KANSAS WATERSHED RESTORATION AND PROTECTION STRATEGY (WRAPS) PROJECT

MILFORD LAKE WATERSHED ASSESSMENT

FINAL REPORT

KDHE Project No. 2004-0027

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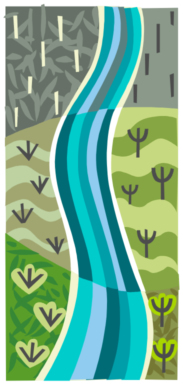
Prepared and Submitted by:
Dr. Kyle R. Douglas-Mankin, Principal Investigator
Dr. Aleksey Y. Sheshukov
Department of Biological and Agricultural Engineering
Kansas State University
129 Seaton Hall
Manhattan KS 66506
785-532-2911
krdm@ksu.edu



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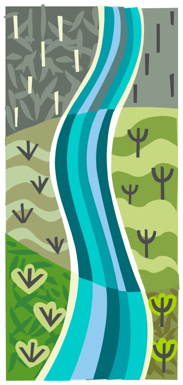
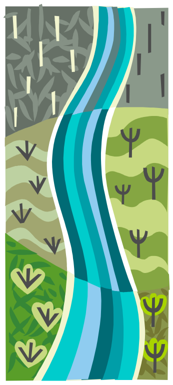


Acknowledgements

This project was made possible with financial support provided by State Water Plan funds administered by the Kansas Department of Health and Environment – Watershed Management Section, granted to K-State Research and Extension through the Kansas WRAPS (Watershed Restoration and Protection Strategy) – Milford Lake Watershed Assessment project (2004-0027).

The Assessment phase of this project resulted from the dedicated team effort of these KSU personnel:

- Aleksey Y. Sheshukov, Watershed Modeler
- Amir Pouyan Nejadhashemi, Watershed Modeler
- Josh Roe, Watershed Economist
- Sumathy Sinnathamby, Graduate Student
- Craig M. Smith, Watershed Economist
- Robert M. Wilson, Watershed Planner
- Sue P. Brown, Watershed Communication
- John C. Leatherman, Professor, Agricultural Economics
- William Hargrove, past KCARE Director



Executive Summary

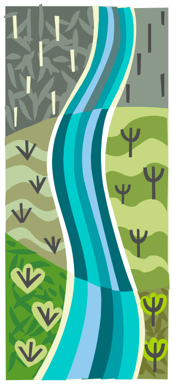
This project served to compile and develop watershed environmental and economic information to assist stakeholders in the Milford Lake to develop a Watershed Restoration and Protection Strategy (WRAPS) Plan and Report.

Initiated in June 2006, this WRAPS Assessment Phase project was completed by July 2009. Project accomplishments include:

- *Watershed Assessment*: We compiled existing information related to the Milford Lake Watershed, culminating in development and publication of a Watershed Atlas.
- *Watershed Modeling*: We completed the SWAT modeling analysis of current watershed conditions.
- *Economic Analysis*: We developed user-friendly decision tools for stakeholder groups to analyze and compare economic and environmental effects of cropland BMPs, vegetative buffer systems, streambank stabilization systems, and tillage systems.

Two stakeholder leadership teams (SLT) were established in 2008 for Milford Lake Watershed, one in the northern portion of the watershed and another in the central area, and actively participated in a critical review of the assessment activities including modeling findings of targeted areas, discussions on non-point source pollution areas in the watershed that could not be identified with SWAT, like areas with high concentration of livestock produced nutrient contribution to stream pollution.

The SLTs were engaged in the process of clarifying WRAPS objectives and assessment needs, refining watershed information and modeling data, reviewing modeling results, and assessing economic and environmental impacts of various management scenarios. Groundtruthing of SWAT identified targeted areas assisted in identifying current BMP implementation rates in the targeted areas and provided basis for economic analysis of future BMP implementation scenarios.



Introduction

The Milford Lake Watershed covers one HUC-8 watersheds above Milford Lake and below the Nebraska state line. Two individual Stakeholder Leadership Teams were formed in upper and middle portions of the watershed. Watershed management and assessment activities were independent for these two SLTs.

Geographic Scope/Location

The Milford Lake Watershed (HUC 10250017) encompasses parts of Jewell, Republic, Washington, Riley, Phillips, Smith, Geary, Dickinson, Clay, Cloud, and Mitchell Counties in north-central Kansas (Figure 1). The watershed is primarily the drainage area for Milford Lake, the state's largest lake with a 16,000 acre surface area and 18,000 acre wildlife area. The watershed also includes Wakefield Lake, Lake Jewell, and several smaller city and county lakes, a state park, and two wetland areas. The Republican River, Buffalo Creek, Elk Creek, Marsh Creek, and Salt Creek are among the larger rivers and streams in the watershed. Milford Lake Watershed occupies six 10-digit HUC watersheds (1025001701, 1025001702, 1025001703, 1025001704, 1025001705, and 1025001706) or 47 12-digit HUC watersheds (102500170101, 102500170102, 102500170103, 102500170104, 102500170105, 102500170106, 102500170107, 102500170201, 102500170202, 102500170203, 102500170204, 102500170205, 102500170301, 102500170302, 102500170303, 102500170304, 102500170305, 102500170306, 102500170307, 102500170309, 102500170310, 102500170401, 102500170402, 102500170403, 102500170404, 102500170405, 102500170406, 102500170407, 102500170408, 102500170409, 102500170501, 102500170502, 102500170503, 102500170504, 102500170505, 102500170506, 102500170507, 102500170508, 102500170601, 102500170602, 102500170603, 102500170604, 102500170605, 102500170606, 102500170607, 102500170608, 102500170609) (Figure 2). Main drainage area of the watershed is 15,923,200 acres or 24,880 sq. mi.

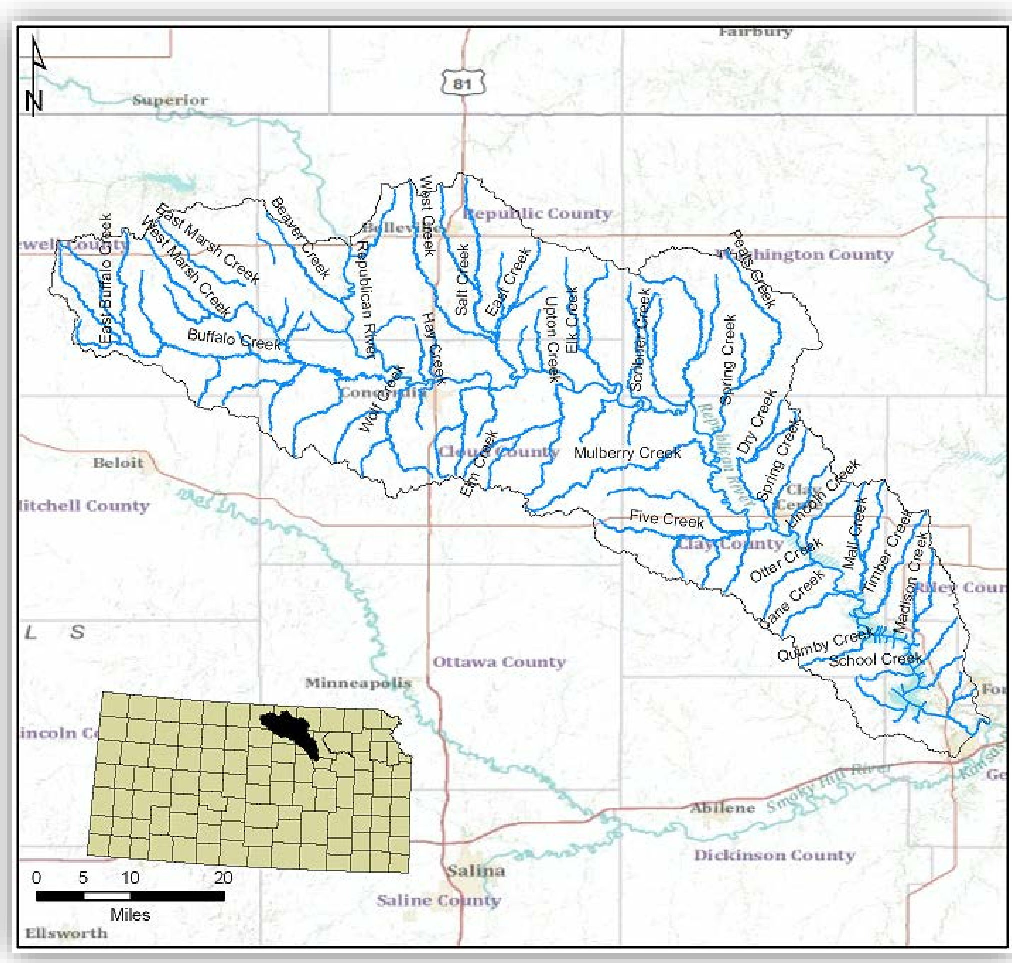


Figure 1 Map of Milford Lake Watershed

Population

The Milford Lake Watershed is primarily an agricultural watershed. There are twenty six towns in the watershed: Clay Center, Clifton, Green, Morganville, Vining, Wakefield, Aurora, Clyde, Concordia, Jamestown, Formoso, Jewell, Mankato, Randall, Fort Riley North, Junction City, Milford, Agenda, Belleville, Courtland, Cuba, Scandia, Scottsville, Linn, Palmer. Population distribution in these cities is presented in Table 1. According to the 2000 U.S. Census Bureau, the estimated total population within the Milford Lake watershed is 49,050 people (1.86 people/sq. mi.). Figure 3 shows the spatial distribution of population per 2000 Census block.

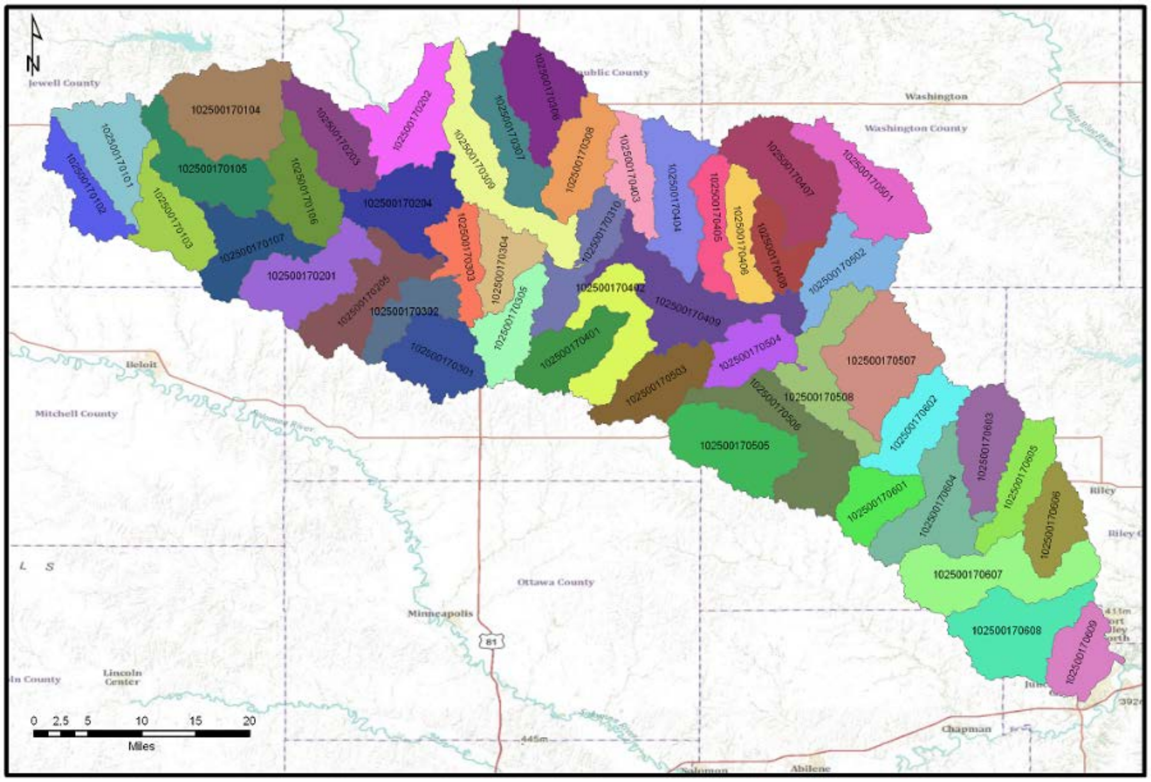


Figure 2 HUC 12 Delineations in the Milford Lake Watershed

Table 1 Main populated areas in the Milford Lake Watershed

Cities	Population	Cities	Population
Clay Center	4,564	Fort Riley North	8,114
Clifton	557	Junction City	18,886
Green	147	Milford	502
Morganville	198	Agenda	81
Vining	58	Belleville	2,239
Wakefield	838	Courtland	334
Aurora	79	Cuba	231
Clyde	740	Scandia	436
Concordia	5,714	Scottsville	21
Jamestown	399	Linn	425
Formoso	129	Palmer	108
Jewell	483	Mankato	976
Randall	90		

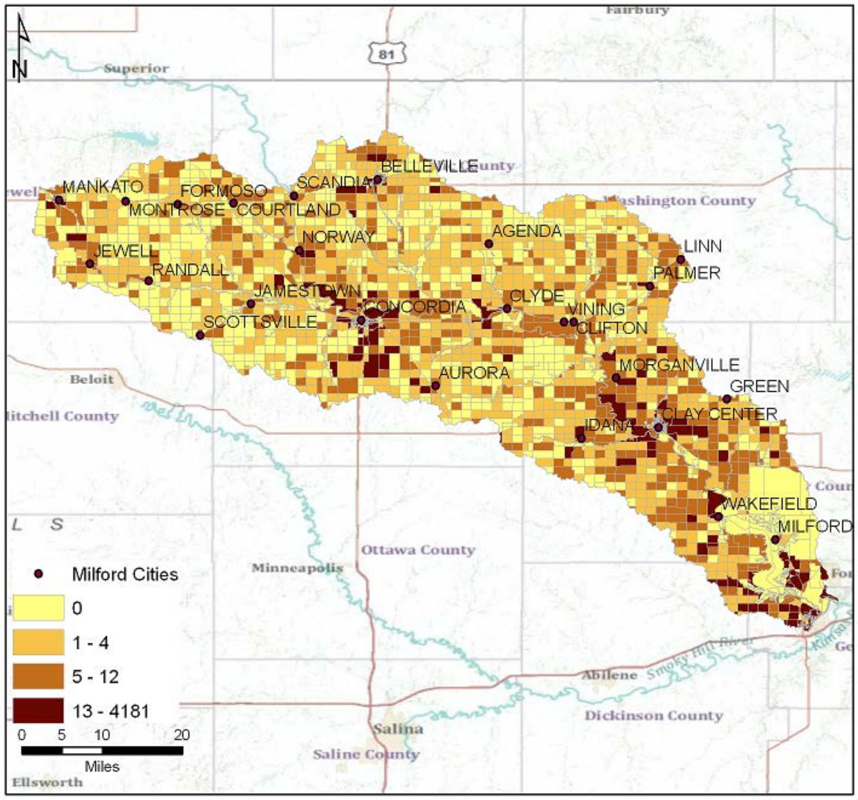


Figure 3 Population density in the Milford Lake Watersheds

Surface Water Resources

Milford Lake is a 15,314 acre impoundment located in Northeastern Kansas in the Kansas-Lower Republican River basin. The maximum depth of the reservoir is 65 feet and the surface area of the reservoir is 16,200 acres. The Kansas-Lower Republican basin contains 22,237 miles of intermittent and 5,392 miles of perennial streams for a total of 27,629 stream miles. The density of 2.7 stream miles per square mile places the basin fourth among the 12 major Kansas basins.

- Belleville City Lake is located in the Republic County with a drainage area of 2.6 square miles and maximum depth of 3.0 meters.
- James town wildlife Management area is located in Cloud County with a drainage area of 137.5 square miles and maximum depth of 1.0 meter.
- Lake Jewell located in Jewell County has a drainage area of 15.1 square miles and maximum depth of 1.0 meter.

Aquifers

The Republican River along with its tributaries is the primary waterways of the Milford Lake Watershed. Two types of aquifers underlie the watershed: Alluvial aquifer and Dakota. The alluvial aquifer lies along and below the river and some of tributaries of Republican River (Figure 4).

- Alluvial Aquifer - The alluvial aquifer is a part of and connected to a river system and consists of sediments deposited by rivers in the stream valleys. The Republican River has an alluvial aquifer that lies along and below the rivers.

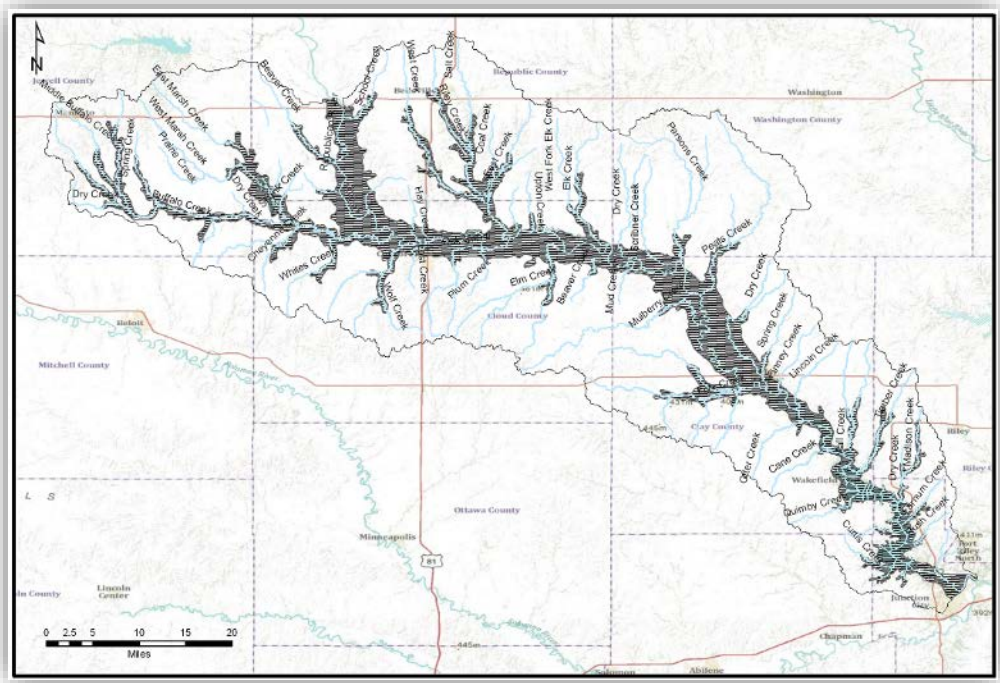


Figure 4 Map of alluvial aquifer underlying the Milford Lake Watersheds

Designated Uses

Milford Lake was built in 1964 by the U.S. Army Corps of Engineers (COE) for flood control, water supply, water quality, navigation, recreation, and fish and wildlife. Bellville City Lake, Lake Jewell and James town wildlife management area is used to support aquatic life and secondary contact recreation (Table 2).

Table 2 Designated Water Uses

Stream Name	AL	CR	DS	FP	GR	IW	IR	LW
Beaver Cr, Buffalo Cr seg.29, Elk Cr, W. Fk, Marsh Cr E, Marsh Cr W, Mulberry Cr, Riley Cr, Salt Cr W, Whites Cr	E	B		X				
Buffalo Cr seg.37, Buffalo Cr Middle, Elk Cr, Elm Cr, Salt Cr, Wolf Cr	E	C		X				
Buffalo Cr E, Cheyenne Cr, Coal Cr, Cool Cr, Dry Cr, East Cr, Elm Cr E Br, Elm Cr W Br, Finney Cr, Five Cr, Hay Cr, Lincoln Cr, Mud								

Cr, Oak Cr, Parsons Cr, Peats Cr, Rush Cr, Spring Cr, Turkey Cr, Upton Cr	E	B						
Fourmile Cr, Otter Cr	E	C						
Huntress Cr	E	B						
Marsh Cr,	E	A		X				
Timber Cr	E	C	X					
Republican River	S	C	X	X	X	X	X	X
Belleville City Lake	E	B		X				
Jamestown WA	E		X					
Milford Reservoir	E	A	X	X		X		
Milford WA	E			X				
Rimrock Park Lake	E	B	O	X		O	O	O

where

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
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

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

Of the approximately 190 public water suppliers in the basin, most use ground water as a source. From the perspective of population served however, most residents in the basin get water from surface water (streams and reservoirs). Table 3 lists the public water supplies in the Lower Republican (Milford Lake) Watershed. Even though the following PWS service customers are in the watershed, not all intake wells are located within the watershed.

Table 3 PWS Serving the Milford Lake Watershed

PWS	County Served	Source (number of active wells, 2010, in parenthesis)	Source Basin*	2007 Pop Served	KWO 2010 Pop (Estimate)
Agenda	RP	2 Wells (1), Republic RWD 02	Kr	72	
Aurora	CD	2 Wells (2)	Kr	74	
Belleville	RP	2 Wells (2)	Kr	2,222	
Clay Center	CY	10 Wells (6)	Kr	4,668	
Clay RWD 01	CY	1 Well (1)	Kr	103	
Clay RWD 02	CY	5 Wells (5) (wells located outside the watershed)	Ss	829	
Clifton	WS	4 Wells (4)	Kr	590	
Cloud RWD 01	CD	4 Wells (4)	Kr	408	
Clyde	CD	3 Wells (3)	Kr	705	
Concordia	CD	6 Wells (5)	Kr	5,203	
Courtland	RP	Republic RWD 1	Kr	304	
Cuba	RP	2 Wells (1) (wells located outside the watershed), Republic RWD 2	Kr	194	
Formoso	JW	1 Well (1), Republic RWD 1	Kr	117	
Geary RWD 01	GE	Junction City	Kr	NA	234
Geary RWD 02	GE	1 Well (1)	Kr	78	
Geary RWD 04	GE	2 Wells (2)	Kr	1,084	
Green	CY	6 Wells (1)	Kr	137	
Jamestown	CD	2 Wells (2), (Cloud RWD 1)	Kr	387	
Jewell	JW	Mitchell RWD 3	Kr	432	
Jewell RWD 01	JW	2 Wells (2)	Kr	472	
Junction City	GE	9 Wells (9)	Kr	20,000	
Linn	WS	2 Wells (2)	Kr	412	
Mankato	JW	5 Wells (3) (wells located outside the watershed)	Kr	933	

Milford	GE	Milford Reservoir	Kr	502	
Mitchell RWD 03	MC, CD, JW	Mitchell RWD 2 (wells located Outside the watershed)	So	NA	1,039
Morganville	CY	2 Wells (1)	Kr	194	
Palmer	WS	3 Wells (3)	Kr	112	
Randall	JW	1 Well (1), Mitchell RWD 3	Kr	73	
Republic RWD 01	RP, JW	3 Wells (3) (wells located outside the watershed)	Kr	426	
Republic RWD 02	RP, WS	2 Wells (2) (wells located outside the watershed)	Kr	1,250	
Scandia	RP	3 Wells (2)	Kr	377	
Wakefield	CY	3 Wells (3)	Kr	859	
Washington RWD 02	WS, CY	4 Wells (4)	Kr	650	

*Kr=Kansas/Republican Basin, Ss= Smoky Hill/Saline Basin. Not all water supplies distributed in the Lower Republican Watershed originate in the Lower Republican Watershed.

KDHE regulates wastewater treatment facilities fail rate within this watershed. Maximum amount of point source pollutants allowed to be discharged is controlled by National Pollutant Discharge Elimination System (NPDES). The watershed has numerous NPDES and wastewater treatment facilities (Table 4). Public water supply diversion points and rural water districts in addition to countless private wells within this watershed are shown in Figure 5.

Table 4 NPDES Sites

NPDES	Facility Name	Ownership	Description	Industrial Classification	City	County
KS0001988	Northern Natural Gas Clifton	Private	Natural Gas Transmission	Not ON Elg	Clifton	WS
KS0002682	General Finance Inc Clay Pits	Private	Clay, Ceramic & Refrac Mat Nec	ON Elg	Concordia	CL
KS0021385	Mankato City Of Stp	Public	Sewerage Systems	Municipal	Mankato	JW
KS0022403	Clyde City Of Stp	Public	Sewerage Systems	Municipal	Clyde	CS
KS0024678	Morganville City Of Stp	Public	Sewerage Systems	Municipal	Morganville	CY
KS0025577	Concordia City Of Stp	Public	Sewerage Systems	Municipal	Concordia	CL
KS0027529	Belleville City Of Stp	Public	Sewerage Systems	Municipal	Belleville	RP

KS0027545	Wakefield City Of Stp	Public	Sewerage Systems	Municipal	Wakefield	CY
KS0034011	Junction City-City Of Stp	Public	Sewerage Systems	Municipal	Junction City	GE
KS0048399	Clay Center City Of Stp	Public	Sewerage Systems	Municipal	Clay Center	CL
KS0048437	Clifton City Of Stp	Public	Sewerage Systems	Municipal	Clifton	WS
KS0079197	Geary Cnty Sewer Dist #4	Public	Sewerage Systems	Municipal	Geary County	GE
KS0083275	Milford Fish Hatchery	Private	Fish Hatcheries And Preserves	Not On El	Milford	GE
KS0083399	Courtland Wwt Facility	Private	Sewerage Systems	Not On El	Courtland	RP
KS0085898	Fina Oil \7	Private	Petroleum Refining	Primary O		
KS0086231	Milford Wwtf	Public	Sewerage Systems	Municipal	Milford	GE
KS0090018	Valley Fertilizer	Pub /Pri			Clay Center	CL
KS0090891	Ps Quarry	Private			Chapman	GE
KS0117340	Hamm N R Quarry Wakefield #80	Private	Crushed & Broken Limestone	On Elg	Clay Center	CL

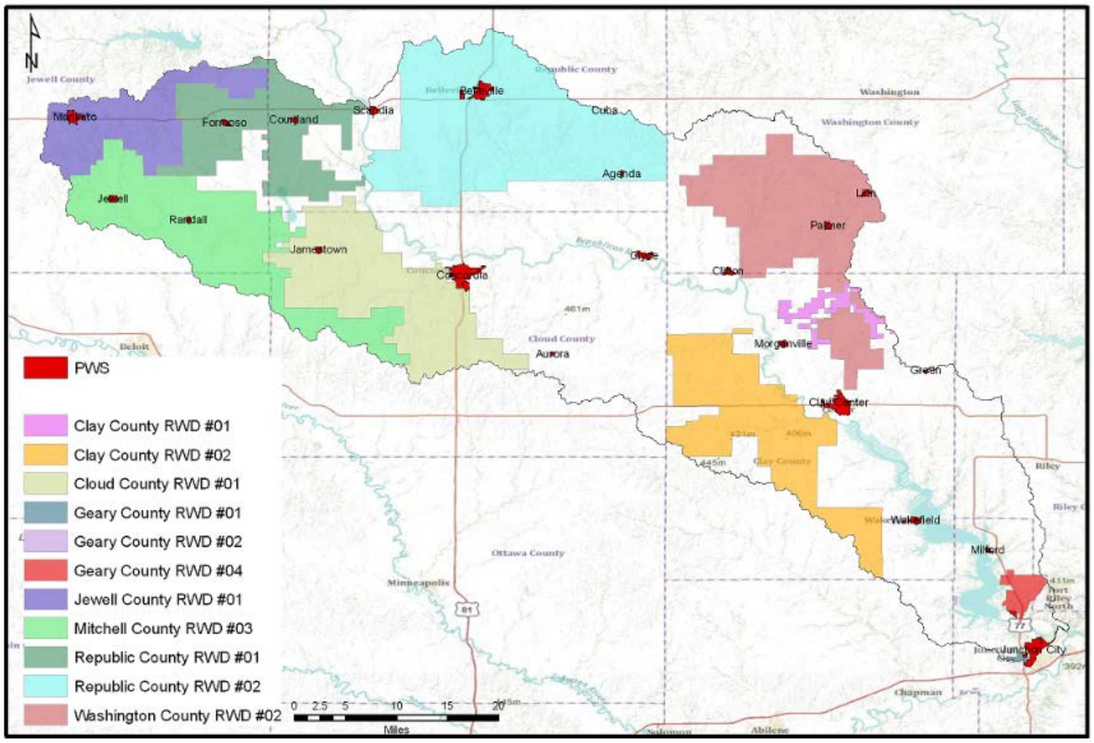


Figure 5 Rural Water Districts (RWD) and Public Water Supply (PWS) Diversion Points in the Milford Lake Watershed

Land Uses / Land Cover

The predominant land use features in the basin are the grasslands in the Flint Hills, crop land in the Republican River floodplain and urbanized areas of Junction City, Concordia, and Clay Center. Grassland and cropland are the most widespread land cover classes covering more than three-quarters of the basin (Figure 6). Table 5 shows the percentage land uses in three land use databases as historical changes from 1980 to 2001. The farm size distribution in the watershed is presented in Figure 7. The harvested crop areas are mainly occupied by four main crops in Kansas: wheat, corn, sorghum, and soybeans (Figure 8).

Common Cropland BMPs in Milford Lake Watershed

BMPs help reduce the amount of soil and nutrients that run off of cropland fields. Keeping these valuable inputs (soil and nutrients) in the field can be of benefit to both the landowner/producer and to society as a whole. Here are just a couple of the benefits:

- Top soil savings can result in higher yields and lower fertilizer costs
- Certain BMPs can offer both water quality protection and wildlife habitat

Below are some of the more popular BMPs in use in the Milford Lake watershed.

- Contour farming is farming the land, tillage and planting of the crop, on the level around the hill. By doing this, each furrow or ridge left by the different implements acts as miniature dams, trapping water, allowing more to soak into the ground. Each row of crop also slows the water. Combined, less water runs off. Soil is erosion reduced. Crop yields are increased in arid areas.

- Grassed waterways are used as outlets to prevent silt and gully formation. The vegetation cover slows the water flow and minimizes channel surface erosion. They can also be used as outlets for water from terraces.
- Vegetative buffers are areas of land that are maintained in permanent vegetation to help reduce nutrient and sediment loss from agricultural fields, improve runoff water quality, and provide habitat for wildlife. Because of these societal benefits, there are several federal and state programs that encourage the installation and maintenance of vegetative buffers.
- No-till is a form of conservation tillage in which chemicals are used in place of tillage for weed control and seedbed preparation. In other words, the soil surface is never disturbed except for planting or drilling operations in a 100 percent no-till system. Two other forms of tillage, reduced tillage and rotational no-till, involve a light to moderate use of tillage equipment. These forms of tillage also control erosion and nutrient runoff, but are not as effective as 100 percent no-till.
- Terraces are embankments constructed perpendicular to the slope of the field and are designed to reduce the length of a field slope and catch water flowing off the slope. Terraces reduce the rate of runoff and allow soil particles to settle out.
- Streambank stabilization projects can reduce the amount of streambank erosion and help prevent the loss of valuable cropland. Stabilization techniques reduce streambank erosion through diverting and/or slowing the movement of water in a stream channel. Some methods that can be employed include bendway-weirs, stone toes, pools and riffles, stream barbs, and willow post plantings.

Table 5 Summary of land use changes from 1980 to 2001

Lanuse Type	Agriculture			Barren Land	Forest Land	Grassland	Urban	Wet-lands/ Water	Shrub	Total
	Cropland	Pasture	Total							
GIRAS 1980s	89.3	0.0	89.3	0.1	0.4	7.6	1.1	1.6	0.0	100.0
NLCD 1992	48.8	10.3	59.1	0.0	4.6	32.6	0.8	2.5	0.4	100.0
NLCD 2001	49.7	0.8	50.5	0.0	4.9	36.4	5.3	2.9	0.0	100.0

Common Livestock Operations

Confined Animal Feeding Operations (CAFOs) with more than 300 animal units must register with KDHE. Majority of CAFOs are located in the south part of the Kansas Lower Republican basin. KDHE monitors the quality of wastewater and waste disposal practices from registered CAFOs, but the small unregistered CAFOs in Kansas, may contribute nutrients and fecal coliform bacteria to the nearest water resources. CAFOs are designed to retain a 25-year, 24-hour rainfall/runoff event as well as an anticipated two weeks of normal wastewater from their operations. Typically, this rainfall event coincides with stream flow that is less than 1-5% of the time. However, since the watershed is dominated by grassland and pasture the number of smaller animal feeding operations that are not registered is presumably high, particularly during seasonal feeding months in the winter.

Distribution of livestock is presented in Figure 9 with beef cattle and hogs occupying more than 97%.

Wildlife Habitat

Milford Reservoir began operation in 1965 and the former Forestry, Fish and Game Commission began operation of the public hunting area in 1967. A total of 26 species of birds, fish and reptiles are listed as threatened or endangered in the Kansas-Lower Republican basin including single species of snake, snail and beetle (Figure 10). There are approximately 19,000 acres of public land surrounding Milford Reservoir on the west side and the upper end. All 19,000 acres are open to public hunting. The Steve Lloyd refuge contains an additional 1100 acres. Both the public hunting area and the refuge are managed to maximize the production of various wildlife species.

The abundant and diversified habitat at Milford supports many species of nongame birds, mammals, reptiles and aquatic life. Hunters will find a variety of game including quail, pheasant, prairie chicken, duck, goose, rabbit, turkey, deer and squirrel. Trappers are also active throughout the season in pursuit of raccoon, muskrat, beaver and other furbearers Species common to the area included Bald Eagles, Elk, Pelicans, Great Blue Herons, waterfowl etc. Fishable populations in the Milford Lake are Wiper, White Bass, Channel Catfish, Black Bass, Walleye, Crappie, Black Bull head, Blue gill, Blue Catfish, Flathead Catfish, Green Sunfish, Largemouth Bass, Small mouth Bass, Spotted Bass, and Walleye. Approximately 15,000 snow geese are currently residing on Milford Lake.

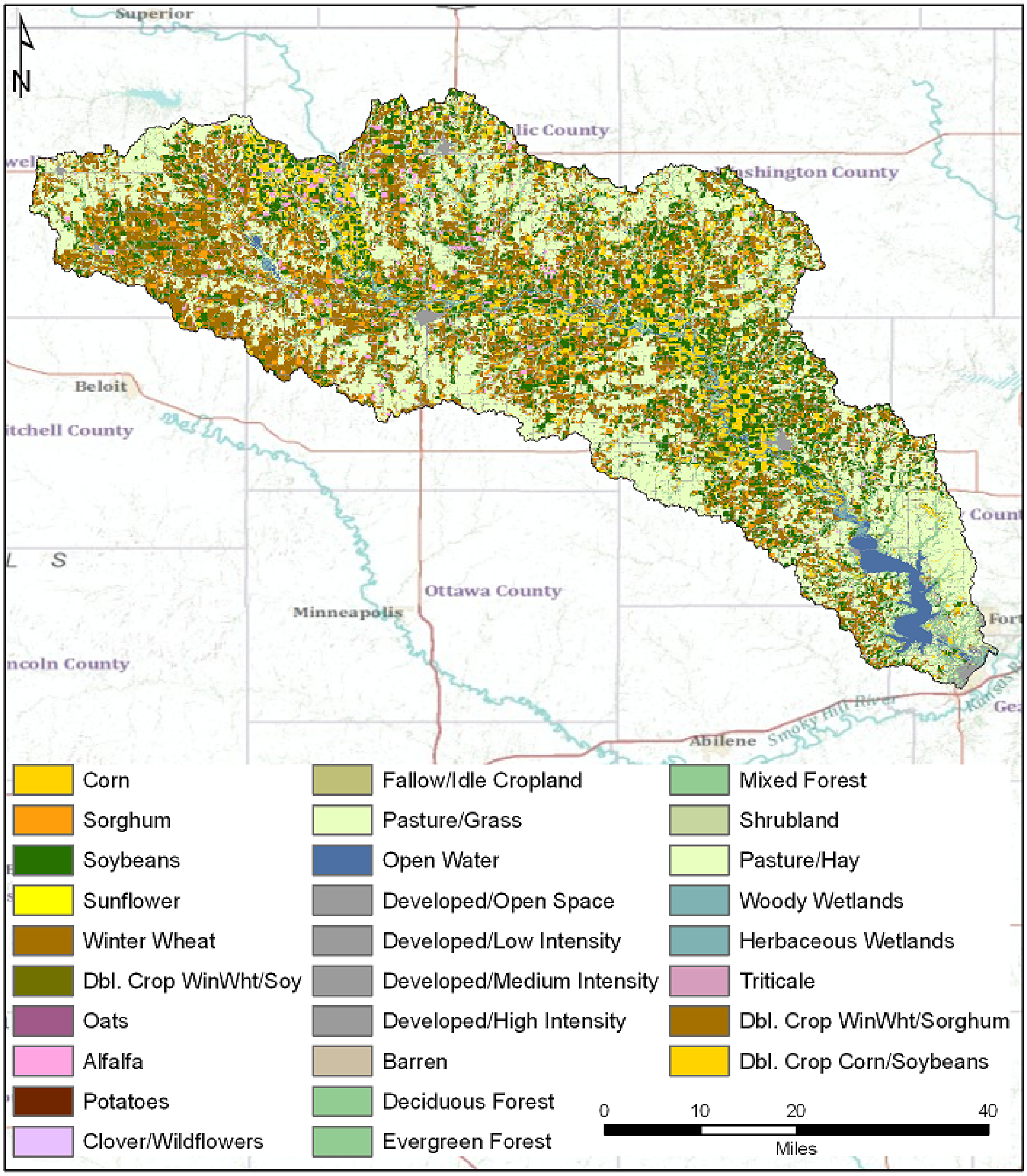


Figure 6 Land cover map (2010 NASS Crop Data Layer)

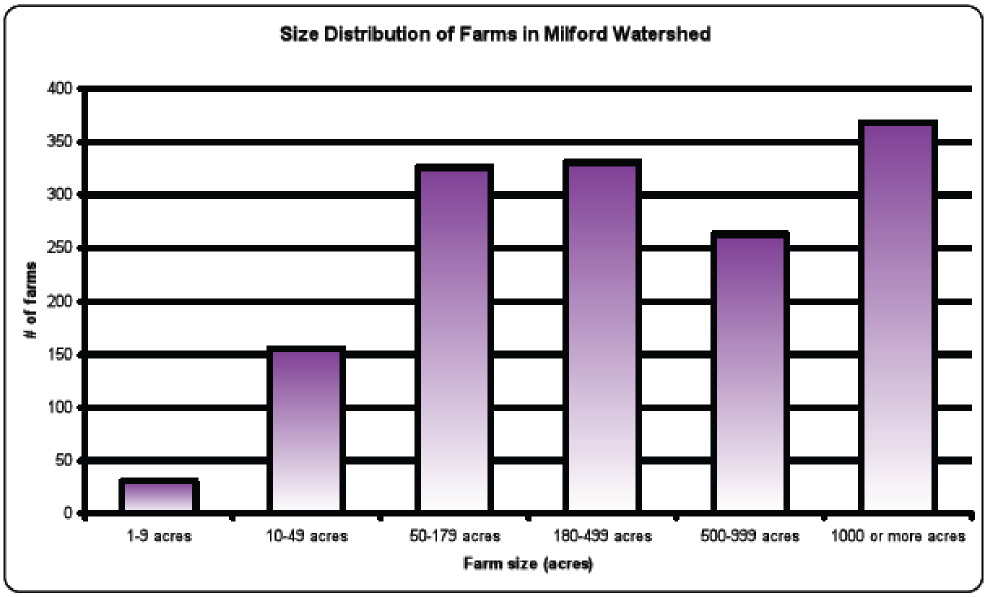


Figure 7 Farm size distribution in Milford Lake Watershed

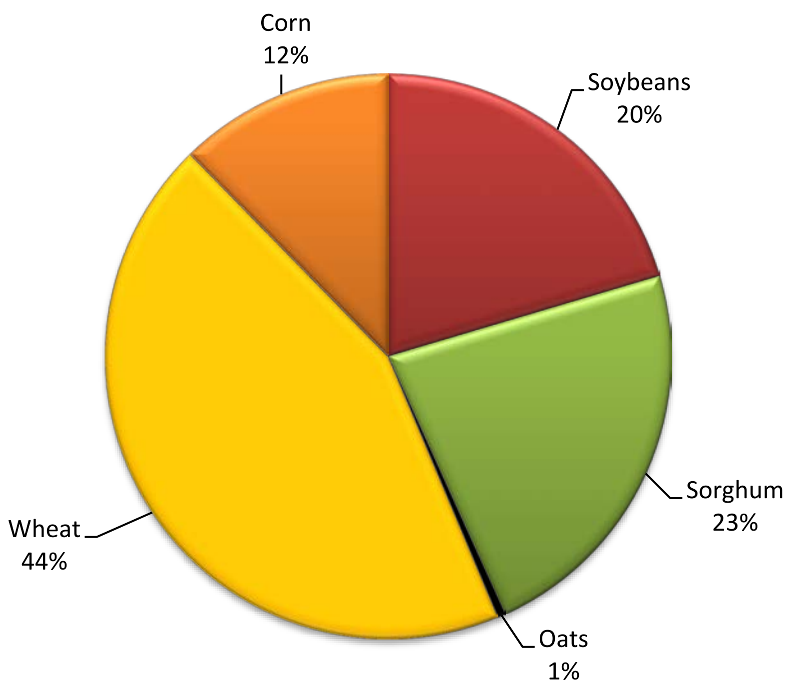


Figure 8 Percentage harvested crop areas (Based on 2010 Crop Data Layer) in the Milford Lake Watershed

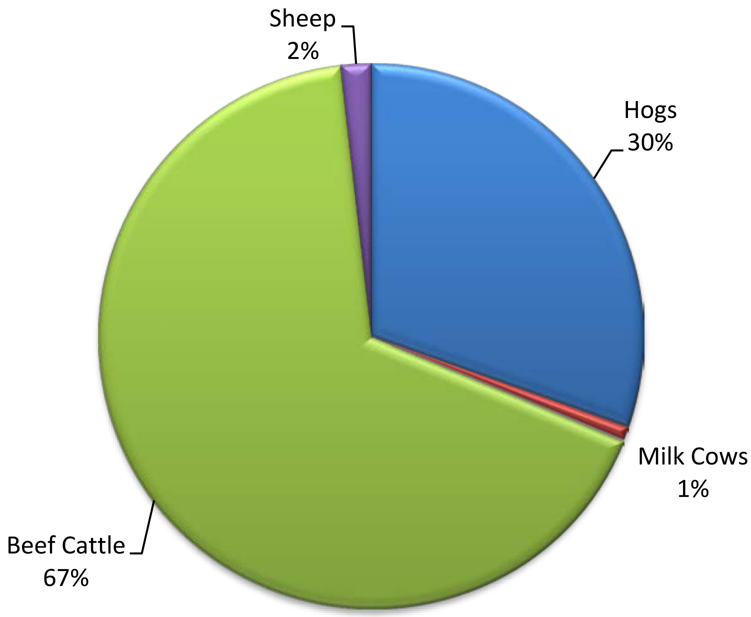


Figure 9 Livestock Distribution in Milford Lake Watershed

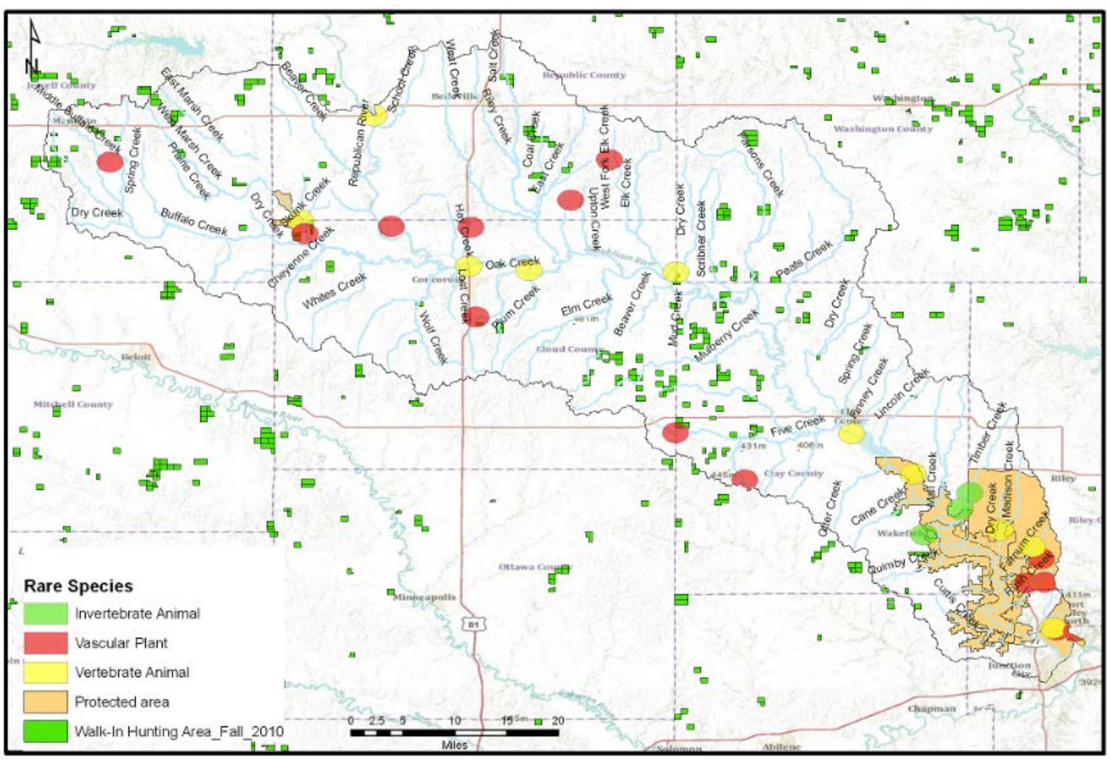


Figure 10 Map of rare species, protected areas, and areas with walk-in hunting access

Recreational Areas

Main recreational area in the watershed is Milford State Park which is located near Junction City on the shores of the state's largest lake, 16,000-acre Milford Reservoir, in Geary County.

Milford State Park is a favorite getaway for outdoors loving visitors, Kansas. The park comprises 7 campgrounds with 141 electric and water hook-ups. Fifty-one of these sites include sewer hook-ups. 108 primitive campsites are available throughout the park. Many game species are present on the 18,800-acre Milford Wildlife Area, and a permanent 1,100-acre wildlife refuge has been established on the northern end of the reservoir for waterfowl management.

Watershed / Water Quality Conditions

When river segments or lakes that are monitored by Kansas Department of Health and Environment (KDHE) have experienced poor quality, a Total Maximum Daily Load (commonly referred to as a TMDL) is established. A TMDL is the maximum amount of pollution that a surface water body can receive and still meet water quality standards.

The Clean Water Act sets water quality goals for the U.S. Section 303(d) of the Clean Water Act requires states to submit to the U.S. EPA a list of impaired water bodies (303(d) list). For each water body listed, the state must develop a Total Maximum Daily Load (TMDL), which defines both the water-quality objective and the strategy needed to meet that objective. In Kansas, the Kansas Department of Health and Environment (KDHE), Division of Environment, Bureau of Water, Watershed Planning Section has responsibility to develop the 303(d) list of impaired water bodies and develop TMDLs to address each concern. The list of impaired waterways is updated by the states every two years. This can be used to identify specific stream segments and lakes for which, in accordance with their priority ranking, TMDLs may need to be developed.

Total Maximum Daily Loads (TMDLs)

KDHE established streams and lakes experienced poor quality as TMDLs. TMDLs within the watershed are mapped in Figure 11 and listed in

Table 6. Salt Creek near Hollis has High Priority TMDL for Dissolved Oxygen and Fecal Coliform Bacteria. Republican River near Clay Center and near Rice is listed as a Medium Priority TMDL for Fecal Coliform Bacteria, whereas Lake Jewell and Rimrock Park Lake are listed for Dissolved Oxygen. Other TMDLs are of Low Priority and relate to the impairments, such as Dissolved Oxygen, Eutrophication, pH, etc.

- TMDLs for the Kansas Lower Republican River Basin
  http://www.kdheks.gov/tmdl/krtmdl.htm

Table 6 TMDLs in the Watershed

Water Segment	TMDL Pollutant	Water Quality Standard	Endgoal of TMDL	Priority	Sampling Station
		High Priority TMDLs			
Salt Creek near Hollis	Dissolved Oxygen	5 mg/l	Reduce ammonia < 0.05mg/l which results in no excursions of DO < 5	High	SC650

Salt Creek near Hollis	Fecal Coliform Bacteria	Primary Contact < 900 colonies per 100 ml water Secondary Contact < 2,000 colonies per 100 ml water	Maintain percent of samples over applicable criteria < 10%	High	SC650
Medium Priority TMDLs					
Republican River near Clay Center	Fecal Coliform Bacteria	Primary Contact< 900 colonies per 100 ml water Secondary Contact < 2,000 colonies per 100 ml water	Maintain percent of samples over applicable criteria < 10%	Medium	SC503 and SC504
Republican River near Rice	Fecal Coliform Bacteria	Primary Contact < 900 colonies per 100 ml water Secondary Contact < 2,000 colonies per 100 ml water	Maintain percent of samples over applicable criteria < 10%	Medium	SC510
Lake Jewell – The *Lake Jewell dam was breached, but has been repaired. However, the TMDL remains inactive until future assessment can occur.*	Aquatic Plants, Eutrophication and Dissolved Oxygen	Nutrients shall be controlled to prevent accelerated succession of aquatic biota or aquatic life, and development of objectionable concentrations of algae or algal by-products DO 5mg/l	Summer Chlorophyll concentrations = or < 20ug/l	Medium	LM062901 in Lake Jewell
Rimrock Park Lake	Dissolved Oxygen	*Rimrock Park Lake lies on the watershed border with Lower Smoky Hill Watershed. It is not incorporated in this WRAPS plan due to the fact that it is downstream of Milford Reservoir. The TMDLs imply that it is applicable to the Smoky Hill Watershed not the Lower Republican.*		Medium	LM070501
Rimrock Park Lake	Eutrophication			Medium	LM070501
Low Priority TMDLs					
Buffalo Creek near Concordia	Fecal Coliform Bacteria	Primary Contact < 900 colonies per 100 ml water Secondary Contact < 2,000 colonies per 100 ml water	Maintain percent of samples over applicable criteria < 10%	Low	SC509
Buffalo Creek near Concordia	Chloride	352 mg/l	Maintain percent of samples over	Low	SC509

			applicable criteria < 10%		
Belleville City Lake	Eutrophication	Nutrients shall be controlled to prevent accelerated succession of aquatic biota or aquatic life, and development of objectionable concentrations of algae or algal by-products	Summer Chlorophyll concentrations = or < 20ug/l	Low	LM060701
Jamestown Wildlife Management Area	Eutrophication and pH	Nutrients shall be controlled to prevent accelerated succession of aquatic biota or aquatic life, and development of objectionable concentrations of algae or algal by-products pH > 6.5 and < 8.5	Summer Chlorophyll concentrations = or < 20ug/l and pH between 6.5 and 8.5	Low	LM052801 in Jamestown WMA
Jamestown Wildlife Management Area	Siltation	Suspended solids shall not interfere with the behavior, reproduction, physical habitat or other factor related to the survival and propagation of aquatic or semiaquatic or terrestrial wildlife	10% or less of samples taken from wetland > 100mg/l TSS	Low	LM052801 in Jamestown WMA
Jamestown Wildlife Management Area	Fecal Coliform Bacteria	2,000 colonies per 100ml water	All FCB samples < 2,000 colonies per 100ml water	Low	LM 052801 in Jamestown WMA

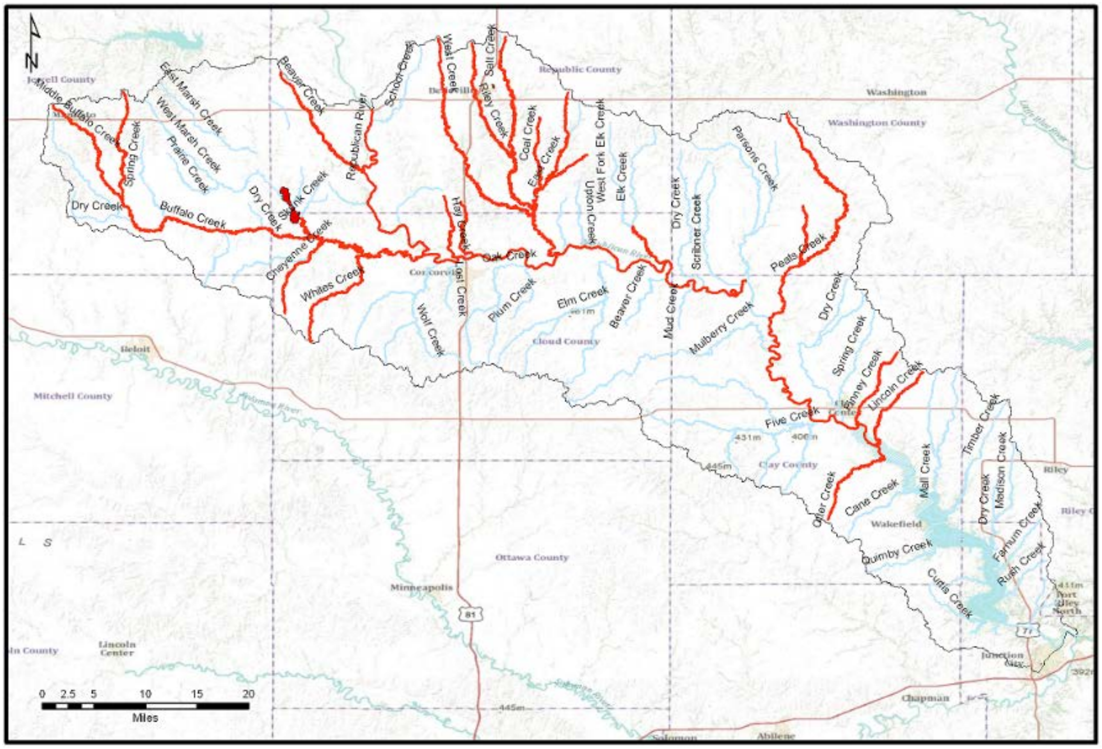


Figure 11 TMDL streams in the Milford Lake Watershed

The 303d List of Impaired Water Bodies

The Lower Republican Watershed has numerous new listings on the 2010 "303d list" (Table 7). 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. TMDL development and revision for waters of the Lower Republican Watershed is scheduled for 2010. TMDLs will be developed over the subsequent two years for "high" priority impairments. Priorities are set by work schedule and TMDL development timeframe rather than severity of pollutant. If it will be greater than two years until the pollutant can be assessed, the priority will be listed as "low". Water bodies are assigned "categories" based on impairment status:

- Category 5 – Waters needing TMDLs
- Category 4a – Waters that have TMDLs developed for them and remain impaired
- Category 4b – NPDES permits addressed impairment or watershed planning is addressing atrazine problem
- Category 4c – Pollution (typically insufficient hydrology) is causing impairment
- Category 3 – Waters that are indeterminate and need more data or information
- Category 2 – Waters that are now compliant with certain water quality standards
- Category 1 – All designated uses are supported, no use is threatened.

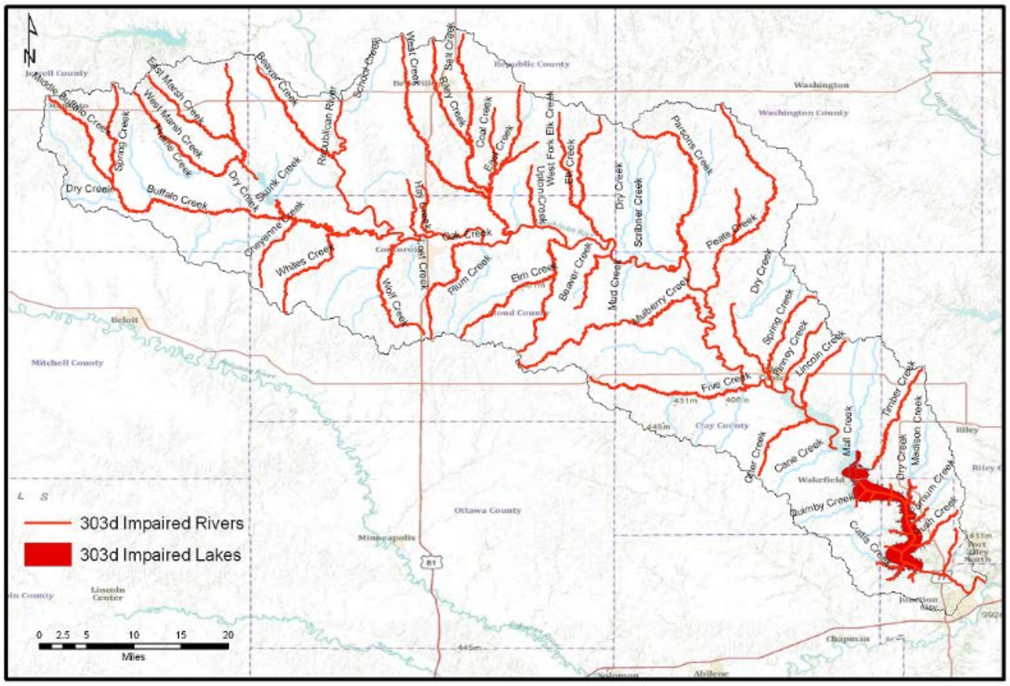


Figure 12 Streams on 303d list in the Milford Lake Watershed

Table 7 303d List of Impaired Waters in the Milford Lake Watershed

Category	Water Segment	Impairment	Priority	Sampling Station
		Medium Priority		
5 –needing TMDL	Republican River near Clay Center	Biology	Medium	SC503
		Low Priority		
5 –needing TMDL	Salt Creek near Hollis	Chloride	Low	SC650
5 –needing TMDL	Elm Creek near Ames	Copper	Low	SC709
5 –needing TMDL	Mulberry Creek near Clifton	Copper	Low	SC710
5 –needing TMDL	Peats Creek near Clifton	Copper	Low	SC649
5 –needing TMDL	Milford Reservoir	Dissolved Oxygen	Low	LM019001
5 –needing TMDL	Elm Creek near Ames	Lead	Low	SC709
5 –needing TMDL	Mulberry Creek near Clifton	Lead	Low	SC710
5 –needing TMDL	Peats Creek near Clifton	Lead	Low	SC649
5 –needing TMDL	Republican River near Clay Center	Lead	Low	SC504

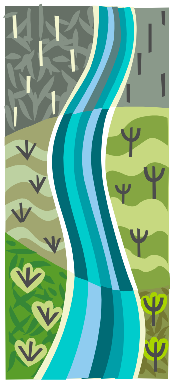
5 –needing TMDL	Republican River near Clay Center	Lead	Low	SC503
5 –needing TMDL	Republican River near Rice	pH	Low	SC510
5 –needing TMDL	Buffalo Creek near Concordia	Sulfate	Low	SC509
5 –needing TMDL	Five Creek near Clay Center	Sulfate	Low	SC711
5 –needing TMDL	Buffalo Creek near Concordia	Total Phosphorus	Low	SC509
5 –needing TMDL	Elm Creek near Ames	Total Phosphorus	Low	SC709
5 –needing TMDL	Mulberry Creek near Clifton	Total Phosphorus	Low	SC710
5 –needing TMDL	Peats Creek near Clifton	Total Phosphorus	Low	SC649
5 –needing TMDL	Republican River near Clay Center	Total Phosphorus	Low	SC504
5 –needing TMDL	Republican River near Clay Center	Total Phosphorus	Low	SC503
5 –needing TMDL	Republican River near Rice	Total Phosphorus	Low	SC510
5 –needing TMDL	Salt Creek near Hollis	Total Phosphorus	Low	SC650
5 –needing TMDL	Wolf Creek near Concordia	Total Phosphorus	Low	SC707
5 –needing TMDL	Buffalo Creek near Concordia	Total Suspended Solids	Low	SC509
5 –needing TMDL	Republican River near Clay Center	Total Suspended Solids	Low	SC504
5 –needing TMDL	Republican River near Clay Center	Total Suspended Solids	Low	SC503
5 –needing TMDL	Salt Creek near Hollis	Total Suspended Solids	Low	SC650
5 –needing TMDL	Mulberry Creek near Clifton	Zinc	Low	SC710
3 – need more information	Buffalo Creek	Ammonia	Permit Pending	NPDES95231

3 – need more information	Jamestown WMA	Arsenic	Small sample size	LM052801
3 – need more information	Wolf Creek near Concordia	Arsenic		SC707
3 – need more information	Peats Creek near Clifton	Atrazine	Last exceedance 2007	SC649

Salt Creek, Peats Creek, and Republican River below Milford Dam have been removed from the 2010 303d list (Table 8). Figure 12 shows the map of 303d Listings in the Watershed.

Table 8 303d Delisted Waters in the Milford Lake Watershed

Category	Water Segment	Impairment	Comments	Sampling Station
2 – no longer needing TMDL	Republican River below Milford Dam	Ammonia	No longer impaired	NPDES34011
2 – no longer needing TMDL	Salt Creek	Ammonia	No longer impaired	NPDES27529
2 – no longer needing TMDL	Milford Reservoir	Eutrophication	Adequate water quality	LM019001
2 – no longer needing TMDL	Peats Creek near Clifton	FCB	Typographic error	SC649
2 – no longer needing TMDL	Republican River below Milford Dam	FCB	No longer impaired	NPDES34011



Goals, Objectives, and Tasks

Goals

The goal of this project was to provide the watershed environmental and economic information needed for the development of a stakeholder-led Watershed Restoration and Protection Strategy (WRAPS) Plan and Report.

A primary goal of this Milford Lake Watershed project was to develop models and tools to evaluate alternative farm and non-farm land use practices in relation to water quality and to document the impact of water restoration and preservation strategies.

Objectives

The objectives of this WRAPS Assessment Phase project were to:

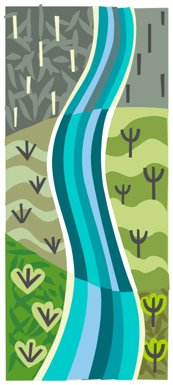
1. characterize watershed conditions,
2. identify needs and opportunities for watershed information to support stakeholder decisions, and
3. understand how the watershed responds to various management scenarios.

Tasks/Activities

The major tasks/activities implemented to achieve project objectives involved:

1. Inform and educate watershed stakeholders.
2. Establish assessment criteria.
3. Inventory existing information.
4. Provide technical information to support implementation decisions.
    a. Watershed Assessment
    b. Watershed Modeling
    c. Economic Analysis
5. Prepare watershed assessment project report.

The completed activities that address the established goals and objectives are presented in the following sections.



Summary of Project Activities and Accomplishments

Timeframe

The activities implemented as part of this WRAPS Assessment Phase project were ongoing for approximately two years, starting in January 2007 and ending in July 2009.

Inform and Educate Watershed Stakeholders

Two Stakeholder Leadership Teams (SLT) were recruited and established in the watershed. One SLT was engaged in assessment activities relevant to the North-West portion of the watershed mainly in Washington, Republic, Jewell, and Mitchel Counties. The second SLT was engaged in assessment activities in Clay, Washington, and Riley Counties. These two teams were active during the assessment project and provided critical stakeholder engagement that resulted in modeling results truly relevant for the WRAPS planning process. Watershed modeling and economic analysis results were presented to the SLTs during several meetings, critically discussed, and the final critical areas were approved.

Activities

The following assessment activities took place during the time span of the project:

Date	Type	# Attendees	# Materials Distributed	Description
1/1/2007	Other	N/A	N/A	The move toward integrated, holistic watershed assessment has meant that more attention must be paid to factors beyond the water body itself—how land is used, what type of vegetative or other cover it has, and how it is managed. Such an approach requires the involvement of landowners, developers, farmers, urban governments, homeowners, and other constituents in the watershed if real progress is desired. Stakeholders need to be involved at each stage of the watershed planning process. Their knowledge of local social, economic, political, and ecological conditions provides the yardstick against which proposed solutions must be measured. Also, the goals, problems, and remediation strategies generated by stakeholders define what's desirable and achievable. In this regard, watershed specialists were asked to help in data collection and analysis procedure. Series of forms and maps were prepared and distributed. Their inputs will be directly incorporated in modeling procedure. However, the Milford Lake Assessment project has been given a lower priority by the KSU WRAPS Steering Committee, with effort and funding redirected (at KDHE request) to meet increased priority of the Neosho/John Redmond Lake Assessment Project. As such, Stakeholder Leadership Team (SLT) development and engagement will be postponed until concerted effort can be dedicated to this project (probably not until after the end of 2007). Because of the close linkage between SLT and assessment activities, significant progress in Milford Lake Assessment Project is not anticipated until after that time. KSU (Mankin, Nejadhashemi) have developed a draft factsheet ("Adaptive Watershed Modeling") to present the watershed modeling selection and revision process. This is an interactive process between KSU WRAPS Technical Team, the SLT, and other local watershed stakeholders, with the final product representing substantial commitment and consensus of all parties. Because watershed modeling and other assessment activities are an interactive process with the SLT, significant progress on modeling is pending formation of the SLT.

Date	Type	# Attendees	# Materials Distributed	Description
5/1/2007	Other	N/A	N/A	The KSU WRAPS Technical Team is in the process of developing a more-formal schedule for this project as well as the other active WRAPS projects in all phases (Development, Assessment, Planning, Implementation). This will likely take the form of a sequential listing of benchmarks for various stages of this Assessment Project, with estimated dates of completion, and will be reported in the next Quarterly Status Report. This schedule will set the anticipated dates to present each stage of assessment information, including modeling outcomes, during this Assessment Project. Up to this point, most of the off-site economic effects evaluation has focused on Tuttle Creek Lake. Once we feel like we have refined our evaluation techniques with Tuttle Creek, we will then apply these lessons and processes to other watersheds – the technical process should be much more efficient by that time. Thorough research is being performed for the benefits-cost estimation of watershed management. Initial research has shown sedimentation as the main cause of future economic loss to Milford Lake, so this will be the main focus of the economic analysis. The economic impacts and benefits of recreation at Milford Lake will be estimated using an input-output impact analysis and non-market valuation techniques. Contact has been made with the Army COE regarding the options for sedimentation remediation from their perspective (dredging, raise the dam, remove the dam, etc.). Conference calls have been made with sedimentation experts at USGS, Kyle Juracek and Waite Ostercamp. Estimates of dredging have been made based on previous Army COE projects. This information has been documented in the form of a sedimentation economics white paper, which was presented at the WFK conference and eventually to the WRAPS local leadership team. This information is critical to the benefit-cost analysis. A program for estimating the Net Present Value of benefits and costs in the future has also been developed.
6/9/2007	Other	8	11	Initial contact has been made with Reid Christianson, KSU Extension Assistant in the Biological and Agricultural Engineering Department, whose area of focus is Urban Stormwater BMPs. If the local leadership team identifies urban stormwater as an issue in the Milford Watershed, then future work will involve the addition of economics to his work on the engineering side.
9/1/2007	Other			A development has started of a basic watershed assessment report to help organize local watershed data and use the STEPL model to provide an introduction to watershed models and their data needs.
5/22/2008	Meeting	100	1	KDHE WRAPS Regional Watershed Seminar, Lawrence, KS. WRAPS Adaptive Modeling presentation (Mankin)
6/17/2008	Meeting	85	1	USDA-CSREES Heartland Regional Workshop: Impact Assessment and Achievements in Water Quality Protection, Nebraska City, NE. June 17-19, 2008. Using Watershed Models to Assess Watershed Needs and Project Impacts: What Models Are, When to Use Them, Shortcomings and Strengths. (Mankin, Invited Presentation) Posted at: http://www.oznet.ksu.edu/waterquality/2008%20Assessment/Workshop/Presentations/Mankin 3.pdf

Date	Type	# Attendees	# Materials Distributed	Description
6/17/2008	Meeting	85	1	USDA-CSREES Heartland Regional Workshop: Impact Assessment and Achievements in Water Quality Protection, Nebraska City, NE. June 17-19, 2008. Case Study: Using Watershed Models to Target Best Management Practices in the Pomona Lake Watershed in Kansas. (Mankin, Invited Presentation) Posted at: http://www.oznet.ksu.edu/waterquality/2008%20Assessment/Workshop/Presentations/Mankin 3.pdf
8/1/2008	Other	N/A	N/A	A comprehensive watershed assessment report (Watershed Atlas) was developed that will help organize local watershed data using simple modeling.
11/3/2008	Workshop	14	0	During 11/03/2008-11/07/2008, Aleksey Sheshukov attended a SWAT/APEX workshop at the Texas A&M University in College Station, TX. The purpose of attending the workshop was to learn about the advanced watershed modeling tools - SWAT and APEX, and train to be proficient applying these tools in the WRAPS projects. This workshop was designed to introduce new version of SWAT (ArcSWAT), review necessary and optional inputs, and familiarize the user with the new ArcGIS interfaces. It also covered sensitivity analysis, model calibration, and uncertainty analysis using the 2005 version of SWAT with an ArcGIS interface.
10/29/2008	SLT Meeting	14	14	SLT Meeting in Belleville. Josh Roe presented the economic effects of recreation at Milford Lake on Clay, Cloud, Ottawa, Mitchell, Republic, and Jewell Counties. This demonstrated to the SLT that although Milford may seem far away from where they live, it provides economic benefits throughout the entire watershed.
10/30/2008	SLT Meeting	14	14	SLT Meeting in Clay Center. Josh Roe presented the economic effects of recreation at Milford Lake on Clay, Cloud, Ottawa, Mitchell, Republic, and Jewell Counties. This demonstrated to the SLT that although Milford may seem far away from where they live, it provides economic benefits throughout the entire watershed.
11/1/2008	Other			Much time and effort was also spent (during this quarter) on developing a tool to evaluate the benefits and costs of alternative watershed management scenarios in Milford Watershed. We are developing a watershed-scale decision-making tool to aid in this evaluation process. K-State Watershed Manager is a spreadsheet program that can support the development of watershed management plans. Using this program, watershed stakeholder groups & technical assistance providers can estimate, optimize, and compare the economic and environmental effects of various watershed management scenarios. This includes cost estimates and estimates of pollutant (sediment, phosphorus, and nitrogen) load reductions for a variety of landscape Best Management Practices (BMPs). K-State Watershed Manager was developed by a group of agricultural economists (Craig Smith, Jeff Williams, John Leatherman, and Josh Roe) at Kansas State University.

Date	Type	# Attendees	# Materials Distributed	Description
3/17/2009	SLT Meeting	15	15	SLT Meeting in Belleville. The SWAT modeling results were presented by the watershed modeler. The watershed modeler presented a watershed assessment summary report including main land characteristics (topography, soil types, and land cover), current TMDL stream concerns, HUC-12 subwatershed map, and county map. The revised STEP-L results were presented to the stakeholders, and the changes from initial STEP-L run were discussed. The modeler presented maps of total sediment and nutrients loadings, and a map with targeted areas (subwatersheds 11, 24, 26, 38, 39, 41, 42, 43) identified by SWAT. Further steps of what needs to be done including the "groundtruthing" were also suggested and discussed. Discussion of further modeling was taken place, stressing the fact that it would be very helpful to pursue a more detailed analysis within the targeted areas to identify the fields of the greatest potential. The process of publishing the Preliminary Assessment Report (i.e., Watershed Atlas) as a K-State Research and Extension publication has begun, and thus making it available digitally online. This process should take about 3 more months for the whole set of 10 Watershed Atlases. Josh Roe (watershed economist) introduced the concept of cost-effective BMP implementation through targeting. Using past projects as a template, he showed how through the use of watershed modeling and optimization techniques, twice the nutrient and sediment runoff can be prevented using the same amount of funds as randomly installing BMPs throughout the watershed. A handout was made showing ten of the most popular crop land BMPs and the SLT was instructed to begin the process of estimating what the current BMP adoption rates were in the targeted areas identified by the modeling. Josh also spent time in calibrating and installing new features on the Watershed Manager. (BMP cost-effectiveness optimization spreadsheet.)

Date	Type	# Attendees	# Materials Distributed	Description
3/19/2009	SLT Meeting	22	22	SLT Meeting in Clay Center. The SWAT modeling results were presented by the watershed modeler. The watershed modeler presented a watershed assessment summary report including main land characteristics (topography, soil types, and land cover), current TMDL stream concerns, HUC-12 subwatershed map, and county map. The revised STEP-L results were presented to the stakeholders, and the changes from initial STEP-L run were discussed. The modeler presented maps of total sediment and nutrients loadings, and a map with targeted areas (subwatersheds 11, 24, 26, 38, 39, 41, 42, 43) identified by SWAT. Further steps of what needs to be done including the "groundtruthing" were also suggested and discussed. Discussion of further modeling was taken place, stressing the fact that it would be very helpful to pursue a more detailed analysis within the targeted areas to identify the fields of the greatest potential. The process of publishing the Preliminary Assessment Report (i.e., Watershed Atlas) as a K-State Research and Extension publication has begun, and thus making it available digitally online. This process should take about 3 more months for the whole set of 10 Watershed Atlases. Josh Roe (watershed economist) introduced the concept of cost-effective BMP implementation through targeting. Using past projects as a template, he showed how through the use of watershed modeling and optimization techniques, twice the nutrient and sediment runoff can be prevented using the same amount of funds as randomly installing BMPs throughout the watershed. A handout was made showing ten of the most popular crop land BMPs and the SLT was instructed to begin the process of estimating what the current BMP adoption rates were in the targeted areas identified by the modeling. Josh also spent time in calibrating and installing new features on the Watershed Manager. (BMP cost-effectiveness optimization spreadsheet.)
6/18/2009	SLT Meeting	12	12	SLT Meeting in Belleville. Josh Roe presented importance of targeting to maximize cost-benefit of conservation practices. Groundtruthing results for targeted watershed areas in Clay and Washington Counties were presented and discussed. The most appropriate cropland BMPs for areas identified by SWAT model were discussed and selected. Josh presented an optimal set of cropland BMPs and showed the increase in "bang for the buck" that occurs if the BMPs are placed in the targeted area compared to random locations throughout the watershed. The SLT was educated on the cost-effectiveness of 12 cropland BMPs and through a dynamic voting procedure, selected their top five.

Establish Assessment Criteria

With assistance of two Stakeholder Leadership Teams, the assessment criteria were established based on the pollutant loads calculated with the watershed assessment models and/or monitoring data information in the Lower Republican River and its tributaries. The assessment criteria were given priorities in the sediment producing agricultural areas, and the areas with heavy livestock grazing facilities. Stream banks along the Lower Republican River were assessed based on available GIS information revised according to local knowledge.

Inventory Existing Information

The watershed assessment team compiled the preliminary assessment information needed for this WRAPS project and revised it with two Stakeholder Leadership Teams. Inventory included topographical information, land uses, soil types, weather data, surface water resources, designated uses, public and rural water supplies, recreational areas, TMDL, agricultural and management practices, etc. This WRAPS project was able to identify relevant information regarding watershed conditions, natural resources, culture, customs, institutions, etc.

The project team inventoried watershed informational resources, TMDL needs inventories, previous watershed assessment reports, water-quality studies, USGS monitoring data, wildlife reports, riparian assessments, etc. Details about this process and the data compiled are presented in the *Watershed Assessment* section, below.

Provide Technical Information to Support Implementation Decisions

Watershed Atlas

Extensive information about the Milford Lake Watershed and surrounding area was collected, compiled, and published as a Preliminary Assessment Report (often called the "Watershed Atlas"). This information was published as a K-State Research and Extension publication, thus making it available digitally online:

Milford Lake Watershed Assessment: Preliminary Report. K-State Research & Extension Publication #EP-142. 68 pages. http://www.ksre.ksu.edu/library/h20ql2/ep142.pdf

This publication included the following topics:

1.0. Milford Lake Watershed Assessment
  - 1.1. Watershed Summary
  - 1.2. Overview of Water Quality Issues and Potential Pollution Sources

2.0. Climate Mapping System
  - 2.1. Precipitation Map
  - 2.2. 30-Year Average Daily Maximum Temperature Map
  - 2.3. 30-Year Average Daily Minimum Temperature Map

3.0. Land Use/ Land Cover
  - 3.1. Land Use (GIRAS 1980s)
  - 3.2. Land Use (NLCD 1992)
  - 3.3. Land Use (NLCD 2001)

4.0. River Network

5.0. Hydrologic Soil Groups

6.0. Water Quality Conditions
  - 6.1. The 303d List of Impaired Waterbodies
  - 6.2. Water Quality Observation Stations
  - 6.3. USGS Gage Stations
  - 6.4. Permitted Point Source Facilities
  - 6.5. Confined Animal Feeding Operations (CAFOs)
  - 6.6. 1990 Population and Sewerage by Census Tract

7.0. Agricultural Economy
- 7.1. Corn Cost-Return Budget
- 7.2. Soybean Cost-Return Budget
- 7.3. Wheat Cost-Return Budget
- 7.4. Grain Sorghum Cost-Return Budget
- 7.5. Alfalfa Cost-Return Budget
- 7.6. Common Cropland BMPs in Milford Reservoir Watershed
  - 7.6.1. Vegetative Buffer: Economic Analysis and Discussion
  - 7.6.2. Streambank Stabilization: Economic Analysis and Discussion
- 7.7. Economic Contributions of Recreation at Milford Lake
- 7.8. Census Data

8.0. Modeling
- 8.1. Subbasin Map
- 8.2. Input Data
- 8.3. Model Output

9.0. Acknowledgment

10.0. Footnotes/Bibliography

TMDL Reports

The TMDL documents provide a rich source of watershed information. Priority categories and a detailed list of impairments were provided in

Table 6.

Republican River Basin TMDL

- http://www.kdheks.gov/tmdl/klr/BuffaloFCB.pdf
- http://www.kdheks.gov/tmdl/klr/BuffaloCl.pdf
- http://www.kdheks.gov/tmdl/klr/RepblcnRClyCntr.pdf
- http://www.kdheks.gov/tmdl/klr/RepblcnRnrCnrdia.pdf
- http://www.kdheks.gov/tmdl/klr/SaltCrDO.pdf
- http://www.kdheks.gov/tmdl/klr/SaltCrFCB.pdf
- http://www.kdheks.gov/tmdl/klr/bellevilleE.pdf
- http://www.kdheks.gov/tmdl/klr/jamestownE.pdf
- http://www.kdheks.gov/tmdl/klr/jamestownSILT.pdf
- http://www.kdheks.gov/tmdl/klr/jamestownFCB.pdf
- http://www.kdheks.gov/tmdl/klr/jewellE.pdf

Within these documents are descriptions and discussions of key water quality conditions and sources, and guidance for potential action. Major topics include:

1. Introduction and problem identification – basic waterbody and watershed data
2. Current water quality condition and desired endpoint – summary of available stream and lake data
3. Source inventory and assessment – data on land uses, point sources
4. Allocation of pollutant reduction responsibility – modeling-based load allocations
5. Implementation – potential activities, state and federal educational and funding support programs, milestones

6. Monitoring – plans for future efforts
7. Feedback – process used by KDHE during TMDL development

More information about KDHE's TMDL process can be found at the KDHE, Division of Environment, Bureau of Water, Watershed Planning Section web site:

Kansas Total Maximum Daily Loads (TMDLs). http://www.kdheks.gov/tmdl/

Watershed Modeling

Soil and Water Assessment Tool (SWAT)

The Milford Lake Watershed was assessed 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 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 the top 20 to 30 percent of the list are selected as critical (targeted) areas for cropland and livestock BMPs implementation.

The SWAT model was developed by USDA- Agricultural Research Service (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 the amount of manure applied to the pasture or grassland, grazing periods, and the 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-ARS. 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 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 provided in the crop 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.

Data Collection

Data for the Milford Lake Watershed SWAT model were collected from a variety of reliable online and printed data sources and knowledgeable agency personnel within the watershed. The primary sources of input data were in the form of thematic GIS layers. Such layers include topography, land use/land cover, and soil spatial distribution. Other input data can also be available in a form of GIS layers, but these were loaded into the model as tables with items manually distributed over subwatersheds or HRUs. Multiple programming utilities had been developed to process the input data, enter it into the SWAT model, and analyze the output results: Visual Basic, Visual Basic for Applications and Visual Studio C++ were used as main programming languages to develop the data processing utilities.

Input data and their online sources were:

1. 30 meters DEM (USGS National Elevation Dataset)
2. 30m NLCD 2001 Land Cover data layer (USDA-NRCS)
3. STATSGO soil dataset (USDA-NRCS)
4. NCDC NOAA daily weather data (NOAA National Climatic Data Center)
5. Point sources (KDHE on county basis)
6. Septic tanks (US Census)
7. Crop rotations (local knowledge)
8. Grazing management practices (local knowledge)

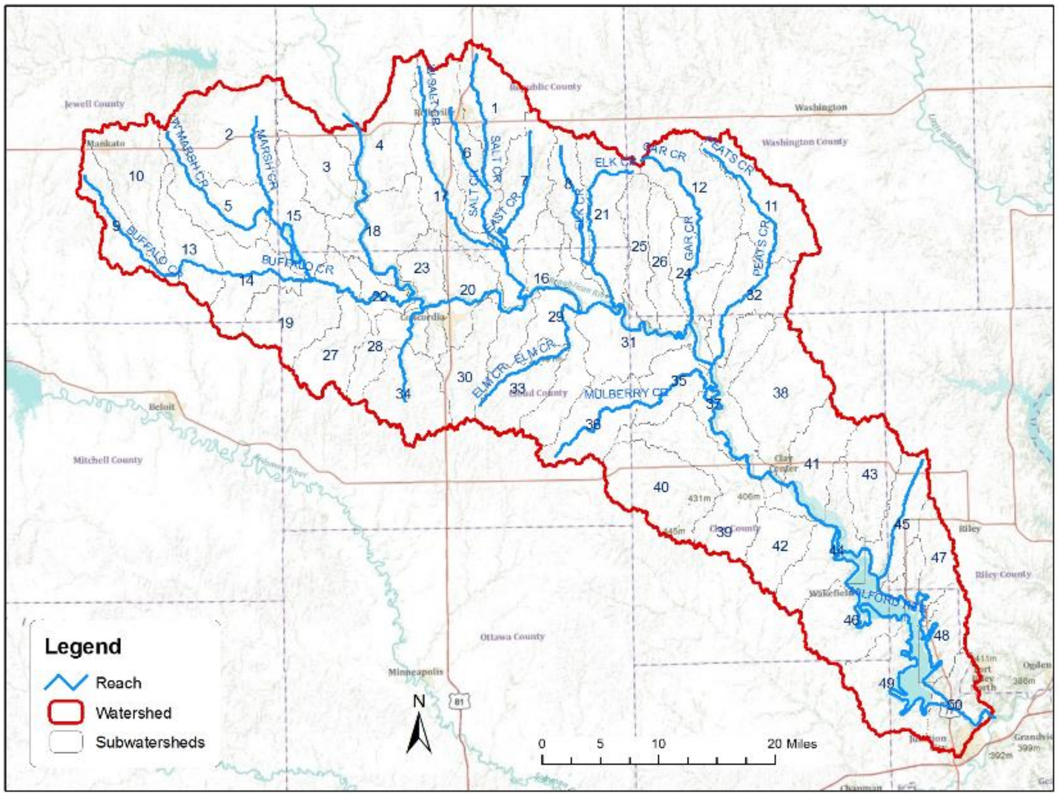


Figure 13 Milford Lake Watershed delineated with SWAT

Topography

The digital elevation map (DEM) for the basin was downloaded from the USGS National Elevation Dataset (NED). Elevations varied from 310 m to 570 m above the sea level (see Figure 14). The watershed was delineated into 50 subwatersheds (see Figure 13).

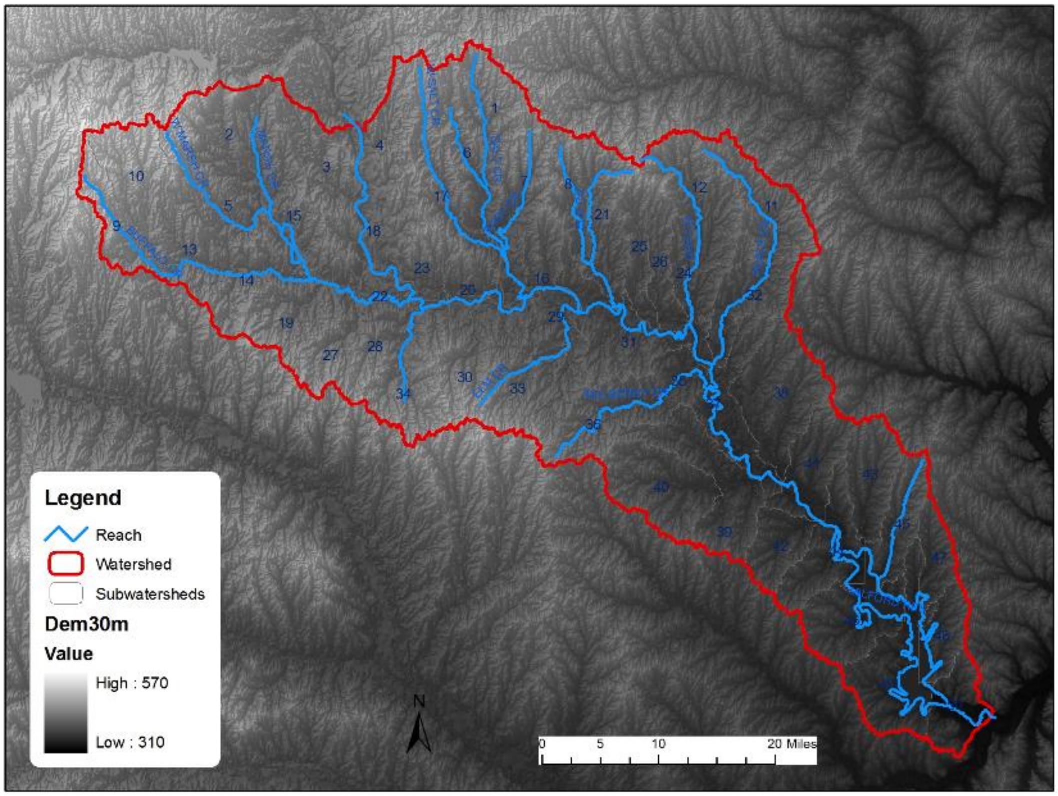


Figure 14 Topography map

Land Use

The land use dataset used in the model was the USDA National Land Cover Dataset (NLCD) prepared in 2001. NLCD 2001 has 10 standardized categories with 6 main categories presented in Figure 15 and summarized in Table 9 for the Lower Republican River Basin and Milford Lake Watershed.

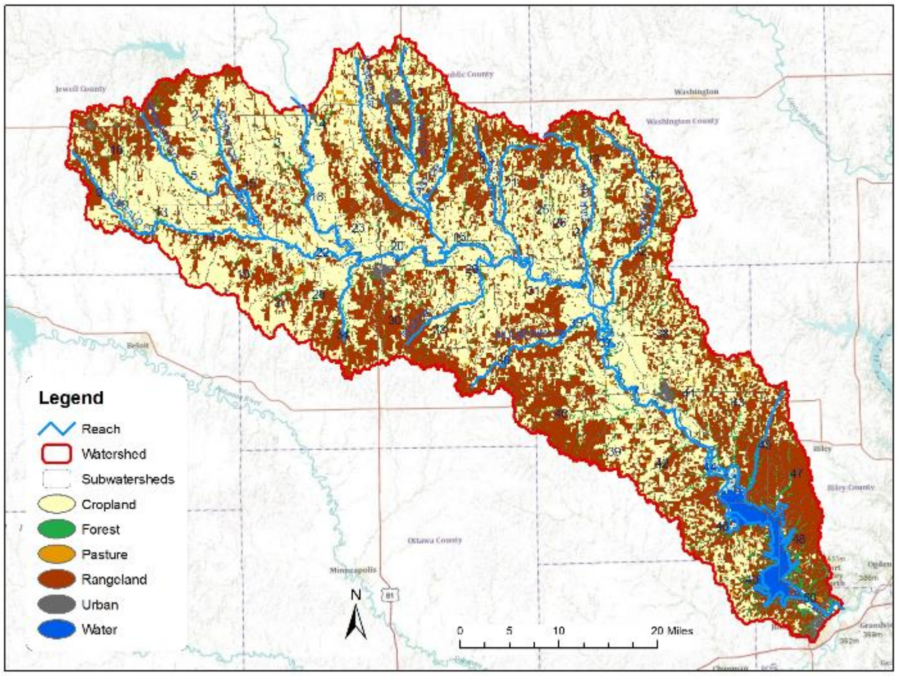


Figure 15 Land use map utilized in the SWAT model

Table 9 Areas of land uses and its classification used in SWAT model

LANDUSE:	Area [ha]	Area [acres]	% Wat. Area
Water	10,339.74	25,550.01	2.02
Residential-Low Density	20,943.63	51,752.76	4.09
Residential-Medium Density	4,942.08	12,212.13	0.96
Residential-High Density	746.73	1,845.21	0.15
Industrial	237.42	586.68	0.05
Southwestern US (Arid) Range	56.79	140.33	0.01
Forest-Deciduous	24,352.02	60,175.06	4.75
Range-Brush	30.24	74.72	0.01
Range-Grasses	187,278	462,773.4	36.53
Agricultural Land-Row Crops	254,673.2	629,310.2	49.68
Wetlands-Forested	3,354.57	8,289.31	0.65
Wetlands-Non-Forested	966.6	2,388.52	0.19
Hay	4,102.2	10,136.74	0.8
Forest-Mixed	371.07	916.93	0.07
Forest-Evergreen	226.62	559.99	0.04
Total	**512,621**	**1,266,712**	**100**

Soils

The Natural Resources Conservation Service (NRCS) State Soil Geographic (STATSGO) soils database and its geo-spatial coverage were used as an input for the SWAT model. Groups A, B, C, and D represent different soil textures and commonly vary from sandy soils in Group A to clay soils in Group D. High percentage of C and D group soils present higher soil erosion potential. Figure 16 and Table 10 show 20 soils, their distribution and characteristics in the watershed.

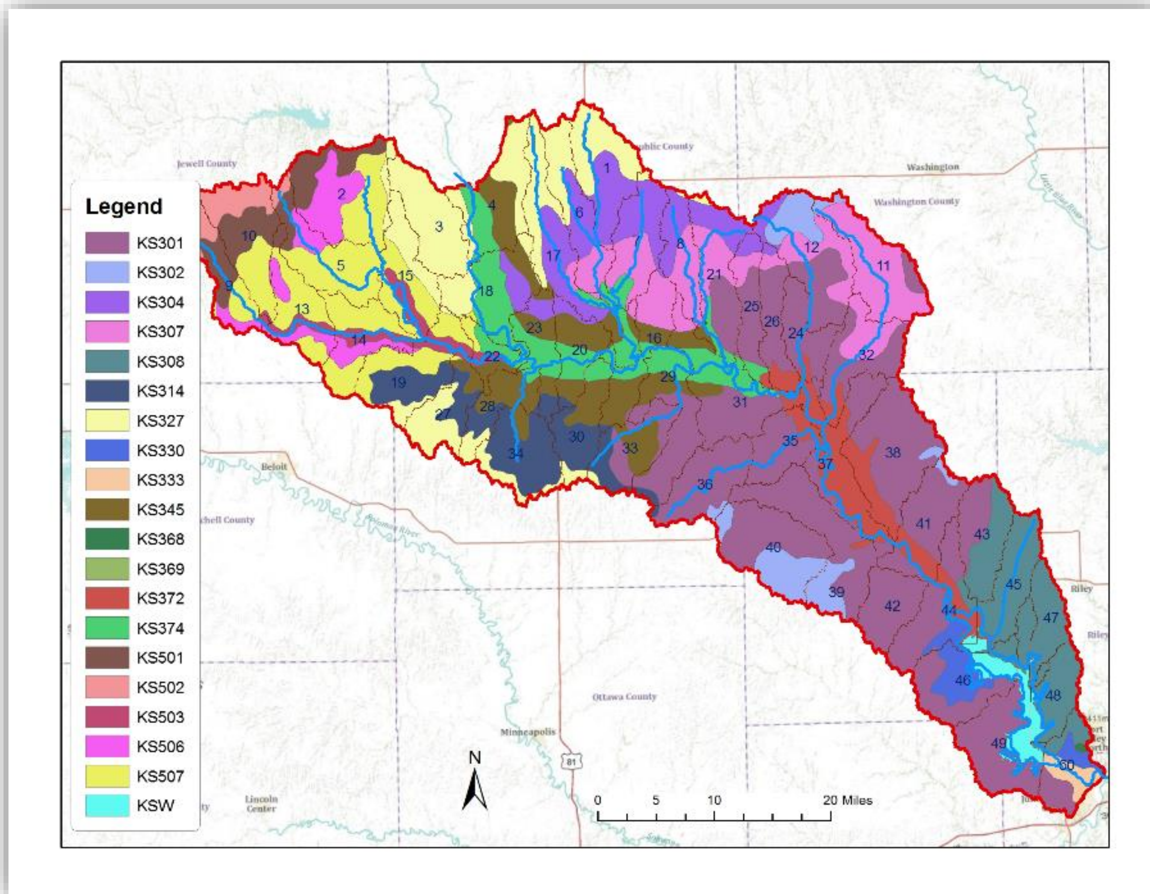


Figure 16 Soil map used in the SWAT model

Table 10 Soil characteristics used in the SWAT model

SOILS:	Area [ha]	Area [acres]	% Wat. Area
KS304	30,468.24	75,288.54	5.94
KS327	49,817.07	123,100.47	9.72
KS307	39,797.73	98,342.18	7.76
KS501	13,013.73	32,157.58	2.54
KS502	6,189.39	15,294.29	1.21
KS506	12,632.94	31,216.63	2.46
KS507	41,704.56	103,054.05	8.14
KS374	29,254.50	72,289.33	5.71

KS345	32,334.21	79,899.45	6.31
KS503	7,101.09	17,547.15	1.39
KS301	143,442.99	354,454.80	27.98
KS302	14,245.20	35,200.60	2.78
KS314	24,148.71	59,672.67	4.71
KS372	21,296.52	52,624.77	4.15
KS308	31,696.92	78,324.67	6.18
KS330	6,818.76	16,849.50	1.33
KSW	5,953.77	14,712.06	1.16
KS333	2,449.71	6,053.36	0.48
KS368	188.55	465.92	0.04
KS369	66.33	163.90	0.01
Total	**512,620.92**	**1,266,711.92**	**100.00**

Other inputs

Weather data was collected and downloaded from NOAA National Climatic Data Center (NCDC, 2009). There are total 15 weather stations around the watershed; 13 stations with precipitation data and 10 stations with non-precipitation data.

Among other input information entered into the SWAT model, we can list crop rotations, grazing management operations, confined animal feeding operations (CAFO), permitted point source facilities, and septic systems. From prior experience, these data should be confirmed and revised using local stakeholder knowledge and information.

In every watershed, there are specific locations that contribute a greater pollutant load due to soil type, proximity to a stream and land use practices. By focusing BMPs in these areas; pollutants can be reduced at a more efficient rate. Through research at the University of Wisconsin, it has been shown that there is a “bigger bang for the buck” with streamlining BMP placement in contrast to a “shotgun” approach of applying BMPs in a random nature throughout the watershed. Therefore, the SLT has targeted areas in the watershed to focus BMP placement for sediment runoff, nutrients and E. coli bacteria from livestock production and stream bank erosion. Targeting for this watershed will be accomplished in three different areas:

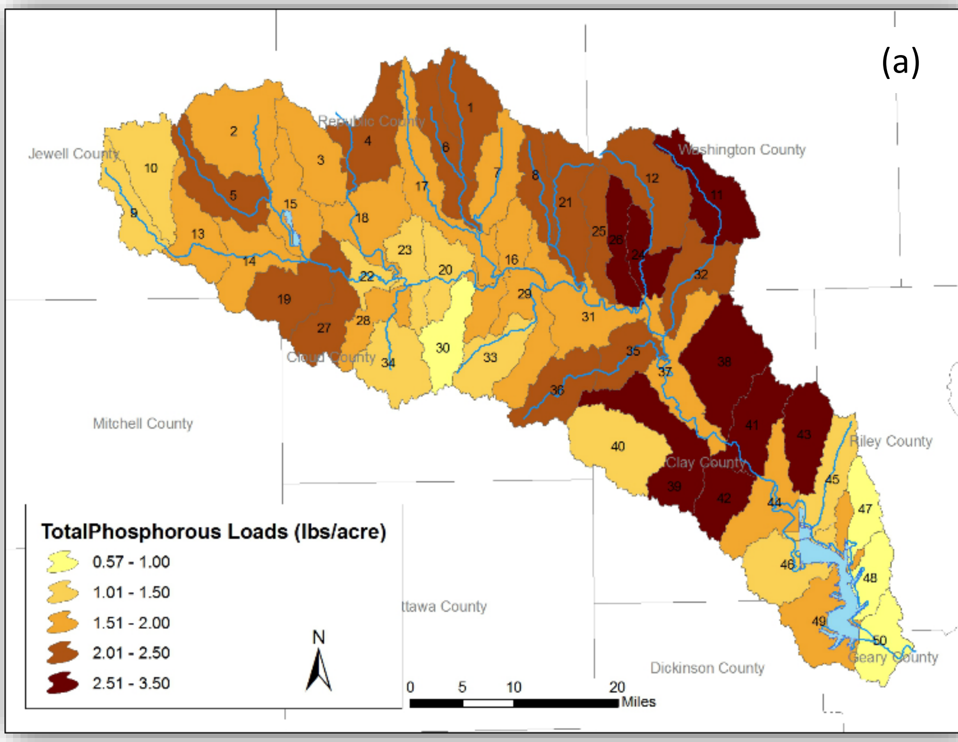
1. Cropland will be targeted for sediment,
2. Rangeland will be targeted for sediment and the same geographic area will be targeted for livestock related phosphorus, and
3. Stream banks will be targeted for sediment.

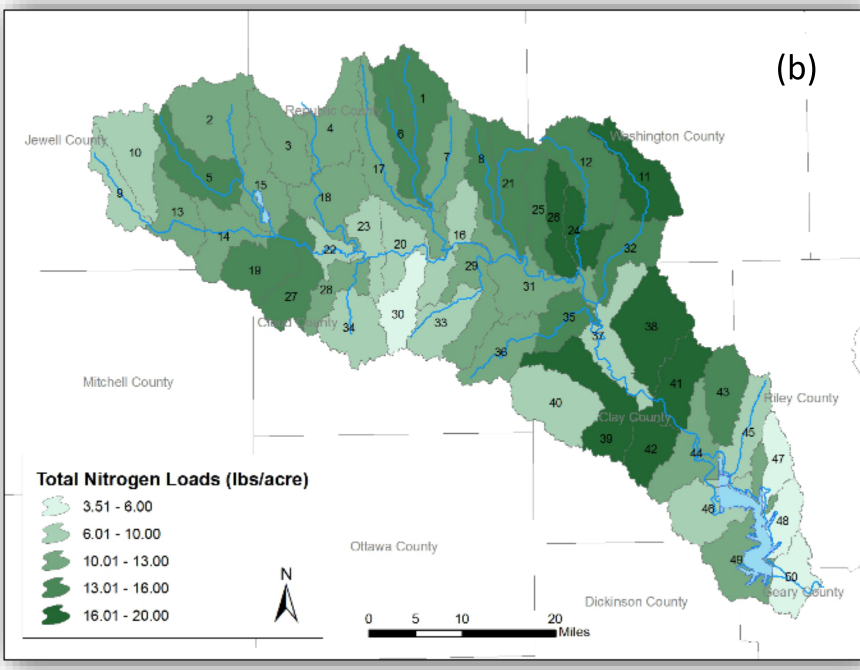
After locating initial critical targeted areas, the area was groundtruthed. Groundtruthing is a method used to determine what BMPs are currently being utilized in the targeted areas. It involves conducting windshield surveys throughout the targeted areas identified by the watershed models to determine which BMPs are currently installed. These surveys are conducted by local agency personnel and members of the SLT that are familiar with the area and its land use history. Groundtruthing provides the current adoption rate of BMPs, pictures of the targeted areas, and may bring forth additional water quality concerns not captured by watershed modeling. In 2009, the groundtruthing provided the current adoption rates for four common BMPs (buffers, no-till, conservation crop rotation and grassed waterways) in the cropland targeted area of the watershed averaged across counties.

The results are as follows:

- Conservation Crop Rotation – current adoption rate of 96 percent
- Grassed waterways – current adoption rate of 82 percent
- No-till cultivation – current adoption rate of 52 percent
- Vegetative buffer strips – current adoption rate of 6 percent

This allows the SWAT model to develop a more accurate determination of appropriate targeted areas. The SWAT model then determined number of acres needed to be implemented for each BMP. The maps produced by the modeling are displayed below. It is noted that the areas are characterized by different color with darker colors indicating higher loads.





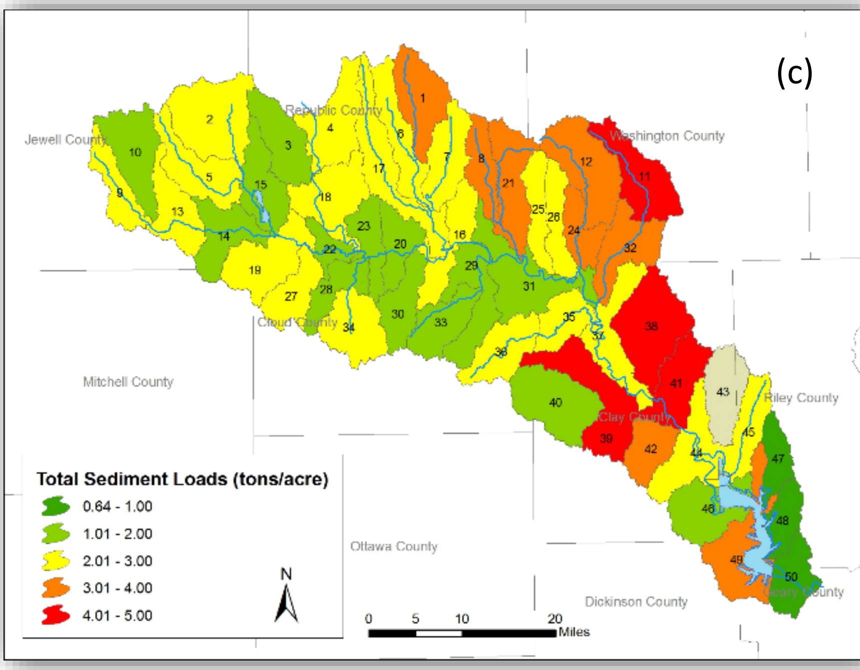


Figure 17 Maps of (a) Phosphorous (lb/acre), (b) Nitrogen (lb/acre), and (c) Sediment (tons/acre) Loads as Determined by SWAT in 50 subbasins of the Milford Lake Watershed

Pollutant Yields

The SWAT model was setup to run for 15 years from 1993 to 2008 with the first 5 years dedicated for a model warm-up period, to allow model parameters to adjust from the default initial condition. The results were collected on an annual basis for each subwatershed and then averaged out over the simulation period. Model output variables, such as sediment yield, organic, mineral and soluble phosphorous concentrations, and nitrate and organic nitrogen concentrations, were collected and combined in the forms of total sediment, phosphorous, and nitrogen loads. Figure 17 presents maps of the loads for Milford Lake Watershed in a scale of graduated colors (darker color indicates higher load).

Average annual yields for each subwatershed are listed in Table 11. All subwatersheds produced relatively high pollutant loads with subwatersheds 11, 24, 26, 38, 39, 41, 42, 43 produced the highest annual yields, with at least 20% or higher of the total watershed nitrogen, phosphorous, and sediment yields.

Table 11 Total pollutant loads for each subwatershed

Subbasin	Area (Hectares)	Total Sediment Yield (tn/ac)	Total Phosphorous Yield (lb/ac)	Total Nitrogen Yield (lb/ac
1	11,381.76	3.18	2.33	14.11
2	16,831.17	2.79	1.79	11.09
3	10,160.19	1.49	1.85	11.78
4	12,174.93	2.58	2.17	12.92
5	11,705.31	2.53	2.05	13.16
6	10,058.67	2.64	2.21	13.76
7	9,922.05	2.34	1.80	10.65
8	6,990.66	3.10	2.18	13.13
9	7,361.19	2.02	1.37	8.93
10	11,829.78	1.48	1.43	9.09
11	12,302.73	4.95	3.15	18.08
12	14,833.71	3.39	2.38	15.05
13	9,231.30	2.71	1.86	11.99
14	9,720.54	1.91	1.57	10.16
15	10,177.47	1.99	1.96	11.94
16	9,039.24	2.16	1.68	9.72
17	14,956.38	2.26	1.96	12.07
18	12,228.12	2.09	1.68	10.19
19	12,766.59	2.51	2.03	13.61
20	6,983.10	1.40	1.27	6.63
21	11,843.28	3.06	2.49	15.42
22	3,726.90	1.33	1.32	7.58
23	6,897.78	1.43	1.17	6.50
24	6,477.48	3.59	3.07	19.49
25	6,531.39	2.61	2.41	15.27
26	6,729.75	2.93	2.73	17.37
27	7,860.42	2.33	2.08	13.33
28	6,630.57	1.97	1.68	10.04

29	11,351.61	1.92	1.77	10.83
30	7,987.50	1.34	0.92	5.99
31	15,593.13	1.99	1.87	11.59
32	10,671.57	3.10	2.41	15.20
33	8,793.45	1.79	1.47	8.88
34	10,774.44	2.27	1.30	9.54
35	7,258.68	2.29	2.12	13.44
36	9,773.19	2.65	2.03	12.78
37	11,180.97	2.13	1.70	9.92
38	16,570.89	4.09	2.84	16.74
39	15,130.71	4.25	3.00	18.04
40	14,288.94	1.80	1.36	8.22
41	10,366.29	4.70	2.84	16.72
42	7,122.96	3.39	2.74	16.43
43	9,578.52	5.01	2.51	15.13
44	11,582.91	2.64	1.90	11.44
45	9,516.06	2.06	1.23	7.37
46	12,172.41	1.74	1.46	8.92
47	5,683.59	0.65	0.58	3.67
48	6,610.59	0.64	0.57	3.51
49	15,314.85	3.05	1.89	11.22
50	7,945.20	0.95	0.93	5.20

Stream Bank Area Assessment

Stream bank area assessment was based on the 1991 1:24000 USDA/NRCS GIS Riparian GIS layer Inventory originating from the Kansas Geospatial Community Commons. Areas of unprotected land with no riparian cover (barren land, crop land, grass land) were considered susceptible for bank erosion and therefore being selected as targeted critical areas.

The layer contained the following categories:

Table 12 Categories in the riparian inventory layer (AAAA)

Land Cover	Description
Forest Land	Areas adjacent to a stream that contains trees with a canopy cover greater than 51% of the 100 foot buffer zone.
Crop Land	Areas adjacent to a stream where no trees area present and in which 51% of the 100 foot buffer is planted or was planted during the previous growing season for the production of adapted crops for harvest, including row crops, small-grain crops, legume, hay crops, nursery crops, and other specialty crops.
Crop/Tree Mix	Cropland land use areas that contain a tree canopy cover of less than 50% of the 100 foot buffer zone.
Grass Land	Areas adjacent to a stream in which 51% or more of the 100 foot buffer contains pastureland, native pasture, or rangeland.
Grassland/Tree Mix	Grassland land use areas that contain a tree canopy cover of less than 50% of the 100 foot buffer zone.
Urban Land	Areas adjacent to a stream where 51% or more of the 100 foot buffer contains dwellings or is located in an urban area without trees adjacent to the stream. Highways, railroads, and other

	transportation facilities are considered to be part of the urban & built-up land base if the area surrounded by other urban and built-up areas.
Urban/Tree Mix	Urban land use areas that contain a tree canopy cover of less than 50% of the 100 foot buffer zone.
Shrub/Scrub Land	Areas adjacent to a stream that contain shrubs or brush/scrub vegetation with a canopy cover greater than 51% of the 100 foot buffer zone. Areas are composed of multi-stemmed woody plants, shrubs, and vines. Including areas that contain a wide diversity of vegetative cover that are not distinguishable.
Animal Production Area	Areas adjacent to a stream that include barns, pens, or corrals used for the storage, feeding, processing, and production of livestock animals with a land use cover of greater than 51% of the 100 foot buffer zone.
Barren Land	An area adjacent to a stream where 51% of the 100 foot buffer contains land without any discernible vegetative cover, including quarries, borrows pits, and dry ponds.

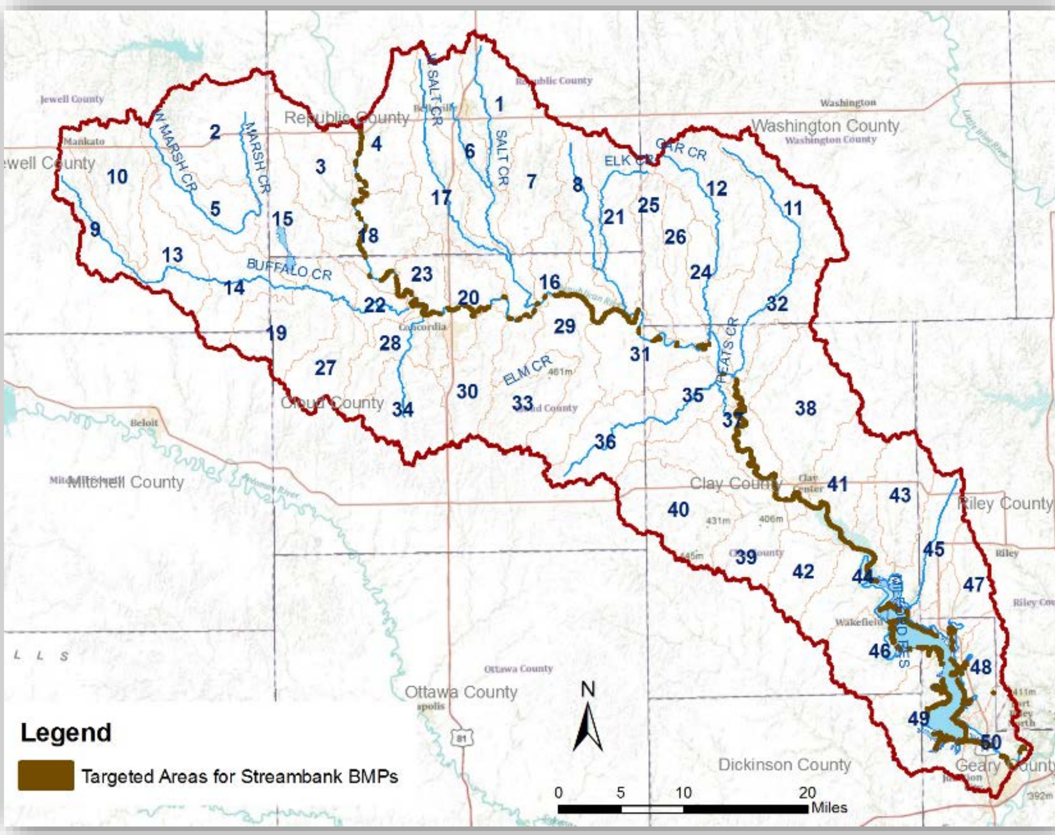


Figure 18 Map of stream bank areas (100 ft) along main stem of rivers

The conducted GIS analysis included a 100 ft buffer along main stem of the Republican River with an intersected riparian coverage (Figure 18). There were approximately 1259 acres of a 100 foot buffer along the river that were considered barren which converts to 104 miles of streambank. After consulting with the SLT, these areas along the Republican River were identified as being targeted for streambank restoration. This riparian area can be vulnerable to runoff and erosion from livestock induced activities. Buffers and filter strips along with forested riparian areas can be used to impede erosion and streambank sloughing. Livestock restriction along the stream will prevent livestock from entering the stream and degrading the banks.

Critical Targeted Areas

The pollutant yields maps produced by the modeling are displayed in Figure 17. The subwatersheds 11, 24, 26, 38, 39, 41, 42, and 43 show the highest potential for erosion, phosphorous, and nitrogen runoff. As stated earlier, this model accounts for land use, soil type, slope, and current conservation practices. This is the area of the watershed with the greatest percentage of cropland, which leads to a higher potential for erosion compared to areas that are mainly composed of grassland. Subbasins 1, 6, 9, 10, 13, 14, 17, 32, 35, and 36 were selected by SLT for livestock BMP implementation. 104 miles of streambank along the Republican River were selected for streambank erosion BMP implementation.

Cropland Erosion

The SWAT delineated (primary ranked) Cropland Targeted Area of this project will be used for the implementation of sediment and nutrient reduction agricultural BMPs. The area includes a portion of the Five Creek, Mall Creek, Lincoln Creek, Finney Creek, Otter Creek, Dry Creek and Peats Creek (HUC-12 numbers in brackets):

- 102500170501 (subbasin 11)
- 102500170408 (subbasin 24)
- 102500170406 (subbasin 26)
- 102500170507 (subbasin 38)
- 102500170506 (subbasin 39)
- 102500170602 (subbasin 41)
- 102500170601 (subbasin 42)
- 102500170603 (subbasin 43)

Livestock Targeted Areas

The SLT has determined areas for targeting livestock phosphorus and bacteria pollutants. Rangeland BMPs will be placed in this area. The top five livestock BMPs were selected by need, cost-effectiveness, and producer acceptability. Adoption rate goals were set for the next 20 years based on their overall need and what can be feasibly adopted. These HUC-12 numbers and the corresponding delineated areas are:

- 102500170306 (subbasin 1)
- 102500170307 (subbasin 6)
- 102500170102 (subbasin 9)
- 102500170101 (subbasin 10)
- 102500170103 (subbasin 13)
- 102500170107 (subbasin 14)
- 102500170309 (subbasin 17)
- 102500170502 (subbasin 32)
- 102500170504 (subbasin 35)
- 102500170503 (subbasin 36)

Streambank Erosion

Targeting streambank areas were identified after the riparian buffer analysis along the Republican River was conducted with GIS, presented to SLT, and approved. Approximately 1259 acres of a 100 foot buffer along the river or 104 miles of streambank were considered a targeted area.

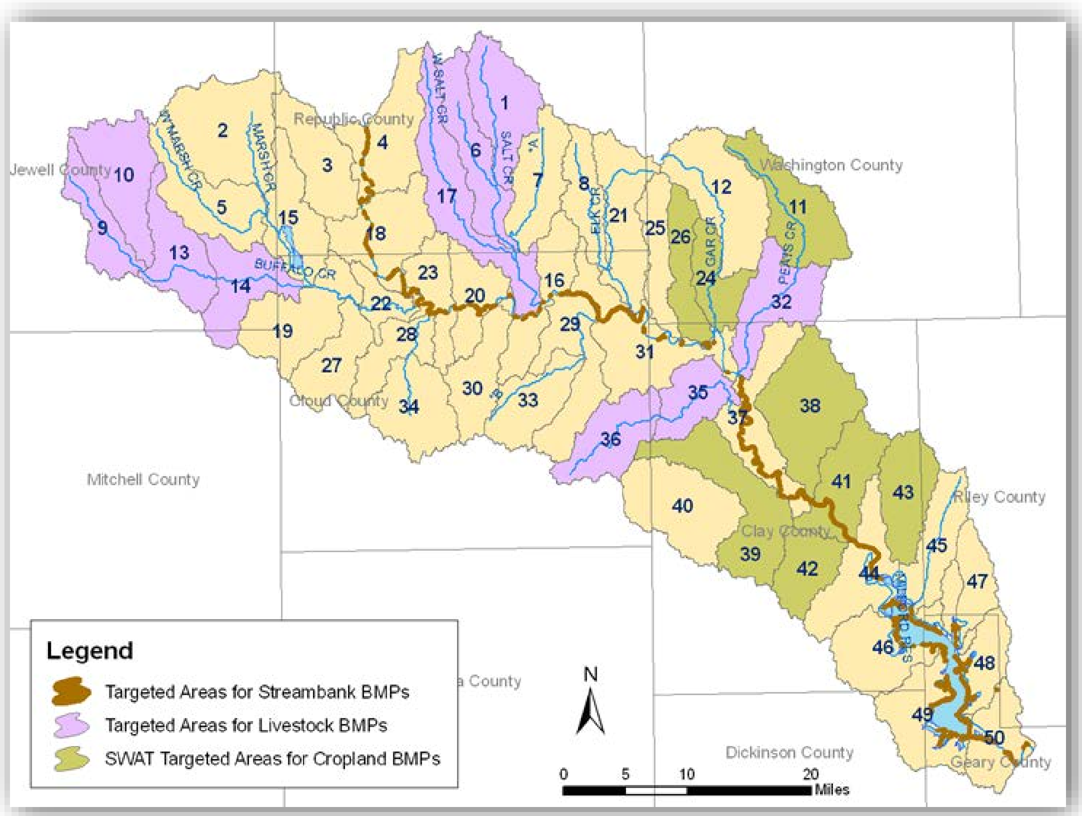


Figure 19 Critical targeted subwatersheds in Milford Lake Watershed

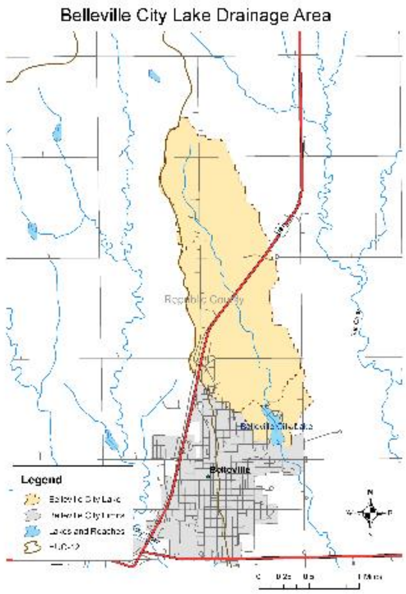
Stakeholder engagement

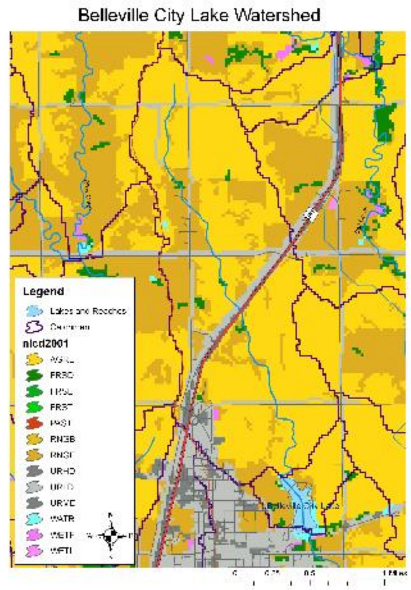
A critical element of the WRAPS watershed modeling process is to engage stakeholders in the collection and verification of watershed data (Mankin, 2008). This process assures that we are modeling "their watershed" using the best local data available. Over a period of several meetings, the watershed modeler meets with stakeholders, presents baseline data, receives feedback and corrections on these data, revises model inputs to represent local data, and re-runs the model using these stakeholder-modified input data.

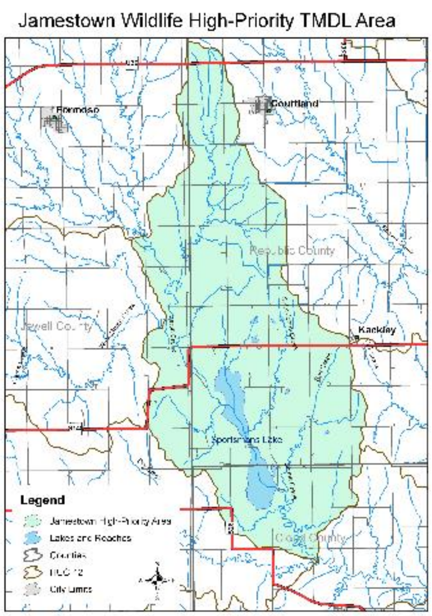
Work Products

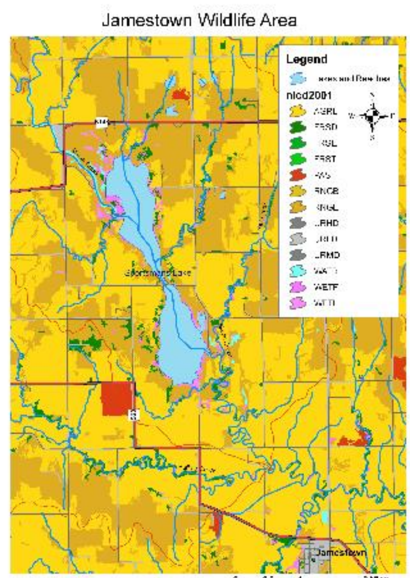
During the iterative engagement process, the stakeholders develop an understanding of how the assessment data and modeling results can be used to inform, but not dictate, their watershed planning decisions. Various maps were provided to stakeholders that helped in understanding watershed water-quality problems, and also assisted in decision-making and identification of potential critical areas not captured by SWAT modeling. Maps of Belleville City

Lake drainage area, Jamestown wildlife high-priority TMDL area, Jewell City Lake drainage area, and Buffalo Creek drainage area, and Salt Creek high-priority TMDL area are shown in Figure 20. Maps of Riley, Republic, Washington, Clay, Cloud, and Jewell Counties that assisted in groundtruthing efforts are presented in Figure 21.









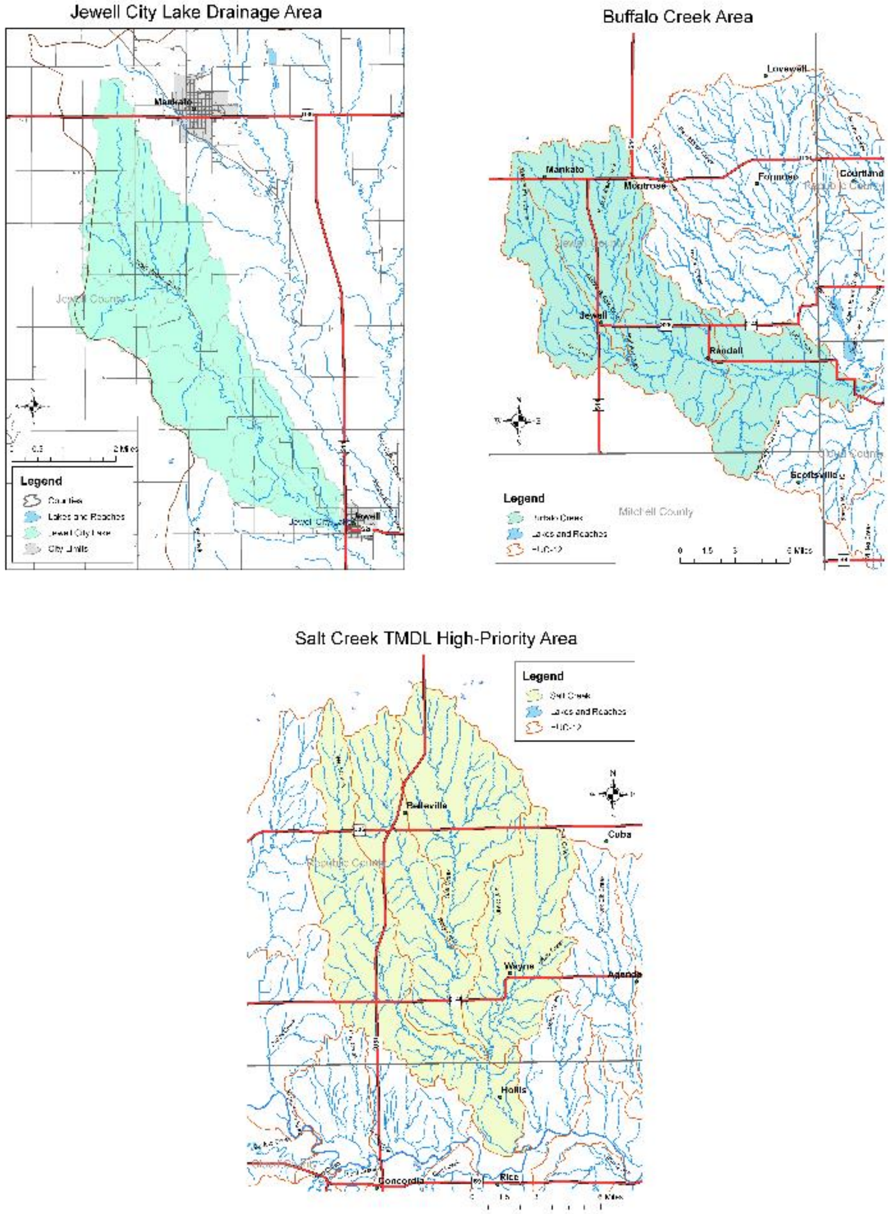
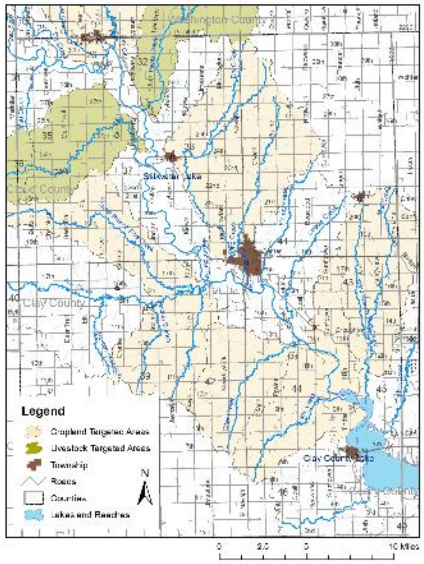
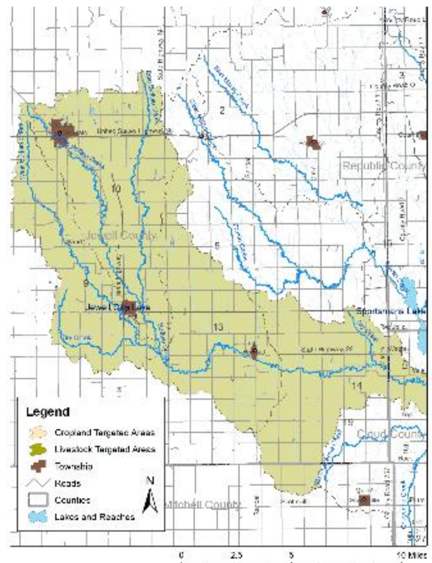


Figure 20 Maps of various drainage and high-priority TMDL areas in Milford Lake watershed prepared for SLT.

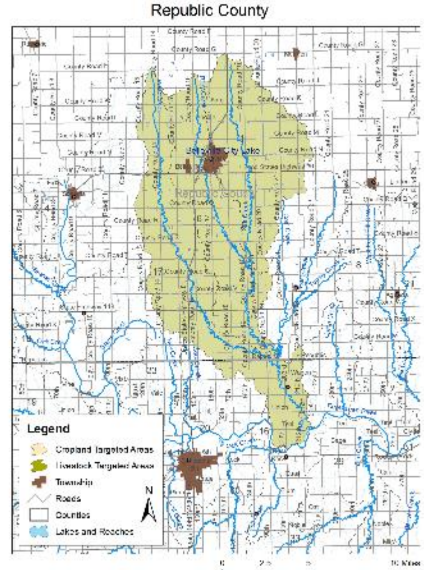
Milford Lake Watershed
Clay County



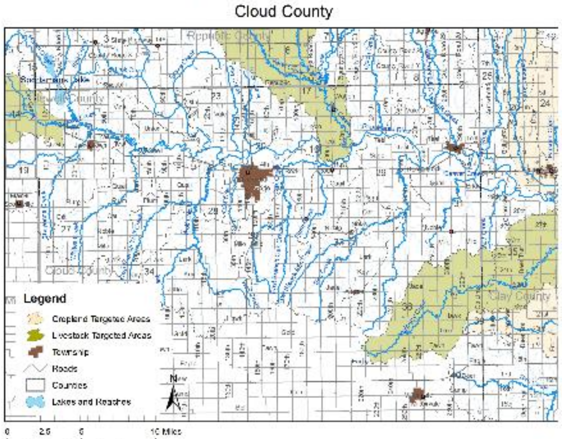
Milford Lake Watershed
Jewell County



Milford Lake Watershed
Republic County



Milford Lake Watershed
Cloud County



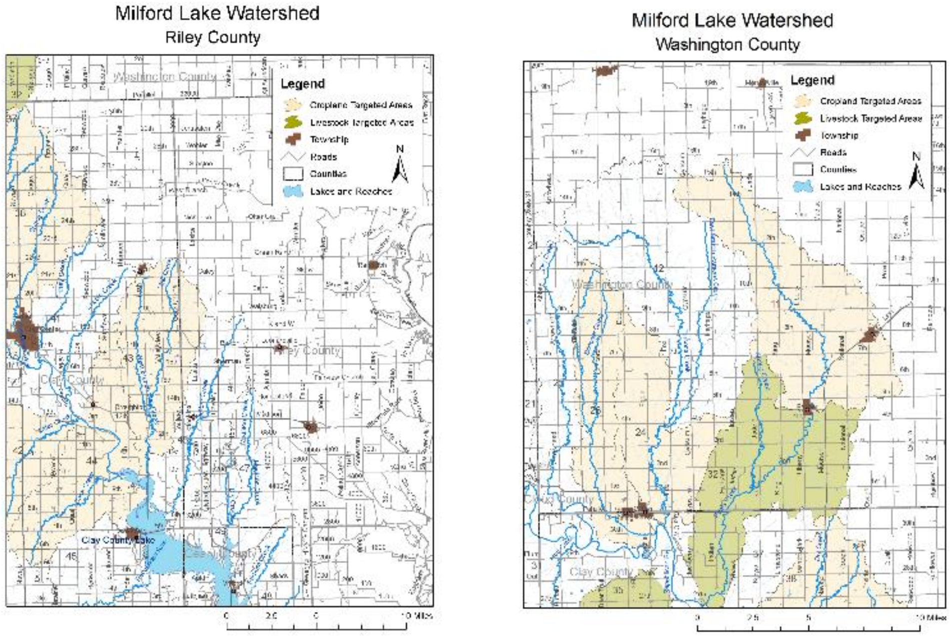


Figure 21 Maps of five counties in Milford Lake Watershed prepared for SLT to assist with groundtruthing.

Economic Analysis

General Economic Research

Cost-return budgets have been developed for Milford Lake Watershed by working with data from the Northeast Kansas Farm Management Association. The budgets are specific to Milford Lake Watershed and vary by inputs and yields. Specific BMP budgets have been developed for vegetative buffers, terraces, stream bank stabilization, and reduced/no-till and available in the Milford Lake Watershed Atlas. The cost-return budgets are compiled for corn, soybean, wheat, grain, and alfalfa crops and presented in the Watershed Atlas (see Appendix A: Watershed Atlas).

We compiled lists of financial incentives/programs available through EQIP for both water quality and quantity conservation practices. These lists include both average costs and cost share percentages. We have also identified other programs which offer funding for conservation practices. Since vegetative and riparian forest buffers are supported through multiple funding programs, separate lists have been created to help producers calculate the amount of cost share and annual incentive payments that are available.

Corn Cost-Return Budget

Table 13 Cost-return projections for corn crops in the Milford Lake Watershed, 2006.

CORN	Yield Level (bu)		
	88	110	133
INCOME PER ACRE			
A. Yield per acre	88	110	133
B. Price per bushel	$2.73	$2.73	$2.73

C. Net government payment	$12.51	$13.60	$14.69
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$252.75	$313.90	$377.78
COSTS PER ACRE			
1. Seed	$51.57	$51.57	$51.57
2. Herbicide	30.80	30.80	30.80
3. Insecticide/Fungicide			
4. Fertilizer and Lime	35.36	44.82	54.80
5. Crop Consulting			
6. Crop Insurance			
7. Drying	11.44	14.30	17.29
8. Miscellaneous	8.25	8.25	8.25
9. Custom Hire / Machinery Expense	65.27	71.63	78.28
10. Non-machinery Labor	7.38	8.09	8.85
11. Irrigation			
12. Land Charge / Rent	48.80	61.00	73.20
G. SUB TOTAL	$258.86	$290.46	$323.04
13. Interest on ½ Nonland Costs	8.94	9.68	10.46
H. TOTAL COSTS	$267.80	$300.15	$333.50
I. RETURNS OVER COSTS (F-H)	-$15.05	$13.75	$44.28
J. TOTAL COSTS/BUSHEL (H/A)	$3.04	$2.73	$2.51
K. RETURN TO ANNUAL COST (I+13)/G	**-2.36%**	**8.07%**	**16.95%**

Soybean Cost-Return Budget

Table 14 Cost-return projections for soybean crops in the Milford Lake Watershed, 2006.

SOYBEANS		Yield Level (bu)	
	26	33	40
INCOME PER ACRE			
A. Yield per acre	26	33	40
B. Price per bushel	$5.92	$5.92	$5.92
C. Net government payment	$12.51	$13.60	$14.69
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$166.43	$208.96	$251.49
COSTS PER ACRE			
1. Seed	$36.30	$36.30	$36.30
2. Herbicide	10.34	10.34	10.34
3. Insecticide/Fungicide			
4. Fertilizer and Lime	10.96	12.51	14.07
5. Crop Consulting			

6. Crop Insurance			
7. Drying			
8. Miscellaneous	8.25	8.25	8.25
9. Custom Hire / Machinery Expense	47.98	50.06	52.13
10. Non-machinery Labor	5.42	5.66	5.89
11. Irrigation			
12. Land Charge / Rent	48.80	61.00	73.20
G. SUB TOTAL	$168.04	$184.11	$200.18
13. Interest on ½ Nonland Costs	5.37	5.54	5.71
H. TOTAL COSTS	$173.41	$189.65	$205.89
I. RETURNS OVER COSTS (F-H)	-$6.98	$19.31	$45.59
J. TOTAL COSTS/BUSHEL (H/A)	$6.67	$5.75	$5.15
K. RETURN TO ANNUAL COST (I+13)/G	**-0.96%**	**13.50%**	**25.63%**

Wheat Cost-Return Budget

Table 15 Cost-return projections for wheat crops in the Milford Lake Watershed, 2006.

WHEAT	Yield Level (bu)		
	40	50	60
INCOME PER ACRE			
A. Yield per acre	40	50	**60**
B. Price per bushel	$4.65	$4.65	**$4.65**
C. Net government payment	$12.51	$13.60	**$14.69**
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$198.51	$246.10	**$293.69**
COSTS PER ACRE			
1. Seed	$9.90	$13.20	**$13.20**
2. Herbicide	1.68	5.09	**5.09**
3. Insecticide/Fungicide			
4. Fertilizer and Lime	35.41	43.32	**50.61**
5. Crop Consulting			
6. Crop Insurance			
7. Drying			
8. Miscellaneous	8.25	8.25	**8.25**
9. Custom Hire / Machinery Expense	45.83	48.84	**56.43**
10. Non-machinery Labor	5.18	5.52	**6.38**

11. Irrigation			
12. Land Charge / Rent	48.80	61.00	**73.20**
G. SUB TOTAL	$155.04	$185.21	**$213.15**
13. Interest on ½ Nonland Costs	4.78	5.59	**6.30**
H. TOTAL COSTS	$159.83	$190.80	**$219.45**
I. RETURNS OVER COSTS (F-H)	$38.69	$55.30	$74.24
J. TOTAL COSTS/BUSHEL (H/A)	$4.00	$3.82	**$3.66**
K. RETURN TO ANNUAL COST (I+13)/G	**28.04%**	**32.88%**	**37.78%**

Grain Sorghum Cost-Return Budget

Table 16 Cost-return projections for grain sorghum crops in the Milford Lake Watershed, 2006.

GRAIN SORGHUM	Yield Level (bu)		
	61	76	90
INCOME PER ACRE			
A. Yield per acre	61	76	**90**
B. Price per bushel	$2.79	$2.79	**$2.79**
C. Net government payment	$12.51	$13.60	**$14.69**
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$182.70	$225.64	**$265.79**
COSTS PER ACRE			
1. Seed	$12.74	$12.74	**$12.74**
2. Herbicide	27.41	27.41	**27.41**
3. Insecticide/Fungicide			
4. Fertilizer and Lime	23.27	30.01	**35.96**
5. Crop Consulting			
6. Crop Insurance			
7. Drying	7.93	9.88	**11.70**
8. Miscellaneous	8.25	8.25	**8.25**
9. Custom Hire / Machinery Expense	58.31	62.84	**67.07**
10. Non-machinery Labor	6.59	7.10	**7.58**
11. Irrigation			
12. Land Charge / Rent	48.80	61.00	**73.20**
G. SUB TOTAL	$193.30	$219.24	**$243.91**
13. Interest on ½ Nonland Costs	6.15	6.68	**7.16**
H. TOTAL COSTS	$199.45	$225.91	**$251.07**

I. RETURNS OVER COSTS (F-H)	-$16.74	-$0.27	$14.72
J. TOTAL COSTS/BUSHEL (H/A)	$3.27	$2.97	**$2.79**
K. RETURN TO ANNUAL COST (I+13)/G	**-5.48%**	**2.92%**	**8.97%**

Alfalfa Cost-Return Budget

Table 17 Cost-return projections for alfalfa crops in the Milford Lake Watershed, 2006.

ALFALFA	Yield Level (ton)		
	3.0	3.5	4.0
INCOME PER ACRE			
A. Yield per acre	3.0	3.5	4.0
B. Price per bushel	$101.00	$101.00	$101.00
C. Net government payment	$12.30	$13.37	$14.44
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$315.30	$366.87	$418.44
COSTS PER ACRE			
1. Seed	$10.17	$10.17	$10.17
2. Herbicide	2.51	2.51	2.51
3. Insecticide/Fungicide	7.08	7.08	7.08
4. Fertilizer and Lime	19.90	26.89	33.88
5. Crop Consulting			
6. Crop Insurance			
7. Drying			
8. Miscellaneous	6.38	6.38	6.38
9. Custom Hire / Machinery Expense	109.42	118.08	126.61
10. Non-machinery Labor	12.36	13.34	14.31
11. Irrigation			
12. Land Charge / Rent	31.60	39.50	47.40
G. SUB TOTAL	$199.43	$223.96	$248.34
13. Interest on ½ Nonland Costs	7.55	8.30	9.04
H. TOTAL COSTS	$206.98	$232.26	$257.38
I. RETURNS OVER COSTS (F-H)	$108.32	$134.61	$161.06
J. TOTAL COSTS/BUSHEL (H/A)	$68.99	$66.36	$64.35
K. RETURN TO ANNUAL COST (I+13)/G	**58.10%**	**63.81%**	**68.50%**

Work Products

The following spreadsheet based decision tools were created to assist with economic analysis in support of the development of watershed management plans.

K-State Watershed Manager Decision-Making Tool

This is a spreadsheet program that can support the development of watershed management plans. Using this program, watershed stakeholder groups & technical assistance providers can estimate, optimize, and compare the economic and environmental effects of various watershed management scenarios. This includes cost estimates and estimates of (sediment, phosphorus, and nitrogen) load reductions for a variety of cropland Best Management Practices (BMPs). *K-State Watershed Manager* was developed by a group of agricultural economists at Kansas State University. The goal was to provide a user-friendly tool which could aid watershed groups in developing cost-effective watershed management plans. The tool development was funded in part through the Kansas Department of Health and Environment by U.S. EPA Section 319 Funds in support of Kansas Watershed Restoration and Protection Strategies (WRAPS).

KSU-Vegetative Buffer Decision-Making Tool

This tool was developed with assistance and input from KSU Ag Economics faculty, NRCS, and Conservation District personnel (buffer coordinators). This tool allows producers and land-managers across the state of Kansas (including Milford Lake Watershed) to evaluate the economic benefits and costs of vegetative buffers, and will help them decide if a buffer makes sense for their operation. This tool also incorporates the funding incentives information gathered previously. This tool is on the KSU Agricultural Economics website, AgManager.

KSU-Streambank Stabilization Decision-Making Tool

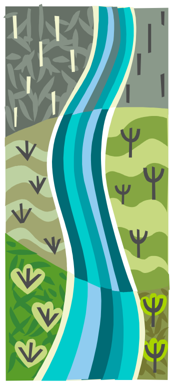
This tool was developed with assistance and input from KSU Ag Economics faculty, Watershed Institute, and KAWS. This tool allows producers and land-managers across the state of Kansas (Milford Lake Watershed) to evaluate the economic benefits and costs of streambank stabilization projects, and will help them decide if stabilizing an eroding streambank makes sense for their operation. This tool also incorporates the funding incentives information gathered previously. This tool is on the KSU Agricultural Economics website, AgManager.

KSU-Tillage Decision-Making Tool

This tool was developed with assistance and input from KSU Ag Economics faculty and Agricultural Extension agents across the state. This tool allows producers and land-managers across the state of Kansas (including Milford Lake Watershed) to evaluate the economic benefits and costs of alternative tillage management strategies, and helps them decide if reducing tillage is a feasible option for their operation. This tool incorporates enterprise budgets so that the user can make their decision based on a comprehensive analysis. This tool is on the KSU Agricultural Economics website, AgManager.

Non-market valuation and input-output impact analysis

Thorough research was performed for the benefits-cost estimation of watershed management. Initial research has shown sedimentation as the main cause of future economic loss to Milford Lake, so this will be the main focus of the economic analysis. The economic impacts and benefits of recreation at the Milford Lake were being estimated using an input-output impact analysis and non-market valuation techniques.



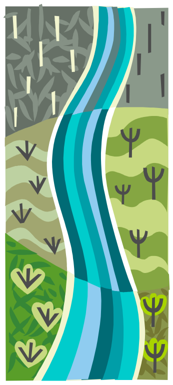
Next Steps / Transition into Planning Phase

This WRAPS Assessment Phase project was completed and all tasks were finished. For transition into the Planning phase, the identified critical areas (cropland, livestock, and stream bank targeted areas) and calculated pollutant loads to the streams will be used to quantify the impacts of potential, and assist the Stakeholder Leadership Team in prioritizing this list of BMPs. The Stakeholder Leadership Team would use model results along with local knowledge about the BMPs that most likely will be accepted by the farmers and implemented on the ground.

The economic aspects of the BMP implementation would also be discussed with the Stakeholder Leadership Team. A variety of decision-making tools that have been developed by K-State would be applied to provide the Stakeholder Leadership Team with the most cost-efficient BMP implementation plan.

For each individual impairment or combination of impairments, a list of recommended BMPs and the cost of implementation would be presented, discussed, and approved by the Stakeholder Leadership Team. The list may include buffers, continuous no-till, nutrient management, and waterways for cropland, riparian and native grass habitat buffers for streambanks, and off-stream watering sites, vegetative filter strips, and relocation of pasture feeding sites for livestock.

To facilitate the transition into the planning phase, an overview of the watershed assessment findings, including the targeted areas, the lists of potential BMPs for each impairment, and the approximate cost of the implementation, should be provided to the Stakeholder Leadership Team.

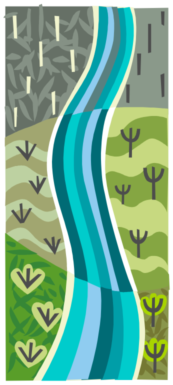


Evaluation of Project Goal, Objectives, and Tasks

The goal of this project was to characterize watershed conditions, identify needs and opportunities for watershed information to support stakeholder decisions, and understand how the watershed responds to various management scenarios.

This Assessment Phase project accomplished all of its objectives, in particular:

- The Stakeholder Leadership Team clarified WRAPS objectives and assessment needs in the watershed and identified informational and data gaps needed to address the objectives and assessment needs
- The assessment team compiled an inventory of existing information and reports related to Milford Lake Watershed.
- The assessment team published a Watershed Atlas online, summarizing watershed climate, soil, topographic, and land use data; economic analyses of agricultural cropping systems and best management practices (BMPs); and STEPL modeling results.
- The assessment team set up and completed detailed SWAT modeling analysis of baseline and SLT revised using local knowledge watershed conditions.
- The assessment team developed user-friendly decision tools for stakeholder groups to analyze and compare economic and environmental effects of cropland BMPs, vegetative buffer systems, streambank stabilization systems, and tillage systems.
- The assessment team completed an analysis of recreational benefits of Milford Lake Lake.
- Watershed model and economic results were delivered, discussed, and approved by the Stakeholder Leadership Team.



Conclusions, Recommendations, and Lessons Learned

Conclusions

Watershed assessment information was prepared by this project including watershed inventory, watershed modeling, identification of critical areas, and economic analysis. A Stakeholder Leadership Team was created and fully engaged in all activities throughout the assessment phase of the WRAPS project. The identified targeted areas were divided into three categories: cropland BMPs, livestock BMPs, and stream bank BMPs. This division was based on the restoration needs and specifics of the watershed. SLT contribution along with the assessment management team was instrumental in identification of livestock and stream bank erosion sites.

Lessons Learned

Several important lessons were learned through the implementation of this Assessment Phase project:

- Watershed data available through various Internet sources should be considered to be “generalized” information and should be confirmed and revised through interactions with stakeholders having local knowledge and data.
- Successful watershed modeling as part of a WRAPS planning process, requires the active engagement of a Stakeholder Leadership Team in a process we have called *Adaptive Watershed Modeling*, where modelers and stakeholders interact iteratively throughout creation of watershed data, development of scenarios, and analysis of results.
- It is helpful to begin discussions of watershed modeling using simple modeling tools (such as STEPL) to allow discussions with stakeholders to focus on important watershed conditions and local information rather than becoming bogged down in discussion of model intricacies.
- Stakeholders benefit from the use of decision tools that integrate economic and environmental impacts of various field and watershed management decisions, and allow them to compare various scenarios.

Recommendations

Watershed modeling is important to the WRAPS Assessment process.

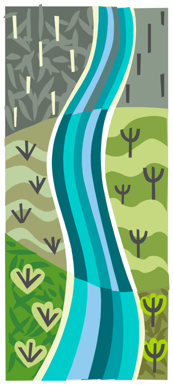
- One Kansas individual skeptical of watershed modeling suggested that K-State should instead simply show real data about how various agricultural management practices impact water quality in each locale. He and I discussed how soil types, rainfall patterns, growing seasons, and management practices, among other factors, could impact results, in addition to how expensive it would be to study even a small number of combinations. In a very short time, this individual began to see how models could be used to extend data from specific combinations of these factors to other combinations where water quality data was not available.

Watershed modeling remains highly sophisticated.

- The project team has been involved with watershed assessment activities in Kansas for more than 12 years. Over this time, watershed assessment tools and models have evolved. Watershed information can now be accessed in digital format for watershed topography, soils, and land-cover. Watershed models have evolved from dedicated research tools to become more user-friendly both in data input and post-processing of results. However, running watershed models remains a highly sophisticated task; correct results are never guaranteed

Believable watershed modeling requires technical skill and social connection.

- The integration of watershed modeling results in the watershed planning process is not a simple endeavor. Once watershed stakeholders lose confidence in the watershed model or modeler, they will not believe the results and will not use these results in their planning. Watershed models generally are not “correct”, but their results can be highly instructive and useful to the WRAPS planning process. Helping stakeholders understand how model results should, and should not, be used requires a committed engagement over a long period of time, and often requires an intermediary, like an Extension Agent or Watershed Specialist, who can help the modeler and the stakeholder bridge the communication gap.
- In short, watershed environmental and economic modeling is critical to success of a WRAPS project, but requires technical staff with a special set of skills and dedication to the enterprise of stakeholder engagement and partnership.



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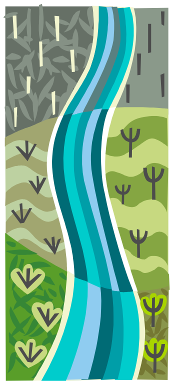
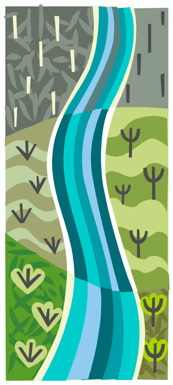


Appendix A: Watershed Atlas

Nejadhashemi, A.P., S.A. Perkins, C.M. Smith, K.R. Mankin, R.M. Wilson, S.P. Brown, and J.C. Leatherman. 2009. Milford Lake Watershed Assessment: Preliminary Report. Kansas State Research and Extension Publication #EP-142. 74 pages. http://www.ksre.ksu.edu/library/h20ql2/EP142.pdf

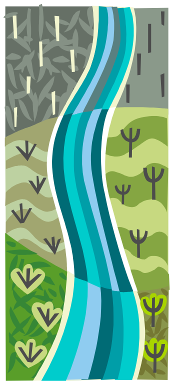


Appendix B: TMDLs

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT, 2000.

- High Priority TMDLs
  - Salt Creeknear Hollis
    http://www.kdheks.gov/tmdl/klr/SaltCrDO.pdf
    http://www.kdheks.gov/tmdl/klr/SaltCrFCB.pdf
- Medium Priority TMDLs
  - RepublicanRiver near Clay Center
    http://www.kdheks.gov/tmdl/klr/RepblcnRClyCntr.pdf
  - RepublicanRiver near Rice
    http://www.kdheks.gov/tmdl/klr/RepblcnRnrCnrdia.pdf
  - Lake Jewell
    http://www.kdheks.gov/tmdl/klr/jewellE.pdf

- Low Priority TMDLs
  - Buffalo Creek near Concordia
    http://www.kdheks.gov/tmdl/klr/BuffaloFCB.pdf
    http://www.kdheks.gov/tmdl/klr/BuffaloCl.pdf
  - BellevilleCity Lake
    http://www.kdheks.gov/tmdl/klr/bellevilleE.pdf
  - JamestownWildlife
    http://www.kdheks.gov/tmdl/klr/jamestownE.pdf
    http://www.kdheks.gov/tmdl/klr/jamestownSILT.pdf
    http://www.kdheks.gov/tmdl/klr/jamestownFCB.pdf



Appendix C: Financial Summary

Summary of Financial Expenditures and Matching Funds				
Category	**Budget**	**Actual**	**Match**	**Total**
Salaries	102,485.00	116,033.44	18,967.72	135,001.16
Fringe Benefits	29,997.00	26,843.71	4,061.29	30,905.00
Travel	3,000.00	1,475.10	-	1,475.10
Supplies	3,413.00	2,461.24		2,461.24
Contractual Services	-	-		-
Other	8,650.00	731.51	29,796.00	30,527.51
Project Indirect Costs	14,755.00	14,755.00		14,755.00
Waived Indirect Costs	-	-	63,709.00	63,709.00
Total	$ 162,300.00	$ 162,300.00	$ 116,534.01	$ 278,834.01