Eagle Creek – 9 Element Watershed Plan Summary

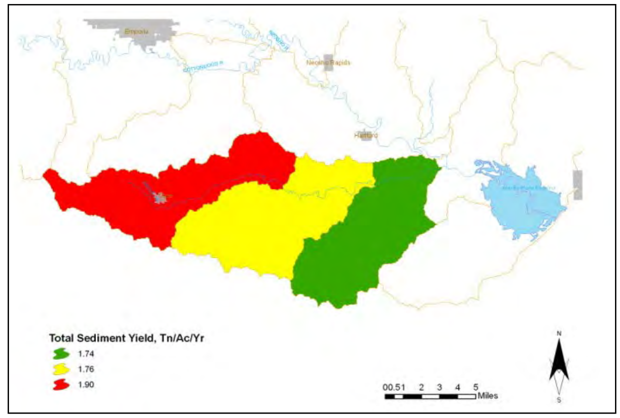
Impairments to be addressed:

John Redmond Reservoir (Silt, EU)

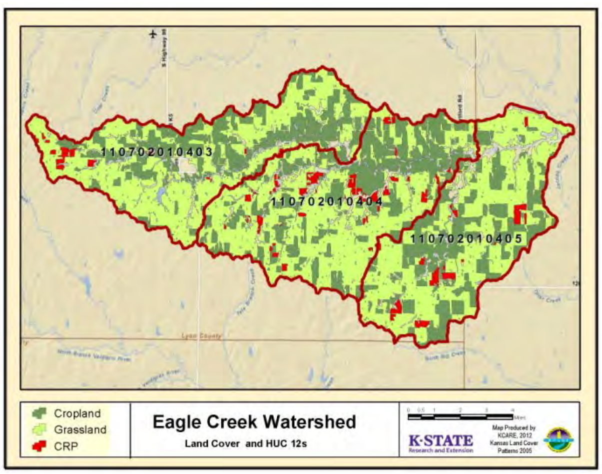
Olpe City Lake (Silt, EU)

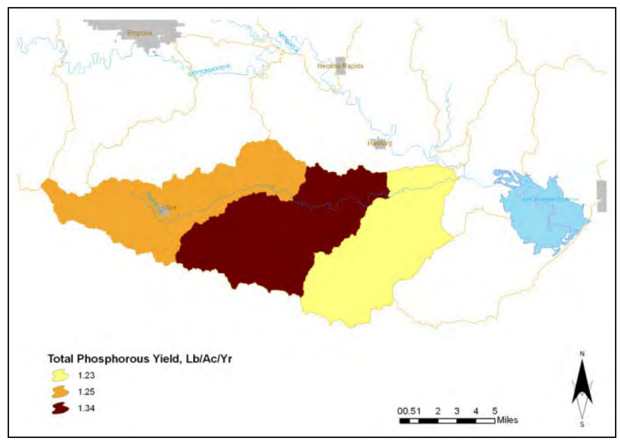
Prioritized Critical Areas for Targeting BMPs

1. Eagle Creek Headwaters, HUC 1107020104(030)
2. South Eagle Creek, HUC 1107020104(040)
3. Fourmile Creek, HUC 1107020104(050)



Total Sediment Yield (tons/acre) as indicated by SWAT.





Total Phosphorous (lbs/acre) as indicated by SWAT.

Targeting considerations:

- Livestock targeted areas were chosen by identifying the local AFO's and CAFO's and by landowner input.
- Cropland BMP Targeted areas were identified through SWAT (Soil and Water Assessment Tool) and STEPL modeling to determine where high levels of phosphorous and sediment where coming from within the Eagle Creek watershed.

Eagle Creek – 9 Element Watershed Plan Summary

Best Management Practices and Load Reduction Goals

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

Phosphorus/Sediment Reducing Cropland BMPs

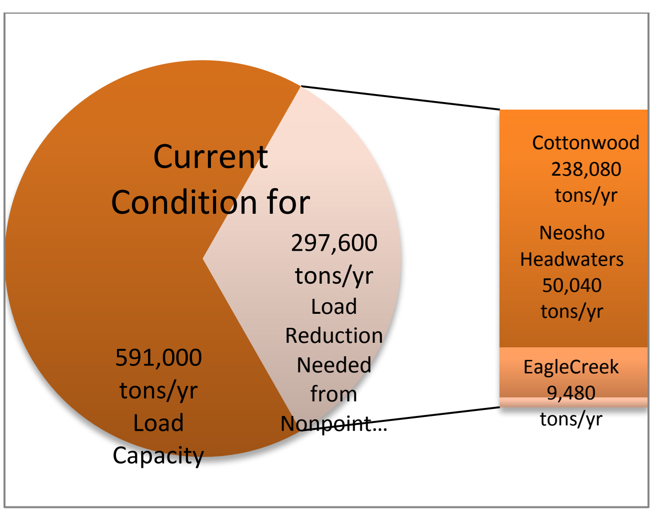
- Grasses Waterways
- No-till cultivation practice
- Buffers
- Terraces
- Minimum till cultivation practice
- Permanent Vegetation

Phosphorus/Sediment Reducing Livestock BMPs

- Vegetative filter strips
- Fence off streams
- Relocate pasture feeding sites
- Off strem watering sites

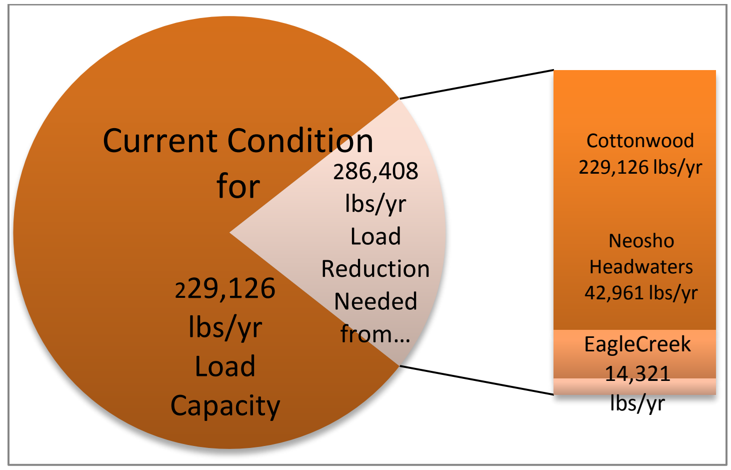
Sediment Reduction:

Required load reduction for Eagle Creek from Nonpoint Sources (3% of Total load for John Redmond)



Phosphorus Reducation:

Required load reduxtion for Eagle Creek from nonpoint sources (5% total load for John Redmond Reservoir)



EAGLE CREEK

WATERSHED RESTORATION AND PROTECTION STRATEGY

LYON AND COFFEY COUNTIES

KANSAS

June 12, 2012

HUC 10 (HUC12): 1107020140 (30, 40, 50)

Partially funded through an Environmental Protection Agency (EPA) Section 319 Grant C9007405-9 administered by the Kansas Department of Health and Environment (KDHE)

FLINT HILLS RC & D
Resource Conservation & Development

Eagle Creek Watershed Stakeholder Leadership Team

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Ann D'Alfonso, Watershed Management Section

Acknowlegments:

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PAGE FOR APPROVAL LETTER

Glossary of Terms

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

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

Biota: Plant and animal life of a particular region.

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

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

E. coli bacteria: 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.

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

Nitrates: Final product of ammonia’s biochemical oxidation. Primary source of nitrogen for plants. Originates from manure and fertilizers.

Nitrogen(N or TN): Element that is essential for plants and animals. TN or total nitrogen is a chemical measurement of all nitrogen forms in a water sample.

Nutrients: Nitrogen and phosphorus in water source.

Phosphorus (P or TP): Element in water that, in excess, can lead to increased biological activity in water. TP or total phosphorus is a chemical measurement of all phosphorus forms in a water sample.

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.

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EAGLE CREEK
WATERSHED RESTORATION AND PROTECTION STRATEGY

1.0 INTRODUCTION

The purpose of this Watershed Restoration and Protection Strategy (WRAPS) report for Eagle Creek Watershed 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 Kansas 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.

A watershed is an area of land that catches precipitation and funnels it to a particular creek, stream, and river and so on, until the water drains into an ocean. A watershed has distinct elevation boundaries that do not follow political “lines” such as county, state and international borders.

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, timber and industrial production. Other crucial objectives are to maintain recreational opportunities and biodiversity while protecting the environment from flooding, and negative effects of urbanization and industrial production. The ultimate goal is watershed restoration and protection that will be “locally led and driven” in conjunction with government agencies in order to better the environment for everyone.

This report is intended to serve as an overall strategy to guide watershed restoration and protection efforts by individuals, local, state, and federal agencies and organizations. At the end of the WRAPS process, the Stakeholder Leadership Team (SLT) will have the capability, capacity and confidence to make decisions that will restore and protect the water quality and watershed conditions of the Eagle Creek Watershed.

2.0 PRIORITY ISSUES AND GOALS OF STAKEHOLDER LEADERSHIP TEAM

The Stakeholder Leadership Team (SLT) was formed out of concern for the health and lifespan of John Redmond Reservoir (JRR), which is the geographic endpoint of this WRAPS plan. Construction of the dam began in 1959 by the US Corps of Engineers (COE) and the multipurpose pool was filled in 1964. In 1963, the reservoir had a storage capacity of 82,230 acre feet. The capacity of the latest survey year (2007) is 50,227 acre feet. Estimated current capacity is 48,010 acre feet. This represents a loss of 41.61% due to sediment that has entered the reservoir from the watershed with a calculated sedimentation rate of 739 acre feet per year. John Redmond Reservoir is ranked third of all Kansas reservoirs in percentage of capacity loss.

The focus of the Eagle Creek Watershed Restoration and Protection Strategy (ECWRAPS) presented here will be to reduce sedimentation and nutrient inputs from livestock waste and cropland in the Eagle Creek Watershed. **The best management practices (BMPs) implemented through this plan will address the impairments in John Redmond Reservoir (JRR) for eutrophication and siltation, and there is optimism that these practices will positively affect the impairments within Eagle Creek Watershed for low dissolved oxygen, eutrophication, and siltation.** The effort is a continuation of a former strategy for Eagle Creek that expired in 2010 (WRAPS 2005). This ECWRAPS builds upon experience gained during the initial implementation and adds current watershed information. It will be used to guide local stakeholders to address water quality and quantity issues that have gained regional and statewide priority. Estimates and schedules are presented that will show clear, measurable success of these efforts, and which will be useful for justifying grant funding as available.

The overall goal of this strategy is to:

> *Promote and install best management practices within the Eagle Creek Watershed to improve and protect the quantity and quality of water within John Redmond Reservoir.*

The enabling objectives to achieve this goal include:

1. Educate and inform residents and stakeholders of impairments and best management practices (BMP) to alleviate them.

2. Demonstrate innovative BMP effectiveness, and

3. Estimate the resources necessary to promote BMP use on the ground sufficient to alleviate water quality and quantity concerns.

A SLT has been implementing the existing WRAPS, with valuable input from technical advisors. Significant stakeholder input detail is provided in the initial WRAPS (WRAPS 2005) which is included via reference to this document. The previous stakeholder input with additional agency and landowner direction has been used to formulate the strategy presented. This ECWRAPS uses the U. S. Environmental Protection Agency (EPA), Region 7, guidelines for watershed management plans, which specifies nine essential elements. Direction from the Kansas Department of Health and Environment (KDHE) was also used.

3.0 WATERSHED REVIEW

There are twelve river basins located in Kansas. The scope of this WRAPS project is in the headwaters portion of the Neosho Basin in south-east Kansas (Figure 1). The Neosho Basin drains the Neosho River and its tributaries into Oklahoma and eventually empties into the Gulf of Mexico. Two other WRAPS projects presently exist in the Neosho Headwaters Watershed, and they are the Twin Lakes WRAPS and the Neosho Headwaters WRAPS. The scopes of these projects are not included in this WRAPS plan. The extent of this plan is Eagle Creek, South Eagle Creek, Four Mile Creek, and their tributaries upstream of John Redmond Reservoir. The confluence of Eagle Creek and Neosho River is the geographical endpoint of this WRAPS project.

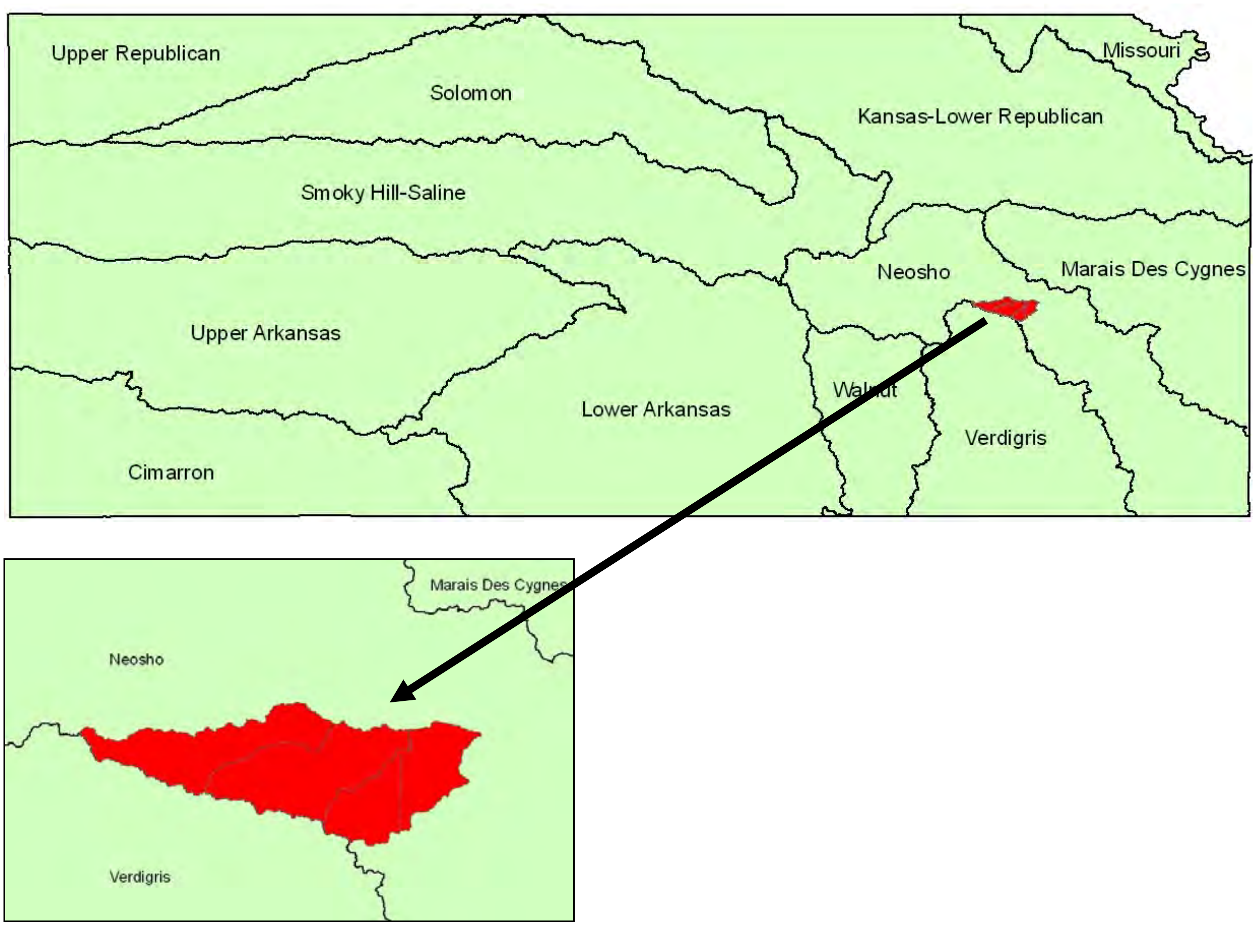

Figure 1. Location of Eagle Creek Watershed.

3.1 WATERSHED DESCRIPTION

Eagle Creek watershed is the southern-most portion of the Neosho River Headwaters sub-basin in east-central Kansas. The watershed is located in south-central Lyon County, and the main-stems flow easterly to the confluence with the Neosho River in west-central Coffey County (Figure 2).

A small segment, approximately 119 acres (0.2 %), of the watershed lies within Greenwood County. The Eagle Creek confluence with the Neosho River is immediately upstream from JRR, which at normal pool backs water upstream of the confluence, though still within historic riverbanks.

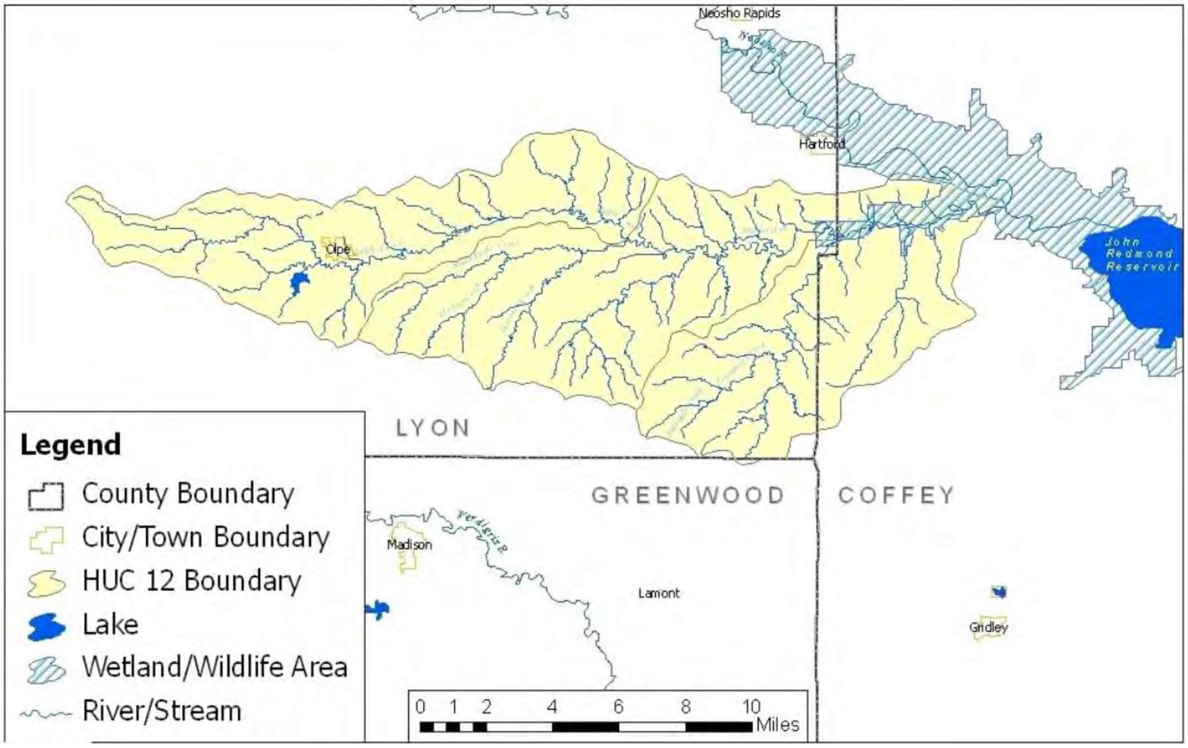

Figure 2. Water Bodies in Eagle Creek Watershed.

The watershed has been divided into three sub-watersheds with HUC 12 delineations (Figure 3). HUC is an acronym for Hydrologic Unit Codes. HUCs are an identification system for watersheds, which gives each watershed a unique HUC number in addition to a common name. As watersheds become smaller, the HUC number will become larger. For example, the Neosho Basin is one of twelve basins in the state of Kansas. Within the Neosho Basin are seven HUC 8 classifications. HUC 8s can further be split into smaller watersheds that are given HUC 10 numbers and HUC 10 watersheds can be further divided into smaller HUC 12s. The geographic scope of the Eagle Creek WRAPS process is comprised of three HUC 12 delineations.

Starting from the confluence with the Neosho River, HUC 110702014050 covers the lower drainage upstream to approximately the confluence with Fourmile Creek, the only named tributary in this sub-watershed. The Flint Hills National Wildlife Refuge encompasses all of the lands adjacent to the Eagle Creek main-stem in this sub-watershed.

The central drainage area (HUC 110702014040) begins upstream from Fourmile Creek to the confluence of South Eagle Creek. Harper and Hoosier Creeks are two named tributaries of South Eagle Creek.

The upper area (HUC 110702014030) includes the headwaters of Eagle Creek, the Olpe City Lake, and the city of Olpe.

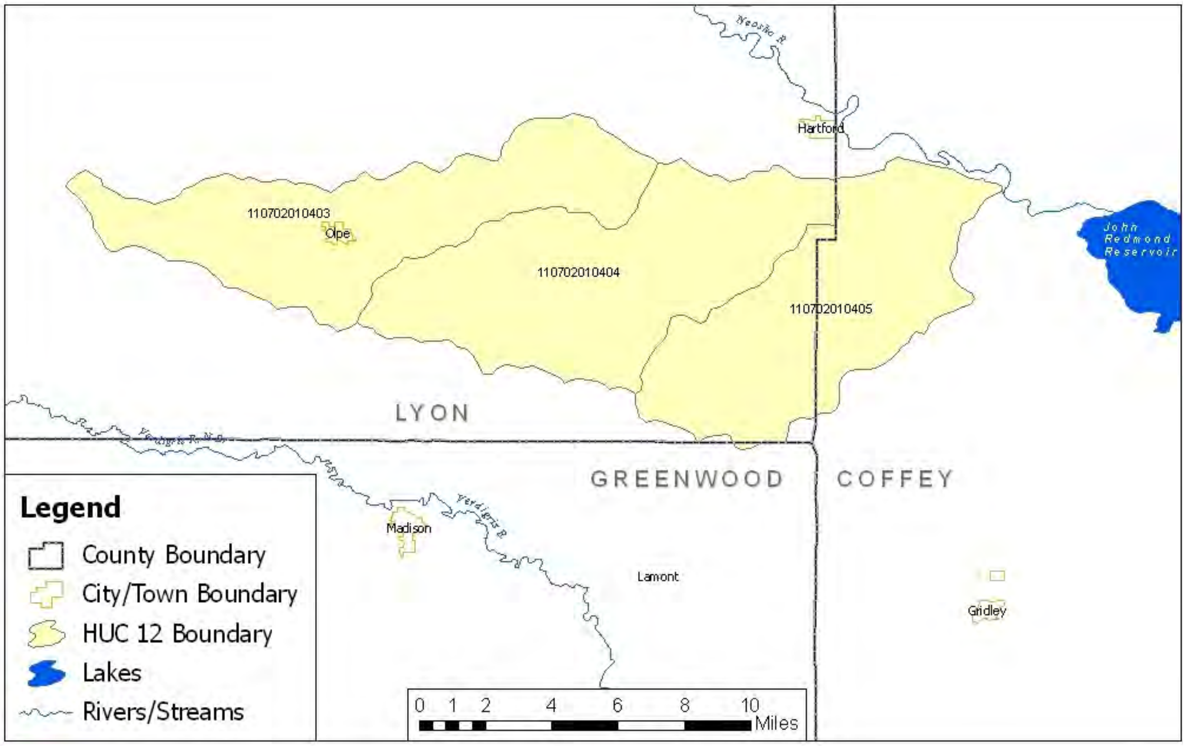

Figure 3. HUC 12 Delineations in Eagle Creek Watershed.

3.1.1 Land Cover/Land Uses

Land use in the Eagle Creek watershed is typical of east-central Kansas. It is primarily agricultural, consisting of 42,445 acres of grassland primarily used for grazing and haying production (58 %). Grassland can contribute fecal coliform bacteria from livestock access to streams and ponds. Erosion can occur from pathways made by livestock in creeks or gullies in pastures. Cropland accounts for 23,788 acres (32 %) within the watershed (Figure 4 and Table 1). Cropland can contribute nutrients from fertilizer and sediment from bare crop ground that will erode during heavy rainfall events. Trees and brush are common along stream courses, and when their acres are combined with other land covers they total 7,128 acres or 10% of the watershed. Olpe is the only city within the watershed and accounts for less than 300 acres or <0.4% of the watershed. The Olpe City Lake is in the headwaters area of this watershed.

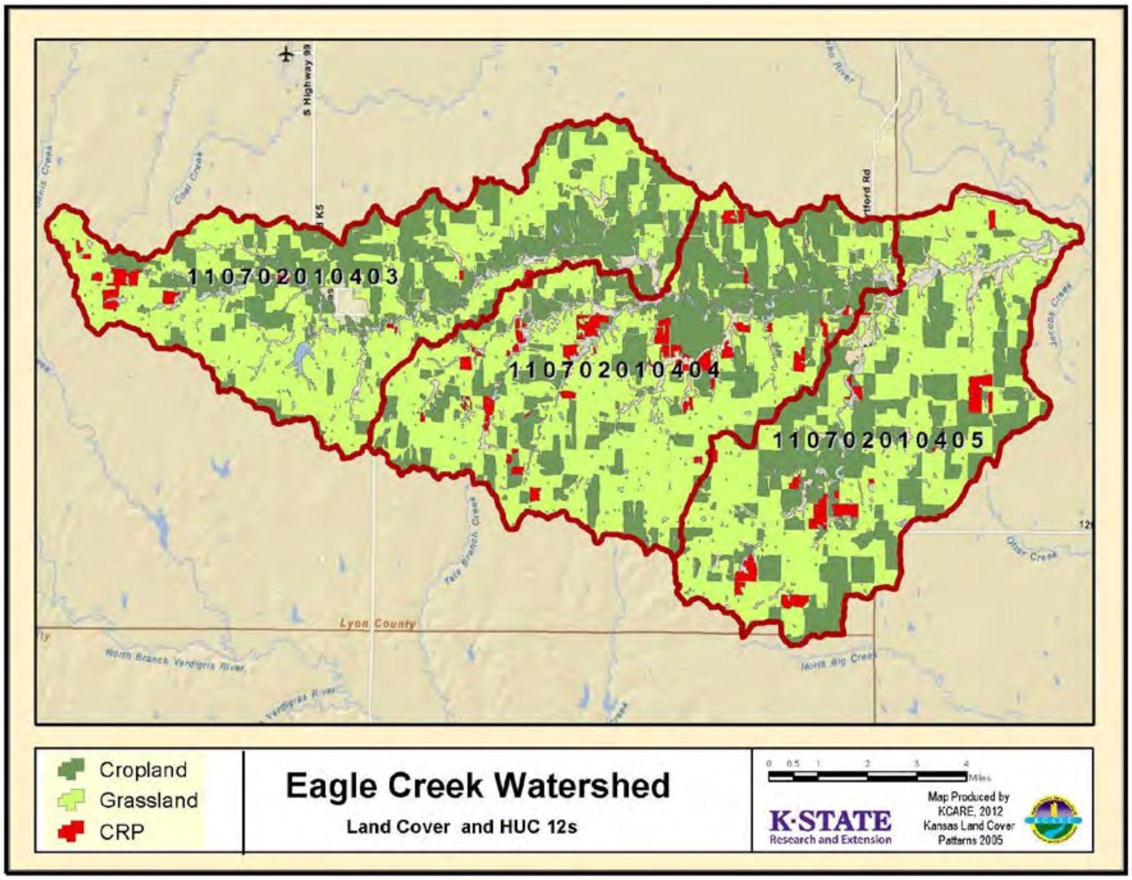

Figure 4. Land Cover in Eagle Creek Watershed.

Table 1. Acreage and Percent Composition of Cropland and Permanent (grass/riparian) Vegetative Cover Estimates in Eagle Creek Watershed. Estimates are broken down by the sub-watersheds (HUC 12).

Eagle Creek HUC 12's	Total	%	Cropland	% Cropland	Grass Cover (1)	% Grass Cover	Urban (2)	% Urban	Other (3)	% Other
110702014030 (EC Headwaters)	23,582	100%	7,790	33%	13,646	58%	288	1.2%	1,859	8%
110702014040 (South EC confluence)	26,651	100%	8,660	32%	15,191	57%	0	0	2,800	11%
110702014050 (Lower EC, including Fourmile Creek)	23,415	100%	7,338	31%	13,608	58%	0	0	2,469	11%
Total	73,648	100%	23,788	32%	42,445	58%	288	0.4%	7,128	10%

Area (acres) and percent composition of land use types

(1) Grass includes all native and tame species grazed, hayed, or unused, within the watersheds.
(2) Urban refers to residential, urban open, urban wood, & urban water
(3) Other refers to industrial, CRP, rock quarries, roads, waterbodies, woodlands, etc.

3.2 DESIGNATED USES

The surface waters in the Eagle Creek Watershed are generally used for aquatic life support, food procurement, and recreational use (Table 2). Surface waters are given certain “designated uses” based on what the waters will be used for as stated in the 2004 Kansas Surface Water Register, which was issued by KDHE (KSWR 2004). For example, waters that will come into contact with human skin or ingested should be of higher quality than waters 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.”

Table 2. Designated Water Uses in Eagle Creek Watershed. (KSWR 2004)**.**

Designated Uses Table								
Stream or Lake Name	AL	CR	DS	FP	GR	IW	IR	LW
Eagle Creek	E	b		X				
Eagle Creek, South	E	b						
Four Mile Creek	E	b		X				
Olpe City Lake	E	A		X				

(1) AL = Aquatic Life Support GR = Groundwater Recharge
CR = Contact Recreation Use IW = Industrial Water Supply
DS = Domestic Water Supply IR = Irrigation Water Supply
FP = Food Procurement LW = Livestock Water Supply

(2) A=Primary contact recreation lakes that have a posted public swimming area
B=Primary contact recreation stream segment is by law or written permission of the landowner open to and accessible by the public
b=Secondary contact recreation stream segment is not open to and accessible by the public under Kansas law
C=Primary contact recreation lakes that are not open to and accessible by the public under Kansas law
S=Special aquatic life use water
E = Expected aquatic life use water
X = Referenced stream segment is assigned the indicated designated use
O = Referenced stream segment does not support the indicated beneficial use
Blank=Capacity of the referenced stream segment to support the indicated designated use has not been determined by use attainability analysis

3.3 WATER QUALITY IMPAIRMENTS/ISSUES

3.3.1 Total Maximum Daily Loads (TMDLs)

A Total Maximum Daily Load (TMDL) designation sets the maximum amount of pollutant that a specific body of water can receive without violating the surface water-quality standards, resulting in failure to support their designated uses. TMDLs provide a tool to target and reduce point and nonpoint pollution sources. TMDLs established by Kansas may be done on a watershed basis and may use a pollutant-by-pollutant approach or a biomonitoring approach or both as appropriate. TMDL establishment means a draft TMDL has been completed, there has been public notice and comment on the TMDL, there has been consideration of the public comment, any necessary revisions to the TMDL have been made, and the TMDL has been submitted to EPA for approval. The desired outcome of the TMDL process is indicated, using the current situation as the baseline. Deviations from the water quality standards will be documented. The TMDL will state its objective in meeting the appropriate water quality

Water quality impairments in Eagle Creek Watershed and JRR are generally considered to result from nonpoint sources primarily associated with agricultural land uses. The expected uses, impairments, and developed TMDLs applicable to Eagle Creek are presented in Table 3. John Redmond Reservoir is a major focal point of this plan since it is a significant water body immediately downstream and benefits directly from conservation efforts within the Eagle Creek Watershed.

Table 3. TMDL Impairments in Eagle Creek Watershed.

Waterbody	HUC 1107020104 (HUC 12)	Impaired Use	Impairment (TMDL)	Assigned priority	Source (nonpoint)	Allocation endpoints
						Target Reductions
John Redmond Reservoir	11070201	Aquatic life, Contact recreation	Siltation, Eutrophication	Medium	Land erosion, Nutrients, Animal Waste	14880 tons sediment/yr (2) 14321 lbs/yr Phosphorus
Olpe City Lake	(03)	Aquatic life, Contact recreation, Water supply	Siltation, Eutrophication	High	Cropland, Animal Waste	18.0 FTU, 279 lbs/yr Phosphorus
Eagle Creek	(03)	Aquatic life	Dissolved oxygen	High	Low flow	>5.0 mg/L DO ≤3.4 mg/L BOD

(1) Waterbodies/TMDL shaded red will be directly targeted by BMPs, those shaded gray will indirectly effected by BMPs, and those not shaded will not addressed.

(2) Information taken from applicable TMDL evaluations accessed on www.kdheks.gov/tmdl

(3) Allocations and reductions for JRR are based on the assignments for non-point sources as assigned by KDHE

John Redmond Reservoir has TMDLs of medium priority for siltation and eutrophication. These TMDLs causes impaired uses listed as aquatic life and contact recreation. **The siltation TMDL is caused by erosion off of the land. The eutrophication TMDL is caused by cropland nutrient and animal waste runoff. These TMDLs will be directly targeted by the BMPs implemented though this plan.** Eagle Creek has a TMDL of high priority for low dissolved oxygen (Figure 5). This TMDL causes an impaired use listed as aquatic life; although, the current TMDL notes low flow conditions as the primary contributor to low dissolved (DO) concentrations observed within Eagle Creek. Recent analysis from the KDHE TMDL Section indicates that nonpoint source contribution cannot be completely ruled out as a factor influencing this impairment. With this information in mind, it is also feasible that BMPs to be implemented as started within this watershed plan will have a positive impact on dissolved oxygen concentrations observed on Eagle Creek. Olpe City Lake has TMDLs of high priority for siltation and eutrophication (Figure 5). These TMDLs cause impaired uses listed as aquatic life, contact recreation, and water supply. The siltation TMDL is caused by erosion off the land.

The eutrophication TMDL is caused by cropland nutrient and animal waste runoff. These TMDLs will be indirectly effected by the BMPs implemented though this plan.

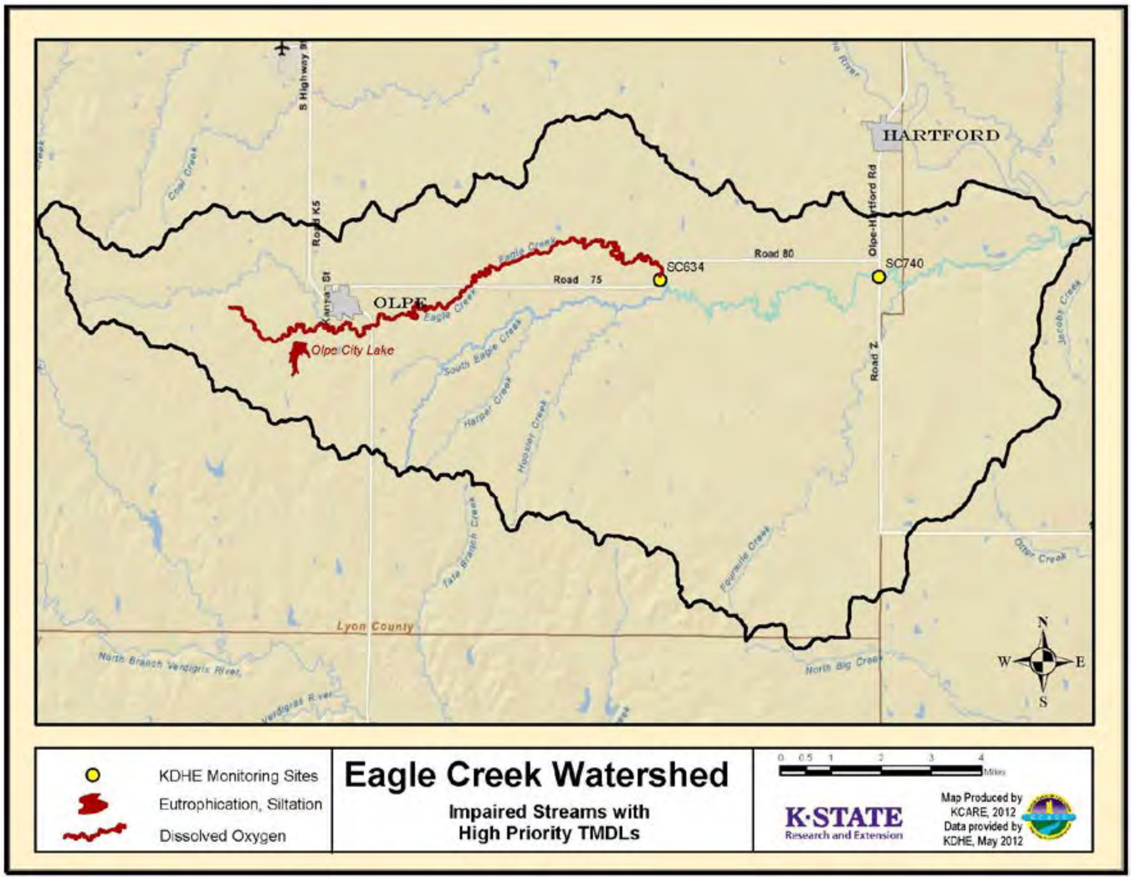

Figure 5. **Impaired Streams and Lakes with High Priority TMDLs.** The highlighted red portions are TMDLs that are not directly targeted (Olpe City Lake: Eutrophication and Siltation) or TMDLs that are not targeted at all (Low Flow: Eagle Creek) through this plan .

BMP implementation is the most vital part in addressing watershed impairments and the impairments within JRR. Table 4 shows the benefits of specific BMPs and the TMDLs they will be associated with.

Table 4. **Benefits of Planned BMPs to Address TMDLs and Impairments within 303d Listed Water Bodies in Eagle Creek Watershed and John Redmond Reservoir.**

BMP	Benefits	TMDL	303d Water Bodies
No-till	1. Enhance water infiltration and stream base flows	Dissolved Oxygen	Eagle Creek South Eagle Creek
	2. Reduce cropland nutrient runoff	Eutrophication	John Redmond Reservoir Olpe City Lake
	3. Reduce sheet erosion and corresponding sediment	Sedimentation	John Redmond Reservoir

BMP	Benefits	TMDL	303d Water Bodies
	inputs		Olpe City Lake
Minimum Tillage	1. Enhance water infiltration and stream base flows	Dissolved Oxygen	Eagle Creek South Eagle Creek
	2. Reduce cropland nutrient runoff	Eutrophication	John Redmond Reservoir Olpe City Lake
	3. Reduce sheet erosion and corresponding sediment inputs	Sedimentation	John Redmond Reservoir Olpe City Lake
Terraces	1. Reduce gully erosion and corresponding sediment inputs	Sedimentation	John Redmond Reservoir Olpe City Lake
Waterway	1. Reduce cropland nutrient runoff	Eutrophication	John Redmond Reservoir Olpe City Lake
	2. Filter sediments from runoff	Sedimentation	John Redmond Reservoir Olpe City Lake
Grassed Buffer	1. Reduce cropland nutrient runoff	Eutrophication	John Redmond Reservoir Olpe City Lake
	2. Filter sediments from runoff	Sedimentation	John Redmond Reservoir Olpe City Lake
Permanent Cover	1. Enhance water infiltration and stream base flows	Dissolved Oxygen	Eagle Creek South Eagle Creek
	2. Reduce sheet erosion and corresponding sediment inputs	Sedimentation	John Redmond Reservoir Olpe City Lake
	3. Reduce cropland nutrient inputs	Eutrophication	John Redmond Reservoir Olpe City Lake
Strategic Fencing	1. Reduce direct inputs of livestock nutrients	Eutrophication	John Redmond Reservoir Olpe City Lake
Permanent Cover	1. Reduce overland nutrient runoff		
Strategic Fencing	1. Reduce direct livestock waste inputs to stream	Eutrophication	John Redmond Reservoir Olpe City Lake

BMP	Benefits	TMDL	303d Water Bodies
Alternative Watering	1. Reduce direct livestock waste inputs to stream	Eutrophication	John Redmond Reservoir Olpe City Lake
Relocate Feed Area	1. Reduce direct livestock waste inputs to stream	Eutrophication	John Redmond Reservoir Olpe City Lake
Vegetative Filter Strip	1. Filter livestock nutrients from runoff	Eutrophication	John Redmond Reservoir Olpe City Lake
	2. Enhance water infiltration and stream base flows	Dissolved Oxygen	Eagle Creek South Eagle Creek

Note:

(1) The SLT expects that all nutrient inputs that address eutrophication impairments will also help reduce dissolved oxygen concentrations in Eagle Creek; however, nutrient input was not considered by the TMDL (KDHE 2002) as contributing to low dissolved oxygen in Eagle Creek.

3.3.2 303d Listings in the Watershed

A 303d list of impaired waters is developed biennially and submitted by KDHE to EPA. To be included on the 303d list, samples taken during the KDHE monitoring program must show that water quality standards are not being met. This in turn means that designated uses are not met. TMDLs will be developed over the next few years for "high" priority impairments. Current 303d impairments within Eagle Creek watershed are listed as low priority (Table 5), but they will continued to be observed for changes.

Table 5. 303d Impairments in Eagle Creek Watershed and John Redmond Reservoir. (KDHE[3] 2010).

Category	Water Segment	Impaired Use	Impairment	Station	Body Type	Priority
4A	Eagle Creek near Hartford	Aquatic Life	Copper	SC740	Stream	Low
4A	Eagle Creek near Olpe	Aquatic Life	Copper	SC634	Stream	Low
3	Eagle Creek near Olpe	Aquatic Life	Atrazne	SC634	Stream	Recent trends indicate concern

3.4 EAGLE CREEK WATERSHED

Designated uses for Eagle Creek include expected aquatic life support, secondary contact recreation, and food procurement. Of these, expected aquatic life support is impaired due to occasional low dissolved oxygen (DO). A total maximum daily load (TMDL) has been established (KDHE 2002). Excessive nutrient inputs commonly cause low DO in streams, however, for Eagle Creek it was concluded that low DO excursions were caused by periodic low flows. This was based on normal biological activity, as measured by biochemical oxygen demand (BOD). This is consistent with an Index for Biological Integrity (IBI) calculated from data collected in 1997 for Eagle Creek indicating a stable fish community, and similarly, a

Macroinvertebrate Biotic Index (MBI) indicating no impacts from nutrient and oxygen demanding pollutants (KDWP 2006). Land use within the watershed that could impact base flow could include conventional tillage limits on infiltration, tree encroachment in rangeland and tributary courses, and hydrological impacts due to dam construction. Nevertheless, lower DO still indicates an oxygen demand, and nutrient loads are likely greater than the lower flows can naturally assimilate. The SLT acknowledges that common sources for these nutrients, primarily phosphorus and nitrogen, come from livestock wastes and cropland fertilizers in the watershed. Consequently, land use practices that reduce these inputs and increase water infiltration, thus stream base-flow, will be promoted.

Copper is another pollutant considered as excessive in Eagle Creek, and for which a TMDL has been established with a low priority for addressing (KDHE 2002). The periodic high copper occurrences were likely from non-point sources, yet the non-point sources are unknown. Copper may originate from roads, cars, agricultural land use, copper based feeds or fertilizers, or building materials. BMPs to reduce sedimentation and nutrient inputs to address DO concerns may also result in a reduction of copper levels. Consequently, this plan will not focus on copper abatement.

Specific monitoring sites have been established within Eagle Creek Watershed (Figure 7). The data collected from these sites provide vital information to researchers in determining the health of the watershed. The SLT has determined that the existing number of monitoring sites are adequate based on the size of the watershed and no additional monitoring will be utilized.

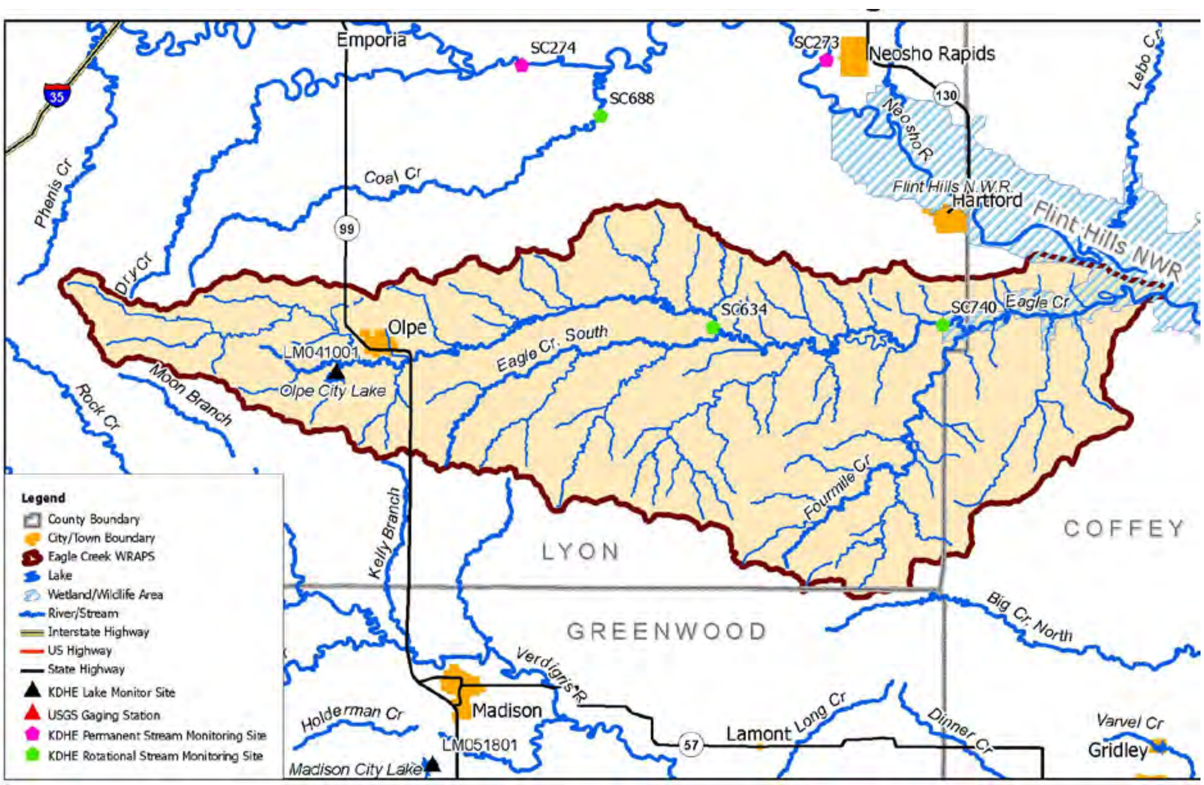

Figure 6. Stream and Lake Monitoring in Eagle Creek Watershed.

3.4.1 Point Sources

Within the watershed, permitted point sources are few and are not considered significant contributors to the impairments, assuming permit compliance. These point sources include the domestic waste lagoons operated by the City of Olpe and four currently state permitted animal feeding operations. Further information is available in the applicable TMDL (KDHE 2002).

The Eagle Creek Watershed encompasses an active rural community that is engaged in the livestock feeding business. Within the watershed there are currently four animal feeding operations (AFOs) that are permitted through the state of Kansas (Figure 8). All AFOs must confine animals for at least 45 days in a 12-month period, and no grass or other vegetation can be present in the confinement area during the normal growing season. These AFOs require permitting because they (1) exceed a certain number of animal units, (2) have manmade ditches or pipes that carry manure or wastewater to surface water, or (3) have animals that come into contact with surface water that passes through the area where they're confined or because they have caused a water quality complaint, were registered, evaluated and deemed a significant potential to pollute.

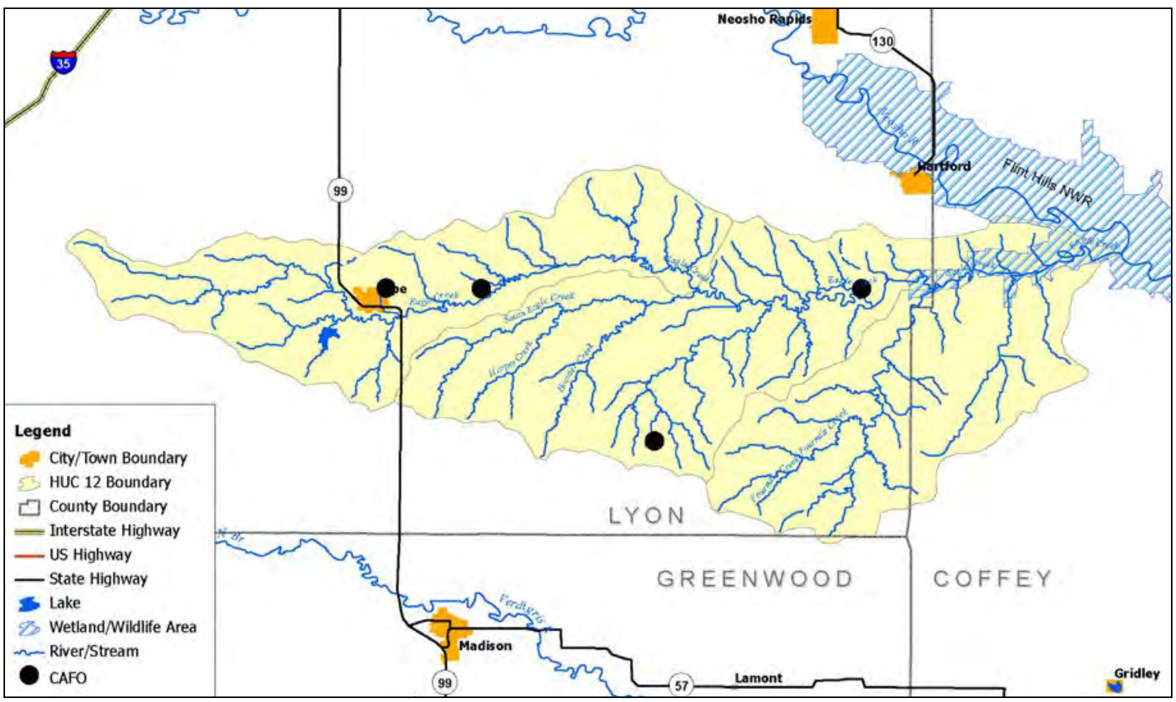

Figure 7. Active Animal Feeding Operations in Eagle Creek Watershed.

Another possible point source of pollution are the much smaller Animal Feeding Operations (AFOs), which do not require permitting. In order to be considered an AFO, the facility must confine animals for at least 45 days in a 12-month period, and no grass or other vegetation can be present in the confinement area during the normal growing season. AFOs were examined within Eagle Creek Watershed using a windshield survey method, which was done by traveling around the watershed and making observations. The approximate number of operations per sub-watershed was recorded and is displayed in Figure 8. At the time of the survey many animals were still out on grass pastures; therefore, to characterize where the operations were a number of factors had to be taken into account. These factors included hay storage, silage presence, feed bunks, watering structures, feeding pens, lack of or type of vegetation in these pens, and additional pieces of evidence that show signs of concentrated animal feedings. AFOs do not require permitting as long as they do not exceed a certain number of animal units, do not have a manmade ditch or pipe that carries manure or wastewater to surface water, or do not have animals that come into contact with surface water that passes through the area where they're confined or because they have caused a water quality complaint, were registered, evaluated and deemed a significant potential to pollute.

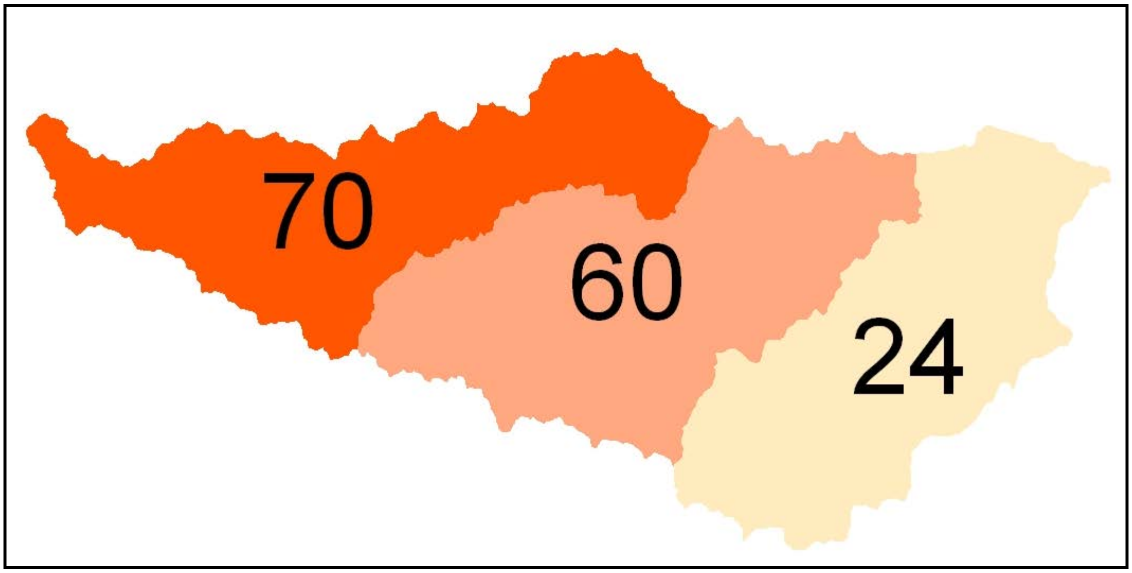

Figure 8. Estimated Number of Animal Feeding Operations per Sub-Watershed in Eagle Creek Watershed.

3.4.2 Public Water Supply (PWS) and National Pollutant Discharge Elimination System (NPDES)

A public water supply (PWS) that derives its water from a surface water supply can be affected by sediment – either in difficulty at the intake in accessing the water or in treatment of the water prior to consumption. Reservoirs can be affected by sediment due to capacity reduction.

Nutrients and fecal coliform bacteria will also affect surface water supplies causing excess cost in treatment prior to public consumption. Blue green algae blooms resulting from excess nutrients can cause conditions restricting or prohibiting use. This can reduce lake user numbers thus affecting the income of businesses or communities serving the recreational (bait shops, city fishing fees etc.). Potable water suppliers in the watershed include the City of Olpe, Lyon County RWD No. 3, and Coffey County RWD No. 2. Supply is piped in from sources outside the watershed. No public potable water supplies are obtained from the Eagle Creek watershed.

Wastewater treatment facilities are permitted and regulated through KDHE. National Pollutant Discharge Elimination System (NPDES) permits specify the maximum amount of pollutants allowed to be discharged to surface waters. Having these point sources located on streams or rivers may impact water quality in the waterways. For example, municipal waste water can contain suspended solids, biological pollutants that reduce oxygen in the water column, inorganic compounds or bacteria. Waste water will be treated to remove solids and organic materials, disinfected to kill bacteria and viruses, and discharged to surface water. Treatment of municipal waste water is similar across the country. Industrial point sources can contribute toxic chemicals or heavy metals. Treatment of industrial waste water is specific to the industry and pollutant discharged. Any pollutant discharge from point sources that is allowed by the state is considered to be Wasteload Allocation. The city of Olpe is permitted through NPDES (Table 6).

Table 6. NPDES Permitted Discharger in Eagle Creek Watershed. (KDHE 2002)**.**

Discharging Facility	Stream Reach	Segment	Design Flow	Type
Olpe MWPT	Eagle Creek	25	0.1671 cfs	Lagoon

3.5 JOHN REDMOND RESERVOIR

Eagle Creek's confluence with the Neosho River is immediately upstream of the conservation pool of JRR. This federal reservoir provides water storage for flood control, industrial and municipal use. Water quality TMDL impairments that have been identified include eutrophication and siltation (KDHE 2002). The BMPs implemented through this plan will focus on reducing the amount of nutrients and sediments to JRR, which addresses the reservoir's TMDLs (see section 5.0 for more details).

3.6 OLPE CITY LAKE

The Olpe City Lake currently has designated TMDL's for eutrophication and siltation (KDHE 2002). Designated uses for the lake are for primary and secondary contact recreation, expected aquatic life support, and food procurement. WRAPS implementation, using BMPs, will contribute to addressing agricultural non-point sources of nutrients and sediments to the lake.

Excessive sedimentation within JRR also impacts storage volume, which presents significant implications during drought conditions to the domestic and industrial water users in the region. Such impacts are beyond the Neosho River basin. The primary industrial purpose of JRR storage is for make-up water to the Coffey County Lake, which is the cooling water reservoir for Wolf Creek Generating Station. Consequently, the Kansas Water Authority in the Kansas Water Plan (KWA 2009) has given high priority to protecting Neosho Basin reservoirs, with JRR loss of capacity from sedimentation being the most pressing issue. This ECWRAPS can be included in the efforts to protect JRR.

3.7 TMDL LOAD ALLOCATIONS

TMDL loading is based on several factors. A total load is derived from the TMDL. Part of this total load is wasteload allocation. This portion comes from point sources in the watershed: NPDES facilities, CAFOs or other regulated sites. Some TMDLs will have a natural or background load allocation, which might be atmospheric deposition or natural mineral content in the waters. After removing all the point source and natural contributions, the amount of load left is the TMDL Load Allocation. This is the amount that originates from nonpoint sources (pollutants originating from diffuse areas, such as agricultural or urban areas that have no specific point of discharge) and is the amount that this WRAPS project is directed to address. The load allocations were provided by KDHE TMDL Watershed Management Section, November 2011 and May 2012. All BMPs derived by the SLT will be directed at these load allocations by nonpoint sources.

The Eagle Creek Watershed has been assigned an annual load reduction goal of 9,480 tons of total sediment/suspended solids. The watershed also has been assigned an annual load reduction goal of 14,321 pounds of total phosphorus, which is 5 percent of the nonpoint source phosphorous load reduction for JRR.

Eagle Creek Watershed will focus on reducing sedimentation and phosphorus loads to Eagle Creek and subsequent delivery to JRR. Load reductions were derived from TMDL review and Soil and Water Assessment Tool (SWAT) modeling adapted from the Neosho Headwaters WRAPS (KSU, 2010).

3.6.1 Siltation

KDHE has set a load reduction goal for siltation for JRR originating from nonpoint sources. This amount is 297,600 tons per year. It is derived from subtracting the total silt load capacity from the silt current condition (Table 7) & (Figure 9). This is the amount that the Eagle Creek, Neosho Headwaters, and the Cottonwood Watersheds will need to remove through BMP installations and conservation practices. In addition to naming a load reduction for the reservoir, KDHE has determined that the Eagle Creek Watershed is responsible for 3.2% (Figure 10) of the load allocation or 9,480 tons of sediment (Table 7).

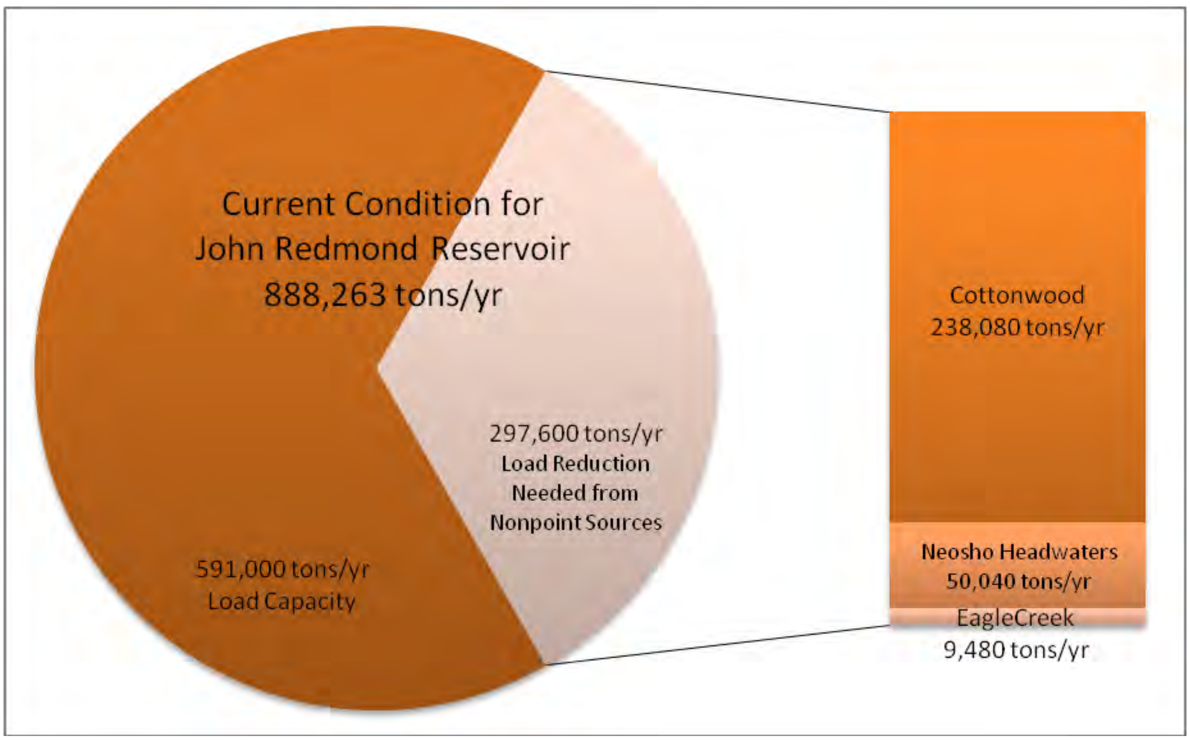

Figure 9. Sediment Load Allocation Amounts for Cottonwood, Eagle Creek and Neosho Headwaters Watersheds.
Total sediment load to JRR is 888,263 tons per year.

Table 7. Siltation Load Allocation for Eagle Creek Watershed. Provided by KDHE TMDL Watershed Management Section, November 2011.

John Redmond Reservoir Siltation TMDL	
Silt Current Condition (tons)	888,623
Less Total Silt Load Capacity (tons)	591,000
Required Load Reduction from Nonpoint Sources (tons) for JRR	**297,600**
Required Annual Load Reductions by Watersheds (tons/yr) to meet TMDL	
Cottonwood (80% of total load reduction)	238,080
Neosho Headwaters (15% of total load reduction)	50,040
Eagle Creek (5% of total load reduction)	**9,480**
Total Load Reduction for John Redmond Reservoir	**297,600**

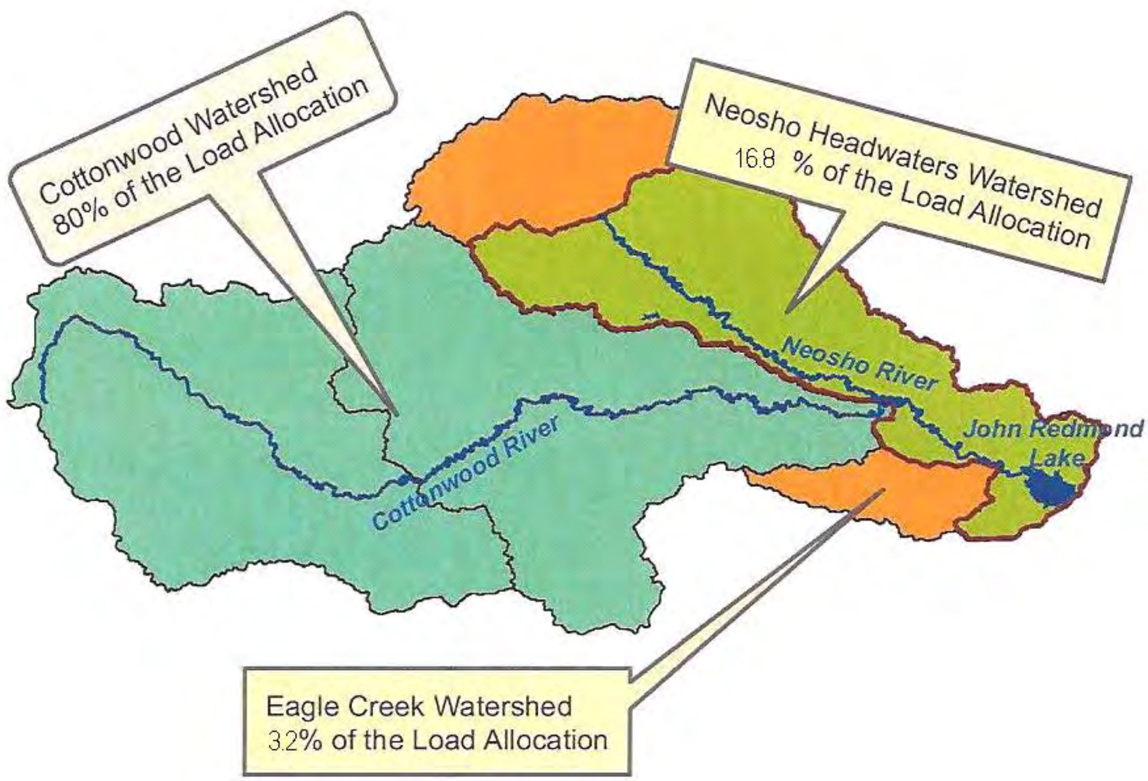

Figure 10. Sediment Load Allocation Percentage Breakdown in Eagle Creek, Neosho Headwaters, and Cottonwood Watersheds.

3.6.2 Phosphorous

The same principal has been applied to phosphorus loads. KDHE has set a load reduction goal for phosphorus in JRR originating from nonpoint sources. This amount is 286,408 pounds per year. It is derived from subtracting the total phosphorus load capacity from the current condition of phosphorus concentration in the reservoir (Figure 11). This is the amount that the Eagle Creek, Neosho Headwaters, and the Cottonwood Watersheds will need to remove through BMP installations and conservation practices. In addition to naming a load reduction for the reservoir, KDHE has determined that the Eagle Creek Watershed is responsible for 5% of the load allocation (Figure 12) or 14,321 pounds of phosphorus (Table 7).

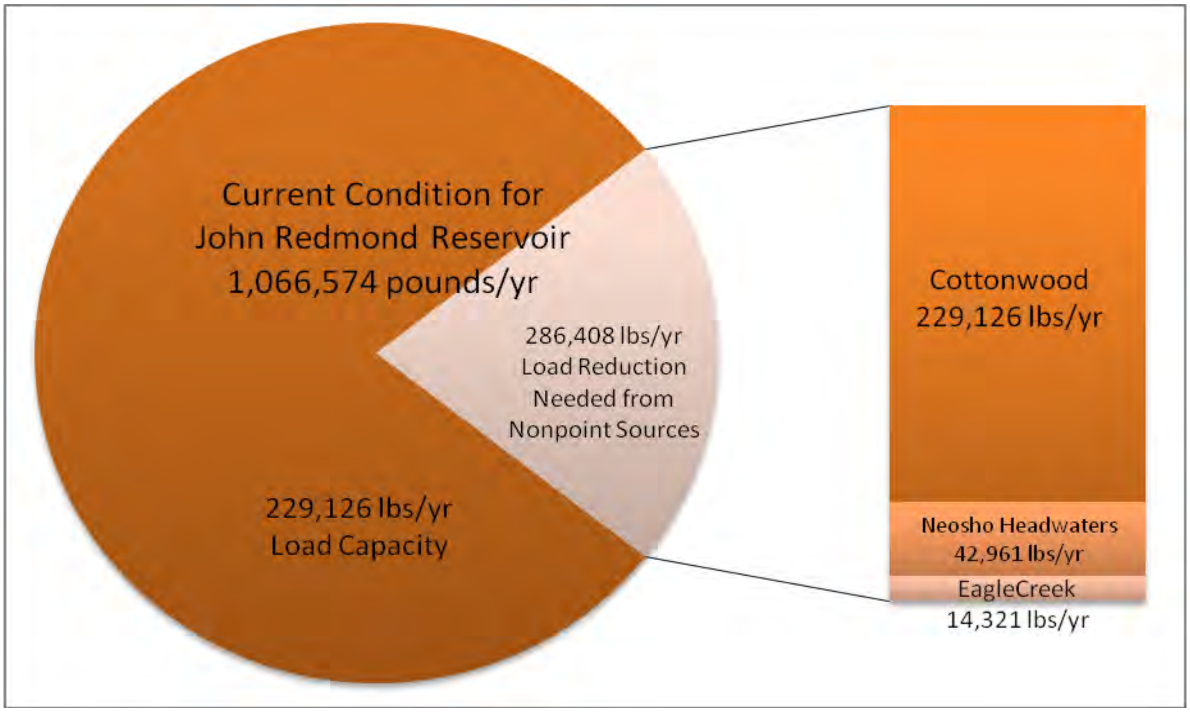

Figure 11. Phosphorus Load Allocation Amounts for Cottonwood, Eagle Creek and Neosho Headwaters Watersheds. Total phosphorus load in JRR is 1,352,982 pounds per year.

Table 8. Phosphorus Load Reduction for Eagle Creek Watershed. Provided by KDHE TMDL Watershed Management Section, November 2011.

John Redmond Reservoir Eutrophication TMDL	
Total Phosphorous (P) Current Condition (lbs)	1,352,982
Less Total P Load Capacity (lbs)	1,066,574
Required Load Reduction from Nonpoint Sources (lbs) for JRR	***286,408***
Required Annual Load Reductions by Watersheds (lbs/yr) to meet TMDL	
Cottonwood (80% of total load reduction)	229,126
Neosho Headwaters (15% of total load reduction)	42,961
Eagle Creek (5% of total load reduction)	**14,321**
Total Load Reduction for John Redmond Reservoir	***286,408***

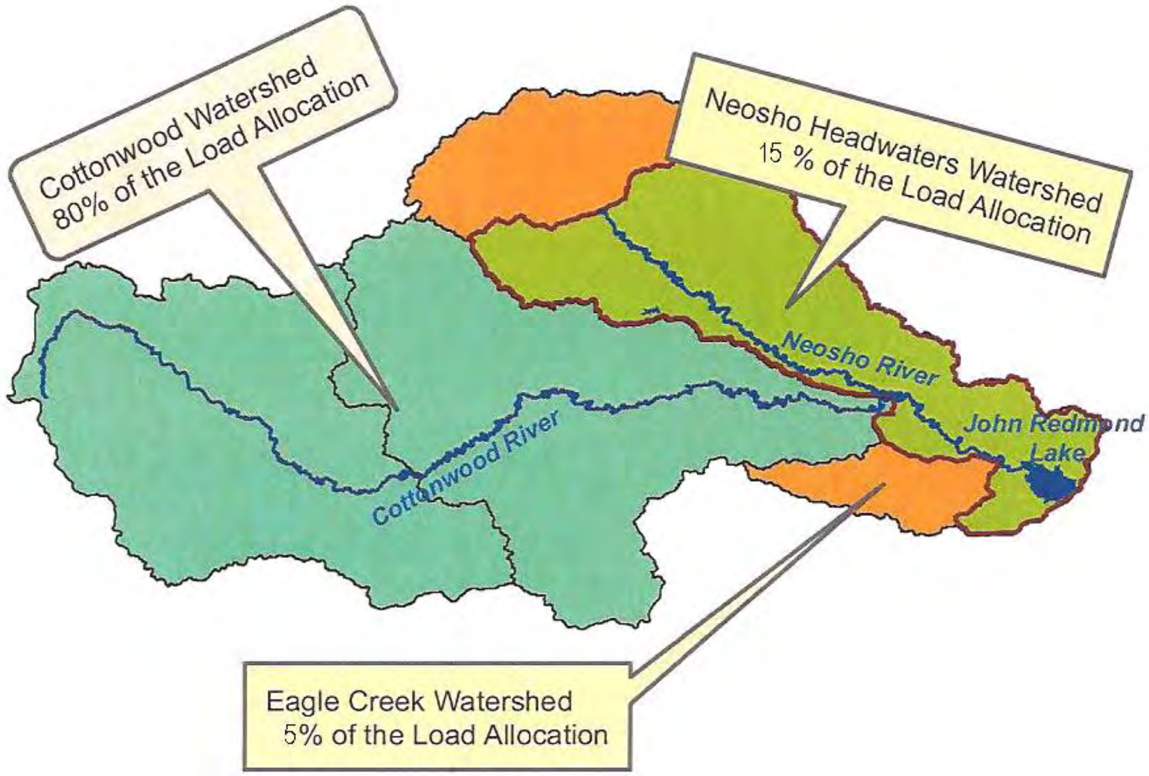

Figure 12. Phosphorus Load Allocation Percentage Breakdown in Eagle Creek, Neosho Headwaters, and Cottonwood Watersheds.

4.0 CRITICAL TARGETED AREAS

4.1 CROPLAND AND LIVESTOCK TARGETED AREAS

The Eagle Creek Watershed was examined for sediment from cropland and livestock related pollutants using the Spreadsheet Tool for Estimating Pollutant Load (STEPL) from Kansas Department of Health and Environment (KDHE). STEPL employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best BMPs. STEPL provides a user-friendly Visual Basic interface to create a customized spreadsheet-based model in Microsoft (MS) Excel. It computes watershed surface runoff; nutrient loads, including nitrogen, phosphorus, and 5-day biological oxygen demand (BOD5); and sediment delivery based on various land uses and management practices. For each watershed, the annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The annual sediment load (sheet and rill erosion only) is calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using the known BMP efficiencies. Results show that load contributions among the sub-watersheds are relatively consistent. This indicates that targeting BMPs at the HUC 12 level would provide little advantage to achieving the overall reductions.

However, when potential to erode estimates from STEP L modeling were completed for the entire Neosho Headwaters Watershed (HUC 11070201, Figure 13), the SLT recognized value in prioritizing efforts. Even though this model was not calibrated for flow, it stills shows the Eagle Creek influences to JRR ranked high relative to the Neosho River Watershed upstream of JRR. The STEP L modeling produced a map for sediment (Figure 13), and the darker colors on the map indicate a greater potential for sediment runoff.

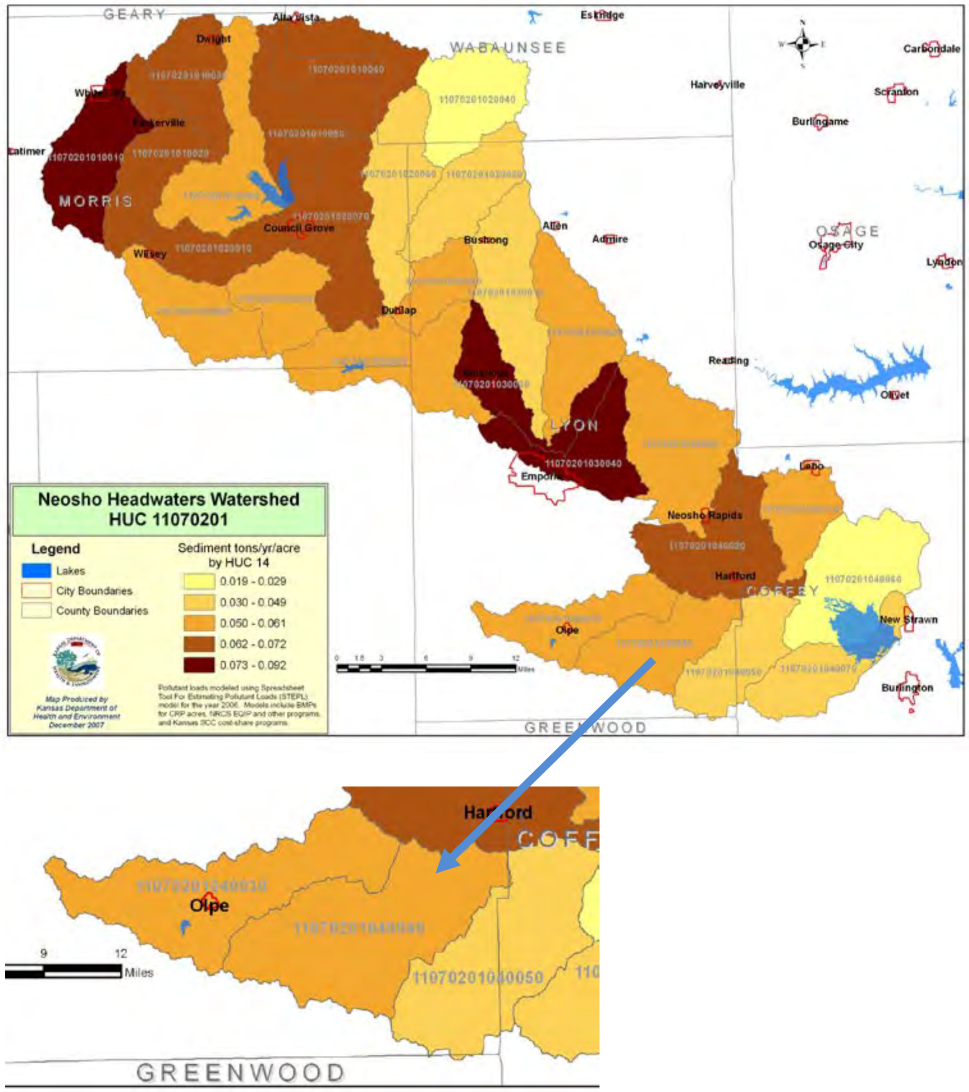

Figure 13. Total Sediment Yield Potential of Eagle Creek Sub Watersheds.

Eagle Creek Watershed was also assessed for sediment from cropland and livestock related pollutants using the Soil and Water Assessment Tool (SWAT) by Kansas State University Department of Biological and Agricultural Engineering. SWAT was used as an assessment tool to estimate annual average pollutant loadings such as nutrients and sediment that are coming from the land into the stream. At the end of simulation runs the average annual loads are calculated for each sub watershed. Some subbasins have higher average annual loads than the others. All subbasins are ranked based on the values of an average annual load, sorted from highest to lowest, and form the ranking list. Subbasins within top 20% to 30% of the list are selected as critical (targeted) areas for cropland and livestock BMPs implementation.

The SWAT model was developed by USDA-ARS from numerous equations and relationships that have evolved from years of runoff and erosion research in combination with other models used to estimate pollutant loads from animal feedlots, fertilizer and agrochemical applications, etc. The SWAT model has been tested for a wide range of regions, conditions, practices, and time scales. Evaluation of monthly and annual streamflow and pollutant outputs indicate SWAT functioned well in a wide range of watersheds. The model directly accounts for many types of common agricultural conservation practices, including terraces and small ponds; management practices, including fertilizer applications; and common landscape features, including grass waterways. The model incorporates various grazing management practices by specifying amount of manure applied to the pasture or grassland, grazing periods, and amount of biomass consumed or trampled daily by the livestock. Septic systems, NPDES discharges, and other point-sources are considered as combined point-sources and applied to inlets of sub watersheds. These features made SWAT a good tool for assessing rural watersheds in Kansas.

The SWAT model is a physically based, deterministic, continuous, watershed scale simulation model developed by the USDA Agricultural Research Service. ArcGIS interface of ArcSWAT version 9.2 was used. It uses spatially distributed data on topography, soils, land cover, land management, and weather to predict water, sediment, nutrient, and pesticide yields. A modeled watershed is divided spatially into sub watersheds using digital elevation data according to the drainage area specified by the user. Sub watersheds are modeled as having non-uniform slope, uniform climatic conditions determined from the nearest weather station, and they are further subdivided into lumped, non-spatial hydrologic response units (HRUs) consisting of all areas within the sub watershed having similar soil, land use, and slope characteristics. The use of HRUs allows slope, soil, and land-use heterogeneity to be simulated within each
Critical Targeted Areas sub watershed, but ignores pollutant attenuation between the source area and stream and limits spatial representation of wetlands, buffers, and other BMPs within a sub watershed.

The model includes subbasin, reservoir, and channel routing components.

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

The SWAT modeling produced maps for sediment (Figure 14). The red color on the map indicates a highest potential for sediment yield.

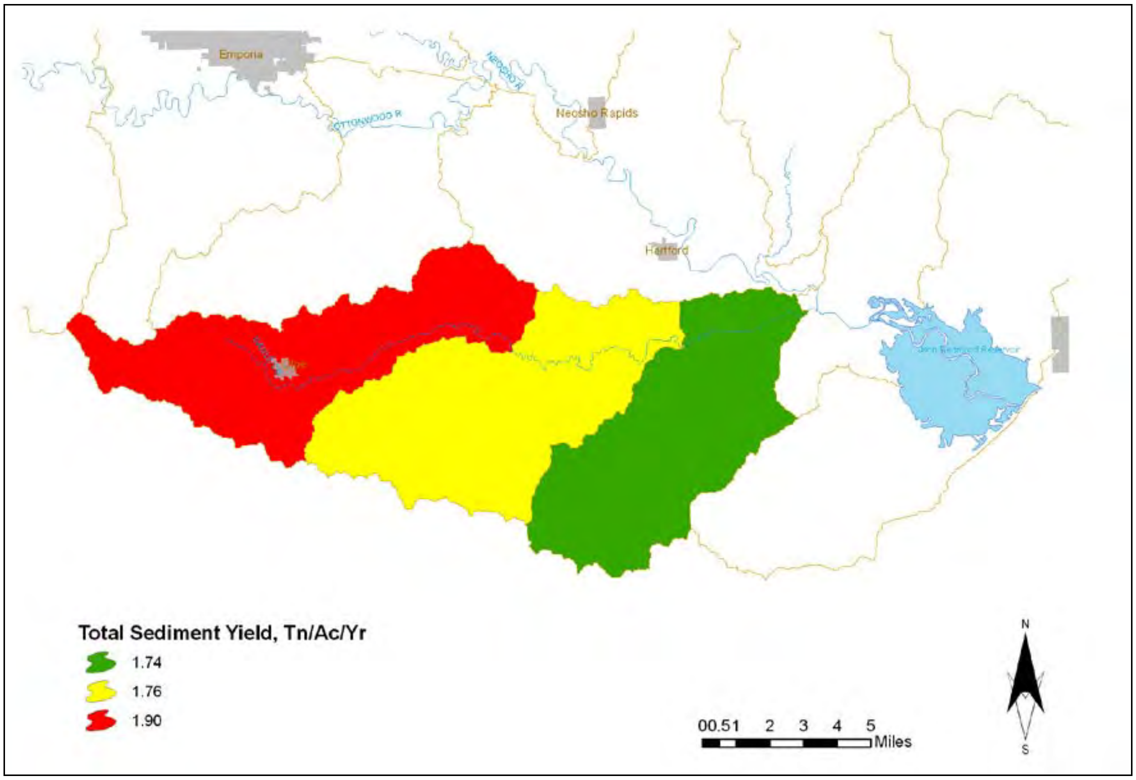

Figure 14. Total Sediment Yield (tons/acre) as indicated by SWAT.
Eagle Creek Headwaters Sub-Watershed in Red.

The STEP L and SWAT models were also used to estimate phosphorous load from each Eagle Creek Sub-watershed, and the results are illustrated in Figure 15 (STEP L) and 16 (SWAT).

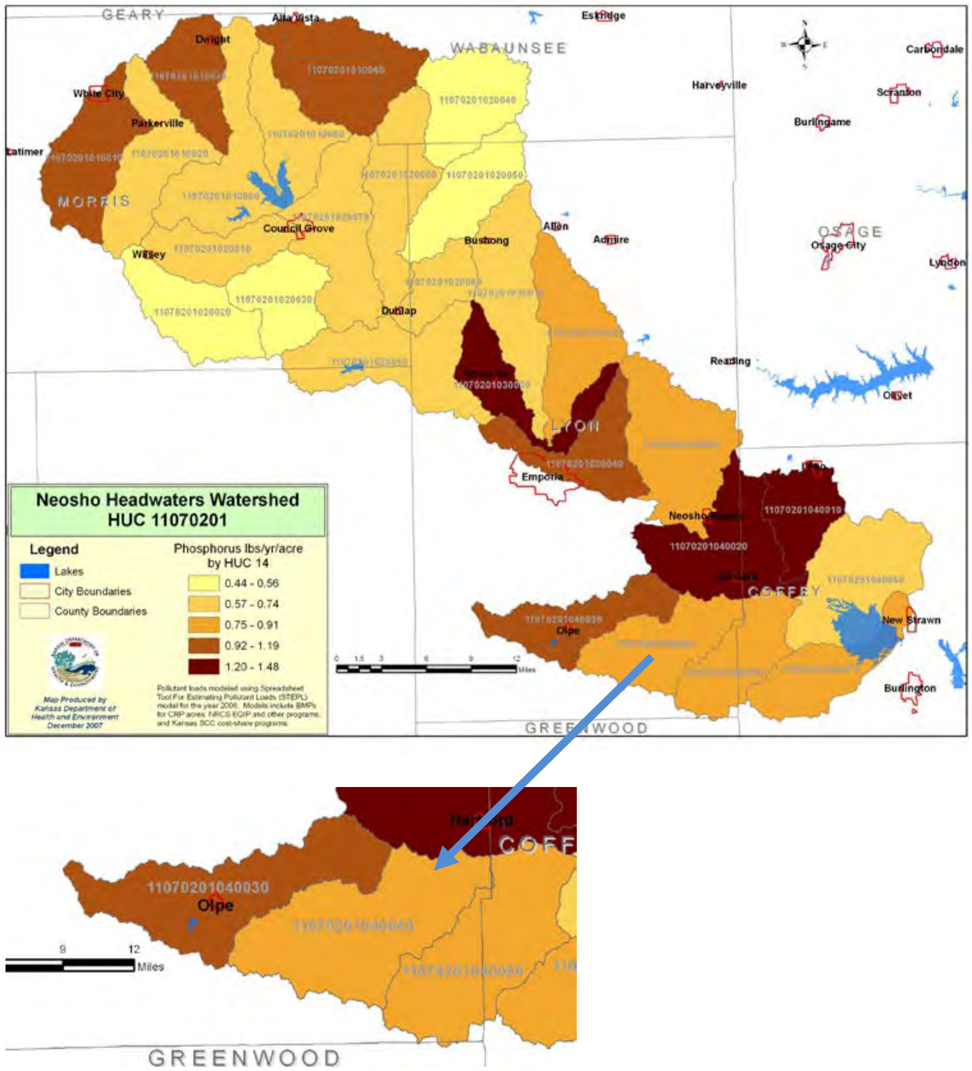

Figure 15. Total Phosphorous Yield Potential of Eagle Creek Sub Watersheds.

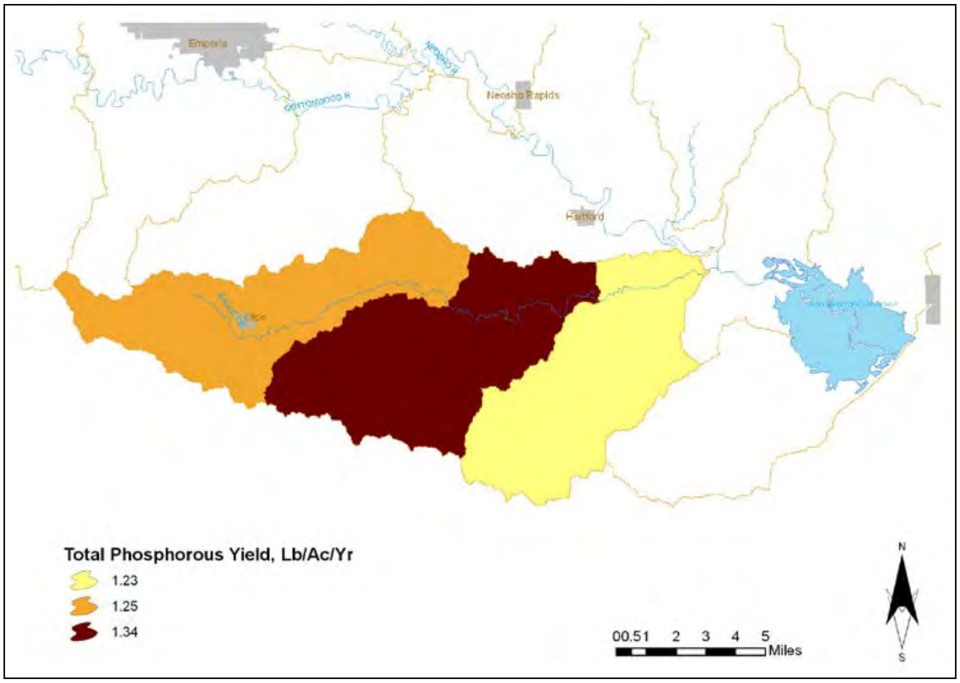

Figure 16. Total Phosphorous (lbs/acre) as indicated by SWAT. *South Eagle Creek tributary in brown.*

4.1.1 Cropland Targeted Areas

The combination of the STEP L and SWAT models indicated the area of Eagle Creek Watershed that is most susceptible to cropland erosion resulting in sediment deposition in downstream water supplies (Figure 17). Based on the models the SLT determined the rankings of each sub-watershed in terms of those most in need of sediment reducing BMPs and they are listed below (highest to lowest priority):

1. Eagle Creek Headwaters, HUC 1107020104(030)
2. South Eagle Creek, HUC 1107020104(040)
3. Fourmile Creek, HUC 1107020104(050)

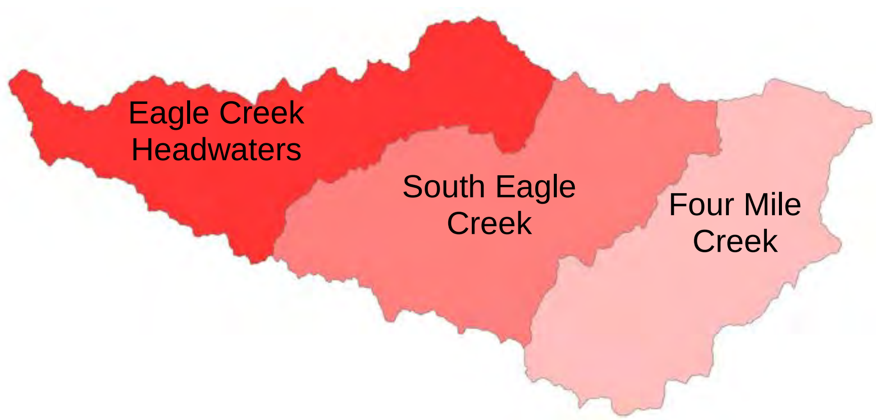

Figure 17. Priority Sub Watersheds for Sediment Reduction in Eagle Creek Watershed. *(Darkest red indicates priority)*

4.1.2 Livestock Targeted Areas

The combination of the STEP L and SWAT models indicated the areas of Eagle Creek Watershed that are most at risk for contributing phosphorous pollutants to downstream water supplies. Using the results of the models combined with the results of the AFO windshield survey the SLT was able to come to a consensus on the targeted watershed (Figure 18). Based on that consensus the SLT determined the rankings of each sub-watershed in terms of those most in need of phosphorous reducing BMPs, and they are listed below (highest to lowest priority):

1. Eagle Creek Headwaters, HUC 1107020104(030)
2. South Eagle Creek, HUC 1107020104(040)
3. Fourmile Creek, HUC 1107020104(050)

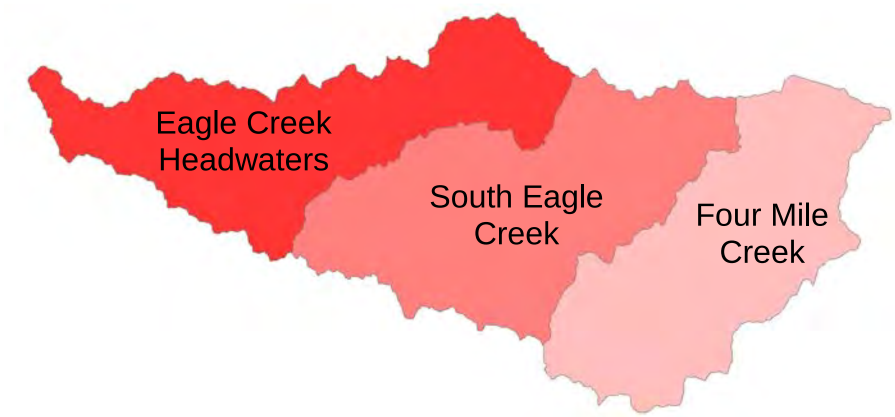

Figure 18. Priority Sub Watersheds for Phosphorous Reduction in Eagle Creek Watershed.
(Darkest red indicates priority)

4.2 LOAD REDUCTION ESTIMATE METHODOLOGY

4.2.1 Cropland

Baseline loadings are calculated using the SWAT model delineated to the HUC 12 watershed scale. Best management practice (BMP) load reduction efficiencies are derived from K-State Research and Extension Publication MF-2572 (KSU 2003). Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

4.2.2 Livestock

Baseline nutrient loadings per animal unit are calculated using the Livestock Waste Facilities Handbook. Livestock management practice load reduction efficiencies are derived from numerous sources including K-State Research and Extension Publication MF-2737 and MF-2454.28 (Powell & George 2006). Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

5.0 IMPAIRMENTS ADDRESSED BY SLT

5.1 SEDIMENT

JRR and Olpe City Lake each have a TMDL for **siltation (sedimentation)**. Silt or sediment accumulation in lakes and wetlands reduces reservoir volume and therefore, limits public access to the lakes because of inaccessibility to boat ramps, beaches and the water side. Also, a decrease in storage in the lake affects domestic and industrial uses of the lake water. In addition to the problem of sediment loading in lakes, pollutants can be attached to the suspended soil particles in the water column causing additional impairments.

Sediment can originate from streambank erosion and sloughing of the sides of the river and stream due to erosion and a lack of riparian cover. Sheet and rill erosion from cropping and pasture systems contributes sediment in the ecosystem; therefore, reducing erosion is necessary for accomplishing a reduction in sediment. Agricultural best management practices (BMPs) such as no-till, minimum tillage, buffer strips around cropland, terraces, grassed waterways and reducing activities within the riparian areas will reduce erosion and improve water quality.

Activities performed on the land affects sediment that is transported downstream to the lakes. Physical components of the terrain are important in sediment movement. The slope of the land, its propensity to generate runoff and soil type is important. Animal movement, such as livestock that regularly cross the stream, can cause pathways that will erode. Another source of sediment is silt that is present in the stream from past activities and is gradually moving downstream with each high intensity rainfall event.

5.1.1 Cropland Erosion

The siltation impairment in JRR and Olpe City Lake is most likely due to cropland erosion. Soil from exposed land runs off into the streams and lakes, which increases the turbidity and concentration of total suspended solids and decreases the transparency. Cropland erosion BMPs have been targeted by STEPL and SWAT modeling analysis. The targeted area is located in the sub-watershed that includes the city of Olpe, which is the furthest sub-watershed from JRR. Causes of erosion are discussed in more detail in the rest of this section.

5.1.1.A Land Use

Land use activities have a significant impact on the types and quantity of sediment transfer in the watershed. Construction projects in the watershed and in communities can leave disturbed areas of soil and unvegetated roadside ditches that can wash in a rainfall event. In addition, agricultural cropland that is under conventional tillage practices as well as a lack of maintenance of agricultural BMP structures can have cumulative effects on land transformation through sheet and rill erosion. The primary land uses in the watershed are grasslands (58%) and cropland (32%). (Figure 19). The lack of urban areas within the watershed confirms that much of silt and sediment, causing the TMDL in JRR and Olpe City Lake, derives from the large acreage of cropland and grasslands. The primary land uses in the **targeted area** of the watershed are nearly identical to those of the whole watershed, grassland (58%) and cropland (33%) (Table 9).

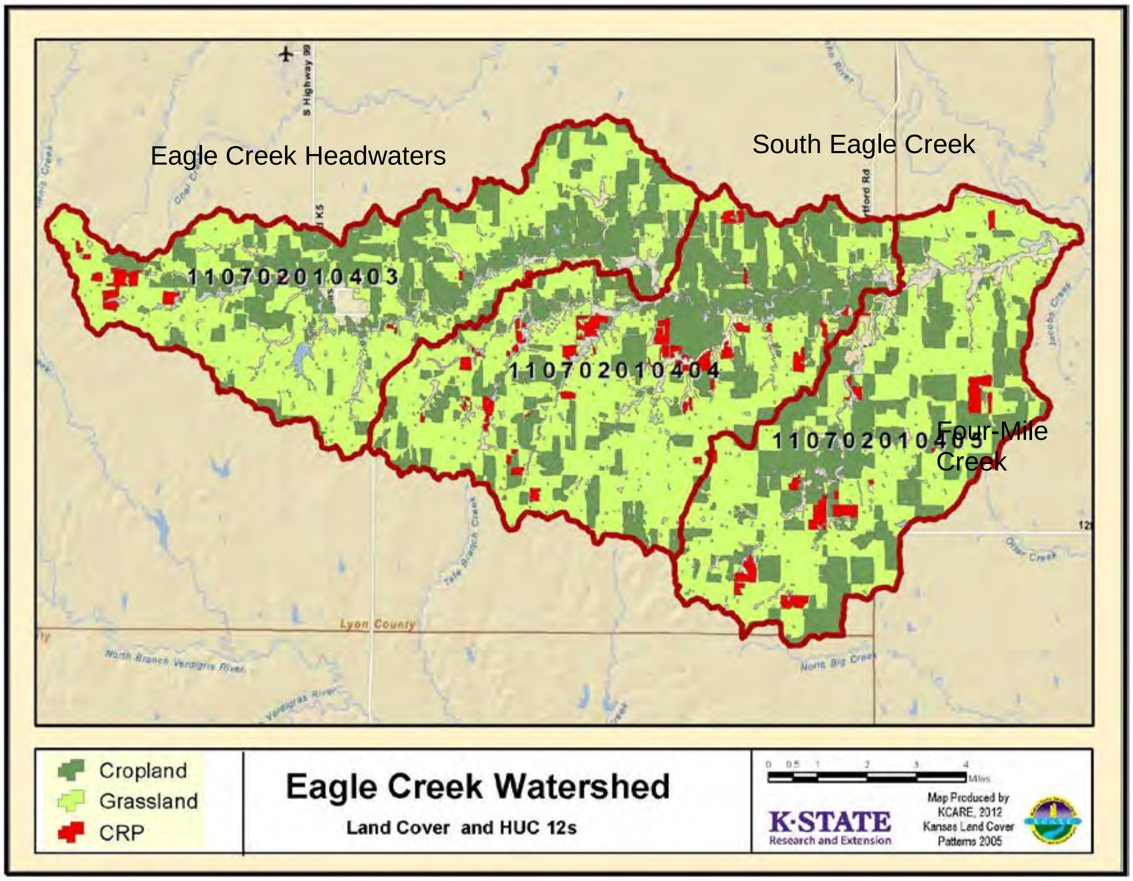

Figure 19. Land Cover in Eagle Creek Watershed.

Table 9. Land Use in the Eagle Creek Watershed Targeted Area.

Eagle Creek Headwaters Targeted Area (HUC12 - 110702014030)		
Land Use	**Acres**	**Percentage**
Grass Cover	13,646	57.9%
Cropland	7,790	33%
Wood	1,208	5.1%
CRP	369	1.6%
Water	255	1.1%
Urban Open	193	0.8%
Residential	88	0.4%
Industrial	27	0.1%
Urban Wood	5	0%
Urban Water	2	0%
TOTAL	**23,582**	**100%**

5.1.2 Steambank Erosion

A qualitative streambank erosion assessment which included the Eagle Creek watershed was performed by the Kansas Water Office using ArcGIS® software. The purpose of the assessment was to identify locations of streambank instability to prioritize restoration needs along streambanks to slow sedimentation rates above JRR. ArcMap®, an ArcGIS® geospatial processing program, was utilized to assess color aerial photography from 2008, provided by National Agriculture Imagery Program (NAIP), and compared it with 1991 black and white aerial photography provided by Data Access & Support Center (DASC). Erosion sites identified in this assessment include locations of stream bank erosion and gully erosion.

The protection of riparian and wetland areas, when systematically implemented and targeted above water supply reservoirs, may significantly reduce future sediment loads, extending storage capacity. An approach that targets entire reaches in the highest priority areas for stabilization, instead of individual scattered sites, is more effective at reducing sediment loads. In an effort to identify the highest priority stream reaches, the Kansas Water Office is conducting assessments using Geographical Information Systems (GIS) and stream water quality monitoring data in the watersheds above water supply reservoirs. As assessments are completed, results are shared with Watershed Restoration and Protection Strategy (WRAPS) Stakeholder Leadership Teams (SLTs) and other agencies to guide prioritization of stream bank restoration to reaches where erosion is most severe.

The assessments quantify annual tons of sedimentation from stream banks within a reservoir's watershed and identify the specific reaches of stream from which the majority of sediment is contributed. Estimated costs for stream bank stabilization are included with the assessment aiding in the planning for future restoration projects.

Another form of erosion contributing to sedimentation in many watersheds in Kansas is the development of gullies alongside streams. Assessment of gully erosion, where appropriate, is included in the assessments.

The visual assessment of Eagle Creek above JRR between 1991 and 2008 aerial photography indicated that the Eagle Creek Watershed is not a high priority for streambank restoration for the purpose of sedimentation reduction. Based on ability to visually identify streambank erosion, none were found to be significant. However, using only speculative views from aerial photography, two instances of potential streambank erosion were identified (Figure 20). Both, however, were not likely significant enough to classify them as a high priority for streambank restoration for sediment reduction.

Most of the riparian area appeared well intact, dominated with a 50 foot or more woodland riparian area and in some cases a 50 foot or more grass buffer. The stream doesn't appear to be cutting new paths and the bends in the stream appeared stable. Visual assessment did show instances of land/gully erosion in cropland fields that could be contributing a relatively small amount of sediment to the streams. In relation to the sediment reduction inputs to JRR, these gullies are low to medium priority. This means that there are either instances of land erosion with no visual channel incisment (low priority), or there are instances of land erosion and visual channel incisment, but no significant riparian erosion of the streambank itself (medium priority).

In summary, evaluation of streambank and riparian areas within the Eagle Creek Watershed showed a low potential for significant sediment contributions to JRR. Two streambank areas were identified that may be valuable for the WRAPS SLT to consider promoting bank stabilization or riparian vegetation projects. Assessment of gully erosion indicated adequate riparian function, but with evidence gully erosion within cropland areas. Targeting conservation efforts on streambank and gully erosion projects within Eagle Creek should be considered a low priority relative to the entire JRR watershed.

Figure 20. Potential Streambank Erosion Sites in Eagle Creek Watershed. The two sites were identified by the Kansas Water Office and are shown in green. Section, township and range locators are shown on figure.

5.1.3 Sediment BMPs with Acres or Projects Needed

The total annual load reduction allocated to Eagle Creek that is needed to meet JRR's sediment TMDL is 9,480 tons of sediment.

The SLT has laid out specific BMPs that they have determined will be acceptable to watershed residents and those commonly used throughout the watershed. **These BMPs will be implemented in the cropland targeted areas to reduce sediment runoff.** An added bonus is that the cropland BMPs aimed at reducing sediment runoff will also address the nutrient/phosphorus impairments. The nutrient/phosphorus BMPs are also listed in Section 5.2.4 of this plan. Specific acreages or projects that need to be implemented per year have been determined through modeling and economic analysis completed in reference to the Neosho Headwaters Watershed 9-Element Plan. However, the Eagle Creek WRAPS SLT reserves the right to install additional and/or different BMPs anywhere in the watershed, as long as the SLT deems that a significant reduction in pollution will occur and there are not any competing projects in higher priority areas. Extensive efforts will be made to implement BMPs in the higher priority areas before turning to the lower priority areas.

In order to determine the amount of BMPs needed on the ground, the SLT decided they first must know how many BMPs are currently been utilized within the watershed On May 4, 2012, Eagle Creek was groundtruthed by local agency personnel and members of the stakeholder leadership team that were familiar with the area and its land use history. Groundtruthing involves conducting windshield surveys throughout the targeted areas identified by the watershed models to determine which BMPs are currently installed. In every sub-watershed ten stops were made at four way intersections (Figure 21); the BMPs present at each of those four way stops was recorded. Groundtruthing provides the current adoption rate of BMPs (Table 10), the adoption rate goals (Table 11), the acres needed to be implemented (Table 11), and may bring forth additional water quality concerns not captured by watershed modeling.

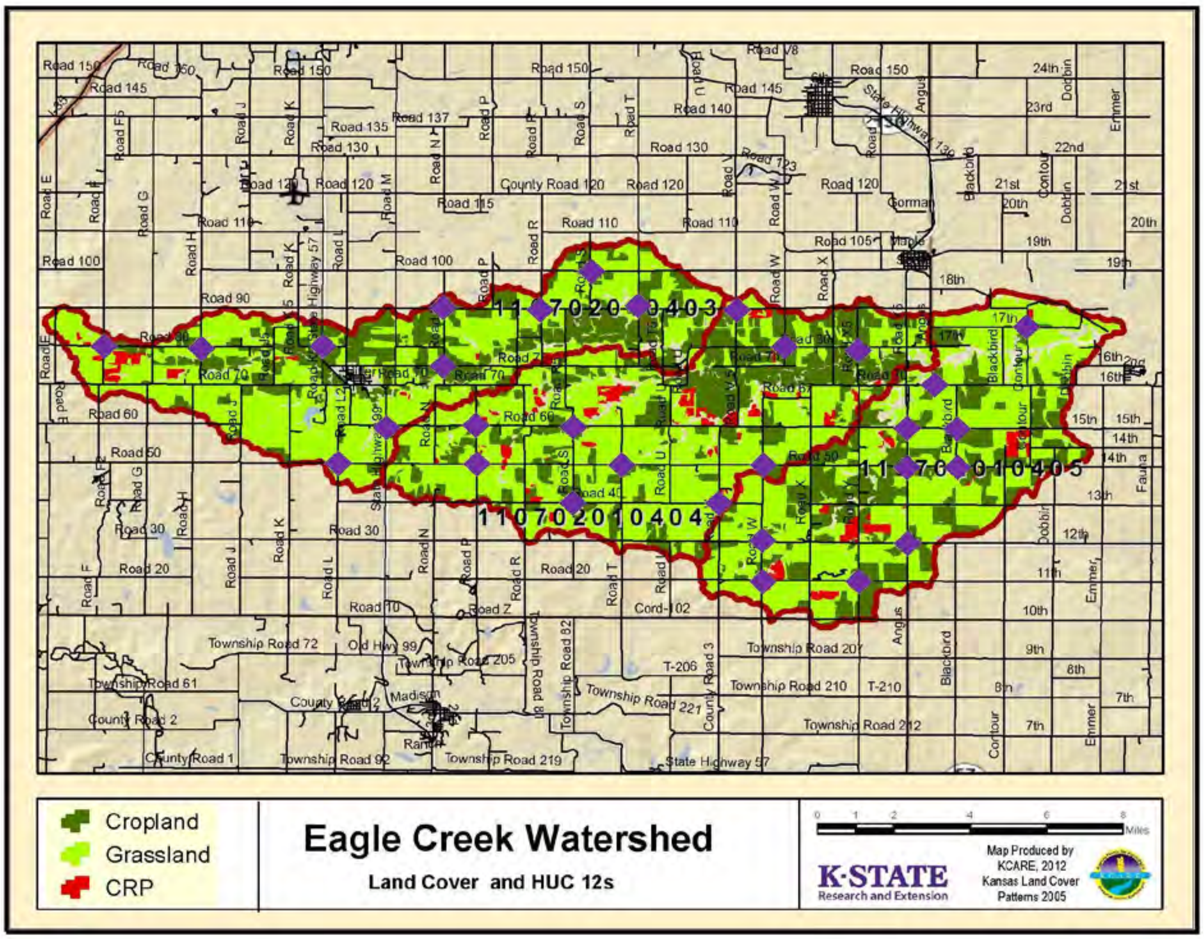

Figure 21. Eagle Creek Sub Watershed Groundtruthing Map. Ground truthing stops are shown as a purple star.

Table 10. Current BMP Adoption Rate in Eagle Creek Watershed.

Eagle Creek BMP Adoption Rates, BMP Condition, and Gully Erosion								
	Current BMPs					Condition of BMPs		
Sub Watershed	Grassed Waterway	Terraces	No-Till	Permanent Vegetation	Buffer	Gully Erosion	Low Terraces	Non-Functioning Waterway
30	23%	45%	18%	0%	9%	32%	70%	40%
40	47%	76%	12%	0%	0%	41%	54%	38%
50	14%	50%	27%	9%	0%	14%	45%	67%
Overall	**26%**	**56%**	**20%**	**3%**	**3%**	**28%**	**56%**	**44%**
Adjusted Overall	*14% (good)*	*25% (good)*						

Table 11. BMPs and Acres Needed to Reduce Sediment Contribution Aimed at Meeting the Siltation TMDL for John Redmond Reservoir.

Protection Measures	BMPs and Other Action	Acres Needed to be Implemented		
		Cropland Groundtruthing Determined by Adoption Rates		
Prevention of sediment contribution from cropland	Encourage no-till and minimum till cultivation practices possibly with cover crops	Current Adoption Rate = 20%	Adoption Rate Goal = 20%	2,379 acres(no-till) 2,379 acres (min-till)
	Installation of terraces	Current Adoption Rate = 25% (good terraces)	Adoption Rate Goal = 30% (good terraces)	7,136 acres
	Establish grassed waterways in crop fields	Current Adoption Rate = 14.5% (good waterways)	Adoption Rate Goal = 30% (good waterways)	7,136 acres
	Establish buffers along crop fields	Current Adoption Rate = 3%	Adoption Rate Goal = 10%	2,379 acres
	Encourage the use of permanent cover vegetation	Current Adoption Rate = 3%	Adoption Rate Goal = 5%	1,189 acres

5.1.4 Sediment Load Reductions

Sediment load reductions expected from the BMPs described in this plan are as presented in Table 12, and they show one possible path to achieving the above reductions. Reductions that each BMP provides were adopted from the Neosho Headwaters WRAPS (KSU 2010). Water quality standards for Eagle Creek will be met by installation and maintenance of the identified BMPs.

Table 12. Estimated Cumulative Sediment Load Reductions for Implemented BMPS on Cropland Aimed at Meeting Load Allocation Goal. The total amount of acres that will be treated are shown below the column headings.

Eagle Creek WRAPS Soil Erosion Reduction (tons)							
Year	No-till	Minimum Till	Terraces	Waterway	Buffers	Permanent Vegetation	Total Reduction
	2,379 acres	*2,379 acres*	*7,136 acres*	*7,136 acres*	*2,379 acres*	*1,189 acres*	
1	85	42	102	135	56	54	**474**
2	169	85	203	271	113	107	**948**
3	254	127	305	406	169	161	**1,422**
4	339	169	406	542	226	214	**1,896**
5	423	212	508	677	282	268	**2,370**
6	508	254	609	813	339	322	**2,844**
7	592	296	711	948	395	375	**3,318**
8	677	339	813	1,083	451	429	**3,792**
9	762	381	914	1,219	508	482	**4,266**
10	846	423	1,016	1,354	564	536	**4,740**
11	931	466	1,117	1,490	621	590	**5,214**
12	1,016	508	1,219	1,625	677	643	**5,688**
13	1,100	550	1,320	1,761	734	697	**6,162**
14	1,185	592	1,422	1,896	790	750	**6,636**
15	1,270	635	1,524	2,031	846	804	**7,110**
16	1,354	677	1,625	2,167	903	858	**7,584**
17	1,439	719	1,727	2,302	959	911	**8,058**
18	1,524	762	1,828	2,438	1,016	965	**8,532**
19	1,608	804	1,930	2,573	1,072	1,019	**9,006**
20	1,693	846	2,031	2,709	1,129	1,072	**9,480**

Table 13 illustrates the annual cropland sediment reduction that would take place if all scheduled cropland BMPs were implemented annually. The percent of TMDL achievement is shown in the right column.

Table 13. Annual Cropland Sediment Reduction and Percentage of TMDL Reduced. Reductions are shown as cumulative

Sediment		
Year	Cropland Reduction (tons)	% of TMDL
1	474	5.00%
2	948	10.00%
3	1,422	15.00%
4	1,896	20.00%
5	2,370	25.00%
6	2,844	30.00%

Sediment		
Year	Cropland Reduction (tons)	% of TMDL
7	3,318	35.00%
8	3,792	40.00%
9	4,266	45.00%
10	4,740	50.00%
11	5,214	55.00%
12	5,688	60.00%
13	6,162	65.00%
14	6,636	70.00%
15	7,110	75.00%
16	7,584	80.00%
17	8,058	85.00%
18	8,532	90.00%
19	9,006	95.00%
20	9,480	100.00%
TSS Goal:	*9,480*	*Tons*

The amount of treated acres by the implementation of the BMPs is an important component to understand the magnitude of the work that has to be on the ground. Table 14 shows the acres that will be treated if all the scheduled BMPs are installed annually.

Table 14. Acres Protected by Cropland BMPs in Eagle Creek Watershed. These acres were used to calculate sediment and phosphorus reduction projections for the Eagle Creek Watershed. Acres also represent expected rates of adoption.

Eagle Creek WRAPS Cropland BMP Adoption (treated acres)							
Year	No-till	Minimum Till	Terraces	Waterway	Buffers	Permanent Vegetation	Total Reduction
1	119	119	357	357	119	59	1,130
2	119	119	357	357	119	59	1,130
3	119	119	357	357	119	59	1,130
4	119	119	357	357	119	59	1,130
5	119	119	357	357	119	59	1,130
6	119	119	357	357	119	59	1,130
7	119	119	357	357	119	59	1,130
8	119	119	357	357	119	59	1,130
9	119	119	357	357	119	59	1,130
10	119	119	357	357	119	59	1,130
11	119	119	357	357	119	59	1,130
12	119	119	357	357	119	59	1,130

Eagle Creek WRAPS Cropland BMP Adoption (treated acres)							
Year	No-till	Minimum Till	Terraces	Waterway	Buffers	Permanent Vegetation	Total Reduction
13	119	119	357	357	119	59	1,130
14	119	119	357	357	119	59	1,130
15	119	119	357	357	119	59	1,130
16	119	119	357	357	119	59	1,130
17	119	119	357	357	119	59	1,130
18	119	119	357	357	119	59	1,130
19	119	119	357	357	119	59	1,130
20	119	119	357	357	119	59	1,130
Total	**2,379**	**2,379**	**7,136**	**7,136**	**2,379**	**1,189**	**22,599**

5.2 EUTROPHICATION AND NUTRIENTS

5.2.1 Livestock Related Pollutants

The eutrophication impairment in John Redmond and Olpe City Lake is most likely caused by livestock in the watershed. In Kansas, animal feeding operations (AFOs) with greater than 300 animal units must register with KDHE. Confined animal feeding operations (CAFOs), those with more than 999 animal units, must be permitted with EPA. An animal unit or AU is an equal standard for all animals based on size and manure production. For example: 1 AU= 1,000 pounds of live animal weight (steer = 1 AU, dairy cow = 1.4 AU, swine = 0.4 AU). The watershed contains several CAFOs. (This data is derived from KDHE, 2003. It may be dated and subject to change). CAFOs are not allowed to release manure from the operation. However, they are allowed to spread manure on cropland fields for distribution. If this application is followed by a rainfall event or the manure is applied on frozen ground, it can run off into the stream. Soluble phosphorus, present in manure, is easily transported in runoff from these fields and from the areas cattle graze. Smaller operations are not regulated by the state. Many of these operations are located along streams because of historic preferences by early settlers. Movement of feeding sites away from the streams and providing alternate watering sites is logistically important to prevention of nutrients entering the stream. Grazing density is an important factor in manure runoff due to the common practice of cattle loafing in ponds and streams during the hot summer months and frequently defecating directly into the water source. Also, overgrazed pastures do not retain manure as well as moderately grazed pastures. This allows for runoff to a greater extent. Over sixty percent of the acres within the watershed are grassland; the grazing density of livestock is moderate in summer and high in winter.

Other nutrient issues can arise from fertilizers applied to non-native pastures. Nitrogen and phosphorus can originate from fertilizer runoff caused by either excess application or a rainfall event immediately after application; although, ***not all phosphorus and nitrogen contributions can be attributed to agricultural practices. Excess fertilization of lawns, golf courses and urban areas can easily transport phosphorus downstream; however, for this WRAPS process, targeting will be for livestock. The sediment reduction targeting within the cropland will also reduce the amount of phosphorous load that enters JRR and Olpe City Lake.***

As mentioned earlier in this report, targeting has been assigned for livestock related phosphorous. Eagle Creek Headwaters Sub-Watershed is the primary target for the reduction of phosphorous, land usage information on this sub-watershed is located in section *5.1.1.A* of this plan.

The SLT determined that critical areas for livestock nutrient reduction BMPs are those immediately adjacent or within the stream and any tributaries within the targeted watershed.

5.2.2 Cropland Related Nutrient Pollutants

One of the major concerns for this plan is JRR's TMDL for eutrophication, which is also a TMDL for Olpe City Lake. Eutrophication is a natural process that occurs when a water body receives excess nutrients. These excess nutrients, primarily nitrogen and phosphorus, create optimum conditions that are favorable for algal blooms and plant growth. Proliferation of algae and subsequent decomposition depletes available dissolved oxygen in the water profile. This lack of oxygen is devastating for aquatic species and can lead to fish kills. The problem in JRR can be traced upstream to Eagle Creek Headwaters and South Eagle Creek, which both have TMDLs for low dissolved oxygen. Desirable criteria for a healthy water profile include dissolved oxygen rates greater than 5 milligrams per liter and biological oxygen demand (BOD) less than 3.5 milligrams per liter. BOD is a measure of the amount of oxygen removed in water while stabilizing biodegradable organic matter. It can be used to indicate organic pollution levels. Excess nutrients can originate from failing septic systems, manure runoff and fertilizer runoff in rural and urban areas.

For more information concerning each, refer to the KDHE website, Watershed Management Section. http://www.kdheks.gov/tmdl/index.htm

An excess in nutrients can be caused by any land practice that will contribute to nitrogen or phosphorus in surface waters. Examples are (but not limited to):

- Fertilizer runoff from agricultural and urban lands,
- Manure runoff from domestic livestock and wildlife in close proximity to streams and rivers,
- Failing septic systems, and
- Phosphorus recycling from lake sediment.

Activities performed on the land affects nutrient loading in the lakes of the watershed. Land use in this watershed is primarily agricultural related; therefore, agricultural BMPs are necessary for reducing nitrogen and phosphorus. Some examples of nitrogen and phosphorus BMPs include:

- Soil sampling and appropriate fertilizer recommendations,
- Minimum and no-till farming practices,
- Filter and buffer strips installed along waterways,
- Reduce contact to streams from domestic livestock,
- Develop nutrient management plans for manure management, and
- Replace failing septic systems.

5.2.3 Phosphorous BMPs with Projects Needed

The current estimated phosphorus load in the Eagle Creek Watershed is 286,408 lbs per year according to the TMDL section of KDHE. **The total load reduction allocated to Eagle Creek Watershed needed to meet the phosphorus TMDL is 14,321 lbs of phosphorus**.

The SLT has laid out specific BMPs that they have determined will be acceptable to watershed residents as listed in Table 15. **These BMPs will be implemented in the livestock and cropland targeted area.** Specific acreages or projects that need to be implemented per year have been determined through modeling and economic analysis completed in reference to the Neosho Headwaters Watershed 9-Element Plan. However, the Eagle Creek WRAPS SLT reserves the right to install additional and/or different BMPs anywhere in the watershed, as long as the SLT deems that a significant reduction in pollution will occur and there are not any competing projects in higher priority areas. Extensive efforts will be made to implement BMPs in the higher priority areas before turning to the lower priority areas.

Table 15. Nutrient Reducing BMPs and Number of Projects to be Installed as Determined by the SLT. These BMPs are aimed at meeting the TMDL in JRR for eutrophication by reducing phosphorous contribution in Eagle Creek.

Protection Measures	BMPs and Other Action	Projects Installed or Total Acres Needed to be Implemented		
Reduce nutrient contribution from livestock	Implement strategic fencing to restrict access to surface water supplies	1 Strategic Fence (Year 1, 5, 9, 13, 17)		
	Promote alternative watering sites	1 Alternative Watering Site (Year 2, 6, 10, 14, 18)		
	Relocate pasture feeding sites	1 Feed Site Relocation (Year 3, 7, 11, 15, 19)		
	Establish vegetative filter strips	2 Filter Strips (Year 4) 1 Filter Strip (Year 8, 12, 16, 20)		
		Cropland Groundtruthing Determined by Adoption Rates		
Prevention of sediment contribution from cropland	Encourage no-till and minimum till cultivation practices possibly with cover crops	Current Adoption Rate = 20%	Adoption Rate Goal = 20%	2,379 acres(no-till) 2,379 acres (min-till)
	Installation of terraces	Current Adoption Rate = 25% (good terraces)	Adoption Rate Goal = 30% (good terraces)	7,136 acres
	Establish grassed waterways in crop fields	Current Adoption Rate = 14.5% (good waterways)	Adoption Rate Goal = 30% (good waterways)	7,136 acres
	Establish buffers along crop fields	Current Adoption Rate = 3%	Adoption Rate Goal = 10%	2,379 acres
	Encourage the use of permanent cover vegetation	Current Adoption Rate = 3%	Adoption Rate Goal = 5%	1,189 acres

5.2.4 Phosphorous Load Reductions

Phosphorous load reductions expected from the livestock BMPs described in this plan are as presented in Table 16, and they show one possible path to achieving the above reductions. Reductions that each BMP provides were adopted from the Neosho Headwaters WRAPS (KSU 2010). Water quality standards for Eagle Creek will be met by installation and maintenance of the identified BMPs.

Table 16. Estimated Livestock Waste Cumulative Phosphorus (pounds per year) kept from Eagle Creek Watershed if BMPs are Implemented.

Annual Phosphorous Load Reductions (lbs)					
Year	Fence Off Stream	Alternative Watering System	Relocate Pasture Feeding Site	Vegetative Filter Strip	Total
1	90	0	0	0	**90**
2	90	76	0	0	**166**
3	90	76	150	0	**316**
4	90	76	150	1,276	**1,592**
5	180	76	150	1,276	**1,682**
6	180	152	150	1,276	**1,758**
7	180	152	300	1,276	**1,908**
8	180	152	300	1,914	**2,546**
9	270	152	300	1,914	**2,636**
10	270	228	300	1,914	**2,712**
11	270	228	450	1,914	**2,862**
12	270	228	450	2,552	**3,500**
13	360	228	450	2,552	**3,590**
14	360	304	450	2,552	**3,666**
15	360	304	600	2,552	**3,816**
16	360	304	600	3,190	**4,454**
17	450	304	600	3,190	**4,544**
18	450	380	600	3,190	**4,620**
19	450	380	750	3,190	**4,770**
20	450	380	750	3,828	**5,408**

Phosphorous load reductions expected from the cropland BMPs described in this plan are as presented in Table 17, and they show one possible path to achieving the above reductions. These BMPs, outlined in section 5.1, hinder sediment runoff and are key elements in meeting the eutrophication TMDL and siltation TMDL for JRR. Reductions that each BMP provides were adopted from the Neosho Headwaters WRAPS (KSU 2010). Water quality standards for Eagle Creek will be met by installation and maintenance of the identified BMPs.

Table 17. Estimated Cumulative Phosphorus (pounds per year) kept from Eagle Creek Watershed if Cropland BMPs are Implemented.

Annual Phosphorous Load Reductions (lbs)							
Year	No-till	Minimum Till	Terraces	Waterway	Buffers	Permanent Vegetation	Total Reduction
1	50	25	112	150	62	59	459
2	100	50	225	300	125	119	919
3	150	75	337	450	187	178	1,378
4	200	100	450	600	250	237	1,837
5	250	125	562	750	312	297	2,296
6	300	150	675	900	375	356	2,756
7	350	175	787	1,050	437	416	3,215
8	400	200	900	1,200	500	475	3,674
9	450	225	1,012	1,350	562	534	4,133
10	500	250	1,125	1,500	625	594	4,593
11	550	275	1,237	1,650	687	653	5,052
12	600	300	1,350	1,800	750	712	5,511
13	650	325	1,462	1,949	812	772	5,970
14	700	350	1,575	2,099	875	831	6,430
15	750	375	1,687	2,249	937	890	6,889
16	800	400	1,800	2,399	1,000	950	7,348
17	850	425	1,912	2,549	1,062	1,009	7,807
18	900	450	2,024	2,699	1,125	1,068	8,267
19	950	475	2,137	2,849	1,187	1,128	8,726
20	1,000	500	2,249	2,999	1,250	1,187	9,185

Table 18 illustrates the reduction of phosphorus that would take place if all scheduled livestock and cropland BMPs were implemented annually. The percent of TMDL achievement is shown in the right column.

Table 18. Annual Phosphorus Reduction and Percentage of TMDL Reduced. Reductions are shown as cumulative

Phosphorous				
Year	Cropland Reduction (lbs)	Livestock Reduction (lbs)	Total Reduction (lbs)	% of TMDL
1	459	90	549	3.84%
2	919	166	1,085	7.57%
3	1,378	316	1,694	11.83%
4	1,837	1,592	3,429	23.95%
5	2,296	1,682	3,978	27.78%
6	2,756	1,758	4,514	31.52%
7	3,215	1,908	5,123	35.77%
8	3,674	2,546	6,220	43.44%

Phosphorous				
Year	Cropland Reduction (lbs)	Livestock Reduction (lbs)	Total Reduction (lbs)	% of TMDL
9	4,133	2,636	6,769	47.27%
10	4,593	2,712	7,305	51.01%
11	5,052	2,862	7,914	55.26%
12	5,511	3,500	9,011	62.93%
13	5,970	3,590	9,560	66.76%
14	6,430	3,666	10,096	70.50%
15	6,889	3,816	10,705	74.75%
16	7,348	4,454	11,802	82.42%
17	7,807	4,544	12,351	86.25%
18	8,267	4,620	12,887	89.99%
19	8,726	4,770	13,496	94.24%
20	9,185	5,408	14,593	101.91%

The quantity of livestock BMPs is an important component to understand the magnitude of the work that has to be on the ground. Table 19 shows the number of projects that have to be done an annual basis. Only once (the fourth year) does the plan require two projects to be implemented in the same year.

Table 19. Quantity of Livestock BMPs Needed. Used to calculate phosphorus reduction projections for Eagle Creek Watershed. These quantities also represent expected rates of adoption. Number of projects are shown as annual adoption rate.

Eagle Creek WRAPS Livestock BMP Adoption					
Year	Fence Off Stream	Alternative Watering System	Relocate Pasture Feeding Site	Vegetative Filter Strip	Total
1	1				1
2		1			1
3			1		1
4				2	2
5	1				1
6		1			1
7			1		1
8				1	1
9	1				1
10		1			1
11			1		1
12				1	1
13	1				1
14		1			1
15			1		1

Eagle Creek WRAPS Livestock BMP Adoption					
Year	Fence Off Stream	Alternative Watering System	Relocate Pasture Feeding Site	Vegetative Filter Strip	Total
16				1	1
17	1				1
18		1			1
19			1		1
20				1	1
Total	**5**	**5**	**5**	**6**	**21**

6.0 INFORMATION AND EDUCATION

6.1 STRATEGY TO INFORM AND ENGAGE STAKEHOLDERS

Initial stakeholder input was obtained from an invited advisory group, and subsequent public meetings (ECWRAPS 2005). Perceived problems, necessary solutions, and guidance toward BMP adoption in the watershed were provided from participants. These have been incorporated into the BMP needs presented within this plan. More details may be found in the Coffey County Regional WRAPS (NPS #K3-035) available from the KDHE, Watershed Management Section.

On an ongoing basis, the SLT has been active. It includes representatives from the Lyon County Conservation District, Coffey County Conservation District, producers, residents, and technical experts including KSU County Extension Agents, NRCS, Kansas Rural Center, and KSU Extension Watershed Specialists. This group recommends and oversees BMP implementation, and through the Eagle Creek WRAPS Coordinator, solicits stakeholder involvement. Resources used are outlined in Table 20.

Table 20. Information and Education Activities and Events as Requested by the SLT in Support of Meeting the TMDLs.

BMP	Target Audience	Information/Education Activity/Event	Time Frame	Estimated Costs	Sponsor/Responsible Agency
Cropland BMP Implementation					
Terraces Waterways Buffers Permanent Cover	Landowners, Rental Operators, and Farmers	Demonstration Project	Annual	$5,000 per demonstration project	-Kansas Rural Center -DOC -NRCS
		Tour/Field Day to Highlight Buffers	Annual	$500 per tour or field day	-Flint Hills RC&D -DOC -Conservation District -NRCS
		Newspaper Articles	Annual - Ongoing	No Charge	-Conservation Districts -NRCS
		Newsletter Article	Quarterly	$500	-Flint Hills RC&D -Conservation Districts - Kansas State Research and Extension (KSURE) -Kansas State Watershed Specialist (KSUWS) -NRCS
		One on One Meetings with Producers	Annual - Ongoing	$2,500	-Flint Hills RC&D -Conservation Districts -KSURE & KSUWS -DOC -NRCS
No-till/ Cover Crops Minimum Till	Landowners, Rental Operators, and Farmers	No-Till Workshop	Annual - Spring	$1,000 per meeting	-Flint Hills RC&D -Conservation Districts -KSURE -No-Till on the Plains -NRCS
		Newsletter Article	Annual	$500	-Flint Hills RC&D -Conservation Districts -KSURE -No-Till on the Plains -NRCS
		One on One Meetings with Producers	Annual - Ongoing	$2,500	-Flint Hills RC&D -Conservation Districts - KSURE -No-Till on the Plains -NRCS
		Scholarships for producers to attend No-Till Winter Conference	Annual – Winter	$150 per person	-No-Till on the Plains -NRCS

BMP	Target Audience	Information/Education Activity/Event	Time Frame	Estimated Costs	Sponsor/Responsible Agency
Livestock BMP Implementation					
Vegetative Filter Strips	Landowners and Ranchers	Demonstration Project	Annual	Combined with buffer demonstration	-Flint Hills RC&D -Kansas Rural Center -DOC - KSURE -NRCS
		Tour/Field Day	Annual	Combined with buffer tour or field day	-Flint Hills RC&D -Kansas Rural Center -DOC -KSURE -NRCS
		Workshop/Tour	Annual	$500 per workshop	-Flint Hills RC&D -Kansas Rural Center -DOC - KSURE & KSUWS -NRCS
		Livestock Filter Strip and Feedlot Relocation Demonstration/Tour	Annual	$1,000 per demonstration or tour	-Conservation Districts -KSURE & KSUWS -NCRS
Relocate Feedlot	Landowners and Small Feedlot Operators	Demonstration Project	Annual	$5,000 per demonstration project	-Flint Hills RC&D -Kansas Rural Center -DOC - KSURE & KSUWS -NRCS
		Tour/Field Day	Annual	$1,000 per tour or field day	-Flint Hills RC&D -Kansas Rural Center -DOC - KSURE & KSUWS -NRCS
		Cost-Share Program Promotion	Annual	No Charge	-Flint Hills RC&D -Kansas Rural Center -DOC - KSURE & KSUWS -NRCS
Strategic Fencing	Landowners and Ranchers	Demonstration Project	Annual – Spring	$5,000 per demonstration project	-Kansas Rural Center -NRCS
		Tour/Field Day	Annual - Summer	$1,000 per tour or field day	-Kansas Rural Center -Conservation Districts -NRCS
		Grazing Informational Meeting	Annual - Fall	$250 per meeting	-Conservation Districts -Kansas Rural Center -NRCS
Alternative Watering System	Landowners and Ranchers	Demonstration Project	Annual – Spring	$5,000 per demonstration project	-Kansas Rural Center -NRCS
		Tour/Field Day	Annual - Summer	$1,000 per tour or field day	-Kansas Rural Center -Conservation Districts -NRCS

BMP	Target Audience	Information/Education Activity/Event	Time Frame	Estimated Costs	Sponsor/Responsible Agency
Livestock BMP Implementation Continued					
Alternative Watering System (Con't)	Landowners and Ranchers (Con't)	Grazing Informational Meeting	Annual - Fall	Combined with relocating pasture feeding site meeting	-Conservation Districts -Kansas Rural Center -NRCS
		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 - KSURE
		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
		Waterfest/Envirofest	Annual – Fall	$700	-Conservation Districts -NRCS -KSURE -Flint Hills RC&D
Education of Adults	Educators, Adult Education	Newsletter	Quarterly	$2,000 per quarter	-Flint Hills RC&D
		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	-Flint Hills RC&D -Kansas Rural Center
		Media campaign to promote healthy watersheds (brochures, news releases, TV, radio, web-based)	Ongoing	$1,000 per year	-Flint Hills RC&D
		Meeting with Soil and Grassland Awards	Annual – Ongoing	No charge	-Conservation Districts
		Media campaign to address urban nutrient runoff (flyers or handouts addressing phosphate & nitrate pollution urban areas)	Annual – Ongoing	$500 per campaign	-Local Environmental Protection Program
		Education campaign about leaking /failing septic systems	Ongoing	$1,500	-Local Environmental Protection Programs
		Watershed display for area events	Annual – Ongoing	$1,000 per event	-Flint Hills RC&D -Conservation Districts -KSURE

6.2 EVALUATION OF INFORMATION AND EDUCATION ACTIVITIES

Success will be measured by maintaining attendance records at demonstrations and workshops. BMP auction participation will be tracked. First time attendees/participants will be considered a better measure over simple totals to measure success of outreach efforts. Brief surveys at workshops or demonstrations will be used to gain knowledge of how participants heard of the WRAPS so that future efforts can be adjusted. Pre and post workshop questionnaires may be utilized to target information to audience, and measure workshop effectiveness.

7.0 COSTS OF IMPLEMENTING BMPS AND POSSIBLE FUNDING SOURCES

The SLT has reviewed all the recommended BMPs listed in the Section 5 of this plan. 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 to more than one impairment, thus being more efficient. The costs of the BMPs (before and after cost share) are shown in Tables 21 & 22, and the total annual costs of BMP implementation is shown in Table 23. There are also costs included with the technical assistance needed to meet the load reductions for this WRAPS plan (Table 24), and some additional technical service providers for BMP implementation and information & education are described in Table 25. Potential sources of funding for WRAPS implementation and other costs are outlined in Table 26.

7.1 COSTS OF IMPLEMENTING BMPS AND INFORMATION & EDUCATION

Table 21. Estimated Costs and Net Costs for Cropland Implemented BMPs. These BMPs will also be used to achieve phosphorous load reductions.

Eagle Creek WRAPS Cropland BMP Cost Before Cost-Share							
Year	No-till	Minimum Till	Terraces	Waterway	Buffers	Permanent Vegetation	Total Reduction
1	$9,240	$4,620	$66,904	$60,659	$3,965	$8,921	$154,309
2	$9,518	$4,759	$68,911	$62,479	$4,084	$9,188	$158,938
3	$9,803	$4,902	$70,978	$64,354	$4,206	$9,464	$163,706
4	$10,097	$5,049	$73,108	$66,284	$4,332	$9,748	$168,618
5	$10,400	$5,200	$75,301	$68,273	$4,462	$10,040	$173,676
6	$10,712	$5,356	$77,560	$70,321	$4,596	$10,341	$178,886
7	$11,034	$5,517	$79,887	$72,430	$4,734	$10,652	$184,253
8	$11,365	$5,682	$82,283	$74,603	$4,876	$10,971	$189,781
9	$11,706	$5,853	$84,752	$76,842	$5,022	$11,300	$195,474
10	$12,057	$6,028	$87,294	$79,147	$5,173	$11,639	$201,338
11	$12,418	$6,209	$89,913	$81,521	$5,328	$11,988	$207,378
12	$12,791	$6,395	$92,610	$83,967	$5,488	$12,348	$213,600
13	$13,175	$6,587	$95,389	$86,486	$5,653	$12,718	$220,008
14	$13,570	$6,785	$98,250	$89,080	$5,822	$13,100	$226,608
15	$13,977	$6,989	$101,198	$91,753	$5,997	$13,493	$233,406
16	$14,396	$7,198	$104,234	$94,505	$6,177	$13,898	$240,408
17	$14,828	$7,414	$107,361	$97,341	$6,362	$14,315	$247,621
18	$15,273	$7,637	$110,582	$100,261	$6,553	$14,744	$255,049
19	$15,731	$7,866	$113,899	$103,269	$6,750	$15,187	$262,701
20	$16,203	$8,102	$117,316	$106,367	$6,952	$15,642	$270,582
3% Inflation							

Eagle Creek WRAPS Cropland BMP Cost After Cost-Share							
Year	No-till	Minimum Till	Terraces	Waterway	Buffers	Permanent Vegetation	Total Reduction
1	$5,637	$4,620	$33,452	$30,330	$396	$4,460	$78,895
2	$5,806	$4,759	$34,455	$31,240	$408	$4,594	$81,262
3	$5,980	$4,902	$35,489	$32,177	$421	$4,732	$83,700
4	$6,159	$5,049	$36,554	$33,142	$433	$4,874	$86,211
5	$6,344	$5,200	$37,650	$34,136	$446	$5,020	$88,797
6	$6,534	$5,356	$38,780	$35,160	$460	$5,171	$91,461
7	$6,730	$5,517	$39,943	$36,215	$473	$5,326	$94,205
8	$6,932	$5,682	$41,142	$37,302	$488	$5,486	$97,031
9	$7,140	$5,853	$42,376	$38,421	$502	$5,650	$99,942
10	$7,355	$6,028	$43,647	$39,573	$517	$5,820	$102,940
11	$7,575	$6,209	$44,957	$40,761	$533	$5,994	$106,029
12	$7,802	$6,395	$46,305	$41,983	$549	$6,174	$109,209
13	$8,037	$6,587	$47,694	$43,243	$565	$6,359	$112,486
14	$8,278	$6,785	$49,125	$44,540	$582	$6,550	$115,860
15	$8,526	$6,989	$50,599	$45,876	$600	$6,747	$119,336
16	$8,782	$7,198	$52,117	$47,253	$618	$6,949	$122,916
17	$9,045	$7,414	$53,680	$48,670	$636	$7,157	$126,604
18	$9,317	$7,637	$55,291	$50,130	$655	$7,372	$130,402
19	$9,596	$7,866	$56,950	$51,634	$675	$7,593	$134,314
20	$9,884	$8,102	$58,658	$53,183	$695	$7,821	$138,343
**3% Inflation*							

Table 22. Estimated Costs and Net Costs for Livestock Implemented BMPs.

Eagle Creek WRAPS Livestock BMP Cost Before Cost-Share					
Year	Fence Off Stream	Alternative Watering System	Relocate Pasture Feeding Site	Vegetative Filter Strip	Total
1	$4,106	$0	$0	$0	$4,106
2	$0	$3,909	$0	$0	$3,909
3	$0	$0	$7,024	$0	$7,024
4	$0	$0	$0	$1,560	$1,560
5	$4,621	$0	$0	$0	$4,621
6	$0	$4,399	$0	$0	$4,399
7	$0	$0	$7,906	$0	$7,906
8	$0	$0	$0	$878	$878
9	$5,201	$0	$0	$0	$5,201
10	$0	$4,952	$0	$0	$4,952
11	$0	$0	$8,898	$0	$8,898

Eagle Creek WRAPS Livestock BMP Cost Before Cost-Share					
Year	Fence Off Stream	Alternative Watering System	Relocate Pasture Feeding Site	Vegetative Filter Strip	Total
12	$0	$0	$0	$988	$988
13	$5,854	$0	$0	$0	$5,854
14	$0	$5,573	$0	$0	$5,573
15	$0	$0	$10,015	$0	$10,015
16	$0	$0	$0	$1,112	$1,112
17	$6,589	$0	$0	$0	$6,589
18	$0	$6,273	$0	$0	$6,273
19	$0	$0	$11,272	$0	$11,272
20	$0	$0	$0	$1,252	$1,252
**3% Inflation*					

Eagle Creek WRAPS Livestock BMP Cost After Cost-Share					
Year	Fence Off Stream	Alternative Watering System	Relocate Pasture Feeding Site	Vegetative Filter Strip	Total
1	$2,053	$0	$0	$0	$2,053
2	$0	$1,954	$0	$0	$1,954
3	$0	$0	$3,512	$0	$3,512
4	$0	$0	$0	$780	$780
5	$2,311	$0	$0	$0	$2,311
6	$0	$2,200	$0	$0	$2,200
7	$0	$0	$3,953	$0	$3,953
8	$0	$0	$0	$439	$439
9	$2,601	$0	$0	$0	$2,601
10	$0	$2,476	$0	$0	$2,476
11	$0	$0	$4,449	$0	$4,449
12	$0	$0	$0	$494	$494
13	$2,927	$0	$0	$0	$2,927
14	$0	$2,787	$0	$0	$2,787
15	$0	$0	$5,007	$0	$5,007
16	$0	$0	$0	$556	$556
17	$3,294	$0	$0	$0	$3,294
18	$0	$3,136	$0	$0	$3,136
19	$0	$0	$5,636	$0	$5,636
20	$0	$0	$0	$626	$626
**3% Inflation*					

Table 23. Total Costs for BMPs if All are Implemented in the Watershed in Support of Attaining TMDLs. After cost-share amounts are shown.

Total Annual WRAPS Cost after Cost-Share by BMP Category			
Year	**Cropland**	**Livestock**	**Total**
1	$78,895	$2,053	**$80,948**
2	$81,262	$1,954	**$83,216**
3	$83,700	$3,512	**$87,212**
4	$86,211	$780	**$86,991**
5	$88,797	$2,311	**$91,108**
6	$91,461	$2,200	**$93,661**
7	$94,205	$3,953	**$98,158**
8	$97,031	$439	**$97,470**
9	$99,942	$2,601	**$102,543**
10	$102,940	$2,476	**$105,416**
11	$106,029	$4,449	**$110,478**
12	$109,209	$494	**$109,704**
13	$112,486	$2,927	**$115,413**
14	$115,860	$2,787	**$118,647**
15	$119,336	$5,007	**$124,343**
16	$122,916	$556	**$123,472**
17	$126,604	$3,294	**$129,898**
18	$130,402	$3,136	**$133,538**
19	$134,314	$5,636	**$139,950**
20	$138,343	$626	**$138,969**

Table 24. Technical Assistance Needed to Implement BMPs.

<table>
<tr><th colspan="2" rowspan="2">BMP</th><th colspan="2">Personnel Needed to Implement BMP</th></tr>
<tr><th>Technical Assistance</th><th>Projected Annual Cost</th></tr>
<tr><td rowspan="6">CROPLAND</td><td>No-till</td><td>WRAPS Coordinator
DOC Buffer Technician
KRC River Friendly Farms Technician
Watershed Specialist</td><td rowspan="10">NRCS District Conservationist
No Charge

Conservation District Soil Technician
No Charge

DOC Buffer Technician
No Charge

WRAPS Coordinator
$60,000

Watershed Specialist
$5,000

KRC River Friendly Farms Technician
$8,000

Kansas State Forester
$5,000</td></tr>
<tr><td>Min-till</td><td>WRAPS Coordinator
DOC Buffer Technician
KRC River Friendly Farms Technician
Watershed Specialist</td></tr>
<tr><td>Terrace</td><td>WRAPS Coordinator
DOC Buffer Technician
KRC River Friendly Farms Technician
Watershed Specialist</td></tr>
<tr><td>Waterway</td><td>WRAPS Coordinator
DOC Buffer Technician
KRC River Friendly Farms Technician
Watershed Specialist</td></tr>
<tr><td>Buffer</td><td>WRAPS Coordinator
DOC Buffer Technician
KRC River Friendly Farms Technician
Watershed Specialist</td></tr>
<tr><td>Permanent Cover</td><td>WRAPS Coordinator
DOC Buffer Technician
KRC River Friendly Farms Technician</td></tr>
<tr><td rowspan="4">LIVESTOCK</td><td>Strategic fencing</td><td>WRAPS Coordinator
KRC River Friendly Farms Technician
Watershed Specialist</td></tr>
<tr><td>Alternative Water</td><td>WRAPS Coordinator
KRC River Friendly Farms Technician
Watershed Specialist</td></tr>
<tr><td>Relocate Feed Area</td><td>WRAPS Coordinator
KRC River Friendly Farms Technician
Watershed Specialist</td></tr>
<tr><td>Vegetative Filter Strip</td><td>WRAPS Coordinator
DOC Buffer Technician
KRC River Friendly Farms Technician
Watershed Specialist</td></tr>
<tr><td colspan="2">Total</td><td></td><td>$78,000</td></tr>
</table>

Table 25. Total Costs for BMPs, I&E, and Technical Assistance in the Watershed in Support of Attaining TMDLs.

Total Annual WRAPS Cost after Cost-Share by BMP Category					
Year	Cropland	Livestock	I&E	Technical Assistance	Total
1	$78,895	$2,053	$25,150	$78,000	**$184,098**
2	$81,262	$1,954	$25,905	$80,340	**$189,461**
3	$83,700	$3,512	$26,682	$82,750	**$196,644**
4	$86,211	$780	$27,482	$85,233	**$199,706**
5	$88,797	$2,311	$28,307	$87,790	**$207,204**
6	$91,461	$2,200	$29,156	$90,423	**$213,240**
7	$94,205	$3,953	$30,030	$93,136	**$221,324**
8	$97,031	$439	$30,931	$95,930	**$224,332**
9	$99,942	$2,601	$31,859	$98,808	**$233,210**
10	$102,940	$2,476	$32,815	$101,772	**$240,003**
11	$106,029	$4,449	$33,799	$104,825	**$249,103**
12	$109,209	$494	$34,813	$107,970	**$252,487**
13	$112,486	$2,927	$35,858	$111,209	**$262,480**
14	$115,860	$2,787	$36,934	$114,546	**$270,126**
15	$119,336	$5,007	$38,042	$117,982	**$280,367**
16	$122,916	$556	$39,183	$121,521	**$284,177**
17	$126,604	$3,294	$40,358	$125,167	**$295,424**
18	$130,402	$3,136	$41,569	$128,922	**$304,029**
19	$134,314	$5,636	$42,816	$132,790	**$315,556**
20	$138,343	$626	$44,101	$136,773	**$319,843**

Table 26. Additional Technical Service Providers for BMP Implementation and Information & Education.

		Services Needed to Implement BMP		
	BMP	**Technical Assistance**	**Information and Education**	**Potential Providers***
CROPLAND	No-till	Management plan development and incentives	Workshops, tours, field demonstrations	1. NRCS 2. KSU 3. KRC 4. CD 5. No-till on the Plains 6. KFS 7. KDWPT 8. RC&D 9. KDHE 10. KRW 11. KDOC
	Min-till	Management plan development and incentives	Workshops, tours, field demonstrations	
	Terrace	Design, cost share and maintenance	Workshops, tours, field demonstrations	
	Waterway	Design, cost share and maintenance	Workshops, tours, field demonstrations	
	Buffer	Design, cost share and maintenance	Workshops, tours, field demonstrations	
	Permanent Cover	Management plan development and incentives	Workshops, tours, field demonstrations	

	BMP	Services Needed to Implement BMP: Technical Assistance	Services Needed to Implement BMP: Information and Education	Potential Providers*
LIVESTOCK	Strategic fencing	Design, cost share and maintenance	Workshops, tours, field demonstrations	1. NRCS 2. KSU 3. KRC 4. CD 5. KDWPT 6. RC&D 7. KDHE 8. KRW 9. KDOC
	Alternative water	Design, cost share and maintenance	Workshops, tours, field demonstrations	
	Relocate Feed Area	Design, cost share, maintenance	Workshops, tours, field demonstrations	
	Vegetative Filter	Design, cost share maintenance	Workshops, tours, field demonstrations	

7.2 POTENTIAL FUNDING SOURCES

Table 27. Potential Funding Sources for BMP Implementation.

Funding Source	Programs
US Department of Agriculture: Natural Resource Conservation Service Farm Service Agency	1. Environmental Quality Incentives Program (EQIP) 2. Conservation Reserve Program (CRP) 3. Wildlife Habitat Incentive Program (WHIP) 4. Wetland Reserve Program (WRP) 5. Conservation Security Program (CSP) 6. Forestland Enhancement Program (FLEP) 7. State Acres for Wildlife Enhancement (SAFE) 8. Grassland Reserve Program (GRP) 9. Farmable Wetlands Program (FWP)
Kansas Department of Health and Environment & Environmental Protection Agency	1. 319 Funding Grants 2. KDHE WRAPS Funding 3. Clean Water Neighbor Grants
Kansas Division of Conservation: Lyon and Coffey County Conservation Districts	1. State cost share funds 2. County cost share funds 3. Enterprise funds 4. Construction equipment rental 5. Administrative support
Kansas Department of Wildlife and Parks and Tourism	1. Wildlife Habitat Improvement Program
U. S. Fish and Wildlife Service	1. Private Lands Conservation Program 2. Partners for Wildlife
Kansas Water Office	1. State Water Plan
No-Till on the Plains **Kansas Forest Service** **National Wild Turkey Federation** **Quail Unlimited** **Ducks Unlimited** **Kansas Alliance for Wetlands and Streams**	1. Current or future programs as the needs arise

8.0 TIMEFRAME AND IMPLEMENTATION SCHEDULE

The plan will be reviewed every five years starting in 2017. The timeframe of this document for BMP implementation to meet both sediment and phosphorus TMDLs would be twenty-five years from the date of publication of this report. Sediment and phosphorus reductions in the water column will not be noticeable by the year 2015 due to a lag time from implementation of BMPs and resulting improvements in water quality. Therefore, the SLT will review sediment and phosphorus concentrations in year 2022. They will examine BMP placement and implementation in 2017 and every subsequent five years after.

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

9.0 MEASURABLE MILESTONES AND PROJECT OUTCOMES

The goal of the Eagle Creek WRAPS plan is to restore water quality for uses supportive of aquatic life, industrial water supply, and recreation for John Redmond Lake. The plan specifically addresses the medium priority eutrophication and siltation TMDLs for John Redmond Lake. Since Eagle Creek is one of the tributaries to John Redmond Lake, and the Eagle Creek WRAPS has prioritized the three HUC 12s located within the Eagle Creek watershed for BMP implementation to address the two TMDLs for John Redmond Lake. The load reduction goals of this plan are for a 5% reduction in phosphorus and 3.2% reduction in TSS entering the lake from the Eagle Creek watershed.

In addition to the impairments listed above, there is a high priority dissolved oxygen TMDL for Eagle Creek. While this plan does not directly address this impairment, it is anticipated that the water quality impairment for Eagle Creek will be positively affected by the BMP implementation plan that has been developed as part of this WRAPS plan.

In order to reach the load reduction goals associated with the above-listed impairments in the Eagle Creek Watershed, a BMP implementation schedule spanning 20 years has been developed. Water quality milestones have been developed for the Eagle Creek watershed, 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.

9.1 WATER QUALITY MILESTONES FOR EAGLE CREEK ABOVE JOHN REDMOND RESERVOIR

As previously stated, this plan estimates that it will take 20 years to implement the planned BMPs necessary to meet the load reduction goals for the impairments being addressed in the Eagle Creek watershed. The table on the following page includes 10-year water quality goals for total phosphorus (TP), total suspended solids (TSS) and dissolved oxygen (DO) for Eagle Creek.

Table 28. Water Quality Milestones.

Water Quality Milestones for Eagle Creek - Total Phosphorus (TP), Total Suspended Solids (TSS) & Dissolved Oxygen (DO)			
	Current Condition* Average TP	**10-Year Goal**	
		Improved Condition Average TP	**Total Reduction Needed**
Sampling Site	**Total Phosphorus (average of data collected during indicated period), ppb**		
Eagle Creek Near Olpe SC634	174	163	**11**
Eagle Creek Near Hartford SC740	96	90	**6**
	Current Condition* Average TSS	**10-Year Goal**	
		Improved Condition Average TSS	**Total Reduction Needed**
Sampling Sites	**Total Suspended Solids (TSS) (average of data collected during indicated period), ppm**		
Eagle Creek Near Olpe SC634	44.5	42	**2.5**
Eagle Creek Near Hartford SC740	20.9	20	**0.9**
	Current Condition* % Samples DO > 5 ppm	**10-Year Goal**	
		Improved Condition	
Sampling Sites	**% Samples with DO > 5 ppm (data collected during indicated period)**		
Eagle Creek Near Olpe SC634	77	DO > 5 ppm for all samples with flows above critical low flow condition (1.1 cfs)	
Eagle Creek Near Hartford SC740	100	**Maintain All Samples DO > 5 ppm**	

*The current conditions for SC634 were determined utilizing sampling data from the KDHE stream monitoring station from 1997 to 2011. The current conditions for SC740 were determined utilizing sampling data from the KDHE stream monitoring station from 2003 to 2011.

9.2 ADDITIONAL WATER QUALITY INDICATORS

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

- Occurrence of algal blooms in John Redmond Lake
- Visitor traffic to John Redmond Lake
- Boating traffic in John Redmond Lake
- Trends of quantity and quality of fishing in John Redmond Lake
- Beach closings

The SLT will assess BMP implementation at year 5 and 10 (2017 and 2022) to determine project success. The SLT may adjust priorities and resources based on the interim milestone achievement.

Table 29. Cropland Best Management Practice Implementation Milestones from 2012 through 2036. Totals are shown as cumulative.

Eagle Creek WRAPS Cropland BMP Adoption Milestones (treated acres)								
	Year	No-till	Min Till	Terraces	Waterway	Buffers	Perm Vegetation	Total Treated Acres
Short-Term	1	119	119	357	357	119	59	1,130
	2	119	119	357	357	119	59	1,130
	3	119	119	357	357	119	59	1,130
	4	119	119	357	357	119	59	1,130
	5	119	119	357	357	119	59	1,130
	Total	*595*	*595*	*1,784*	*1,784*	*595*	*297*	*5,650*
Medium-Term	6	119	119	357	357	119	59	1,130
	7	119	119	357	357	119	59	1,130
	8	119	119	357	357	119	59	1,130
	9	119	119	357	357	119	59	1,130
	10	119	119	357	357	119	59	1,130
	Total	*1,189*	*1,189*	*3,568*	*3,568*	*1,189*	*595*	*11,299*

Eagle Creek WRAPS Cropland BMP Adoption Milestones (treated acres)									
	Year	**No-till**	**Min Till**	**Terraces**	**Waterway**	**Buffers**	**Perm Vegetation**	**Total Treated Acres**
Long-Term	11	119	119	357	357	119	59	1,130
	12	119	119	357	357	119	59	1,130
	13	119	119	357	357	119	59	1,130
	14	119	119	357	357	119	59	1,130
	15	119	119	357	357	119	59	1,130
	16	119	119	357	357	119	59	1,130
	17	119	119	357	357	119	59	1,130
	18	119	119	357	357	119	59	1,130
	19	119	119	357	357	119	59	1,130
	20	119	119	357	357	119	59	1,130
	Total	*2,379*	*2,379*	*7,136*	*7,136*	*2,379*	*1,189*	*22,599*

Table 30. Livestock Best Management Practice Implementation Milestones from 2012 through 2036. Totals are shown as cumulative.

Eagle Creek WRAPS Livestock BMP Adoption Milestones						
Year	**Fence Off Stream**	**Alternative Watering System**	**Relocate Pasture Feeding Site**	**Vegetative Filter Strip**	**Total**	**Year**
Short-Term	1	1				1
	2		1			1
	3			1		1
	4				2	2
	5	1				1
	Total	*2*	*1*	*1*	*2*	*6*
Medium-Term	6		1			1
	7			1		1
	8				1	1

Eagle Creek WRAPS Livestock BMP Adoption Milestones						
Year	**Fence Off Stream**	**Alternative Watering System**	**Relocate Pasture Feeding Site**	**Vegetative Filter Strip**	**Total**	**Year**
	9	1				1
	10		1			1
	Total	*3*	*3*	*2*	*3*	*11*
Long-Term	11			1		1
	12				1	1
	13	1				1
	14		1			1
	15			1		1
	16				1	1
	17	1				1
	18		1			1
	19			1		1
	20				1	1
	Total	*5*	*5*	*5*	*6*	*21*

10.0 MONITORING WATER QUALITY PROGRESS

Load reductions will be evaluated using the BMP implementation milestones presented in Section 9.0. This is possible because the milestone targets were derived from the load reduction analyses presented in Section 5.0. It is expected that achievement of these milestones will cause improvements to the water quality of Eagle Creek and John Redmond Reservoir. Reductions to the rate of JRR sedimentation as measured by the Kansas Water Office or US Corp of Engineers will be a method to evaluate load reductions. Available water quality and biological data will be reviewed by the SLT to support improvement expectations. Sources of information are from the KDWP stream surveys, WRAPS monitoring data, and KDHE data. No additional monitoring will be needed beyond those that have been listed. During periods of when the plan is being reviewed the need for additional monitoring will examined again.

KDHE continues to monitor water quality in the Eagle Creek watershed by maintaining the monitoring stations located within the watershed. The map below indicates the locations of the monitoring sites located within the Eagle Creek watershed, as well as the BMP targeted areas that have been identified and discussed in previous sections of this plan (Figure 22)..

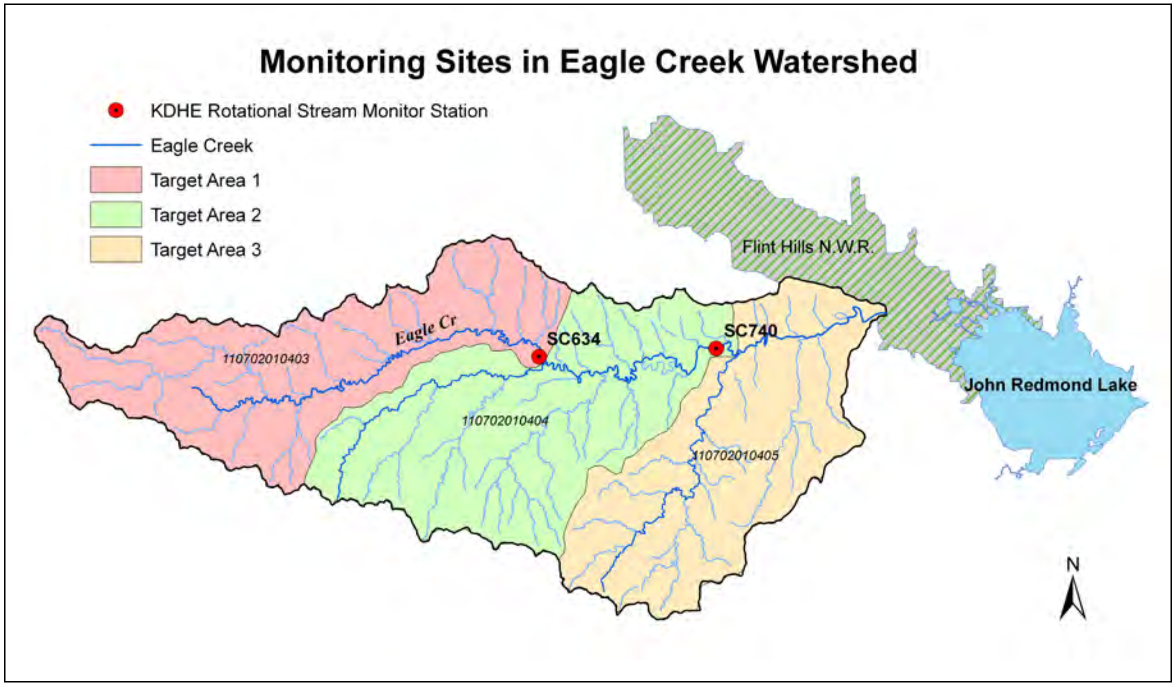

Figure 22. Eagle Creek Monitoring Sites.

The map shows the two rotational KDHE monitoring stations located along Eagle Creek, which 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 for at each site may vary depending on the season at collection time and other factors.

It should be noted that SC634 monitoring station was not sampled from Jan 2001 to May 2010. Due to this lack of data overall monitoring data could be skewed. This resulted in 40 less samples being collected. Although low flow may not have changed, however, nutrients and bacteria may have. This site was reinstated as it was sampled starting January 2011 as part of the TMDL revision process. To present, 3 out of 4 samples (October visits showed only pools, therefore no data was collected).

10.1 EVALUATION OF MONITORING DATA

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

The water quality milestones for the Eagle Creek watershed extend through a ten-year period from 2012 to 2022; however the BMP implementation schedule extends through a 20-year period. Throughout that period, KDHE will continue to analyze and evaluate the monitoring data collected. After the first ten years of monitoring and 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. 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.

11.0 BIBLIOGRAPHY

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Olpe City Lake Eut: http://www.kdheks.gov/tmdl/ne/OlpeE.pdf
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12.0 APPENDIX

12.1 SERVICE PROVIDERS

Table 31. Service Providers for Eagle Creek Watershed.

Organization	Acronym	Programs	Purpose	Assistance	Contact
Environmental Protection Agency	EPA	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 www.epa.gov
Flint Hills Resource Conservation and Development	FHRC&D	Natural resource development and protection	Plan and Implement projects and programs that improve environmental quality of life.	Technical	(620) 343-3570 www.flinthillsrcd.org
Kansas Alliance for Wetlands and Streams	KAWS	Streambank Stabilization Wetland Restoration Cost share programs	The Kansas Alliance for Wetlands and Streams organized in 1996 to promote the protection, enhancement, restoration and establishment of wetlands and streams in Kansas.	Technical	(620) 289-4663 www.kaws.org
Kansas Department of Agriculture	KDA	Watershed structures permitting.	Available for watershed districts and multipurpose small lakes development.	Technical and Financial	(785) 296-2933 www.accesskansas.org/kda
Kansas Department of Wildlife, Parks, & Tourism	KDWPT	Land and Water Conservation Funds	Provides funds to preserve develop and assure access to outdoor recreation.	Technical & Financial	(620) 672-5911

Organization	Acronym	Programs	Purpose	Assistance	Contact
Kansas Department of Wildlife, Parks, & Tourism (con't)	KDWPT	Conservation Easements for Riparian and Wetland Areas	To provide easements to secure and enhance quality areas in the state.	Technical & Financial	(785) 296-2780
		Wildlife Habitat Improvement Program	To provide limited assistance for development of wildlife habitat.		(620) 672-5911
		North American Waterfowl Conservation Act	To provide up to 50 percent cost share for the purchase and/or development of wetlands and wildlife habitat.		(620) 342-0658
		MARSH program in coordination with Ducks Unlimited	May provide up to 100 percent of funding for small wetland projects.		(620) 672-5911
		Chickadee Checkoff	Projects help with eagles, songbirds, threatened and endangered species, turtles, lizards, butterflies and stream darters.		
		Walk In Hunting Program	Funding is an optional donation line item on the KS Income Tax form. Landowners receive a payment incentive to allow public hunting on their property.		
		F.I.S.H. Program	Landowners receive incentive to allow public fishing access to their ponds and streams.		

Organization	Acronym	Programs	Purpose	Assistance	Contact
Kansas Division of Conservation and Conservation Districts	KDOC CD	Water Resources Cost Share Nonpoint Source Pollution Control Fund Riparian and Wetland Protection Program Stream Rehabilitation Program Kansas Water Quality Buffer Initiative Watershed district and multipurpose lakes	Provide cost share assistance to landowners for establishment of water conservation practices. Provides financial assistance for nonpoint pollution control projects which help restore water quality. Funds to assist with wetland and riparian development and enhancement. Assist with streams that have been adversely altered by channel modifications. Compliments Conservation Reserve Program by offering additional financial incentives for grass filters and riparian forest buffers. Programs are available for watershed district and small multipurpose lakes.	Technical & Financial Technical & Financial	(785) 296-3600 www.scc.ks.gov/ Lyon Co (620) 343-2812 Coffey Co (620) 364-2313 www.kacdnet.org
Kansas Department of Health and Environment	KDHE	**Nonpoint Source Pollution Program** Livestock & Municipal waste	Provide funds for projects that will reduce nonpoint source pollution. Compliance monitoring.	Technical & Financial	(785) 296-5500 www.kdhe.state.ks.us

Organization	Acronym	Programs	Purpose	Assistance	Contact
Kansas Department of Health and Environment	KDHE	State Revolving Loan Fund	Makes low interest loans for projects to improve and protect water quality.		
Kansas Forest Service	KFS	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
Kansas Rural Center	KRC	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	(913) 873-3431 www.kansasruralcenter.org
Kansas Rural Water Association	KRWA	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

Organization	Acronym	Programs	Purpose	Assistance	Contact
Kansas State University Research and Extension	KSURE	Kansas Center for Agricultural Resources and Environment (KCARE)	Provide programs, expertise and educational materials that relate to minimizing the impact of rural and urban activities on water quality.	Technical	www.kcare.ksu.edu
		Kansas Environmental Leadership Program (KELP)	Educational program to develop leadership for improved water quality.		(785) 532-7108 www.ksre.ksu.edu/kelp
		Kansas Local Government Water Quality Planning and Management	Provide guidance to local governments on water protection programs.		(785) 532-2643 www.ksre.ksu.edu/olg
		Rangeland and Natural Area Services (RNAS)	Reduce non-point source pollution emanating from Kansas grasslands.		(785) 532-0416 www.ksre.ksu.edu/olg
		WaterLINK	Service-learning projects available to college and university faculty and community watersheds in Kansas.		www.k-state/waterlink
		Kansas Pride: Healthy Ecosystems/ Healthy Communities	Help citizens appraise local natural resources & develop short & long term plans and activities to protect, sustain and restore their resources.	Technical	(785) 532-5840 www.kansasprideprogam.ksu.edu/
		Citizen Science	Education & volunteer work for enhanced resource stewardship.		www.ksre.ksu.edu/kswater/

Organization	Acronym	Programs	Purpose	Assistance	Contact
Kansas Water Office	KWO	Public Information and Education	Provide information and education to the public on Kansas Water Resources	Technical & Financial	(785) 296-3185
U.S. Army Corp of Engineers	COE	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 www.usace.army.mil
U.S. Fish and Wildlife Service	USFWS	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 www.fws.gov
U.S. Geological Survey	USGS	National streamflow Information Program Water Cooperative Program	Provides streamflow data Provide cooperative studies and water-quality information	Technical	(785) 832-3539 ks.water.usgs.gov Nrtw.usgs.gov
U.S. Department of Agriculture: Natural Resource Conservation Service & Farm Service Agency	USDA NRCS FSA	Conservation Compliance	Primarily for the technical assistance to develop conservation plans on cropland. To provide technical	Technical & Financial	(785) 823-4500 http://www.ks.nrcs.usda.gov/

Organization	Acronym	Programs	Purpose	Assistance	Contact
U.S. Department of Agriculture: Natural Resource Conservation Service & Farm Service Agency	USDA NRCS FSA	Conservation Operations Watershed Planning and Operations Wetland Reserve Program Wildlife Habitat Incentives Program Grassland Reserve Program, EQIP, and Conservation	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.		

12.2 BMP DEFINITIONS

12.2.1 Cropland

No-Till

- A management system in which chemicals may be used for weed control and seedbed preparation.
- The soil surface is never disturbed except for planting or drilling operations in a 100% no-till system.
- Cover crops may be also be established in the no-till system
- 75% erosion reduction efficiency, 40% phosphorous reduction efficiency.
- WRAPS groups and KSU Ag Economists have decided $10 an acre for 10 years is an adequate payment to entice producers to convert, 50% cost-share available from NRCS.

Minimum Till

- A management system in which chemicals may be used for weed control and seedbed preparation.
- The soil surface is never disturbed except for planting or drilling operations in a 100% no-till system.
- Cover crops may be also be established in the no-till system
- 38% erosion reduction efficiency, 20% phosphorous reduction efficiency.
- WRAPS groups and KSU Ag Economists have decided $5 an acre for 10 years is an adequate payment to entice producers to convert, 50% cost-share available from NRCS.

Terraces

- Earth embankment and/or channel constructed across the slope to intercept runoff water and trap soil.
- One of the oldest/most common BMPs
- 30% Erosion Reduction Efficiency, 30% phosphorous reduction efficiency
- $1.25 per linear foot, 50% cost-share available from NRCS

Grassed Waterway

- Grassed strip used as an outlet to prevent silt and gully formation.
- Can also be used as outlets for water from terraces.
- On average for Kansas fields, 1 acre waterway will treat 10 acres of cropland.
- 40% erosion reduction efficiency, 40% phosphorous reduction efficiency.
- $800 an acre, 50% cost-share available from NRCS.

Vegetative Buffer

- Area of field maintained in permanent vegetation to help reduce nutrient and sediment loss from agricultural fields, improve runoff water quality, and provide habitat for wildlife.
- On average for Kansas fields, 1 acre buffer treats 15 acres of cropland.
- 50% erosion reduction efficiency, 50% phosphorous reduction efficiency
- Approx. $1,000/acre, 90% cost-share available from NRCS.

Permanent Cover

- Tilled land that is converted and maintained as permanent vegetation to help reduce nutrient and sediment loss, improve runoff water quality, and provide habitat for wildlife.
- WRAPS group has decided $150 an acre is an adequate payment to entice producers to convert, 50% cost-share available from NRCS.

12.2.2 Livestock

Vegetative Filter Strip

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

Relocate Feeding Sites

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

Alternative (Off-Stream) Watering System

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

Strategic Fencing

- Fencing out streams and ponds to prevent livestock from entering.
- 95% P reduction.
- 25 year life expectancy.
- Approximately $4,106 per ¼ mile of fence, including labor, materials, and maintenance.

12.3 SUB WATERSHED TABLES

Table 32. Acres Treated by Sub Watershed.

Sub Watershed #30 Cropland BMP Adoption (treated acres)							
Year	No-till	Min Till	Terraces	Waterway	Buffers	Perm Vegetation	Total Treated Acres
1	39	39	117	117	39	19	370
2	39	39	117	117	39	19	370
3	39	39	117	117	39	19	370
4	39	39	117	117	39	19	370
5	39	39	117	117	39	19	370
6	39	39	117	117	39	19	370
7	39	39	117	117	39	19	370
8	39	39	117	117	39	19	370
9	39	39	117	117	39	19	370
10	39	39	117	117	39	19	370
11	39	39	117	117	39	19	370

12	39	39	117	117	39	19	370
13	39	39	117	117	39	19	370
14	39	39	117	117	39	19	370
15	39	39	117	117	39	19	370
16	39	39	117	117	39	19	370
17	39	39	117	117	39	19	370
18	39	39	117	117	39	19	370
19	39	39	117	117	39	19	370
20	39	39	117	117	39	19	370
Total	**779**	**779**	**2,337**	**2,337**	**779**	**390**	**7,401**

Sub Watershed #40 Cropland BMP Adoption (treated acres)							
Year	**No-till**	**Min Till**	**Terraces**	**Waterway**	**Buffers**	**Perm Vegetation**	**Total Treated Acres**
1	43	43	130	130	43	22	411
2	43	43	130	130	43	22	411
3	43	43	130	130	43	22	411
4	43	43	130	130	43	22	411
5	43	43	130	130	43	22	411
6	43	43	130	130	43	22	411
7	43	43	130	130	43	22	411
8	43	43	130	130	43	22	411
9	43	43	130	130	43	22	411
10	43	43	130	130	43	22	411
11	43	43	130	130	43	22	411
12	43	43	130	130	43	22	411
13	43	43	130	130	43	22	411
14	43	43	130	130	43	22	411
15	43	43	130	130	43	22	411
16	43	43	130	130	43	22	411
17	43	43	130	130	43	22	411
18	43	43	130	130	43	22	411
19	43	43	130	130	43	22	411
20	43	43	130	130	43	22	411
Total	**866**	**866**	**2,598**	**2,598**	**866**	**433**	**8,227**

Sub Watershed #50 Cropland BMP Adoption (treated acres)							
Year	**No-till**	**Min Till**	**Terraces**	**Waterway**	**Buffers**	**Perm Vegetation**	**Total Treated Acres**
1	37	37	110	110	37	18	349
2	37	37	110	110	37	18	349
3	37	37	110	110	37	18	349
4	37	37	110	110	37	18	349
5	37	37	110	110	37	18	349

6	37	37	110	110	37	18	349
7	37	37	110	110	37	18	349
8	37	37	110	110	37	18	349
9	37	37	110	110	37	18	349
10	37	37	110	110	37	18	349
11	37	37	110	110	37	18	349
12	37	37	110	110	37	18	349
13	37	37	110	110	37	18	349
14	37	37	110	110	37	18	349
15	37	37	110	110	37	18	349
16	37	37	110	110	37	18	349
17	37	37	110	110	37	18	349
18	37	37	110	110	37	18	349
19	37	37	110	110	37	18	349
20	37	37	110	110	37	18	349
Total	**734**	**734**	**2,201**	**2,201**	**734**	**367**	**6,971**

Table 33. Soil Erosion Reduction by Sub Watershed.

Sub Watershed #30 WRAPS Soil Erosion Reduction (tons)							
Year	No-till	Min Till	Terraces	Waterway	Buffers	Perm Vegetation	Total Reduction
1	28	14	33	44	18	18	**155**
2	55	28	67	89	37	35	**310**
3	83	42	100	133	55	53	**466**
4	111	55	133	177	74	70	**621**
5	139	69	166	222	92	88	**776**
6	166	83	200	266	111	105	**931**
7	194	97	233	310	129	123	**1,087**
8	222	111	266	355	148	140	**1,242**
9	249	125	299	399	166	158	**1,397**
10	277	139	333	443	185	176	**1,552**
11	305	152	366	488	203	193	**1,707**
12	333	166	399	532	222	211	**1,863**
13	360	180	432	577	240	228	**2,018**
14	388	194	466	621	259	246	**2,173**
15	416	208	499	665	277	263	**2,328**
16	443	222	532	710	296	281	**2,484**
17	471	236	565	754	314	298	**2,639**
18	499	249	599	798	333	316	**2,794**
19	527	263	632	843	351	334	**2,949**
20	554	277	665	887	370	351	**3,104**
Sub Watershed #40 WRAPS Soil Erosion Reduction (tons)							
Year	No-till	Min Till	Terraces	Waterway	Buffers	Perm Vegetation	Total Reduction
1	31	15	37	49	21	20	**173**
2	62	31	74	99	41	39	**345**
3	92	46	111	148	62	59	**518**
4	123	62	148	197	82	78	**690**
5	154	77	185	247	103	98	**863**
6	185	92	222	296	123	117	**1,035**
7	216	108	259	345	144	137	**1,208**
8	247	123	296	394	164	156	**1,380**
9	277	139	333	444	185	176	**1,553**
10	308	154	370	493	205	195	**1,726**
11	339	169	407	542	226	215	**1,898**
12	370	185	444	592	247	234	**2,071**
13	401	200	481	641	267	254	**2,243**
14	431	216	518	690	288	273	**2,416**
15	462	231	555	740	308	293	**2,588**
16	493	247	592	789	329	312	**2,761**

17	524	262	629	838	349	332	**2,933**
18	555	277	666	887	370	351	**3,106**
19	585	293	703	937	390	371	**3,279**
20	616	308	740	986	411	390	**3,451**
Sub Watershed #50 WRAPS Soil Erosion Reduction (tons)							
Year	**No-till**	**Min Till**	**Terraces**	**Waterway**	**Buffers**	**Perm Vegetation**	**Total Reduction**
1	26	13	31	42	17	17	**146**
2	52	26	63	84	35	33	**292**
3	78	39	94	125	52	50	**439**
4	104	52	125	167	70	66	**585**
5	131	65	157	209	87	83	**731**
6	157	78	188	251	104	99	**877**
7	183	91	219	292	122	116	**1,024**
8	209	104	251	334	139	132	**1,170**
9	235	117	282	376	157	149	**1,316**
10	261	131	313	418	174	165	**1,462**
11	287	144	345	460	191	182	**1,608**
12	313	157	376	501	209	198	**1,755**
13	339	170	407	543	226	215	**1,901**
14	366	183	439	585	244	232	**2,047**
15	392	196	470	627	261	248	**2,193**
16	418	209	501	668	279	265	**2,339**
17	444	222	533	710	296	281	**2,486**
18	470	235	564	752	313	298	**2,632**
19	496	248	595	794	331	314	**2,778**
20	522	261	627	836	348	331	**2,924**

Table 34. Phosphorous Reduction by Sub Watershed.

Sub Watershed #30 WRAPS Phosphorous Reduction (pounds)							
Year	No-till	Min Till	Terraces	Waterway	Buffers	Perm Vegetation	Total Reduction
1	16	8	37	49	20	19	150
2	33	16	74	98	41	39	301
3	49	25	110	147	61	58	451
4	65	33	147	196	82	78	602
5	82	41	184	246	102	97	752
6	98	49	221	295	123	117	902
7	115	57	258	344	143	136	1,053
8	131	65	295	393	164	156	1,203
9	147	74	331	442	184	175	1,354
10	164	82	368	491	205	194	1,504
11	180	90	405	540	225	214	1,654
12	196	98	442	589	246	233	1,805
13	213	106	479	638	266	253	1,955
14	229	115	516	688	286	272	2,106
15	246	123	552	737	307	292	2,256
16	262	131	589	786	327	311	2,406
17	278	139	626	835	348	330	2,557
18	295	147	663	884	368	350	2,707
19	311	156	700	933	389	369	2,857
20	327	164	737	982	409	389	3,008

Sub Watershed #40 WRAPS Phosphorous Reduction (pounds)							
Year	No-till	Min Till	Terraces	Waterway	Buffers	Perm Vegetation	Total Reduction
1	18	9	41	55	23	22	167
2	36	18	82	109	45	43	334
3	55	27	123	164	68	65	502
4	73	36	164	218	91	86	669
5	91	45	205	273	114	108	836
6	109	55	246	328	136	130	1,003
7	127	64	287	382	159	151	1,170
8	146	73	328	437	182	173	1,338
9	164	82	369	491	205	194	1,505
10	182	91	409	546	227	216	1,672
11	200	100	450	601	250	238	1,839
12	218	109	491	655	273	259	2,006
13	237	118	532	710	296	281	2,173
14	255	127	573	764	318	303	2,341
15	273	136	614	819	341	324	2,508
16	291	146	655	873	364	346	2,675

17	309	155	696	928	387	367	2,842
18	328	164	737	983	409	389	3,009
19	346	173	778	1,037	432	411	3,177
20	364	182	819	1,092	455	432	3,344

Sub Watershed #50 WRAPS Phosphorous Reduction (pounds)							
Year	**No-till**	**Min Till**	**Terraces**	**Waterway**	**Buffers**	**Perm Vegetation**	**Total Reduction**
1	15	8	35	46	19	18	142
2	31	15	69	93	39	37	283
3	46	23	104	139	58	55	425
4	62	31	139	185	77	73	567
5	77	39	173	231	96	92	708
6	93	46	208	278	116	110	850
7	108	54	243	324	135	128	992
8	123	62	278	370	154	146	1,133
9	139	69	312	416	173	165	1,275
10	154	77	347	463	193	183	1,417
11	170	85	382	509	212	201	1,558
12	185	93	416	555	231	220	1,700
13	200	100	451	601	251	238	1,842
14	216	108	486	648	270	256	1,983
15	231	116	520	694	289	275	2,125
16	247	123	555	740	308	293	2,267
17	262	131	590	786	328	311	2,408
18	278	139	624	833	347	330	2,550
19	293	146	659	879	366	348	2,692
20	308	154	694	925	385	366	2,833

Table 35. Costs (before cost-share) by Sub Watershed.

Sub Watershed #30 WRAPS Cropland BMP Cost Before Cost-Share							
Year	No-till	Min Till	Terraces	Waterway	Buffers	Perm Vegetation	Total
1	$3,026	$1,513	$21,909	$19,865	$1,298	$2,921	$50,532
2	$3,117	$1,558	$22,567	$20,460	$1,337	$3,009	$52,048
3	$3,210	$1,605	$23,244	$21,074	$1,377	$3,099	$53,610
4	$3,307	$1,653	$23,941	$21,706	$1,419	$3,192	$55,218
5	$3,406	$1,703	$24,659	$22,358	$1,461	$3,288	$56,875
6	$3,508	$1,754	$25,399	$23,028	$1,505	$3,387	$58,581
7	$3,613	$1,807	$26,161	$23,719	$1,550	$3,488	$60,338
8	$3,722	$1,861	$26,946	$24,431	$1,597	$3,593	$62,149
9	$3,833	$1,917	$27,754	$25,164	$1,645	$3,701	$64,013
10	$3,948	$1,974	$28,587	$25,919	$1,694	$3,812	$65,933
11	$4,067	$2,033	$29,444	$26,696	$1,745	$3,926	$67,911
12	$4,189	$2,094	$30,328	$27,497	$1,797	$4,044	$69,949
13	$4,314	$2,157	$31,238	$28,322	$1,851	$4,165	$72,047
14	$4,444	$2,222	$32,175	$29,172	$1,907	$4,290	$74,209
15	$4,577	$2,289	$33,140	$30,047	$1,964	$4,419	$76,435
16	$4,714	$2,357	$34,134	$30,948	$2,023	$4,551	$78,728
17	$4,856	$2,428	$35,158	$31,877	$2,083	$4,688	$81,090
18	$5,002	$2,501	$36,213	$32,833	$2,146	$4,828	$83,523
19	$5,152	$2,576	$37,299	$33,818	$2,210	$4,973	$86,028
20	$5,306	$2,653	$38,418	$34,833	$2,277	$5,122	$88,609
**3% Inflation*							

Sub Watershed #40 WRAPS Cropland BMP Cost Before Cost-Share							
Year	No-till	Min Till	Terraces	Waterway	Buffers	Perm Vegetation	Total
1	$3,364	$1,682	$24,356	$22,083	$1,443	$3,248	$56,176
2	$3,465	$1,732	$25,087	$22,745	$1,487	$3,345	$57,861
3	$3,569	$1,784	$25,840	$23,428	$1,531	$3,445	$59,597
4	$3,676	$1,838	$26,615	$24,131	$1,577	$3,549	$61,385
5	$3,786	$1,893	$27,413	$24,855	$1,624	$3,655	$63,227
6	$3,900	$1,950	$28,236	$25,600	$1,673	$3,765	$65,123
7	$4,017	$2,008	$29,083	$26,368	$1,723	$3,878	$67,077
8	$4,137	$2,069	$29,955	$27,159	$1,775	$3,994	$69,089
9	$4,261	$2,131	$30,854	$27,974	$1,828	$4,114	$71,162
10	$4,389	$2,195	$31,779	$28,813	$1,883	$4,237	$73,297
11	$4,521	$2,260	$32,733	$29,678	$1,940	$4,364	$75,496
12	$4,657	$2,328	$33,715	$30,568	$1,998	$4,495	$77,761
13	$4,796	$2,398	$34,726	$31,485	$2,058	$4,630	$80,094
14	$4,940	$2,470	$35,768	$32,430	$2,120	$4,769	$82,496
15	$5,088	$2,544	$36,841	$33,403	$2,183	$4,912	$84,971

16	$5,241	$2,620	$37,946	$34,405	$2,249	$5,059	$87,520
17	$5,398	$2,699	$39,085	$35,437	$2,316	$5,211	$90,146
18	$5,560	$2,780	$40,257	$36,500	$2,386	$5,368	$92,850
19	$5,727	$2,863	$41,465	$37,595	$2,457	$5,529	$95,636
20	$5,899	$2,949	$42,709	$38,723	$2,531	$5,695	$98,505
**3% Inflation*							

Sub Watershed #50 WRAPS Cropland BMP Cost Before Cost-Share							
Year	**No-till**	**Min Till**	**Terraces**	**Waterway**	**Buffers**	**Perm Vegetation**	**Total**
1	$2,850	$1,425	$20,638	$18,712	$1,223	$2,752	$47,600
2	$2,936	$1,468	$21,257	$19,273	$1,260	$2,834	$49,028
3	$3,024	$1,512	$21,895	$19,851	$1,297	$2,919	$50,499
4	$3,115	$1,557	$22,552	$20,447	$1,336	$3,007	$52,014
5	$3,208	$1,604	$23,228	$21,060	$1,376	$3,097	$53,575
6	$3,304	$1,652	$23,925	$21,692	$1,418	$3,190	$55,182
7	$3,404	$1,702	$24,643	$22,343	$1,460	$3,286	$56,837
8	$3,506	$1,753	$25,382	$23,013	$1,504	$3,384	$58,543
9	$3,611	$1,805	$26,144	$23,704	$1,549	$3,486	$60,299
10	$3,719	$1,860	$26,928	$24,415	$1,596	$3,590	$62,108
11	$3,831	$1,915	$27,736	$25,147	$1,644	$3,698	$63,971
12	$3,946	$1,973	$28,568	$25,902	$1,693	$3,809	$65,890
13	$4,064	$2,032	$29,425	$26,679	$1,744	$3,923	$67,867
14	$4,186	$2,093	$30,308	$27,479	$1,796	$4,041	$69,903
15	$4,312	$2,156	$31,217	$28,303	$1,850	$4,162	$72,000
16	$4,441	$2,220	$32,154	$29,153	$1,905	$4,287	$74,160
17	$4,574	$2,287	$33,118	$30,027	$1,963	$4,416	$76,385
18	$4,711	$2,356	$34,112	$30,928	$2,021	$4,548	$78,676
19	$4,853	$2,426	$35,135	$31,856	$2,082	$4,685	$81,037
20	$4,998	$2,499	$36,189	$32,811	$2,145	$4,825	$83,468
**3% Inflation*							

Table 36. Costs (after cost-share) by Sub Watershed.

Sub Watershed #30 WRAPS Cropland BMP Cost After Cost-Share							
Year	**No-till**	**Min Till**	**Terraces**	**Waterway**	**Buffers**	**Perm Vegetation**	**Total**
1	$1,846	$1,513	$10,955	$9,932	$130	$1,461	$25,836
2	$1,901	$1,558	$11,283	$10,230	$134	$1,504	$26,611
3	$1,958	$1,605	$11,622	$10,537	$138	$1,550	$27,410
4	$2,017	$1,653	$11,970	$10,853	$142	$1,596	$28,232
5	$2,078	$1,703	$12,330	$11,179	$146	$1,644	$29,079
6	$2,140	$1,754	$12,699	$11,514	$151	$1,693	$29,951
7	$2,204	$1,807	$13,080	$11,860	$155	$1,744	$30,850
8	$2,270	$1,861	$13,473	$12,215	$160	$1,796	$31,775

9	$2,338	$1,917	$13,877	$12,582	$164	$1,850	$32,729
10	$2,408	$1,974	$14,293	$12,959	$169	$1,906	$33,710
11	$2,481	$2,033	$14,722	$13,348	$174	$1,963	$34,722
12	$2,555	$2,094	$15,164	$13,749	$180	$2,022	$35,763
13	$2,632	$2,157	$15,619	$14,161	$185	$2,083	$36,836
14	$2,711	$2,222	$16,087	$14,586	$191	$2,145	$37,941
15	$2,792	$2,289	$16,570	$15,023	$196	$2,209	$39,080
16	$2,876	$2,357	$17,067	$15,474	$202	$2,276	$40,252
17	$2,962	$2,428	$17,579	$15,938	$208	$2,344	$41,460
18	$3,051	$2,501	$18,106	$16,416	$215	$2,414	$42,703
19	$3,142	$2,576	$18,650	$16,909	$221	$2,487	$43,985
20	$3,237	$2,653	$19,209	$17,416	$228	$2,561	$45,304
**3% Inflation*							

Sub Watershed #40 WRAPS Cropland BMP Cost After Cost-Share							
Year	**No-till**	**Min Till**	**Terraces**	**Waterway**	**Buffers**	**Perm Vegetation**	**Total**
1	$2,052	$1,682	$12,178	$11,042	$144	$1,624	$28,722
2	$2,114	$1,732	$12,543	$11,373	$149	$1,672	$29,583
3	$2,177	$1,784	$12,920	$11,714	$153	$1,723	$30,471
4	$2,242	$1,838	$13,307	$12,065	$158	$1,774	$31,385
5	$2,310	$1,893	$13,707	$12,427	$162	$1,828	$32,327
6	$2,379	$1,950	$14,118	$12,800	$167	$1,882	$33,296
7	$2,450	$2,008	$14,541	$13,184	$172	$1,939	$34,295
8	$2,524	$2,069	$14,978	$13,580	$178	$1,997	$35,324
9	$2,599	$2,131	$15,427	$13,987	$183	$2,057	$36,384
10	$2,677	$2,195	$15,890	$14,407	$188	$2,119	$37,475
11	$2,758	$2,260	$16,366	$14,839	$194	$2,182	$38,600
12	$2,840	$2,328	$16,857	$15,284	$200	$2,248	$39,758
13	$2,926	$2,398	$17,363	$15,743	$206	$2,315	$40,950
14	$3,013	$2,470	$17,884	$16,215	$212	$2,385	$42,179
15	$3,104	$2,544	$18,421	$16,701	$218	$2,456	$43,444
16	$3,197	$2,620	$18,973	$17,202	$225	$2,530	$44,748
17	$3,293	$2,699	$19,542	$17,718	$232	$2,606	$46,090
18	$3,392	$2,780	$20,129	$18,250	$239	$2,684	$47,473
19	$3,493	$2,863	$20,732	$18,797	$246	$2,764	$48,897
20	$3,598	$2,949	$21,354	$19,361	$253	$2,847	$50,364
**3% Inflation*							

Sub Watershed #50 WRAPS Cropland BMP Cost After Cost-Share							
Year	**No-till**	**Min Till**	**Terraces**	**Waterway**	**Buffers**	**Perm Vegetation**	**Total**
1	$1,739	$1,425	$10,319	$9,356	$122	$1,376	$24,337
2	$1,791	$1,468	$10,629	$9,637	$126	$1,417	$25,067

3	$1,845	$1,512	$10,947	$9,926	$130	$1,460	$25,819
4	$1,900	$1,557	$11,276	$10,223	$134	$1,503	$26,594
5	$1,957	$1,604	$11,614	$10,530	$138	$1,549	$27,392
6	$2,016	$1,652	$11,963	$10,846	$142	$1,595	$28,213
7	$2,076	$1,702	$12,322	$11,171	$146	$1,643	$29,060
8	$2,138	$1,753	$12,691	$11,507	$150	$1,692	$29,932
9	$2,203	$1,805	$13,072	$11,852	$155	$1,743	$30,830
10	$2,269	$1,860	$13,464	$12,207	$160	$1,795	$31,755
11	$2,337	$1,915	$13,868	$12,574	$164	$1,849	$32,707
12	$2,407	$1,973	$14,284	$12,951	$169	$1,905	$33,688
13	$2,479	$2,032	$14,713	$13,339	$174	$1,962	$34,699
14	$2,553	$2,093	$15,154	$13,740	$180	$2,021	$35,740
15	$2,630	$2,156	$15,609	$14,152	$185	$2,081	$36,812
16	$2,709	$2,220	$16,077	$14,576	$191	$2,144	$37,917
17	$2,790	$2,287	$16,559	$15,014	$196	$2,208	$39,054
18	$2,874	$2,356	$17,056	$15,464	$202	$2,274	$40,226
19	$2,960	$2,426	$17,568	$15,928	$208	$2,342	$41,432
20	$3,049	$2,499	$18,095	$16,406	$214	$2,413	$42,675
**3% Inflation*							

Table 37. Livestock BMP Adoption, Costs, and Phosphorous Reduction by Sub Watershed.

Livestock BMP Adoption by Sub Watershed					
Sub Watershed	**Fence Off Stream**	**Alternative Watering System**	**Relocate Pasture Feeding Site**	**Vegetative Filter Strip**	**Total Adoption**
30	2	1	2	2	7
40	2	2	1	2	7
50	1	2	2	2	7
Total	5	5	5	6	21
Livestock BMP Cost* Before Cost-Share by Sub Watershed					
Sub Watershed	**Fence Off Stream**	**Alternative Watering System**	**Relocate Pasture Feeding Site**	**Vegetative Filter Strip**	**Total Cost**
30	$8,212	$3,795	$13,242	$1,428	$26,677
40	$8,212	$7,590	$6,621	$1,428	$23,851
50	$4,106	$7,590	$13,242	$1,428	$26,366
Total	$20,530	$18,975	$33,105	$4,284	$76,894
**2011 Dollars*					
Livestock BMP Cost After Cost-Share by Sub Watershed					

Sub Watershed	**Fence Off Stream**	**Alternative Watering System**	**Relocate Pasture Feeding Site**	**Vegetative Filter Strip**	**Total Cost**
30	$4,106	$1,898	$6,621	$714	$13,339
40	$4,106	$3,795	$3,311	$714	$11,926
50	$2,053	$3,795	$6,621	$714	$13,183
Total	$10,265	$9,488	$16,553	$2,142	$38,447

**2011 Dollars*

Livestock BMP Phosphorous Load Reduction by Sub Watershed (pounds)					
Sub Watershed	**Fence Off Stream**	**Alternative Watering System**	**Relocate Pasture Feeding Site**	**Vegetative Filter Strip**	**Total Load Reduction**
30	180	76	300	1,276	1,832
40	180	152	150	1,276	1,758
50	90	152	300	1,276	1,818
Total	450	380	750	3,828	5,408