the potential erosion ranges found in the priority watersheds shown in Figure 4 (page 17).

Table 2. Potential Erosion levels associated with the RUSLE2 evaluation.

Erosion Potential	Area (acres)	Sediment Loss (tons/year)
Very High (6-8 tons/year)	223	1561
High (4-6 tons/year)	7371	36855
Moderate (2-4 tons/year)	17176	51528
Low (0-2 tons/year)	27214	27214
Total	51,984	117158

4.2 Natural Resources Conservation Service Rapid Watershed Assessments

The Natural Resources Conservation Service (NRCS) develops rapid watershed assessments (RWA) which provide initial estimates of where conservation investments would best address the concerns of landowners, conservation districts, and other community organizations and stakeholders within a watershed. These assessments help landowners and local leaders set priorities and determine the best actions to achieve their goals.

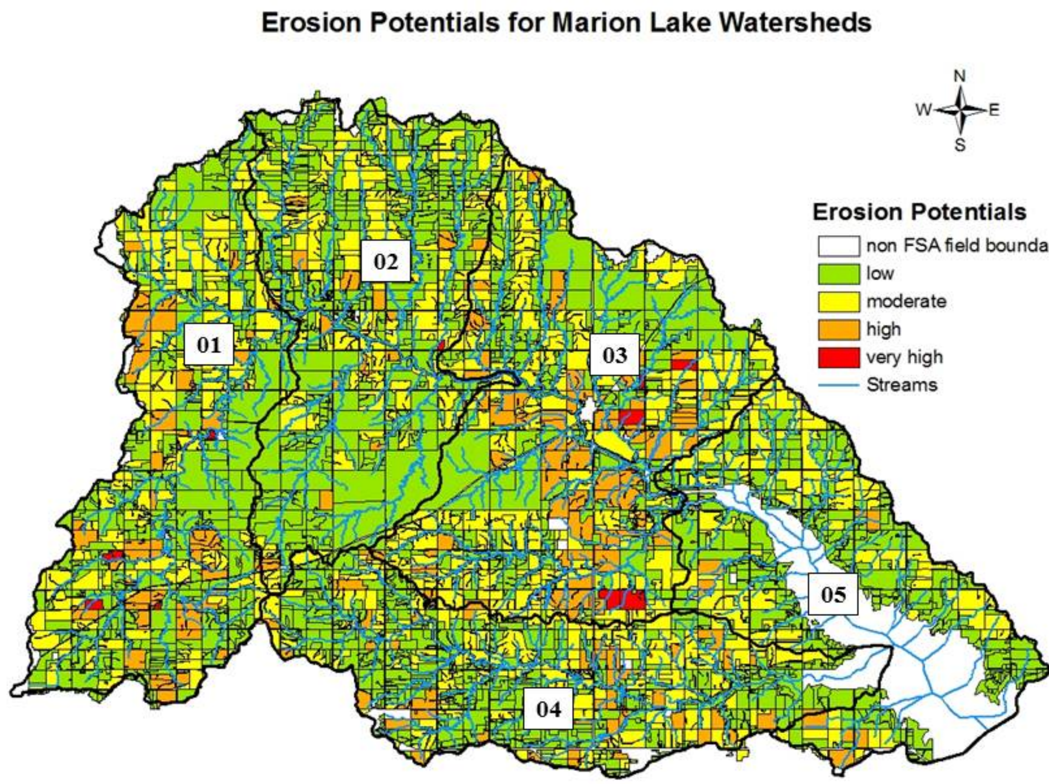


Figure 4. Erosion potentials for fields in the Marion Lake HUC 1107020201 watershed (boxes show HUC12 sub watersheds).

The extent of the WRAPS is the Upper Portion of the North Fork of the Cottonwood River, Silver Creek, and French Creek. The geographic endpoint of the watershed is the outflow from the dam on Marion Lake. The Marion WRAPS SLT selected the following HUC subwatersheds highlighted in Figure 5 (HUC 110702020103 which includes 31,970 acres in the Silver Creek and North Cottonwood River and HUC 110702020104 wich includes 23,091 acres in French Creek) to implement best management practices (BMPs). HUC is an acronym for Hydrologic Unit Codes. HUCs are an identification system for watersheds. Each watershed has a unique

HUC number in addition to a common name. As watersheds become smaller, the HUC number will become larger. There are five HUC 12's comprising the Marion Lake Watershed (HUC 110702020101 Dry Creek, HUC 110702020102 Perry Creek, HUC 110702020103 North Cottonwood River and Silver Creek, HUC 110702020104 French Creek, and HUC 110702020105 Marion Lake and surrounding lands; ranging in size from 23,100 to 32,000 acres. The highest HUC 12 is dominated by open water (the lake) and cropland. French Creek is 45% cropland and 41% grassland. The North Cottonwood River drains the remaining three HUC 12's; the lowest has the highest proportion of cropland in the watershed (47%) while the middle sub-watershed has the lowest (33%). The uppermost sub-watershed is similar to the lower sub-watershed but has more forestland.

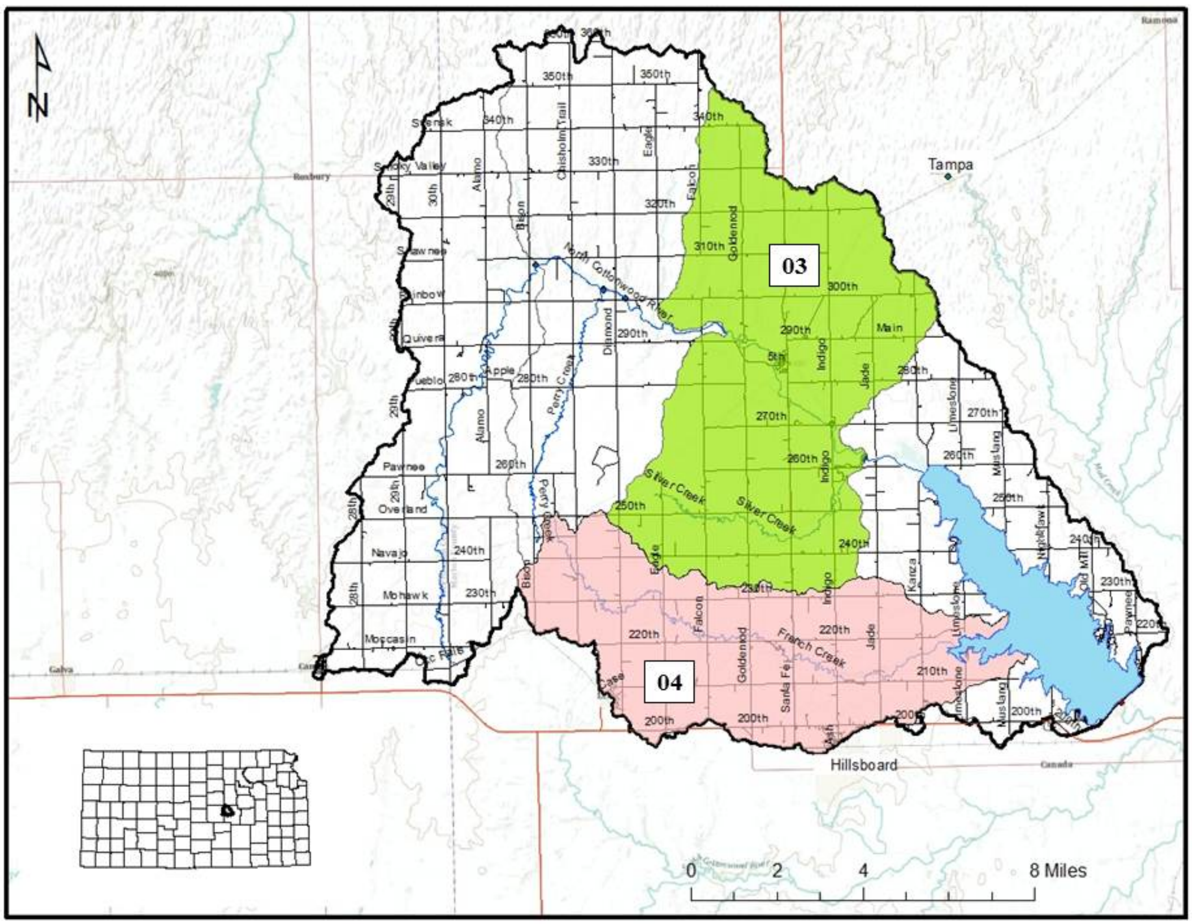
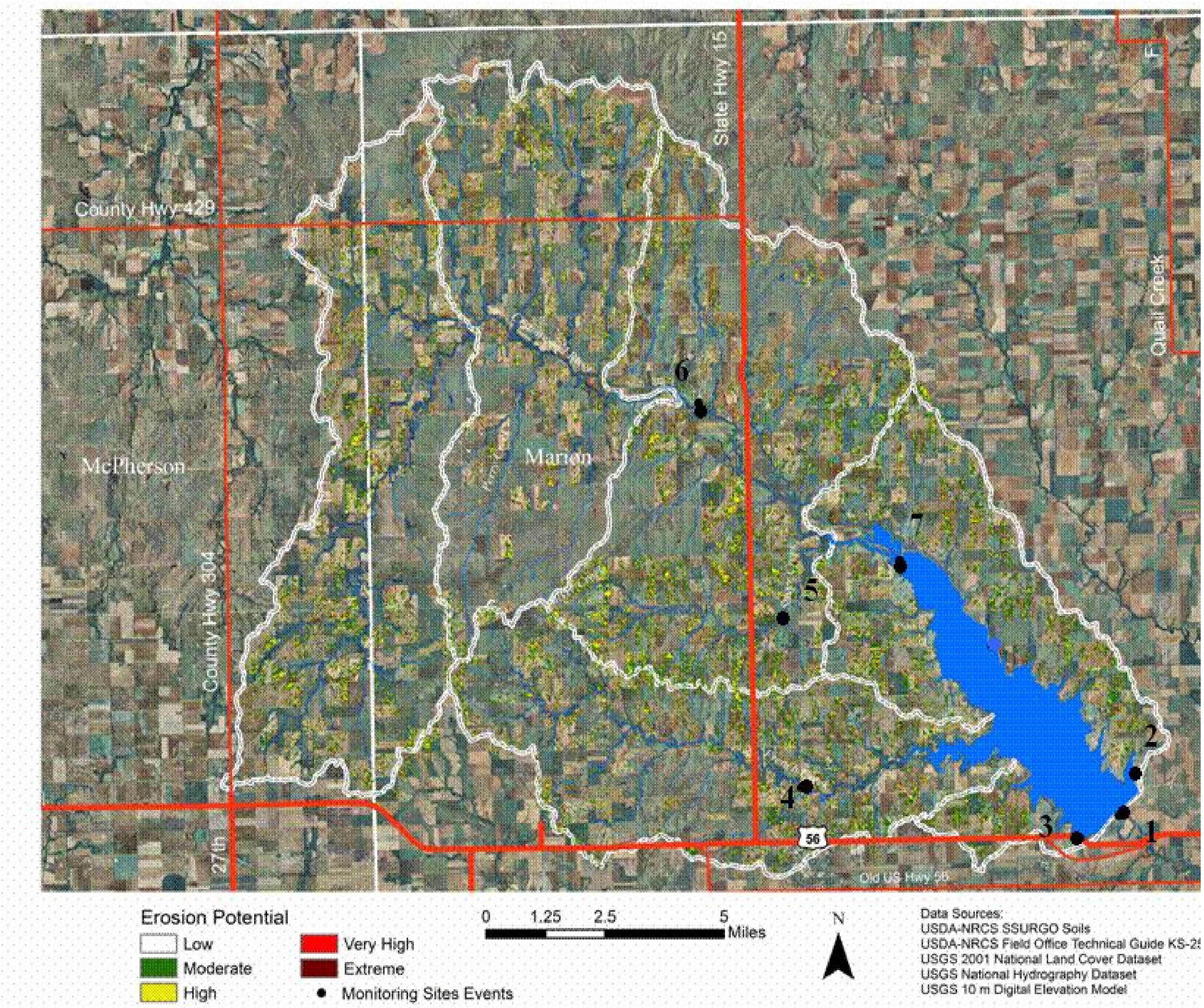


Figure 5. HUC12 110702020103 and 110702020104 planned for initial BMP implementation.

Monitoring data has been collected starting in 2007 at seven locations in the watershed and lake shown in Figure 6 and Table 2. Samples are collected weekly during the summer months of April through September and monthly during the winter month of October through March. Each stream monitoring site is calibrated to measure daily flowrates. With the measure contaminant concerntrations and the flowrate daily contaminant loadings can be measured or estimated.

Figure 6. Seven Marion Lake and watershed monitoring locations.



Taking estimated long term flows and the TSS (total suspended sediments), TN (total nitrogen) and TP (total phosphorus) concentrations sampled on the North Cottonwood River and French Creek, a majority of nutrient loadings comes down the North Cottonwood River, because of its greater hydrologic contributions (roughly 2.5 – 2.9 times greater load than French Creek).

Figures 7 through 9 show current water quality trends. Because of land use and hydrology considerations as well as their proximity to the lake and the presence of the other impairments on the streams themselves, the SLT selected the highest priority HUC 12 should be the lower North Cottonwood (110702020103) which includes Spring Creek, followed by French Creek (110702020104). Placement of Best Management Practices should be concentrated in those two sub-watersheds during the initial stages of implementing the watershed plan for Marion Lake. Additional attention will be given to activities and practices in the immediate vicinity of Marion Lake within 110702020105, given the direct impact those activities would have on the lake.

Table 3. Monitoring site location description and coordinates for Marion Lake.

Site Number	Site Location	Site Coordinates
1	Marion Lake Outflow	Lat 38.36834 Lon 97.08391
2	Marion Cove Public Use Area	Lat 38.37625 Lon 97.07643
3	Below Rest Stop on West Side of Marion Dam	Lat 38.36335 Lon 97.09213
4	French Creek North of Hillsboro on Indigo Road	Lat 38.36335 Lon 97.09213
5	Silver Creek near Indigo Road and 250th Street	Lat 38.43500 Lon 97.20632
6	North Branch of the Cottonwood River Near Durham	Lat 38.49526 Lon 97.24301
7	North End of Marion Reservoir on bridge on Kanza Road	Lat 38.44759 Lon 97.16637

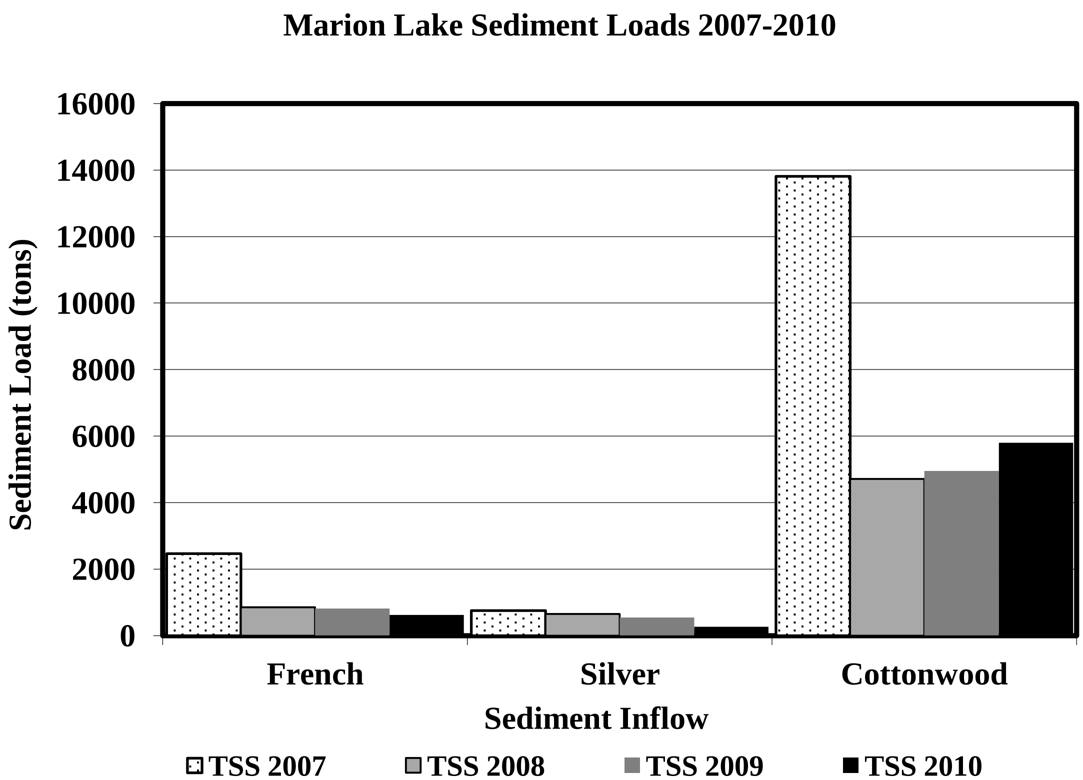


Figure 7. Monitored sediment loading flowing into Marion Lake, 2007-2010.

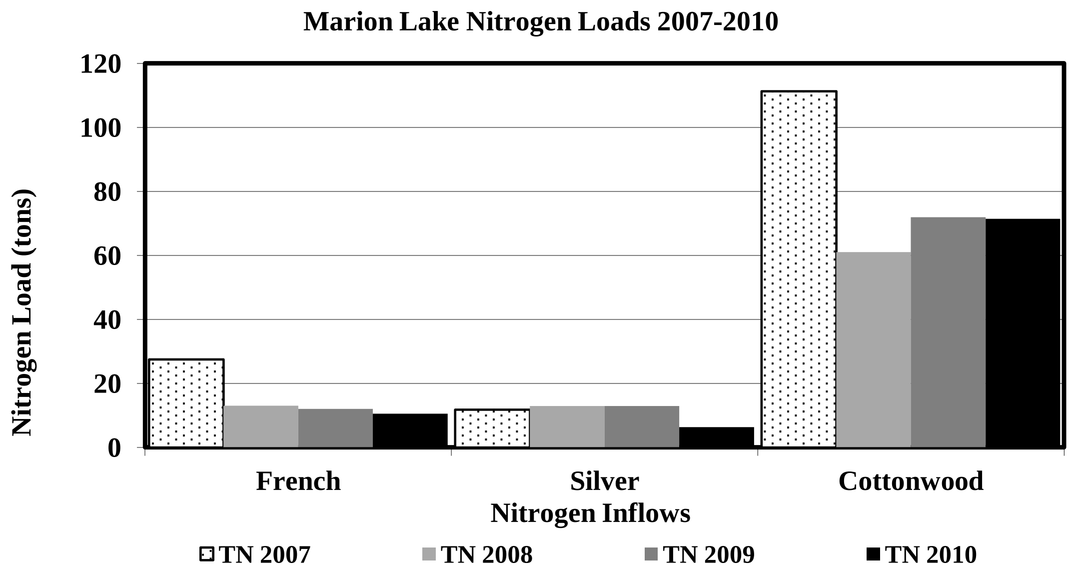


Figure 8. Total nitrogen loading in Marion Lake, 2007 to 2010.

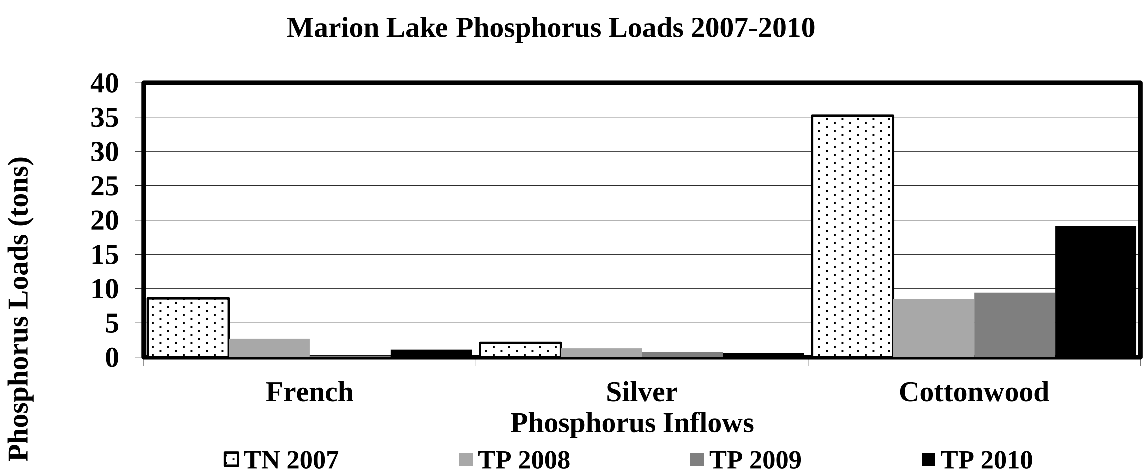


Figure 9. Total phosphorus flowing into Marion Lake, 2007-2010.

4.3 Land Cover/Land Uses

A detailed land use study compiled by the Natural Resources Conservation Service (NRCS) indicated 83% of the watershed is either in grass or cropland. The total land use ratio in the watershed is 52% cropland and the remaining 48% grazing land according to the study (Figure 10). Examination of the NRCS soil survey for this watershed has many soils with a very low permeability. This would indicate much of the watershed has soils with high clay contents and when tilled, soil erosion from these fields can lead to excessive transport of suspended sediments and the nutrients that can be tranported with the soil particles (Figure 11).

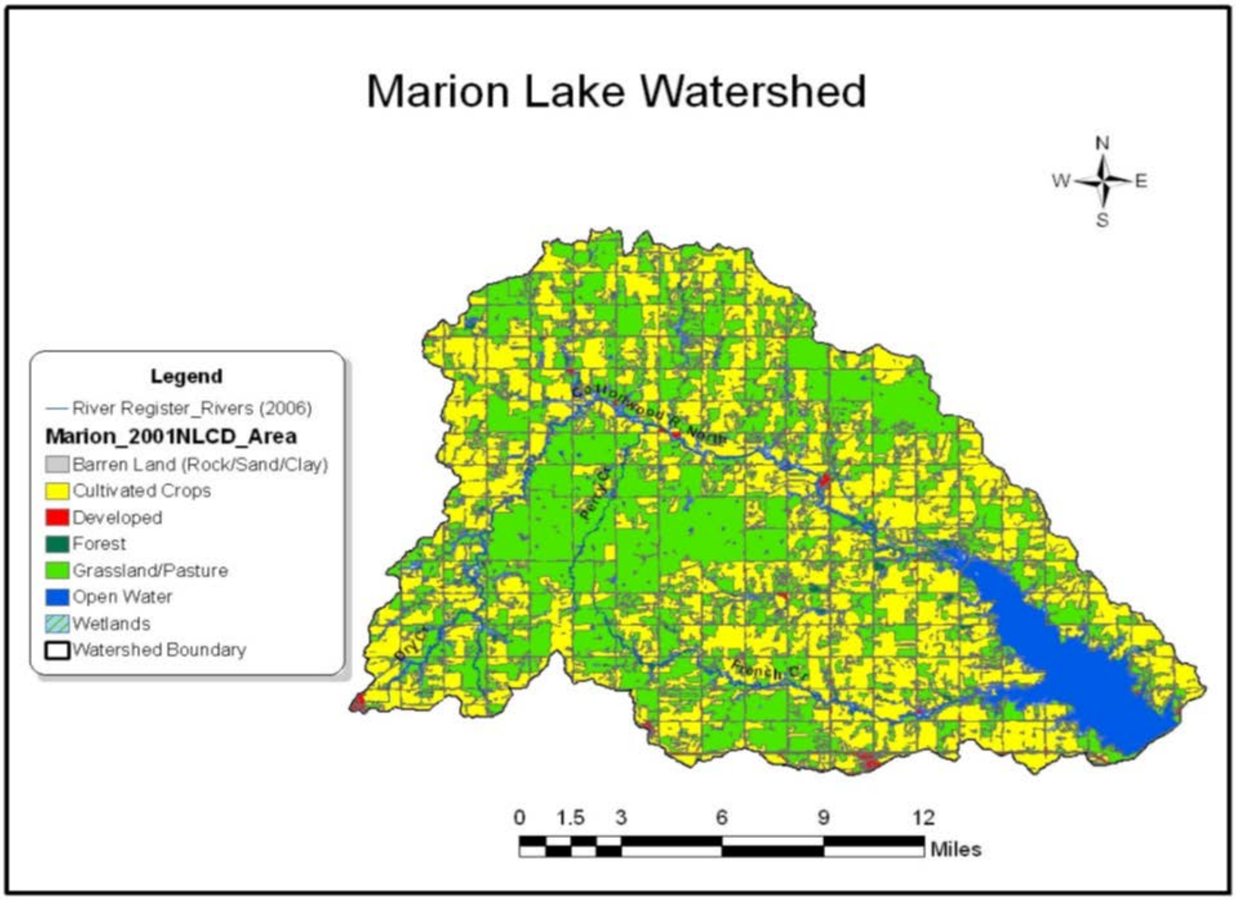


Figure 10. Landuse map for Marion Lake watershed.

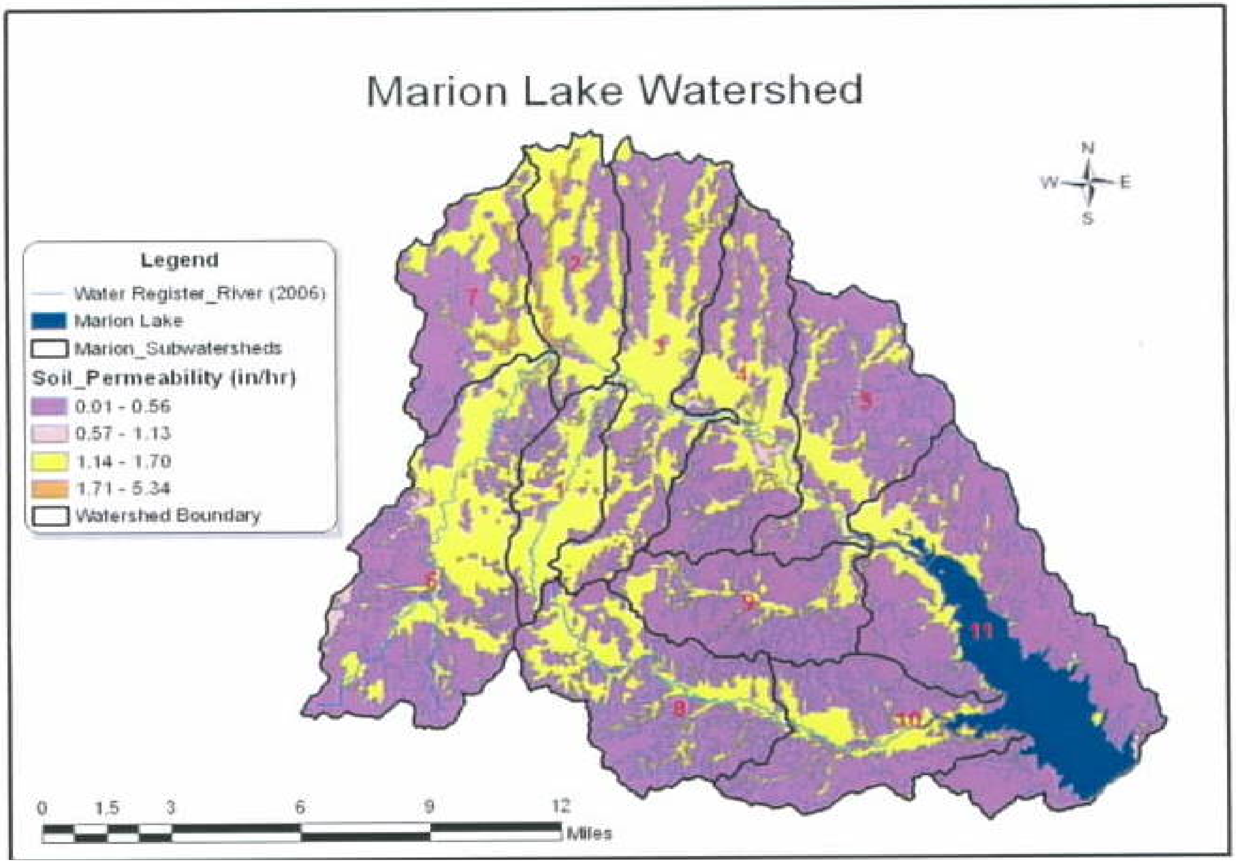


Figure 11. Soil permeability for the Marion Lake watershed.

4.4 Marion Lake Watershed 2010 303(d) list for Impaired Waters and TMDLs

Marion Lake and its watershed have three impaired waters, all with existing TMDLs:

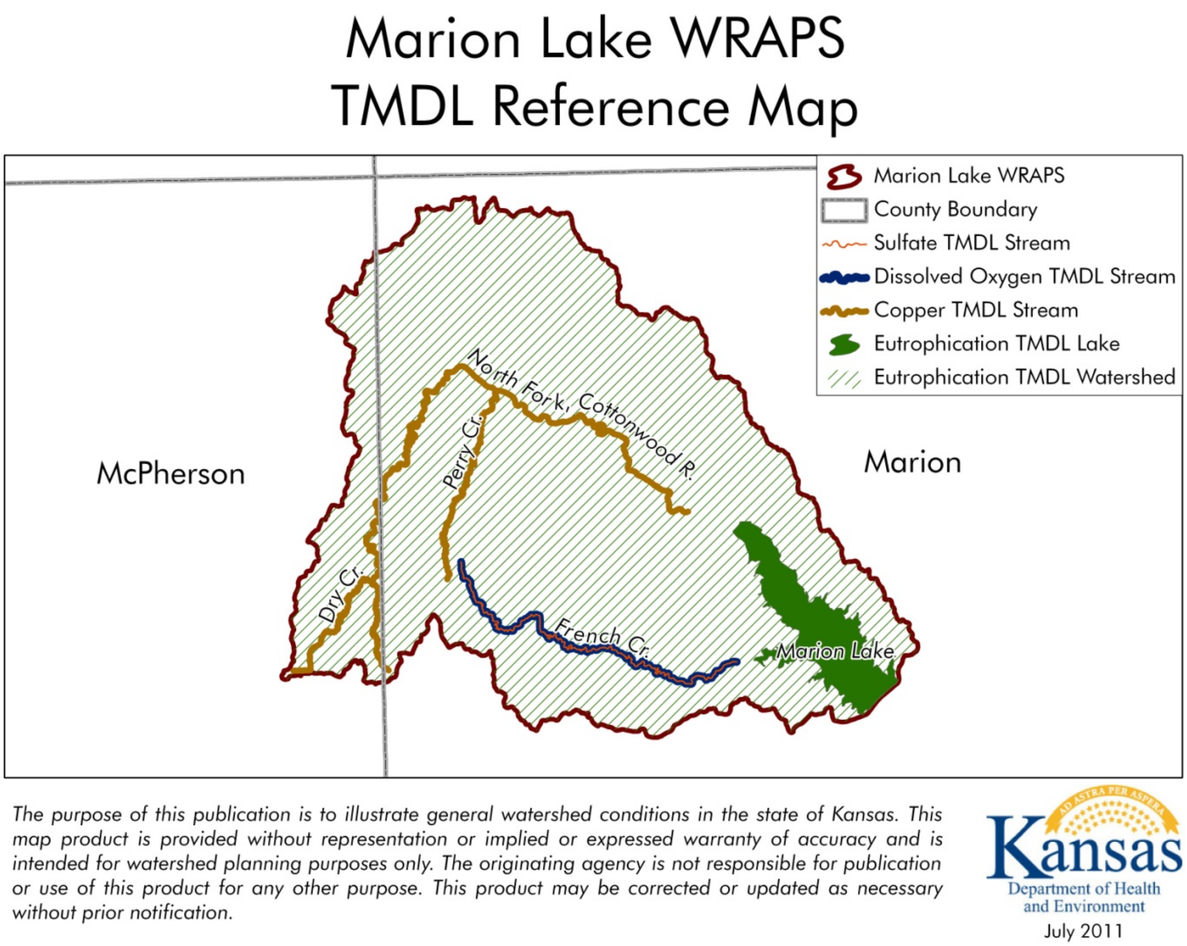
1. Marion Lake – Eutrophication – High Priority
2. French Creek – Deficient Dissolved Oxygen – Medium Priority
3. North Cottonwood River – Copper Toxicity – Low Priority
4. French Creek – Sulfate – Low Priority

The implementation of Best Management Practices (BMPs) recommended in this plan are intended to directly address the eutrophication impairment for Marion Lake. In addition, the dissolved oxygen impairment on French Creek should be positively affected by the implementation of these BMPs. Positive affects will be created through activites listed in this plan that lead to the reduction of P, as well as the reduction of sediment and Nitrogen.

Table 4. Shows the 2010 303(d) list for impaired waters in the Marion Lake watershed.

Cat	Stream/Lake	Impaired Use	Impairment	Station	Counties	Body Type	Priority	Comment
4a	N. Cottonwood River	Aquztic Life	Copper	SC636	MP, MN, HV	Watershed	Low	TMDL 2/25/2005
4a	French Creek	Aquatic Life	Dissolved Oxygen	SC676	MN	Watershed	Medium	TMDL 12/13/2002
4a	Marion Lake	Aquatic Life	Eutrophication	LM020001	MN	Lake	High	TMDL 9/30/2009
4a	French Creek	Water Supply	Sulfate	SC676	MN	Watershed	Low	TMDL 12/13/2002
3	N. Cottonwood River	Water Supply	Sulfate	SC636	MO, MN, HV	Watershed	NA	NA

Figure 12. Marion Lake WRAPS Impaired Waters/ TMDL Map



Marion Lake level of eutrophication: Trophic State Index = 59 (Fully Eutrophic), ranging from 36 in 1993 to 66 in 2002. The Marion Lake High Priotority TMDL for Eutrophication is being directly addressed by this plan. The total phosphorus in Marion Lake exceeds the levels required to meet its designated use and is therefore being addressed to help alleviate in-lake phosphorus loading. The Goal of this plan is to reduce the in-lake phosphorus by 70,000 lbs/year to meet the Eutrophication TMDL.

Low TN:TP ratios and warm, dry weather, accompanying the prolonged dissolved oxygen (DO) stratification, create favorable conditions for excessive cyanobacteria blooms. More specifically, extensive agricultural activities (e.g., animal feeding operations) cause an imbalance nutrient export (i.e., increased TP levels in conjunction with decreased TN level) from the watershed. Soil test results from Kansas State University indicated that on average the top 6″ soil in Marion County had 36 mg/L of available P. Because Marion Lake has a long hydrological residence time (2.2 years) and approximately 93% of the TP load is retained annually in the lake, internal P released from lake sediment may play the important role of fueling the undesired algal blooms when the lake undergoes extensive DO stratification. A recent study conducted by the Kansas Biological Survey revealed that the average internal P releasing rate was 21 mg/m2/day, ranging from 17 to 24 mg/m2/day. Understanding what environmental factors contribute to cultural eutrophication and the subsequent appearance of algal blooms has been at the center of total watershed management. Specifically, nutrient loading, thermal stratification, hydrological condition (e.g., residence times and flushing rates), and land use/land cover patterns have all been identified as important factors contributing to water quality problems that occur in Marion Lake.

The Trophic State Index (TSI) is derived from the chlorophyll a concentration (Chla). Trophic state assessments of potential algal productivity were made based on Chla, nutrient levels, and values of the Carlson Trophic State Index (TSI). Generally, some degree of eutrophic conditions is seen with Chla over 12 μg/L and hypereutrophy occurs at levels over 30 μg/L. The Carlson TSI derives from the Chla concentrations and scales the trophic state as follows:

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

The impairments on North Cottonwood River and French Creek are each documented by three exceedances of water quality standards among 28 samples collected on both streams over five years. The copper impairment occurred in two of the five years, the most recent occurring in 2001, while the deficiency in dissolved oxygen occurred in three years with the most recent occurrence in late 2009. The incidence of high copper typically occurred during high flows when sediment and suspended solid material was transported in the North Cottonwood River. Since the water quality criteria for copper is a function of the hardness of the water, these periods of elevated copper concentrations were aggravated by the decreased hardness during runoff. Conversely, the episodes of low dissolved oxygen happen during periods of lower flow and warm temperatures. Typically, some evidence of organic matter loading is also present during these times. Neither of these issues warrant immediate attention from the WRAPS and may, in fact, be corrected by practices installed to address the higher priority issue of eutrophication in Marion Lake.

Based on KDHE data, a rise in total phosphorus and Chlorophyll a has been noted over time (Figures 13 and 14). No specific threshold for in-lake phosphorus has been established but chlorophyll a needs to average below 12 ppb initially and under 10 ppb in the long term for a water supply reservoir.

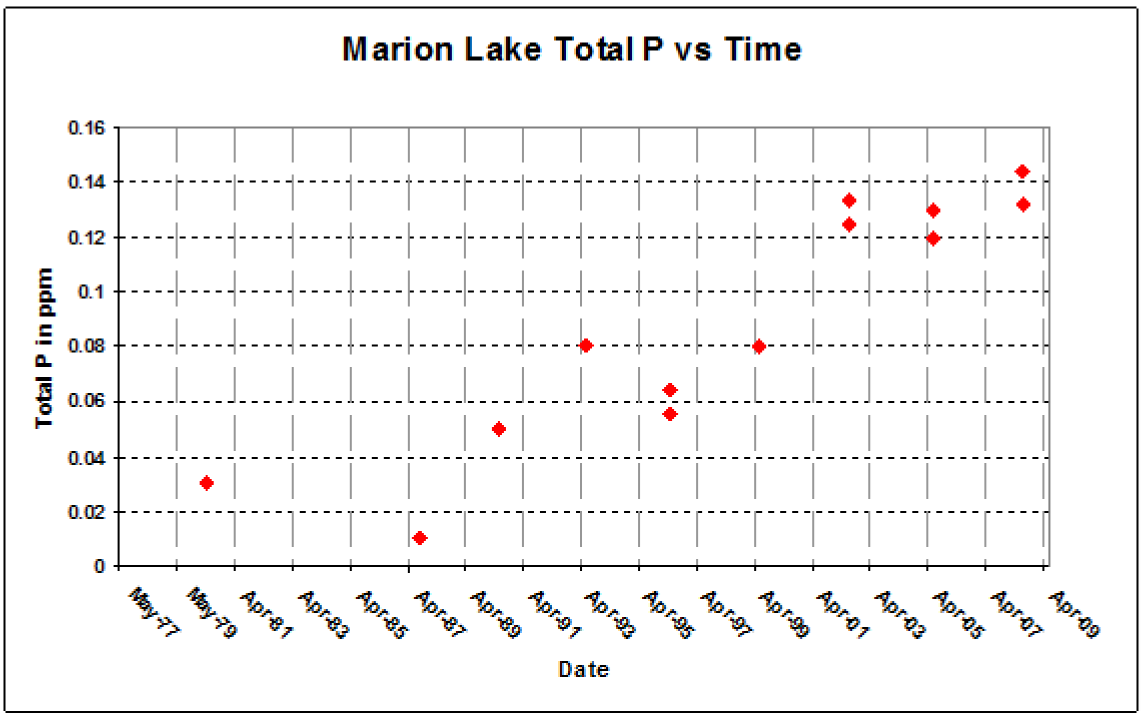


Figure 13. KDHE temporal monitoring of phosphorus in Marion Lake.

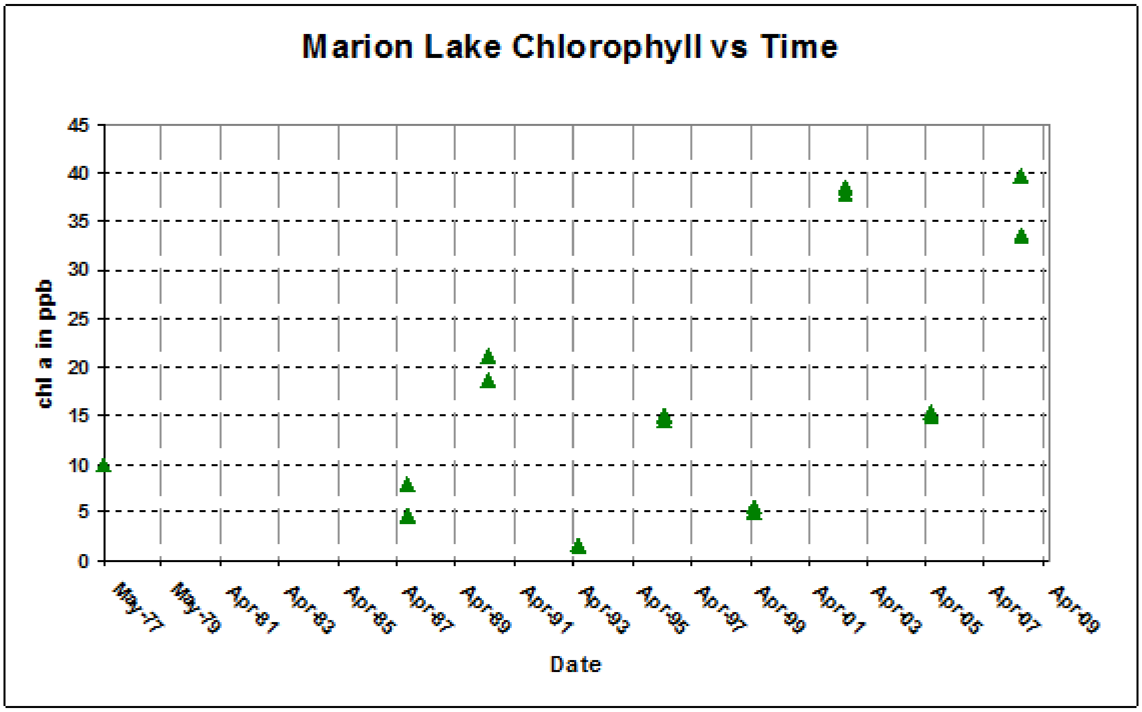


Figure 14. KDHE temporal monitoring of Chlorophyll a in Marion Lake.

It is apparent that during periods of high phosphorus and limited nitrogen (low TN:TP values, Figure 15), algal productivity increases. Since blue-green algae have the ability to fix nitrogen, they have an inbred advantage over more desirable species of algae.

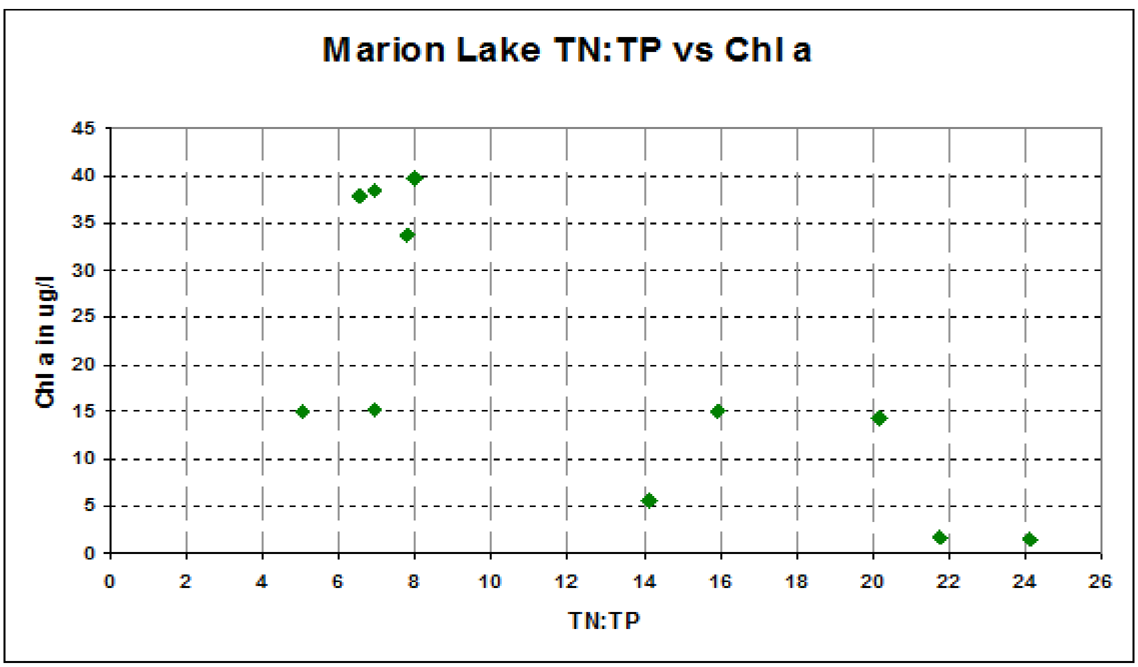


Figure 15. KDHE monitoring showing increased Chlorophyll a with lower TN:TP ratios.

There also appears to be a long term decrease in the transparency of the lake as measured by Secchi disk depths (Figure 16). There is an atypical direct relationship between total suspended solids and Chlorophyll a, given that increased turbidity usually diminishes the availability of light for photosynthesis and primary productivity, (Figure 17). In the case of Marion Lake, transparency extends into the first 0.5 meters of the lake and then is all but extinguished. TSS values taken in samples within that photic zone may be sufficiently high enough to curtail some availability of light. It is also possible that some of the TSS is composed of algal material itself.

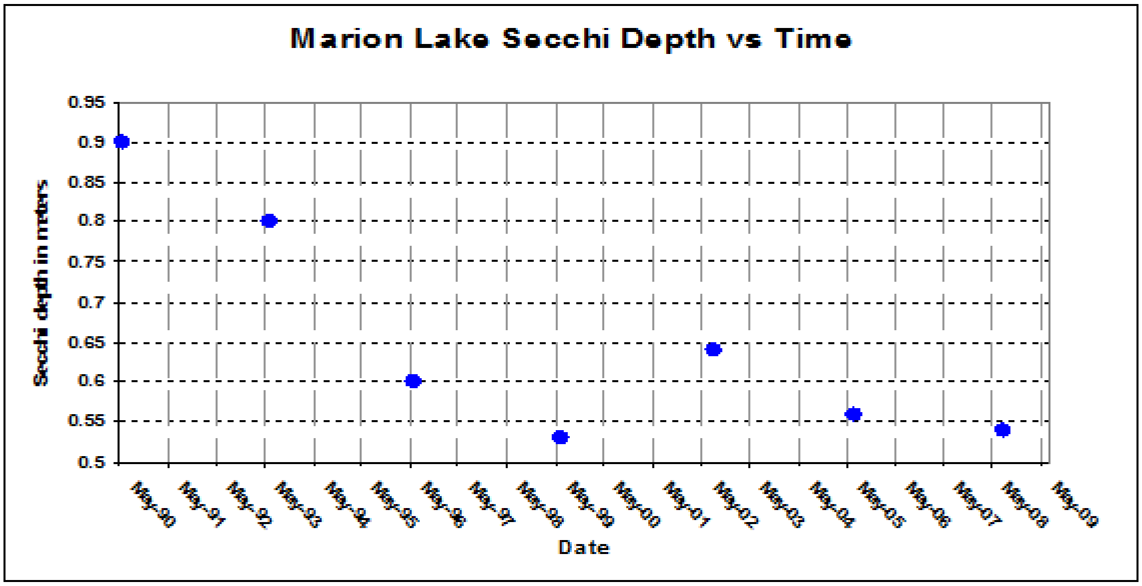


Figure 16. KDHE temporal monitoring of Secchi disk depths in Marion Lake.

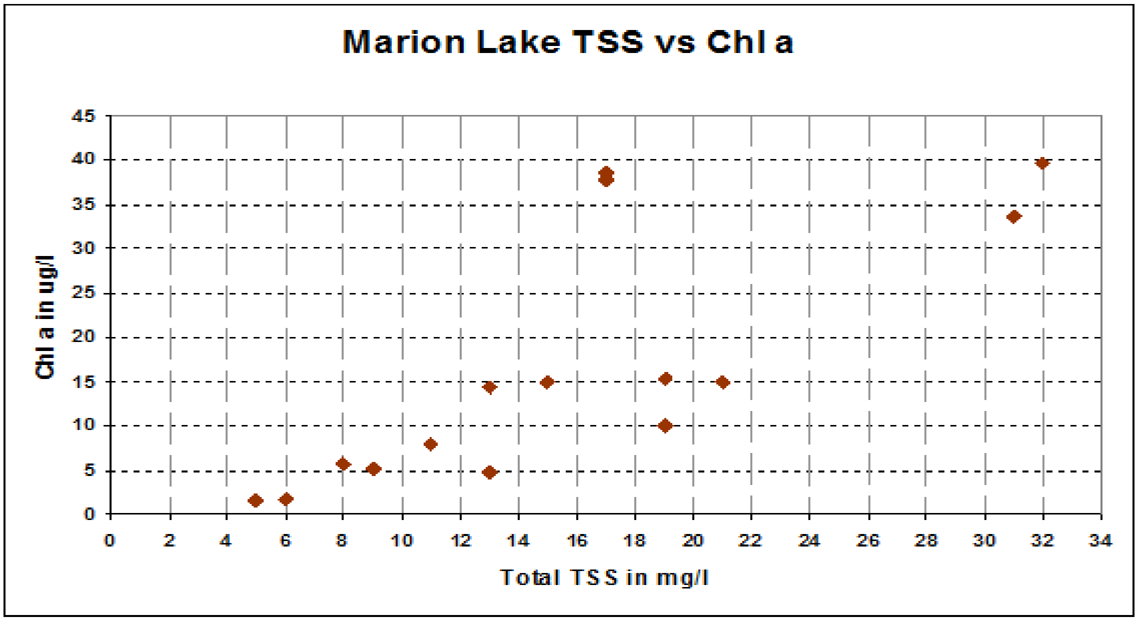


Figure 17. KDHE monitoring showing increased Chlorophyll a with high levels of suspended sediments.

Finally, profiles of temperature and dissolved oxygen taken in the lake indicate the lake stratifies weakly, if at all. With the complete mixing of the water column, dissolved oxygen remains above the water quality standard of 5 mg/l in a majority of the lake volume. The last complete profile taken in 2005 indicates the lower third of the lake depth slips below acceptable levels, however. Some of this may result from the deposition and degradation of organic material produced from algal growth in the upper levels of the lake water. The other consequence of the consistent mixing of the water column is the re-introduction of nutrients from the depths of the lake back into the primary productivity zone.

4.5 Marion Lake Watershed NPDES and CAFO information

Four NPDES permitted facilities are located within the watershed (Figure 18). Two are non-overflowing lagoon systems (Table 5). Non-overflowing lagoons are prohibited from discharging and would only contribute a total phosphorus or ammonia load under extreme precipitation events (flow durations exceeded up to 5 percent of the time). Such events would not occur at a frequency or for a duration sufficient to add to the impairments in Marion Lake. Canton and Lehigh MWTP facilities discharge their effluents via Dry Creek and French Creek, respectively, and eventually these treated sewages flow into Marion Lake. For lagoon systems in Kansas, average effluent TN and TP concentrations are 7 mg/L and 2 mg/L, respectively (written communication, Mike Tate, BOW, KDHE).

There are 38 confined animal feedlot operations (AFO/CAFOs) registered (either certified or permitted), which are primarily located in the central portion of the watershed (Figure 18). All of these permitted livestock facilities (10 dairy, 21 beef, 4 swine, and 3 mixed of beef/horse/swine) have waste management systems designed to minimize runoff entering their operation or detaining runoff emanating from their facilities. In addition, they are designed to retain a 25-year, 24-hr rainfall/runoff event as well as an anticipated two weeks of normal wastewater from their operations. Typically, this rainfall event coincides with stream flow that is less than 1-5% of time. Though the total potential number of animals is 11,755 head in the watershed, the actual number of animals at the feedlot operations is typically less than the allowable permitted number. Approximately 40% of land around the lake is grassland, and the grazing density of livestock is moderate in summer and high in winter. Because of seasonally high density of these livestock operations in the watershed, the animal waste from both confined and unconfined feeding sites is considered a major potential source of phosphorus loading going into Marion Lake. The laboratory results (Mehlich 3) of 319 soil samples collected from Marion County show that available P averages 36 mg/L in the top 6" soils, with a range from 2.5 mg/L to 51+ mg/L (written comm., David Mengel, KSU, 2007).

The population density of the watershed is 10.5 people per square mile. Many septic systems are scattered around the lake. Though Marion County has approximately 1,663 septic systems, the failing rate of these systems is 0.93% (National Environmental Service Center, 1998). The failing septic systems are seen as a minor source of nutrients to the lake.

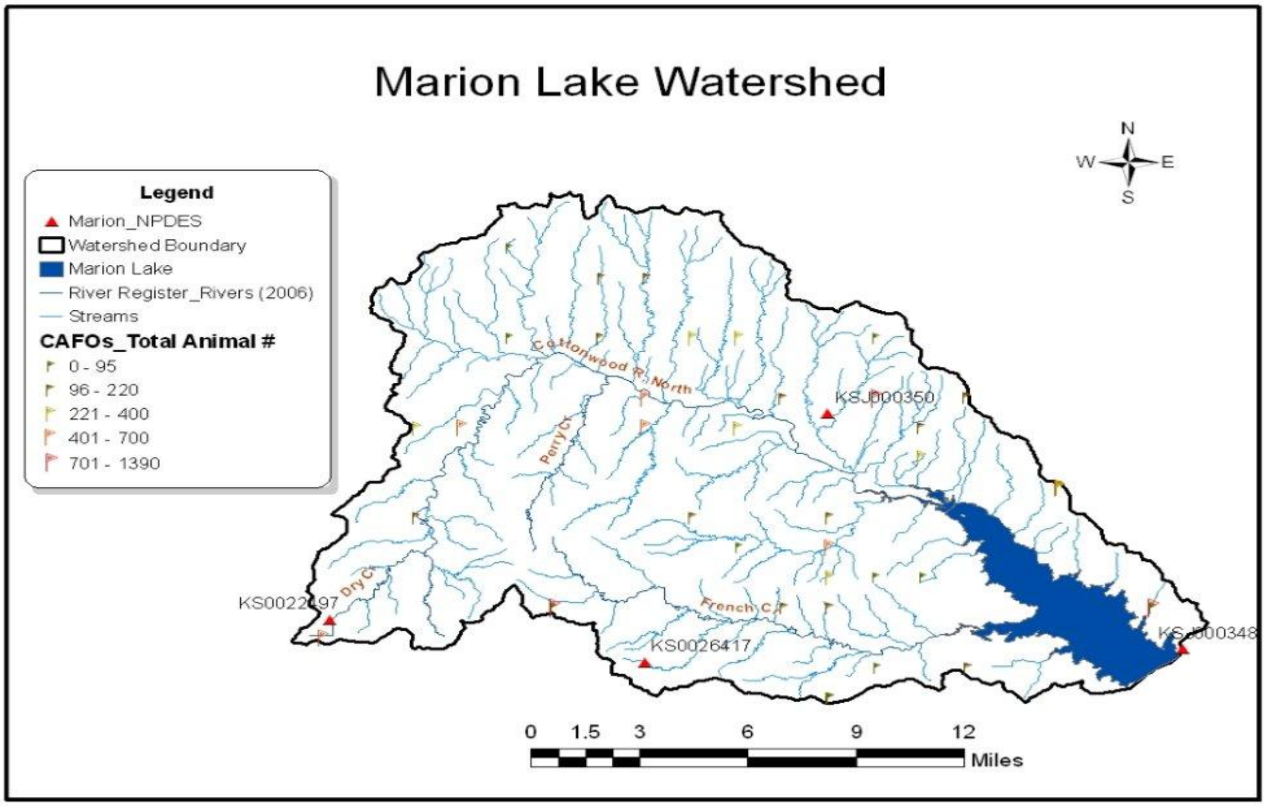


Figure 18. NPDES permitted and CAFO operations in Marion Lake watershed.

Table 5. Characteristics of NPDES facilities located in the Marion Lake watershed.

NPDES Permit	Facility Name	Type	Design Flow	Reach (Segement)
KS-0022497	Canton MWTP	Three-Cell Lagoon	0.12 MGD	Dry Creek (40)
KSJ-000350	Durham MWTP	Four-Cell Lagoon	Non-Overflowing	-
KS-0026417	Lehigh MWTP	Three-Cell Lagoon	0.02 MGD	French Creek (16)
KSJ-000348	Marion Co. S.D. #1	Two-Cell Lagoon	Non-Overflowing	-

4.6 Marion Lake Watershed Public Water Supply information

Most of the rural area in Marion County is served with groundwater wells or rural water districts whose water is supplied from outside the county. There are three municipalities that use water from Marion Lake. The city of Marion and Hillsboro treat water out of Marion Lake and Hillsboro furnishes water to the city of Peabody. The primary water supply problem experienced by these water suppliers is the taste and odor problems created by the blue-green algae (cyanobacteria) created by the extreme eutrophic conditions in Marion Lake. Other problems created by these algae is their ability to produce toxins. These biochemical poisons come in two main forms, hepatotoxins (that primarily target the liver) and neurotoxins (that target the nervous system). Well over 100 different algal toxins have been identified to date, but the group referred to as microcystins are the most frequently observed as well as some of the more toxic metabolic compounds known. A large percentage of the public will report "allergic" type reactions after exposure to blue-green algae, such as intestinal problems, respiratory problems, or skin irritations. A number of the microcystins have also been implicated as tumor promoting compounds, which makes chronic exposures (low exposure over time) a growing concern. The current water treatment facilities in these towns struggle to address these drinking water concerns. Table 6 shows the public water supply information for Marion Lake.

Table 6. Public water supply information for Marion Lake.

Public Water Supplier	Population Served (2010 Est.)
Marion	1,927
Hillsboro	2,993
Hillsboro to Peabody	1,210

5.0 An estimate of the load reductions expected from management measures.

Load reduction goals that must be achieved to meet water quality standards are determined by comparing TMDL requirements with the current loads to receiving streams and Marion Lake based on either watershed modeling results or water quality sampling records. These comparisons will be made at monitoring sites at Marion Lake and the North Fork of the Cottonwood River, Silver Creek and French Creek. Current loads must be reduced sufficiently to meet the standard when they exceed the TMDL requirements. Watershed contaminant contributions above each of these sampling locations must meet the load reduction at that respective site. Unit load reductions from best management practices will be accumulated until a sufficient number of practices are implemented in each targeted tributary to meet the total load reduction goals. The efforts and the program described in this plan will initially highlight the TMDL requirements and load reductions in the inflows to ensure that water quality improvements are achieved in Marion Lake early in the plan.

5.1 Load Reduction Requirements

Water quality standards define the TMDL requirements at the three inflow tributaries. The primary focus of this plan will be the Eutrophication TMDL for Marion Lake as an urban public water supply and major recreational destination. Standards for the Lake specify yearly load limits from the watershed into the Lake. Water quality data obtained from the Lake by KDHE over the past three decades reflect the current loads into the Lake. Watershed modeling results also provide insight into the loads expected under current land use conditions and for several simulated conditions including native prairie. Comparisons of loads under measured (sampling data) and model simulated conditions and the TMDL standard provide a load reduction estimate required to meet the standard and protect Marion Lake. Target contaminants were found to be nutrients, primarily phosphorus, and sediment in the Lake. Watershed modeling conducted by KDHE computed expected loads for nutrients into the lake for current land use conditions and subwatersheds (Figures 19, 20 and 21)

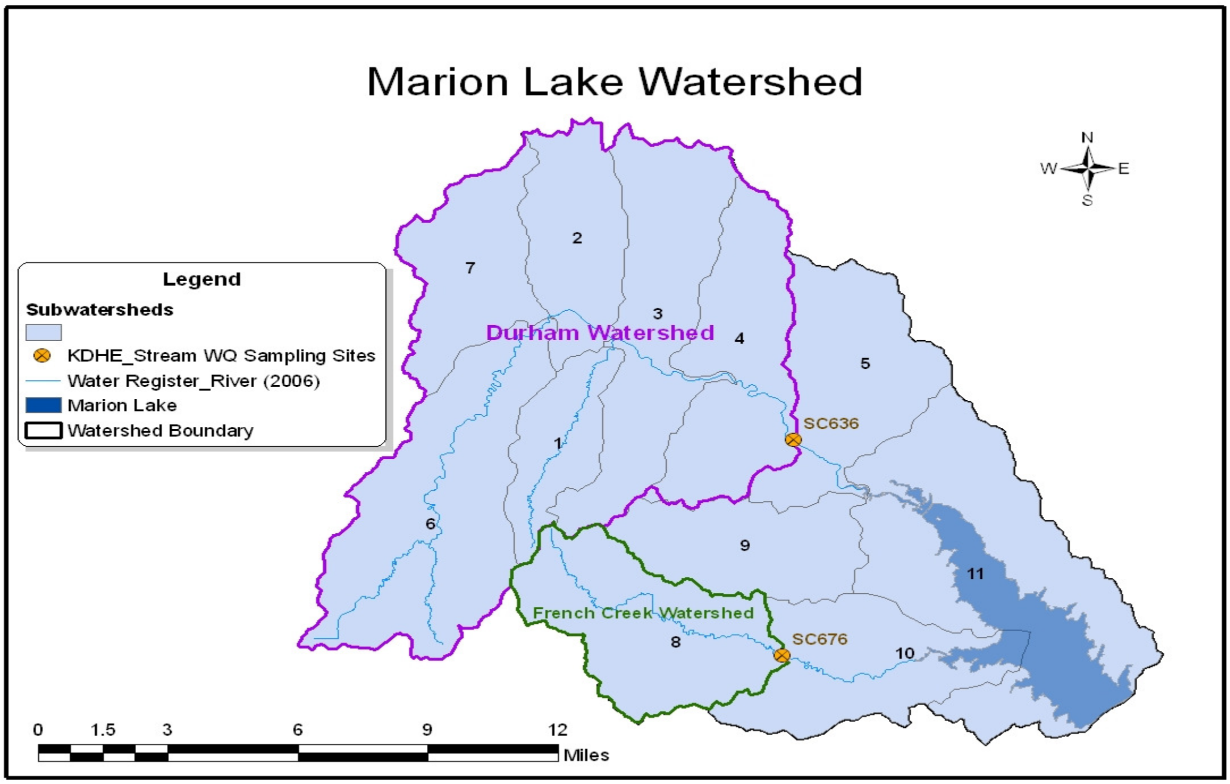


Figure 19. Subwatersheds used in KDHE modeling.

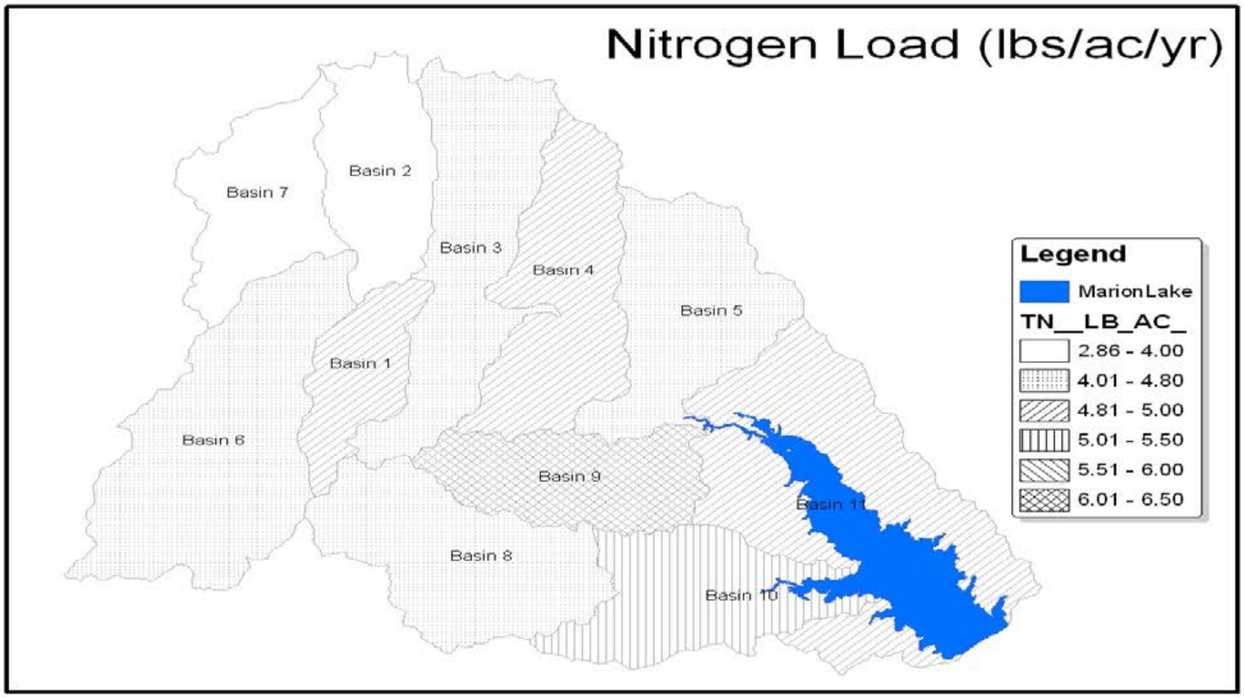


Figure 20. KDHE subwatershed modeling prioritizing nitrogen losses.

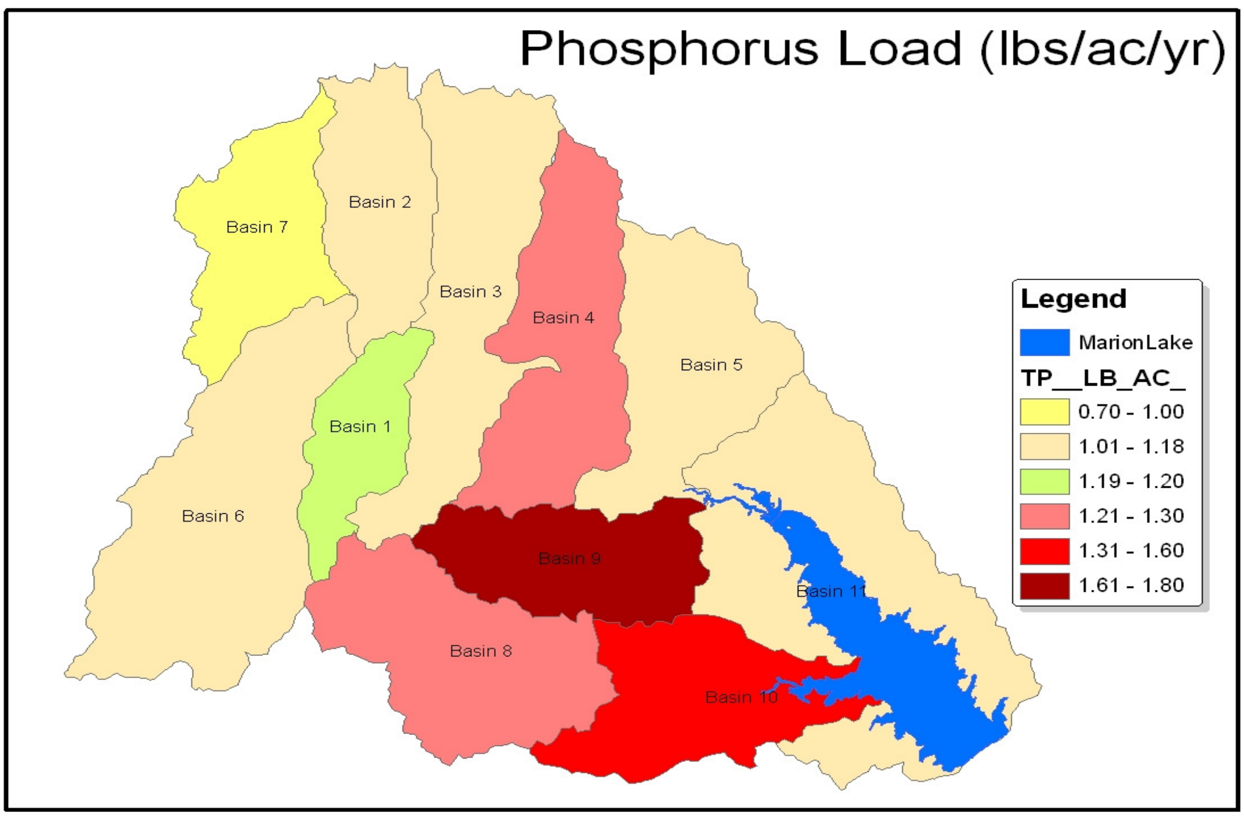


Figure 21. KDHE subwatershed modeling prioritizing phosphorus losses.

5.2 Nutrient Load Reductions from the 2008 Marion Lake Eutrophication TMDL

The revised Marion Lake Eutrophication TMDL completed in late 2008 indicated the need to reduce both nitrogen and phosphorus loads to effectively restore the trophic level of the lake to support its designated uses, particularly potable water supply, primary contact recreation and aquatic life.

There are two endpoints to be achieved in the lake relative to Chlorophyll a content; the first is an interim concentration of 12 ppb to support primary recreation; the final endpoint is a Chlorophyll a concentration of 10 ppb.

KDHE 2008 modeling loads to the lake are 579,172 lbs./yr. TN and 148,126 lbs./yr. TP. After accounting for the waste load allocation dedicated to Lehigh and Canton discharges to the watershed and a margin of safety that hedges load allocations to non-point sources to ensure reductions are sufficient to achieve the endpoints, load reductions of 422,804 lbs./yr. TN and 108,131 lbs./yr. TP are necessary to maintain chlorophyll a levels at or below 12 ppb. An additional reduction of 52,126 lbs./yr. TN and 13,338 lbs./yr. TP is required to have average Chlorophyll a concentrations reduced to 10 ppb.

Monitoring data shown in Figures 7, 8 and 9 show 4 years of data whose values are less than the modeled data. Consultation with the KDHE TMDL Section concluded the following:
The Marion WRAPS should focus on achieving the Marion Lake eutrophication TMDL through BMP implementation to reduce phosphorus loads to the lake. The following Phosphorus Load Reduction goals should be utilized for BMP implementation:

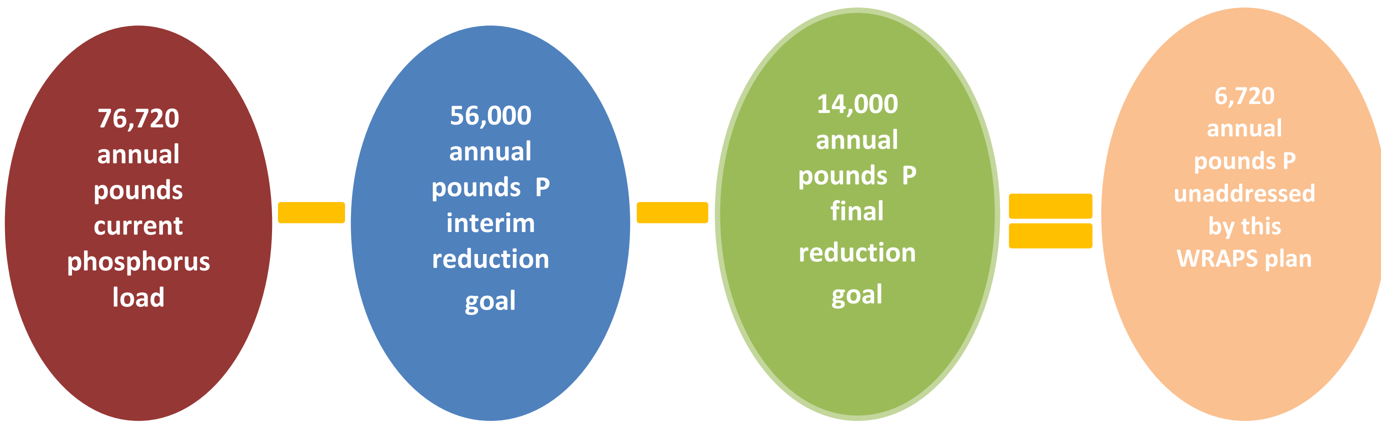
Interim Phosphorus Reduction Goal of 56,000 lbs/year from current conditions to achieve 12ppb in-lake chlorophyll a.

Final Phosphorus Reduction Goal of 70,000 lbs./year from current conditions to achieve 10ppb in-lake chlorophyll a. (See Figure 22 on next page)

5.3 Phosphorus in the Soil

Research of the chemistry of soil inorganic phosphorus has shown a complex system of reactions and compound formation dependent on factors such as soil pH; type and amount of soil minerals; amount of phosphorus in the soil; and other soil factors. Likewise, the chemistry of organic soil phosphorus is complex and probably less understood than inorganic soil phosphorus chemistry. Breakdown (mineralization) of soil organic matter and crop residue by soil microorganisms, however, is recognized as being a major contributor of plant-available phosphorus in many soils, particularly in soils with high levels of organic matter.

Figure 22. The total phosphorus load reduction needed to meet the Marion Lake TMDL.



In most soils, phosphorus moves little because of the low amount dissolved in the soil solution. Leaching losses of inorganic phosphorus are generally low. Soil erosion and crop removal are the major ways soils lose phosphorus.

Soluble phosphorus present in the soil solution at any time is usually low. For most soils, the amount of phosphorus dissolved in the soil solution is no more than a fraction of a pound per acre. This means little phosphorus in the soil solution is available for plant absorption in the form of phosphate ions needed for plant uptake. Crops need much more phosphorus than what is dissolved in the soil solution; however, in our soils, a rapid replenishment of the phosphorus in soil solution occurs as plants absorb phosphorus (equilibration). This maintenance of phosphorus in the soil solution by dissolving of phosphorus minerals is the key to the plant-available phosphorus status of the soil.

The amount of phosphorus available to crops depends on the quantity of phosphorus in the soil solution and on the continued release of phosphorus from minerals to maintain the soil solution level of phosphate phosphorus. In Kansas soils, the predominant form of mineral phosphorus is associated with calcium or magnesium complexes. This pool of phosphorus can be considered as a future supply of available phosphorus for plant uptake.

Soil-test phosphorus used in Kansas measures the phosphorus supplying capacity of soils, thus estimating the requirement of additional fertilization for optimum plant growth. Levels of soil test phosphorus also provide the likelihood of plant response to phosphorus application. Evaluation of phosphorus levels also can provide information about the potential risk associated with high testing soils and nonpoint source pollution of surface waters. Soil test methods used by laboratories do not measure the total quantity of plant-available phosphorus in the soil, but rather measure a fraction of those compounds that maintain plant-available phosphorus in the soil solution. In Kansas soils, those fractions likely include the phosphorus present in soil solution as well as part of the readily soluble and very slowly soluble fractions. The amount of phosphorus measured with a soil test is an index that is related to the fertilizer needs of crops. The soil test value is related to the probability of crop response to phosphorus fertilizer by conducting many phosphorus fertilizer rate experiments on many soils across the state.

Phosphorus fertilizer does not remain dissolved in the soil water for long since soils adsorb phosphorus. As a result, recovery (utilization) of phosphorus by plants is usually less than 30 percent in the first year after application and in some cases is 10 percent or less. In Kansas soils, however, the applied phosphorus that is not recovered in the year of application will be retained in the soil and be taken up by crops in succeeding years, and is expressed in the soil test phosphorus. The first step in putting a phosphorus fertilization program together is to soil test to determine the need for phosphorus. Once the need for phosphorus is established, application methods should be considered. Band placement can improve uptake on low and very low testing soils. Knowing that phosphorus is equally available from various products, selection of a phosphorus fertilizer should be based on its suitability for the application method and adaptation to the farmer’s operation and economics (Diaz et al., 2011).

5.4 Phosphorus Interpretations.

Kansas State University phosphorus recommendations provide two main options for producers, depending on circumstances for specific producers, fields and situations. 'Sufficiency' fertility programs are intended to estimate the long-term average amount of fertilizer phosphorus required to, on the average, provide optimum economic return in the year of nutrient application while achieving about 90 to 95 percent of maximum yield. In some years greater amounts of nutrient are required for optimum yield and economic return, while in other years less than recommended amounts of nutrient would suffice. There is little consideration of future soil test values and soil test values will likely stabilize in the 'low', crop responsive range.

'Build-maintenance' recommendations are intended to apply enough phosphorus to build soil test values to a target soil test value over a planned timeframe (typically 4 to 8 years) and then maintain soil test values in a target range in future years. If soil test values exceed the target range, no phosphorus is recommended with the exception of low starter applied rates if desired. Build-maintenance fertility programs are not intended to provide optimum economic returns in a given year, but rather attempt to minimize the probability of phosphorus limiting crop yields while providing for near maximum yield potential (Leikam et al., 2003).

Sources of contaminant that exceed the standards are primarily associated with excess runoff from rural landscape. Land uses that limit vegetative cover on agricultural lands deposit contaminants at or near streams and waterways are the most vulnerable to excess runoff because of the decreased ability to retain storm runoff and associated contaminants. Therefore nonpoint source management measures must be those that increase runoff retention, infiltration and contaminant filtering capabilities at or near where precipitation occurs. Nonpoint source management measures must address modification of land uses on cropland and livestock areas to control the deposition of nutrients and bacteria near streams and to retain excess storm runoff. Specific crop and livestock management practices that limit runoff and transport of nutrients and animal wastes from washing off will be installed in those areas determined to be the most effective locations for reducing contaminant loads in French and Silver Creeks, North Cottonwood River and Marion Lake. In general, the most effective locations will be those project sites at or near streams and waterways and those within subwatershed in close proximity to Clinton Lake.

This plan has selected the medium nutrient soil test levels for various crops grown in the watershed as shown in Table 6 (Leikam et al., 2003).

Table 7. Medium soil test levels for nutrients in the top six inch soil layer.

Crop	Phosphorus (lbs/A)	Nitrogen (lbs/A)
Wheat	45	75
Grain sorghum	40	130
Soybeans	40	0
Corn	50	160
Grass (warm season)	30	0

Part of the rapid assessment included examining the crops grown during 2011 and practices that were used across the two priority watersheds. Using the medium soil test levels for nutrients in the soil and losses were unformiy distributed across the fields planted to the different crops grow in the watersheds.

Table 8 shows the load of sediment, total phosphorus and total nitrogen from different crops and rangleland in the priority watersheds.

Table 8. Marion Lake loading of sediment, total phosphorus and total nitrogen.

Crop	2011 Crop % of WS	Sediment (tons/year)	Total Phosphorus (tons/year)	Total Nitrogen (tons/year)
Wheat	42	49206	24	90
Grain Sorhgum	10	11574	8	37
Soybeans	15	17574	8	0
Corn	4	4686	3	18
Grass (warm season)	29	33976	7	0
Total	100	117158	50	146

5.5 Critical Areas and Methodology for Implementation of Non-Point Source Management Measures

Water quality standards have been established at two locations within the Marion Lake Watershed. One is at Marion Lake and the other is on the streams flowing into the Lake. The most effective locations for reducing contaminant loads would be at sites where contaminant sources are dominant and in closer proximity to Marion Lake or the streams flowing into the Lake.

Contaminant transport simulations for nutrients and sediment flowing into Marion Lake compared loads from the three major streams directly into the Lake. Modeling results, from BATHTUB, GWLF, Rusle2 and information from Marion Lake TMDL, indicated the French and Lower North Cottonwood River/Silver Creek tributaries contributed more nutrients into the

Lake per unit area than other subwatersheds (Figures 20 and 21). The Marion SLT reviewed all models conducted for the Marion Lake watershed, Bathtub,GWLF, Rulse2 (Rapid Assessment), and other water quaity data, to determine the target areas of HUC 110702020104, the French Creek HUC 12, subwatershed and HUC 110702020103, the Lower North Cottonwood River/Silver Creek HUC subwatershed. The SLT discussed these results and decided it will be most effective to have the primary focus of implementation of non-point source management practices(listed in this plan), at dominant contaminant source sites, over the next 20 years, within these targets areas.

6.0 Best Management Practices Needed to Meet TMDL of Phosphorus Load Reduction

The pollutant of most concern in the Marion Lake Watershed is phosphorus. Monitoring data shown in Figures 7, 8 and 9 show 4 years of data whose values are less than the modeled data. Consultation with the KDHE TMDL Section concluded the following: The Marion WRAPS should focus on achieving the Marion Lake eutrophication TMDL; BMP implementation should focus on reducing phosphorus loads to the lake.

The following Phosphorus Load Reduction goals should be utilized for BMP implementation:
Interim Phosphorus Reduction Goal of 56,000 lbs./year from current conditions to achieve 12ppb in-lake chlorophyll a.

Final Phosphorus Reduction Goal of 70,000 lbs./year from current conditions to achieve 10ppb in-lake chlorophyll a. (Table12 Page 46)

6.1 Potential Cropland Best Management Practices

Practice 1. Vegetative Buffers (Grass or Forest): Area of field maintained in permanent vegetation to help reduce nutrient and sediment loss from agricultural fields, improve runoff water quality, and provide habitat for wildlife.

On average for Kansas fields – 1 acre buffer treats 15 acres of cropland

50% erosion reduction efficiency - 50% phosphorous reduction efficiency

Approximately $1,000 per acre cost - 90% cost-share available from federal or state

Practice 2. No-till cropping methods: Maintain vegetative cover and soil profile integrity without turning the soil. Minimal disturbance of the soil profile for planting and harvesting enhances infiltration and plant root development retaining excess storm runoff. Undisturbed land surface and prominent vegetative cover prevent soil erosion and wash off of phosphorus and sediment to the stream. No-till cropping provides 75% erosion reduction efficiency, 40% phosphorous reduction efficiency. WRAPS groups and KSU Ag Economists have decided $10 an acre is adequate payment to entice producers to convert to no-till. 50% cost-share is available from federal or state funds. Cover crops incorporated with no-till will assist in improving the erosion reduction efficiency and phosphorus reduction efficiency. Marion WRAPS will assist farmers by providing cost share for the purchase of seed to implement cover crops. Amount of cost share will be determined by percentage basis on cost of seed.

Practice 3. Terraces and Grassed Waterways (Diversions (Gradient or Parallel)) - implement contour terraces with tile outlets or grass waterways. Construct terraces to limit wash off of storm water and route excess runoff to pipe outlets then down gradient to the waterway. Terraces prevent overland erosion and formation of gullies, decreasing transport of phosphorus and sediment to the stream. To repair grass waterways several methods can be used; install a tile outlet in existing terraced cropland/ water retention structure and/or repair erosional gulley in waterway. Prevents formation of deep gullies in the waterways and minimizes the maintenance requirements of a waterway. Terracing can reduce phosphorus losses by 10 to 30%. Implementing or repairing grass waterways can reduce phosphorus 50 %. Costs can vary from $1.25 for gradient terraces per foot to $1.45 for parallel terraces per foot and does not include cost of pipe or tile. 50% cost share available from federal or state funds when eligible. WRAPS will pay cost share to cover gully and erosion control not covered by federal or state funds, cut not to exceed 70% cost-share.

Practice 4. Grade stabilization: Grade stabilization structures are used to control the grade and head cutting in earthen channels. In the Marion watersheds these structures will be used at the edge of the fields in locations where tillage is occurring across ephemeral streams. These structures prevent additional erosion from head cuts that start at the edge of the field, slow the water off the field preventing wash outs in ditches and county roads. NRCS estimated depending on soil type and other factors estimate 6 tons of sediment per acre is reduced from entering sub basin streams. Sediment reduction will reduce phosphorus load reduction. Cost to implement is determined by size of structure designed to site. Federal and state cost-share will be available when project is eligible. WRAPS will not exceed 70% cost-share.

Practice 5. Soil testing: Intensive soil testing will be provided to producers to assist in managing the amount, source, placement, form and timing of the application of nutrients and soil amendments. Cost-share will be provided through WRAPS for intensive soil testing not to exceed 90%.

Practice 6. Constructed: Construct wetland retention structure at outfall to terrace tile outlets or at the location of a concentrated out flow from a non-terraced field, to allow runoff from a 2 year, 24 hour storm event to dissipate, not as decreased runoff, but through infiltration and evapotranspiration. Wetlands reduce nutrient losses by 50 to 60 %. Cost-share funds are available through federal and state program at approximately $1,500 per acre of wetland.

6.2 Potential Livestock Best Management Practices

Practice 1. Alternative watering Source: Establish alternative watering systems within pastures and rangeland to remove cattle from streams or water bodies. May require new water source, such as well or pond, etc., other than stream. Water pumps and frost free lines will move water to the frost proof tanks or tire tanks from the source of water using public power or solar energy. Studies show cattle will drink from tank over a stream or pond 80% of the time. Average phosphorus load reduction range from 30 to 98% with greater efficiencies for limited stream access. Cost for installation of solar system, including present value of maintenance costs is $3795. Cost Share available from federal or state funds 50% when eligible.

Practice 2. Rangeland Management – Includes improving grazing management which will increase forage productivity and quality on land. Standard, continuous stocking results in selective and incomplete grazing. This can mean wasted forage and lower live-weight gains per acre of land. To help reduce waste and increase forage will require alternative water and feeding sites, and fencing. With controlled grazing practices it will help remove cattle from streams as an additional benefit. When proper livestock management is used it will reduce the amount of nutrients entering the streams through better distribution of manure within the area.

Practice 3. Vegetative Buffers or Filter Strips: Improved native vegetation buffer between feeding sites and stream will establish a sustainable and ecologically functional filter strip along the steam and assist in additional reduction of nutrient load reduction. Planting stream corridors with less palatable cover will discourage livestock from grazing near streams. Fencing is installed to improve grazing efficiency and limit stream access in some situations. There is an estimated 10 year lifespan for the buffer when periodic mowing or haying is utilized. Estimated phosphorus load reduction is 50%. Approximate cost of implementation is $1,000 per acre. Cost share available from federal or state funds is 90% when eligible.

If proper livestock management practices are used, reduction of nutrients from these sources can be reduced by 40 to 50 percent (Devlin et al., 2003).

7.0 Marion Lake Watershed BMPS Needs within the Priority Subwatersheds

The Neosho River Basin Total Maximum Daily Load (TMDL), Upper Cottonwood Sub basin (located in Marion and McPherson Counties) report states that Marion Reservoir is fully eutrophic. All designated uses are impaired to some degree by eutrophication. A detailed land use study compiled by the Natural Resources Conservation Service (NRCS) indicated 83% of the watershed is either in grass or cropland. The total land use ratio in the watershed is 52% cropland and the remaining 48% grazing land according to the study (Figure 10). Examination of the NRCS soil survey for this watershed has many soils with a very low permeability. This would indicate much of the watershed has soils with high clay contents and when tilled, soil erosion from these fields can lead to excessive transport of suspended sediments and the nutrients that can be tranported with the soil particles (Figure 11).

Load reduction goals that must be achieved to meet water quality standards are determined by comparing TMDL requirements with the current loads to receiving streams and Marion Lake based on either watershed modeling results or water quality sampling records as discussed in this plan earlier. To achieve the High Prioity TMDL Goal for Marion Lake several agricultural practices have been recommended: (1) Apply nutrient best management practices (BMPs) to reduce nutrient additions from excess fertilization; (2) Promote and adopt continuous no-till cultivation to minimize soil erosion and nutrient transports; (3) Install grass buffer strips along streams; (4) Reduce activities within riparian areas; (5) Setback both confined and non-confined animal feeding operation sites; (6) Evaluate a lake application of chelating agents to bond phosphorus to sediments; and (7) Construct ponds/detention basins, erosion control structures and/or wetlands to reduce soil erosion and to trap sediment and lower peak runoff rates. In addition, a watershed management team needs to work with research agencies and/or institutes to develop new technologies to effectively and efficiently remove P from the watershed.

Because land use within the watershed is predominately cropland (determined by TMDL the report) the watershed, around the reservoir, has a high potential for nonpoint source pollutants. An estimated 148,126 pounds of Total Phosphorus Load enters the reservoir within a year. The recommended percent of reduction, to improve trophic condition of the reservoir from its current fully eutrophic status is70,000 pounds per year from current conditions

During the visual inspection of the Marion Lake priority watersheds, to upgrade previous Rapid Assessment Modeling, several items became apparent.

Wheat represented 42% of the area in the priority subwatersheds. It appears many of these acres are in continuous wheat which, in most cases means that the farmer is using conventional tillage. Conventional tillage leaves limited residue on the land surface and leaves the land surface vulnerable to both water and wind erosion. This type of tillage also causes the loss of organic matter in the soil through oxidation. This organic matter is important in creating soil structure that can reduce erosion and hold the nutrients in soil. The low level of organic matter in these fields also requires addition of additional nutrients beyond what would be needed if the organic matter levels were higher. Additionally, coninuous wheat needs this tillage as a tool to reduce weeds, insects and diseases associated with a continous crop. This has been an ongoing problem in Central and South Central Kansas wheat farming. A number of farmers have started a program of crop rotation using other row crops with either a double crop of wheat after soybeans or wheat some where in the rotation. By using crop rotation many of these farmers have been able to also use no tillage with their farming.

Many of the upper reaches of the streams in the priority watersheds are ephemeral in nature (flow only on runoff events) and traverse the farmers fields. In many of these situations the farmer acually farm through the streams. The dilemma with this action is that when we have a runoff event it washes any loss soil that has been tilled into the stream, carrying the nutrients with the runoff. If additional runoff upslope from this stream is carring sediment and nutrients they are dropped into the stream.

Grasslands and pastures represent 30% of the priority subwatersheds and for the most part have been planted to warm season grasses that need limited fertilzation. Several of these grasslands contained ephemeral streams and showed stream bank erosion. The original stream bank assessment was done on higher order streams.

In working with best management practices the Stakeholder Leadership Team has several sources of funds they can access to help farmers and ranchers implement these practices. Funding sources include the Natural Resources Conservation Service (NRCS-Federal), Kansas Department of Agriculture, Division of Conservation (formerly SCC-State), KDHE WRAPS (EPA 319-State), and Marion County (local). These funds vary from year to year, with most of the effort focused on soil conservation. Fortunately, most of the phosphorus moves with the soil sediments which can be controlled by soil conservation practices.

Table 10, on the next page, lists the 2005 NRCS needs inventory for the Marion Lake watershed. An estimated percentage of acres within the target areas are shown in the Percent of Total column. The last column reflects the estimated priority areas acreage in BMP needs for cropland and grassland. Other BMP needs the percentage of area is reflected in the Estimated Priority Area Acres.

Table 10. Marion Lake Priority Watersheds BMP Needs.

MARION WRAPS	AcresTotal	Cropland	Grassland
Marion Lake Watershed	130560.00	56140.80	52224.00
Priority HUCs	55061.00	25417.00	21935.00
BMP Needs	**Watershed Acres (2005 NRCS Inventory)**	**Percent of Total**	**Estimated Priority Area Acres (WRAPS)**
Cropland Needing Treatment	56000.00	1.00	25353.25
Grassland Needing Treatment	27000.00	0.52	11340.48
Cropland BMPs	**Watershed Acres**	**% Cropland Needing Treatment**	**Estimated Priority Area Acres**
acres needing terraces (new & rebuilds)	17000.00	0.30	7696.52
acres needing waterways (new & restoration)	44100.00	0.79	19965.69
acres needing no-till	27000.00	0.48	12223.89
acres needing conservation tillage	46350.00	0.83	20984.35
Grassland BMPs	**Watershed Acres**	**% Grassland Needing Treatment**	**Estimated Priority Area Acres**
Rangeland/Pasture Mgmt	27000.00	0.52	11406.20
No. confined livestock facilities (unpermitted)	14 facilities	NA	TBD
No. concentrated non-confined livestock operations	90 operations	NA	TBD
Other BMP needs	**Watershed Acres**	**Estimated Priority Area Acres**	
buffer (treated acres)	20000.00	9048.00	
cover crop acres	NA	12000.00	
constructed wetlands (treated acres)	400.00	77.00	
acres needing grade stablization (treated acres)	5000.00	2368.00	
alternative water sources	38.00	8.00	

7.1 BMPS Implementation Schedule

The number of acres or practices intalled each year to meet the TMDL reductions are listed in Table 11 on the next page. Many of the farmers in the watershed are near retirement and are not willing to change practices or buy new equipment. For this reason the implementation starts slow and accelerates near the end of the implementation. This plan will be assessed every five years by confirming that the farmers and ranchers have continued their practices and evaluation on monitoring data to make sure that the practices are meeting the planned phosphorus reductions.

Table 11. BMP Implementation Schedule for the Marion Lake Priority Watersheds.

MARION WRAPS BMP IMPLEMENTATION SCHEDULE (Priority HUCs 110702020103 & 110702020104)

Phosphorus Load Reduction Goal (Interim)=56,000 lbs./yr.

Phosphorus Load Reduction Goal (Final)=70,000 lbs./yr.

Goal	Year									
		Cropland BMPs							Livestock BMPs	
		Acres Treated								Number
Acres Treated		No-Till & Conservation Tillage	Cover Crop	New Terraces	Grass Waterways	Buffers	Grade Stabilization	Constructed Wetlands	Rangeland Mgmt.	Alt. Water Sources (no.)
	1	500	200	100	100	217	640	3	500	1
	2	500	200	100	100	217	0	3	500	1
	3	500	200	100	100	217	0	3	500	1
	4	500	200	100	100	217	0	3	500	1
	5	500	200	100	100	217	0	3	500	1
Short-Term Total		2500	1000	500	500	1085	640	15	2500	5
	6	1000	400	200	200	217	0	6	1000	2
	7	1000	400	200	200	434	0	6	1000	2
	8	1000	200	200	200	434	640	6	1000	2
	9	1000	400	200	200	434	0	6	1000	2
	10	1000	400	200	200	434	640	6	1000	2
	11	1000	200	200	200	434	0	0	1000	1
	12	1000	200	200	200	434	0	0	1000	1
	13	1000	200	200	200	434	640	0	1000	1
	14	1000	200	200	200	434	0	0	1000	1
	15	1000	200	400	400	434	0	0	0	1
Mid-Term Total		12500	3800	2700	2700	5208	2560	45	11500	20
	16	4000	400	400	400	858	640	5	1000	2
	17	4000	400	400	400	858	0	0	1000	2
	18	4000	400	400	400	858	640	5	1000	2
	19	4000	400	400	400	858	0	5	1000	2
	20	4000	400	400	400	858	640	5	1000	2
	21	4000	400	400	400	858	0	0	1000	2
	22	4000	200	400	400	858	0	5	1000	1
	23	4000	200	400	400	858	640	0	1000	1
	24	4000	200	400	400	858	0	5	1000	1
	25	4000	200	400	400	434	0	0	1000	1
Long-Term Total		40500	7000	6700	6700	13454	5120	75	21500	56

Indicates a portion of these BMPs will need to be implemented outside of priority HUCs (additional assessments will be conducted to help direct BMPs to areas of greatest need).

7.2 BMP Load Reduction Table

The phosphorus load reduction for each BMP over the the implementation period is shown on the next page. The total phosphorus load reduction is highlighted at the bottom of the Table 12. 25 years of BMP implementation will meet the final TMDL load reduction goal.

Table 12. BMP Phosphorus Load Reductions for the Marion Lake Priority Watersheds.

Year	Cropland BMPs							Livestock BMPs		
	Acres Treated								Number	
	No-Till & Conservation Tillage	Cover Crop	New Terraces	Grass Waterways	Buffers	Grade Stabilization	Const. Wetlands	Rangeland Mgmt	Alt. Water Sources (no.)	Total P Load Reduction
1	290	104	41.2	137	166.4	305	8	191	273	
2	290	104	41.2	137	166.4	0	8	191	273	
3	290	104	41.2	137	166.4	0	8	191	273	
4	290	104	41.2	137	166.4	0	8	191	273	
5	290	104	41.2	137	166.4	0	8	191	273	
Short-Term Totals										
	1450	520	206	685	832	305	40	955	1365	6358
6	580	208	82.4	274	332.8	0	16	382	546	
7	580	208	82.4	274	332.8	0	16	382	546	
8	580	104	82.4	274	332.8	305	16	382	546	
9	580	208	82.4	274	332.8	0	16	382	546	
10	580	208	82.4	274	332.8	305	16	382	546	
11	580	104	82.4	274	332.8	0	0	382	273	
12	580	104	82.4	274	332.8	0	0	382	273	
13	580	104	82.4	274	332.8	305	0	382	273	
14	580	104	82.4	274	332.8	0	0	382	273	
15	580	104	164.8	548	665.6	0	0	0	273	
Mid-Term Totals										
	7250	1976	1112	3699	4492.8	1220	120	4393	5460	29723
16	1624	208	164.8	548	665.6	305	13.3	382	546	
17	1624	208	164.8	548	665.6	0	0	382	546	
18	1624	208	164.8	548	665.6	305	13.3	382	546	
19	1624	208	164.8	548	665.6	0	13.3	382	546	
20	1624	208	164.8	548	665.6	305	13.3	382	546	
21	1624	208	164.8	548	665.6	0	0	382	546	
22	1624	104	164.8	548	665.6	0	13.3	382	273	
23	1624	104	164.8	548	665.6	305	0	382	273	
24	1624	104	164.8	548	665.6	0	13.3	382	273	
25	1624	104	164.8	548	665.6	0	0	382	273	
Long-Term Totals										
	23490	3640	2760	9179	11149	2440	200	8213	9828	70899
										P load reduction goal met

7.3 Best Management Practices Needed to Meet TMDL

After the first significant concentrations of blue-green algae were identified in June of 2003, by KDHE, A task force was formed of local government entities, federal agencies, state agencies, local citizens and the WRAPS SLT. The task force was faced with many questions: 1.) how do we treat the phenomena; 2.) will it continue to appear; 3.) can the lake continue to be used as a public water source; 4.) will it affect the seasonal recreational activities associated with the lake, the economic potential of the county and main street businesses; 5.) where do we start and what will be the outcome if there are not any answers. Heavy concentrations of blue-green algae continued to appear from 2003 through the summer of 2007.

The task force learned there was not an immediate "fix" to eradicate the blue-green algae. It took several years of sediment and nutrient loading, and the perfect atmospheric conditions to cause the bloom and the lake to become fully eutrophic. It would take years to reduce the nutrient load entering the reservoir. It was determined the best way to curb the outbreaks was to continue with the Nonpoint Source Water Quality plan from a previous two day watershed study, conducted by USGS in 1998 and the basis of the 319 Nonpoint Water Quality Project (later to be known as WRAPS). Not any baseline data had been established with the original plan. A multi-year watershed study was adopted to establish baseline data.

The watershed study included modeling that determined "hot spots of highly erodible land" and land use. Streambank and channel surveys were conducted to establish if most of the sediment and nutrient loading was coming from land use or was a significant portion coming from eroding streambanks. With this information the SLT decided to continue with BMP implementation to improve water quality such as; buffers, waterways, terraces, grade stabilization structures, converting marginal cropland to grass, small constructed wetlands to filter sediment and nutrients before they enter a stream, alternative water source to remove cattle from stream, and rangeland management. These BMPs were recommended as continued activities to reduce phosphorus entering the lake from the watershed tributaries, in their 2008 TMDL report. Streambank erosion was considered a minor contributor to the nutrient load entering the reservoir. The study indicated established riparian areas, along the meandering streams should not be disturbed to correct minor erosion from the streambanks. Only three sites were recommended for streambank and riparian stabilization projects.

This plan has laid out specific BMPs that will give watershed residents a range of alternative practices to meet the TMDL. At the beginning of this process, BMPs were discussed at the SLT meetings. These BMPs are listed in the table below. The acres, number of projects and costs needed annually for the targeted areas are shown in the tables beginning with Table 13, on page 49 through

Table 13 and following table generated by: Josh Roe, 785-532-3035, roe@sku.edu 9/15/2011

25 Year Cropland Scenario			
Marion Lake WRAPS, Targeted Area BMP Scenario			
	Priority Area		
Sub-Basin	**110702020103**	**110702020104**	**Total**
% of BMPs	50%	50%	100%
Proposed BMP Implementation (treated acres)			
Vegetative Buffers	6,727	6,727	**13,454**
Grassed Waterways	3,350	3,350	**6,700**
No-Till	20,250	20,250	**40,500**
Terraces	3,350	3,350	**6,700**
Cover Crops	3,500	3,500	**7,000**
Grade Stabilization	2,560	2,560	**5,120**
Wetlands	375	375	**750**
Estimated Cost			
Total Investment Cost	$3,782,689	$3,782,689	**$7,565,378**
Available Cost-Share	$1,983,927	$1,983,927	**$3,967,854**
Net Cost	$1,798,762	$1,798,762	**$3,597,525**
Estimated Annual Runoff Reduction			
Soil Erosion (tons)	47,541	47,541	**95,082**
Phosphorus (pounds)	32,996	32,996	**65,992**
Nitrogen (pounds/acre)	76,853	76,853	**153,706**
ESTIMATED Average Annual Runoff			
Soil Erosion (tons/acre)	2.10	2.10	
Phosphorus (pounds/acre)	2.16	2.16	
Nitrogen (pounds/acre)	7.28	7.28	

Table 13. Estimated Acreage Treated for Cropland

Annual Adoption (treated acres), Cropland BMPs								
Year	Vegetative Buffers	Grassed Waterways	No-Till	Terraces	Cover Crops	Grade Stabilization	Wetlands	Total Adoption
1	217	100	500	100	200	640	30	1,787
2	217	100	500	100	200	0	30	1,147
3	217	100	500	100	200	0	30	1,147
4	217	100	500	100	200	0	30	1,147
5	217	100	500	100	200	0	30	1,147
6	217	200	1,000	200	200	0	60	1,877
7	434	200	1,000	200	200	0	60	2,094
8	434	200	1,000	200	200	640	60	2,734
9	434	200	1,000	200	200	0	60	2,094
10	434	200	1,000	200	200	640	60	2,734
11	434	200	1,000	200	200	0	0	2,034
12	434	200	1,000	200	200	0	0	2,034
13	434	200	1,000	200	200	640	0	2,674
14	434	200	1,000	200	200	0	0	2,034
15	434	400	1,000	400	200	0	0	2,434
16	868	400	4,000	400	400	640	50	6,758
17	868	400	4,000	400	400	0	0	6,068
18	868	400	4,000	400	400	640	50	6,758
19	868	400	4,000	400	400	0	50	6,118
20	868	400	2,000	400	400	640	50	4,758
21	868	400	2,000	400	400	0	0	4,068
22	868	400	2,000	400	400	0	50	4,118
23	868	400	2,000	400	400	640	0	4,708
24	868	400	2,000	400	400	0	50	4,118
25	434	400	2,000	400	400	0	0	3,634

Table 14. Annual Adoption Cropland BMPs (treated acres)

Annual Phosphorus Runoff Reduction (lbs.), Cropland BMPs								
Year	Vegetative Buffers	Grassed Waterways	No-Till	Terraces	Cover Crops	Grade Stabilization	Wetlands	Total
1	234	86	432	65	0	691	32	1,541
2	469	173	864	130	0	691	65	2,391
3	703	259	1,296	194	0	691	97	3,241
4	937	346	1,728	259	0	691	130	4,091
5	1,172	432	2,160	324	0	691	162	4,941
6	1,406	605	3,024	454	0	691	227	6,407
7	1,875	778	3,888	583	0	691	292	8,106
8	2,344	950	4,752	713	0	1,382	356	10,498
9	2,812	1,123	5,616	842	0	1,382	421	12,198
10	3,281	1,296	6,480	972	0	2,074	486	14,589
11	3,750	1,469	7,344	1,102	0	2,074	486	16,224
12	4,218	1,642	8,208	1,231	0	2,074	486	17,859
13	4,687	1,814	9,072	1,361	0	2,765	486	20,185
14	5,156	1,987	9,936	1,490	0	2,765	486	21,820
15	5,625	2,333	10,800	1,750	0	2,765	486	23,758
16	6,562	2,678	14,256	2,009	0	3,456	540	29,501
17	7,500	3,024	17,712	2,268	0	3,456	540	34,500
18	8,437	3,370	21,168	2,527	0	4,147	594	40,243
19	9,374	3,715	24,624	2,786	0	4,147	648	45,295
20	10,312	4,061	26,352	3,046	0	4,838	702	49,311
21	11,249	4,406	28,080	3,305	0	4,838	702	52,581
22	12,187	4,752	29,808	3,564	0	4,838	756	55,905
23	13,124	5,098	31,536	3,823	0	5,530	756	59,867
24	14,062	5,443	33,264	4,082	0	5,530	810	63,191
25	14,530	5,789	34,992	4,342	0	5,530	810	65,992

Table 15. Annual Phosphorus Runoff Reduction (lbs.), Cropland

Annual Nitrogen Runoff Reduction (lbs.), Cropland BMPs								
Year	Vegetative Buffers	Grassed Waterways	No-Till	Terraces	Cover Crops	Grade Stabilization	Wetlands	Total
1	395	291	910	218	0	2,330	109	4,253
2	790	582	1,820	437	0	2,330	218	6,177
3	1,185	874	2,730	655	0	2,330	328	8,101
4	1,580	1,165	3,640	874	0	2,330	437	10,025
5	1,975	1,456	4,550	1,092	0	2,330	546	11,948
6	2,370	2,038	6,370	1,529	0	2,330	764	15,401
7	3,160	2,621	8,190	1,966	0	2,330	983	19,248
8	3,949	3,203	10,010	2,402	0	4,659	1,201	25,425
9	4,739	3,786	11,830	2,839	0	4,659	1,420	29,273
10	5,529	4,368	13,650	3,276	0	6,989	1,638	35,450
11	6,319	4,950	15,470	3,713	0	6,989	1,638	39,079
12	7,109	5,533	17,290	4,150	0	6,989	1,638	42,708
13	7,899	6,115	19,110	4,586	0	9,318	1,638	48,667
14	8,689	6,698	20,930	5,023	0	9,318	1,638	52,296
15	9,479	7,862	22,750	5,897	0	9,318	1,638	56,944
16	11,058	9,027	30,030	6,770	0	11,648	1,820	70,354
17	12,638	10,192	37,310	7,644	0	11,648	1,820	81,252
18	14,218	11,357	44,590	8,518	0	13,978	2,002	94,662
19	15,798	12,522	51,870	9,391	0	13,978	2,184	105,742
20	17,377	13,686	55,510	10,265	0	16,307	2,366	115,512
21	18,957	14,851	59,150	11,138	0	16,307	2,366	122,770
22	20,537	16,016	62,790	12,012	0	16,307	2,548	130,210
23	22,117	17,181	66,430	12,886	0	18,637	2,548	139,798
24	23,696	18,346	70,070	13,759	0	18,637	2,730	147,238
25	24,486	19,510	73,710	14,633	0	18,637	2,730	153,706

Table 16. Annual Nitrogen Runoff Reduction (lbs.), Cropland BMPs

Total Annual Cost Before Cost-Share, Cropland BMPs								
Year	Vegetative Buffers	Grassed Waterways	No-Till	Terraces	Cover Crops	Grade Stabilization	Wetlands	Total Cost
1	$14,467	$16,000	$38,845	$10,000	$9,000	$80,000	$33,000	$201,312
2	$14,901	$16,480	$40,010	$10,300	$9,270	$0	$33,990	$124,951
3	$15,348	$16,974	$41,211	$10,609	$9,548	$0	$35,010	$128,700
4	$15,808	$17,484	$42,447	$10,927	$9,835	$0	$36,060	$132,561
5	$16,282	$18,008	$43,720	$11,255	$10,130	$0	$37,142	$136,537
6	$16,771	$37,097	$90,064	$23,185	$10,433	$0	$76,512	$254,063
7	$34,548	$38,210	$92,766	$23,881	$10,746	$0	$78,807	$278,958
8	$35,584	$39,356	$95,549	$24,597	$11,069	$98,390	$81,172	$385,717
9	$36,652	$40,537	$98,415	$25,335	$11,401	$0	$83,607	$295,947
10	$37,751	$41,753	$101,368	$26,095	$11,743	$104,382	$86,115	$409,207
11	$38,884	$43,005	$104,409	$26,878	$12,095	$0	$0	$225,272
12	$40,050	$44,295	$107,541	$27,685	$12,458	$0	$0	$232,030
13	$41,252	$45,624	$110,767	$28,515	$12,832	$114,061	$0	$353,052
14	$42,490	$46,993	$114,090	$29,371	$13,217	$0	$0	$246,161
15	$43,764	$96,806	$117,513	$60,504	$13,613	$0	$0	$332,200
16	$90,154	$99,710	$484,154	$62,319	$28,043	$124,637	$85,688	$974,706
17	$92,859	$102,701	$498,679	$64,188	$28,885	$0	$0	$787,312
18	$95,645	$105,782	$513,639	$66,114	$29,751	$132,228	$90,907	$1,034,066
19	$98,514	$108,956	$529,048	$68,097	$30,644	$0	$93,634	$928,893
20	$101,470	$112,224	$272,460	$70,140	$31,563	$140,280	$96,443	$824,580
21	$104,514	$115,591	$280,634	$72,244	$32,510	$0	$0	$605,493
22	$107,649	$119,059	$289,053	$74,412	$33,485	$0	$102,316	$725,974
23	$110,879	$122,631	$297,724	$76,644	$34,490	$153,288	$0	$795,656
24	$114,205	$126,310	$306,656	$78,943	$35,525	$0	$108,547	$770,186
25	$58,816	$130,099	$315,856	$81,312	$36,590	$0	$0	$622,672

**3% Inflation*

Table 17. Total Annual Cost Before Cost Share, Cropland BMPs

Total Annual Cost After Cost-Share, Cropland BMPs								
Year	Vegetative Buffers	Grassed Waterways	No-Till	Terraces	Cover Crops	Grade Stabilization	Wetlands	Total Cost
1	$1,447	$8,000	$23,695	$5,000	$9,000	$40,000	$3,300	$90,442
2	$1,490	$8,240	$24,406	$5,150	$9,270	$0	$3,399	$51,955
3	$1,535	$8,487	$25,139	$5,305	$9,548	$0	$3,501	$53,514
4	$1,581	$8,742	$25,893	$5,464	$9,835	$0	$3,606	$55,119
5	$1,628	$9,004	$26,669	$5,628	$10,130	$0	$3,714	$56,773
6	$1,677	$18,548	$54,939	$11,593	$10,433	$0	$7,651	$104,842
7	$3,455	$19,105	$56,587	$11,941	$10,746	$0	$7,881	$109,715
8	$3,558	$19,678	$58,285	$12,299	$11,069	$49,195	$8,117	$162,201
9	$3,665	$20,268	$60,033	$12,668	$11,401	$0	$8,361	$116,396
10	$3,775	$20,876	$61,834	$13,048	$11,743	$52,191	$8,612	$172,079
11	$3,888	$21,503	$63,689	$13,439	$12,095	$0	$0	$114,615
12	$4,005	$22,148	$65,600	$13,842	$12,458	$0	$0	$118,053
13	$4,125	$22,812	$67,568	$14,258	$12,832	$57,030	$0	$178,625
14	$4,249	$23,497	$69,595	$14,685	$13,217	$0	$0	$125,243
15	$4,376	$48,403	$71,683	$30,252	$13,613	$0	$0	$168,327
16	$9,015	$49,855	$295,334	$31,159	$28,043	$62,319	$8,569	$484,295
17	$9,286	$51,351	$304,194	$32,094	$28,885	$0	$0	$425,809
18	$9,564	$52,891	$313,320	$33,057	$29,751	$66,114	$9,091	$513,788
19	$9,851	$54,478	$322,719	$34,049	$30,644	$0	$9,363	$461,104
20	$10,147	$56,112	$166,200	$35,070	$31,563	$70,140	$9,644	$378,877
21	$10,451	$57,796	$171,186	$36,122	$32,510	$0	$0	$308,066
22	$10,765	$59,529	$176,322	$37,206	$33,485	$0	$10,232	$327,539
23	$11,088	$61,315	$181,612	$38,322	$34,490	$76,644	$0	$403,471
24	$11,420	$63,155	$187,060	$39,472	$35,525	$0	$10,855	$347,486
25	$5,882	$65,049	$192,672	$40,656	$36,590	$0	$0	$340,849

**3% Inflation*

Table 18. Total Annual Cost After Cost Share, Cropland BMPs

Phosphorus				
Year	Cropland Reduction (lbs.)	Livestock Reduction (lbs.)	Total Reduction (lbs.)	% of Goal
1	1,541	184	1,725	2%
2	2,391	367	2,758	4%
3	3,241	551	3,792	5%
4	4,091	734	4,825	7%
5	4,941	918	5,859	8%
6	6,407	1,285	7,691	11%
7	8,106	1,652	9,758	14%
8	10,498	2,019	12,516	18%
9	12,198	2,386	14,583	21%
10	14,589	2,753	17,341	25%
11	16,224	3,044	19,267	28%
12	17,859	3,335	21,193	30%
13	20,185	3,626	23,811	34%
14	21,820	3,917	25,737	37%
15	23,758	3,993	27,750	40%
16	29,501	4,360	33,861	48%
17	34,500	4,727	39,226	56%
18	40,243	5,094	45,336	65%
19	45,295	5,461	50,756	73%
20	49,311	5,828	55,138	79%
21	52,581	6,195	58,775	84%
22	55,905	6,486	62,391	89%
23	59,867	6,777	66,643	95%
24	63,191	7,068	70,258	100%
25	65,992	7,359	73,351	105%
Phosphorous Goal:		**70,000**	**Pounds**	

Table 19. Phosphorus Reduction Goal 70,000 Pounds

Phosphorus		
Best Management Practice Category	**Total Load Reduction (lbs.)**	**% of Phosphorous Goal**
Livestock	7,359	11%
Cropland	65,992	94%
Total	**65,992**	**105%**

Table 20. Total Phosphorus Load Reduction

Nitrogen			
Year	**Cropland Reduction (lbs.)**	**Livestock Reduction (lbs.)**	**Total Reduction (lbs.)**
1	4,253	143	4,396
2	6,177	286	6,463
3	8,101	429	8,530
4	10,025	573	10,597
5	11,948	716	12,664
6	15,401	1,002	16,403
7	19,248	1,288	20,537
8	25,425	1,575	27,000
9	29,273	1,861	31,134
10	35,450	2,147	37,597
11	39,079	2,290	41,369
12	42,708	2,433	45,142
13	48,667	2,577	51,243
14	52,296	2,720	55,016
15	56,944	2,863	59,807
16	70,354	3,149	73,503
17	81,252	3,436	84,688
18	94,662	3,722	98,384
19	105,742	4,008	109,750
20	115,512	4,294	119,806
21	122,770	4,581	127,351
22	130,210	4,724	134,934
23	139,798	4,867	144,665
24	147,238	5,010	152,248
25	153,706	5,153	158,860

Table 21. Total Nitrogen Load Reduction Goal

Total Annual WRAPS Cost after Cost-Share by BMP Category			
Year	Cropland	Livestock	Total Annual Cost
1	$90,442	$4,898	$95,340
2	$51,955	$5,044	$57,000
3	$53,514	$5,196	$58,710
4	$55,119	$5,352	$60,471
5	$56,773	$5,512	$62,285
6	$104,842	$11,355	$116,197
7	$109,715	$11,696	$121,410
8	$162,201	$12,047	$174,248
9	$116,396	$12,408	$128,804
10	$172,079	$12,780	$184,859
11	$114,615	$10,614	$125,228
12	$118,053	$10,932	$128,985
13	$178,625	$11,260	$189,885
14	$125,243	$11,598	$136,841
15	$168,327	$2,870	$171,198
16	$484,295	$15,260	$499,555
17	$425,809	$15,718	$441,527
18	$513,788	$16,190	$529,978
19	$461,104	$16,675	$477,780
20	$378,877	$17,176	$396,053
21	$308,066	$17,691	$325,756
22	$327,539	$14,692	$342,231
23	$403,471	$15,132	$418,603
24	$347,486	$15,586	$363,073
25	$340,849	$16,054	$356,903

Table 22. Annual WRAPS Cost-Share by BMP Category

Alternative Livestock Watering System Adoption, Load Reduction, and Cost							
Year	Adoption	P Reduction	Cumulative P Reduction	N Reduction	Cumulative N Reduction	Cost Before Cost-Share	Cost After Cost-Share
1	1	76	76	143	143	$3,795	$1,898
2	1	76	152	143	286	$3,909	$1,954
3	1	76	228	143	429	$4,026	$2,013
4	1	76	304	143	573	$4,147	$2,073
5	1	76	380	143	716	$4,271	$2,136
6	2	152	532	286	1,002	$8,799	$4,399
7	2	152	684	286	1,288	$9,063	$4,531
8	2	152	836	286	1,575	$9,335	$4,667
9	2	152	988	286	1,861	$9,615	$4,807
10	2	152	1,140	286	2,147	$9,903	$4,952
11	1	76	1,216	143	2,290	$5,100	$2,550
12	1	76	1,292	143	2,433	$5,253	$2,627
13	1	76	1,368	143	2,577	$5,411	$2,705
14	1	76	1,444	143	2,720	$5,573	$2,787
15	1	76	1,520	143	2,863	$5,740	$2,870
16	2	152	1,672	286	3,149	$11,825	$5,912
17	2	152	1,824	286	3,436	$12,180	$6,090
18	2	152	1,976	286	3,722	$12,545	$6,273
19	2	152	2,128	286	4,008	$12,921	$6,461
20	2	152	2,280	286	4,294	$13,309	$6,655
21	2	152	2,432	286	4,581	$13,708	$6,854
22	1	76	2,508	143	4,724	$7,060	$3,530
23	1	76	2,584	143	4,867	$7,272	$3,636
24	1	76	2,660	143	5,010	$7,490	$3,745
25	1	76	2,736	143	5,153	$7,714	$3,857
Total	**36**	**2,736**		**5,153**			

Table 23. BMP Alternative Watering System Adoption

Rangeland Management Plan Adoption, Load Reduction, and Cost					
Year	Adoption (acres)	P Reduction	Cumulative P Reduction	Cost Before Cost-Share	Cost After Cost-Share
1	500	108	108	$6,000	$3,000
2	500	108	215	$6,180	$3,090
3	500	108	323	$6,365	$3,183
4	500	108	430	$6,556	$3,278
5	500	108	538	$6,753	$3,377
6	1,000	215	753	$13,911	$6,956
7	1,000	215	968	$14,329	$7,164
8	1,000	215	1,183	$14,758	$7,379
9	1,000	215	1,398	$15,201	$7,601
10	1,000	215	1,613	$15,657	$7,829
11	1,000	215	1,828	$16,127	$8,063
12	1,000	215	2,043	$16,611	$8,305
13	1,000	215	2,258	$17,109	$8,555
14	1,000	215	2,473	$17,622	$8,811
15	0	0	2,473	$0	$0
16	1,000	215	2,688	$18,696	$9,348
17	1,000	215	2,903	$19,256	$9,628
18	1,000	215	3,118	$19,834	$9,917
19	1,000	215	3,333	$20,429	$10,215
20	1,000	215	3,548	$21,042	$10,521
21	1,000	215	3,763	$21,673	$10,837
22	1,000	215	3,978	$22,324	$11,162
23	1,000	215	4,193	$22,993	$11,497
24	1,000	215	4,408	$23,683	$11,842
25	1,000	215	4,623	$24,394	$12,197
Total	**21,500**	**4,623**			

Table 24. Rangeland Management Plan BMP Adoption

Table 25. HUC 110702020103 Annual Adoption Cropland BMPs

Sub Watershed #110702020103 Annual Adoption (treated acres), Cropland BMPs								
Year	Vegetative Buffers	Grassed Waterways	No-Till	Terraces	Cover Crops	Grade Stabilization	Wetlands	Total Adoption
1	109	50	250	50	100	320	15	894
2	109	50	250	50	100	0	15	574
3	109	50	250	50	100	0	15	574
4	109	50	250	50	100	0	15	574
5	109	50	250	50	100	0	15	574
6	109	100	500	100	100	0	30	939
7	217	100	500	100	100	0	30	1,047
8	217	100	500	100	100	320	30	1,367
9	217	100	500	100	100	0	30	1,047
10	217	100	500	100	100	320	30	1,367
11	217	100	500	100	100	0	0	1,017
12	217	100	500	100	100	0	0	1,017
13	217	100	500	100	100	320	0	1,337
14	217	100	500	100	100	0	0	1,017
15	217	200	500	200	100	0	0	1,217
16	434	200	2,000	200	200	320	25	3,379
17	434	200	2,000	200	200	0	0	3,034
18	434	200	2,000	200	200	320	25	3,379
19	434	200	2,000	200	200	0	25	3,059
20	434	200	1,000	200	200	320	25	2,379
21	434	200	1,000	200	200	0	0	2,034
22	434	200	1,000	200	200	0	25	2,059
23	434	200	1,000	200	200	320	0	2,354
24	434	200	1,000	200	200	0	25	2,059
25	217	200	1,000	200	200	0	0	1,817

Sub Watershed #110702020104 Annual Adoption (treated acres), Cropland BMPs								
Year	Vegetative Buffers	Grassed Waterways	No-Till	Terraces	Cover Crops	Grade Stabilization	Wetlands	Total Adoption
1	109	50	250	50	100	320	15	894
2	109	50	250	50	100	0	15	574
3	109	50	250	50	100	0	15	574
4	109	50	250	50	100	0	15	574
5	109	50	250	50	100	0	15	574
6	109	100	500	100	100	0	30	939
7	217	100	500	100	100	0	30	1,047
8	217	100	500	100	100	320	30	1,367
9	217	100	500	100	100	0	30	1,047
10	217	100	500	100	100	320	30	1,367
11	217	100	500	100	100	0	0	1,017
12	217	100	500	100	100	0	0	1,017
13	217	100	500	100	100	320	0	1,337
14	217	100	500	100	100	0	0	1,017
15	217	200	500	200	100	0	0	1,217
16	434	200	2,000	200	200	320	25	3,379
17	434	200	2,000	200	200	0	0	3,034
18	434	200	2,000	200	200	320	25	3,379
19	434	200	2,000	200	200	0	25	3,059
20	434	200	1,000	200	200	320	25	2,379
21	434	200	1,000	200	200	0	0	2,034
22	434	200	1,000	200	200	0	25	2,059
23	434	200	1,000	200	200	320	0	2,354
24	434	200	1,000	200	200	0	25	2,059
25	217	200	1,000	200	200	0	0	1,817

Table. 26 HUC 1107020201014 Annual Adoption Cropland BMPs

Table 27. HUC 110702020103 Annual Phosphorus Runoff Reduction

Sub Watershed #110702020103 Annual Phosphorus Runoff Reduction								
Year	Vegetative Buffers	Grassed Waterways	No-Till	Terraces	Cover Crops	Grade Stabilization	Wetlands	Total
1	117	43	216	32	0	346	16	771
2	234	86	432	65	0	346	32	1,196
3	352	130	648	97	0	346	49	1,621
4	469	173	864	130	0	346	65	2,046
5	586	216	1,080	162	0	346	81	2,471
6	703	302	1,512	227	0	346	113	3,203
7	937	389	1,944	292	0	346	146	4,053
8	1,172	475	2,376	356	0	691	178	5,249
9	1,406	562	2,808	421	0	691	211	6,099
10	1,641	648	3,240	486	0	1,037	243	7,294
11	1,875	734	3,672	551	0	1,037	243	8,112
12	2,109	821	4,104	616	0	1,037	243	8,929
13	2,344	907	4,536	680	0	1,382	243	10,093
14	2,578	994	4,968	745	0	1,382	243	10,910
15	2,812	1,166	5,400	875	0	1,382	243	11,879
16	3,281	1,339	7,128	1,004	0	1,728	270	14,751
17	3,750	1,512	8,856	1,134	0	1,728	270	17,250
18	4,218	1,685	10,584	1,264	0	2,074	297	20,121
19	4,687	1,858	12,312	1,393	0	2,074	324	22,648
20	5,156	2,030	13,176	1,523	0	2,419	351	24,655
21	5,625	2,203	14,040	1,652	0	2,419	351	26,290
22	6,093	2,376	14,904	1,782	0	2,419	378	27,953
23	6,562	2,549	15,768	1,912	0	2,765	378	29,933
24	7,031	2,722	16,632	2,041	0	2,765	405	31,595
25	7,265	2,894	17,496	2,171	0	2,765	405	32,996

Sub Watershed #110702020104 Annual Phosphorus Runoff Reduction								
Year	Vegetative Buffers	Grassed Waterways	No-Till	Terraces	Cover Crops	Grade Stabilization	Wetlands	Total
1	117	43	216	32	0	346	16	771
2	234	86	432	65	0	346	32	1,196
3	352	130	648	97	0	346	49	1,621
4	469	173	864	130	0	346	65	2,046
5	586	216	1,080	162	0	346	81	2,471
6	703	302	1,512	227	0	346	113	3,203
7	937	389	1,944	292	0	346	146	4,053
8	1,172	475	2,376	356	0	691	178	5,249
9	1,406	562	2,808	421	0	691	211	6,099
10	1,641	648	3,240	486	0	1,037	243	7,294
11	1,875	734	3,672	551	0	1,037	243	8,112
12	2,109	821	4,104	616	0	1,037	243	8,929
13	2,344	907	4,536	680	0	1,382	243	10,093
14	2,578	994	4,968	745	0	1,382	243	10,910
15	2,812	1,166	5,400	875	0	1,382	243	11,879
16	3,281	1,339	7,128	1,004	0	1,728	270	14,751
17	3,750	1,512	8,856	1,134	0	1,728	270	17,250
18	4,218	1,685	10,584	1,264	0	2,074	297	20,121
19	4,687	1,858	12,312	1,393	0	2,074	324	22,648
20	5,156	2,030	13,176	1,523	0	2,419	351	24,655
21	5,625	2,203	14,040	1,652	0	2,419	351	26,290
22	6,093	2,376	14,904	1,782	0	2,419	378	27,953
23	6,562	2,549	15,768	1,912	0	2,765	378	29,933
24	7,031	2,722	16,632	2,041	0	2,765	405	31,595
25	7,265	2,894	17,496	2,171	0	2,765	405	32,996

Table 28. HUC 110702020104 Annual Phosphorus Runoff Reduction

Table 29. HUC 110702020103 Annual Nitrogen Runoff Reduction

Sub Watershed #110702020103 Annual Nitrogen Runoff Reduction								
Year	Vegetative Buffers	Grassed Waterways	No-Till	Terraces	Cover Crops	Grade Stabilization	Wetlands	Total
1	197	146	455	109	0	1,165	55	2,127
2	395	291	910	218	0	1,165	109	3,089
3	592	437	1,365	328	0	1,165	164	4,050
4	790	582	1,820	437	0	1,165	218	5,012
5	987	728	2,275	546	0	1,165	273	5,974
6	1,185	1,019	3,185	764	0	1,165	382	7,700
7	1,580	1,310	4,095	983	0	1,165	491	9,624
8	1,975	1,602	5,005	1,201	0	2,330	601	12,713
9	2,370	1,893	5,915	1,420	0	2,330	710	14,636
10	2,765	2,184	6,825	1,638	0	3,494	819	17,725
11	3,160	2,475	7,735	1,856	0	3,494	819	19,540
12	3,554	2,766	8,645	2,075	0	3,494	819	21,354
13	3,949	3,058	9,555	2,293	0	4,659	819	24,333
14	4,344	3,349	10,465	2,512	0	4,659	819	26,148
15	4,739	3,931	11,375	2,948	0	4,659	819	28,472
16	5,529	4,514	15,015	3,385	0	5,824	910	35,177
17	6,319	5,096	18,655	3,822	0	5,824	910	40,626
18	7,109	5,678	22,295	4,259	0	6,989	1,001	47,331
19	7,899	6,261	25,935	4,696	0	6,989	1,092	52,871
20	8,689	6,843	27,755	5,132	0	8,154	1,183	57,756
21	9,479	7,426	29,575	5,569	0	8,154	1,183	61,385
22	10,268	8,008	31,395	6,006	0	8,154	1,274	65,105
23	11,058	8,590	33,215	6,443	0	9,318	1,274	69,899
24	11,848	9,173	35,035	6,880	0	9,318	1,365	73,619
25	12,243	9,755	36,855	7,316	0	9,318	1,365	76,853

Sub Watershed #110702020104 Annual Nitrogen Runoff Reduction								
Year	Vegetative Buffers	Grassed Waterways	No-Till	Terraces	Cover Crops	Grade Stabilization	Wetlands	Total
1	197	146	455	109	0	1,165	55	2,127
2	395	291	910	218	0	1,165	109	3,089
3	592	437	1,365	328	0	1,165	164	4,050
4	790	582	1,820	437	0	1,165	218	5,012
5	987	728	2,275	546	0	1,165	273	5,974
6	1,185	1,019	3,185	764	0	1,165	382	7,700
7	1,580	1,310	4,095	983	0	1,165	491	9,624
8	1,975	1,602	5,005	1,201	0	2,330	601	12,713
9	2,370	1,893	5,915	1,420	0	2,330	710	14,636
10	2,765	2,184	6,825	1,638	0	3,494	819	17,725
11	3,160	2,475	7,735	1,856	0	3,494	819	19,540
12	3,554	2,766	8,645	2,075	0	3,494	819	21,354
13	3,949	3,058	9,555	2,293	0	4,659	819	24,333
14	4,344	3,349	10,465	2,512	0	4,659	819	26,148
15	4,739	3,931	11,375	2,948	0	4,659	819	28,472
16	5,529	4,514	15,015	3,385	0	5,824	910	35,177
17	6,319	5,096	18,655	3,822	0	5,824	910	40,626
18	7,109	5,678	22,295	4,259	0	6,989	1,001	47,331
19	7,899	6,261	25,935	4,696	0	6,989	1,092	52,871
20	8,689	6,843	27,755	5,132	0	8,154	1,183	57,756
21	9,479	7,426	29,575	5,569	0	8,154	1,183	61,385
22	10,268	8,008	31,395	6,006	0	8,154	1,274	65,105
23	11,058	8,590	33,215	6,443	0	9,318	1,274	69,899
24	11,848	9,173	35,035	6,880	0	9,318	1,365	73,619
25	12,243	9,755	36,855	7,316	0	9,318	1,365	76,853

Table 30. HUC 110702020104 Annual Nitrogen Runoff Reduction

Table 31. HUC 110702020103 Total Annual Cost Before Cost-Share, Cropland BMPs

Sub Watershed #110702020103 Total Annual Cost Before Cost-Share, Cropland BMPs								
Year	Vegetative Buffers	Grassed Waterways	No-Till	Terraces	Cover Crops	Grade Stabilization	Wetlands	Total Cost
1	$7,233	$8,000	$19,423	$5,000	$4,500	$40,000	$16,500	$100,656
2	$7,450	$8,240	$20,005	$5,150	$4,635	$0	$16,995	$62,476
3	$7,674	$8,487	$20,605	$5,305	$4,774	$0	$17,505	$64,350
4	$7,904	$8,742	$21,223	$5,464	$4,917	$0	$18,030	$66,280
5	$8,141	$9,004	$21,860	$5,628	$5,065	$0	$18,571	$68,269
6	$8,385	$18,548	$45,032	$11,593	$5,217	$0	$38,256	$127,031
7	$17,274	$19,105	$46,383	$11,941	$5,373	$0	$39,404	$139,479
8	$17,792	$19,678	$47,774	$12,299	$5,534	$49,195	$40,586	$192,859
9	$18,326	$20,268	$49,208	$12,668	$5,700	$0	$41,803	$147,974
10	$18,876	$20,876	$50,684	$13,048	$5,871	$52,191	$43,058	$204,604
11	$19,442	$21,503	$52,204	$13,439	$6,048	$0	$0	$112,636
12	$20,025	$22,148	$53,771	$13,842	$6,229	$0	$0	$116,015
13	$20,626	$22,812	$55,384	$14,258	$6,416	$57,030	$0	$176,526
14	$21,245	$23,497	$57,045	$14,685	$6,608	$0	$0	$123,080
15	$21,882	$48,403	$58,757	$30,252	$6,807	$0	$0	$166,100
16	$45,077	$49,855	$242,077	$31,159	$14,022	$62,319	$42,844	$487,353
17	$46,430	$51,351	$249,339	$32,094	$14,442	$0	$0	$393,656
18	$47,822	$52,891	$256,819	$33,057	$14,876	$66,114	$45,453	$517,033
19	$49,257	$54,478	$264,524	$34,049	$15,322	$0	$46,817	$464,446
20	$50,735	$56,112	$136,230	$35,070	$15,782	$70,140	$48,221	$412,290
21	$52,257	$57,796	$140,317	$36,122	$16,255	$0	$0	$302,746
22	$53,825	$59,529	$144,526	$37,206	$16,743	$0	$51,158	$362,987
23	$55,439	$61,315	$148,862	$38,322	$17,245	$76,644	$0	$397,828
24	$57,102	$63,155	$153,328	$39,472	$17,762	$0	$54,274	$385,093
25	$29,408	$65,049	$157,928	$40,656	$18,295	$0	$0	$311,336

**3% Inflation*

Sub Watershed #110702020104 Total Annual Cost Before Cost-Share, Cropland BMPs								
Year	Vegetative Buffers	Grassed Waterways	No-Till	Terraces	Cover Crops	Grade Stabilization	Wetlands	Total Cost
1	$7,233	$8,000	$19,423	$5,000	$4,500	$40,000	$16,500	$100,656
2	$7,450	$8,240	$20,005	$5,150	$4,635	$0	$16,995	$62,476
3	$7,674	$8,487	$20,605	$5,305	$4,774	$0	$17,505	$64,350
4	$7,904	$8,742	$21,223	$5,464	$4,917	$0	$18,030	$66,280
5	$8,141	$9,004	$21,860	$5,628	$5,065	$0	$18,571	$68,269
6	$8,385	$18,548	$45,032	$11,593	$5,217	$0	$38,256	$127,031
7	$17,274	$19,105	$46,383	$11,941	$5,373	$0	$39,404	$139,479
8	$17,792	$19,678	$47,774	$12,299	$5,534	$49,195	$40,586	$192,859
9	$18,326	$20,268	$49,208	$12,668	$5,700	$0	$41,803	$147,974
10	$18,876	$20,876	$50,684	$13,048	$5,871	$52,191	$43,058	$204,604
11	$19,442	$21,503	$52,204	$13,439	$6,048	$0	$0	$112,636
12	$20,025	$22,148	$53,771	$13,842	$6,229	$0	$0	$116,015
13	$20,626	$22,812	$55,384	$14,258	$6,416	$57,030	$0	$176,526
14	$21,245	$23,497	$57,045	$14,685	$6,608	$0	$0	$123,080
15	$21,882	$48,403	$58,757	$30,252	$6,807	$0	$0	$166,100
16	$45,077	$49,855	$242,077	$31,159	$14,022	$62,319	$42,844	$487,353
17	$46,430	$51,351	$249,339	$32,094	$14,442	$0	$0	$393,656
18	$47,822	$52,891	$256,819	$33,057	$14,876	$66,114	$45,453	$517,033
19	$49,257	$54,478	$264,524	$34,049	$15,322	$0	$46,817	$464,446
20	$50,735	$56,112	$136,230	$35,070	$15,782	$70,140	$48,221	$412,290
21	$52,257	$57,796	$140,317	$36,122	$16,255	$0	$0	$302,746
22	$53,825	$59,529	$144,526	$37,206	$16,743	$0	$51,158	$362,987
23	$55,439	$61,315	$148,862	$38,322	$17,245	$76,644	$0	$397,828
24	$57,102	$63,155	$153,328	$39,472	$17,762	$0	$54,274	$385,093
25	$29,408	$65,049	$157,928	$40,656	$18,295	$0	$0	$311,336

**3% Inflation*

Table 32. HUC 110702020104 Total Annual Cost Before Cost Share, Cropland BMPs

Table 33. HUC 11072020103 Total Annual Cost After Cost-Share, Cropland BMPs

Sub Watershed #110702020103 Total Annual Cost After Cost-Share, Cropland BMPs								
Year	Vegetative Buffers	Grassed Waterways	No-Till	Terraces	Cover Crops	Grade Stabilization	Wetlands	Total Cost
1	$723	$4,000	$11,848	$2,500	$4,500	$20,000	$1,650	$45,221
2	$745	$4,120	$12,203	$2,575	$4,635	$0	$1,700	$25,978
3	$767	$4,244	$12,569	$2,652	$4,774	$0	$1,750	$26,757
4	$790	$4,371	$12,946	$2,732	$4,917	$0	$1,803	$27,560
5	$814	$4,502	$13,335	$2,814	$5,065	$0	$1,857	$28,387
6	$839	$9,274	$27,470	$5,796	$5,217	$0	$3,826	$52,421
7	$1,727	$9,552	$28,294	$5,970	$5,373	$0	$3,940	$54,857
8	$1,779	$9,839	$29,142	$6,149	$5,534	$24,597	$4,059	$81,100
9	$1,833	$10,134	$30,017	$6,334	$5,700	$0	$4,180	$58,198
10	$1,888	$10,438	$30,917	$6,524	$5,871	$26,095	$4,306	$86,040
11	$1,944	$10,751	$31,845	$6,720	$6,048	$0	$0	$57,307
12	$2,003	$11,074	$32,800	$6,921	$6,229	$0	$0	$59,027
13	$2,063	$11,406	$33,784	$7,129	$6,416	$28,515	$0	$89,313
14	$2,124	$11,748	$34,798	$7,343	$6,608	$0	$0	$62,621
15	$2,188	$24,201	$35,841	$15,126	$6,807	$0	$0	$84,164
16	$4,508	$24,927	$147,667	$15,580	$14,022	$31,159	$4,284	$242,147
17	$4,643	$25,675	$152,097	$16,047	$14,442	$0	$0	$212,905
18	$4,782	$26,446	$156,660	$16,528	$14,876	$33,057	$4,545	$256,894
19	$4,926	$27,239	$161,360	$17,024	$15,322	$0	$4,682	$230,552
20	$5,073	$28,056	$83,100	$17,535	$15,782	$35,070	$4,822	$189,439
21	$5,226	$28,898	$85,593	$18,061	$16,255	$0	$0	$154,033
22	$5,382	$29,765	$88,161	$18,603	$16,743	$0	$5,116	$163,770
23	$5,544	$30,658	$90,806	$19,161	$17,245	$38,322	$0	$201,735
24	$5,710	$31,577	$93,530	$19,736	$17,762	$0	$5,427	$173,743
25	$2,941	$32,525	$96,336	$20,328	$18,295	$0	$0	$170,425

3% Inflation

Sub Watershed #110702020104 Total Annual Cost After Cost-Share, Cropland BMPs								
Year	Vegetative Buffers	Grassed Waterways	No-Till	Terraces	Cover Crops	Grade Stabilization	Wetlands	Total Cost
1	$723	$4,000	$11,848	$2,500	$4,500	$20,000	$1,650	$45,221
2	$745	$4,120	$12,203	$2,575	$4,635	$0	$1,700	$25,978
3	$767	$4,244	$12,569	$2,652	$4,774	$0	$1,750	$26,757
4	$790	$4,371	$12,946	$2,732	$4,917	$0	$1,803	$27,560
5	$814	$4,502	$13,335	$2,814	$5,065	$0	$1,857	$28,387
6	$839	$9,274	$27,470	$5,796	$5,217	$0	$3,826	$52,421
7	$1,727	$9,552	$28,294	$5,970	$5,373	$0	$3,940	$54,857
8	$1,779	$9,839	$29,142	$6,149	$5,534	$24,597	$4,059	$81,100
9	$1,833	$10,134	$30,017	$6,334	$5,700	$0	$4,180	$58,198
10	$1,888	$10,438	$30,917	$6,524	$5,871	$26,095	$4,306	$86,040
11	$1,944	$10,751	$31,845	$6,720	$6,048	$0	$0	$57,307
12	$2,003	$11,074	$32,800	$6,921	$6,229	$0	$0	$59,027
13	$2,063	$11,406	$33,784	$7,129	$6,416	$28,515	$0	$89,313
14	$2,124	$11,748	$34,798	$7,343	$6,608	$0	$0	$62,621
15	$2,188	$24,201	$35,841	$15,126	$6,807	$0	$0	$84,164
16	$4,508	$24,927	$147,667	$15,580	$14,022	$31,159	$4,284	$242,147
17	$4,643	$25,675	$152,097	$16,047	$14,442	$0	$0	$212,905
18	$4,782	$26,446	$156,660	$16,528	$14,876	$33,057	$4,545	$256,894
19	$4,926	$27,239	$161,360	$17,024	$15,322	$0	$4,682	$230,552
20	$5,073	$28,056	$83,100	$17,535	$15,782	$35,070	$4,822	$189,439
21	$5,226	$28,898	$85,593	$18,061	$16,255	$0	$0	$154,033
22	$5,382	$29,765	$88,161	$18,603	$16,743	$0	$5,116	$163,770
23	$5,544	$30,658	$90,806	$19,161	$17,245	$38,322	$0	$201,735
24	$5,710	$31,577	$93,530	$19,736	$17,762	$0	$5,427	$173,743
25	$2,941	$32,525	$96,336	$20,328	$18,295	$0	$0	$170,425

**3% Inflation*

Table 34. HUC 110702020104 Total Annual Cost After Cost Share, Cropland BMPs

7.4 Possible Funding Sources

The SLT has reviewed all the recommended BMPs listed in Section 6 of this plan, for each impairment. It has been determined by the SLT that specific BMPs will be the target of implementation funding for each category (cropland, and livestock). Most of the BMPs that are targeted will be advantageous, too more than one impairment, thus being more efficient.

Table 35. BMP Funding Needs

BMP	Technical Service Provider	Per Year	Units	Cost/Unit	Cost/Year
Buffers	FSA, DOC, NRCS, Conservation				
Native Grass	District, KDWPT,	12	acres	$ 1,000.00	$ 12,000.00
Riparian	Kansas Forest Service, NRCS, DOC,	2	acres	$ 1,000.00	$ 2,000.00
	KSU, KRC				
Structural Practices					
Terraces	NRCS, Conservation District				
Gradient		20,000	lf	$ 1.25	$ 25,000.00
Parallel		5000	lf	$ 2.00	$ 10,000.00
Diversions		100	cu.yd	$ 225.00	$ 22,500.00
Waterways		11	acres	$ 1,500.00	$ 16,500.00
Grade Stabilization Structure		2	each	$ 9,000.00	$ 18,000.00
Constructed Wetland		1	each	$ 1,500.00	$ 7,500.00
Conversion to No-till	DOC, NRCS, No-till on the	500	acres	$ 10.00	$ 5,000.00
Seed	Plains,	200	lbs	$ 60.00	$ 1,200.00
Intensive Soil Testing	KSU, NRCS	250	acres	$ 25.00	$ 6,250.00
Alternative watering source	NRCS, DOC, Conservation	3	each	$ 6,000.00	$ 18,000.00
	Districts, KRC				
Rangeland Management		500	acres		
Fencing	NRCS, DOC, Conservation	5000	lf	$	$

				3,650.00	3,650.00
Feeding Sites	District, KRc, KSU	10	each	$ 300.00	$ 3,000.00
Watering systems					
pond		2	each	$ 6,000.00	$ 12,000.00
tank		2	each	$ 3,795.00	$ 7,590.00
wells		1	each	$ 5,000.00	$ 5,000.00
	Total Estimated BMP Needs				$ 175,190.00
Estimated cost-share from other sources	DOC, NRCS,Conservation District, KRC,KDHE, KFS, Landowner in-kind funding				$ 87,595.00
	Balance needed from WRAPS				$ 87,595.00

Table 35 cont't BMP Funding Needs)

8.0 INFORMATION AND EDUCATION

The objective set by the Marion Lake SLT for Information and Education is to "Increase overall awareness and interest in the quality of surface water in the watershed and impact the farming and ranching operations have on water quality. To obtain this objective the coordinator will perform the following activities:

1. One-on- One personal contact has been shown to be the most effective means to encourage voluntary implementation of BMPs. The WRAPS Coordinator will make at least 5 personal contacts each month with landowner/producers, especially in target areas of plan
    - A. Inform land user of project expectations.
    - B. Inform land user of available resources such as technical assistance, financial assistance, etc. directly or by referral.
    - C. Encourage farmer to farmer communication between neighbors to increase knowledge of program and incentives.
    - D. Set up small group meetings in coffee shops, machine sheds Co-Op elevator offices, etc. as extension of farmer to farmer approach.

2. Provide 3 educational workshops and/or tours on water quality BMPs, annually, through technical advisors stakeholders and partners. Promote workshops and tours through;

A. Personal visits
B. Phone calls
C. Letters of invitation
D. News articles
E. Flyers
F. Brochures
G. Conduct local farm tours and/or field days, to see completed projects and hear about water quality benefits from cooperating farmers.

3. Provide quarterly fact sheet or on an as needed basis more often to Stakeholder Task Force, county, cities and general public about activities within the watershed and data collected from monitoring sites.

4. Attend and provide monthly detailed report to Marion County Conservation District (Project Management Team) on project expenditures and activities. Seek approval on special demonstration projects not meeting NRCS specification or alternate plans.

5. Write news articles, brochures and develop presentations for general public information.

6. Set quarterly meeting of the Stakeholder Leadership Team.

7. Attend meetings of organizations, agencies, etc. to increase knowledge of water quality issues and activities.

8. Seek opportunities to work with youth within Marion County, to promote water quality. Currently Marion County Fourth Grade EnviroFest is held annually in early fall.

10. Set up displays in strategic places throughout the watershed for viewing by producers and general public.

11. Work with Flint Hills WRAPS coordinators to produce quarterly newsletter “The Waterlog” that cover eight watersheds sponsored by the RC&D.

Information dissemination and education of the watershed landowners and residents will play a vital role in the success of the Marion Lake WRAPS project. Many of these education efforts will be undertaken with the other WRAPS and WRAPS coordinators that are sponsored by the Flint Hills RC&D. Some will be undertaken with the Cottonwood River WRAPS because Marion Lake is part of the Cottonwood Basin. The tables on the next pages from 73 to 78 outline the informative efforts that will be undertaken either individually or collectively showing the timing, responsible parties, technical service providers that will need to be involved and the overall funding requirements for these efforts. They are also tied to specific BMPs that the SLT has deemed necessary to meet the load reduction requirements set forth by KDHE and some will be tied to the regional area of the Flint Hills RC&D.

8.1 Information and Education Activities and Events as Requested by the SLT

Marion Lake SLT selected many Information and Education Activities and Events, listed in the Table 36, to assist farmers and ranchers in learning more about the benefits of the selected BMPs, in the target areas of the watershed. Some of the activities and/or events will be coordinator with the Upper Cottonwood River WRAPS project. Marion and Upper Cottonwood WRAPS cover 98 percent of Marion County. Some of the events listed in Table 35 may pertain to those selected by the Upper Cottonwood WRAPS SLT members.

Marion WRAPS is sponsored by the Flint Hills Resource Conservation and Development Area Inc. That organization also sponsors 7 other WRAPS projects within close proximity of the Lake Watershed and Marion County. Several of the events will be held, on a regional basis, to allow opportunities for state and national speakers to address the regional agricultural community. Cost could be prohibitive for one WRAPS project to afford this quality speaker. Marion Lake SLT agreed to pay a share of the cost for such regional events or activities. It will also give the Marion farmers and ranchers to learn about particular BMPs, and their benefits, not selected to be part of this plan, but could be adopted in amendments or revision of the plan.

Table 36. Information and Education Activities and Events as Requested by the SLT

BMP	Target Audience	Information/Education Activity/Event	Time Frame	Estimated Costs	Responsible Agency
Cropland BMP Implementation					
Buffers Grass Waterway New Terraces	Land owners and Farmers	Demonstration Project	Annual	$5,000 per project	Kansas Rural Center Buffer Coordinator NRCS
		Tour/Field Day to Highlight Buffers	Annual	$500 per event	Flint Hills RC&D Buffer Coordinator Marion County Conservation District NRCS
		Newspaper Articles	Annual - Ongoing	No Charge	Marion County Conservation Districts NRCS
		Newsletter Article	Quarterly	$500	Flint Hills RC&D Marion County Conservation Districts Kansas Research and Extension NRCS
		One on One Meetings with Producers	Annual - Ongoing	Cost included in Technical Assistance for Coordinator	Flint Hills RC&D Marion County Conservation Districts, Kansas Research and Extension and Buffer Coordinators NRCS Kansas Forest Service
		Soil Testing	Ongoing	$500	Kansas State University

BMP	Target Audience	Information/Education Activity/Event	Time Frame	Estimated Costs	Sponsor/Responsible Agency
Cropland BMP Implementation, Cont.					
No-till/ Cover Crop	Farmers and Land Owners	No-Till Workshop	Annual - Spring	$1,000 per meeting	Flint Hills RC&D Marion County Conservation Districts Kansas State Research and Extension NRCS No-Till on the Plains
		Newsletter Article	Annual	$500	Flint Hills RC&D Conservation Districts Kansas State R & E NRCS No Till on the Plains
		One on One Meetings with Producers	Annual - Ongoing	Cost included with Technical Assistance for Coordinator	Flint Hills RC&D Marion County Conservation District Kansas State R & E NRCS No-Till on the Plains
		Scholarships for producers to attend No-Till Winter Conference	Annual – Winter	($150 per person) $1500 total	No-till on the Plains DOC
Soil Testing (Regional Nutrient Management Planning)	Farmers	Soil Tests	Annual - Ongoing	$500	Kansas State University NRCS
		Newsletter Article	Annual	$500	Flint Hills RC&D Conservation Districts Kansas Research and Extension
		One on One Meetings with Producers	Annual - Ongoing	$10,000	Flint Hills RC&D NRCS Marion County Conservation District Kansas State R & E Kansas Rural Center
		Regional Demonstration Projects	Annual-Ongoing	$1000	Flint Hills RC&D NRCS Marion County Conservation District Kansas State R & E Kansas Rural Center
		Regional Tour/ Field Day	Annual-Ongoing	$1000	Flint Hills RC&D NRCS Marion County Conservation District Kansas State R & E Kansas Rural Center

BMP	Target Audience	Information/Education Activity/Event	Time Frame	Estimated Costs	Sponsor/Responsible Agency
Cropland BMP Implementation Cont.					
Grade Stabilization	Farmer/ Landowners	Newsletter Article	Annual	$500	Flint Hills RC&D Conservation Districts Kansas Research and Extension
		One on One Meetings with Producers	Annual - Ongoing	$10,000	Flint Hills RC&D NRCS Marion County Conservation District Kansas State Research and Extension Kansas Rural Center
		Demonstration Projects	Annual-Ongoing	$1000	Flint Hills RC&D NRCS Marion County Conservation District Kansas State Research and Extension Kansas Rural Center
		Tour/ field Day	Annual-Ongoing	$1000	Flint Hills RC&D NRCS Marion County Conservation District Kansas State Research and Extension Kansas Rural Center

BMP	Target Audience	Information/Education Activity/Event	Time Frame	Estimated Costs	Sponsor/Responsible Agency
Cropland BMP Implementation Cont.					
Constructed Wetland	Farmer/ Landowners	Newsletter Article	Annual	$500	Flint Hills RC&D Conservation Districts Kansas Research and Extension
		One on One Meetings with Producers	Annual - Ongoing	$10,000	Flint Hills RC&D NRCS Marion County Conservation District Kansas State Research and Extension Kansas Rural Center
		Demonstration Projects	Annual-Ongoing	$1000	Flint Hills RC&D NRCS Marion County Conservation District Kansas State R & E Kansas Rural Center
		Tour/ Field Day	Annual-Ongoing	$1000	NRCS Marion County Conservation District Kansas State R & E Kansas Rural Center

BMP	Target Audience	Information/Education Activity/Event	Time Frame	Estimated Costs	Sponsor/Responsible Agency
Livestock BMP Implementation					
Rangeland Management Alternative Water Source	Ranchers	Tour/Field Day	Annual - Summer	$500 per tour or field day	Kansas Rural Center Conservation Districts
		Rangeland Informational Meeting featuring Jim Gerrish (Regional)	Annual - Fall	Combined with relocating pasture feeding site meeting $10,000	Conservation Districts Kansas Rural Center
		Demonstration project for pond construction and spring developments	Annual - Fall	$10,000 per project	Conservation Districts NRCS

BMP	Target Audience	Information/Education Activity/Event	Time Frame	Estimated Costs	Sponsor/Responsible Agency
Watershed Wide Information and Education					
Education of Youth	Educators, K-12 Students	Day on the Farm	Annual – Spring	$500 per event	Conservation Districts Kansas Farm Bureaus Kansas FFA Kansas State Research and Extension
		Poster, essay and speech contests	Annual – Spring	$200	Conservation Districts
		Envirothon	Annual - Spring	$250	Conservation Districts
		Curriculum workshop K-12 educators	Annual - Summer	$2,000 per workshop	KACEE
		Envirofest / Water Festival	Annual - Fall	$700	Conservation District NRCS KSURE Flint Hills RC&D
Education of Adults	Educators, Adult Education	Newsletter	Quarterly	$2,000 per quarter	Flint Hills RC&D Conservation Districts Kansas Research and Extension
		Presentation at annual meeting	Annual – Winter	No charge	Conservation District Flint Hills RC&D KSURE
		River Friendly Farms producer notebook	Annual – Ongoing	$250 per notebook	Kansas Rural Center
		Media campaign to promote healthy watersheds (brochures, news releases, TV, radio, web-based)	Ongoing	$1,000 per year	Conservation Districts Kansas State Research and Extension
		Educational campaign about leaking/failing septic systems	Ongoing	$1,500 per year	Local Environmental Protection Programs

BMP	Target Audience	Information/Education Activity/Event	Time Frame	Estimated Costs	Sponsor/Responsible Agency
Watershed Wide Information and Education, Cont.					
		Meeting with Soil and Grassland Awards	Annual – Ongoing	No charge	Conservation Districts
		Media campaign to promote healthy watersheds (brochures, news releases, TV, radio, web-based)	Ongoing	$1,000 per year	Conservation Districts Kansas State Research and Extension
		Media campaign to address urban nutrient runoff (flyers or handouts addressing phosphate and nitrate pollution from urban areas)	Annual – Ongoing	$500 per campaign	Local Environmental Protection Program
		Watershed display for area events	Annual – Ongoing	$1,000 per event	Conservation Districts Kansas State Research and Extension
Total annual cost for Information and Education if all events are implemented				**$81,900**	

8.2 Evaluation of Information and Education Activities

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

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

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

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

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

9.0 Timeframe

The interim timeframe for initial BMP implementation would be twenty five years from the date of publication of this plan. The plan will be reviewed every five years starting in 2016.

Table 37. Review Schedule for Pollutants and BMPs.

Review Year	Phosphorus	BMP Placement
2016	X	X
2021	X	X
2026	X	X
2031	X	X
2036	X	X

Targeting and BMP implementation might shift over time in order to achieve TMDLs.

- Timeframe for reaching the **phosphorus TMDL** will be twenty five years.

10.0 Water Quality Milestones to Determine Improvements

The goal of the Marion Lake WRAPS plan is to restore water quality for uses supportive of aquatic life, domestic water supply, and recreation for Marion Lake. The plan specifically addresses the high priority eutrophication TMDL for Marion Lake. In order to reach the load reduction goals associated with the Marion Lake impairment, a BMP implementation schedule spanning 25 years has been developed.

The selected BMPs included in the plan will be implemented throughout the targeted areas within the Marion Lake watershed, including the North Cottonwood River, Perry Creek, and French Creek sub watersheds, since these are the major tributaries to Marion Lake. While French Creek has a high priority TMDL for dissolved oxygen, this plan does not specifically address the DO TMDL. It is anticipated that the water quality impairment will be positively affected by the BMP implementation plan that has been developed as part of this WRAPS plan.

Water quality milestones have been developed for Marion Lake, 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. In order to provide additional water quality information associated with this plan, separate water quality milestones are also included for the North Cottonwood River and French Creek. These water quality indicators will enable KDHE and the Marion Lake WRAPS to measure water quality improvements within the watershed above Marion Lake, which should directly affect the water quality of the lake itself.

10.1 Water Quality Milestones for North Cottonwood River & French Creek

While the primary focus of this plan is the high priority eutrophication TMDL for Marion Lake, it is anticipated that due to the BMP implementation plan for the targeted areas within the watershed, water quality improvements may also be achieved in the major lake tributaries, including North Cottonwood River and French Creek. The table on the following page includes 10-year and long term water quality goals for total phosphorus (TP), dissolved oxygen (DO), and total suspended solids (TSS) in the North Cottonwood River and French Creek.

Table 38. Ten Year and Long Term TMDL Water Quality Goals for the North Cottonwood River and French Creek.

Water Quality Milestones for North Cottonwood River & French Creek								
	Current Condition (1993 - 2009)* Median TP	**10-Year Goal**		**Long Term Goal**		**Current Condition (1993 - 2009) **DO < 5 mg/L**	**10-Year Goal**	**Long Term Goal**
		Improved Condition (2012 - 2021) Median TP	**Total Reduction Needed**	**Improved Condition Median TP**	**Total Reduction Needed**		**Improved Condition (2012 - 2021) **DO < 5 mg/L**	**Improved Condition **DO < 5 mg/L**
Sampling Sites	**Total Phosphorus (median of data collected during indicated period), ppb**					****Percent of Samples with DO < 5 mg/L (data collected during indicated period)**		
North Cottonwood SC636	163	130	**33**	113	**50**	3%	**All samples with DO > 5 mg/L**	
French Creek SC676	143	115	**28**	98	**45**	10%	5%	**Maintain DO > 5 mg/L when streamflow is above the critical low flow condition**
	Current Condition (1993 - 2009)* Median TSS	**10-Year Goal**		**Long Term Goal**				
		Improved Condition (2012 - 2021) Median TSS	**Total Reduction Needed**	**Improved Condition Median TSS**	**Total Reduction Needed**			
Sampling Sites	**TSS (median of data collected during indicated period), ppm**							
North Cottonwood SC636	26	24	**2.4**	20	**6**			
French Creek SC676	31	27	**4.4**	20	**11**			

*The Current Conditions were calculated using available data from KDHE's rotational monitoring sites from 1993-2009, with sampling data every 4 years

10.2 Water Quality Milestones for Marion Lake

As previously stated, in order to reach the load reduction goals for Marion Lake, a BMP implementation schedule spanning 25 years has been developed. Several water quality milestones and indicators have been developed for Marion Lake, as included herein, to determine the effectiveness of the BMPs implemented as part of the load reduction goals outlined in the plan.

The table on the following page includes 10-year water quality goals, as well as long term water quality goals for various parameters monitored in Marion Lake.

Table 39. Ten Year and Long Term Water Quality Goals in Marion Lake.

Water Quality Milestones for Marion Lake										
	Current Condition* (2007 - 2010) Average TP	**10-Year Goal**		**Long Term Goal**		**Current Condition (2007 - 2010) Average TN**	**10-Year Goal**		**Long Term Goal**	
		Improved Condition (2012 – 2021) Average TP	**Total Reduction Needed**	**Improved Condition Average TP**	**Total Reduction Needed**		**Improved Condition (2011 – 2021) Average TN**	**Total Reduction Needed**	**Improved Condition Average TN**	**Total Reduction Needed**
Sampling Site	**Total Phosphorus (average of data collected during indicated period), ppb**					**Total Nitrogen (average of data collected during indicated period), ppm**				
Marion Lake	166	107	**59**	48	**118**	1.06	0.80	**0.26**	0.54	**0.52**
	Current Condition* (1996 – 2005) Chlorophyll a	**10-Year Goal**		**Long Term Goal**		**Current Condition (1999 - 2006) Secchi (Avg)**	**10-Year Goal**		**Long Term Goal**	
		Improved Condition (2012 - 2021) Chlorophyll a	**Total Reduction Needed**	**Improved Condition Chlorophyll a**			**Improved Condition (2011 - 2021) Secchi (Avg)**		**Improved Condition Secchi (Avg)**	
Sampling Site	**Chlorophyll a (average of data collected during indicated period), ppb**					**Secchi (average of data collected during indicated period), m**				
Marion Lake LM020001	21	12	**9**	**Maintain Average Chlorophyll a ≤ 10**		0.61	**Secchi depth > 1.0**		**Maintain Secchi depth > 1.5**	

*The existing conditions for TN and TP were calculated using Dr. Phil Barnes monitoring data collected between 2007-2010 from three monitoring sites sampled continually each year and the KDHE data from the monitoring site at Marion Lake. Chlorophyll a and Secchi data was used from KDHE monitoring data from 1996 to 2005, with sampling data every 3 years.

10.3 Additional Water Quality Indicators

In addition to the monitoring data, other water quality indicators can be utilized by KDHE and the SLT. Such indicators may include anecdotal information from the SLT and other citizen groups within the watershed (skin rash outbreaks, fish kills, nuisance odors), which can be used to assess short-term deviations from water quality standards. These additional indicators can act as trigger-points that might initiate further revisions or modifications to the WRAPS plan by KDHE and the SLT.

- Taste and odor issues in public water supply from Marion Lake
- Occurrence of algal blooms in Marion Lake
- Visitor traffic to Marion Lake
- Boating traffic in Marion Lake
- Trends of quantity and quality of fishing in Marion Lake
- Beach closings at Marion Lake
- No fish kills on North Cottonwood River, Perry or French Creeks

11.0 Monitoring Water Quality Progress

KDHE continues to monitor water quality in the Marion Lake watershed by maintaining the monitoring stations located within the watershed. The map below indicates the locations of the monitoring sites located within the Marion Lake watershed, as well as the BMP targeted areas that have been identified and discussed in previous sections of this plan.

The map, on the next page, shows the two rotational KDHE monitoring stations within the watershed. The rotational sites are typically sampled every four years. The sites are sampled for nutrients, *E. Coli* bacteria, chemicals, turbidity, alkalinity, dissolved oxygen, pH, ammonia and metals. The pollutant indicators tested at each site may vary depending on the season at collection time and other factors. In addition to the two KDHE monitoring stations there are seven additional monitoring stations managed by Dr. Phil Barnes from Kansas State University (KSU). The KSU monitoring stations are located on each branch of the North Cottonwood, French Creek, Silver Creek, including three in-lake monitoring sites and one out flow site. These stations are sampled continually year around.

There is also a KDHE lake monitoring station (LM020001) located within Marion Lake. The KDHE lake monitoring sites are typically sampled every 3 years.

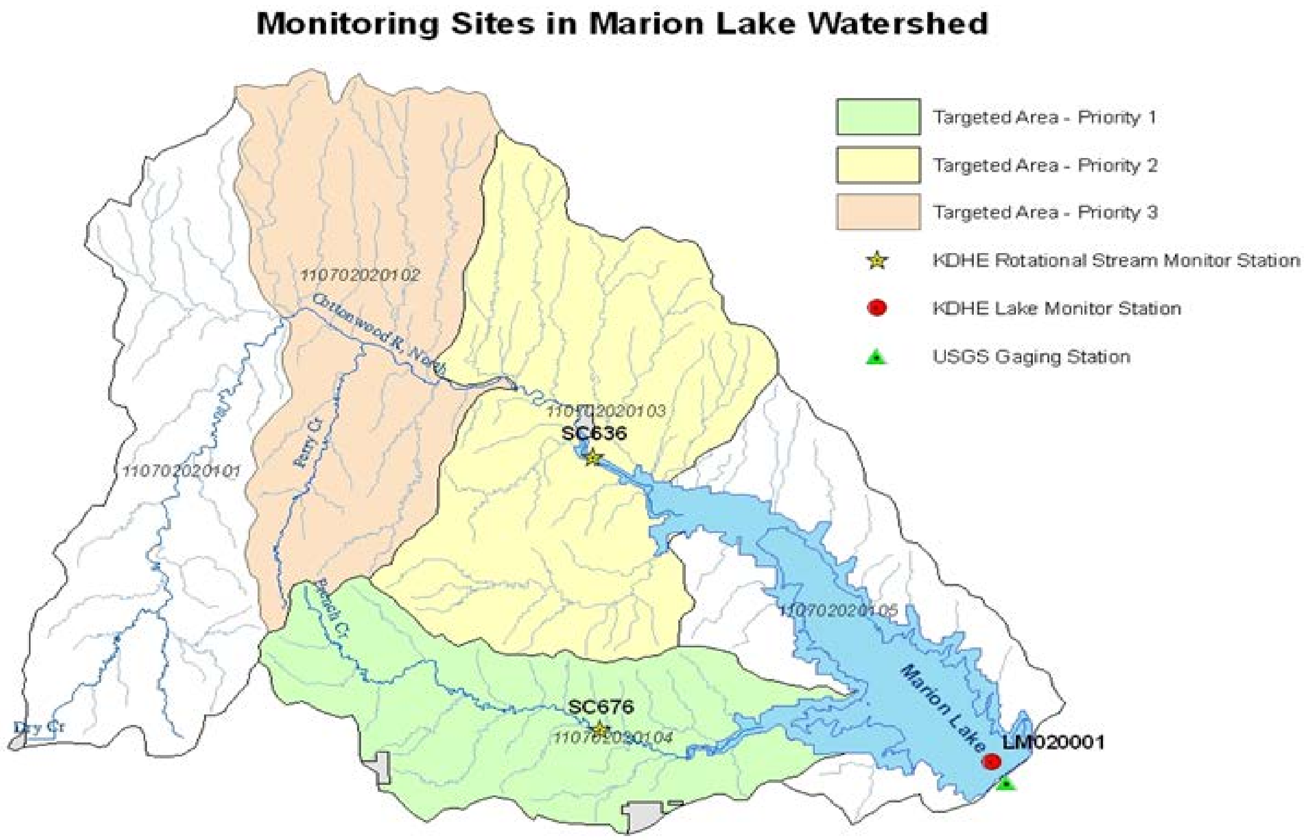


Figure 23. KDHE monitoring sites on Marion Lake and its watersheds

11.1 Streambank Assessment and Local Water Quality Monitoring

The Watershed Institute, Inc. performed a streambank assesment of the streams in the Marion Lake WRAPS area. As part of the Institute's assessment, bankpins were placed in streambanks on the North Cottonwood River and French Creek target areas and other sub-basins of the watershed. Monitoring of the sites will continue, on an annual basis, to determine future erosion of the streambanks. Location of the sites, within the target areas. The locations of the sites are shown in Figure 4. Those sites within the target areas on French Creek (4 sites) and North Cottonwood River, one site, are located in close proximity of the reservoir on the map.

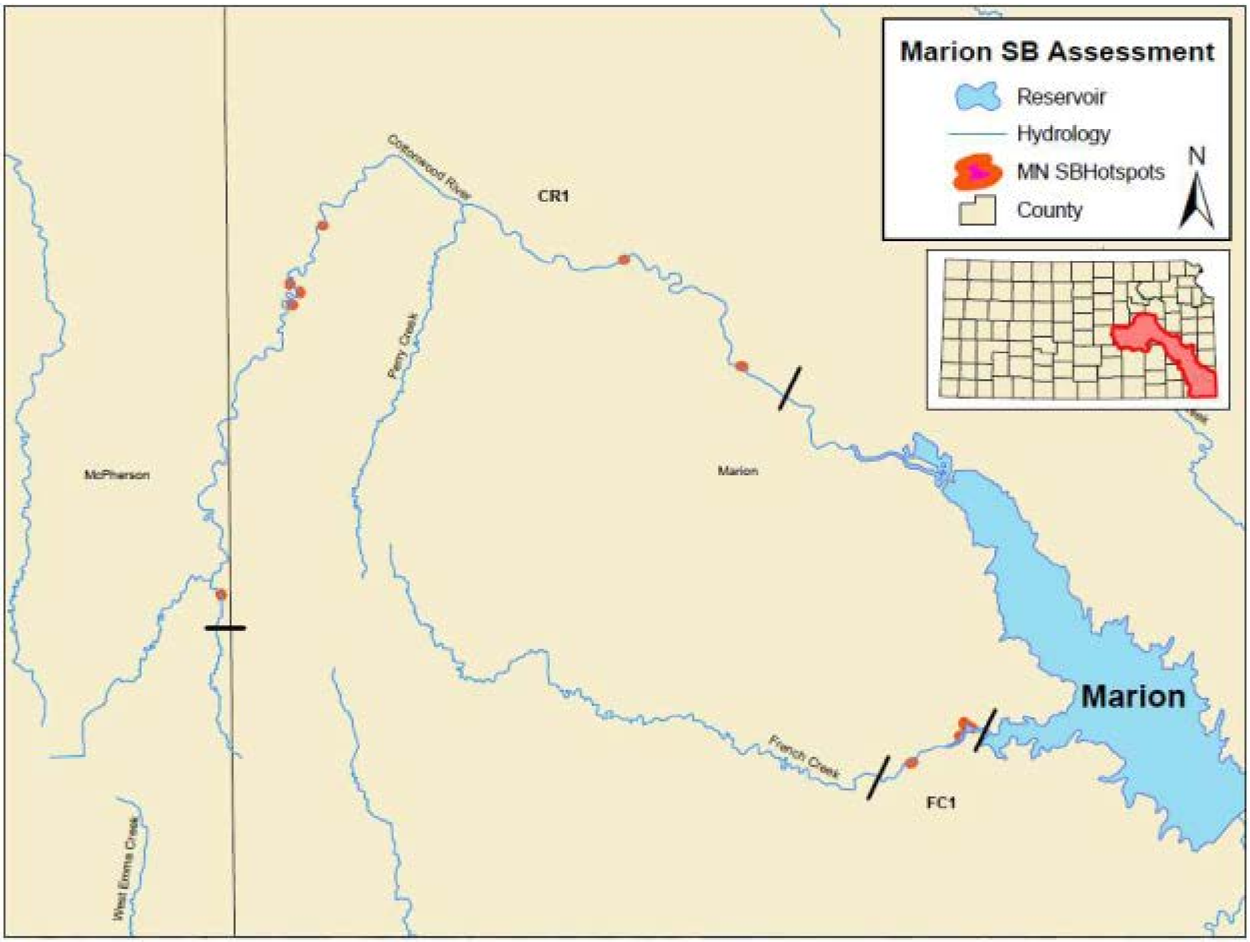


Figure 24. Location of streambank monitoring sites in Marion Lake Watershed

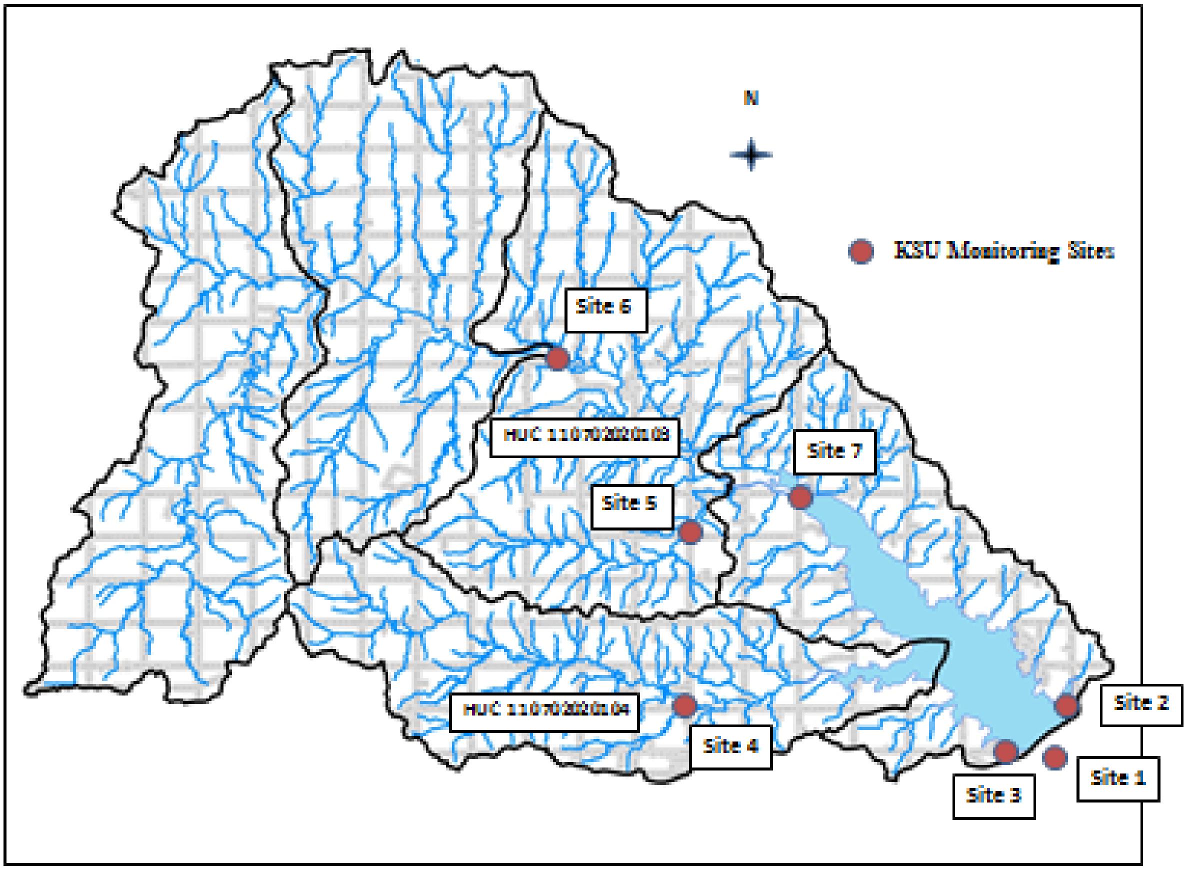


Figure 42. Seven Marion Lake and watershed monitoring locations (KSU).

Table 31. Monitoring site location description and coordinates for Marion Lake.

Site Number	Site Location	Site Coordinates
1	Marion Lake Outflow	Lat 38.36834 Lon 97.08391
2	Marion Cove Public Use Area	Lat 38.37625 Lon 97.07643
3	Below Rest Stop on West Side of Marion Dam	Lat 38.36335 Lon 97.09213
4	French Creek North of Hillsboro on Indigo Road	Lat 38.36335 Lon 97.09213
5	Silver Creek near Indigo Road and 250th Street	Lat 38.43500 Lon 97.20632
6	North Branch of the Cottonwood River Near Durham	Lat 38.49526 Lon 97.24301
7	North End of Marion Reservoir on bridge on Kanza Road	Lat 38.44759 Lon 97.16637

Monitoring data has been collected starting in 2007 at seven locations in the watershed and lake shown in Figure 18 and Table 31. Samples are collected weekly during the summer months of April through September and monthly during the winter month of October through March. Each stream monitoring site is calibrated to measure daily flowrates. With the measure contaminant concerntrations and the flowrate daily contaminant loadings can be measured or estimated.
Taking estimated long term flows and the TSS (total suspended sediments), TN (total nitrogen) and TP (total phosphorus) concentrations sampled on the North Cottonwood River and French Creek, a majority of nutrient loadings comes down the North Cottonwood River, because of its greater hydrologic contributions (roughly 2.5 – 2.9 times greater load than French Creek).

Because of land use and hydrology considerations as well as their proximity to the lake and the presence of the other impairments on the streams themselves, the SLT selected the highest priority HUC 12 should be the lower North Cottonwood (110702020103) which includes Spring Creek, followed by French Creek (110702020104). Placement of Best Management Practices should be concentrated in those two sub-watersheds during the initial stages of implementing the watershed plan for Marion Lake. Additional attention will be given to activities and practices in the immediate vicinity of Marion Lake within 110702020105, given the direct impact those activities would have on the lake.

11.2 Evaluation of Monitoring Data

The first concentrated level of blue-green algae that occurred in the summer of 2003 gave rise to many issues pertaining to Marion Lake: 1) what caused the outbreak; 2) does it pose a health threat; 3) how do we treat or eradicate the blue-green algae; and 4) what can be done to improve water quality in the lake. With assistance from KDHE, Tulsa District and Marion Corp of Engineers, and a local task force, numerous scenarios were considered. Although it was not an immediate "fix" it was decided the only long term solution was to reduce nutrients and sediment from entering the lake from the watershed to meet the reduction of total phosphorus TMDL goal of 85% nutrient reduction. Blue-green Algae continued to develop in the lake for the next 3 spring and summer seasons in high concentrations.

The SLT, NRCS, and Conservation District looked at the data available for the watershed, the number of BMPs, location of practices and were they effective, in reducing the impairments causing the eutrophication. It was determined there was no available base line data for the watershed. To obtain base line data a multi-year watershed study was developed that would focus on level of erosion from land use and streams and measure the inflow and outflow volume of water, nutrients, sediment and other pollutants.

Funds for the multi-year study were provided by KDHE and the Kansas Water Office through WRAPS and Water Plan budget in SFY 2006 and from the Marion County Commission. Marion County Commission continues to provide funds for continued water quality monitoring in the lake and certain tributaries. Water quality monitoring data is collected once a week from April 1st. through September 30th, after significant rainfall events and once a month from October 1st through March 31st. Monitoring equipment, provided by K-State University Biological and

Agricultural Engineering, will be utilized to monitor certain BMPs and certain location within the target areas of the watershed. The SLT and the Marion County Commission has not set an end date as to when certain aspects of the watershed assessment process should end. Both entities feel Marion Lake (reservoir) is too important as a public water source and economic value to the county.

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

As long as the existing seven KSU monitoring station are available, the SLT and KDHE will use their data to assist measuring progress from BMP implementation within the Marion watershed. If KSU data are not available, the Marion SLT will refer to KDHE monitoring data to continue evaluation.

The BMP implementation schedule and water quality milestones for the Marion Lake watershed extend through a 25-year period from 2012 to 20. Throughout that period, KDHE will continue to analyze and evaluate the monitoring data collected. After the first ten years of monitoring and BMP implementation, KDHE will evaluate the available water quality data to determine whether the water quality milestones have been achieved. KDHE and the SLT can address any necessary modifications or revisions to the plan based on the data analysis. In 2037, at the end of the plan, a determination can be made as to whether the water quality standards have been attained.

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

Table 32. Service Provider List

Organization	Programs	Purpose	Technical or Financial Assistance	Phone	Website address
Environmental Protection Agency	Clean Water State Revolving Fund Program Watershed Protection	Provides low cost loans to communities for water pollution control activities. To conduct holistic strategies for restoring and protecting aquatic resources based on hydrology rather than political boundaries.	Financial	913-551-7003 913-551-7003	www.epa.gov
Flint Hills RC&D	Natural resource development and protection	Plan and Implement projects and programs that improve environmental quality of life.	Technical	620-340-0113 ext. 9	www.flinthillsrcd.com/
Kansas Dept. of Agriculture	Watershed structures permitting.	Available for watershed districts and multipurpose small lakes development.	Technical and Financial	785-296-2933	www.accesskansas.org/kda
Kansas Forest Service	Conservation Tree Planting Program Riparian and Wetland Protection Program	Provides low cost trees and shrubs for conservation plantings. Work closely with other agencies to promote and assist with establishment of riparian forestland and manage existing stands.	Technical	785-532-3312 785-532-3310	www.kansasforests.org

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Phone	Website address
Kansas Dept. of Health and Environment	**Nonpoint Source Pollution Program** Livestock waste Municipal waste State Revolving Loan Fund	Provide funds for projects that will reduce nonpoint source pollution. Compliance monitoring. Makes low interest loans for projects to improve and protect water quality.	Technical and Financial	785-296-5500	www.kdhe.state.ks.us
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
Kansas Rural Center	**The Heartland Network** **Clean Water Farms-River Friendly Farms** **Sustainable Food Systems Project** **Cost share programs**	The Center is committed to economically viable, environmentally sound and socially sustainable rural culture.	Technical and Financial	785-873-3431	http://www.kansasruralcenter.org

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Phone	Website address
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	http://www.krwa.net
US Army Corps of Engineers	Planning Assistance to States Environmental Restoration	Assistance in development of plans for development, utilization and conservation of water and related land resources of drainage Funding assistance for aquatic ecosystem restoration.	Technical	816-983-3157 816-983-3157	www.usace.army.mil
US Fish and Wildlife Service	Fish and Wildlife Enhancement Program Private Lands Program	Supports field operations which include technical assistance on wetland design. Contracts to restore, enhance, or create wetlands.	Technical	785-539-3474 785-539-3474	www.fws.gov
The Watershed Institute		Survey and Design of streambank and grade stabilization projects	Technical	785-228-3148	www.watershedinstitute.biz

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Phone	Website address
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	http://www.krwa.net
US Army Corps of Engineers	Planning Assistance to States Environmental Restoration	Assistance in development of plans for development, utilization and conservation of water and related land resources of drainage Funding assistance for aquatic ecosystem restoration.	Technical	816-983-3157 816-983-3157	www.usace.army.mil
US Fish and Wildlife Service	Fish and Wildlife Enhancement Program Private Lands Program	Supports field operations which include technical assistance on wetland design. Contracts to restore, enhance, or create wetlands.	Technical	785-539-3474 785-539-3474	www.fws.gov
The Watershed Institute		Survey and Design of streambank and grade stabilization projects	Technical	785-228-3148	www.**watershedinstitute**.biz

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Phone	Website address
Wild Horse Riverworks		Survey and Design of streambank and grade stabilization projects	Technical	785-213-3778	riverworker@yahoo.com

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Phone
USDA- Natural Resources Conservation Service and Farm Service Agency	Conservation Compliance Conservation Operations Watershed Planning and Operations Wetland Reserve Program Wildlife Habitat Incentives Program Grassland Reserve Program, EQIP, and Conservation Reserve Program	Primarily for the technical assistance to develop conservation plans on cropland. To provide technical assistance on private land for development and application of Resource Management Plans. Primarily focused on high priority areas where agricultural improvements will meet water quality objectives. Cost share and easements to restore wetlands. Cost share to establish wildlife habitat which includes wetlands and riparian areas. Improve and protect rangeland resources with cost-sharing practices, rental agreements, and easement purchases.	Technical and Financial	Marion Co 620-382-3714 McPherson Co 620-241-1836

12.0 Glossary of Terms

BATHTUB: A lake or reservoir simulation using empirical relationships between nutrient loading and eutrophication indicies.
Best Management Practices (BMP): Environmental protection practices used to control pollutants, such as sediment or nutrients, from common agricultural or urban land use activities.
Biological Oxygen Demand (BOD): Measure of the amount of oxygen removed from aquatic environments by aerobic microorganisms for their metabolic requirements.
Biota: Plant and animal life of a particular region.
Chlorophyll a: Common pigment found in algae and other aquatic plants that is used in photosynthesis.
Designated Uses: Recognized uses by KDHE that should be attained in a water body.
Dissolved Oxygen (DO): Amount of oxygen dissolved in water.
E. coli bacteria: Bacteria normally found in gastrointestinal tracts of animals. Some strains cause diarrheal diseases.
Eutrophication (E): Excess of mineral and organic nutrients that promote a proliferation of plant life in lakes and ponds.
Fecal coliform bacteria (FCB): Bacteria that originate in the intestines of all warm blooded animals.
Municipal Water System: Water system that serves at least 25 people or has more than 15 service connections.
National Pollutant Discharge Elimination System (NPDES) Permit: Required by Federal law for all point source discharges into waters.
Nitrates: Final product of ammonia's biochemical oxidation. Primary source of nitrogen for plants. Contained in manure and fertilizers.
Nitrogen(N or TN): Element that is essential for plants and animals. TN or total nitrogen is a chemical measurement of all nitrogen forms in a water sample.
Nutrients: Nitrogen and phosphorus in water source.
Phosphorus (P or TP): Element in water that, in excess, can lead to increased biological activity.
Riparian Zone: Margin of vegetation within approximately 100 feet of waterway.
Sedimentation: Deposition of slit, clay or sand in slow moving waters.
Secchi Disk: Circular plate 10-12" in diameter with alternating black and white quarters used to measure water clarity by measuring the depth at which it can be seen.
Stakeholder Leadership Team (SLT): Organization of watershed residents, landowners, farmers, ranchers, agency personnel and all persons with an interest in water quality.
Total Maximum Daily Load (TMDL): Maximum amount of pollutant that a specific body of water can receive without violating the surface water-quality standards, resulting in failure to support their designated uses.
Total Suspended Solids (TSS): Measure of the suspended organic and inorganic solids in water. Used as an indicator of sediment or silt.
Water Quality Standard (WQS): Mandated in the Clean Water Act. Defines goals for a waterbody by designating its uses, setting criteria to protect t those uses and establishing provisions to protect waterbodies from pollutants.

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