River City WRAPS

9 Element Watershed Plan Overview

Impairments to be addressed

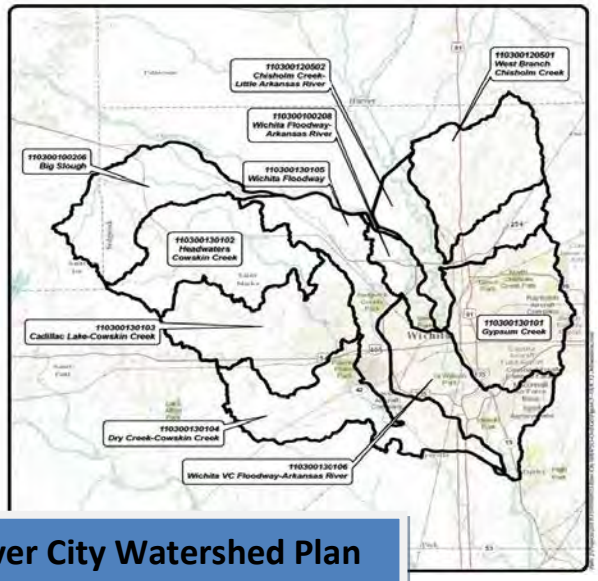
Directly addressing High Priority TMDLs for:

- Bacteria – Cowskin Creek
- Biology – Cowskin Creek

Positively affected impairments include:

- Arkansas River – Bacteria (High Priority)
- Arkansas River – Biology (Medium Priority)

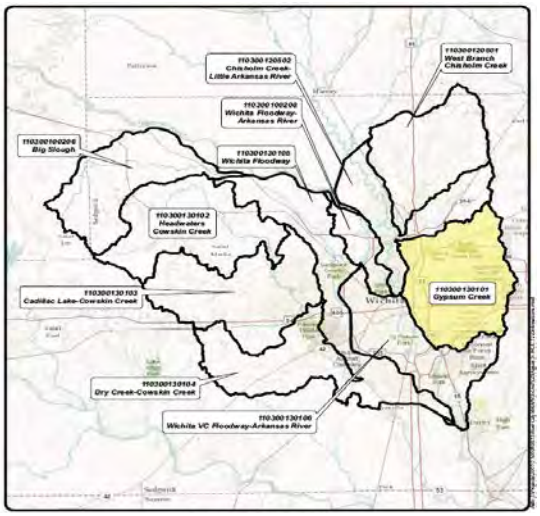
Additionally, the River City WRAPS is addressing stream quality degradation issues in Gypsum Creek



The River City WRAPS watershed plan contains a 50 year implementation schedule. Years 1-5 will be used to establish the WRAPS and gather additional information.

River City Watershed Plan Years 1-5

- **Targeted Studies to assess data gaps**
- **Information and Education in Cowskin Creek Watershed**
- **Pilot BMP Projects on Gypsum Creek**
- **Continued Water Quality Monitoring Area**



<u>Priority Areas for Gypsum Creek</u>

The priority area for the Gypsum Creek includes one HUC 12 within the Chisholm Creek watershed and is depicted as the yellow-colored watershed on the adjacent map. Best Management Practices (BMPs) to address stream degradation issues on Gypsum Creek were chosen by the Stakeholder Leadership Team.

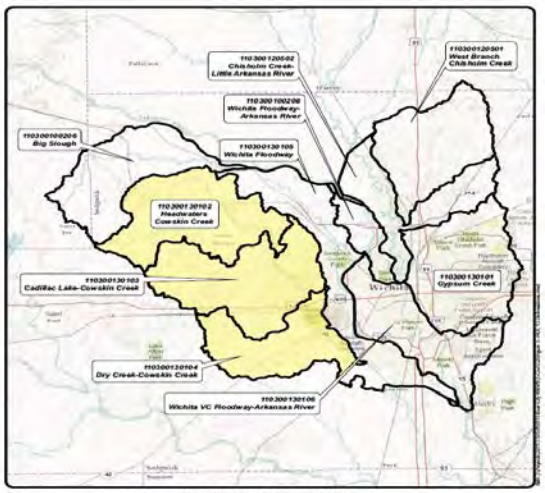
Urban Best Management Practices in Gypsum Creek

- Water quality swales
- Extended Detention Basins
- Permanent Re-vegetation
- Pervious Pavement
- Rain Gardens/Bioretention Cells
- Streambank Stabilization
- Stream Buffers

Best Management Practices and Load Reduction Goals for the Cowskin Creek Watershed

Cowskin Creek

The Cowskin Creek priority area is comprised of 3 HUC 12's. This targeted are is depicted in the yellow-colored watershed on the adjacent map. Best Management Practices (BMPs) to address bacteria in the Cowskin Creek watershed were chosen by the Stakeholder Leadership Team and KDHE based on needs and water quality information found in the Cowskin Creek Bacteria TMDL. Load Reduction Goals were established via The Watershed Model and consultation with KDHE. If these load reduction goals are achieved, it is believed that both the Biology and Bacteria TMDLs on Cowskin Creek will be met.



<u>Urban</u>

- Water quality swales
- Extended Detention Basins
- Permanent Re-vegetation
- Pervious Pavement
- Rain Gardens/Bioretention Cells
- Streambank Stabilization
- Stream Buffers

<u>Rural</u>

- Septic System repair
- Riparian buffers
- Livestock Waste System Upgrades
- Relocation of Livestock Feeding Stations
- Rotational Grazing
- Livestock Stream Access Restriction
- Grassed Waterways

Total Nitrogen

Load Reduction Goal is 54,670 lbs/yr.

Total Phosphorus

Load Reduction Goal is 54,663 lbs/yr.

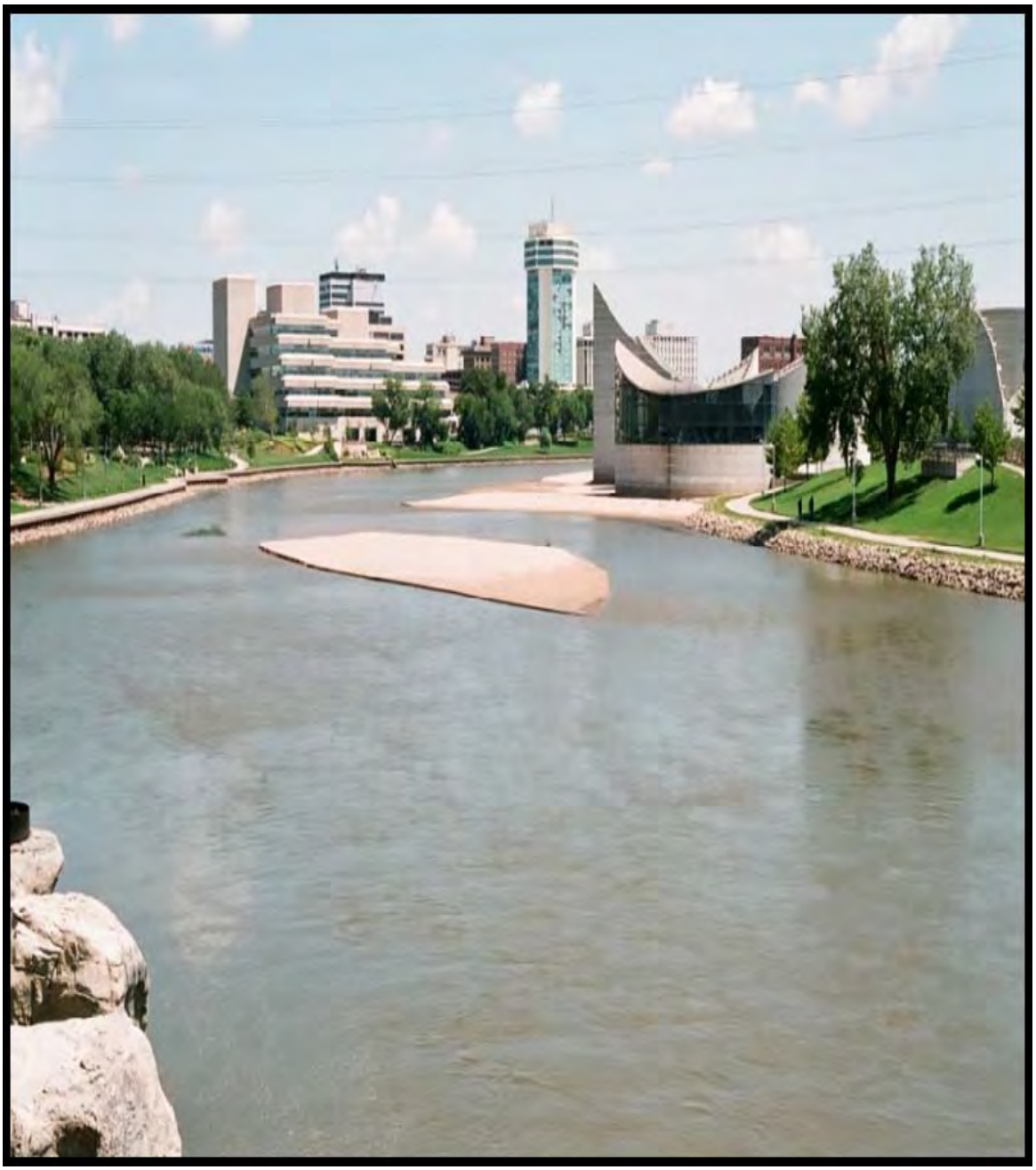
Sediment

Load Reduction Goal is 2,990 tons/yr.

In addition to implementing BMPs within this watershed, the River City WRAPS has developed an in-depth Information & Education plan for this watershed that will include:

- Pet Waste Education
- Septic System Education and Enforcement
- Low-Input Lawn Care
- Impervious Surface Disconnection/ Rain Gardens
- Commercial BMP Education
- Agricultural BMP education

LOWER ARKANSAS BASIN
RIVERCITY WRAPS
WATERSHED RESTORATION AND PROTECTION PLAN



SERVICE AREA
MIDDLE ARKANSAS-SLATE WATERSHED
WITHIN THE CITY OF WICHITA ENVIRONS
DECEMBER 2012

TABLE OF CONTENTS

LIST OF ACRONYMS

BMP	Best Management Practice
CAFO	Confined Animal Feeding Operation
CFS	Cubic Feet per Second
ECB	Escherichia Coliform Bacteria
FCB	Fecal Coliform Bacteria
GIS	Geographic Information System
HOA	Homeowners Association
HUC	Hydrologic Unit Code
I&E	Information and Education
SLT	Stakeholder Leadership Team
KDHE	Kansas Department of Health and Environment
LA	Load Allocation
LC	Load Capacity
MS4	Municipal Separate Storm Sewer Systems
NPS	Non-point Source
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources and Conservation Service
O&M	Operations and Maintenance
POTW	Publicly owned Treatment Works
SMAB	Stormwater Management Advisory Board
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
USGS	United States Geological Survey
WIN	Wichita Independent Neighborhoods
WIRE	Wichita Initiative to Renew the Environment
WLA	Waste Load Allocation
WTM	Watershed Treatment Model

LIST OF FIGURES

LIST OF TABLES

1.0 PREFACE

RiverCity WRAPS vision is to improve and protect the water quality of the Lower Arkansas River and its watershed through appropriate sustainable practices, community involvement, and education so that water quality becomes a valued component of life in South Central Kansas. Our mission is to develop and implement water quality improvement projects in the community that restore and protect the overall health of the river's watershed ecosystem. In addition, RiverCity WRAPS seeks to educate the public on the importance of water quality and best management practices each citizen and local entities can participate in to help protect the river well into the future.

The purpose of this Watershed Restoration and Protection Strategy (WRAPS) plan is to outline a plan for achieving the watershed restoration and protection goal of meeting designated use criteria for all segments of the watershed and providing for the protection of water resources that currently meet designated use water quality standards, but may be in danger of degradation.

This plan is intended to serve as the overall guide for successful implementation of watershed protection and restoration efforts by stakeholders, including individuals, private organizations, and local, state, and federal government agencies, leading to the achievement of our stated goals and objectives.

2.0 PRIORITY ISSUES AND GOALS OF THE STAKEHOLDER LEADERSHIP TEAM (SLT)

Designated uses for all watershed stem segments include Secondary Contact Recreation and Expected Aquatic Life Support. Designated uses for main stem watershed segments include Primary Contact Recreation, Domestic Water Supply, Food Procurement, Groundwater Recharge, Industrial Water Supply Use, Irrigation Use, and Livestock Watering Use.

Stakeholder survey information and comments received at public presentations indicated that the assigned designated uses were consistent with the expectations and watershed goals expressed by the stakeholder community.

2.1 WATERSHED CONCERNS

During the first meeting of the SLT, a round-table discussion was held to discuss watershed issues and concerns. The discussion was based on information obtained through surveys completed by stakeholders during community outreach efforts, personal knowledge of the watershed, Website feedback, and input from homeowners associations, neighborhood associations, civic groups and professional organizations within the community.

Stakeholder feedback identified the following watershed concerns and impairments that should be addressed through the WRAPS program. These concerns included:

- Litter and trash in rivers & streams interferes with recreational use, impairs water quality and decreases aesthetic value of the river corridor.
- Excessive run-off from impervious surfaces contributes to contamination, silt loading, and flooding problems.
- Contamination in runoff from parks, lawns, golf courses and athletic fields contributes to high nutrient loads, chemical contamination and eutrophication.
- Increased public awareness and education is needed to modify behaviors and actions that adversely affect the watershed.
- Lack of river access for recreational purposes affects public awareness of watershed conditions and limits understanding of the resource.
- Promotion of river use would be an effective tool to increase public awareness and improve perceptions of the watershed.

2.2 WATER QUALITY IMPAIRMENTS

The SLT reviewed and discussed existing surface water quality data obtained from the 2008 and 2010 303(d) List of Impaired Waters, City of Wichita Storm Water Management, Middle Arkansas-Slate Watershed Conditions Report, 2009 Kansas Water Plan and reviewed summaries of Total Maximum Daily Loads (TMDLs) established for the watershed and sub-watersheds to evaluate known issues affecting the watershed.

Based on available information, public response to surveys and SLT discussion and knowledge, the following water quality impairments are targeted for action by the RiverCity WRAPS program. Listed in order of priority, these impairments include:

1. Bacteria
2. Nitrate and phosphorus (nutrient loading and biological impairment)
3. Sediment loading
4. Pollutants associated with sediments (i.e. pesticide, fertilizers, and metals).

The SLT has agreed that the goal of the WRAPS project will be to meet designated use criteria for all segments of the watershed. Meeting the applicable TMDLs established by KDHE is critical to achieving this goal. The SLT also recognizes that water resources without assigned TMDLs may be “threatened” by pollution and may become degraded in the future if no action is taken. The protection of water resources that currently meet designated use water quality standards was also considered.

3.0 WATERSHED REVIEW

The Arkansas River begins high in the Rocky Mountains near Leadville, Colorado. It descends the eastern slope of the Continental Divide as a clear mountain stream and flows through the flat agricultural lands of southeastern Colorado and western and central Kansas. The Little Arkansas is a major tributary of the Arkansas River, and originates approximately 75 miles northwest of Wichita. The Little Arkansas flows southeasterly for about 90 river miles to its confluence with the Arkansas River at Wichita. Within the Wichita-Sedgwick County area, both rivers are sandy, meandering streams.

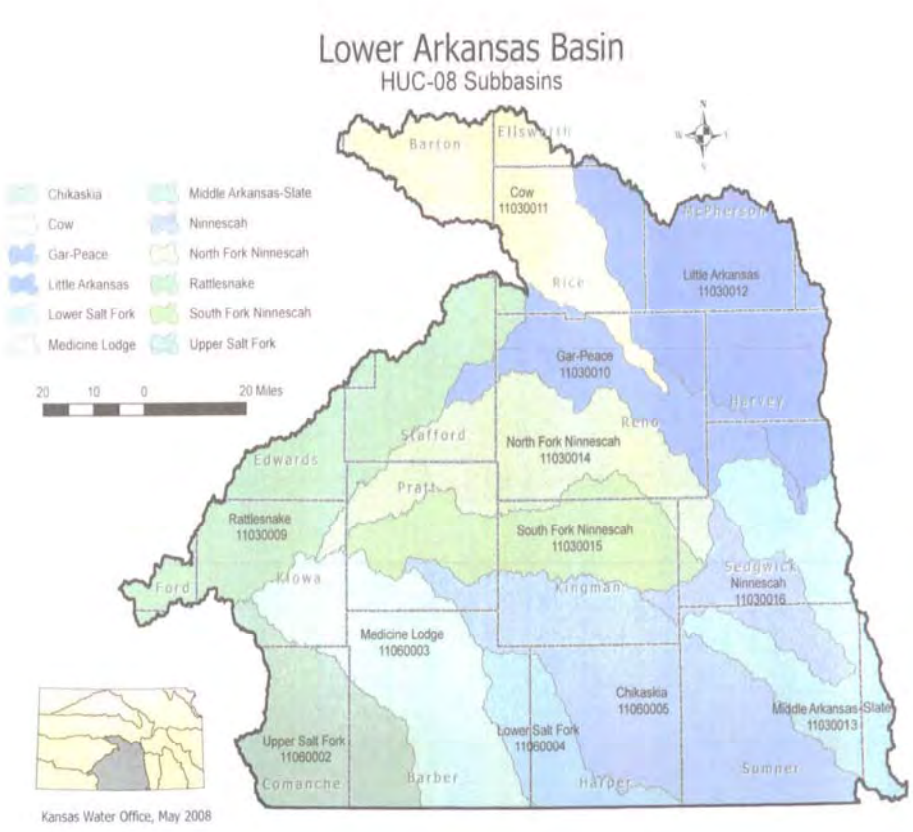


FIGURE 1: LOWER ARKANSAS BASIN KANSAS WATER OFFICE, MAY 2008

This WRAPS project is part of a coordinated effort by the City of Wichita as well as other federal, state, local agencies and private sector organizations to develop a watershed restoration and protection strategy for the portion of the Middle-Arkansas-Slate sub-watershed within the Wichita Environs. Figure 2 below shows the geographic extent of the Middle Arkansas-Slate Watershed.

The 8 digit hydrologic unit code (HUC 8) for the Middle Arkansas-Slate Watershed is 11030013.

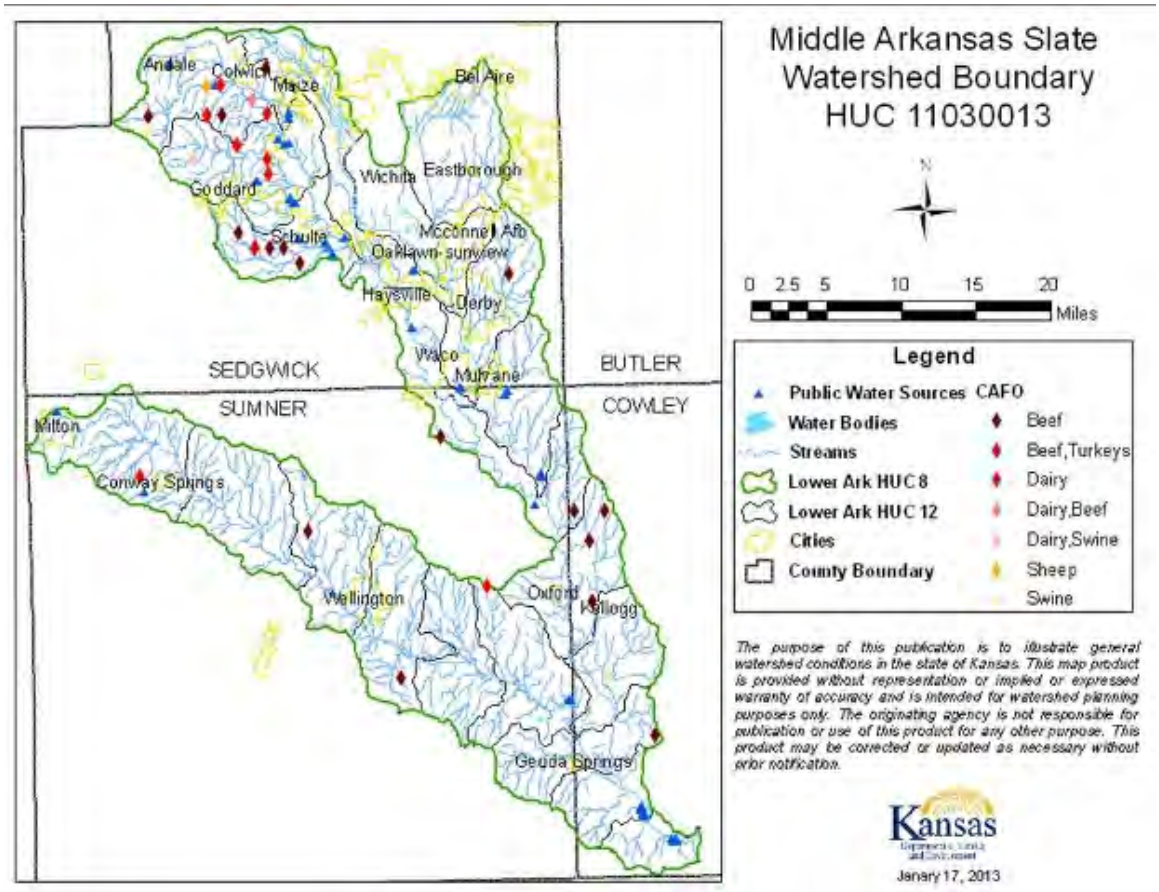


Figure 2: Middle Arkansas-Slate Watershed
Figure obtained from KDHE Bureau of Water, Watershed Planning and TMDL Program

The RiverCity WRAPS watershed is generally defined by the limits of the City of Wichita extending northwest and northeast into rural portions of Sedgwick County, including a relatively small portion of the Middle Arkansas-Slate HUC 8 Watershed. Watersheds included in the Little Arkansas (11030012) HUC are included for mapping purposes and impact the RiverCity WRAPS area; however, water quality impairments for these watersheds will be addressed through the Little Arkansas WRAPS project. Big Slough, a part of the Gar-Peace Watershed (11030010) is included due to the influence on water quality in the RiverCity WRAPS area.

Figure 3 represents the Lower Arkansas RiverCity WRAPS watershed service area.

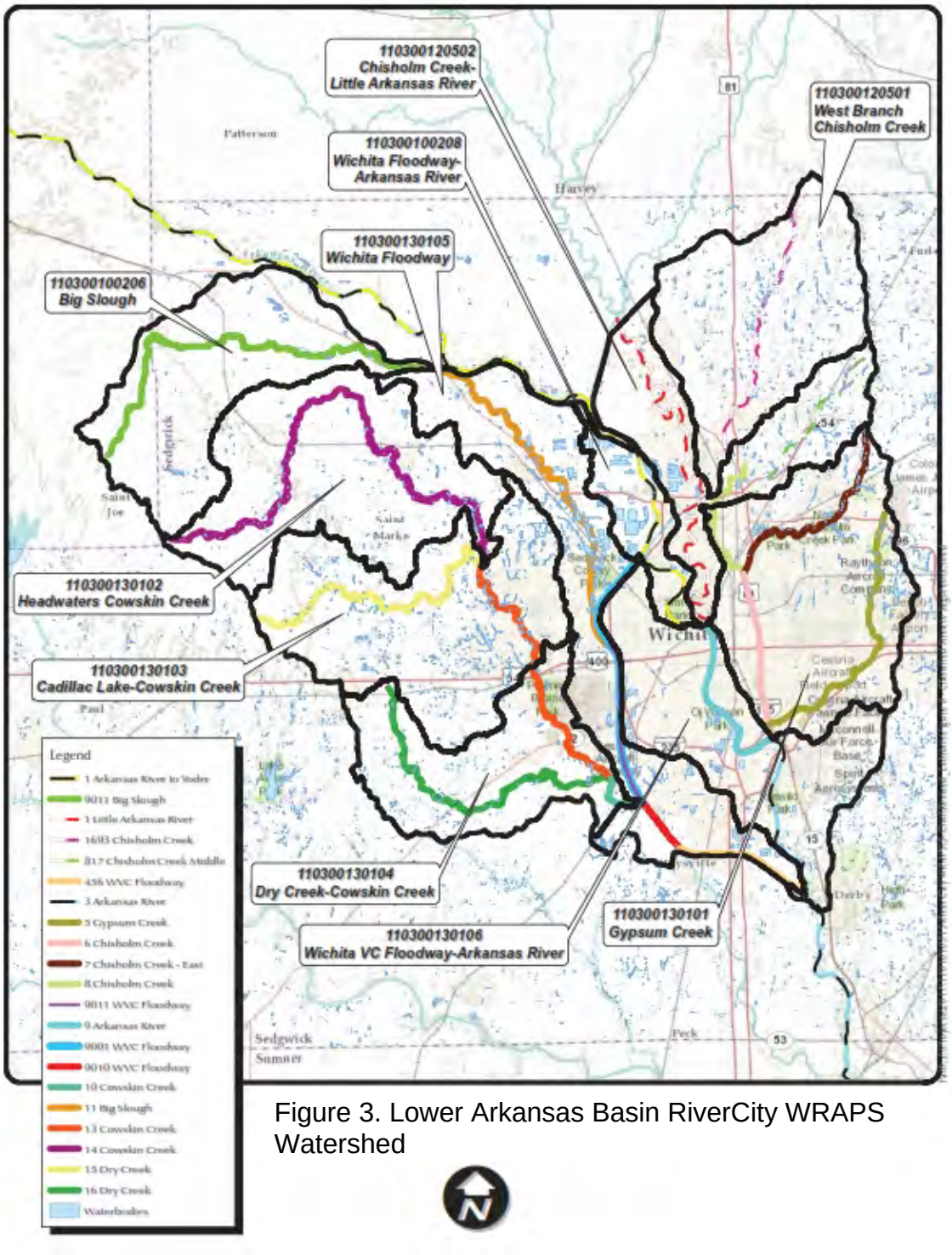


Figure 3. Lower Arkansas Basin RiverCity WRAPS Watershed

3.1 LAND COVER/LAND USES

Analyzing land uses within the watershed provides insight to which land uses might have the greatest influence on the watershed and which potential contaminant sources are most likely to be significant within that watershed. Land use within the Middle Arkansas-Slate Watershed is predominantly agricultural in nature, with grassland comprising 73.4% of the area and row crop comprising 12.3 %. Urban area accounts for 11.5% of the land use.

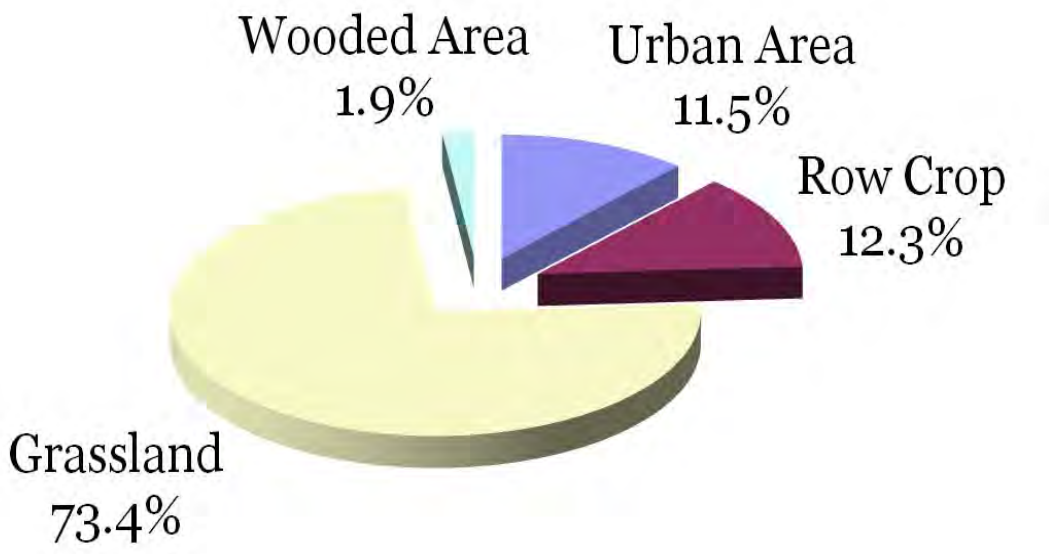


Figure 4: Land Use in Watershed
Watershed Conditions Report for HUC 8 11030013 (Middle Arkansas -Slate), 2000

The RiverCity WRAPS area accounts for the majority of the urban land use within the watershed. In the urban area of Wichita, surface runoff potential is greatly increased by the higher percentage of impervious surface area associated with urban commercial and residential development. Increased surface run-off, in turn contributes to increased soil erosion potential, stream channel and bank alterations to accommodate increased flows, and influx of pollutants associated with surface run-off including bacteria, nutrients, herbicides and pesticides. The utilization of on-site septic and lagoon waste water treatment systems for urban and suburban developments may contribute to increased nutrient and bacteria loads.

Figure 5 shows current land use, by HUC 12, for the RiverCity WRAPS area.

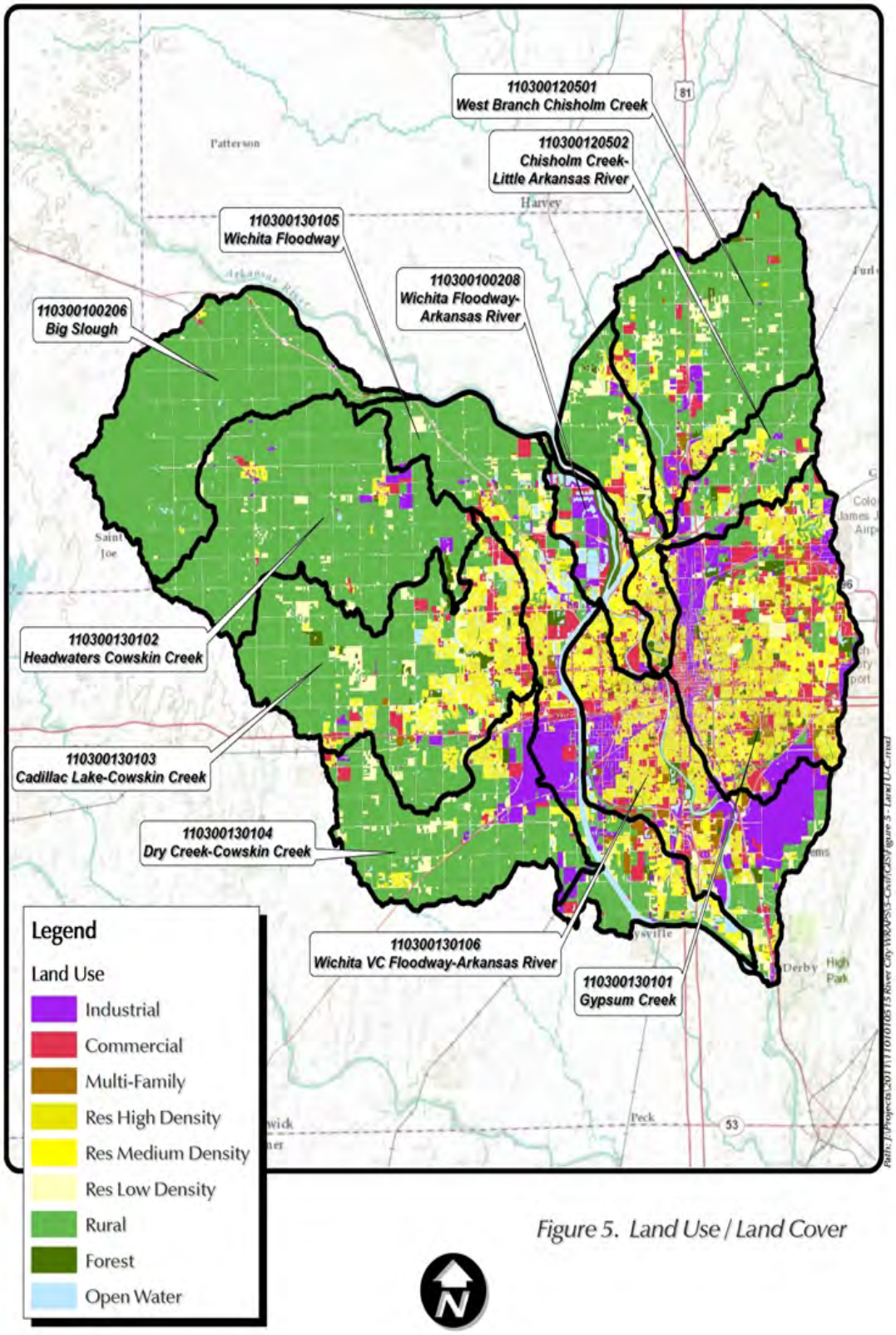


Figure 5. Land Use / Land Cover

Table 1 summarizes land use at the HUC 12 level.

TABLE 1: LAND USE SUMMARY RIVERCITY WRAPS AREA

HUC Name	HUC 12	Acreage	Land Use	Land Use %
Big Slough	110300100206	26	Commercial	0.1%
		12	Industrial	0.0%
		38	Forest	0.1%
		27,709	Rural	95.2%
		181	Open Water	0.6%
		35	Res High Density	0.1%
		39	Res Medium Density	0.1%
		160	Res Low Density	0.6%
		4	Res Multi-Family	0.0%
		874	Roads	3.1%
W. Branch Chisholm Creek	110300120501	1,049	Commercial	3.5%
		929	Industrial	3.1%
		333	Forest	1.1%
		21,504	Rural	71.6%
		517	Open Water	1.7%
		782	Res High Density	2.6%
		742	Res Medium Density	2.5%
		2,209	Res Low Density	7.4%
		157	Res Multi-Family	0.5%
		1,721	Roads	6.1%
Chisholm Creek / Little Arkansas	110300120502	1,042	Commercial	4.6%
		851	Industrial	3.8%
		650	Forest	2.9%
		10,931	Rural	48.3%
		724	Open Water	3.2%
		1,219	Res High Density	5.4%
		2,360	Res Medium Density	10.4%
		1,987	Res Low Density	8.8%
		149	Res Multi-Family	0.7%
		2,409	Roads	12.1%
Gypsum Creek	110300130101	5,642	Commercial	15.9%
		4,574	Industrial	12.9%
		930	Forest	2.6%
		3,298	Rural	9.3%
		364	Open Water	1.0%
		6,003	Res High Density	16.9%
		4,034	Res Medium Density	11.3%

HUC Name	HUC 12	Acreage	Land Use	Land Use %
		1,525	Res Low Density	4.3%
		1,783	Res Multi-Family	5.0%
		28,153	Roads	20.8
Headwaters Cowskin Creek	110300130102	391	Commercial	1.1%
		674	Industrial	1.9%
		181	Forest	0.5%
		31,921	Rural	88.5%
		188	Open Water	0.5%
		118	Res High Density	0.3%
		322	Res Medium Density	0.9%
		1,050	Res Low Density	2.9%
		3	Res Multi-Family	0.0%
		1,185	Roads	3.4%
Cadillac Lake / Cowskin Creek	110300130103	2,096	Commercial	5.6%
		310	Industrial	0.8%
		665	Forest	1.8%
		21,368	Rural	56.9%
		867	Open Water	2.3%
		2,034	Res High Density	5.4%
		3,488	Res Medium Density	9.3%
		3,168	Res Low Density	8.4%
		317	Res Multi-Family	0.8%
		1,933	Roads	8.6%
Dry Creek / Cowskin Creek	110300130104	698	Commercial	2.9%
		2,342	Industrial	9.8%
		91	Forest	0.4%
		16,188	Rural	67.7%
		137	Open Water	0.6%
		735	Res High Density	3.1%
		719	Res Medium Density	3.0%
		1,521	Res Low Density	6.4%
		42	Res Multi-Family	0.2%
		1,910	Roads	6.0%
Wichita Floodway	110300130105	2,496	Commercial	7.5%
		3,246	Industrial	9.7%
		365	Forest	1.1%
		14,069	Rural	42.1%
		0	Rural	0.0%
		3,278	Open Water	9.8%
		1,682	Res High Density	5.0%

HUC Name	HUC 12	Acreage	Land Use	Land Use %
		2,289	Res Medium Density	6.8%
		0	Res Medium Density	0.0%
		0	Res Medium Density	0.0%
		2,510	Res Low Density	7.5%
		0	Res Low Density	0.0%
		642	Res Multi-Family	1.9%
		2,599	Roads	8.5%
Wichita Valley Center Floodway / Arkansas River	110300130106	2,874	Commercial	10.2%
		6,684	Industrial	23.7%
		421	Forest	1.5%
		3,229	Rural	11.4%
		1,148	Open Water	4.1%
		4,220	Res High Density	14.9%
		1,993	Res Medium Density	7.1%
		1,115	Res Low Density	3.9%
		1,329	Res Multi-Family	4.7%
		4,280	Roads	18.6%

A number of potential non-point pollutant sources are associated with land use identified in the watersheds comprising the RiverCity WRAPS service area. In rural areas, agricultural practices may have a significant effect on surface water quality. Run-off from small livestock feeding or watering stations located in proximity to streams and drainage areas contributing to stream flow are a source of sediment, bacterial and nutrient loading. Overstocking of grazing areas may also contribute to these impairments. Cropland may contribute to nutrient and sediment loading, depending on management practices. Many agricultural operations incorporate land application of manure from livestock operations as a part of their nutrient management programs and, depending on practices, can contribute to nutrient and bacterial loads as a result of surface water run-off.

Stream channels may contribute significant proportions of total sediment load due to stream bank erosion. Stream bank erosion contributes nitrogen and phosphorous to surface waters, and is estimated to have a disproportionate impact on phosphorous

loads because of the adsorption of phosphorus to soil particles, which are released when stream bank failures release sediment into streams.

Many suburban and rural residences in the watershed rely on septic or lagoon systems for treatment of domestic waste water. Failing on-site wastewater systems are a potential source of both nutrients and bacteria.

In urban areas, roadway corridors generate a disproportionate amount of pollutant loading. This is primarily because of their high imperviousness, which allows pollutants to build up over time and to run off directly into the stormwater collection system rather than be filtered through vegetation. Commercial and Industrial land uses also export relatively high pollutant loads due to the high amount of impervious surfaces directly connected to the storm sewer system; and also because of relatively high landscape maintenance inputs.

Residential land uses constitute the majority of urban lands in the studied watersheds. Although they generally have lower levels of imperviousness, their impact is proportionally great because of their widespread distribution. Bacteria from pet waste and residential turf grass areas that are highly maintained are potential pollutants generated by urban residential land use. Concentrations of geese adjacent to water bodies in urban areas may also be a significant source of bacterial and nutrient loading.

3.2 DESIGNATED USES

Designated uses for the watershed include primary contact recreation, domestic water supply, food procurement, groundwater recharge, industrial water supply, irrigation and livestock watering. The following charts summarize surface water and lake designated uses based on information provided in the 2000 Middle Arkansas-Slate Watershed Conditions Report.

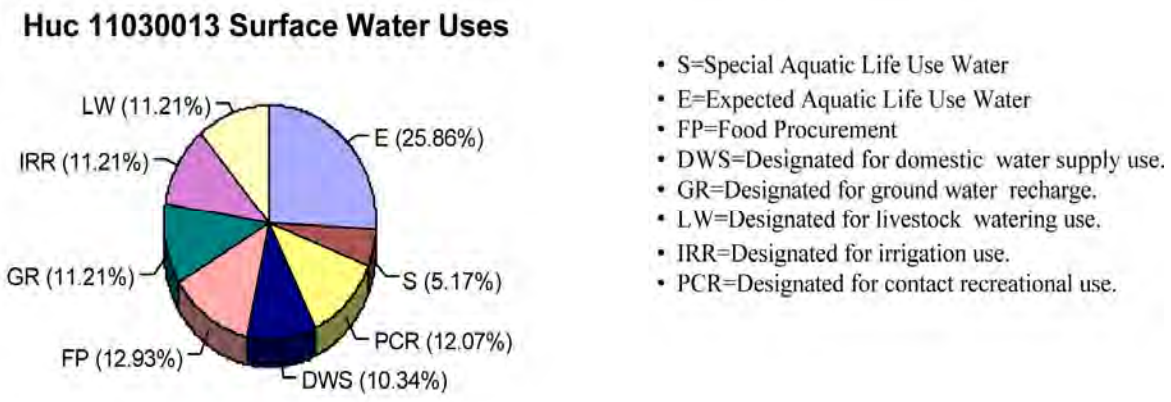


Figure 6: Surface Water Uses

Watershed Conditions Report for HUC 8 11030013 (Middle Arkansas -Slate), 2000

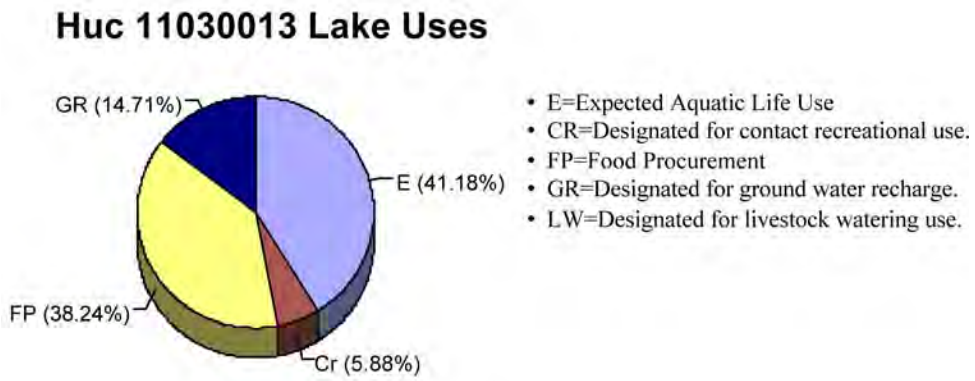


Figure 7: Lake Uses
Watershed Conditions Report for HUC 8 11030013 (Middle Arkansas -Slate), 2000

The following table summarizes stream and lake designated use in the RiverCity WRAPS service area.

TABLE 2: DESIGNATED WATER USES FOR THE RIVERCITY WRAPS WATERSHED
Kansas Surface Water Register, December 15, 2010

Stream Name	Segment	Class	Designated Use							
			AL	CR	DS	FP	GR	IW	IR	LW
Arkansas River	1	GP	S	B	X	X	X	X	X	X
Arkansas River	3	GP	S	B	X	X	X	X	X	X
Arkansas River	9	GP	S	B	X	X	X	X	X	X
Little Arkansas	1	GP	E	B	X	X	X	X	X	X
Big Slough	9011	GP	E	b	X	O	X	X	X	X
Big Slough	11	GP	S	B	X	X	X	X	X	X
Chisholm Creek Middle Fork	817	GP	E	b	O	O	O	O	X	X
Chisholm Creek	1693	GP	E	a	X	X	X	X	X	X
Chisholm Creek	6	GP	R	a	O	O	O	O	O	O
Chisholm Creek	8	GP	E	a	O	X	X	X	X	X
Chisholm Creek East	7	GP	E	B	X	X	X	X	X	X
Cowskin Creek	10	GP	E	B	X	X	X	X	X	X
Cowskin Creek	13	GP	E	C	X	X	X	X	X	X
Cowskin Creek	14	GP	E	b	X	X	X	X	X	X
Dry Creek	15	GP	E	b	O	O	X	O	X	X
Dry Creek	16	GP	E	b	O	O	X	O	X	X
Gypsum Creek	5	GP	E	B	X	X	X	X	X	X
Wichita Valley Center (WVC) Floodway	456	GP	S	b	X	X	X	X	X	X
WVC Floodway	9001	GP	E	b	X	X	X	X	X	X
WVC Floodway	9010	GP	E	b	X	O	X	X	X	X
WVC Floodway	9011	GP	E	b	O	X	X	O	X	X
Buffalo Park Lake		GP	E	B	X	X	X	X	X	X
Cadillac Lake (Pracht Wetland)		GP	E	B	X	X	X	X	X	X
Chisholm Creek Park Lake		GP	E	B	X	X	O	X	X	X
Eagle Lake (Belaire Lake)		GP	E	B	X	X	O	X	X	X
Emery Park Lake		GP	E	A	X	X	X	X	X	X
Harrison Park Lake		GP	E	B	X	X	O	X	X	X
Horseshoe Lake		GP	E	B	X	X	X	X	X	X
Kid's Lake		GP	E	B	X	X	X	X	X	X
Moss Lake		GP	E	B	X	X	X	X	X	X

Stream Name	Segment	Class	Designated Use							
			AL	CR	DS	FP	GR	IW	IR	LW
Riggs Park Lake		GP	E	B	X	X	X	X	X	X
Vics Lake		GP	E	B	X	X	X	X	X	X
Watson Park Lake		GP	E	B	X	X	X	X	X	X
Windmill Lake		GP	E	B	X	X	X	X	X	X

Abbreviations:
HUC = hydrologic unit code
CLASS = antidegradation category
GP = general purpose waters
EX = exceptional state waters
ON = outstanding national resource waters
AL = designated for aquatic life use
S = special aquatic life use water
E = expected aquatic life use water
R = restricted aquatic life use water
CR = designated for contact recreational use
A = Primary contact recreation lakes that have a posted public swimming area
B = Primary contact recreation lakes or streams that are by law or written permission of the landowner open to and accessible by the public
C = Primary contact recreation lakes or streams that are not open to and accessible by the public under Kansas law
a = Secondary contact recreation lakes or streams that are by law or written permission of the landowner open to and accessible by the public
b = Secondary contact recreation lakes or streams that are not open to and accessible by the public under Kansas law
DS = designated for domestic water supply use
FP = designated for food procurement use
GR = designated for ground water recharge
IW = designated for industrial water supply use
IR = designated for irrigation use
LW = designated for livestock watering use
X = referenced lake or stream segment is assigned the indicated designated use
O = referenced lake or stream segment does not support the indicated designated use
blank = capacity of the referenced lake or stream segment to support the indicated designated use has not been determined by use attainability analysis.
KWP = Kansas Wildlife and Parks
LK/ L = lake
NWR = National Wildlife Refuge
RES = reservoir
SFL = State Fishing Lake
W = wetland
W.A. = Wildlife Area
SEG = stream segment
ON = outstanding national resource waters
C = Primary contact recreation stream segment is not open to and accessible by the public under Kansas law
Br = branch
Cr = creek
Fk = fork
M = middle
R = river

As previously stated, designated uses for main stem watershed segments include Primary and Secondary Contact Recreation, Domestic Water Supply, Food Procurement, Groundwater Recharge, Industrial Water Supply Use, Irrigation Use, Livestock Watering Use and Expected Aquatic Life Support. The SLT has also identified increased public use of the river as a means of improving awareness of the watershed. Along with protection of waters meeting their designated use criteria, achieving primary and secondary contact recreation use criteria and food procurement are expected to be a significant factor in improving public perception of the river and expanding use of the resource. Stakeholder surveys indicate that 90 percent of respondents consider water quality of our rivers and streams important.

Forty percent indicate water quality as a significant factor in both their quality of life and/or income. Achieving all designated use criteria will support improved quality of life, economic growth, and continued sustainable development of the river corridor as a valued amenity to life in Sedgwick County.

3.3 Special Aquatic Life Use Waters

According to the Kansas Surface Water Register, December 15, 2010, no surface waters within the RiverCity WRAPS service area are designated as special aquatic life use waters. Designated Critical Habitat for the Arkansas River Shiner, Plains Minnow and Silver Chub includes the Arkansas River in southern Sedgwick County. All suitable habitats within the Cowskin Creek and Big Slough Drainage basins, located in Sedgwick and Sumner Counties are designated critical habitat for the Eastern Spotted Skunk.

3.4 Public Water Supply (PWS) and Wastewater Management

3.4.1 PWS

The City of Wichita obtains its water from Cheney Reservoir (65 %) and from water wells located north of the city in the Equus Beds (35%). Six other cities in or near the RiverCity WRAPS service area also obtain water from the City of Wichita.

Additionally, Wichita has developed an integrated local water supply plan (ILWS). Components of the ILWS include increased use of surface water storage from Cheney Reservoir, water conservation programs, redevelopment of an obsolete well field near Bentley, expansion of a well field within the city limits and additional raw water pipelines to increase the water supply system's capacity. An additional component of the ILWS includes the Aquifer Storage and Recovery Program (ASR) intended to partially compensate for depletion of the Equus Beds aquifer by capturing and storing above base-flow water from the Little Arkansas River. The ASR is located in the Little Arkansas WRAPS service area; however, indirect water quality benefits including reduced TSS and nutrient loading may be realized within the RiverCity WRAPS watersheds as a result of ASR implementation.

Assuming that this plan is implemented in its entirety, the City of Wichita will have sufficient water supply until the year 2050 for all of the incorporated cities within Sedgwick County. Although the City of Wichita is developing a plan that would have adequate water supply for all of the cities in Sedgwick County, this does not imply that the other cities in the County would wish to contract for this water supply. Each city would have to consider its own water supply situation vs. the additional costs of running distribution lines from Wichita's water source as well as the additional surcharges incurred through contracts with the City of Wichita. Should second and third class cities develop their own water supplies and not contract with the City of Wichita, this should extend the predicted water supply for Wichita beyond the year 2050. If Wichita is not able to implement its integrated water supply plan, then the City of Wichita only has an adequate water supply until the year 2015.

Rural areas of Sedgwick County include households on small to large acreage, farms, ranches, and a variety of businesses and industries. In general, water is supplied in these areas through private water wells. In areas of the county where groundwater is difficult to obtain, residents may be able to obtain water through a rural water district or by connecting to a city line. However, the availability of these resources is contingent upon the customer's location relative to a rural water district or nearby city.

3.4.2 WASTEWATER MANAGEMENT

Table 3 shows that 5 cities have an adequate wastewater management system in place for at least 11-50 years into the future. Two of the incorporated cities know that their current wastewater management system may not be adequate within the near future (5-10 years). For instance, Andale uses a non-discharging lagoon system with a capacity for 800 people. The U.S. Census Bureau Population Estimates for 2002 indicate a population of 789. Andale anticipated beginning construction on a fourth lagoon cell in 2004 to handle the population growth for the near future. If their population continues as it did from 1990-2000 at a rate of 35.3%, Andale may need to consider additional wastewater management practices by the year 2010.

The City of Valley Center's Wastewater Treatment Plant is nearly at capacity. The city intends to make a decision as to whether they should upgrade their system, contract with Wichita, or contract with Chisholm Creek Utility Authority (CCUA) to meet their future needs.

TABLE 3: PUBLIC WATER SUPPLY AND WASTEWATER MANAGEMENT
From Sedgwick County Water Supply and Wastewater Management Assessment 2004

Water Supply System		Waste Water Treatment		
City	**Water Source**	**Treatment Type**	**Capacity**	**Future**
Andale	2 wells	Non-discharging lagoon	800 person capacity	4th cell planned 2004
Colwich	2 wells	3 cell lagoon	200,000 gpd capacity	Current capacity for population of 2,000
Derby	20 yr contract with City of Wichita	POTW	2.5 million gpd capacity	Additional capacity may be needed by 2050.
Eastborough	City of Wichita	City of Wichita POTW	Contract with City of Wichita	(see City of Wichita)
Haysville	5 wells	POTW	2 million gpd	no expansion plans
Kechi	City of Wichita	City of Wichita POTW	120,000 gpd discharge	Contract with City of Wichita
Maize	2 wells	POTW	500,000 gpd capacity	Studying future needs
Park City	20-yr contract with City of Wichita + well fields	CCUA Treatment Plant	2.16 million gpd capacity	CCUA treatment plant
Valley Center	20 yr contract with City of Wichita	POTW	Treats 160 million gal/year	Nearly at capacity in 2004
Wichita	Cheney Reservoir = 65%; Equus Beds – 35%	4 POTWs	57 million gpd capacity	New facility planned for 2006

Residents, businesses, and industries located in the unincorporated portions of Sedgwick County have several options for managing their wastewater. Soils must be tested for percolation rates to determine if a sewage lagoon, septic system, or alternative sewage system is appropriate. Testing and results must be performed and reported by a qualified testing lab or qualified engineer or geologist. Those located near a city may have the option to hook up to a city's sewage system. In Sedgwick County, permits for individual wastewater systems are issued by the Department of Code Enforcement.

3.5 AQUIFERS

The Equus Beds aquifer is the principal source of fresh and usable water in south central Kansas. The aquifer underlies portions of a four-county area which is about 900,000 acres in size.

There are approximately 2,000 non-domestic water wells that withdraw an average of 157,000 acre-feet from the aquifer (51.2 billion gallons) each year. Industrial usage accounts for about 15 percent of the average total; irrigation accounts for 50 percent; and municipal accounts for 34 percent. Other uses account for one percent.

The Equus Beds Groundwater Management District No. 2 was formed in 1975 to manage groundwater supplies within its boundaries. The Equus Beds aquifer is managed on two fundamental management principles: 1) Aquifer Safe-yield Principle which limits groundwater withdraws to annual groundwater recharge; and 2)

Groundwater Quality Principle which seeks to maintain by protection and remediation the naturally occurring water quality of the aquifer.

This Management Program is a comprehensive aquifer management plan that was developed, adopted and implemented by the Board of Directors of the Equus Beds Groundwater Management District No. 2 to carry out these two management principles.

3.6 303(d) LISTINGS IN THE WATERSHED

According to the Watershed Conditions Report for HUC 8 11030013 (KDHE Non-point Source Section, 11/28/00), the primary pollutant concern within the Middle Arkansas-Slate streams and rivers was E. Coli Bacteria (ECB). Additional pollutant concerns within the watershed included chloride, sulfate and excess nutrients such as phosphate and nitrogen. The primary pollutant concern in lakes and ponds within the watershed was eutrophication, a natural process which is typically accelerated by excessive silt loading and high nutrient levels.

Based on the current 303(d) List of Impaired Waters, (April, 2012) primary pollutants of concern within the Middle Arkansas-Slate streams and rivers continue to be bacteria, biological impairment and nutrient load. Eutrophication continues to be the primary impairment associated with lakes and ponds in the watershed.

Potential sources of contamination affecting the watershed include registered and unregistered feedlots, unrestricted livestock access to streams and rivers, wastewater treatment facilities, septic systems, wildlife and pet waste, row crop agriculture and urban/suburban runoff.

Figure 8 on the following page shows the location of classified stream segments included in the current 303(d) List of Impaired/Potentially Impaired Waters and located within the RiverCity WRAPS area.

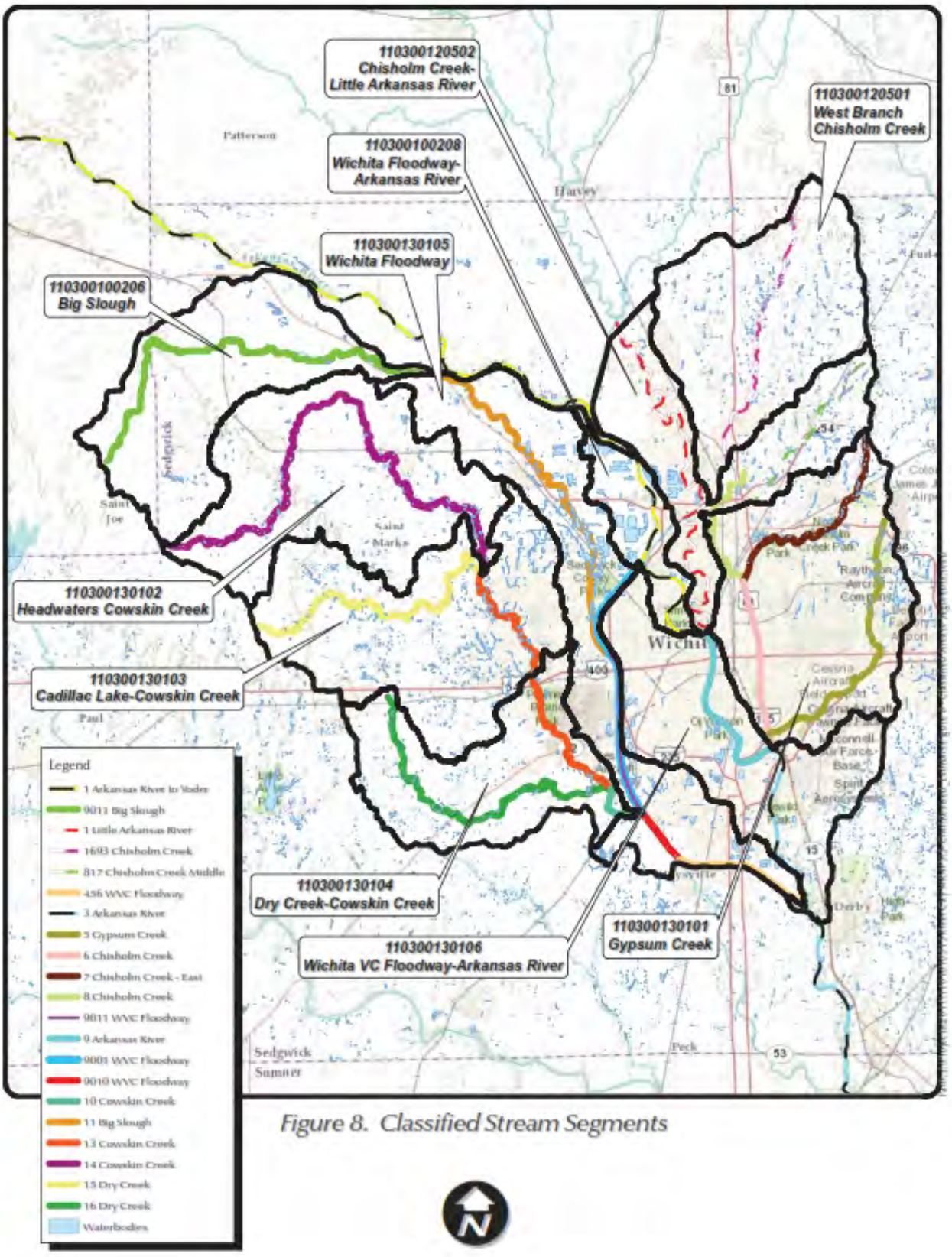


Figure 8. Classified Stream Segments

Water bodies are assigned categories depending on their characteristics and stage of TMDL development. These categories are;

- Category 5 Listed as 303d. Available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed
- Category 4a Waters that have developed TMDLs and remain impaired
- Category 4b NPDES permits or watershed planning are addressing impairments
- Category 4c Pollution (typically insufficient hydrology) is causing impairment
- Category 3 No recent data to indicate use support, water falls short of statistical impairment, bacteria data.
- Category 2 Waters that are now compliant with pollutant specific water quality standards.
- Category 1 Water has never been listed

Table 4 summarizes impaired and potentially impaired waters, including impairment, priority status and TMDL status, located within the RiverCity WRAPS service area.

TABLE 4: 2012 303(D) LIST OF IMPAIRED/POTENTIALLY IMPAIRED WATERS

Cat.	Stream/Lake Name	Impaired Use	Impairment	Station	County	Water Body Type	Priority	Comment
5	Chisholm Creek Park Lake	Aquatic Life	Eutrophication	LM064601	SG	Lake	Low	Small sample size, but sampled in 2008 and high nutrients and chla >20ppb with degrading trend
5	Emery Park Lake	Aquatic Life	Eutrophication	LM063201	SG	Lake	Low	
5	Harrison Park Lake	Aquatic Life	Eutrophication	LM022301	SG	Lake	Low	
5	Moss Lake	Aquatic Life	Eutrophication	LM064101	SG	Lake	Low	
5	Riggs Park Lake	Aquatic Life	Eutrophication	LM022401	SG	Lake	Low	
5	Arkansas River@ Derby	Aquatic Life	Lead	SC281	SG	Watershed	Low	
5	Arkansas River @ Wichita	Aquatic Life	Lead	SC729	SG,SU	Watershed	Low	
5	Cowskin Cr @ Wichita	Aquatic Life	Lead	SC730	SG,SU	Watershed	Low	
5	Arkansas River @ Derby	Food Procure-ment	PCB	SC281	SG	Watershed	Low	Fish Consumption advisory
5	Arkansas River @ Derby	Aquatic Life	Total Phosphorous	SC281	SG	Watershed	Low	median value: 0.678 > median flag value:0.201
5	Arkansas River @ Wichita	Aquatic Life	Total Phosphorous	SC729	SG,SU	Watershed	Low	median over 2000-2011 =0.222 mg/l

Cat.	Stream/Lake Name	Impaired Use	Impairment	Station	County	Water Body Type	Priority	Comment
5	Cowskin Cr @ Wichita	Aquatic Life	Total Phosphorous	SC730	SG,SU	Watershed	Low	median value:0.394 5>median flag value:0.201
5	Cowskin Creek In Wichita-Valley Center Floodway	Aquatic Life	Total Phosphorus	SC288	SG	Watershed	Low	median value: 0.212 > median flag value:0.201
4a	**Arkansas River @ Derby**	**Aquatic Life**	**Biology**	**SC281**	**SG**	**Watershed**	**Med.**	**TMDL approved 7/27/2001**
4a	Arkansas River @ Wichita	Aquatic Life	Biology	SC729	SG,SU	Watershed	Low	TMDL approved 7/27/2001 SB281
4a	**Cowskin Cr @ Wichita**	**Aquatic Life**	**Biology**	**SC730**	**SG,SU**	**Watershed**	**High**	**TMDL approved 9/28/2007 SB346**
4a	Cowskin Creek In Wichita-Valley Center Floodway	Aquatic Life	Biology	SC288	SG	Watershed	High	TMDL Approved on 9/28/2007, SB346
4a	Arkansas River @ Derby	Water Supply	Chloride	SC281	SG	Watershed	Medium	TMDL Approved on 9/20/2006
4a	Arkansas River @ Wichita	Water Supply	Chloride	SC729	SG,SU	Watershed	Med.	TMDL approved on 9/20/2006
4a	Cadillac Lake (Pracht Wetland)	Aquatic Life	Eutrophication	LM054101	SG	Lake	Low	TMDL approved 11/13/2000
4a	Horseshoe Lake	Aquatic Life	Eutrophication	LM063501	SG	Lake	Low	TMDL approved 11/13/2000
4a	Kid's Lake	Aquatic Life	Eutrophication	LM63601	SG	Lake	Low	TMDL approved 11/13/2000
4a	Watson Park Lake	Aquatic Life	Eutrophication	LM064401	SG	Lake	Low	TMDL approved 11/13/2000
4a	**Arkansas River @ Derby**	**Rec**	**Fecal Coli**	**SC281**	**SG**	**Watershed**	**High**	**TMDL approved 8/9/2000**
4a	**Arkansas River @ Wichita**	**Rec**	**Fecal Coli**	**SC729**	**SG,SU**	**Watershed**	**High**	**TMDL approved 8/9/2000**
4a	**Cowskin Cr @ Wichita**	**Rec**	**Fecal Coli**	**SC730**	**SG,SU**	**Watershed**	**High**	**TMDL approved 8/9/2000**
4a	**Cowskin Cr @ Wichita-Valley Center Floodway**	**Rec**	**Fecal Coli**	**SC288**	**SG**	**Watershed**	**High**	**TMDL approved 8/9/2000**

Rec. = recreational use

3.7 TOTAL MAXIMUM DAILY LOADS IN THE WATERSHED

A Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant that a water body can receive and still safely meet water quality standards. Exceeding the TMDL typically results in failure to support designated use for the specific water body. The TMDL allocates the allowable load to point sources (Waste Load Allocation or WLA) and nonpoint sources (Load Allocation or LA) which include both anthropogenic and natural background sources of the pollutant. The process of developing TMDLs determines;

1. The pollutants causing water quality impairments.
2. The degree of deviation away from applicable water quality standards.
3. The levels of pollution reduction needed to achieve water quality standards.
4. Corrective actions, including load allocations, to be implemented among point and nonpoint sources in the watershed affecting the water quality limited water body.
5. The monitoring and evaluation strategies needed to assess the impact of corrective actions in achieving TMDLs and water quality standards.
6. Provisions for future revision of TMDLs based on those evaluations.

In summary, TMDLs provide the basis for targeting and addressing point and nonpoint source pollution sources. The objective of the WRAPS process is to address high priority TMDLs within the specified watershed. KDHE reviews TMDLs on a five year rotational basis. Current TMDLs for the RiverCity WRAPs watersheds were developed in 2001 and 2006. TMDL stream segments are shown on Figure 9. Five-year review of TMDLs in the Lower Arkansas Basin was planned for 2011.

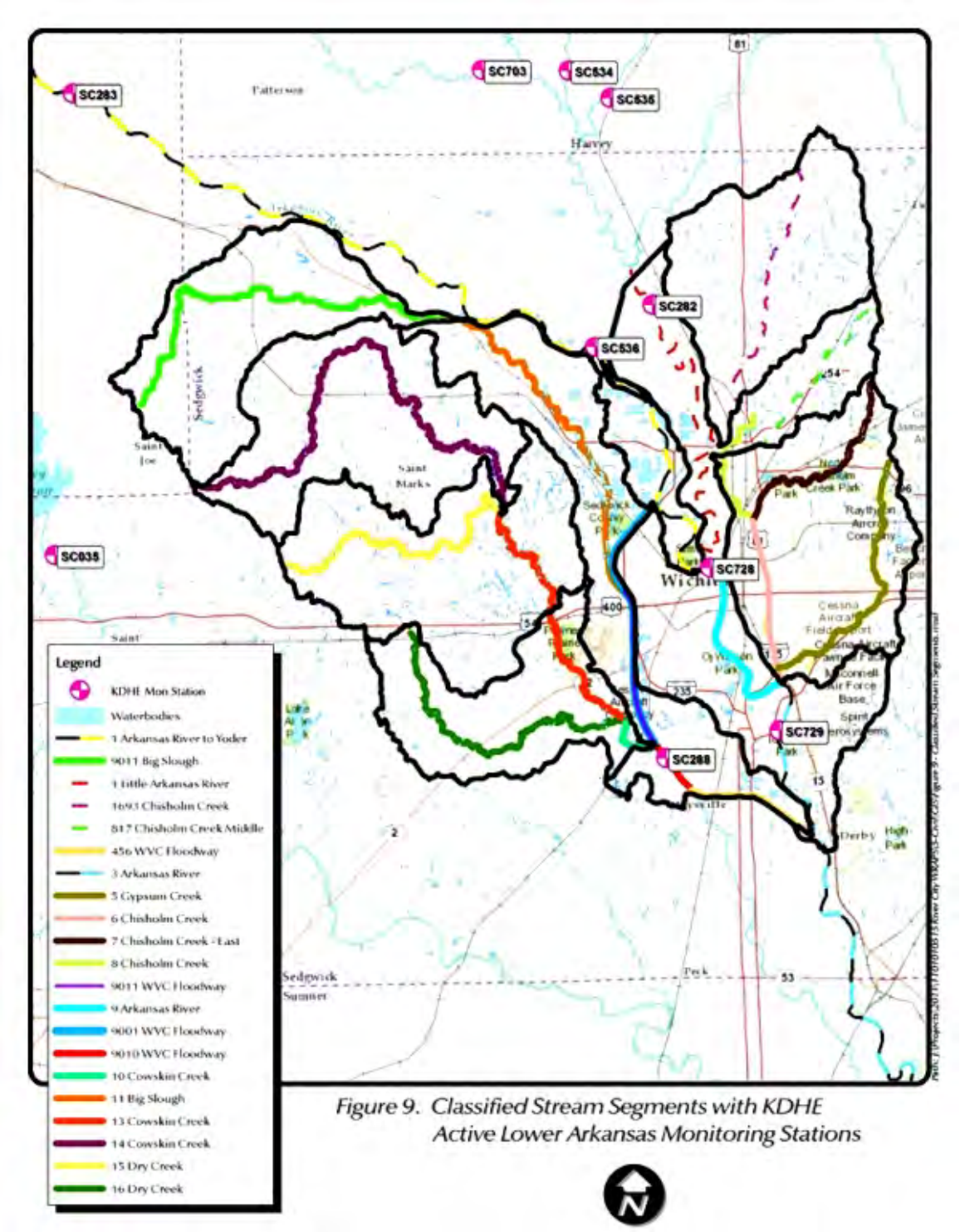


Figure 9. Classified Stream Segments with KDHE Active Lower Arkansas Monitoring Stations

3.7.1 ARKANSAS RIVER BELOW WICHITA: BACTERIA

This TMDL addresses bacteria in the Arkansas River below Wichita, and encompasses a drainage area of 1,720 square miles between Derby and Maize, Kansas with the main stem segment starting at the confluence with the Little Arkansas River and ending with the confluence of Cowskin Creek (Segment 3). Tributary segments named in this TMDL

include Segment 7 of East Chisholm Creek, Segments 6 and 8 of Chisholm Creek and Segment 5 of Gypsum Creek. Most of the watershed along the Arkansas River is urban with a high percentage of impervious area. The Little Arkansas River and Cowskin Creek are predominantly cropland with grasslands available for grazing.

Source inventory and assessment includes a number of NPDES permitted wastewater dischargers within the City of Wichita and wastewater treatment plants at Park City, Kechi and Valley Center; livestock waste management systems, particularly within the Cowskin Creek and Little Arkansas drainages; increased run-off associated with high percentages of impervious area of urban areas of the drainage; failing or poorly designed on-site waste systems within rural northern Sedgwick County and peripheral developments surrounding cities; domestic pet waste in urban settings; and background levels associated with contributions from wildlife.

Based on the assessment of potential sources, the distribution of excursions from water quality standards and the relationship of those excursions to flow conditions, non-point sources are seen as the primary cause of bacteria water quality violations.

Because the Arkansas River lies within an urban setting, but reflects contributions from outlying rural areas, particularly along the Little Arkansas River and Cowskin Creek, this TMDL is considered a high priority for implementation under State Water Plan Implementation Priority. Given the total contributions occurring within the drainage of the Arkansas River in and around Wichita, the entire watershed and all segments are treated as high priority pending additional assessment. Developed TMDLs for Cowskin Creek and the Little Arkansas River are also high priority and should be implemented concurrently with this TMDL.

The TMDL specifies the following desired implementation activities;

1. Renew necessary state and federal permits and monitor permitted facilities for permit compliance
2. Install necessary proper manure and livestock waste storage
3. Install necessary grass buffer strips along streams.
4. Install necessary pasture management practices, including proper stock density on grasslands
5. Remove feeding sites in proximity to streams
6. Reduce livestock use of riparian areas
7. Insure proper on-site waste system operations in proximity to main streams.
8. Evaluate stormwater management options to reduce urban runoff contributions to stream

Primary participants for implementation include the City of Wichita Stormwater Management Program and small livestock producers operating without need of permits along priority stream segments. Implementation activities should be targeted toward areas with the greatest potential to impact the stream, typically activities located within one mile of the streams including:

1. Facilities without water quality controls
2. Unpermitted permanent feeding/holding areas
3. Sites where drainage runs through or adjacent livestock areas
4. Sites where livestock have full access to stream and stream is primary water supply
5. Grazed acreage, overstocked acreage and acreage with poor range condition
6. Poor riparian sites
7. Near stream feeding sites
8. Failing on-site waste systems
9. Uncontrolled entry points for urban runoff
10. Coincidental areas of impervious surfaces and incidental fecal waste dropping
11. Failing sewer lines

3.7.2 COWSKIN CREEK: BACTERIA

This TMDL addresses bacteria and encompasses a drainage area of 189.4 square miles including Cowskin Creek Segments 12, 13, and 14, starting at the confluence with the Big Slough River south of Wichita with headwaters near Andale, in Sedgwick County. Tributary segments named in this TMDL include Segments 15 and 16 of Dry Creek and Segment 11 of Big Slough. Approximately 78 percent of this watershed is cropland. Ten percent is urban and ten percent is grassland. Grazing density of livestock is considered moderate throughout the watershed.

Source inventory and assessment identifies five NPDES permitted wastewater dischargers within the watershed, including four lagoons and one activated sludge plant; thirty-seven permitted livestock waste management systems; failing or poorly designed on-site waste systems within rural Sedgwick County and peripheral developments surrounding cities; and background levels associated with contributions from wildlife.

As determined for the Arkansas River bacteria impairment, the distribution of excursions from water quality standards and the relationship of those excursions to flow conditions within the Cowskin drainage indicate non-point sources as the primary cause of bacteria water quality violations.

Because Cowskin Creek is in a mixed rural-urban setting, subject to increased pressure of development, Cowskin Creek is a major tributary to the Arkansas River below Wichita and because of joint opportunities to put bacteria, nutrient and sediment BMPs in the watershed, this TMDL is considered a high priority for State Water Plan Implementation. Because the north and west portions of the Cowskin drainage include most agricultural production and opportunities for BMP installation, these areas are suggested as the priority focus for implementation.

The TMDL specifies the following desired implementation activities;

1. Renew necessary state and federal permits and monitor permitted facilities for permit compliance
2. Install necessary proper manure and livestock waste storage
3. Install necessary grass buffer strips along streams.

4. Install necessary pasture management practices, including proper stock density on grasslands.
5. Remove feeding sites in proximity to streams.
6. Reduce livestock use of riparian areas.
7. Insure proper on-site waste system operations in proximity to main streams.
8. Evaluate stormwater management options to reduce urban runoff contributions to stream

Primary participants for implementation will be the City of Wichita Stormwater Program and small livestock producers operating without need of permits along the priority stream segments. Implemented activities should be targeted at those areas with greatest potential to impact the stream. Nominally, this would be activities located within one mile of the streams including:

1. Facilities without water quality controls
2. Unpermitted permanent feeding/holding areas
3. Sites where drainage runs through or adjacent livestock areas
4. Sites where livestock have full access to stream and stream is primary water supply
5. Grazed acreage, overstocked acreage and acreage with poor range condition
6. Poor riparian sites
7. Near stream feeding sites
8. Failing on-site waste systems
9. Uncontrolled entry points for urban runoff
10. Coincidental areas of impervious surfaces and incidental fecal waste dropping

3.7.3 COWSKIN CREEK: BIOLOGICAL NUTRIENT IMPAIRMENT BUNDLED WITH PH

This TMDL, developed in 2007, addresses Biological Nutrient Impairment and encompasses a drainage area of 150.2 square miles including Cowskin Creek Segments 12, 13, and 14, starting at the confluence with the Big Slough River south of Wichita with headwaters near Andale, in Sedgwick County. Tributary segments named in this TMDL include Segments 15 and 16 of Dry Creek and Segment 11 of Big Slough. Approximately 67 percent of this watershed is cropland. Of the remaining area, twelve percent is urban, eight percent non-native grassland, 6 percent is prairie and three percent is forest. Future conditions in the watershed will likely see more urbanization, with projections of 47 percent of the watershed developed by 2030.

Source inventory and assessment identifies eight NPDES permitted wastewater dischargers within the watershed, including four lagoons and one activated sludge plant; one proposed activated sludge plant, and two cooling water ponds; twenty-five permitted livestock waste management systems; failing or poorly designed on-site waste systems within rural Sedgwick County and peripheral developments surrounding cities; and background levels associated with contributions from wildlife.

Based on the assessment of potential sources, the distribution of excursions from water quality standards and the relationship of those excursions to flow conditions, non-point sources are allocated 53 percent of the difference between the load capacity and NPDES and MS4 waste load allocations.

Because Cowskin Creek is in a mixed rural-urban setting, subject to increased pressure of development and a major tributary to the Arkansas River below Wichita, this TMDL is considered a high priority for State Water Plan implementation. While additional monitoring, source assessment and definition of the relationship between aquatic

community response and nutrient loading are studied, the emphasis of this TMDL should be improved point-source performance in nutrient removal and reducing the nonpoint and urban stormwater contributions of sediment and nutrients in the watershed.

The north and west portions of the Cowskin drainage are suggested as the priority focus of implementation of agricultural productions BMPs. Segments 12, 13, and 14 constitute the main streams which reflect biological impacts from watershed activities. The eastern portion of the watershed should emphasize urban stormwater control and reductions.

The TMDL specifies the following desired implementation activities;

1. Implement necessary soil sampling to recommend appropriate fertilizer applications on cropland.
2. Maintain necessary conservation tillage and contour farming to minimize cropland erosion.
3. Install necessary grass buffer strips along streams.
4. Reduce activities within riparian areas.
5. Install proper manure storage.
6. Implement necessary nutrient management plans to manage manure application to land.
7. Monitor wastewater discharges for excessive nutrient loadings.
8. Implement appropriate urban best management practices to reduce the impact of stormwater on the receiving streams.
9. Evaluate removal of non-permitted obstructions in the channel of Cowskin Creek.

Primary participants for implementation will likely be agricultural producers operating within the western drainage and the City of Wichita to the east. Inventory of those areas with greatest potential to impact the stream, typically within a mile of the stream, should include:

1. Total row crop acreage
2. Cultivation alongside stream
3. Fields with manure applications
4. On-site wastewater discharges to stream
5. Condition of riparian areas
6. Presence of livestock along stream
7. Uncontrolled entry points for urban runoff
8. Impervious area generating increased runoff

3.8 TMDL LOAD ALLOCATIONS

TMDL load allocation identifies allowable loads for point, nonpoint, and background sources and is based on a number of factors. Each pollutant source and its relative contribution to the water quality impairment are determined. Total load is derived from the TMDL. For point sources, NPDES facilities, confined animal feeding operations (CAFOs) or other regulated facilities, waste load allocations (WLA) are based on NPDES permits which consider the type of wastewater and treatment, volume of discharged effluent, degree of compliance with existing permits, potential for future growth and expected flow conditions over which they are expected to provide protection. Nonpoint source load allocations (LA) are the load remaining after removal of point source and natural contributions to the total load, and reflect the load originating from agricultural and urban areas that have no specific point of discharge. The WRAPS project is

directed to address nonpoint source LA. All BMPs derived by the SLT will be directed at this LA.

3.8.1 BACTERIA

While the TMDL's referenced in the previous section refer to Fecal Coliform Bacteria (FCB), per House Bill 2219 (2003) there is no longer a Water Quality Standard for FCB. Existing TMDLs are evaluated using the new bacteria indicator, E. Coli Bacteria (ECB), which has been found to have a much better correlation between illness and concentration. The term Bacteria is currently preferred when referencing bacterial impairments since both FCB and ECB are bacteria and this term effectively bridges the two indicators, and is used in this document.

The desired endpoint for bacteria specified in both TMDLs is to fully support both Primary and Secondary Contact Recreation. All FCB TMDLs are still in place; however, the desired endpoints are based on the ECB standard. A revised primary contact recreation TMDL curve will be established by KDHE for Phase Two of this TMDL.

As stated in the TMDL documents, the nature of bacteria loading is too dynamic to assign fixed allocations for waste loads and nonpoint loads. Neither TMDL identified current bacteria concentrations or loading rates; or quantitative loading capacities (LC), WLAs and LAs. Instead, allocation of sources reflects the expected contribution of bacteria loading under defined flow conditions. These flow conditions are defined by the presumed ability of point or nonpoint sources to be the dominant influence on stream water quality. Differentiation between assumed point and nonpoint source contributions are made by demarcating the seasonal TMDL curves at a particular flow duration level. Frequent, low flows represent conditions which are the responsibility of point sources to maintain water quality. Those infrequent flows greater than the designated low flow are the responsibility of nonpoint sources up to the high flow exclusion value (66.5 cubic feet per second (cfs) for Cowskin Creek and 2,000 cfs for the Arkansas River).

For the Arkansas River, point source attribution is defined as the flow regime between 75 and 100 percent exceedence, or 0-300 cfs. Nonpoint source allocation, or LA, is assigned responsibility for maintaining water quality over flow conditions exceeded less than 75 percent of the time, or 300-2,000 cfs.

For Cowskin Creek, point source attribution is defined as the flow regime between 65 and 100 percent exceedence, or 0-5 cfs. Nonpoint source attribution is assigned responsibility for maintaining water quality over flow conditions exceeded less than 75 percent of the time, or 5-66.5 cfs.

Sources of bacterial contamination were assumed to be primarily agricultural and rural, but impacting urban waters. For this reason both TMDLs were designated as High Priority by KDHE. The endpoints were to be addressed through expected, though unspecified, reductions in loading from the various sources in the watershed resulting from implementation of rural and urban corrective actions and Best Management Practices (BMPs).

3.8.2 BIOLOGICAL

The TMDL for Biological impairment for Cowskin Creek was originally approved in 2000 and revised in 2007. The stream segment is considered to be partially supporting, with measured Kansas Biotic Index (KBI) values greater than 2.6 and Macroinvertebrate Biotic Index (MBI) values between 4.51 and 5.39. MBI values less than 4.5 are

considered to be fully supporting of aquatic life. Average MBI values less than 4.5 are the desired endpoint for this TMDL.

As with FCB, the TMDL assumes that low flows up to the 75th percentile (6.86 cfs now, which will increase to 17.29 cfs with future wastewater treatment plant expansion) are primarily wastewater discharges and constitute the point source contribution of pollutants to the watershed. Higher, less frequent flows (from 6.86 to 75.14 cfs currently, or 17.29 to 92.43 cfs in the future) are primarily stormwater runoff and contribute the nonpoint source portion of pollutant loads. Flows greater than 75.14 cfs now or 92.43 cfs in the future will constitute high flows and be excluded.

Specific correlations between pollutant loads and MBI scores have not been developed. However, the TMDL assumes that nutrient (nitrogen and phosphorous) and sediment concentrations have a strong influence on MBI scores and aquatic life support. The TMDL assumes that in-stream concentrations of 2.0 milligrams per liter (mg/L) total nitrogen (TN), 0.2 mg/L of total phosphorus (TP), and 100 mg/L of total suspended solids (TSS) will result in meeting the desired endpoint. The TMDL therefore specifies WLAs and LAs based on meeting these pollutant concentrations. The TMDL also specifies allowable loads for Municipal Separate Storm Sewer Systems (MS4), which constitute the urban portions of the watershed that are to be addressed by this WRAPS effort. The MS4 allocations provide for future urban growth. Table 6 below, from the 2007 revised TMDL document, provides WLAs and LAs for various flow conditions.

TABLE 5: LOAD CAPACITIES, WASTELOAD ALLOCATIONS AND LOAD ALLOCATIONS FOR NITROGEN, PHOSPHORUS AND TOTAL SUSPENDED SOLIDS AT MONITORING SITE SC 288

(Obtained from Cowskin Creek TMDL revised 2007)

percentile	est flow	flow - ww	new ww	future flow	TN LC	TN WLA	TN MS4	TN LA	TP LC	TP WLA	TP MS4	TP LA	TSS LC	TSS WLA	TSS MS4	TSS LA
90	2.65	0	17.29	17.29	186.7	186.7	0.0	0.0	18.7	18.7	0.0	0.0	1.4	1.4	0.0	0.0
75	6.86	0	17.29	17.29	186.7	186.7	0.0	0.0	18.7	18.7	0.0	0.0	1.4	1.4	0.0	0.0
50	16	9.14	17.29	26.43	285.4	186.7	46.4	52.3	28.5	18.7	4.6	5.2	7.1	1.4	2.7	3.0
25	35.3	28.44	17.29	45.73	493.9	186.7	144.4	162.8	49.4	18.7	14.4	16.3	12.3	1.4	5.1	5.8
10	82	75.14	17.29	92.43	998.2	186.7	381.4	430.1	99.8	18.7	38.1	43.0	25.0	1.4	11.1	12.5

Load Capacities, Wasteload Allocations and Load Allocations for Nitrogen, Phosphorus and TSS at Monitoring Site 288

To assist with this project, KDHE compared its analytical data and corresponding flows for Monitoring Site SC 288, to estimate current pollutant load in the watershed. KDHE then developed the following target load reductions for the Cowskin Creek Watershed, based on the flow conditions provided in the table:

- TN - 197 pounds per day (lbs./day) or 71,923 pounds per year (lbs./yr.); an 18-percent reduction over existing loads
- TP - 150 pounds per day (lbs./day) or 54,670 pounds per year (lbs./yr.); a 65-percent reduction from existing loads
- TSS - 8.2 tons per day (tpd) or 2,990 tons per year (tpy); a 25-percent reduction from existing loads

The load reduction targets do not differentiate between urban and agricultural loads ("MS4" and "LA" in Table 6, above) because there is insufficient data attributing the observed concentrations to specific sources.

4.0 CRITCAL TARGETED AREAS

Using the TMDL documents' Source Inventory and Assessments as a starting point, critical areas were identified using a combination of water quality modeling and land use analysis. Water quality modeling was then used to determine the acreages of areas requiring treatment, by testing the required extent of treatment required to meet the load reduction targets. This process is described in the following sections.

4.1 WATER QUALITY MODELING

The Watershed Treatment Model (WTM; Center for Watershed Protection 2010) was selected for the critical areas analysis. WTM was developed for the U.S. Environmental Protection Agency (EPA) Region 5 and is used for developing TMDLs and water quality plans. WTM was selected because:

1) It evaluates the major impairments of this WRAPS effort (TN, TP, TSS);
2) It is a relatively simple spreadsheet-based model, and the level-of-effort required is well-matched to the limited modeling scope in this WRAPS effort;
3) WTM allows the testing of both structural and non-structural BMPs, including information and education (I&E), as well as operations and maintenance efforts;
4) The model is populated with default values for both pollutant generation and BMP effectiveness based on extensive national research, which is important where little or no local information is available or where data gaps exist;
5) Developed by the Center for Watershed Protection for EPA, it is a recognized and accepted model for these purposes.

WTM generates total annual pollutant load estimates in pounds for TN, TP, TSS; and total annual runoff volume. Loads are estimated for existing conditions, for existing conditions with future BMPs, and for future land use if desired. The estimated pollutant loads are used to see how existing conditions and potential BMP scenarios compare with a TMDL's LC, WLA, and LA requirements. The model allows the user to estimate potential load reductions and treatment area requirements by testing various BMPs and treatment acreage combinations until load reduction targets are met. Furthermore, the model allows the user to estimate the relative contributions of urban and rural areas, various land uses, and other contributing sources such as septic systems and sewer overflows.

WTM default values were used for this effort because little to no local data is available regarding concentrations of pollutants generated by various sources. Significant data gaps include:

1) Monitoring data to differentiate the actual concentrations of target pollutants originating from various point and non-point sources for model calibration; including but not limited to land uses, land management practices, stream bank erosion, septic systems, sewers, and agricultural activities and practices.

2) Local pollutant export estimates from various land uses, management practices, and activities.

3) Local estimates of the effectiveness of existing BMPs and I&E programs.

4) Information to identify livestock impact areas.

5) Estimates of agricultural BMPs applied in rural areas outside the Wichita city limits.

The lack of information described above could cause pollutant loads to be underestimated from some sources and overestimated from others, while the lack of

information regarding existing agricultural BMPs could cause some overestimation of pollutant loads from those areas.

WTM models were developed for targeted HUC 12 watersheds within the RiverCity WRAPS study area, to help determine the relative contributions of subwatersheds and specific land uses within the larger TMDL watersheds. Initial model results for TN, TP, and TSS concentrations appear to be within the correct order of magnitude based on available City and KDHE sampling data. Because default values were used in the modeling, uncertainties exist as noted above, and because much of the sampling data used for comparison are not flow-based, the modeling results provide at best a general estimate of total pollutant loads and concentrations for chemical pollutants. Despite these limitations, the results also provide at least a relative indication of pollutant sources, which is more detailed information than provided in the TMDL documents and is more detailed than has been developed by other WRAPS efforts in the state.

Evaluating bacteria loads is notoriously difficult as noted above; the impact of BMPs on bacteria impairments will be assessed by comparing monitoring results to the bacteria index used by KDHE to assess the relative frequency and magnitude of the bacteria concentrations at KDHE monitoring sites. See Section 9.1.2 for additional information.

Evaluation of the model results generally support the basic conclusions of the Source Assessment and Inventory sections of the TMDL documents, and KDHE's estimated load allocations. Average annual loads in the HUC 12 watersheds were estimated to be higher where rural land within the watershed is a greater percentage of the total watershed area. Urban areas were estimated to generate greater pollutant loadings per acre than rural areas. This is due to very high assumed loading rates from impervious surfaces and managed turf areas. Other assumed sources include wastewater contributions from sanitary sewer overflows (SSO) and wastewater treatment plant (WWTP) discharges, and septic systems to a lesser extent. However, the proportions of pollutants attributable to various point and nonpoint sources in both rural and urban may be less certain because of the data gaps noted above: the coincidence of high TP and bacteria concentrations indicates significant sources of animal or human waste, but the model attributes the majority of TP and TN concentrations to general land uses. Specifically, rural areas were estimated to have relatively high export rates for nutrients and TSS, and relatively low contributions from livestock or septic systems. Additional assessment of potential agricultural sources may help clarify these assumptions.

A detailed assessment of stream bank stability was beyond the scope of this effort. Therefore, WTM model defaults were used to estimate stream erosion. The WTM model estimates that stream channels contribute the most significant proportion of total sediment load in the urban areas due to stream bank erosion, and is estimated to have a significant impact on phosphorous loads. However, extensive regional and national studies have determined that habitat availability and quality, particularly in urban streams, plays a major role in presence or absence of macroinvertebrates that are sensitive to pollutants (a major component of the MBI assessment). More generally, water quality has been shown to be correlated with the quality and quantity of riparian corridor vegetation. Finally, recent research also indicates that decomposing leaf litter in urban areas may be a significant, and manageable, phosphorus source in urban and suburban areas. Additional stream assessment and yard waste management pilot testing will help the SLT verify or adjust the model results, as appropriate.

Because reliable load allocations are not feasible at this time, bacteria sources in both the Cowskin Creek and Arkansas River High-Priority TMDL watersheds should be

addressed indirectly by focusing on actions that are known to reduce bacteria loads, such as pet waste education and residential septic systems; and BMPs to address chemical pollutants that will also help to reduce bacteria loads. This approach is consistent with the recommended TMDL implementation measures, and with other WRAPS efforts. As with TSS, addressing sources of other contaminants will also help to reduce bacteria loads.

Based on this assessment, the WTM model results are suitable for screening and preliminary planning purposes, to estimate relative effectiveness of BMPs to meet required load reduction targets for chemical pollutants, and to identify source areas for bacteria. Additional assessment should be undertaken to more accurately determine the pollutant loads being generated by various rural and urban sources.

4.2 TARGETED AREAS

4.2.1 GYPSUM CREEK WATERSHED

Gypsum Creek Watershed (HUC 110300130101) occupies the east central area of the City of Wichita. Segment 5 of Gypsum Creek begins near 37th Street North and Webb Road, flowing southwesterly through the city to its confluence with the Arkansas River near 31st Street South and Kansas Highway 15 (K-15). Land use within the watershed is predominantly urban. Residential use comprises approximately 37 percent of the land use, followed by commercial (16 percent) and industrial (13 percent). Roads and streets account for up to 20 percent of the area. Approximately 9 percent of the land is considered rural with minor forest and open water area. Gypsum Creek is a highly visible stream, flowing through residential areas, parks, and commercial centers and is considered a high priority watershed by the SLT. The current and projected future land use in the Gypsum Creek watershed provide an excellent opportunity for evaluation of urban BMPs that will be applicable to all urban portions of the watershed. Table 1, page 7 summarizes land use in the Gypsum Creek watershed.

Although Gypsum Creek is not listed as an impaired stream and no TMDLs have been established for this stream, Segment 5 of Gypsum Creek is included as a tributary segment associated with the Arkansas River below Wichita TMDL for FCB. Implementation of BMPs in the Gypsum Creek watershed will positively affect water quality in the Arkansas River below Wichita.

A detailed urban stream restoration study was completed for a portion of Gypsum Creek in 2004 by the City of Wichita. This study included assessment of chemical, physical and biological characteristics of the stream. Although water quality parameters generally met water quality standards, concentrated amounts of salts and inorganic ions were indicated at base flow condition potentially stressing metabolic function of aquatic organisms and elevated levels of nutrients and chlorophyll *a* suggested eutrophic

conditions exist in the stream. Benthic macroinvertebrate (BMI) assessment indicated degraded biological integrity.

This study also developed detailed plans for demonstration projects to improve water quality, restore channel stability and enhance aquatic habitat and information education projects to enhance public awareness of issues affecting water quality.

4.2.2 COWSKIN CREEK WATERSHED

Cowskin Creek headwaters near Andale in northwestern Sedgwick County, flowing easterly through predominantly rural areas, then southeasterly through the western portion of the City of Wichita, where it joins Big Slough and the Wichita-Valley Center Floodway near 55th Street South and West Street. Cowskin Creek and it's tributary streams eventually join the Arkansas River near Derby. Land use in the watersheds is predominantly agricultural with cropland comprising 67 percent of the area. Urban land use comprises approximately 12 percent of land use, followed by non-native prairie (8%), prairie (6 %) and forest (3%). HUC 12 watersheds included in the targeted area include Headwaters Cowskin Creek (110300130102), Cadillac Lake-Cowskin (110300130103), Dry Creek-Cowskin (110300130104), Wichita Floodway (110300130105) and Wichita Valley Center Floodway (110300130106).

Two high priority TMDLs have been established for Cowskin Creek and its tributary segments to address FCB and biological nutrients impairments. Potential non-point pollutant sources include livestock waste, grazing or feeding operations near streams, run-off from cropland, failing on-site waste systems, urban contributions from impervious surfaces, pet waste, and increased run-off resulting from urban land development. Management practices and BMPs to address these sources include separation of livestock from streams, relocation of livestock watering and feeding areas, rotational grazing, nutrient management, installation of grass buffers and riparian corridor restoration. Implementation of BMPs in the Cowskin Creek watershed will directly address these TMDLs.

4.3 LOAD REDUCTION ESTIMATES

As described above, WTM estimates load reductions from various management practices, I&E efforts, and structural BMPs. The model estimates these load reductions directly based on the extent of the areas addressed, and performance data obtained from an extensive review of national data and studies. For this reason, WTM results were used to estimate potential load reductions from various BMPs, as described in the following section.

5.0 IMPAIRMENTS ADDRESSED BY THE SLT

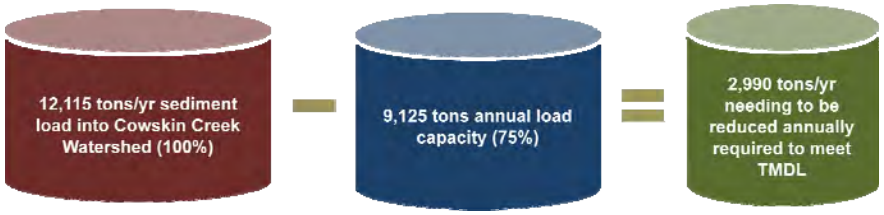
Based on the analysis described in previous sections, the SLT has determined to directly address the Biological and Bacteria impairments in the Cowskin Creek watershed and nutrients and TSS that are assumed to be contributing to biological impairment. Biological impairment will be addressed through TN, TP, and TSS load reduction targets. Based on conclusions presented in of the City of Wichita Water Quality Sutdy of The Arkansas River Phase 2 Report (HDR, 2004) ,addressing these impairments will also reduce bacteria loads and will positively affect other High and Medium Priority TMDLs and identified impairments (such TP and TSS), because many of the proposed BMPs are also effective in treating bacteria. The bacteria index is utilized by KDHE to assess the relative frequency and magnitude of the bacteria concentrations at KDHE monitoring sites, and will be used as a measure of progress toward meeting the Bacteria TMDL; see section 9.1.2 for a detailed discussion. TSS in particular is often used as a proxy for

addressing other surface water pollutants. This information is further supported by the U.S. Geological Survey publication titled *Regression Analysis and Real Time Monitoring to Estimate Constituent Concentrations, Loads, and Yields in the Little Arkansas River, south Central Kansas,* U.S.G.S Water Resources Investigations Report 00-4126,

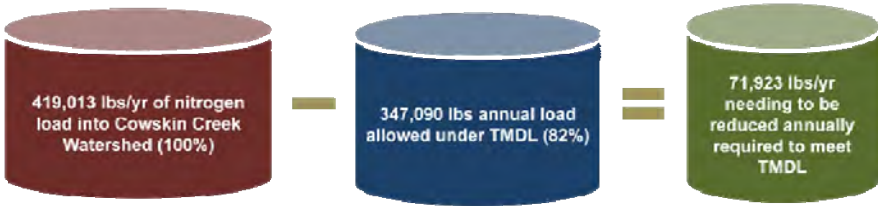
Current Targeted HUC 12 Watersheds:

Headwaters Cowskin Creek (110300130102)
Cadillac Lake-Cowskin (110300130103)
Dry Creek-Cowskin (110300130104)
Wichita Floodway (110300130105)
Wichita Valley Center Floodway (110300130106)

The current estimated sediment load from nonpoint sources in the Cowskin Creek watershed is 12,115 tons per year according to the Watershed Planning Section (TMDL) of KDHE. **The total annual load reduction allocated to Cowskin Creek needed to meet the Biological TMDL is 2,990 tons of sediment.** This is the amount of sediment that needs to be removed from the watershed and is the target of the BMP installations that will be placed in the watershed. These BMPs have been determined as feasible and approved by the SLT.

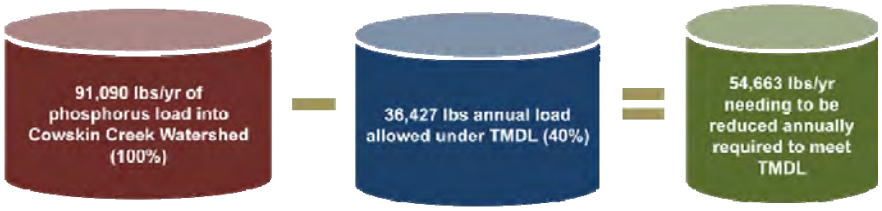


The current estimated nitrogen load from nonpoint sources in the Cowskin Creek watershed is 419,013 pounds per year according to the Watershed Planning Section (TMDL) of KDHE. **The total annual load reduction allocated to Cowskin Creek needed to meet the Biological TMDL is 71,923 pounds of nitrogen.** This is the amount of nitrogen that needs to be removed from the watershed and is the target of the BMP installations that will be placed in the watershed. These BMPs have been determined as feasible and approved by the SLT.



The current estimated phosphorus load from nonpoint sources in the Cowskin Creek watershed is 91,090 pounds per year according to the Watershed Planning Section (TMDL) of KDHE. **The total annual load reduction allocated to Cowskin Creek needed to meet the Biological TMDL is 54,663 pounds of phosphorus.** This is the amount of phosphorus that needs to be removed from the watershed and is the target of

the BMP installations that will be placed in the watershed. These BMPs have been determined as feasible and approved by the SLT.



Because rural areas currently make up such a large proportion of the land area and pollutant loads in the RiverCity WRAPS planning area, addressing rural contributions is critical to the overall health of the watersheds and to satisfying the TMDL requirements. However, the rural areas are outside of the City of Wichita's jurisdiction. Sedgwick County, the Cooperative Extension Service, Conservation District, outlying cities and towns, and other responsible parties will take the lead in addressing pollutants originating outside the Wichita city limits. The City and SLT will respond to possible partnerships with these entities when requested, and cooperate with the development of an overall approach to benefit overall watershed health.

To address the impairments that the SLT has selected, the project team evaluated the assumed pollutant sources and identified corresponding BMPs that could be successfully implemented to address these sources.

A number of BMPs were identified based on existing guidance, published effectiveness data, conversations with KDHE and with local practitioners, and the project team's experience and professional judgment. The initial BMPs included I&E and operations and maintenance (O&M) activities, as well as structural and nonstructural practices for both urban and rural areas. The project team used available geographic information systems (GIS) mapping of land uses, cover types, and other natural resources such as streams to estimate the extent that structural and nonstructural BMPs could be implemented throughout the targeted watersheds. WTM was then used to estimate the relative benefits of various BMPs and treatment acreages in reducing pollutant loads, and various combinations of BMPs were tested to determine which combinations would produce the required load reductions.

Based on the information currently available, meeting the required load reductions (particularly TP, which is present at relatively high concentrations and is difficult to address) will likely be a physically, socially, technically, and financially challenging undertaking. The highly complex combination of land uses and jurisdictions, sheer extent of BMPs that will likely be required, and the potential expense of

these efforts exacerbate the challenges. Initial order-of-magnitude cost estimates using treatment volumes from the WTM model and unit costs from similar projects studies in the region indicate that the cost of this program would run into the tens of millions of dollars (excluding land costs), as noted in Section 7.

For this reason the SLT proposes a 50-year implementation program based on an adaptive management approach. The first five years of the program would be used to conduct the following activities:

- Continue and expand I&E activities in conjunction with regional partners, including Sedgwick County, agricultural organizations, and environmental advocacy organizations.
- Pilot projects (described in the following section); to test the capital and life-cycle costs, savings, and pollutant reduction effectiveness of potential I&E, non-structural, and structural BMPs for application in the Gypsum and Cowskin Creek watersheds, and citywide.
- Address data gaps through carefully targeted studies, including but not limited to the following:
    - Additional pollutant source assessment by or in cooperation with rural partners to identify livestock impact areas, and other sources such as human waste management.
    - A detailed stream assessment to determine the actual pollutant contributions from stream bank failures and the effects that the presence or absence of aquatic habitat plays in the Biological impairment of Cowskin Creek; as well as opportunities to restore stream banks and riparian buffers.
    - BMP retrofit analysis to identify and evaluate the most feasible and effective locations for siting other structural BMPs.
- Continued water quality monitoring, including fixed sampling locations in key watershed areas and reaches as described in Section 10; and temporary monitoring of pilot projects to assist in determining their effectiveness.

The proposed implementation strategies for the remaining 45 years are more general in nature. The implementation program will be reassessed upon completion of the year 1 through 5 activities, and proposed I&E programs, structural, and non-structural BMPs will be adapted based on the lessons learned. Implementation will continue until the reduction targets are met or the impairments are otherwise addressed.

The implementation program is described in the following sections, and greater detail on the implementation schedule is provided in Section 8. The following table summarizes water bodies with established TMDLs in the RiverCity WRAPS service area.

TABLE 6: TMDLS FOR RIVERCITY WRAPS

Category	Main Stem Segments	Tributary Segments	TMDL Pollutant	End goal of TMDL	Priority	Sampling Location
4a	Cowskin segments 12, 13, 14 starting at confluence with the Big Slough River; Headwaters near Andale	Dry Creek (15, 16) Big Slough (11)	E. Coli Bacteria	Phase I endpoint to achieve SCR value of 2,000 colonies /100 ml Phase II will include PCR TMDL curve	High	SC288, SC702
4a	Cowskin segments 12, 13, 14 starting at confluence with the Big Slough River; Headwaters near Andale	Dry Creek (15, 16) Big Slough (11)	Biological Nutrient bundled with pH	Average Macroinvertebrate Biotic Index (MBI) 4.5 or less over 2006-2013.	High	SB346, SC730, SC288

Targeted stream segments are identified below on Figure 10.

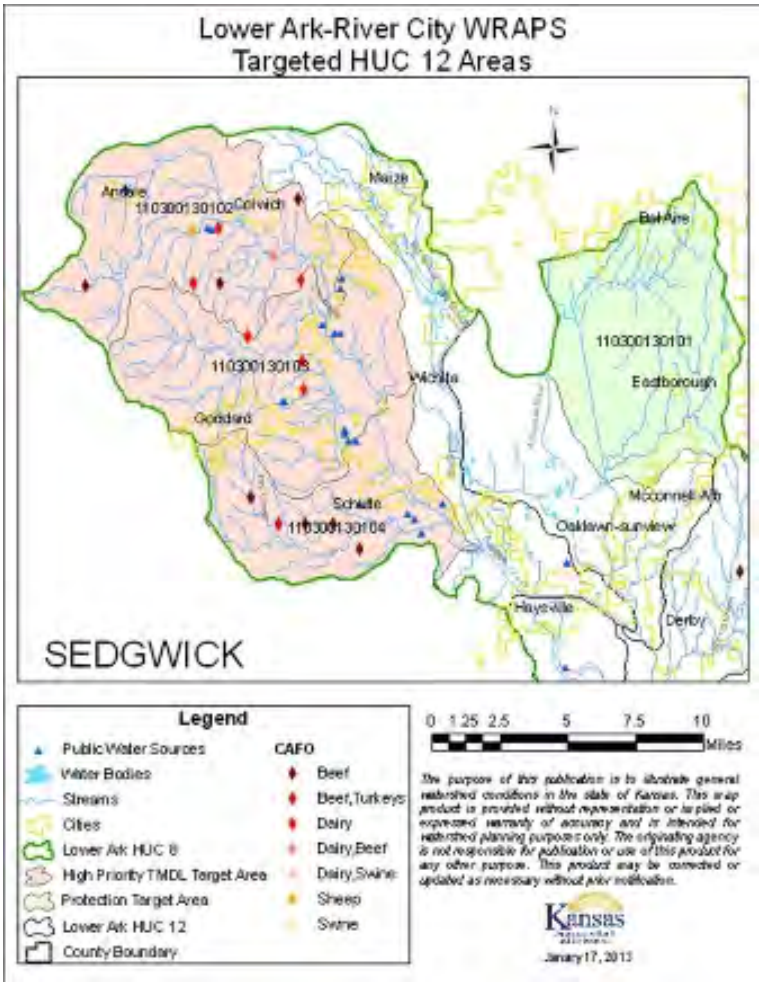


Figure 10 Cowskin Creek: TMDL Reference Map
Figure obtained from KDHE Bureau of Water, Watershed Planning and TMDL Program

5.1 GYPSUM CREEK WATERSHED

Improving the health of the Gypsum Creek watershed is a community and SLT priority. Although Gypsum Creek is not listed as water quality impaired, BMPs and I&E efforts will positively affect the Bacteria TMDL for the Lower Arkansas River south of Derby. Lessons learned from implementing pilot projects will also be applied to the Cowskin Creek watershed, described in Section 5.2.

The following tables illustrate potential BMPs that were evaluated for the Gypsum Creek watershed, and the initial 5-year implementation program.

TABLE 7: PROPOSED BMPS FOR THE GYPSUM CREEK WATERSHED

BMP	Description	TP Removal Efficiency	TN Removal Efficiency	TSS Removal Efficiency	FCB Removal Efficiency
Water Quality Swale	Native vegetation or bioswale designed to filter and infiltrate runoff	30%	25%	60%	0% direct removal; approx. 10% runoff reduction*
Extended Detention Basin**	Basin with native vegetation and a water quality stage to detain and slowly discharge runoff from the water quality storm	10 to 30%	15 to 50%	55 to 80 %	70% to 80%
Permanent Revegetation	Replacement of non-native lawns with native vegetation to infiltrate and filter runoff, and reduce maintenance inputs	50%	50%	75%	0% direct removal; approx. 50% runoff reduction*
Rain Garden or Bioretention	Vegetated depression that captures, filters, and infiltrates runoff; bioretention includes underdrain system	65%	55%	85%	90%
Stream bank Stabilization	Stream bank stabilized with vegetation or structural reinforcement to prevent erosion	Varies by Location and Bank Condition			
Stream and Lake Buffer	Riparian zone or lake perimeter vegetated with native grasses, trees, or shrubs to filter runoff and stabilize stream banks	50%	50%	85%	0% direct removal; approx. 62% runoff reduction***

Notes

Source: Watershed Treatment Model, 2010 Ed., Center for Watershed Protection

* Direct removal from runoff by treatment; runoff reduction reduces the total runoff volume, and therefore total pollutant loads.

** Higher removal rates are for wet extended detention

*** Direct removal from runoff by treatment; runoff reduction reduces the total runoff volume, and therefore total pollutant loads. Waterfowl deterrence not included in estimate.

Table 8: Proposed Gypsum Creek Implementation Program and Schedule (Years 1 Through 5)

BMP	Description	Year 1	Year 2	Year 3	Year 4	Year 5
Clean Water Neighborhood Challenge	Comprehensive down spout disconnection, lawn care & yard waste management, rain barrels and gardens	Edgemoor Park Neighborhood		To Be Determined		
Stream Buffers	15-foot native grass buffer to filter runoff, stabilize stream-banks, deter geese; no mowing, woody vegetation removal	Install buffer in Edgemoor Park	1 mile City stream bank	Install in Clean Water Neighborhood (TBD)		
Rain Gardens and Bio-retention	Vegetated depression that captures, filters, and infiltrates runoff	Disconnect downspout & rain garden at Edgmoor Park Community Center		Bioretention on City property in Clean Water Neighborhood		
Permanent Revegetation	Replace non-native lawns with native vegetation; monitor maintenance savings and runoff reduction		5 Acres			
Water Quality Monitoring	Short-term, periodic monitoring of runoff volume and water quality downstream of BMP installations		Downstream of permanent revegation area	Downstream of Blue Water Neighborhood	Down-stream of permanent revegation area	Prepare to install improved monitoring network
Water Quality Swale	Native vegetation swale to slow, filter, and infiltrate runoff				Install 600 feet along City right-of-way	
Stream bank Stabilization	Flood terraces, wetland restoration, stream bank stabilization, vegetated buffer installation					0.75 Miles
Additional Analysis	Assessment and analysis to further evaluate problems, fine-tune solutions & budget		Stream and riparian buffer analysis			Revise Nine Critical Element Plan

Notes:

Detention practices, rain gardens and bioretention effectively treat bacteria, while runoff reduction from other practices (water quality swales and grassed waterways, terraces and filter strips, stream buffers) reduce runoff and resulting total pollutant loads. Collectively these BMPs will positively affect bacteria concentrations in the Lower Arkansas River below Derby.

5.2 COWSKIN CREEK WATERSHED

The following tables illustrate potential agricultural and urban BMPs that were evaluated for the Cowskin Creek watershed, and the potential land cover for application of agricultural BMPs (Table 10, Kansas Applied Remote Sensing Program of the Kansas Biological Survey, University of Kansas and "Rural" land use category; Source: Sedgwick County, Kansas). I&E practices are described in greater detail in Section 6.0.

TABLE 9: PROPOSED AGRICULTURAL BMPS - COWSKIN CREEK TARGETED AREAS DIRECTLY ADDRESSING TMDLS - COWSKIN CREEK HUC 12S

BMP	Description	TP Removal Efficiency	TN Removal Efficiency	TSS Removal Efficiency	FCB Removal Efficiency
Relocate Livestock Feeding Stations	Relocation of animal feed lots away from streams, and establishment of vegetated buffer.	30-80%	30-80%	Not determined, but potentially significant	Not determined, but potentially significant
Relocate Winter Feed Sites	Relocation of winter feed sites away from streams.	30-80%	30-80%	Not determined, but potentially significant	Not determined, but potentially significant
Restrict livestock access to waterways	Alternative watering sites away streams or ponds / Fencing stream or ponds to prevent livestock from entering.	95%	95%	Not determined, but potentially significant	Not determined, but potentially significant
No Till / Nutrient Management / Crop Rotation (Crop Land)	Comprehensive program of No Till farming, nutrient management plans, and crop rotation.	67%	58%	85%	0%
Terraces and Grassed Waterways (Crop Land)	Vegetated terraces and drainage ways that slow, filter, and infiltrate runoff	58%	58%	58%	0% direct removal; approx. 10% runoff reduction*
Stream Buffer	Riparian zone vegetated with native grasses, trees, or shrubs to filter runoff and stabilize stream banks	57-74%	50-67%	63-78%	- 15 to 47% direct removal; approx. 10% runoff reduction*
Information/ Education	Provide I&E on the effectiveness, and feasibility of the above BMPs; available cost-share programs	Varies			

Sources: US EPA Menu of BMPs; KSU Research and Extension
Sedgwick County Conservation District; (www.sedgwickcounty.org/conservation/nps.html)
Watershed Treatment Model 2010 Ed., Center for Watershed Protection

TABLE 10: AGRICULTURAL LAND COVER FOR BMP APPLICATION - COWSKIN CREEK TARGETED AREAS DIRECTLY ADDRESSING TMDLS - COWSKIN CREEK HUC 12S

Cover (Acres)	HUC 12				TOTAL
	110300130102	110300130103	110300130104	110300130105	
Crop Land[a]	21,700	12,151	10,288	6,725	50,864
Pasture[a]	10,221	10,586	6,150	8,529	35,486
TOTAL[b]	31,921	22,737	16,438	15,254	86,350

Note:

a Source: Kansas Applied Remote Sensing Program of the Kansas Biological Survey, University of Kansas

b "Rural" land use category; Source: Sedgwick County, Kansas. Note: Cropland and Pasture include potential stream buffer acreage.

TABLE 11: PROPOSED URBAN BMPS - COWSKIN CREEK TARGETED AREAS DIRECTLY ADDRESSING TMDLS - COWSKIN CREEK HUC 12S

BMP	Description	TP Removal Efficiency	TN Removal Efficiency	TSS Removal Efficiency	FCB Removal Efficiency
Water Quality Swale	Native vegetation or bioswale designed to filter and infiltrate runoff	30%	25%	60%	0% direct removal; approx. 10% runoff reduction*
Extended Detention Basin**	Basin with native vegetation and a water quality stage to detain and slowly discharge runoff from the water quality storm	10 to 30%	15 to 50%	55 to 80 %	70% to 80%
Permanent Revegetation	Replacement of non-native lawns with native vegetation to infiltrate and filter runoff, and reduce maintenance inputs	50%	50%	75%	0% direct removal; approx. 50% runoff reduction*
Rain Garden or Bioretention	Vegetated depression that captures, filters, and infiltrates runoff; bioretention includes underdrain system.	65%	55%	85%	90%
Stream bank Stabilization	Stream bank stabilized with vegetation or structural reinforcement to prevent erosion	Varies by Location and Bank Condition			
Stream and Lake Buffer	Riparian zone or lake perimeter vegetated with native grasses, trees, or shrubs to filter runoff and stabilize stream banks	50%	50%	85%	0% direct removal; approx. 62% runoff reduction***

Notes

Source: Watershed Treatment Model, 2010 Ed., Center for Watershed Protection

* Direct removal from runoff by treatment; runoff reduction reduces the total runoff volume, and therefore total pollutant loads.

** Higher removal rates are for wet extended detention

*** Direct removal from runoff by treatment; runoff reduction reduces the total runoff volume, and therefore total pollutant loads. Waterfowl deterrence not included in estimate.

The following tables provide a detailed listing of activities over the first 5 years of the program, followed by BMP implementation and pollution reduction estimates over the 50-year implementation program for the Cowskin Creek watershed. I&E activities will be conducted citywide as well as being targeted specifically in the Cowskin Creek watershed, and reflect the combined efforts of the City, Sedgwick County Stormwater Management Program, and other planned watershed education initiatives; these are described in greater detail in section 6.0. The extent of physical BMP implementation opportunities is based on GIS analysis of existing land uses and natural resources; the extent of implementation required to address TP loadings in particular; and assumed adoption rates over the 50-year program period. The WTM model was used to determine the extent of BMPs needed to meet the load reductions. Selected urban and agricultural BMPs were tested on increasing acreages of various land uses until the cumulative load reduction targets were met in a realistic and feasible manner. The assessment is based on existing land use acreages for 2012.

TABLE 12: PROPOSED COWSKIN CREEK IMPLEMENTATION PROGRAM AND SCHEDULE (Years 1 through 5)
TARGETED AREAS DIRECTLY ADDRESSING TMDLS - COWSKIN CREEK HUC 12S

BMP	Description	Year 1	Year 2	Year 3	Year 4	Year 5
Blue Water Neighborhood	Comprehensive down spout disconnection, lawn care & yard waste management, rain barrels and gardens		To Be Determined			
Stream Buffers	15-foot native grass buffer to filter runoff, stabilize stream banks, deter geese; no mowing, woody vegetation removal	1 mile City stream bank	Install in Blue Water Neighbor-hood (TBD)	1 mile City stream bank		
Rain Gardens and Bio-retention	Vegetated depression that captures, filters, and infiltrates runoff		Bioretention on City property in Clean Water Neighborhood			
Permanent Revegetation	Replace non-native lawns with native vegetation; monitor maintenance savings and runoff reduction	5 Acres		5 Acres		
Water Quality Monitoring	Short-term, periodic monitoring of runoff volume and water quality downstream of BMP installations.		Downstream of permanent revegation area	Downstream of Blue Water Neighbor-hood	Downstream of permanent revegation area	Prepare to install improved monitoring network
Water Quality Swale	Native vegetation swale to slow, filter, and infiltrate runoff				Install 600 feet along City right-of-way.	
Extended Detention Basin	Construct or retrofit existing basin with water quality stage, outlet, & native vegetation					Retrofit existing detention basin

BMP	Description	Year 1	Year 2	Year 3	Year 4	Year 5
Additional Analysis	Assessment and analysis to further evaluate problems, fine-tune solutions & budget		Stream and riparian buffer analysis	BMP Locator model and analysis	Agricultural source assessment and model	Revise Nine Critical Element Plan

TABLE 13: PROPOSED COWSKIN CREEK URBAN BMP IMPLEMENTATION (YEARS 6 THROUGH 50)
TARGETED AREAS DIRECTLY ADDRESSING TMDLS - COWSKIN CREEK HUC 12S

Year	Stream Buffers (Acres)	Streambank Stabilization (Miles)	Permanent Revegetation (Acres)	Commercial Bioretention (Acres)	Water Quality Swales (Acres)	Residential Rain Gardens (Acres)	Pond and Lake Buffers (Acres)	Detention/ Retention (Acres)
6	22		67				56	262
7	22		67				56	262
8	22		67				56	262
9	22		67				56	262
10	22		67				56	262
11	22		67				56	262
12	22		67				56	262
13	22		67				56	262
14	22		67				56	262
16	22		67				56	262
17	22		67				56	262
18	22		67				56	262
19	22		67				56	262
20	22		67				56	262
21	22	3	67	14	50	98	56	
22	22	3	67	14	50	98	56	
23	22	3	67	14	50	98	56	
24	22	3	67	14	50	98	56	
25	22	3	67	14	50	98	56	
26		3		14	50	98		
27		3		14	50	98		
28		3		14	50	98		
29		3		14	50	98		
30		3		14	50	98		
31		3		14	50	98		
32		3		14	50	98		
33		3		14	50	98		
34		3		14	50	98		
35		3		14	50	98		

Year	Stream Buffers (Acres)	Streambank Stabilization (Miles)	Permanent Revegetation (Acres)	Commercial Bioretention (Acres)	Water Quality Swales (Acres)	Residential Rain Gardens (Acres)	Pond and Lake Buffers (Acres)	Detention/ Retention (Acres)
36		3		14	50	98		
37		3		14	50	98		
38		3		14	50	98		
39		3		14	50	98		
40		3		14	50	98		
41		3		14	50	98		
42		3		14	50	98		
43		3		14	50	98		
44		3		14	50	98		
45		3		14	50	98		
46		3		14	50	98		
47		3		14	50	98		
48		3		14	50	98		
49		3		14	50	98		
50		3		14	50	98		
TOTAL	436	96	1,338	410	1,489	2,946	1,117	16,427

Note: Stream buffer acres were determined by estimating the number of stream miles that are not currently buffered with vegetation, and then applying a standard buffer width on each side of the stream to the currently un-buffered stream miles. Current land use was not considered because of the relatively narrow buffer width, and because acres of stream buffer are relatively small compared with total available land.

TABLE 14: PROPOSED AGRICULTURAL BMP IMPLEMENTATION - COWSKIN CREEK TARGETED AREAS DIRECTLY ADDRESSING TMDLS - COWSKIN CREEK HUC 12S

Year	Stream Buffers (Acres)	Livestock Practices (Operations / Average AUs)*	No Till/ Nutrient Management/ Crop Rotation (Acres)	Terraces and Grassed Waterways (Acres)	Streambank Stabilization (Miles)
1	25	1 / 228	327	305	0
2	25		327	305	0
3	25		327	305	0
4	25		327	305	0
5	25		327	305	0
6	25	1 / 228	327	305	0
7	25		327	305	0
8	25		327	305	0
9	25		327	305	0
10	25		327	305	0
11	25	1 / 228	327	305	0
12	25		327	305	0
13	25		327	305	0
14	25		327	305	0
15	25		327	305	0
16	25	1 / 228	327	305	0
17	25		327	305	0
18	25		327	305	0
19	25		327	305	0
20	25		327	305	0

Year	Stream Buffers (Acres)	Livestock Practices (Operations / Average AUs)*	No Till/ Nutrient Management/ Crop Rotation (Acres)	Terraces and Grassed Waterways (Acres)	Streambank Stabilization (Miles)
21	25	1 / 228	327	305	12
22	25		327	305	12
23	25		327	305	12
24	25		327	305	12
25	25		327	305	12
26	25	1 / 228	327	305	12
27	25		327	305	12
28	25		327	305	12
29	25		327	305	12
30	25		327	305	12
31	25	1 / 228	327	305	12
32	25		327	305	12
33	25		327	305	12
34	25		327	305	12
35	25		327	305	12
36	25	1 / 228	327	305	12
37	25		327	305	12
38	25		327	305	12
39	25		327	305	12
40	25		327	305	12
41	25	1 / 228	327	305	12
42	25		327	305	12
43	25		327	305	12
44	25		327	305	12
45	25		327	305	12
46	25	1 / 228	327	305	12
47	25		327	305	12
48	25		327	305	12
49	25		327	305	12
50	25		327	305	12
TOTAL	1,255	10 / 2,280	16,344	15,259	345

Notes: Stream buffer acres were determined by estimating the number of stream miles that are not currently buffered with vegetation, and then applying a standard buffer width on each side of the stream to the currently unbuffered stream miles. Current land use was not considered because of the relatively narrow buffer width, and because acres of stream buffer are relatively small compared with total available land.

* Includes relocating feed lots and winter feed sites, alternative feeding and watering with fenced streams.

AU Animal Unit

TABLE 15: ESTIMATED TN LOAD REDUCTIONS
TARGETED AREAS DIRECTLY ADDRESSING TMDLS - COWSKIN CREEK HUC 12S

Additive Annual TN Reduction, All BMPs					
Year	Agricultural BMPs (pounds)	Information/ Education (pounds)	Urban BMPs (pounds)	Cumulative Annual Load Reduction (pounds)	Percent of Load Reduction Target
1	14,155	401	0	14,556	27%
2	16,040	802	0	16,842	31%
3	17,925	1,203	0	19,128	35%
4	19,811	1,604	0	21,415	39%
5	21,696	2,005	0	23,701	43%
6	36,127	2,406	967	39,501	72%
7	38,290	2,807	1,934	43,031	79%
8	40,452	3,208	2,902	46,562	85%
9	42,614	3,609	3,869	50,092	92%
10	44,776	4,010	23,136	71,923	132%*
Subtotal Year 1-10	44,776	4,010	23,136	71,923	132%*
11	59,208	4,411	24,103	87,722	160%
12	61,370	4,812	25,071	91,253	167%
13	63,532	5,213	26,038	94,783	173%
14	65,695	5,614	27,005	98,314	180%
15	67,857	6,015	27,972	101,844	186%
16	82,289	6,416	28,939	117,644	215%
17	84,451	6,817	29,907	121,175	222%
18	86,613	7,218	30,874	124,705	228%
19	88,775	7,619	31,841	128,235	235%
20	90,938	8,020	32,808	131,766	241%
Subtotal Year 11-20	90,938	8,020	32,808	131,766	241%
21	105,369	8,421	34,614	148,405	271%
22	107,531	8,822	36,421	152,774	279%
23	109,694	9,223	38,227	157,144	287%
24	111,856	9,624	40,033	161,513	295%
25	114,018	10,025	41,839	165,883	303%
26	128,450	10,426	42,862	181,738	332%
27	130,612	10,827	43,885	185,325	339%
28	132,774	11,228	44,908	188,911	346%
29	134,936	11,629	45,931	192,497	352%
30	137,099	12,030	46,954	196,083	359%
Subtotal Year 21-30	137,099	12,030	46,954	196,083	359%

Additive Annual TN Reduction, All BMPs (Continued)					
Year	Agricultural BMPs (pounds)	Information/ Education (pounds)	Urban BMPs (pounds)	Cumulative Annual Load Reduction (pounds)	Percent of Load Reduction Target
31	151,530	12,431	47,977	211,939	388%
32	153,692	12,832	49,000	215,525	394%
33	155,855	13,233	50,023	219,111	401%
34	158,017	13,634	51,046	222,697	407%
38	178,935	15,239	55,137	249,311	456%
39	181,098	15,640	56,160	252,897	463%
40	183,260	16,041	57,183	256,483	469%
31	151,530	12,431	47,977	211,939	388%
32	153,692	12,832	49,000	215,525	394%
33	155,855	13,233	50,023	219,111	401%
Subtotal Year 31-40	183,260	16,041	57,183	256,483	469%
41	197,691	16,442	58,206	272,339	498%
42	199,854	16,843	59,229	275,925	505%
43	202,016	17,244	60,252	279,511	511%
44	204,178	17,645	61,275	283,097	518%
45	206,340	18,046	62,298	286,684	524%
46	220,772	18,447	63,320	302,539	553%
47	222,934	18,848	64,343	306,125	560%
48	225,096	19,249	65,366	309,711	567%
49	227,259	19,650	66,389	313,298	573%
50	229,421	20,051	67,412	316,884	580%
TOTAL	229,421	20,051	67,412	316,884	580%

Notes: Total Load Reduction Target: 71,923 Pounds per Year; * denotes year that target would be met.
BMPs also positively affect Bacteria loads

TABLE 16: ESTIMATED TP LOAD REDUCTIONS
Targeted Areas Directly Addressing TMDLs - Cowskin Creek HUC 12s

Additive Annual TP Reduction, All BMPs					
Year	Agricultural BMPs (pounds)	Information/ Education (pounds)	Urban BMPs (pounds)	Cumulative Annual Load Reduction (pounds)	Percent of Load Reduction Target
1	1,777	20	0	1,797	3%
2	2,153	39	0	2,192	4%
3	2,528	59	0	2,587	5%
4	2,903	79	0	2,982	5%

Additive Annual TP Reduction, All BMPs					
Year	Agricultural BMPs (pounds)	Information/ Education (pounds)	Urban BMPs (pounds)	Cumulative Annual Load Reduction (pounds)	Percent of Load Reduction Target
5	3,278	98	0	3,377	6%
6	5,056	118	200	5,373	10%
7	5,431	137	400	5,968	11%
8	5,806	157	599	6,563	12%
7	5,431	137	400	5,968	11%
8	5,806	157	599	6,563	12%
Subtotal Year 1-10	6,557	196	6,988	13,741	25%
11	8,334	216	7,188	15,738	29%
12	8,709	236	7,388	16,333	30%
13	9,085	255	7,587	16,927	31%
14	9,460	275	7,787	17,522	32%
15	9,835	295	7,987	18,116	33%
16	11,612	314	8,187	20,113	37%
17	11,988	334	8,386	20,708	38%
18	12,363	353	8,586	21,303	39%
19	12,738	373	8,786	21,897	40%
20	13,113	393	8,986	22,492	41%
Subtotal Year 11-20	13,113	393	8,986	22,492	41%
21	15,074	412	9,338	24,824	45%
22	15,632	432	9,690	25,753	47%
23	16,190	452	10,041	26,683	49%
24	16,748	471	10,393	27,612	51%
25	17,306	491	10,745	28,542	52%
26	19,266	511	10,950	30,726	56%
27	19,824	530	11,154	31,508	58%
28	20,382	550	11,359	32,291	59%
29	20,940	569	11,564	33,073	61%
30	21,498	589	11,768	33,855	62%
Subtotal Year 21-30	21,498	589	11,768	33,855	62%
31	23,458	609	11,973	36,040	66%
32	24,016	628	12,177	36,822	67%
33	24,574	648	12,382	37,604	69%
34	25,132	668	12,587	38,386	70%

Additive Annual TP Reduction, All BMPs					
Year	Agricultural BMPs (pounds)	Information/ Education (pounds)	Urban BMPs (pounds)	Cumulative Annual Load Reduction (pounds)	Percent of Load Reduction Target
35	25,690	687	12,791	39,169	72%
36	27,650	707	12,996	41,353	76%
37	28,208	727	13,201	42,135	77%
38	28,766	746	13,405	42,918	79%
39	29,324	766	13,610	43,700	80%
40	29,882	785	13,814	44,482	81%
Subtotal Year 31-40	29,882	785	13,814	44,482	81%
41	31,843	805	14,019	46,667	85%
42	32,401	825	14,224	47,449	87%
43	32,959	844	14,428	48,231	88%
44	33,517	864	14,633	49,013	90%
45	34,075	884	14,837	49,796	91%
46	36,035	903	15,042	51,980	95%
47	36,593	923	15,247	52,762	97%
48	37,151	943	15,451	53,545	98%
49	37,709	962	15,656	54,327	99%
50	38,267	982	15,860	55,109	101%*
TOTAL	38,267	982	15,860	55,109	101%*

Notes: Total Load Reduction Target: 54,663 Pounds per Year; * denotes year that target would be met.
BMPs also positively affect FCB loads

TABLE 17: ESTIMATED TSS LOAD REDUCTIONS

Targeted Areas Directly Addressing TMDLs - Cowskin Creek HUC 12s

Additive Annual TSS Reduction (tons), All BMPs					
Year	Agricultural BMPs (tons)	Information/ Education (tons)	Urban BMPs (tons)	Cumulative Annual Load Reduction (tons)	Percent of Load Reduction Target
1	27	1	0	27	1%
2	53	1	0	55	2%
3	80	2	0	82	3%
4	106	3	0	109	4%
5	133	3	0	136	5%
6	160	4	22	186	6%
7	186	5	44	235	8%
8	213	5	65	284	9%

Additive Annual TSS Reduction (tons), All BMPs					
Year	Agricultural BMPs (tons)	Information/ Education (tons)	Urban BMPs (tons)	Cumulative Annual Load Reduction (tons)	Percent of Load Reduction Target
9	240	6	87	333	11%
10	266	7	655	928	31%
Subtotal Year 1-10	266	7	655	928	31%
11	293	7	677	977	33%
12	319	8	699	1027	34%
13	346	9	721	1076	36%
14	373	9	743	1125	38%
15	399	10	765	1174	39%
16	426	11	786	1223	41%
17	452	11	808	1272	43%
18	479	12	830	1321	44%
19	506	13	852	1370	46%
20	532	14	874	1419	47%
Subtotal Year 11-20	532	14	874	1419	47%
21	628	14	915	1557	52%
22	724	15	956	1695	57%
23	820	16	998	1833	61%
24	916	16	1039	1971	66%
25	1012	17	1080	2109	71%
26	1107	18	1111	2236	75%
27	1203	18	1142	2364	79%
28	1299	19	1173	2491	83%
29	1395	20	1204	2619	88%
30	1491	20	1235	2746	92%
Subtotal Year 21-30	1491	20	1235	2746	92%
31	1587	21	1266	2874	96%
32	1682	22	1297	3001	100%*
33	1778	22	1328	3129	105%
34	1874	23	1359	3257	109%
35	1970	24	1390	3384	113%
36	2066	24	1421	3512	117%
37	2162	25	1452	3639	122%
38	2258	26	1484	3767	126%
39	2353	26	1515	3894	130%
40	2449	27	1546	4022	135%

Additive Annual TSS Reduction (tons), All BMPs					
Year	Agricultural BMPs (tons)	Information/ Education (tons)	Urban BMPs (tons)	Cumulative Annual Load Reduction (tons)	Percent of Load Reduction Target
Subtotal Year 31-40	2449	27	1546	4022	135%
41	2545	28	1577	4149	139%
42	2641	28	1608	4277	143%
43	2737	29	1639	4405	147%
44	2833	30	1670	4532	152%
45	2929	30	1701	4660	156%
46	3024	31	1732	4787	160%
47	3120	32	1763	4915	164%
48	3216	32	1794	5042	169%
49	3312	33	1825	5170	173%
50	3408	34	1856	5297	177%
TOTAL	3408	34	1856	5297	177%

Notes:
Total Load Reduction Target: 2,990 Tons per Year; * denotes year that target would be met.
Detention practices, rain gardens and bioretention effectively treat bacteria, while runoff reduction from other practices (water quality swales and grassed waterways, terraces and filter strips, stream buffers) reduce runoff and resulting total pollutant loads. Collectively these BMPs will positively affect bacteria concentrations.

Additional implementation strategies and assumptions include the following.

I&E activities are ongoing and will increase in the future, as the Sedgwick County Stormwater Management Program has begun annual watershed education in Spring 2012.

Although the extent of existing agricultural BMPs is unknown, outreach efforts are underway by Sedgwick County Cooperative Extension and the Sedgwick County Conservation District, among others. These activities will continue during the 50-year program period, with coordination and cooperation from the City and SLT. Other approved WRAPS projects assume a 40-percent adoption rate for agricultural BMPs over a 20-year program period; the SLT assumes that a 60-percent adoption rate is realistic over 50 years.

The program will initially focus on highly cost-effective BMPs such as permanent

conversion of managed turf to native vegetation; installations of stream buffers and filter strips; and disconnection of impervious surfaces. These BMPs will have low initial capital costs and labor requirements that may be offset by volunteer labor; and reductions in net O&M costs will help offset the costs of more capital-intensive BMPs proposed for later years.

A number of planned detention and retention basins will be implemented for flood damage reduction, and will incorporate a water quality stage. Proposed funding from the Sedgwick County Stormwater Management Program will make these basins possible.

As with agricultural BMPs, the extensive implementation required for many urban BMPs will be achieved systematically over a 50-year period. Some BMPs, particularly rain gardens or bioretention, may be incorporated as existing parking and landscapes require renovation.

The voluntary application of other BMPs, such as pervious pavement, will be encouraged. Some or all of these additional BMPs may be incorporated into the implementation plan as their cost-effectiveness is determined.

Additional information on estimated load reduction estimates by impairment and BMP are provided in the appendix.

6.0 INFORMATION AND EDUCTATION

6.1 INFORMATION AND EDUCATION ACTIVITIES AND EVENTS

Demographics and watershed issues associated with the urban portions of the RiverCity WRAPS present unique circumstances and challenges. Development of effective community outreach, I&E programs require a significantly higher level of effort to reach the larger and more diverse populations of a metropolitan area. Rural areas currently make up a large proportion of the land area contributing to pollutant loads in the Cowskin watersheds.

Therefore, addressing rural contributions is also a critical element of the RiverCity WRAPS project. Many watershed concerns and issues, both urban and rural, identified by the SLT are directly related to common property maintenance and agricultural practices of individual property owners. I&E targeting modification of these activities is expected to

have a significant effect on water quality within the watershed. Adoption rates and implementation of these practices will be highly dependent on effective I&E programs designed to increase public awareness regarding the positive influence achievable through the actions of individuals.

Significant I&E efforts planned for implementation in the first 5 years of this WRAPS include the Clean Water Neighborhood Challenge, a program developed by RiverCIty WRAPS to educate and recognize residents regarding opportunities to improve the health of their watershed. Homeowners in targeted neighborhoods will be encouraged to implement simple, yet scientifically accepted, practices that reduce runoff and resulting pollutant loads starting on their own properties. Rather than focusing on one specific practice, the program is intended to offer homeowners a menu of residential BMP choices.

The SLT has selected the Edgemoor Park area, located in the Gypsum Creek watershed as a pilot neighborhood. The pilot neighborhood is located on the East Branch Dry Creek of Gypsum Creek, north of Edgemoor Park. Adjacent Edgemoor Park provides the opportunity for implementation of larger scale pilot BMP projects on publically owned property creating an excellent opportunity to evaluate the effectiveness of both residential scale and larger scale BMPs. The target area is generally bound on the north by East 13th Street North, on the south by East 9th Street North, on the east by Farmstead Street and on the west by North Ridgewood Street. Edgemoor Park is adjacent south of East 9th Street.

Table 18 summarizes information and education targeting implementation, operation and maintenance of planned BMPs.

TABLE 18: INFORMATION AND EDUCATION IN SUPPORT OF BMPS

I&E Practice	Description	Existing	Planned	Target Audience	RiverCity WRAPS Partnerships
Low-Input Lawn Care and Yard Waste Management	Grasscycling, leaf litter management, reduced fertilizer and pesticides, native lawn conversion	Web site, water bill inserts, exhibits, presentations	Increased outreach, multimedia advertising, and targeted pilot areas	City and County residential, HOA, Neighborhood Associations	City of Wichita, Sedgwick County, WIRE
Impervious Surface Disconnect / Rain Garden Education	Design and installation guidance for residential and commercial property	Web site, water bill inserts, exhibits, presentations	Increased outreach, multimedia advertising, and targeted pilot areas	City and County residential, HOA, Neighborhood Associations	City of Wichita, Sedgwick County, WIRE
Commercial BMP Education	Design, installation, and cost/benefit for rain gardens, bio-retention, pervious pavement, downspout disconnection	Presentations, BMP demonstration projects	Multimedia advertising; workshops; training; volunteer installations of each commercial BMP type	Commercial and residential property developers, commercial property owners	City of Wichita, Sedgwick County SMP, WIRE, Visioneering, REAP
Agricultural BMP Education	Planning, design, installation of agricultural BMPs; cost/benefit and cost-share programs	Brochures, web sites, presentations	Multimedia advertising; workshops; training; volunteer installations of each agricultural BMP type	Rural Sedgwick County / agricultural producers	Sedgwick County Extension / Conservation District, Sedgwick County, NRCS

Notes:

BMP Best Management Practice
HOA Homeowners Association
NRCS Natural Resources Conservation Service
WIRE Wichita Imitative to Renew the Environment

Table 19 summarizes information and education activities intended to promote watershed awareness and public participation in the WRAPS process.

TABLE 19: INFORMATION AND EDUCATION IN SUPPORT OF PUBLIC AWARENESS AND PARTICIPATION

I&E Practice	Description	Existing	Planned	Target Audience	RiverCity WRAPS Partnerships
Pet Waste Education	Proper residential and public pet waste disposal	Web site, water bill inserts, exhibits, presentations	Increased outreach, and multimedia advertising, and targeted pilot areas	City and County residential, HOA, neighborhood associations	City of Wichita, Sedgwick County, WIRE, WIN
Septic System Education and Enforcement	Proper septic system operation, maintenance and repair; eventual replacement	Web site, water bill inserts, inspections and enforcement	Increased outreach, multimedia advertising	Rural and suburban property owners w/o POTW connection	City of Wichita, Sedgwick County, WIRE, Sedgwick County Extension
Low-Input Lawn Care	Grasscycling, leaf litter management, reduced fertilizer and pesticides, native lawn conversion	Web site, water bill inserts, exhibits, presentations	Increased outreach, multimedia advertising, and targeted pilot areas	City and County residential, HOA, neighborhood associations	City of Wichita, Sedgwick County SMP, WIRE, WIN
Impervious Surface Disconnection / Rain Garden Education	Design and installation guidance for residential and commercial property	Web site, water bill inserts, exhibits, presentations	Increased outreach, multimedia advertising, and targeted pilot areas	City and County residential, HOA, neighborhood associations	City of Wichita, Sedgwick County SMP, WIRE, WIN
Agricultural BMP Education	Planning, design, installation of agricultural BMPs; cost/benefit and cost-share programs	Brochures, web sites, presentations	Multimedia advertising; workshops; training; volunteer installations of each agricultural BMP type	Rural Sedgwick County / agricultural producers	Sedgwick County Extension / Conservation District, Sedgwick County Stormwater Management Program, NRCS
Earth Day Presentation	General Watershed Awareness	Earth Day Booth with Presentation	Earth Day Booth with Presentation	General public and elementary/ middle schools	City of Wichita, WIRE, Sedgwick County Extension
Blue Water Neighbor Program	Comprehensive impervious surface disconnection /rain garden education, low-input lawn care, yard and pet waste management, in targeted neighborhoods		Pilot project in Edgemoor neighborhood, recruitment of additional neighborhood associations and HOAs	HOA and neighborhood associations within Wichita city limits	WIRE, WIN, City of Wichita

Notes:

BMP Best Management Practice
HOA Homeowners Association
NRCS Natural Resources Conservation Service
POTW Publicly-owned Treatment Works
WIN Wichita Independent Neighborhoods
WIRE Wichita Imitative to Renew the Environment

6.2 EVALUATION OF INFORMATION AND EDUCATION EFFORTS

Information and Education activities funded through the RiverCity WRAPS will be required to include a program evaluation component designed to assess program effectiveness. Although evaluation methods may vary from program to program, all projects must, at a minimum, include participant learning objectives and estimate outcomes relative to behavior changes and BMP adoption rates expected to result from the information and education activities. Service providers will be required to submit written evaluations of their activities summarizing participation rates, demonstrating successful delivery of learning objectives and progress toward achieving WRAPS goals and objectives.

7.0 COSTS OF IMPLEMENTING BMPS AND POSSIBLE FUNDING SOURCES

The total estimated cost of the 50-year RiverCity WRAPS implementation program is approximately $85,000,000 in 2012 dollars, after deducting matching funds from other potential funding sources. The estimated costs are based on the program for addressing impairments outlined in Section 5.0. Estimated costs are general and are based on a variety of sources, as described below.

Short-term costs (years 1 through 5) include three basic components: pilot projects, additional analysis, and education in support of BMPs. Small pilot project costs are based on recent, similar projects, including native vegetation establishment and BMP construction costs.

However, estimated costs for the much larger Gypsum Creek bank stabilization pilot came from a design analysis. The estimated cost of additional studies and analysis are also based on recent projects of similar scope. Finally, estimated educational costs are based in part on the cost of recent educational programs implemented by the Sedgwick County SMAB. The cost estimate on the following pages assumes a budget of about $100,000 to $110,000 for Years 1 through 5, including $40,000 to $50,000 for pilot projects; $30,000 for additional studies and analysis; and $30,000 for targeted I&E. The SLT will develop more detailed budgets for each program year based on detailed project plans; the scope and detail of each project will necessarily be adjusted to match available funding, and volunteer labor and equipment.

Long-term implementation costs (years 6 through 50) include program administration; annual, targeted I&E; and BMP implementation. The estimated costs include a part-time WRAPS coordinator to oversee implementation, solicit additional funding, and provide technical assistance to local government and landowners. The cost estimate assumes that the position will be shared with another WRAPS group, or with another entity such as the county Stormwater Management Program. Targeted I&E costs are the same as years 1 through 5, assuming that each year's efforts will support implementation of BMPs proposed for that stage of the program.

The majority of program costs for years 6 through 50 are for structural and non-structural BMP implementation. Urban and agricultural BMP costs are estimated separately. Cost estimates for Agricultural BMPs were based on information provided by K-State Research and Extension, as documented in the 2011 Little Arkansas

WRAPS Nine Critical Element Plan. With the exception of stream bank stabilization, costs for urban BMPs are based on actual construction and landscape establishment costs for recent projects in Kansas, Missouri, and Nebraska. Stream bank stabilization costs from the Little Arkansas WRAPS were used for urban areas as well.

Grant money and matching funds for program implementation could potentially be obtained from a variety of sources. The estimated project costs presented below assume that matching funds will be available from the following sources:

- **WRAPS Implementation Grants:** During years 1 through 5, pilot projects, targeted education and monitoring, and additional analyses (with the exception of the Gypsum Creek bank stabilization) would be funded through the state WRAPS program, if sufficient funding is available.
- **Sedgwick County Stormwater Management Program:** The business plan for the proposed countywide program recommends a dedicated, countywide sales tax to fund multiple-benefit stormwater projects. The program would provide a 75-percent cost share for qualifying projects. The cost estimate assumes that matching County funds would be obtained for detention basin construction and retrofit for water quality treatment.
- **Federal Cost Share Programs**: Federal programs provide matching funds for the following agricultural BMPs, as documented by the Little Arkansas WRAPS SLT:
    - No-till farming - 39%
    - Nutrient management plans - 50%
    - Terraces - 50%
    - Grassed waterways - 50%
    - Vegetative buffers - 90%
    - Relocate feeding site - 50%
    - Alternative watering system - 50%

Finally, the proposed program is front-loaded with landscape conversion, including stream, lake, and pond buffer installations, and permanent revegetation. Once

completed, the operations and maintenance savings should more than offset the capital costs for the remainder of the program life, resulting in a net break-even program cost over 50 years. However, the proposed budget below includes only costs and not assumed savings. Additional cost information is included in the Appendix.

TABLE 20: SUMMARY OF ESTIMATED PROGRAM COSTS

Summary of Costs				
Year	I&E and Administration	Agricultural BMPs	Urban BMPs	Cumulative Cost
1	$40,000	$294,071	$0	$334,071
2	$110,000	$280,624	$0	$724,695
3	$110,000	$280,624	$0	$1,115,320
4	$110,000	$280,624	$0	$1,505,944
5	$860,000	$280,624	$0	$2,646,568
6	$110,000	$294,071	$1,371,616	$4,422,256
7	$60,000	$280,624	$1,371,616	$6,134,496
8	$60,000	$280,624	$1,371,616	$7,846,736
9	$60,000	$280,624	$1,371,616	$9,558,977
10	$60,000	$280,624	$6,371,616	$16,271,217
11	$110,000	$294,071	$1,371,616	$18,046,904
12	$60,000	$280,624	$1,371,616	$19,759,145
13	$60,000	$280,624	$1,371,616	$21,471,385
14	$60,000	$280,624	$1,371,616	$23,183,626
15	$60,000	$280,624	$1,371,616	$24,895,866
16	$110,000	$294,071	$1,371,616	$26,671,553
17	$60,000	$280,624	$1,371,616	$28,383,794
18	$60,000	$280,624	$1,371,616	$30,096,034
19	$60,000	$280,624	$1,371,616	$31,808,274
20	$60,000	$280,624	$1,371,616	$33,520,515
21	$110,000	$692,546	$1,874,212	$36,197,273
22	$60,000	$679,099	$1,874,212	$38,810,585
23	$60,000	$679,099	$1,874,212	$41,423,896
24	$60,000	$679,099	$1,874,212	$44,037,207
25	$60,000	$679,099	$1,874,212	$46,650,519
26	$110,000	$692,546	$789,919	$48,242,984
27	$60,000	$679,099	$789,919	$49,772,001
28	$60,000	$679,099	$789,919	$51,301,019
29	$60,000	$679,099	$789,919	$52,830,037
30	$60,000	$679,099	$789,919	$54,359,055
31	$110,000	$692,546	$789,919	$55,951,519

Summary of Costs				
Year	I&E and Administration	Agricultural BMPs	Urban BMPs	Cumulative Cost
32	$60,000	$679,099	$789,919	$57,480,537
33	$60,000	$679,099	$789,919	$59,009,555
34	$60,000	$679,099	$789,919	$60,538,573
35	$60,000	$679,099	$789,919	$62,067,591
36	$110,000	$692,546	$789,919	$63,660,055
37	$60,000	$679,099	$789,919	$65,189,073
38	$60,000	$679,099	$789,919	$66,718,091
39	$60,000	$679,099	$789,919	$68,247,109
40	$60,000	$679,099	$789,919	$69,776,126
41	$110,000	$692,546	$789,919	$71,368,591
42	$60,000	$679,099	$789,919	$72,897,609
43	$60,000	$679,099	$789,919	$74,426,627
44	$60,000	$679,099	$789,919	$75,955,645
45	$60,000	$679,099	$789,919	$77,484,662
46	$110,000	$692,546	$789,919	$79,077,127
47	$60,000	$679,099	$789,919	$80,606,145
48	$60,000	$679,099	$789,919	$82,135,163
49	$60,000	$679,099	$789,919	$83,664,180
50	$60,000	$679,099	$789,919	$85,193,198

8.0 TIMEFRAME

As previously noted, based on the information currently available, meeting the required load reductions (particularly TP, which is present at relatively high concentrations and is difficult to address) will likely be a physically, socially, technically, and financially challenging undertaking.

Because of the anticipated difficulty, the SLT proposes a 50-year implementation plan based on an adaptive management. It has identified a detailed program of additional research, BMP pilot projects, and I&E for the first 5-year period, as described in the previous sections, based on its current understanding of conditions in the watershed, options for improving water quality, and available funding. The proposed implementation strategies for the remaining 45 years are more general in nature. However, additional monitoring and study of both pollutant sources and BMP effectiveness will improve the community's understanding of the watershed's needs and the most effective means of improving watershed health. The approach will be revised periodically (on a 5-year basis) as described in Section 11. With each revision, the remainder of the implementation program and schedule will be adapted as the cost-effectiveness of various approaches is better understood.

9.0 MEASURABLE MILESTONES

9.1 WATER QUALITY MILESTONES TO DETERMINE IMPROVEMENTS

The goal of the River City WRAPS plan is to restore water quality for uses supportive of aquatic life, domestic water supply, irrigation, livestock watering, food procurement, ground water recharge, and recreation for Cowskin Creek. The plan specifically addresses the high priority biological nutrient TMDL and the high priority bacteria TMDL for Cowskin Creek.

In addition to the above impairments, there is a high priority bacteria TMDL and a medium priority biology TMDL for the Arkansas River. While this plan is not directly addressing these impairments, it is anticipated that they will be positively affected by the BMP implementation plan that has been developed as part of this WRAPS plan. Additionally, the River City WRAPS is addressing stream quality degradation issues in Gypsum Creek. As stated earlier in the plan, the WRAPS SLT is planning to implement a variety of urban BMPs to address the Gypsum Creek issues.

In order to reach the load reduction goals associated with these impairments, a BMP implementation schedule spanning 50 years has been developed. Separate water quality milestones have been developed for Cowskin Creek, along with additional indicators of water quality. The purpose of the milestones and indicators is to measure water quality improvements associated with the BMP implementation schedules contained in this plan.

9.1.1 WATER QUALITY MILESTONES FOR COWSKIN CREEK – BIOLOGICAL NUTRIENT TMDL

As previously stated, this plan estimates that it will take 50 years to implement the planned BMPs necessary to meet the load reduction goals for the impairments being addressed by this River City WRAPS plan. The table on the following page includes 10-year and long-term water quality goals related to the high priority biological nutrient TMDL that was developed for Cowskin Creek. The TMDL focuses on average concentrations during the runoff condition, which is defined in the TMDL as flows greater than the median flow condition. The TMDL establishes relationships between sediment and phosphorus concentrations relative to flow conditions. Therefore, the current condition for high flow concentrations has been established with the 90th percentile concentration at sampling site SC288 from 2000-2011. These current conditions have been utilized to develop water quality milestones for total phosphorus (TP), total nitrogen (TN), and total suspended solids (TSS), as indicated in the table on the following page.

TABLE 21: WATER QUALITY MILESTONES FOR COWSKIN CREEK

Water Quality Milestones for Cowskin Creek					
	Current Condition* Average TP Runoff Condition	10-Year Goal		Long Term Goal	
		Improved Condition Average TP	Total Reduction Needed	Improved Condition Average TP	Total Reduction Needed
Sampling Sites	**Average TP for Runoff Condition (average of data collected during indicated period for runoff flow condition), ppb**				
Cowskin Creek SC288	500	425	**15%**	200	**60%**

	Current Condition* Average TN Runoff Condition	10-Year Goal	Long Term Goal	
		Improved Condition Average TN	Improved Condition Average TN	Total Reduction Needed
Sampling Sites	**Average TN for Runoff Condition (average of data collected during indicated period for runoff flow condition), ppm**			
Cowskin Creek SC288	2.3	2.2	2.0	**13%**

	Current Condition* Average TSS Runoff Condition	10-Year Goal	Long Term Goal	
		Improved Condition Average TSS	Improved Condition Average TSS	Total Reduction Needed
Sampling Sites	**Average TSS for Runoff Condition (average of data collected during indicated period for runoff flow condition), ppm**			
Cowskin Creek SC288	133	125	100	**33%**

*The current conditions for SC288 was determined utilizing sampling data from the KDHE stream monitoring stations from 2000 to 2011.

9.1.2 WATER QUALITY MILESTONES FOR COWSKIN CREEK – BACTERIA

As noted previously, this plan is addressing the high priority bacteria TMDL for Cowskin Creek. The original TMDL was developed in 2000, and in 2003, the standard for bacteria changed to *E. coli* and the use of a geometric mean to assess the impairment was developed.

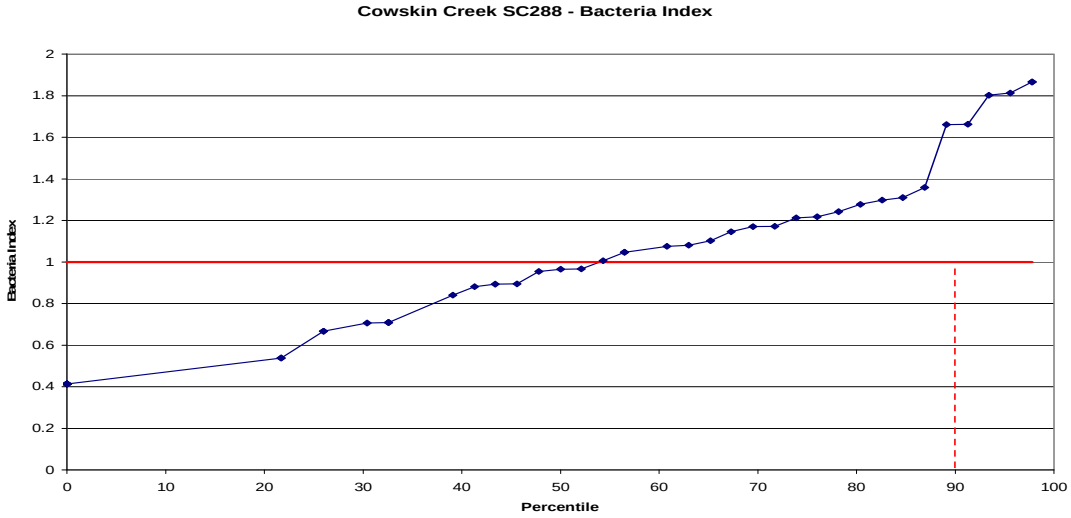
Bacteria load reductions resulting from the implementation of targeted BMPs should result in less frequent exceedence of the nominal *E. Coli* Bacteria (ECB) criterion (262 Colony Forming Units (CFUs)/100ml) for the sampling station SC288 on Cowskin Creek, and in lowered magnitude of those exceedence.

In order to assess the impact of BMPs addressing bacteria impairments the relative frequency and magnitude of bacteria concentrations seen in the receiving streams, monitored by KDHE on a routine or rotational basis, must be measured to determine if water quality improvements are being achieved. The bacteria index is utilized by KDHE to assess the relative frequency and magnitude of the bacteria concentrations at KDHE monitoring sites.

The calculated bacteria index for the Cowskin Creek sampling station SC288 is the natural logarithm of each sample value taken during the April-October Primary Recreation season, divided by the natural logarithm of the bacteria criteria for Primary Recreation Class B [ln(262)].

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

The indicator will be the Upper Decile of those index values, with the target being that the index is below 1.0 at the upper decile (90th percentile). Ultimately, compliance with water quality standards will require sampling 5 times within 30 days during several periods during the primary recreation season, and calculating the geometric mean of those samplings. Meeting that test will be justification for delisting the stream impairment. Cowskin Creek was sampled in accordance with the standard for four events, totaling 20 samples, during 2009. Two of the four sampling events yielded geometric means over the standard.



The water quality goal for the bacteria impairment on Cowskin Creek is for at least 90% of the samples taken during April through October to be below the water quality criterion of 262 cfus/100 ml.

9.2 ADDITIONAL WATER QUALITY INDICATORS

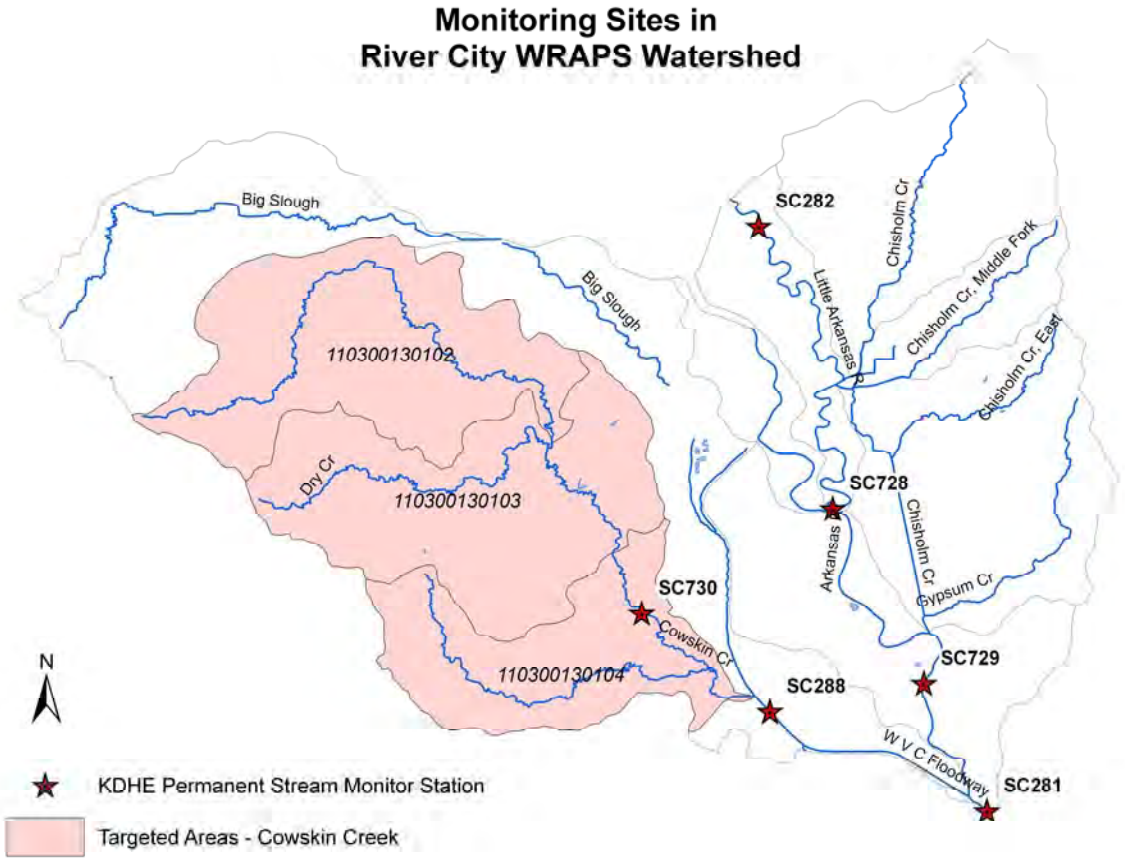
In addition to the monitoring data, other water quality indicators can be utilized by KDHE and the SLT. Such indicators may include anecdotal information from the SLT and other citizen groups within the watershed (skin rash outbreaks, fish kills, nuisance odors), which can be used to assess short-term deviations from water quality standards. The

additional indicators below can act as trigger-points that might initiate further revisions or modifications to the WRAPS plan by KDHE and the SLT:

- Occurrence of algal blooms in streams
- Increased water quality complaints to the City of Wichita or KDHE
- Trends of quantity and quality of fishing in streams

9.3 Monitoring Water Quality Progress

KDHE continues to monitor water quality in the River City WRAPS Watershed by maintaining the monitoring stations located within the watershed. The map included in this section shows the monitoring stations located within the River City WRAPS Watershed. The map has been color-coded to indicate the subwatersheds that have



been targeted for BMP implementation and water quality monitoring by this plan.

The map on this page shows the KDHE monitoring stations located in streams and lakes. The permanent stream monitoring sites are continuously sampled. The sites are sampled for nutrients, *E. Coli* bacteria, chemicals, turbidity, alkalinity, dissolved oxygen, pH, ammonia and metals. The pollutant indicators tested for each site may vary depending on the season at collection time and other factors.

9.4 Evaluation of Monitoring Data

Monitoring data in the River City WRAPS will be used to determine water quality progress, track water quality milestones, and to determine the effectiveness of the BMP implementation outlined in the plan. The schedule of review for the monitoring data will

be tied to the water quality milestones that have been developed for each watershed, as well as the frequency of the sampling data.

The BMP implementation schedules and water quality milestones for the River City WRAPS watershed extend through a twenty-year period. Throughout the plan period, KDHE will continue to analyze and evaluate the monitoring data collected. After the first ten years of monitoring and BMP implementation, KDHE will evaluate the available water quality data to determine whether the water quality milestones have been achieved. KDHE and the SLT can address any necessary modifications or revisions to the plan based on the data analysis. At the end of the plan, a determination can be made as to whether the water quality standards have been attained.

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

10.0 MONITORING WATER QUALITY PROGRESS

10.1 EXISTING MONITORING NETWORK

Active water quality monitoring stations in the RiverCity WRAPS service area include seven KDHE Bureau of Water permanent water quality monitoring stations, four City of Wichita wet weather water quality monitoring stations and eight USGS gauging stations.

The KDHE monitoring sites are permanent sites and are anticipated to be continued into the future. The sites are monitored for water quality parameters considered key indicators of water quality impairments identified within the targeted watersheds. City of

Wichita monitoring sites are associated with the Stormwater Management program and are anticipated to continue into the future. These monitoring points are wet weather stations. Sampling events are triggered by precipitation events meeting run-off criteria under the current stormwater NPDES permit requirements. USGS gauging stations record stream flow and discharge data. In some cases, limited field and laboratory water quality data is available.

Relevant and available data will be reviewed by the SLT on an annual basis, with special attention to data collected from the targeted watersheds, to assess BMP effectiveness and progress toward achieving load allocations as specified in TMDLs addressing water quality concerns specific to the targeted watersheds. More specifically, water quality parameters of total phosphorus, total nitrogen, total suspended solids and E. Coli Bacteria have been identified as pollutants of concern. BMP effectiveness will be evaluated based on measured reduction of these target pollutants. Additionally, reduction of average and peak flow will be considered as a positive indication of BMP implementation targeting run-off reduction.

Figure 11 on the following page shows active monitoring sites planned for data review on an annual basis.

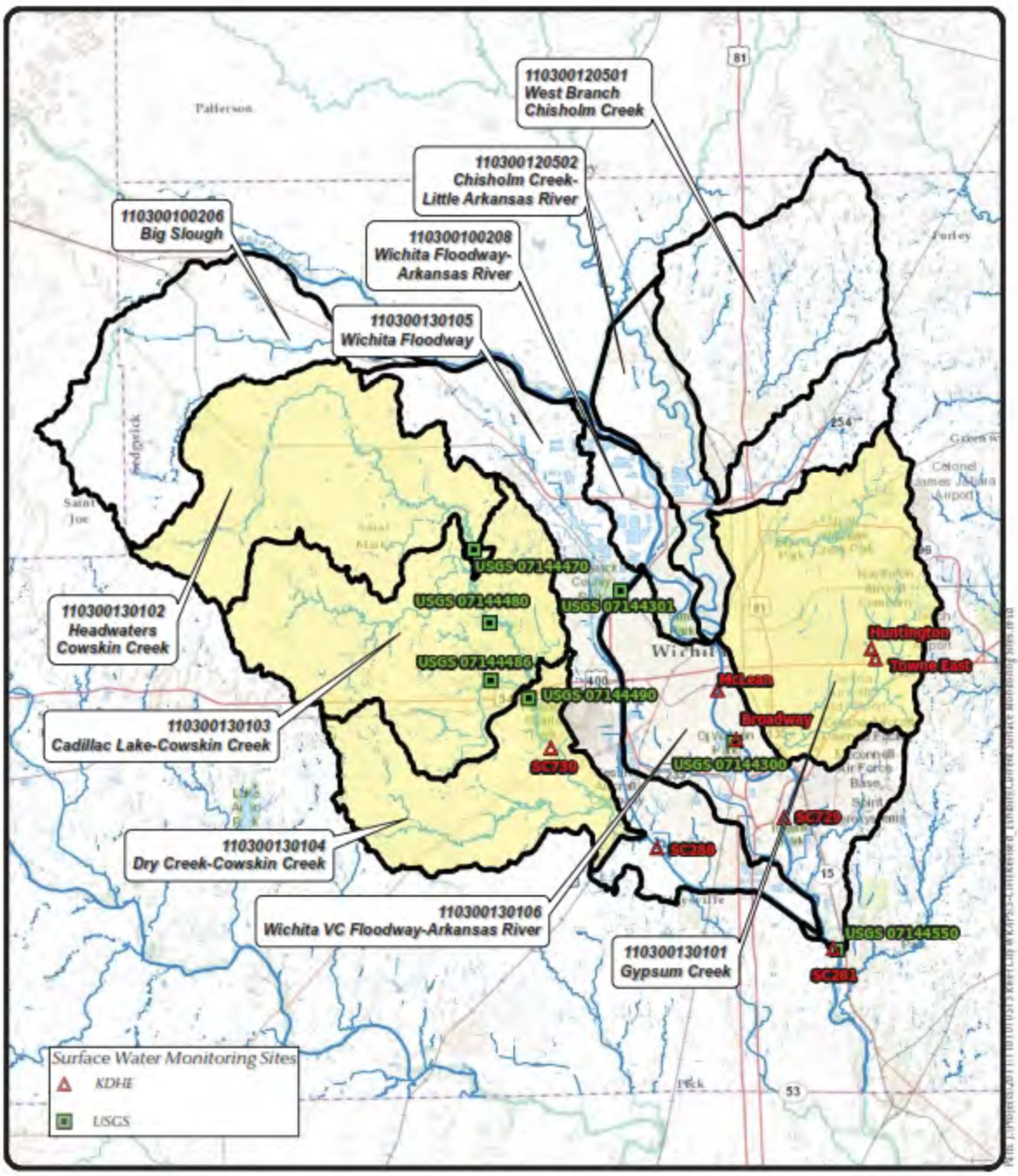


Figure 11. Current Surface Water Monitoring Sites

Table 22 summarizes the current water quality monitoring program.

TABLE 22: WATER QUALITY MONITORING

Agency	Site ID	Target Impairment	Stream	Parameters
KDHE	SC730	Biological, E. Coli Bacteria	Cowskin Cr @ Wichita	TP, TN, TSS, FCB,
KDHE	SC288	Biological, E. Coli Bacteria	Cowskin Cr. @ Wichita/VC Floodway	TP, TN, TSS, FCB
KDHE	SC281	Biological, E. Coli Bacteria	Arkansas @ Derby	TP, TN, TSS, FCB
KDHE	SC729	TP, E. Coli Bacteria	Arkansas @ Wichita	TP, TN, TSS, FCB
City of Wichita	Huntington	Biological, E. Coli Bacteria	Armour Br Gypsum Cr	TP, TN, TSS, FCB
City of Wichita	Towne East	Biological, E. Coli Bacteria	Armour Br Gypsum Cr	TP, TN, TSS, FCB
City of Wichita	McLean	Biological, E. Coli Bacteria	Arkansas	TP, TN, TSS, FCB
City of Wichita	Broadway	Biological, E. Coli Bacteria	Arkansas	TP, TN, TSS, FCB
USGS	07144301	Biological, E. Coli Bacteria	Floodway @ Arkansas Wichita	Flow
USGS	07144470	Biological, E. Coli Bacteria	Cowskin @ 29th N	Flow
USGS	07144490	Biological, E. Coli Bacteria	Cowskin @ Kellogg	Flow
USGS	07144480	Biological, E. Coli Bacteria	Cowskin @ 119th E.	Flow
USGS	07144486	Biological, E. Coli Bacteria	Calfskin @ 119th E	Flow
USGS	071444300	Biological, E. Coli Bacteria	Arkansas @ Wichita	Flow
USGS	071444550	Biological, E. Coli Bacteria	Arkansas @ Derby	Flow

10.2 SUPPLEMENTAL MONITORING

The active water quality and flow monitoring sites provide adequate information regarding the Cowskin Creek watershed as a whole; however, data gaps have been identified relative to water quality characteristics of predominantly rural reaches of the watershed and at the downstream limits of sub-watersheds within the Cowskin basin. Little or no information relative to identification of pollutant source "hot spots" or differentiation between rural and urban pollutant contributions is available.

Water quality data for the Gypsum Creek watershed is limited to the Huntington and Towne East stormwater monitoring stations and KDHE SC729 on the Arkansas River, located approximately 1 mile south of the Gypsum Creek confluence. Although these monitoring stations provide general information relative to stormwater event discharge and water quality data indicative of potential pollutant contributions from the entire Gypsum Creek watershed, the available data does not allow differentiation of pollutant

contributions from predominantly commercial land use and predominantly residential land use or facilitate identification of significant non-point pollution sources.

No active water quality monitoring sites include stream flow or discharge data specific to the monitoring location. Availability of monitoring station specific flow data would allow better differentiation between point source and non-point source contributions and facilitate evaluation BMP effectiveness.

From the early 1980's through 2008 the City of Wichita periodically monitored water quality parameters at more than 30 sites including the Arkansas River, Little Arkansas River, Chisholm Creek, Gypsum Creek, Cowskin Creek, Wichita/Valley Center Floodway, and Slough Creek. Monitoring at these locations ceased in 2008 or earlier; however a water quality database has been retained and provides historic water quality data that will be valuable for purposes of evaluating water quality trends influenced by BMP implementation and information education programs. Where feasible and practical, supplemental monitoring programs should incorporate previously established sites to take advantage of existing data.

Supplemental water quality monitoring needs identified by the SLT include reactivation of five former monitoring stations within the Cowskin watershed and two former monitoring stations within the Gypsum Creek watershed. One additional water quality monitoring station is proposed for the Cowskin and two new stations are planned within the Gypsum Creek watershed. The following table summarizes the planned supplemental water quality monitoring network for the target watersheds.

TABLE 23: PLANNED SUPPLEMENTAL WATER QUALITY MONITORING

Site ID	Target Impairment	Stream	Parameters
KDHE SC730	Biological, E. Coli Bacteria	Cowskin Cr @ Wichita	TP, TN, TSS, FCB, Flow
KDHE SC288	Biological, E. Coli Bacteria	Cowskin Cr. @ Wichita/VC Floodway	TP, TN, TSS, FCB Flow
WRAPS[1]	Biological, E. Coli Bacteria	Cowskin @ 37th Street N	TP, TN, TSS, FCB Flow
WRAPS[1]	Biological, E. Coli Bacteria	Cowskin at 21st Street N.	TP, TN, TSS, FCB Flow
WRAPS[1]	Biological, E. Coli Bacteria	Cowskin at 39th Street South	TP, TN, TSS, FCB Flow
WRAPS[1]	Biological, E. Coli Bacteria	Cowskin @ Ridge Rd South	TP, TN, TSS, FCB Flow
WRAPS[1]	Biological, E. Coli Bacteria	Cowskin @ Wichita/VC Floodway South	TP, TN, TSS, FCB Flow
WRAPS[2]	Biological, E. Coli Bacteria	Cowskin @ Kellogg (US 54)	TP, TN, TSS, FCB Flow
KDHE SC281	Biological, E. Coli Bacteria	Arkansas @ Derby	TP, TN, TSS, FCB Flow
KDHE SC729	TP, E. Coli Bacteria	Arkansas @ Wichita	TP, TN, TSS, FCB Flow
Wichita Huntington	Biological, E. Coli Bacteria	Armour Br Gypsum Cr	TP, TN, TSS, FCB Flow
Wichita Towne East	Biological, E. Coli Bacteria	Armour Br Gypsum Cr	TP, TN, TSS, FCB Flow

Site ID	Target Impairment	Stream	Parameters
Wichita McLean	Biological, E. Coli Bacteria	Arkansas	TP, TN, TSS, FCB Flow
Wichita Broadway	Biological, E. Coli Bacteria	Arkansas	TP, TN, TSS, FCB Flow
WRAPS[1]	Biological, E. Coli Bacteria	Gypsum/Dry Creek at Hillside	TP, TN, TSS, FCB Flow
WRAPS[1]	Biological, E. Coli Bacteria	Canal (I-135) @ Pawnee (Chisholm Cr Contribution)	TP, TN, TSS, FCB Flow
WRAPS[2]	Biological, E. Coli Bacteria	Gypsum Cr. @ Mt Vernon (Central Gyp Cr)	TP, TN, TSS, FCB Flow
WRAPS[2]	Biological, E. Coli Bacteria	Gypsum Creek @ Kellogg (W. Middle & E. Branch Gyp Cr)	TP, TN, TSS, FCB Flow
USGS 07144301	Biological, E. Coli Bacteria	Floodway @ Arkansas Wichita	Flow
USGS 07144490	Biological, E. Coli Bacteria	Cowskin Cr. @ Kellogg St	Flow
USGS 07144470	Biological, E. Coli Bacteria	Cowskin Cr. @ 29th St. North	Flow
USGS 07144480	Biological, E. Coli Bacteria	Cowskin Cr. @ 119th St. West	Flow
USGS 07144486	Biological, E. Coli Bacteria	Calfskin Cr. @ 119th West	Flow
USGS 071444300	Biological, E. Coli Bacteria	Arkansas @ Wichita	Flow
USGS 071444550	Biological, E. Coli Bacteria	Arkansas @ Derby	Flow

Notes:
1) Former monitoring site to be reactivated
2) Planned new site

Figure 12 on the following page indicates supplemental monitoring network sites, including active sites that would be retained in the monitoring program.

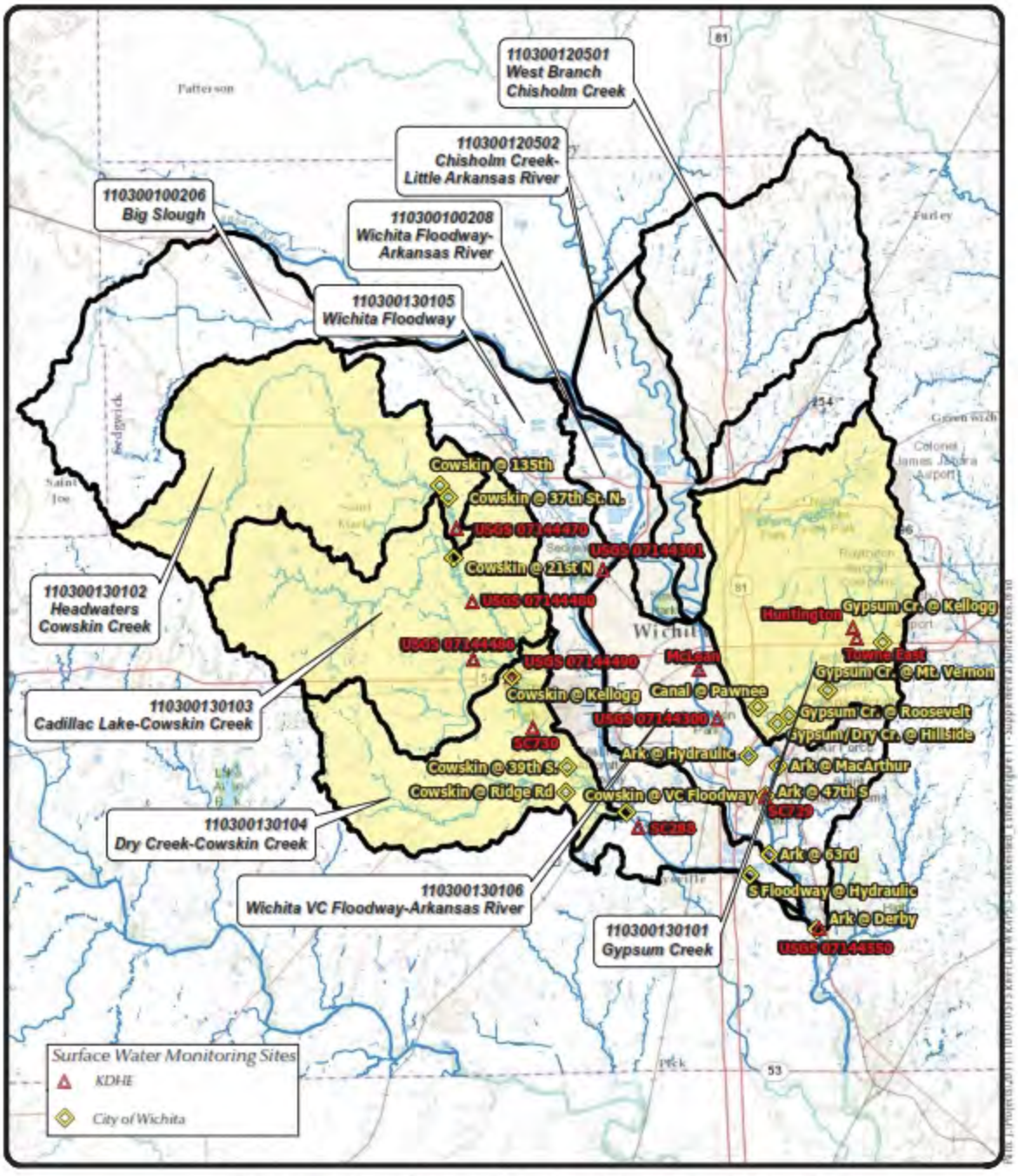


Figure 12. Supplemental Surface Water Monitoring Sites

Supplemental water quality monitoring during years 1 – 5 will be conducted by volunteers recruited by the SLT using relatively simple and inexpensive field test methods for flow, TP, TN and TSS. Because of the methods and equipment required,

field sampling for bacteria is not recommended. The SLT will seek partnerships with the City of Wichita and/or local colleges in an effort to arrange periodic bacterial analysis of water samples collected by the volunteer sampling crews. The purpose of the volunteer monitoring program is two-fold; 1) to obtain supplemental water quality data establishing current water quality characteristics, 2) to evaluate supplemental sampling locations and data obtained relative to determining the long-term monitoring program planned for implementation in year 6. Estimated costs for supplemental monitoring for the life of the plan can be found on the Administrative and Educational Costs in the Additional Analysis/Reporting table, pages 81 and 82.

In addition to the planned long-term supplemental monitoring network, temporary monitoring stations will be established when feasible to provide a more direct indication of the effectiveness of the pilot BMPs. Monitoring locations will be identified upstream and downstream from pilot projects, as well as in control watersheds with similar characteristics.

11.0 REVIEW OF THE WATERSHED PLAN – 2017

The SLT will evaluate implementation results during years 1 through 5 to determine which strategies have provided the greatest benefit, and which are most cost-effective effective. During this phase of the program, the SLT will also monitor lessons learned by other regional WRAPS groups, state and national research on BMP effectiveness and cost, and emerging I&E strategies; as well as local, state, and federal funding availability. The Nine Critical Element Plan will be updated based on these findings. The SLT will develop a revised, detailed implementation plan for years 6 through 10, and will adjust the longer-term implementation strategies and forecasts as appropriate.

Subsequent review and plan revisions will be conducted at 5-year intervals until load reductions are met or it is determined that impairments have otherwise been adequately addressed.

APPENDIX A - DATA TABLES

Total Cumulative Annual Pollutant Reduction					
BMP	**TN (pounds)**	**TP (pounds)**	**TSS (pounds)**	**Runoff (acre feet)**	**Implementation Years**
Education Practices:					
Impervious Surface Disconnection	638	122	29,490	56	1 to 50
Improved Lawn Care	5,008	652	38,061	186	1 to 50
Pet Waste Education	14,405	209	0	0	1 to 50
Subtotal	20,051	982	67,550	242	
	(	Tons TSS:	34		
Urban Structural and Nonstructural BMPs					
Permanent Revegetation	10,849	2,030	275,059	1,347	6 to 25
Wet Pond (13th & 167th St.)a	18,300	5,989	1,092,430	0	Year 10
Water Quality Swales (Urban)	7,250	1,197	288,136	302	21 to 50
Bioretention (Commercial Rooftops)	3,983	697	105,022	309	21 to 50
Dry Extended Detention Pond	2,758	787	346,143	0	6 to 20
Rain Gardens (Residential)	16,338	2,873	429,532	1,266	21 to 50
Pond and Lake Buffers	3,921	739	111,082	403	6 to 25
Stream bank Stabilization (Urban)	3,116	1,371	1,038,547	0	21 to 50
Riparian Buffers (Urban)	897	177	25,551	115	6 to 25
Subtotal	67,412	15,860	3,711,502	3,741	
	(	Tons TSS:	1,856		
Agricultural BMPs					
No Till/Nutrient Management/Crop Rotation	45,966	9,751	1,524,943	495	1 to 50
Terraces and Grass Waterways (Crop Land)	44,712	8,301	1,034,270	1,115	1 to 50
Stream bank Stabilization (Rural)	12463	5484	4154188	0	21 to 50
Livestock Practices*	122,693	14,022	0	0	1 to 50
Riparian Buffers (Rural)	3,588	709	102,206	461	1 to 50
Subtotal	229,421	38,267	6,815,608	2,070	
	(	Tons TSS:	3,408		
Total Annual NPS Load Reduction	**316,884**	**55,109**	**10,594,660**	**6,054**	
	(	Tons TSS:	5,297		

Additive Annual TN Reduction (pounds), Agricultural BMPs							
Year	**Stream Buffers**	**Livestock Practices**	**Grassed Waterways (Pasture)**	**No Till/ Nutrient Management/Crop Rotation**	**Terraces and Grassed Waterways (Crop Land)**	**Stream bank Stabilization**	**Cumulative Annual Load Reduction**
1	72	12269	0	919	894	0	14155
2	144	12269	0	1839	1788	0	16040
3	215	12269	0	2758	2683	0	17925
4	287	12269	0	3677	3577	0	19811
5	359	12269	0	4597	4471	0	21696
6	431	24539	0	5516	5365	277	36127
7	502	24539	0	6435	6260	554	38290
8	574	24539	0	7355	7154	831	40452
9	646	24539	0	8274	8048	1108	42614
10	718	24539	0	9193	8942	1385	44776
11	789	36808	0	10113	9837	1662	59208
12	861	36808	0	11032	10731	1939	61370
13	933	36808	0	11951	11625	2216	63532
14	1005	36808	0	12871	12519	2493	65695
15	1076	36808	0	13790	13414	2769	67857
16	1148	49077	0	14709	14308	3046	82289
17	1220	49077	0	15629	15202	3323	84451
18	1292	49077	0	16548	16096	3600	86613
19	1363	49077	0	17467	16991	3877	88775
20	1435	49077	0	18387	17885	4154	90938
21	1507	61346	0	19306	18779	4431	105369
22	1579	61346	0	20225	19673	4708	107531
23	1650	61346	0	21145	20567	4985	109694
24	1722	61346	0	22064	21462	5262	111856
25	1794	61346	0	22983	22356	5539	114018
26	1866	73616	0	23903	23250	5816	128450
27	1937	73616	0	24822	24144	6093	130612
28	2009	73616	0	25741	25039	6370	132774
29	2081	73616	0	26661	25933	6647	134936
30	2153	73616	0	27580	26827	6924	137099
31	2224	85885	0	28499	27721	7201	151530
32	2296	85885	0	29419	28616	7478	153692
33	2368	85885	0	30338	29510	7754	155855
34	2440	85885	0	31257	30404	8031	158017

Additive Annual TN Reduction (pounds), Agricultural BMPs							
Year	**Stream Buffers**	**Livestock Practices**	**Grassed Waterways (Pasture)**	**No Till/ Nutrient Management/Crop Rotation**	**Terraces and Grassed Waterways (Crop Land)**	**Stream bank Stabilization**	**Cumulative Annual Load Reduction**
35	2511	85885	0	32177	31298	8308	160179
36	2583	98154	0	33096	32193	8585	174611
37	2655	98154	0	34015	33087	8862	176773
38	2727	98154	0	34935	33981	9139	178935
39	2798	98154	0	35854	34875	9416	181098
40	2870	98154	0	36773	35770	9693	183260
41	2942	110423	0	37693	36664	9970	197691
42	3014	110423	0	38612	37558	10247	199854
43	3085	110423	0	39531	38452	10524	202016
44	3157	110423	0	40451	39346	10801	204178
45	3229	110423	0	41370	40241	11078	206340
46	3301	122693	0	42289	41135	11355	220772
47	3372	122693	0	43208	42029	11632	222934
48	3444	122693	0	44128	42923	11909	225096
49	3516	122693	0	45047	43818	12186	227259
50	3588	122693	0	45966	44712	12463	229421

Additive Annual TN Reduction (pounds), Information and Education				
Year	Impervious Surface Disconnection	Improved Lawn Care	Pet Waste Education	Cumulative Annual Load Reduction
1	13	100	288	401
2	26	200	576	802
3	38	300	864	1203
4	51	401	1152	1604
5	64	501	1441	2005
6	77	601	1729	2406
7	89	701	2017	2807
8	102	801	2305	3208
9	115	901	2593	3609
10	128	1002	2881	4010
11	140	1102	3169	4411
12	153	1202	3457	4812
13	166	1302	3745	5213
14	179	1402	4033	5614
15	191	1502	4322	6015
16	204	1603	4610	6416
17	217	1703	4898	6817
18	230	1803	5186	7218
19	242	1903	5474	7619
20	255	2003	5762	8020
21	268	2103	6050	8421
22	281	2204	6338	8822
23	293	2304	6626	9223
24	306	2404	6914	9624
25	319	2504	7203	10025
26	332	2604	7491	10426
27	344	2704	7779	10827
28	357	2805	8067	11228
29	370	2905	8355	11629
30	383	3005	8643	12030
31	395	3105	8931	12431
32	408	3205	9219	12832
33	421	3305	9507	13233
34	434	3405	9795	13634
35	446	3506	10084	14036

Additive Annual TN Reduction (pounds), Information and Education				
Year	**Impervious Surface Disconnection**	**Improved Lawn Care**	**Pet Waste Education**	**Cumulative Annual Load Reduction**
36	459	3606	10372	14437
37	472	3706	10660	14838
38	485	3806	10948	15239
39	497	3906	11236	15640
40	510	4006	11524	16041
41	523	4107	11812	16442
42	536	4207	12100	16843
43	548	4307	12388	17244
44	561	4407	12676	17645
45	574	4507	12965	18046
46	587	4607	13253	18447
47	599	4708	13541	18848
48	612	4808	13829	19249
49	625	4908	14117	19650
50	638	5008	14405	20051

Additive Annual TN Reduction (pounds), Urban BMPs									
Year	Stream Buffers	Streambank Stabilization	Permanent Revegetation	Commercial Bioretention	Water Quality Swales	Residential Rain Gardens	Pond and Lake Buffers	Detention/ Retention	Cumulative Annual Load Reduction
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0
6	44.8	0	542.5	0	0	0	196.0	183.8	967
7	89.7	0	1084.9	0	0	0	392.1	367.7	1934
8	134.5	0	1627.4	0	0	0	588.1	551.5	2902
9	179.4	0	2169.9	0	0	0	784.2	735.3	3869
10	224.2	0	2712.4	0	0	0	980.2	19219	23136
11	269.1	0	3254.8	0	0	0	1176.2	19403	24103
12	313.9	0	3797.3	0	0	0	1372.3	19587	25071
13	358.8	0	4339.8	0	0	0	1568.3	19771	26038
14	403.6	0	4882.3	0	0	0	1764.4	19955	27005
15	448.4	0	5424.7	0	0	0	1960.4	20139	27972
16	493.3	0	5967.2	0	0	0	2156.4	20322	28939
17	538.1	0	6509.7	0	0	0	2352.5	20506	29907
18	583.0	0	7052.2	0	0	0	2548.5	20690	30874
19	627.8	0	7594.6	0	0	0	2744.6	20874	31841
20	672.7	0	8137.1	0	0	0	2940.6	21058	32808
21	717.5	103.9	8679.6	132.8	241.7	544.6	3136.6	21058	34614
22	762.3	207.7	9222.1	265.6	483.3	1089.2	3332.7	21058	36421
23	807.2	311.6	9764.5	398.3	725.0	1633.8	3528.7	21058	38227
24	852.0	415.4	10307.0	531.1	966.7	2178.4	3724.8	21058	40033
25	896.9	519.3	10849.5	663.9	1208.3	2723.0	3920.8	21058	41839
26	896.9	623.1	10849.5	796.7	1450.0	3267.7	3920.8	21058	42862
27	896.9	727.0	10849.5	929.5	1691.6	3812.3	3920.8	21058	43885
28	896.9	830.8	10849.5	1062.2	1933.3	4356.9	3920.8	21058	44908
29	896.9	934.7	10849.5	1195.0	2175.0	4901.5	3920.8	21058	45931
30	896.9	1038.5	10849.5	1327.8	2416.6	5446.1	3920.8	21058	46954
31	896.9	1142.4	10849.5	1460.6	2658.3	5990.7	3920.8	21058	47977
32	896.9	1246.3	10849.5	1593.4	2900.0	6535.3	3920.8	21058	49000
33	896.9	1350.1	10849.5	1726.1	3141.6	7079.9	3920.8	21058	50023
34	896.9	1454.0	10849.5	1858.9	3383.3	7624.5	3920.8	21058	51046
35	896.9	1557.8	10849.5	1991.7	3625.0	8169.1	3920.8	21058	52069

Additive Annual TN Reduction (pounds), Urban BMPs									
Year	Stream Buffers	Streambank Stabilization	Permanent Revegetation	Commercial Bioretention	Water Quality Swales	Residential Rain Gardens	Pond and Lake Buffers	Detention/ Retention	Cumulative Annual Load Reduction
36	896.9	1661.7	10849.5	2124.5	3866.6	8713.7	3920.8	21058	53091
37	896.9	1765.5	10849.5	2257.2	4108.3	9258.3	3920.8	21058	54114
38	896.9	1869.4	10849.5	2390.0	4350.0	9803.0	3920.8	21058	55137
39	896.9	1973.2	10849.5	2522.8	4591.6	10347.6	3920.8	21058	56160
40	896.9	2077.1	10849.5	2655.6	4833.3	10892.2	3920.8	21058	57183
41	896.9	2180.9	10849.5	2788.4	5074.9	11436.8	3920.8	21058	58206
42	896.9	2284.8	10849.5	2921.1	5316.6	11981.4	3920.8	21058	59229
43	896.9	2388.7	10849.5	3053.9	5558.3	12526.0	3920.8	21058	60252
44	896.9	2492.5	10849.5	3186.7	5799.9	13070.6	3920.8	21058	61275
45	896.9	2596.4	10849.5	3319.5	6041.6	13615.2	3920.8	21058	62298
46	896.9	2700.2	10849.5	3452.3	6283.3	14159.8	3920.8	21058	63320
47	896.9	2804.1	10849.5	3585.0	6524.9	14704.4	3920.8	21058	64343
48	896.9	2907.9	10849.5	3717.8	6766.6	15249.0	3920.8	21058	65366
49	896.9	3011.8	10849.5	3850.6	7008.3	15793.6	3920.8	21058	66389
50	896.9	3115.6	10849.5	3983.4	7249.9	16338.3	3920.8	21058	67412

Additive Annual TP Reduction (pounds), Agricultural BMPs						
Year	Stream Buffers	Livestock Practices	No Till/ Nutrient Management/Crop Rotation	Terraces and Grassed Waterways (Crop Land)	Stream bank Stabilization	Cumulative Annual Load Reduction
1	14	1402	195	166	0	1777
2	28	1402	390	332	0	2153
3	43	1402	585	498	0	2528
4	57	1402	780	664	0	2903
5	71	1402	975	830	0	3278
6	85	2804	1170	996	0	5056
7	99	2804	1365	1162	0	5431
8	113	2804	1560	1328	0	5806
9	128	2804	1755	1494	0	6181
10	142	2804	1950	1660	0	6557
11	156	4207	2145	1826	0	8334
12	170	4207	2340	1992	0	8709
13	184	4207	2535	2158	0	9085
14	199	4207	2730	2324	0	9460
15	213	4207	2925	2490	0	9835
16	227	5609	3120	2656	0	11612
17	241	5609	3315	2823	0	11988
18	255	5609	3510	2989	0	12363
19	270	5609	3705	3155	0	12738
20	284	5609	3900	3321	0	13113
21	298	7011	4095	3487	183	15074
22	312	7011	4290	3653	366	15632
23	326	7011	4485	3819	548	16190
24	340	7011	4680	3985	731	16748
25	355	7011	4875	4151	914	17306
26	369	8413	5070	4317	1097	19266
27	383	8413	5265	4483	1279	19824
28	397	8413	5460	4649	1462	20382
29	411	8413	5655	4815	1645	20940
30	426	8413	5850	4981	1828	21498
31	440	9815	6045	5147	2011	23458
32	454	9815	6240	5313	2193	24016
33	468	9815	6435	5479	2376	24574
34	482	9815	6630	5645	2559	25132

Additive Annual TP Reduction (pounds), Agricultural BMPs						
Year	**Stream Buffers**	**Livestock Practices**	**No Till/ Nutrient Management/Crop Rotation**	**Terraces and Grassed Waterways (Crop Land)**	**Stream bank Stabilization**	**Cumulative Annual Load Reduction**
35	496	9815	6825	5811	2742	25690
36	511	11218	7020	5977	2925	27650
37	525	11218	7215	6143	3107	28208
38	539	11218	7410	6309	3290	28766
39	553	11218	7605	6475	3473	29324
40	567	11218	7800	6641	3656	29882
41	582	12620	7995	6807	3838	31843
42	596	12620	8190	6973	4021	32401
43	610	12620	8385	7139	4204	32959
44	624	12620	8580	7305	4387	33517
45	638	12620	8776	7471	4570	34075
46	653	14022	8971	7637	4752	36035
47	667	14022	9166	7803	4935	36593
48	681	14022	9361	7969	5118	37151
49	695	14022	9556	8135	5301	37709
50	709	14022	9751	8301	5484	38267

Additive Annual TP Reduction (pounds), Information and Education				
Year	**Impervious Surface Disconnection**	**Improved Lawn Care**	**Pet Waste Education**	**Cumulative Annual Load Reduction**
1	2	13	4	20
2	5	26	8	39
3	7	39	13	59
4	10	52	17	79
5	12	65	21	98
6	15	78	25	118
7	17	91	29	137
8	19	104	33	157
9	22	117	38	177
10	24	130	42	196
11	27	143	46	216
12	29	156	50	236
13	32	169	54	255
14	34	182	58	275
15	36	195	63	295
16	39	208	67	314
17	41	222	71	334
18	44	235	75	353
19	46	248	79	373
20	49	261	84	393
21	51	274	88	412
22	53	287	92	432
23	56	300	96	452
24	58	313	100	471
25	61	326	104	491
26	63	339	109	511
27	66	352	113	530
28	68	365	117	550
29	70	378	121	569
30	73	391	125	589
31	75	404	129	609
32	78	417	134	628
33	80	430	138	648
34	83	443	142	668
35	85	456	146	687

Additive Annual TP Reduction (pounds), Information and Education				
Year	**Impervious Surface Disconnection**	**Improved Lawn Care**	**Pet Waste Education**	**Cumulative Annual Load Reduction**
36	88	469	150	707
37	90	482	154	727
38	92	495	159	746
39	95	508	163	766
40	97	521	167	785
41	100	534	171	805
42	102	547	175	825
43	105	560	180	844
44	107	573	184	864
45	109	586	188	884
46	112	599	192	903
47	114	612	196	923
48	117	625	200	943
49	119	638	205	962
50	122	652	209	982

Additive Annual TP Reduction (pounds), Urban BMPs									
Year	Stream Buffers	Streambank Stabilization	Permanent Revegetation	Commercial Bioretention	Water Quality Swales	Residential Rain Gardens	Pond and Lake Buffers	Detention/ Retention	Cumulative Annual Load Reduction
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0
6	8.9	0	101.5	0	0	0	36.9	52.5	200
7	17.7	0	203.0	0	0	0	73.9	104.9	400
8	26.6	0	304.5	0	0	0	110.8	157.4	599
9	35.5	0	406.0	0	0	0	147.8	209.9	799
10	44.3	0	507.5	0	0	0	184.7	6252	6988
11	53.2	0	608.9	0	0	0	221.7	6304	7188
12	62.1	0	710.4	0	0	0	258.6	6356	7388
13	70.9	0	811.9	0	0	0	295.5	6409	7587
14	79.8	0	913.4	0	0	0	332.5	6461	7787
15	88.7	0	1014.9	0	0	0	369.4	6514	7987
16	97.5	0	1116.4	0	0	0	406.4	6566	8187
17	106.4	0	1217.9	0	0	0	443.3	6619	8386
18	115.3	0	1319.4	0	0	0	480.2	6671	8586
19	124.1	0	1420.9	0	0	0	517.2	6724	8786
20	133.0	0	1522.4	0	0	0	554.1	6776	8986
21	141.9	45.7	1623.9	23.2	39.9	95.8	591.1	6776	9338
22	150.7	91.4	1725.4	46.5	79.8	191.5	628.0	6776	9690
23	159.6	137.1	1826.8	69.7	119.7	287.3	665.0	6776	10041
24	168.5	182.8	1928.3	93.0	159.6	383.0	701.9	6776	10393
25	177.3	228.5	2029.8	116.2	199.6	478.8	738.8	6776	10745
26	177.3	274.2	2029.8	139.5	239.5	574.5	738.8	6776	10950
27	177.3	319.9	2029.8	162.7	279.4	670.3	738.8	6776	11154
28	177.3	365.6	2029.8	186.0	319.3	766.0	738.8	6776	11359
29	177.3	411.3	2029.8	209.2	359.2	861.8	738.8	6776	11564
30	177.3	457.0	2029.8	232.5	399.1	957.5	738.8	6776	11768
31	177.3	502.7	2029.8	255.7	439.0	1053.3	738.8	6776	11973
32	177.3	548.4	2029.8	279.0	478.9	1149.0	738.8	6776	12177
33	177.3	594.0	2029.8	302.2	518.8	1244.8	738.8	6776	12382
34	177.3	639.7	2029.8	325.5	558.7	1340.5	738.8	6776	12587
35	177.3	685.4	2029.8	348.7	598.7	1436.3	738.8	6776	12791
36	177.3	731.1	2029.8	372.0	638.6	1532.0	738.8	6776	12996

Additive Annual TP Reduction (pounds), Urban BMPs									
Year	**Stream Buffers**	**Streambank Stabilization**	**Permanent Revegetation**	**Commercial Bioretention**	**Water Quality Swales**	**Residential Rain Gardens**	**Pond and Lake Buffers**	**Detention/ Retention**	**Cumulative Annual Load Reduction**
37	177.3	776.8	2029.8	395.2	678.5	1627.8	738.8	6776	13201
38	177.3	822.5	2029.8	418.5	718.4	1723.5	738.8	6776	13405
39	177.3	868.2	2029.8	441.7	758.3	1819.3	738.8	6776	13610
40	177.3	913.9	2029.8	465.0	798.2	1915.0	738.8	6776	13814
41	177.3	959.6	2029.8	488.2	838.1	2010.8	738.8	6776	14019
42	177.3	1005.3	2029.8	511.5	878.0	2106.5	738.8	6776	14224
43	177.3	1051.0	2029.8	534.7	917.9	2202.3	738.8	6776	14428
44	177.3	1096.7	2029.8	557.9	957.8	2298.0	738.8	6776	14633
45	177.3	1142.4	2029.8	581.2	997.8	2393.8	738.8	6776	14837
46	177.3	1188.1	2029.8	604.4	1037.7	2489.5	738.8	6776	15042
47	177.3	1233.8	2029.8	627.7	1077.6	2585.3	738.8	6776	15247
48	177.3	1279.5	2029.8	650.9	1117.5	2681.0	738.8	6776	15451
49	177.3	1325.2	2029.8	674.2	1157.4	2776.8	738.8	6776	15656
50	177.3	1370.9	2029.8	697.4	1197.3	2872.6	738.8	6776	15860

Additive Annual TSS Reduction (tons), Agricultural BMPs						
Year	**Stream Buffers**	**Livestock Practices**	**No Till/ Nutrient Management/Crop Rotation**	**Terraces and Grassed Waterways (Crop Land)**	**Stream bank Stabilization**	**Cumulative Annual Load Reduction**
1	1.0	0	15	10	0	27
2	2.0	0	30	21	0	53
3	3.1	0	46	31	0	80
4	4.1	0	61	41	0	106
5	5.1	0	76	52	0	133
6	6.1	0	91	62	0	160
7	7.2	0	107	72	0	186
8	8.2	0	122	83	0	213
9	9.2	0	137	93	0	240
10	10.2	0	152	103	0	266
11	11.2	0	168	114	0	293
12	12.3	0	183	124	0	319
13	13.3	0	198	134	0	346
14	14.3	0	213	145	0	373
15	15.3	0	229	155	0	399
16	16.4	0	244	165	0	426
17	17.4	0	259	176	0	452
18	18.4	0	274	186	0	479
19	19.4	0	290	197	0	506
20	20.4	0	305	207		532
21	21.5	0	320	217	69	628
22	22.5	0	335	228	138	724
23	23.5	0	351	238	208	820
24	24.5	0	366	248	277	916
25	25.6	0	381	259	346	1012
26	26.6	0	396	269	415	1107
27	27.6	0	412	279	485	1203
28	28.6	0	427	290	554	1299
29	29.6	0	442	300	623	1395
30	30.7	0	457	310	692	1491
31	31.7	0	473	321	762	1587
32	32.7	0	488	331	831	1682
33	33.7	0	503	341	900	1778
34	34.7	0	518	352	969	1874
35	35.8	0	534	362	1039	1970

Additive Annual TSS Reduction (tons), Agricultural BMPs						
Year	**Stream Buffers**	**Livestock Practices**	**No Till/ Nutrient Management/Crop Rotation**	**Terraces and Grassed Waterways (Crop Land)**	**Stream bank Stabilization**	**Cumulative Annual Load Reduction**
36	36.8	0	549	372	1108	2066
37	37.8	0	564	383	1177	2162
38	38.8	0	579	393	1246	2258
39	39.9	0	595	403	1315	2353
40	40.9	0	610	414	1385	2449
41	41.9	0	625	424	1454	2545
42	42.9	0	640	434	1523	2641
43	43.9	0	656	445	1592	2737
44	45.0	0	671	455	1662	2833
45	46.0	0	686	465	1731	2929
46	47.0	0	701	476	1800	3024
47	48.0	0	717	486	1869	3120
48	49.1	0	732	496	1939	3216
49	50.1	0	747	507	2008	3312
50	51.1	0	762	517	2077	3408

Additive Annual TSS Reduction (tons), Information and Education				
Year	Impervious Surface Disconnection	Improved Lawn Care	Pet Waste Education	Cumulative Annual Load Reduction
1	0.3	0.4	0.0	0.7
2	0.6	0.8	0.0	1.4
3	0.9	1.1	0.0	2.0
4	1.2	1.5	0.0	2.7
5	1.5	1.9	0.0	3.4
6	1.8	2.3	0.0	4.1
7	2.1	2.7	0.0	4.7
8	2.4	3.0	0.0	5.4
9	2.7	3.4	0.0	6.1
10	2.9	3.8	0.0	6.8
11	3.2	4.2	0.0	7.4
12	3.5	4.6	0.0	8.1
13	3.8	4.9	0.0	8.8
14	4.1	5.3	0.0	9.5
15	4.4	5.7	0.0	10.1
16	4.7	6.1	0.0	10.8
17	5.0	6.5	0.0	11.5
18	5.3	6.9	0.0	12.2
19	5.6	7.2	0.0	12.8
20	5.9	7.6	0.0	13.5
21	6.2	8.0	0.0	14.2
22	6.5	8.4	0.0	14.9
23	6.8	8.8	0.0	15.5
24	7.1	9.1	0.0	16.2
25	7.4	9.5	0.0	16.9
26	7.7	9.9	0.0	17.6
27	8.0	10.3	0.0	18.2
28	8.3	10.7	0.0	18.9
29	8.6	11.0	0.0	19.6
30	8.8	11.4	0.0	20.3
31	9.1	11.8	0.0	20.9
32	9.4	12.2	0.0	21.6
33	9.7	12.6	0.0	22.3
34	10.0	12.9	0.0	23.0
35	10.3	13.3	0.0	23.6
36	10.6	13.7	0.0	24.3

Additive Annual TSS Reduction (tons), Information and Education				
Year	**Impervious Surface Disconnection**	**Improved Lawn Care**	**Pet Waste Education**	**Cumulative Annual Load Reduction**
37	10.9	14.1	0.0	25.0
38	11.2	14.5	0.0	25.7
39	11.5	14.8	0.0	26.3
40	11.8	15.2	0.0	27.0
41	12.1	15.6	0.0	27.7
42	12.4	16.0	0.0	28.4
43	12.7	16.4	0.0	29.0
44	13.0	16.7	0.0	29.7
45	13.3	17.1	0.0	30.4
46	13.6	17.5	0.0	31.1
47	13.9	17.9	0.0	31.7
48	14.2	18.3	0.0	32.4
49	14.4	18.6	0.0	33.1
50	14.7	19.0	0.0	33.8

Additive Annual TSS Reduction (tons), Urban BMPs									
Year	Stream Buffers	Streambank Stabilization	Permanent Revegetation	Commercial Bioretention	Water Quality Swales	Residential Rain Gardens	Pond and Lake Buffers	Detention/ Retention	Cumulative Annual Load Reduction
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0
6	0.6	0	6.9	0	0	0	2.8	11.5	22
7	1.3	0	13.8	0	0	0	5.6	23.1	44
8	1.9	0	20.6	0	0	0	8.3	34.6	65
9	2.6	0	27.5	0	0	0	11.1	46.2	87
10	3.2	0	34.4	0	0	0	13.9	604	655
11	3.8	0	41.3	0	0	0	16.7	615	677
12	4.5	0	48.1	0	0	0	19.4	627	699
13	5.1	0	55.0	0	0	0	22.2	639	721
14	5.7	0	61.9	0	0	0	25.0	650	743
15	6.4	0	68.8	0	0	0	27.8	662	765
16	7.0	0	75.6	0	0	0	30.5	673	786
17	7.7	0	82.5	0	0	0	33.3	685	808
18	8.3	0	89.4	0	0	0	36.1	696	830
19	8.9	0	96.3	0	0	0	38.9	708	852
20	9.6	0	103.1	0	0	0	41.7	719	874
21	10.2	17.3	110.0	1.8	4.8	7.2	44.4	719	915
22	10.9	34.6	116.9	3.5	9.6	14.3	47.2	719	956
23	11.5	51.9	123.8	5.3	14.4	21.5	50.0	719	998
24	12.1	69.2	130.7	7.0	19.2	28.6	52.8	719	1039
25	12.8	86.5	137.5	8.8	24.0	35.8	55.5	719	1080
26	12.8	103.9	137.5	10.5	28.8	43.0	55.5	719	1111
27	12.8	121.2	137.5	12.3	33.6	50.1	55.5	719	1142
28	12.8	138.5	137.5	14.0	38.4	57.3	55.5	719	1173
29	12.8	155.8	137.5	15.8	43.2	64.4	55.5	719	1204
30	12.8	173.1	137.5	17.5	48.0	71.6	55.5	719	1235
31	12.8	190.4	137.5	19.3	52.8	78.7	55.5	719	1266
32	12.8	207.7	137.5	21.0	57.6	85.9	55.5	719	1297
33	12.8	225.0	137.5	22.8	62.4	93.1	55.5	719	1328
34	12.8	242.3	137.5	24.5	67.2	100.2	55.5	719	1359
35	12.8	259.6	137.5	26.3	72.0	107.4	55.5	719	1390
36	12.8	276.9	137.5	28.0	76.8	114.5	55.5	719	1421

Additive Annual TSS Reduction (tons), Urban BMPs									
Year	**Stream Buffers**	**Streambank Stabilization**	**Permanent Revegetation**	**Commercial Bioretention**	**Water Quality Swales**	**Residential Rain Gardens**	**Pond and Lake Buffers**	**Detention/ Retention**	**Cumulative Annual Load Reduction**
37	12.8	294.3	137.5	29.8	81.6	121.7	55.5	719	1452
38	12.8	311.6	137.5	31.5	86.4	128.9	55.5	719	1484
39	12.8	328.9	137.5	33.3	91.2	136.0	55.5	719	1515
40	12.8	346.2	137.5	35.0	96.0	143.2	55.5	719	1546
41	12.8	363.5	137.5	36.8	100.8	150.3	55.5	719	1577
42	12.8	380.8	137.5	38.5	105.6	157.5	55.5	719	1608
43	12.8	398.1	137.5	40.3	110.5	164.7	55.5	719	1639
44	12.8	415.4	137.5	42.0	115.3	171.8	55.5	719	1670
45	12.8	432.7	137.5	43.8	120.1	179.0	55.5	719	1701
46	12.8	450.0	137.5	45.5	124.9	186.1	55.5	719	1732
47	12.8	467.3	137.5	47.3	129.7	193.3	55.5	719	1763
48	12.8	484.7	137.5	49.0	134.5	200.4	55.5	719	1794
49	12.8	502.0	137.5	50.8	139.3	207.6	55.5	719	1825
50	12.8	519.3	137.5	52.5	144.1	214.8	55.5	719	1856

Administration and Education Costs					
Year	**Pilot Projects**	**Information/ Education**	**Additional Analysis/ Reporting**	**WRAPS Coordinator**	**Cumulative Cost**
1	$40,000	$0	$0	$0	$40,000
2	$50,000	$30,000	$30,000	$0	$150,000
3	$50,000	$30,000	$30,000	$0	$260,000
4	$50,000	$30,000	$30,000	$0	$370,000
5	$800,000	$30,000	$30,000	$0	$1,230,000
6	$0	$30,000	$50,000	$30,000	$1,340,000
7	$0	$30,000	$0	$30,000	$1,400,000
8	$0	$30,000	$0	$30,000	$1,460,000
9	$0	$30,000	$0	$30,000	$1,520,000
10	$0	$30,000	$0	$30,000	$1,580,000
11	$0	$30,000	$50,000	$30,000	$1,690,000
12	$0	$30,000	$0	$30,000	$1,750,000
13	$0	$30,000	$0	$30,000	$1,810,000
14	$0	$30,000	$0	$30,000	$1,870,000
15	$0	$30,000	$0	$30,000	$1,930,000
16	$0	$30,000	$50,000	$30,000	$2,040,000
17	$0	$30,000	$0	$30,000	$2,100,000
18	$0	$30,000	$0	$30,000	$2,160,000
19	$0	$30,000	$0	$30,000	$2,220,000
20	$0	$30,000	$0	$30,000	$2,280,000
21	$0	$30,000	$50,000	$30,000	$2,390,000
22	$0	$30,000	$0	$30,000	$2,450,000
23	$0	$30,000	$0	$30,000	$2,510,000
24	$0	$30,000	$0	$30,000	$2,570,000
25	$0	$30,000	$0	$30,000	$2,630,000
26	$0	$30,000	$50,000	$30,000	$2,740,000
27	$0	$30,000	$0	$30,000	$2,800,000
28	$0	$30,000	$0	$30,000	$2,860,000
29	$0	$30,000	$0	$30,000	$2,920,000
30	$0	$30,000	$0	$30,000	$2,980,000
31	$0	$30,000	$50,000	$30,000	$3,090,000
32	$0	$30,000	$0	$30,000	$3,150,000
33	$0	$30,000	$0	$30,000	$3,210,000
34	$0	$30,000	$0	$30,000	$3,270,000
35	$0	$30,000	$0	$30,000	$3,330,000
36	$0	$30,000	$50,000	$30,000	$3,440,000
37	$0	$30,000	$0	$30,000	$3,500,000

Administration and Education Costs					
Year	**Pilot Projects**	**Information/ Education**	**Additional Analysis/ Reporting**	**WRAPS Coordinator**	**Cumulative Cost**
38	$0	$30,000	$0	$30,000	$3,560,000
39	$0	$30,000	$0	$30,000	$3,620,000
40	$0	$30,000	$0	$30,000	$3,680,000
41	$0	$30,000	$50,000	$30,000	$3,790,000
42	$0	$30,000	$0	$30,000	$3,850,000
43	$0	$30,000	$0	$30,000	$3,910,000
44	$0	$30,000	$0	$30,000	$3,970,000
45	$0	$30,000	$0	$30,000	$4,030,000
46	$0	$30,000	$50,000	$30,000	$4,140,000
47	$0	$30,000	$0	$30,000	$4,200,000
48	$0	$30,000	$0	$30,000	$4,260,000
49	$0	$30,000	$0	$30,000	$4,320,000
50	$0	$30,000	$0	$30,000	$4,380,000

Agricultural BMP Costs (After Cost Share)						
Year	Stream Buffers	Livestock Practices	No Till/ Nutrient Management/Crop Rotation	Terraces and Grassed Waterways (Crop Land)	Stream bank Stabilization	Cumulative Cost
1	$2,509	$13,447	$18,404	$259,712	$0	$294,071
2	$2,509		$18,404	$259,712	$0	$574,695
3	$2,509		$18,404	$259,712	$0	$855,320
4	$2,509		$18,404	$259,712	$0	$1,135,944
5	$2,509		$18,404	$259,712	$0	$1,416,568
6	$2,509	$13,447	$18,404	$259,712	$0	$1,710,639
7	$2,509		$18,404	$259,712	$0	$1,991,264
8	$2,509		$18,404	$259,712	$0	$2,271,888
9	$2,509		$18,404	$259,712	$0	$2,552,512
10	$2,509		$18,404	$259,712	$0	$2,833,136
11	$2,509	$13,447	$18,404	$259,712	$0	$3,127,208
12	$2,509		$18,404	$259,712	$0	$3,407,832
13	$2,509		$18,404	$259,712	$0	$3,688,456
14	$2,509		$18,404	$259,712	$0	$3,969,080
15	$2,509		$18,404	$259,712	$0	$4,249,705
16	$2,509	$13,447	$18,404	$259,712	$0	$4,543,776
17	$2,509		$18,404	$259,712	$0	$4,824,400
18	$2,509		$18,404	$259,712	$0	$5,105,024
19	$2,509		$18,404	$259,712	$0	$5,385,649
20	$2,509		$18,404	$259,712	$0	$5,666,273
21	$2,509	$13,447	$18,404	$259,712	$398,475	$6,358,819
22	$2,509		$18,404	$259,712	$398,475	$7,037,918
23	$2,509		$18,404	$259,712	$398,475	$7,717,018
24	$2,509		$18,404	$259,712	$398,475	$8,396,117
25	$2,509		$18,404	$259,712	$398,475	$9,075,216
26	$2,509	$13,447	$18,404	$259,712	$398,475	$9,767,762
27	$2,509		$18,404	$259,712	$398,475	$10,446,862
28	$2,509		$18,404	$259,712	$398,475	$11,125,961
29	$2,509		$18,404	$259,712	$398,475	$11,805,060
30	$2,509		$18,404	$259,712	$398,475	$12,484,159
31	$2,509	$13,447	$18,404	$259,712	$398,475	$13,176,706
32	$2,509		$18,404	$259,712	$398,475	$13,855,805
33	$2,509		$18,404	$259,712	$398,475	$14,534,904
34	$2,509		$18,404	$259,712	$398,475	$15,214,003
35	$2,509		$18,404	$259,712	$398,475	$15,893,103
36	$2,509	$13,447	$18,404	$259,712	$398,475	$16,585,649

Agricultural BMP Costs (After Cost Share)						
Year	**Stream Buffers**	**Livestock Practices**	**No Till/ Nutrient Management/Crop Rotation**	**Terraces and Grassed Waterways (Crop Land)**	**Stream bank Stabilization**	**Cumulative Cost**
37	$2,509		$18,404	$259,712	$398,475	$17,264,748
38	$2,509		$18,404	$259,712	$398,475	$17,943,847
39	$2,509		$18,404	$259,712	$398,475	$18,622,947
40	$2,509		$18,404	$259,712	$398,475	$19,302,046
41	$2,509	$13,447	$18,404	$259,712	$398,475	$19,994,592
42	$2,509		$18,404	$259,712	$398,475	$20,673,691
43	$2,509		$18,404	$259,712	$398,475	$21,352,790
44	$2,509		$18,404	$259,712	$398,475	$22,031,890
45	$2,509		$18,404	$259,712	$398,475	$22,710,989
46	$2,509	$13,447	$18,404	$259,712	$398,475	$23,403,535
47	$2,509		$18,404	$259,712	$398,475	$24,082,634
48	$2,509		$18,404	$259,712	$398,475	$24,761,734
49	$2,509		$18,404	$259,712	$398,475	$25,440,833
50	$2,509		$18,404	$259,712	$398,475	$26,119,932

Urban BMP Costs (After Cost Share)									
Year	Stream Buffers	Stream bank Stabilization	Permanent Revegetation	Commercial Bioretention	Water Quality Swales	Residential Rain Gardens	Pond and Lake Buffers	Detention/ Retention	Cumulative Cost
1	$0	$0	$0	$0	$0	$0	$0	$0	$0
2	$0	$0	$0	$0	$0	$0	$0	$0	$0
3	$0	$0	$0	$0	$0	$0	$0	$0	$0
4	$0	$0	$0	$0	$0	$0	$0	$0	$0
5	$0	$0	$0	$0	$0	$0	$0	$0	$0
6	$163,636	$0	$501,782	$0	$0	$0	$418,875	$287,323	$1,371,616
7	$163,636	$0	$501,782	$0	$0	$0	$418,875	$287,323	$2,743,232
8	$163,636	$0	$501,782	$0	$0	$0	$418,875	$287,323	$4,114,848
9	$163,636	$0	$501,782	$0	$0	$0	$418,875	$287,323	$5,486,465
10	$163,636	$0	$501,782	$0	$0	$0	$418,875	$5,287,323	$11,858,081
11	$163,636	$0	$501,782	$0	$0	$0	$418,875	$287,323	$13,229,697
12	$163,636	$0	$501,782	$0	$0	$0	$418,875	$287,323	$14,601,313
13	$163,636	$0	$501,782	$0	$0	$0	$418,875	$287,323	$15,972,929
14	$163,636	$0	$501,782	$0	$0	$0	$418,875	$287,323	$17,344,545
15	$163,636	$0	$501,782	$0	$0	$0	$418,875	$287,323	$18,716,161
16	$163,636	$0	$501,782	$0	$0	$0	$418,875	$287,323	$20,087,777
17	$163,636	$0	$501,782	$0	$0	$0	$418,875	$287,323	$21,459,394
18	$163,636	$0	$501,782	$0	$0	$0	$418,875	$287,323	$22,831,010
19	$163,636	$0	$501,782	$0	$0	$0	$418,875	$287,323	$24,202,626
20	$163,636	$0	$501,782	$0	$0	$0	$418,875	$287,323	$25,574,242
21	$163,636	$302,016	$501,782	$76,117	$100,520	$311,266	$418,875	$0	$27,448,454
22	$163,636	$302,016	$501,782	$76,117	$100,520	$311,266	$418,875	$0	$29,322,666
23	$163,636	$302,016	$501,782	$76,117	$100,520	$311,266	$418,875	$0	$31,196,878
24	$163,636	$302,016	$501,782	$76,117	$100,520	$311,266	$418,875	$0	$33,071,091
25	$163,636	$302,016	$501,782	$76,117	$100,520	$311,266	$418,875	$0	$34,945,303
26		$302,016		$76,117	$100,520	$311,266	$0	$0	$35,735,221
27		$302,016		$76,117	$100,520	$311,266	$0	$0	$36,525,140
28		$302,016		$76,117	$100,520	$311,266	$0	$0	$37,315,058
29		$302,016		$76,117	$100,520	$311,266	$0	$0	$38,104,977
30		$302,016		$76,117	$100,520	$311,266	$0	$0	$38,894,895
31		$302,016		$76,117	$100,520	$311,266	$0	$0	$39,684,814
32		$302,016		$76,117	$100,520	$311,266	$0	$0	$40,474,732
33		$302,016		$76,117	$100,520	$311,266	$0	$0	$41,264,651
34		$302,016		$76,117	$100,520	$311,266	$0	$0	$42,054,569
35		$302,016		$76,117	$100,520	$311,266	$0	$0	$42,844,488
36		$302,016		$76,117	$100,520	$311,266	$0	$0	$43,634,407
37		$302,016		$76,117	$100,520	$311,266	$0	$0	$44,424,325

Urban BMP Costs (After Cost Share)									
Year	Stream Buffers	Stream bank Stabilization	Permanent Revegetation	Commercial Bioretention	Water Quality Swales	Residential Rain Gardens	Pond and Lake Buffers	Detention/ Retention	Cumulative Cost
38		$302,016		$76,117	$100,520	$311,266	$0	$0	$45,214,244
39		$302,016		$76,117	$100,520	$311,266	$0	$0	$46,004,162
40		$302,016		$76,117	$100,520	$311,266	$0	$0	$46,794,081
41		$302,016		$76,117	$100,520	$311,266	$0	$0	$47,583,999
42		$302,016		$76,117	$100,520	$311,266	$0	$0	$48,373,918
43		$302,016		$76,117	$100,520	$311,266	$0	$0	$49,163,836
44		$302,016		$76,117	$100,520	$311,266	$0	$0	$49,953,755
45		$302,016		$76,117	$100,520	$311,266	$0	$0	$50,743,673
46		$302,016		$76,117	$100,520	$311,266	$0	$0	$51,533,592
47		$302,016		$76,117	$100,520	$311,266	$0	$0	$52,323,510
48		$302,016		$76,117	$100,520	$311,266	$0	$0	$53,113,429
49		$302,016		$76,117	$100,520	$311,266	$0	$0	$53,903,347
50		$302,016		$76,117	$100,520	$311,266	$0	$0	$54,693,266

APPENDIX B

BIBLIOGRAPHY

COMPREHENSIVE AND AREA PLANS, ZONING, AND SUBDIVISION REGULATIONS

Arkansas River Coalition. 2008. *Arkansas River Access Plan*. Accessed on-line at: http://www.wichita.gov/CityOffices/Environmental/River/ARCAP/

City of Kechi. Zoning Regulation. Accessed online at: http://www.kechiks.com/index.php?option=com_rokdownloads&view=folder&Itemid=29

City of Maize. 2006. *Maize Comprehensive Plan*. Prepared by the Planning and Zoning Department. August. Accessed online at: http://www.cityofmaize.org/PDF/MaizeCompPlan.pdf

City of Park City. 2008. *Comprehensive Development Plan 2008-2018*. Prepared by the Planning Department. August. Accessed online at: http://www.parkcityks.com/index.aspx?NID=140

City of Valley Center. 2007. *Comprehensive Development Plan*. Planning Commission. November. Accessed online at: http://www.valleycenterks.org/index.aspx?nid=92

Wichita Area Metropolitan Planning Organization (WAMPO). 2011. *WAMPO Development and Transportation Trends Report—2011*. Accessed on-line at: http://www.wichita.gov/CityOffices/Planning/AP/Comprehensive/2011DevTrends.htm

WAMPO. 2007. *Regional Pathway System Plan*. September. Accessed on-line at: http://www.wampoks.org/IconMenu/Pathways.htm

Wichita-SedgwickCounty Metopolitan Area Planning Department (MAPD). 2008. *Wichita Parks Recreation and Open Space Plan*. December. Accessed on-line at: http://www.wichita.gov/CityOffices/Planning/AP/Comprehensive/PROSPlan

MAPD. 2005. Comprehensive Plan & Development Activity Home Page. May. Accessed on-line at: http://www.wichita.gov/CityOffices/Planning/AP/Comprehensive/

MAPD. 2004. "Functional Land Use Guide." Accessed on-line at: http://www.wichita.gov/NR/rdonlyres/69115285-70E0-4ABA-A4D6-CC248F03A516/0/fu_landuse_map2004.gif

MAPD. No Date. *K-96 Corridor Economic Development Plan*. Accessed on-line at: http://www.wichita.gov/CityOffices/Planning/AP/Comprehensive/k-96econdevplan.htm

REGULATORY AND PERMIT DOCUMENTS

City of Maize. Storm Water Management Home Page. Department of Public Works. Accessed online at: http://www.cityofmaize.org/stormwater.php

City of Valley Center. 2004. NPDES Municipal Storm Water Permit, Permit # M-LA16-SU01. Accessed online at: http://www.valleycenterks.org/DocumentView.aspx?DID=1127

City of Valley Center. 2005. Stormwater Treatment Ordinance. Accessed online at: http://www.valleycenterks.org/DocumentView.aspx?DID=1125

City of Wichita. 2011. *Storm Water Manual*. Prepared by the Department of Public Works and Utilities. Accessed on-line at: http://www.wichita.gov/CityOffices/PublicWorks/StormWater/Manual/

City of Wichita, Kansas. 2010a. Draft Floodplain Management Ordinance. January. Accessed on-line at: http://www.wichita.gov/NR/rdonlyres/87AA0344-E581-4427-A459-A904B88C75C8/0/100126CityofWichitaFPOrdinanceHIGHLIGHTED.pdf

City of Wichita. 2010b. Stormwater Treatment Ordinance. Public Works and Utilities, Stormwater Management. http://www.wichita.gov/NR/rdonlyres/8081CA74-A64E-4B7A-8B5F-CFE4269DA1F9/0/NPDESPermit20072012.pdf

City of Wichita, Kansas. 2010c. Municipal Code, Section 16.032 - Stormwater Pollution Prevention. November. http://library.municode.com/index.aspx?clientID=14166&stateID=16&statename=Kansas

City of Wichita, Kansas. 2010d. Annual Report - Wichita NPDES Municipal Storm Water Permit, Permit # M-AR94-SO01. Prepared by the Office of Environmental Health.

City of Wichita, Kansas. 2009a. Annual Report - Wichita NPDES Municipal Storm Water Permit, Permit # M-AR94-SO01. Prepared by the Office of Environmental Health.

City of Wichita, Kansas. 2008a. Annual Report - Wichita NPDES Municipal Storm Water Permit, Permit # M-AR94-SO01. Prepared by the Office of Environmental Health.

City of Wichita, Kansas. 2007. Municipal Code, Section 27.06 - Floodplain Management. February. http://library.municode.com/index.aspx?clientID=14166&stateID=16&statename=Kansas

Kansas Department of Health and Environment. 2010a. Lower Arkansas River Basin TMDLs. Bureau of Water – Watershed Planning Section. Accessed on-line at: http://www.kdheks.gov/tmdl/latmdl.htm.

Kansas Department of Health and Environment. Kansas Surface Water Register, December 15, 2010. Accessed on-line at: http://www.kdheks.gov/befs/download/Current_Kansas_Surface_Register.pdf

Sedgwick County, Kansas. 2010. Sedgwick County Storm Water Management Code, Resolution No. 196-10. November 23.

Sedgwick County, Kansas. 2004. NPDES Municipal Storm Water Permit, Permit # M-AR94-SU01.

CAPITAL IMPROVEMENT PLANS AND STUDIES

City of Wichita. 2009b. *Adopted Capital Improvement Program 2009-2018*. Accessed on-line at: http://www.wichita.gov/NR/rdonlyres/90BB6045-04B7-433B-BE17-E4104CAEBA8B/0/20092018AdoptedCIPbook2Feb2010.pdf

City of Wichita. 2008b. *Calfskin Creek Watershed Study*. Prepared by MKEC for Public Works and Utilities, Stormwater Management. June.

Patti Banks Associates, PEC, and Black & Veatch. 2010. *Final Business Plan*. Prepared for the Sedgwick County Public Works Department and the Sedgwick County Stormwater Management Advisory Board. November 1.

Professional Engineering Consultants. 2006. *Cadillac Lake Drainage Study*. Prepared for the City of Wichita. August.

GENERAL REFERENCE

Center for Watershed Protection (CWP). 1995. *Site Planning for Urban Stream Protection*. December.

CWP. 2000. *Managing Watersheds for Quality Development*. March. Accessed on-line at: http://www.kdheks.gov/nps/resources/NPSMgmtPlanAppendices_combined_04.29.2011.pdf

Kansas State University Research and Extension. Accessed online at: http://www.agronomy.ksu.edu/extension/p.aspx?tabid=84

Visoneering Wichita. Environmental Sustainability Alliance Home Page. Accessed online at: http://visioneeringwichita.com/sa-environmental.cfm

Wichita Initiative for a Renewed Environment. Home Page. Accessed online at: http://wichita.kumc.edu/care/

U.S. EPA, National Menu of Best Management Practices. Accessed online at http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

NATURAL RESOURCE PLANS, STUDIES, AND REFERENCES

City of Wichita. Equus Beds Aquifer Storage and Recovery Project Main Website. Accessed online at: www.wichita.gov/CityOffices/WaterAndSewer/ProductionAndPumping/ASR/

City of Wichita. 2004. Water Quality Study of the Arkansas River - Phase 2 Report. Prepared by HDR for the City of Wichita. January.

Kansas Department of Health and Environment. 2010b. Kansas Non-Point Source Pollution Management Plan Update. Prepared by the Bureau of Water, Planning and Management Section. Accessed online at: http://www.kdheks.gov/nps/resources/KSNPSMgmtPlan_04-29-2011_final.pdf

Kansas Department of Health and Environment. No Date. Bureau of Water – Watershed Management. Sedgwick County Projects. Accessed on-line at: http://www.kdheks.gov/nps/project/sg.htm

- Arkansas River Water Quality Study
- Golf Course Water Quality Protection Demonstration Site Selection
- Golf Course Water Quality Protection and Implementation Demonstration & Technical assistance
- High School Lake and Stream Monitoring
- Investigation the effects of Stormwater Runoff from Public Use and Recreational Areas Part 1-3
- Stormwater Treatment /Parking lots (Riverside Neighborhood Stormwater Project)
- Water Quality Evaluation of NPS Urban Stormwater Runoff from Public Use and Recreation areas Parts 1-2
- Constructed Wetlands in Sedgwick County

Kansas State Research and Extension. Bookstore/Library Home Page. Accessed online at: http://www.ksre.ksu.edu/library/p.aspx?tabid=16&topic=Environment%20and%20Natural%20Resources

- Cheney Lake Watershed: Assessing the Impact of Implementing Conservation practices in the Cheney Lake Watershed
- Cheney Lake Watershed: Conservation Practice Implementation History and Trends.

Kansas Department of Wildlife & Parks. 2006. Stream Monitoring and Assessment Program, Sub-watershed Report. February. Accessed online at: http://www.kdwpt.state.ks.us/news/layout/set/print/Services/Stream-Assessment-and-Monitoring-Program/Sub-Watershed-report

Sedgwick County. Environmental Resources. Conservation District. Non-Point Source Pollution Program. Accessed online at: http://www.sedgwickcounty.org/environment/non-point_source_polution.asp

U.S. Army Corps of Engineers. 2004. *Final Environmental Assessment - Cowskin Creek Local Flood Protection Project, Wichita, Kansas*. Prepared by the Tulsa District for the City of Wichita, Kansas. July.

U.S. Geological Survey. 2003. Estimated Flood-Inundation Maps for Cowskin Creek in Western Wichita, Kansas. Water-Resources Investigations Report 03-4074. Prepared in Cooperation with the City of Wichita, Kansas.

U.S. Geological Survey. *Regression Analysis and Real Time Monitoring to Estimate Constituent Concentrations, Loads, and Yields in the Little Arkansas River, south Central Kansas,* U.S.G.S Water Resources Investigations Report 00-4126.

U.S. Geological Survey. Effects of Artificial Recharge on Water Quality in the Equus Beds Aquifer, South Central Kansas, 1995-2000. Accessed on-line at http://ks.water.usgs.gov/pubs/fact-sheets/fs.096-01.pdf

GEOGRAPHIC INFORMATION SYSTEMS (GIS) DATA

City of Derby. Geographic Information Systems. Accessed online at: http://www.derbyweb.com/departments/gis-department.cfm

University of Kansas. Kansas Applied Remote Sensing Program of the Kansas Biological Survey. Accessed online at: http://kars.ku.edu/

Sedgwick County GIS. Accessed online at: http://gis.sedgwick.gov/whatsavailable.asp

WATER QUALITY DATA

City of Wichita. No Date. Quarterly Monitoring Data, NPDES Municipal Storm Water Permit, Permit # M-AR94-SO01. Prepared by the