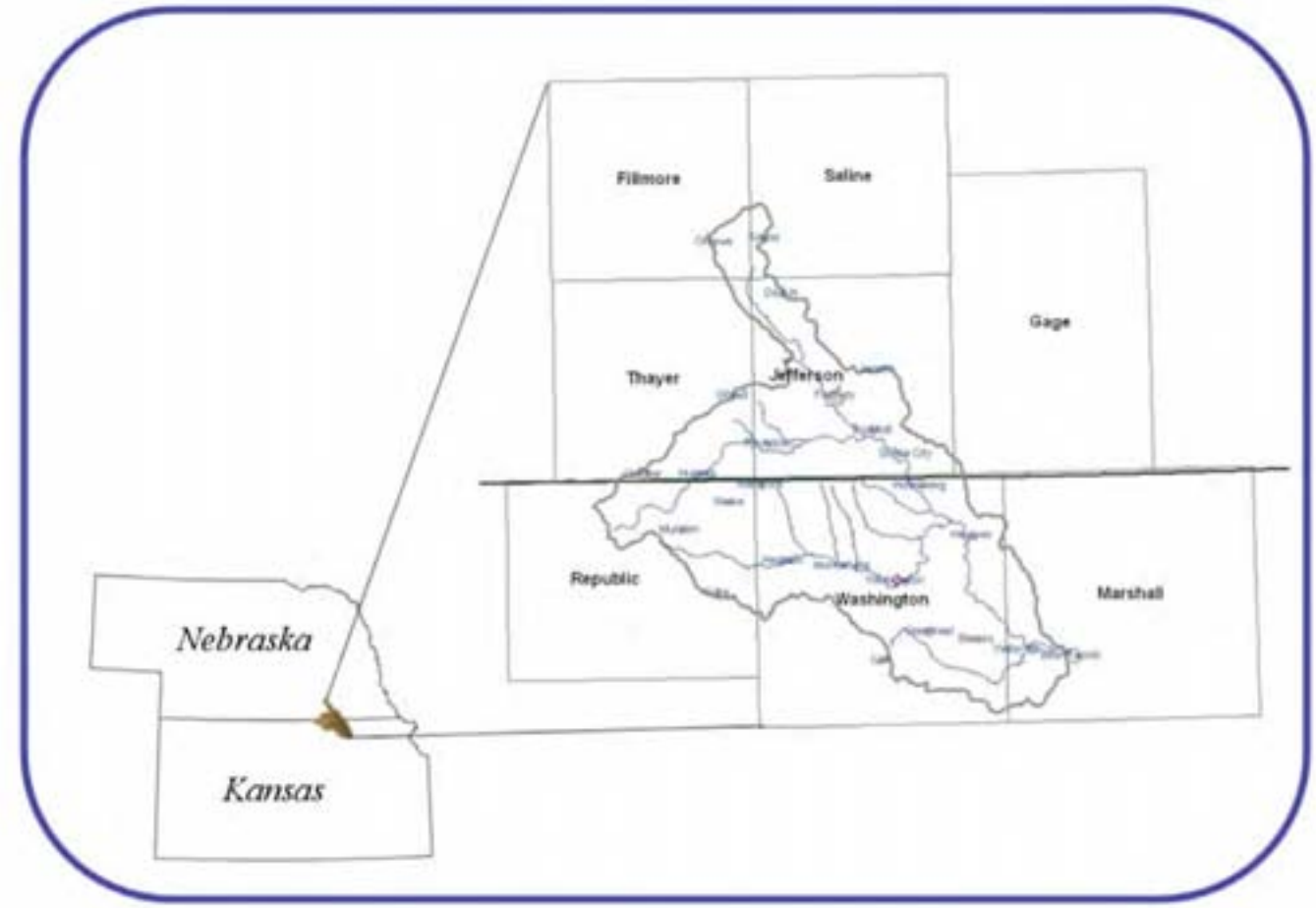
Lower Little Blue Watershed Assessment: Preliminary Report



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1.0 Lower Little Blue Watershed Assessment

Figure 1. Major roads and cities – Lower Little Blue Watershed

1.1 Watershed Summary

The Lower Little Blue Watershed is located primarily in Republic, Washington and Marshall counties in northeast Kansas. It contains the Little Blue River, which originate in Nebraska, in addition to the numerous creeks and tributaries. The Little Blue River feeds into the Big Blue River and into Tuttle Creek Lake, which is an important lake in the watershed, providing recreation and flood control. Lake Idlewild and Washington County State Fishing Lake Wildlife Area are located in the watersheds. The Lower Little Blue Watershed is a Category I designation, indicating the watershed is in need of restoration and protection to sustain water quality.

Crop production is the predominant land usage (47 percent) for the watershed. Grassland is the second largest land usage at 41 percent. Woodland, water, and urban areas constitute the remaining 12 percent of land cover[1].

1.2 Overview of Water Quality Issues and Potential Pollution Sources

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

Fecal coliform bacteria is listed as a TMDL in the Little Blue River. The presence of fecal coliform bacteria indicates the water has been in contact with warm-blooded animals. Potential sources include feedlots, wastewater treatment plants, failing septic systems, and wildlife. Target TMDL endpoint is less than 200 colony forming units per 100 ml water for swimming, and less than 2,000 colony forming units per 100ml water for boating and fishing.

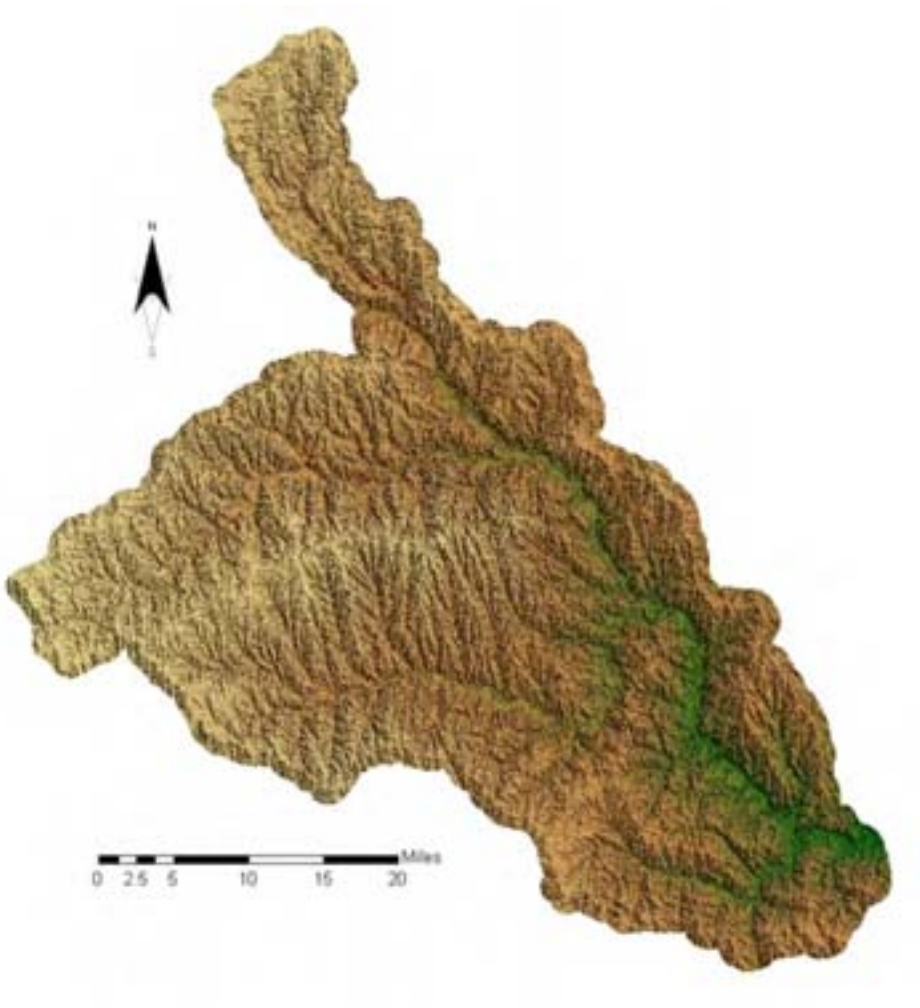

Figure 2. Relief Maps – Lower Little Blue Watershed [3]

Eutrophication is a primary pollutant for Lake Idlewild and Washington County Wildlife Area. Excess nutrient loading from the watershed creates conditions favorable for algae blooms and aquatic plant growth resulting in low dissolved oxygen rates and an unfavorable habitat for aquatic life. Surplus nutrients originate from manure and fertilizer runoff in rural and urban areas. Washington County State Fishing Lake has related TMDLs for low dissolved oxygen and aquatic life inhibition. These TMDLs are caused by many of the same conditions as eutrophication. Many agricultural producers in the watershed implement best management practices (known as BMPs) to prevent nutrient runoff. Some common BMPs include: the use of conservation tillage and cover crops, maintaining buffer strips along field edges, and proper timing of fertilizer application.

Washington Wildlife Area is impaired by siltation. Silt or sediment accumulation in lakes and wetlands reduces reservoir volume and limits public access to the lakes. In addition to the problem of sediment loading in lakes, copper and beryllium can be attached to the suspended soil particles in the water column causing higher than normal concentrations. Reducing erosion is necessary for a reduction in sediment. Agricultural best management practices such as conservation tillage, grass buffer strips around cropland, and reducing activities within the riparian areas will reduce erosion and improve water quality[2].

2.0 Climate Mapping System

2.1 Precipitation Map[4]

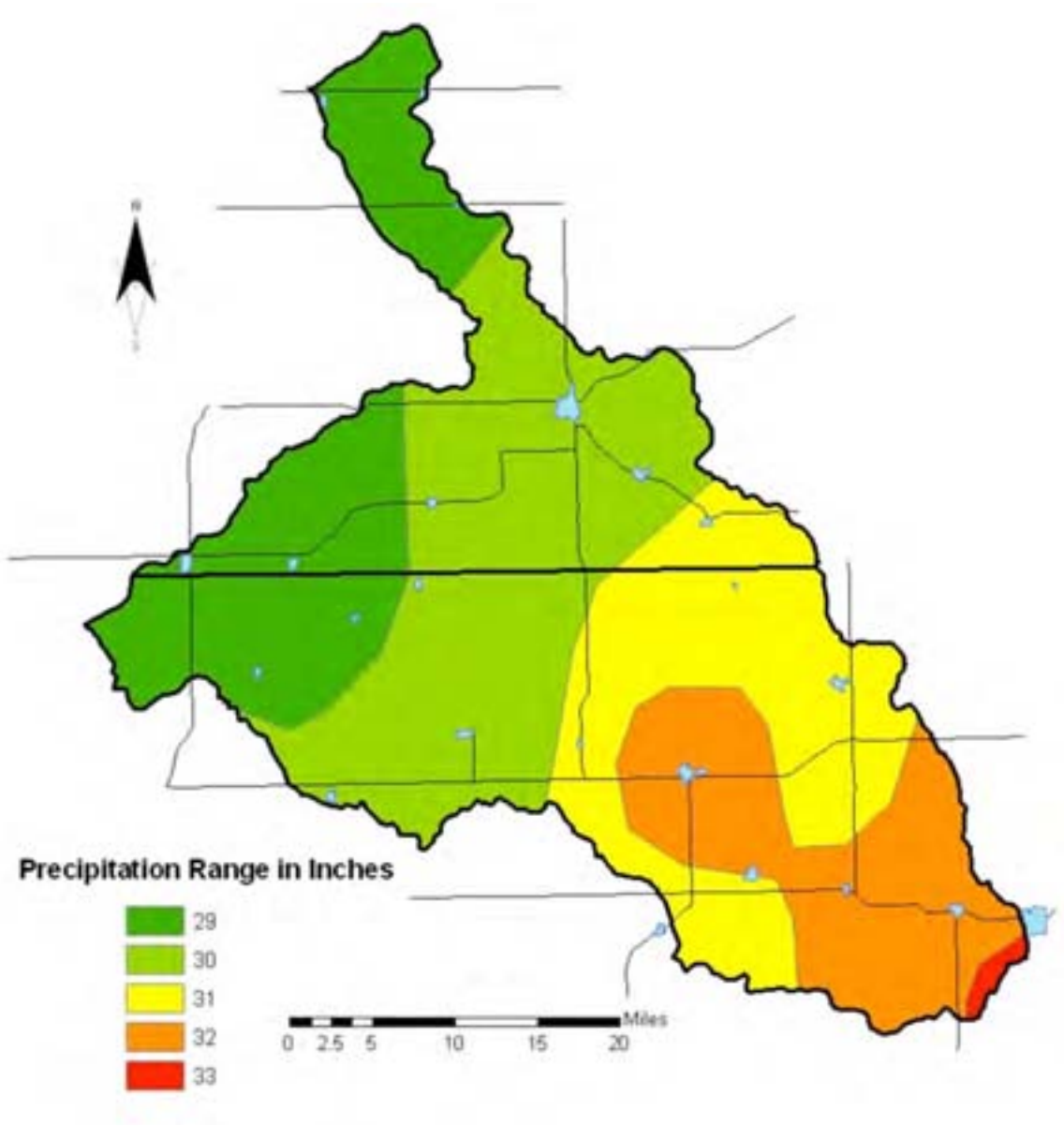

Figure3. 30-year average annual precipitation in inches, 1971 – 2000.

2.2 30-Year Average Daily Maximum Temperature Map[5]

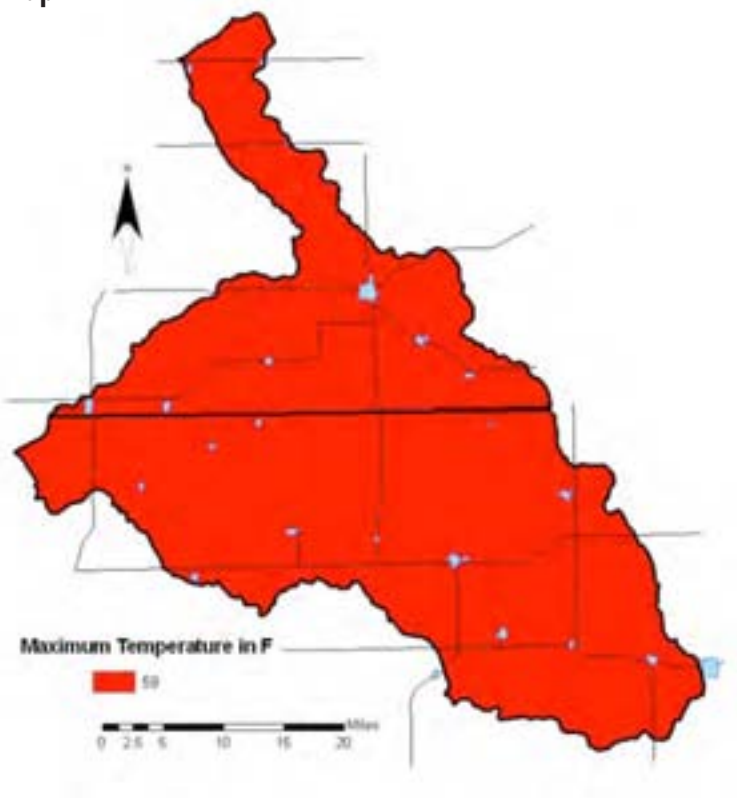

Figure 4. 30-year average daily maximum temperature in degrees Fahrenheit, 1971 – 2000

2.3 30-Year Average Daily Minimum Temperature Map[6]

Figure 5. 30-year average daily minimum temperature in degrees Fahrenheit, 1971 – 2000

3.0 Land Use/ Land Cover

3.1 Land Use (GIRAS 1980s)[7]

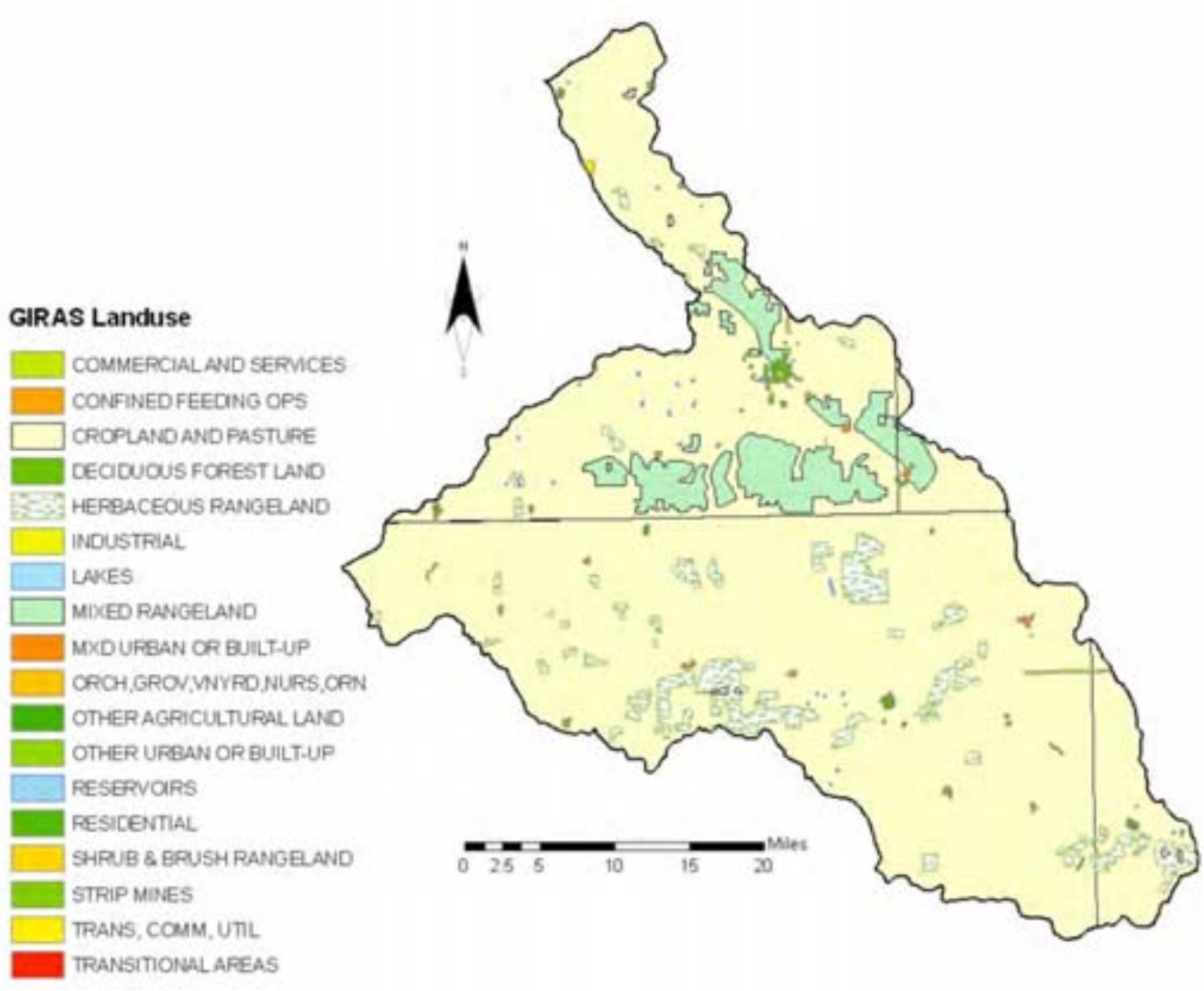

Figure 6. GIRAS 1980s land use classification.

3.2 Land Use (NLCD 1992)[8]

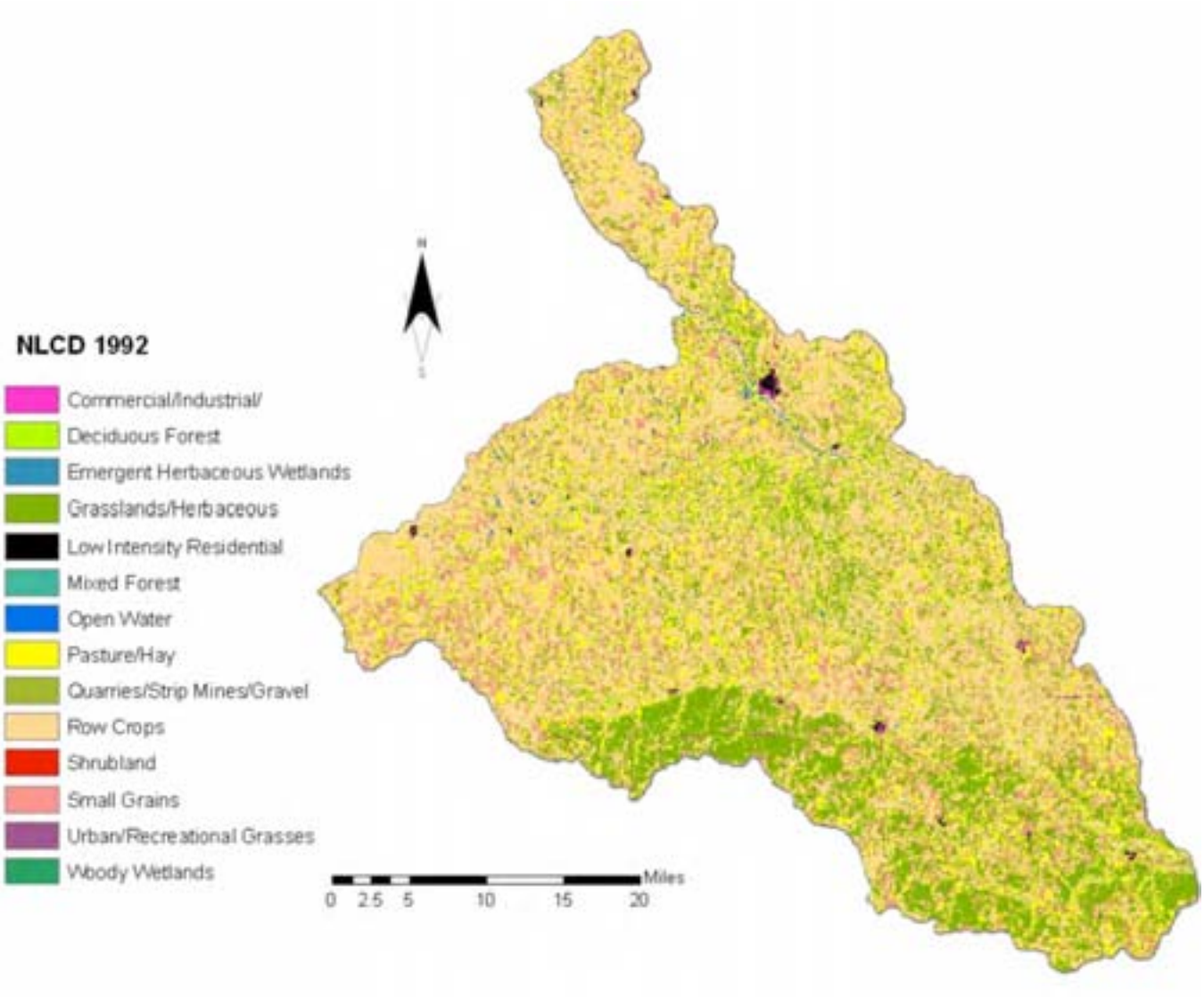

Figure 7. NLCD 1992 land use classification.

3.2.1 NLCD 1992 Land Cover Class Definitions[34]

The following definitions are from the EPA's National Land Cover Database, found at: *http://www.epa.gov/mrlc/definitions.html#1992*

11. Open Water – all areas of open water, generally with less than 25% cover of vegetation/land cover.

21. Low Intensity Residential – Includes areas with a mixture of constructed materials and vegetation. Constructed materials account for 30-80 percent of the cover. Vegetation may account for 20 to 70 percent of the cover. These areas most commonly include single-family housing units. Population densities will be lower than in high intensity residential areas.

23. Commercial/Industrial/Transportation – Includes infrastructure (e.g. roads, railroads, etc.) and all highly developed areas not classified as High Intensity Residential.

32. Quarries/Strip Mines/Gravel Pits – Areas of extractive mining activities with significant surface expression.

41. Deciduous Forest – Areas dominated by trees where 75 percent or more of the tree species shed foliage simultaneously in response to seasonal change.

43. Mixed Forest – Areas dominated by trees where neither deciduous nor evergreen species represent more than 75 percent of the cover present.

51. Shrubland – Areas dominated by shrubs; shrub canopy accounts for 25-100 percent of the cover. Shrub cover is generally greater than 25 percent when tree cover is less than 25 percent. Shrub cover may be less than 25 percent in cases when the cover of other life forms (e.g. herbaceous or tree) is less than 25 percent and shrubs cover exceeds the cover of the other life forms.

71. Grasslands/Herbaceous – Areas dominated by upland grasses and forbs. In rare cases, herbaceous cover is less than 25 percent, but exceeds the combined cover of the woody species present. These areas are not subject to intensive management, but they are often utilized for grazing.

81. Pasture/Hay – Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops.

82. Row Crops – Areas used for the production of crops, such as corn, soybeans, vegetables, tobacco, and cotton.

83. Small Grains – Areas used for the production of graminoid crops such as wheat, barley, oats, and rice.

85. Urban/Recreational Grasses – Vegetation (primarily grasses) planted in developed settings for recreation, erosion control, or aesthetic purposes. Examples include parks, lawns, golf courses, airport grasses, and industrial site grasses.

91. Woody Wetlands – Areas where forest or shrubland vegetation accounts for 25-100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.

92. Emergent Herbaceous Wetlands – Areas where perennial herbaceous vegetation accounts for 75-100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.

3.3 Land Use (NLCD 2001)[1]

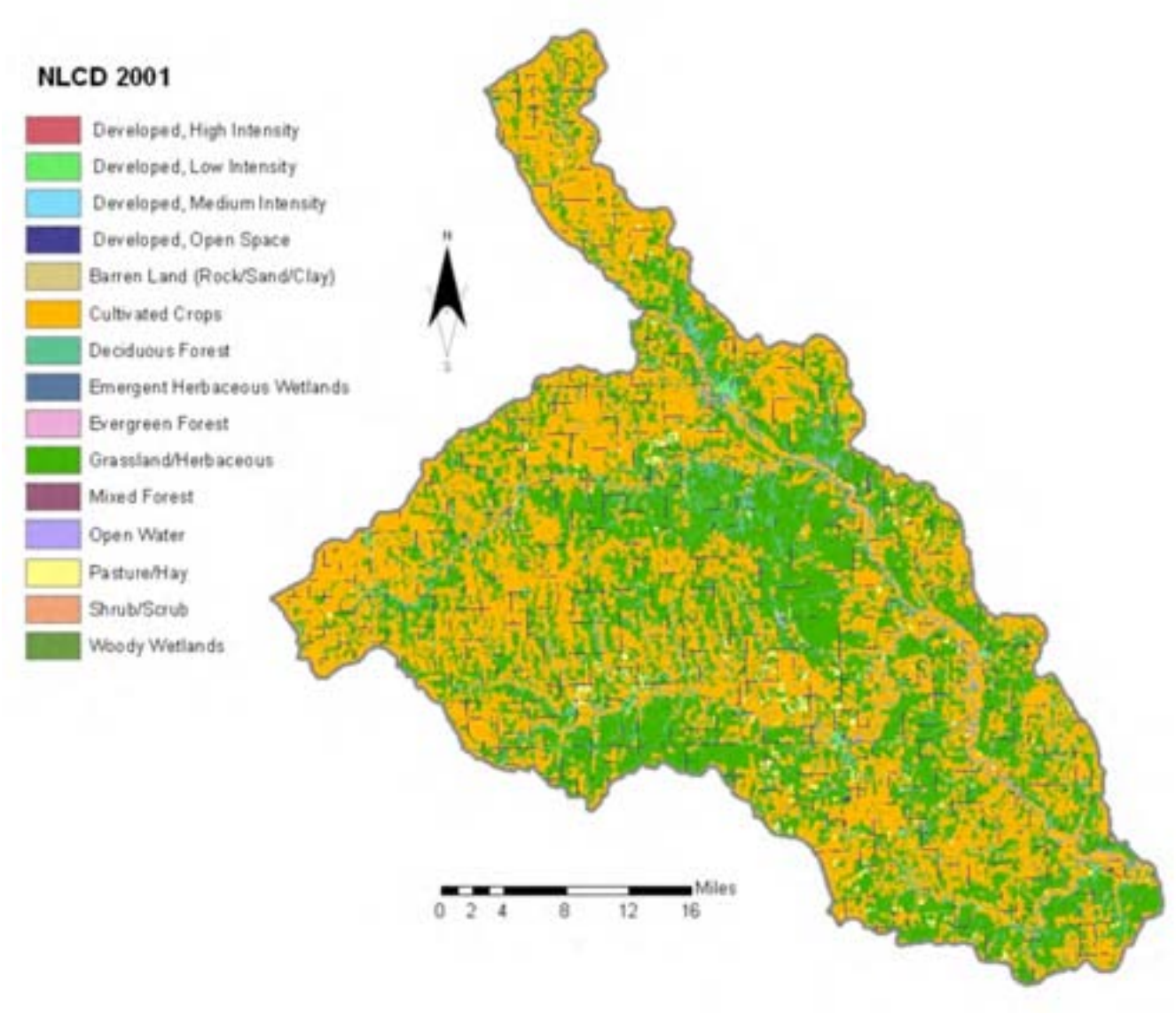

Figure 8. NLCD 2001 land use classification.

3.3.1 NLCD 2001 Land Cover Class Definitions[35]

The following definitions are from the EPA's National Land Cover Database, found at: *http://www.epa.gov/mrlc/definitions.html#2001*

11. Open Water – All areas of open water, generally with less than 25% cover of vegetation or soil.

21. Developed, Open Space – Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

22. Developed, Low Intensity – Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single-family housing units.

23. Developed, Medium Intensity – Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79 percent of the total cover. These areas most commonly include single-family housing units.

24. Developed, High Intensity – Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to100 percent of the total cover.

31. Barren Land (Rock/Sand/Clay) – Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.

41. Deciduous Forest – Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.

42. Evergreen Forest – Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.

43. Mixed Forest – Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.

52. Shrub/Scrub – Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.

71. Grassland/Herbaceous – Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.

81. Pasture/Hay – Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.

82. Cultivated Crops – Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.

90. Woody Wetlands – Areas where forest or shrubland vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

92. Emergent Herbaceous Wetlands – Areas where perennial herbaceous vegetation accounts for 75-100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.

Table 1. Summary of land use covers

Land Use Type	Agriculture			Barren Land	Forest Land	Grassland	Urban	Wetlands/ Water	Shrub	Total
	Cropland	Pasture	Total							
GIRAS 1980s	749411		749411	647	758	98675	5667	447	0	855605
NLCD 1992	481633	126386	608019	348	16087	219801	5469	5688	34	855446
NLCD 2001	394084	10048	404131	113	53045	349299	38574	10343	100	855605

4.0 River Network[9]

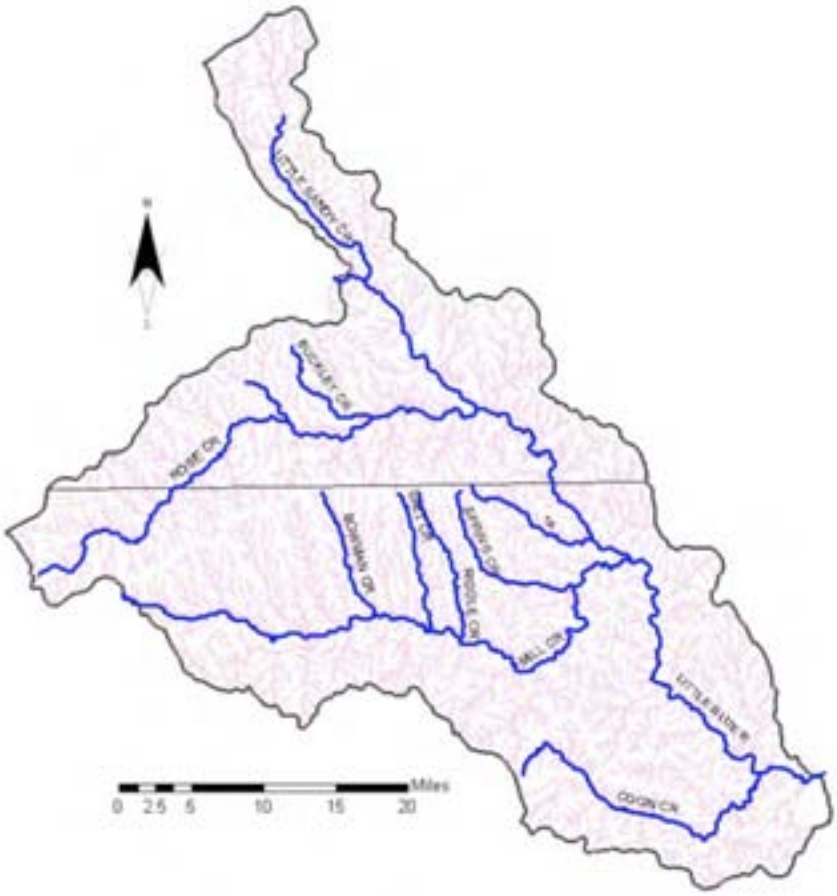

Figure 9. River network – Lower Little Blue Watershed

5.0 Hydrologic Soil Groups[10]

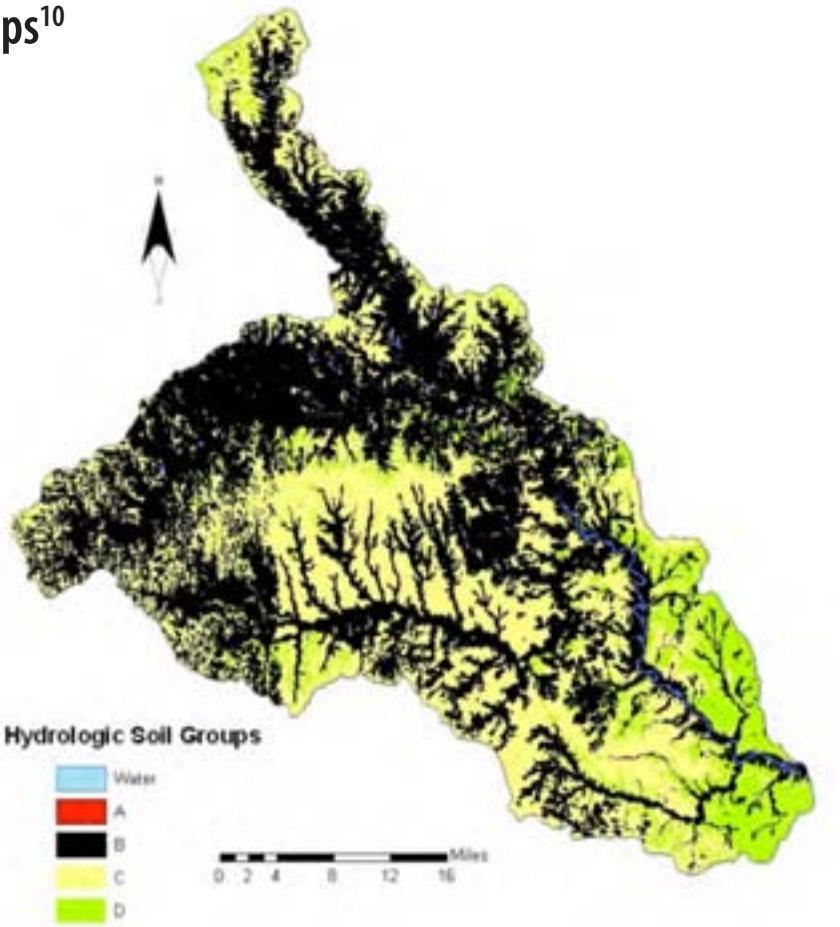

Figure 10. Hydrologic Soil Groups – SSURGO Database – Lower Little Blue Watershed

6.0 Water Quality Conditions

6.1 The 303d List of Impaired Waterbodies[2]

This map shows all impaired streams that are not meeting their designated uses (impaired waters) because of excess pollutants as defined in Section 303(d) of the Clean Water Act. The list of impaired waterways is updated by the states every two years. This can be used to identify specific stream segments and lakes for which, in accordance with their priority ranking, TMDLs may need to be developed.

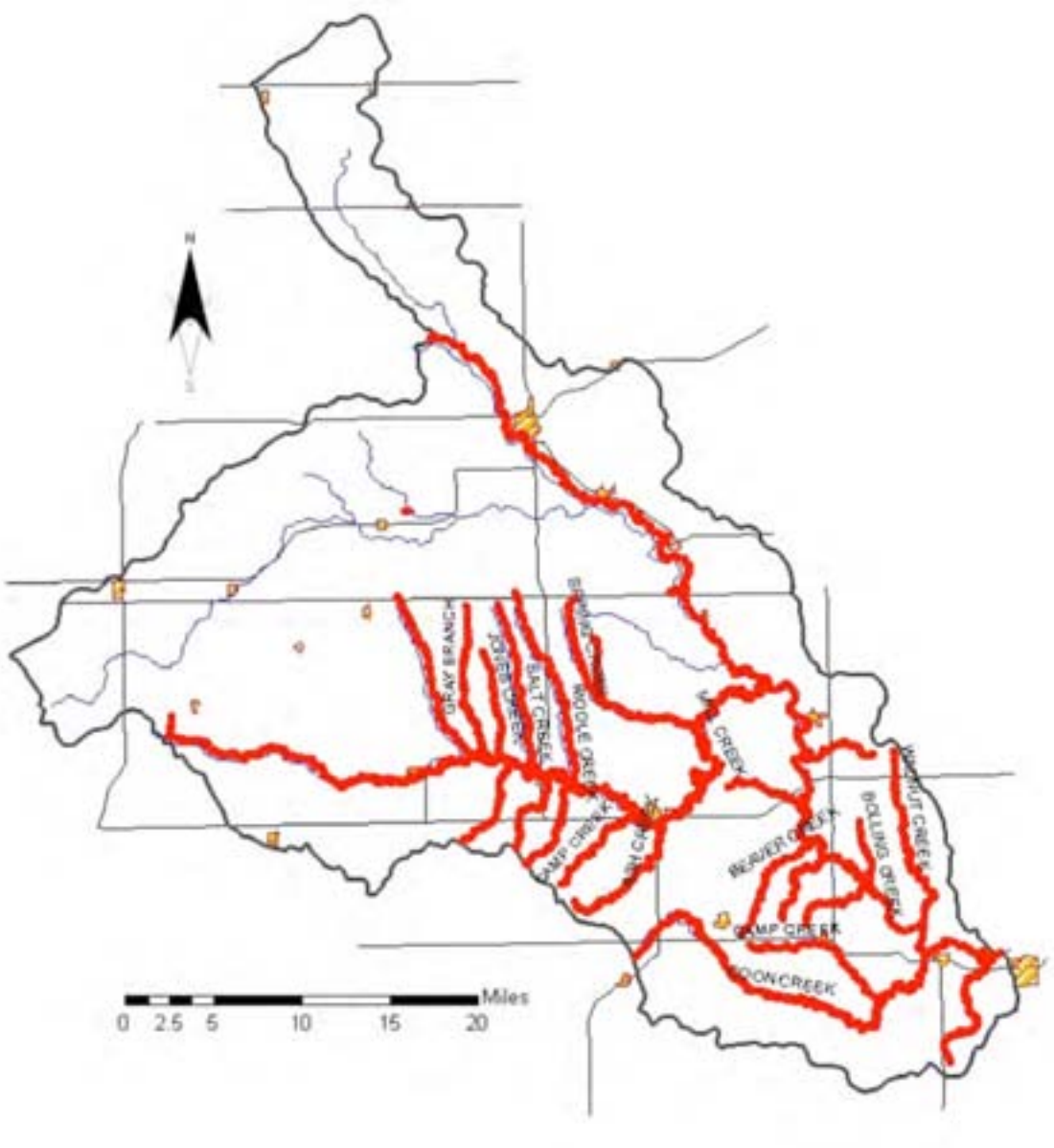

Figure 11. Impaired Waterbodies based on the 303d list – Lower Little Blue Watershed.

Table 2. The 303d List of Impaired Waterbodies

State	Waterbody Name	Impairment
KS	Ash Creek	Fecal Coliform
KS	Beaver Creek	Fecal Coliform
KS	Bolling Creek	Fecal Coliform
KS	Bowman Creek	Fecal Coliform
NE	Buckley Reservoir	Nutrients, Suspended Solids, Siltation, Turbidity
KS	Buffalo Creek	Fecal Coliform
KS	Camp Creek	Fecal Coliform
KS	Cedar Creek	Fecal Coliform
KS	Coon Creek	Fecal Coliform
KS	Fawn Creek	Fecal Coliform
KS	Gray Branch	Fecal Coliform
KS	Iowa Creek	Fecal Coliform
KS	Jones Creek	Fecal Coliform
KS	Lane Branch	Fecal Coliform
NE	Little Blue River	Pesticides, Pathogens
KS	Little Blue River	Fecal Coliform
KS	Malone Creek	Fecal Coliform
KS	Melvin Creek	Fecal Coliform
KS	Mercer Creek	Fecal Coliform
KS	Mill Creek	Fecal Coliform
KS	Riddle Creek	Fecal Coliform
KS	Salt Creek	Fecal Coliform
KS	School Creek	Fecal Coliform
KS	Spring Creek	Fecal Coliform
KS	Walnut Creek	Fecal Coliform
KS	Washington Co Sfl	Low Dissolved Oxygen, Macrophytes

6.2 Water Quality Observation Stations[11]

USEPA Observation-level water quality monitoring data is useful for identifying the location of water quality data in a given watershed.

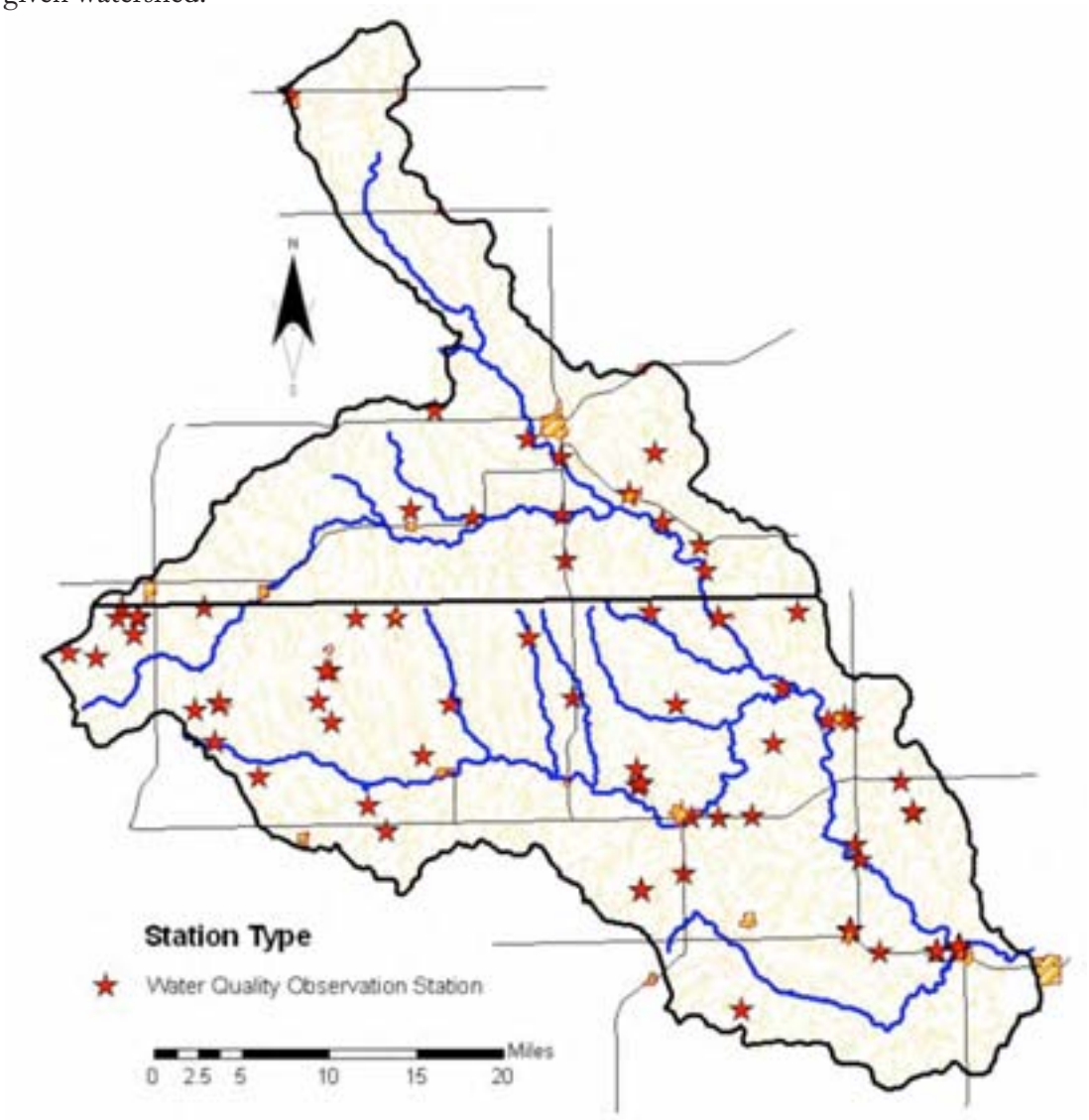

Figure 12. Lakes and Streams Water Quality Observation Stations – Lower Little Blue Watershed.

Table 3. Water Quality Observation Station

State	Agency	Station ID	Station Name
KS	USGS	06884025	Little Blue R At Hollenberg, KS
KS	USGS	06884200	Mill C At Washington, KS
KS	USGS	06884400	L Blue R Nr Barnes, KS
KS	KDHE	000232	Little Blue R. Near Hollenberg, KS
NE	NDEQ	300906	Little Blue River
NE	USGS	06884000	Little Blue River near Fairbury, NE.
KS	USGS	06884300	Mill C Tr Nr Washington, KS
KS	USGS	06884390	L Blue R At Hanover, KS
KS	USGS	06884500	L Blue R At Waterville, KS
KS	USGS	393912096592101	05S 04E 04BBA 01

State	Agency	Station ID	Station Name
KS	USGS	394152096450801	04S 06E 16DDD 01
KS	USGS	394152096464301	04S 06E 17DCC 01
KS	USGS	394153096501701	04S 05E 14CCD 01
KS	USGS	394156096463901	04S 06E 17DC 01
KS	USGS	394205096450701	04S 06E 16DAD 01
KS	USGS	394205096451601	04S 06E 16DAC 01
KS	USGS	394205096451602	04S 06E 16DAC 02
KS	USGS	394205096451603	04S 06E 16DAC 03
KS	USGS	394302096521301	04S 05E 09CA 01
KS	USGS	394302096521302	04S 05E 09CA 02
KS	USGS	394305096520902	04S 05E 09CAA 02
KS	USGS	394305096520903	04S 05E 09CAA 03
KS	USGS	394517097053801	03S 03E 33ABA 01
KS	USGS	394517097053802	03S 03E 33ABA 02
KS	USGS	394517097053803	03S 03E 33ABA 03
KS	USGS	394605097025101	03S 03E 25BB 01
KS	USGS	394719096514601	03S 05E 16DAC 01
KS	USGS	394830097215701	03S 01E 07BC 01
KS	USGS	394850096480001	03S 06E 06CDC 01
KS	USGS	394851096582301	03S 04E 03CCC 01
KS	USGS	394853096475701	03S 06E 06CD 01
KS	USGS	394948097230501	02S 01W 36CC 01
KS	USGS	395024096484201	02S 05E 36AB 01
KS	USGS	395029097053701	02S 03E 33ABA 01
KS	USGS	395029097053702	02S 03E 33ABA 02
KS	USGS	395029097053703	02S 03E 33ABA 03
KS	USGS	395036097052801	02S 03E 28DDC 01
KS	USGS	395120097300801	02S 02W 26AA 01
KS	USGS	395121097054501	02S 03E 28ABB 01
KS	USGS	395215097193101	02S 01E 21BAB 01
KS	USGS	395225096565001	02S 04E 14CDA 01
KS	USGS	395304097325701	02S 02W 16BA 01
KS	USGS	395330096514701	02S 05E 09DAB 01
KS	USGS	395343096521101	02S 05E 09BDA 01
KS	USGS	395356097252201	02S 01W 10BB 01
KS	USGS	395430097030301	02S 03E 02ADD 01
KS	USGS	395442097341301	02S 02W 05B 01
KS	USGS	395445097174201	02S 01E 03AAD 01
KS	USGS	395457097094501	01S 02E 35DDD 01
KS	USGS	395458097323501	01S 02W 33DCD 01
KS	USGS	395501097261301	01S 01W 33CD 01
KS	USGS	395501097324001	01S 02W 33DC 01
KS	USGS	395513096561100	Mill C Nr Hanover, KS
KS	USGS	395632097252301	01S 01W 27BB 01
KS	USGS	395632097254001	01S 01W 28AA 01
KS	USGS	395725097403401	01S 03W 20AB 01
KS	USGS	395738097421601	01S 03W 18CC 01

State	Agency	Station ID	Station Name
KS	USGS	395800097123201	01S 02E 16BDD 01
KS	USGS	395830097380101	01S 03W 10DD 01
KS	USGS	395902096550301	01S 05E 07BBC 01
KS	USGS	395908097210901	01S 01E 07AA 01
KS	USGS	395908097234101	01S 01W 11AB 01
KS	USGS	395910097043601	01S 03E 10ABB 01
KS	USGS	395922097374401	01S 03W 02CC 01
KS	USGS	395922097374402	01S 03W 02CC 02
KS	USGS	395922097390901	01S 03W 04DD 01
KS	USGS	395926097374801	01S 03W 02CCB 01
KS	USGS	395948097333001	01S 02W 05AD 01
KS	USGS	395952097384701	01S 03W 03BCA 01
NE	USGS	400146097100401	1N 2E26AB 1
NE	USGS	400223097011901	1N 4E19BD 1
NE	USGS	400330097034501	1N 3E14BABC1
NE	USGS	400330097034502	1N 3E14BABC2
NE	USGS	400356097160101	1N 1E12CA 1
NE	USGS	400359097101400	Rose Creek Nr Fairbury, NE
NE	USGS	400422097195901	1N 1E 8AA 1
NE	USGS	400501097054901	1N 3E 4BD 1
NE	USGS	400659097040801	2N 3E27AA 1
NE	USGS	400751097122001	2N 2E21AB 1
NE	USGS	400923097181701	2N 1E10BD 1
NE	USGS	402516097272001	5N 1W 8BA 1

6.3. USGS Gage Stations[12]

USGS inventory of surface water gaging station data including 7Q10 low and monthly mean stream flow.

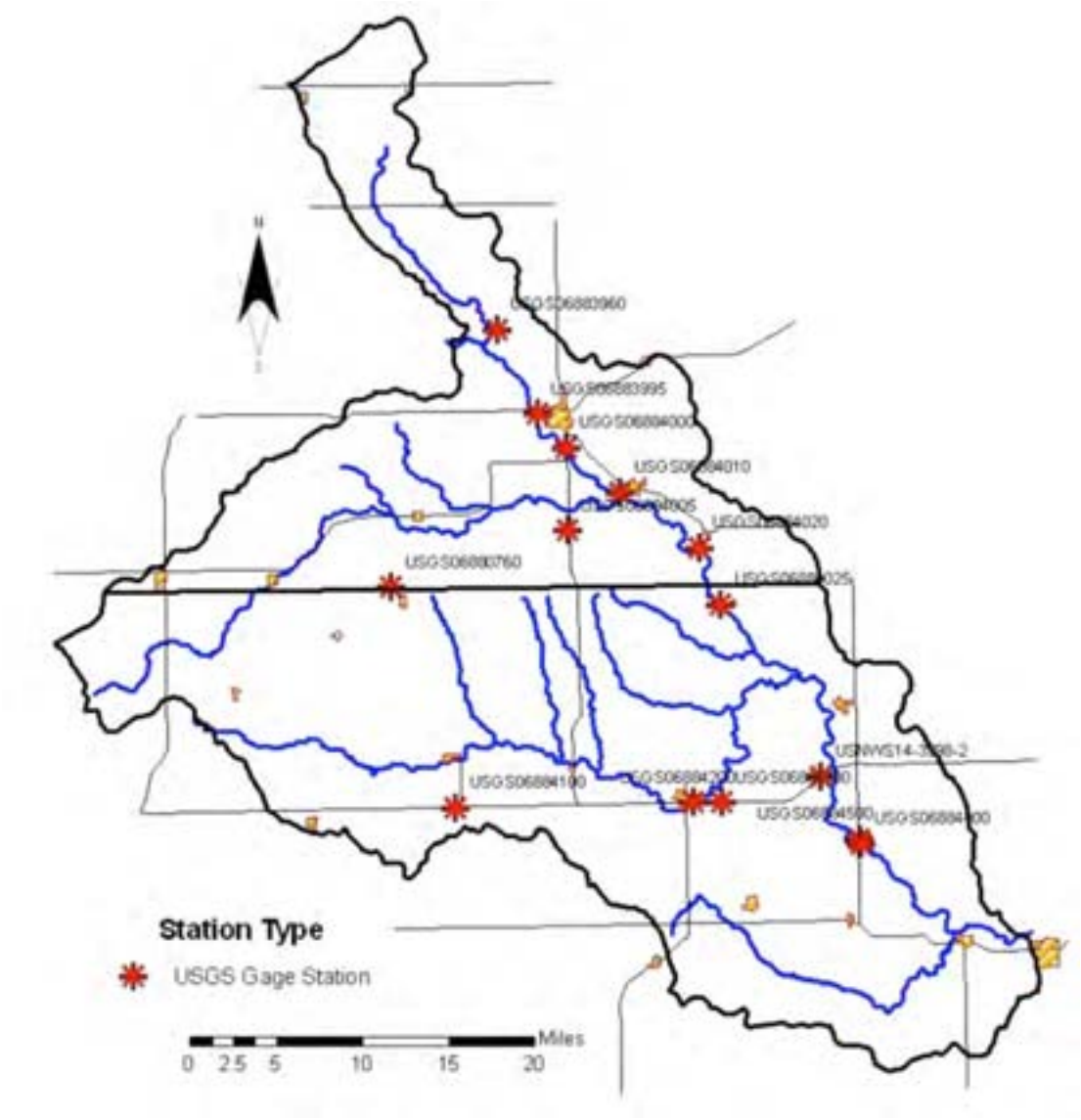

Figure 13. USGS Gage Stations – Lower Little Blue Watershed.

Table 4. USGS Gage Station[12]

Gage ID	Stream Flow (cfs)												
	Mean	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
USGS06883960	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS06883995	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS06884000	367.49	160.44	270.74	500.31	302.01	520.15	900.79	457.26	321.02	375.68	271.23	167.51	139.63
USGS06884010	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS06884005	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS06884020	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS06880760	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS06884025	452.34	126.69	271.96	1366.55	576.17	518.59	718.13	511.41	424.70	356.28	140.33	196.77	142.63
USN-WS14-3398-2	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS06884100	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS06884200	98.99	64.12	89.95	212.70	90.18	174.01	153.16	50.69	59.11	125.58	89.14	50.90	25.38
USGS06884300	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS06884500	626.09	204.98	408.09	515.05	516.51	1001.54	1921.16	962.50	547.12	605.11	393.47	253.59	190.24
USGS06884400	665.72	318.36	499.28	1258.00	601.30	1067.71	1111.03	655.12	473.77	733.80	708.59	299.23	218.68

Table 5. Estimated peak-streamflow frequencies for selected gaging stations with at least 10 years of annual peak-discharge data for unregulated, rural streams in Kansas[13]

USGS ID	Station Name	Drainage Area (mi^2)	2-year ft^3/s	5-year ft^3/s	10-year ft^3/s	25-year ft^3/s	50-year ft^3/s	100-year ft^3/s	200-year ft^3/s
06884025	Little Blue River at Hollenberg	2750	11200	21000	29300	42100	53400	66300	81000
06884100	Mulberry Creek tributary near Haddam	1.64	166	414	669	1120	1560	2110	2790
06884200	Mill Creek at Washington	344	4830	8160	10600	13900	16500	19200	22000
06884300	Mill Creek tributary near Washington	3.2	524	1090	1600	2400	3120	3940	4880
06884400	Little Blue River near Barnes	3320	13100	21200	27200	35400	41900	48700	55900
06884500	Little Blue River at Waterville	3510	11600	24000	35400	53700	70600	90300	113000

Table 6. USGS gaging stations period of record for Lower Little Blue[12]

USGS ID	Drainage Area (mi^2)	Period of record	
		Begin	End
06883995	2350	09/30/02	09/30/03
06884000	2350	11/08/85	present
06884025	2752	09/30/04	present
06884200	344	09/30/59	present
06884400	3351	04/30/58	present
06884500	3509	05/31/22	04/30/58

6.4 Permitted Point Source Facilities[14]

NPDES permit-holding facility information; contains parameter-specific loadings to surface waters computed using the EPA Effluent Decision Support System (EDSS) for 1990-1999. The summary of discharge concentrations and loads allows the user to perform a planning-level assessment of the magnitude and severity of point source contributions. Analyzing the data for different years can provide information to evaluate changes in contributions from various point sources over time and support trend analysis.

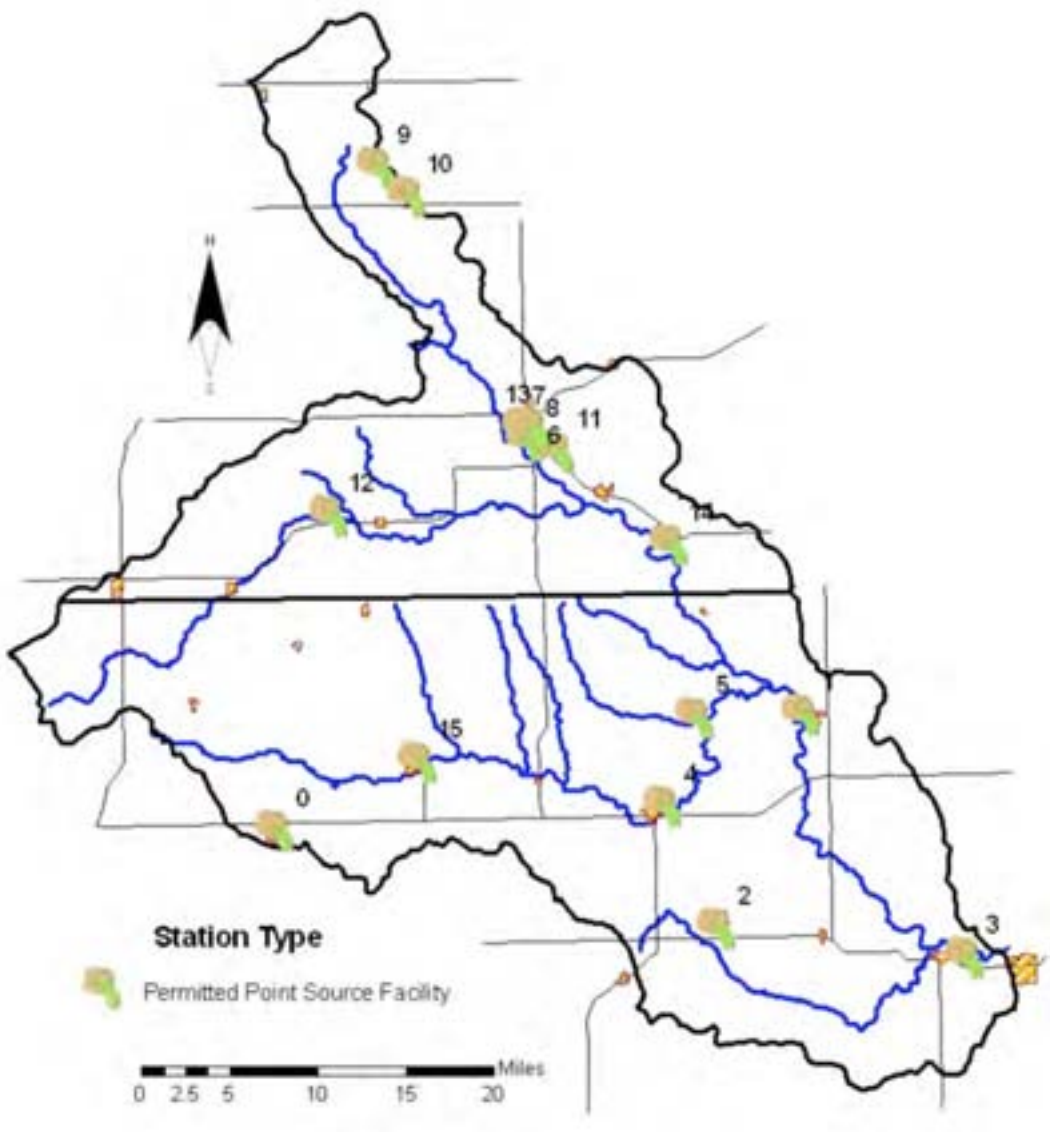

Figure 14. NPDES permit-holding facilities – Lower Little Blue Watershed.

Table 7. Permitted Point Source Facilities[14]

ID	NPDES	Facility Name	Ownership	Description	Industrial Classification	City	County	Flow Rate (million gallons/day)
0	KS0027120	Cuba, City Of Stp	Public	Sewerage Systems	Municipal	Cuba	Republic	0.00000
1	KS0048402	Hanover, City Of Stp	Public	Sewerage Systems	Municipal	Hanover	Washington	0.10000
2	KS0048411	Greenleaf, City Of Wwtp	Public	Sewerage Systems	Municipal	Greenleaf	Washington	0.07000
3	KS0048429	Waterville, City Of Stp	Public	Sewerage Systems	Municipal	Waterville	Marshall	0.00000
4	KS0089991	Washington, City Of	Public	Sewerage Systems	Municipal	Waverly	Coffey	0.18000
5	KS0117315	Hamm N R Koehler Quarry #34	Private	Crushed & Broken Limestone	ON Elg.	Washington	Washington	0.00000
6	NE0000205	Roode Packing Co Fairbury	Private	Meat Packing Plants	ON Elg.	Fairbury	Jefferson	0.32500
7	NE0000361	Fairbury Power Plant	Public	Electrical Services	Primary O	Fairbury	Jefferson	3.00000
8	NE0024384	Fairbury Wwtf	Public	Sewerage Systems	Municipal	Fairbury	Jefferson	1.00000
9	NE0027316	Tobias Wtp		Water Supply	Not ON Elg.	Tobias	Saline	0.00000
10	NE0045144	Daykin	Public	Sewerage Systems	Municipal	Daykin	Jefferson	0.00000
11	NE0052361	Roode Packing Co.	Private	Beef Cattle Feedlots	ON Elg.	Fairbury	Jefferson	0.00000
12	NE0107841	Wright Thomas L Rfd	Private	Beef Cattle Feedlots	ON Elg.		Thayer	0.00000
13	NE0114081	Fairbury Foods Product Inc	Public	Sausages & Prepared Meat Prod	ON Elg.	Fairbury	Jefferson	0.00000
14	NE0121771	Steele City Wtp		Water Supply	Not ON Elg.	Steele City	Jefferson	0.00000
15	KS0048518	Haddam, City Of						0.00000

6.5 Confined Animal Feeding Operations (CAFOs)[15]

Animal feeding operations classified as large or presenting a high risk to discharge can be classified as CAFOs and are likely required to have an NPDES permit. This map shows the locations and permit numbers for these sites in the Lower Little Blue watershed.

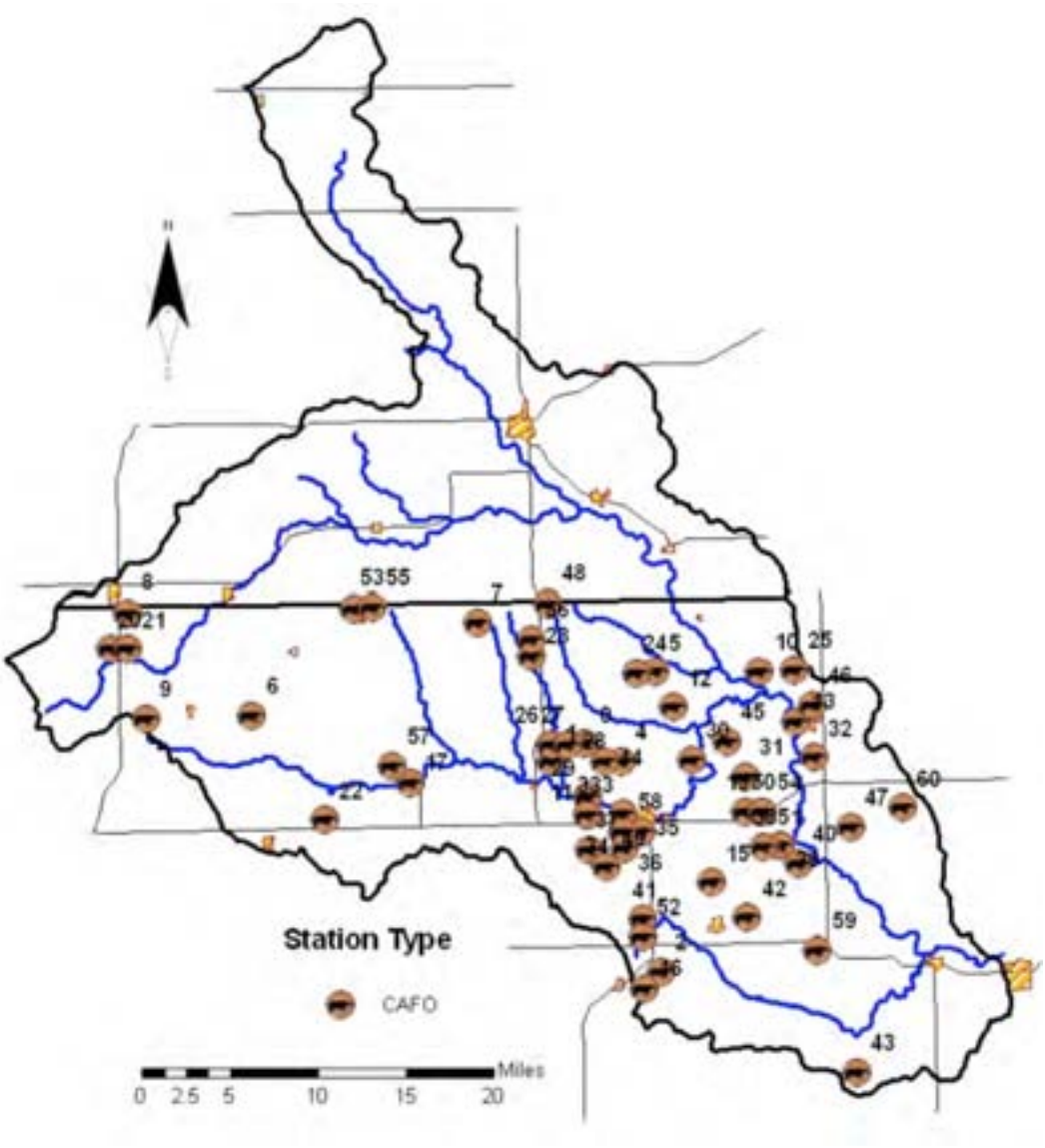

Figure 15. Confined Animal Feeding Operations facilities – Lower Little Blue Watershed.

Table 8. Confined Animal Feeding Operations[15]

ID	Permit No.	Total Head	Animal Unit System	Animal Type
0	A-BBWS-H002	8000	3200	Swine
1	A-BBWS-H003	3600	1440	Swine
2	A-BBWS-D002	950	1250	Dairy
3	A-BBWS-C006	2160	2160	Beef
4	A-BBWS-H007	7410	1284	Swine
5	A-BBWS-H008	7055	1202	Swine
6	A-BBRP-C001	2002	2004	Beef, Horses
7	A-BBWS-C007	3500	3500	Beef
8	A-BBRP-BA04	140	140	Beef
9	A-BBRP-BA02	500	500	Beef
10	A-BBWS-BA05	400	400	Beef
11	A-BBWS-BA07	150	150	Beef
12	A-BBWS-MA04	80	112	Dairy
13	A-BBWS-BA03	600	600	Beef
14	A-BBWS-BA09	110	110	Beef
15	A-BBWS-MA07	50	70	Dairy
16	A-BBWS-MA03	100	140	Dairy
17	A-BBWS-BA11	200	200	Beef
18	A-BBWS-BA08	800	800	Beef
19	A-BBWS-MA08	40	56	Dairy
20	A-BBRP-M002	160	200	Dairy
21	A-BBRP-B001	400	400	Beef
22	A-BBRP-BD01	150	150	Beef
23	A-BBWS-M003	355	375	Dairy, Beef
24	A-BBWS-S044	3576	646	Swine
25	A-BBWS-S047	1630	480	Swine, Beef
26	A-BBWS-S040	2000	800	Swine
27	A-BBWS-S045	2498	999	Swine
28	A-BBWS-S007	240	96	Swine
29	A-BBWS-B013	800	800	Beef
30	A-BBWS-S024	2340	180	Swine
31	A-BBWS-S013	3338	855	Swine
32	A-BBWS-S042	800	320	Swine
33	A-BBWS-C008	2000	2000	Beef
34	A-BBWS-S030	1820	728	Swine
35	A-BBWS-S053	360	144	Swine
36	A-BBWS-B006	950	950	Beef
37	A-BBWS-S022	1400	560	Swine
38	A-BBWS-S052	2000	800	Swine
39	A-BBWS-S050	3247	899	Swine
40	A-BBWS-S041	3950	800	Swine
41	A-BBWS-S031	630	172	Swine
42	A-BBWS-S033	2440	320	Swine
43	A-BBWS-S051	1132	241	Swine
44	A-BBWS-S043	9990	0	Swine

ID	Permit No.	Total Head	Animal Unit System	Animal Type
45	A-BBWS-S028	360	76	Swine
46	A-BBWS-B001	600	600	Beef
47	A-BBWS-S005	400	160	Swine
48	A-BBWS-S034	2400	960	Swine
49	A-BBWS-M001	350	358	Dairy, Beef
50	A-BBWS-S026	3562	825	Swine
51	A-BBWS-S037	3980	800	Swine
52	A-BBWS-S018	680	200	Swine
53	A-LRWS-K001	950	0	Kennel
54	A-BBWS-S016	900	160	Swine
55	A-BBWS-S032	230	48	Swine
56	A-BBWS-S035	2000	860	Swine, Beef
57	A-BBWS-B002	306	306	Beef
58	A-BBWS-B011	950	950	Beef
59	A-BBWS-S027	436	14	Swine
60	A-BBMS-S035	990	200	Swine

6.6 1990 Population and Sewerage by Census Tract[16]

The 1990 Population and Sewerage by Census Tract can be used to examine specific areas for population density and the prevalence of septic systems, which can be significant sources of pathogens, household chemicals, and nutrients (especially nitrate) escaping into groundwater and nearby receiving water bodies.

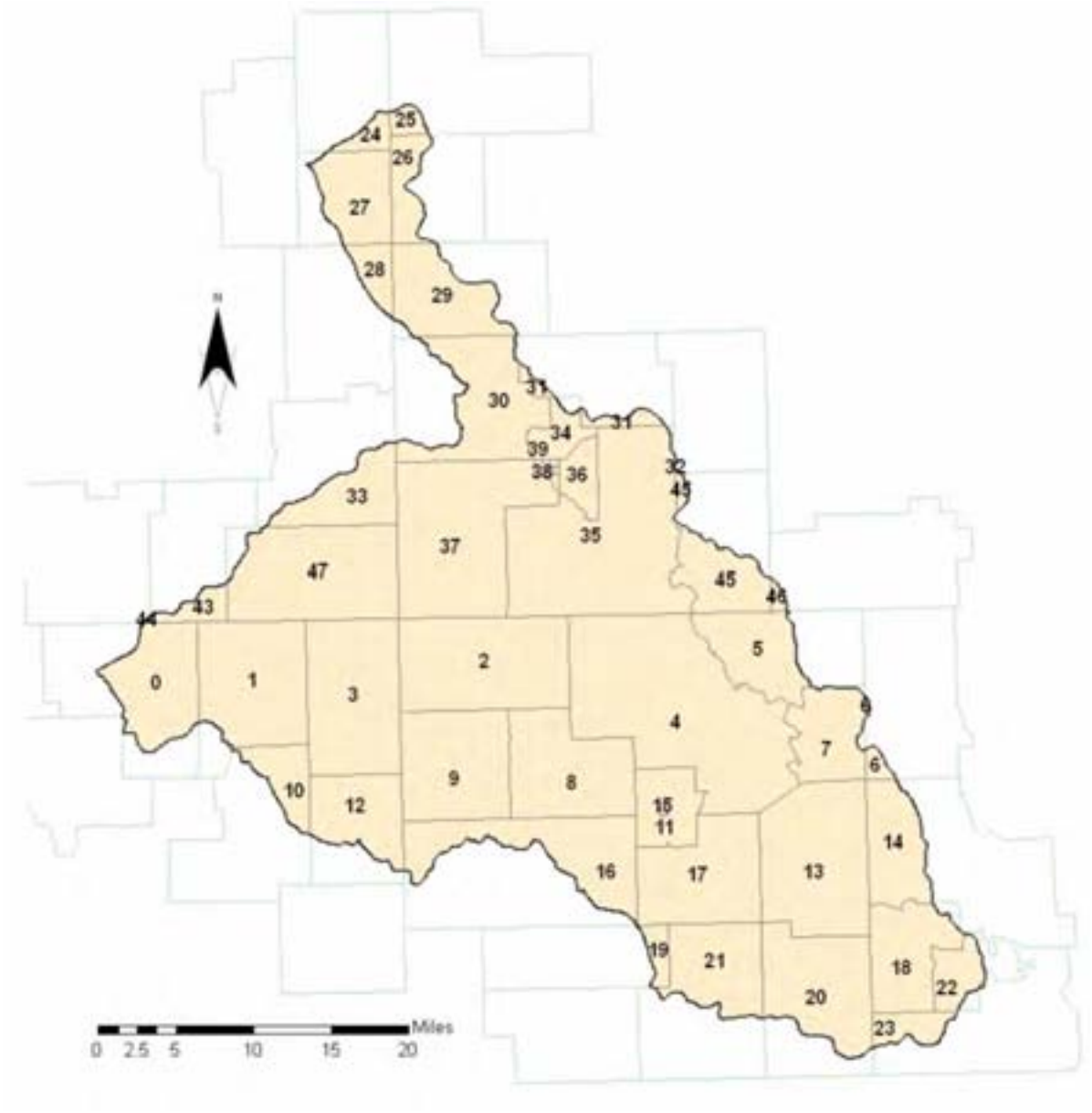

Figure 16. Population and Sewerage by Census – Lower Little Blue Watershed.

Table 9. 1990 Population and Sewerage by Census Tract[16]

ID	Tract	Population	House Units	Sewerage Public	Sewerage Septic	Sewerage Other
0	978200	270	114	0	114	0
1	978100	342	149	74	66	9
2	978600	199	115	58	47	10
3	978100	273	145	71	74	0
4	978600	346	148	0	125	23
5	978600	300	123	4	98	21
6	979100	590	214	0	200	14

ID	Tract	Population	House Units	Sewerage Public	Sewerage Septic	Sewerage Other
7	978600	965	412	341	68	3
8	978600	355	170	99	61	10
9	978600	295	167	121	32	14
10	978100	268	89	0	61	28
11	978600	1030	493	421	57	15
12	978100	350	212	154	58	0
13	978700	366	188	108	80	0
14	979300	374	155	12	138	5
15	978600	454	248	246	2	0
16	978700	235	128	9	101	18
17	978700	603	290	215	75	0
18	979300	785	393	340	53	0
19	978700	738	295	205	90	0
20	978700	144	80	0	71	9
21	978700	210	78	0	78	0
22	979300	562	236	178	58	0
23	979300	197	98	0	81	17
24	991600	576	326	204	119	3
25	990800	336	131	0	125	6
26	990800	353	162	74	76	12
27	991600	270	162	82	77	3
28	993100	439	216	137	60	19
29	993600	438	182	102	67	13
30	993600	341	135	0	119	16
31	993600	362	155	69	80	6
32	993600	382	158	29	123	6
33	993200	210	106	21	78	7
34	993700	1031	409	312	87	10
35	993600	528	226	74	141	11
36	993700	745	349	267	75	7
37	993600	434	180	62	118	0
38	993800	405	257	257	0	0
39	993700	621	325	320	0	5
40	993700	757	373	373	0	0
41	993800	726	408	408	0	0
42	993800	409	273	273	0	0
43	993200	531	254	199	55	0
44	993100	445	196	68	61	67
45	993600	652	282	175	92	15
46	994700	653	283	148	122	13
47	993200	181	104	49	55	0

7.0. Agricultural Economy

7.1 Corn Cost-Return Budget[17]

Table 10. Cost-return projections for corn crops in the Lower Little Blue Watershed, 2006.

Corn	Yield Level (bu)		
	88	**110**	**133**
Income Per Acre			
A. Yield per acre	88	110	133
B. Price per bushel	$2.73	$2.73	$2.73
C. Net government payment	$12.51	$13.60	$14.69
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$252.75	$313.90	$377.78
Costs Per Acre			
1. Seed	$51.57	$51.57	$51.57
2. Herbicide	30.80	30.80	30.80
3. Insecticide/Fungicide	0.27	0.27	0.27
4. Fertilizer and Lime	35.36	44.82	54.80
5. Crop Consulting			
6. Crop Insurance			
7. Drying	11.44	14.30	17.29
8. Miscellaneous	8.25	8.25	8.25
9. Custom Hire / Machinery Expense	65.27	71.63	78.28
10. Non-machinery Labor	7.38	8.09	8.85
11. Irrigation			
12. Land Charge/Rent	48.80	61.00	73.20
G. Sub Total	$258.86	$290.46	$323.04
13. Interest on ½ Nonland Costs	8.94	9.68	10.46
H. Total Costs	$267.80	$300.15	$333.50
I. Returns Over Costs (F-H)	**-$15.05**	**$13.75**	**$44.28**
J. Total Costs/bushel (H/A)	$3.04	$2.73	$2.51
K. Return To Annual Cost (I+13)/G	-2.36%	8.07%	16.95%

7.2 Soybean Cost-Return Budget[17]

Table 11. Cost-return projections for soybean crops in the Lower Little Blue Watershed, 2006.

Soybeans	Yield Level (bu)		
	26	33	40
Income Per Acre			
A. Yield per acre	26	33	40
B. Price per bushel	$5.92	$5.92	$5.92
C. Net government payment	$12.51	$13.60	$14.69
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$166.43	$208.96	$251.49
Costs Per Acre			
1. Seed	$36.30	$36.30	$36.30
2. Herbicide	10.34	10.34	10.34
3. Insecticide/Fungicide			
4. Fertilizer and Lime	10.96	12.51	14.07
5. Crop Consulting			
6. Crop Insurance			
7. Drying			
8. Miscellaneous	8.25	8.25	8.25
9. Custom Hire / Machinery Expense	47.98	50.06	52.13
10. Non-machinery Labor	5.42	5.66	5.89
11. Irrigation			
12. Land Charge / Rent	48.80	61.00	73.20
G. Sub Total	$168.04	$184.11	$200.18
13. Interest on ½ Nonland Costs	5.37	5.54	5.71
H. Total Costs	$173.41	$189.65	$205.89
I. Returns Over Costs (F-H)	**-$6.98**	**$19.31**	**$45.59**
J. Total Costs/bushel (H/A)	$6.67	$5.75	$5.15
K. Return To Annual Cost (I+13)/G	-0.96%	13.50%	25.63%

7.3 Wheat Cost-Return Budget[17]

Table 12. Cost-return projections for wheat crops in the Lower Little Blue Watershed, 2006.

Wheat	Yield Level (bu)		
	40	50	60
Income Per Acre			
A. Yield per acre	40	50	60
B. Price per bushel	$4.65	$4.65	$4.65
C. Net government payment	$12.51	$13.60	$14.69
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$198.51	$246.10	$293.69
Costs Per Acre			
1. Seed	$9.90	$13.20	$13.20
2. Herbicide	1.68	5.09	5.09
3. Insecticide/Fungicide			
4. Fertilizer and Lime	35.41	43.32	50.61
5. Crop Consulting			
6. Crop Insurance			
7. Drying			
8. Miscellaneous	8.25	8.25	8.25
9. Custom Hire / Machinery Expense	45.83	48.84	56.43
10. Non-machinery Labor	5.18	5.52	6.38
11. Irrigation			
12. Land Charge / Rent	48.80	61.00	73.20
G. Sub Total	$155.04	$185.21	$219.45
13. Interest on ½ Nonland Costs	4.78	5.59	6.30
H. Total Costs	$159.83	$190.80	$219.45
I. Returns Over Costs (F-H)	**$38.69**	**$55.30**	**$74.24**
J. Total Costs/bushel (H/A)	$4.00	$3.82	$3.66
K. Return To Annual Cost (I+13)/G	28.04%	32.88%	37.78%

7.4 Grain Sorghum Cost-Return Budget[17]

Table 13. Cost-return projections for grain sorghum crops in the Lower Little Blue Watershed, 2006.

Grain Sorghum	Yield Level (bu)		
	61	76	90
Income Per Acre			
A. Yield per acre	61	76	90
B. Price per bushel	$2.79	$2.79	$2.79
C. Net government payment	$12.51	$13.60	$14.69
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$182.70	$225.64	$265.79
Costs Per Acre			
1. Seed	$12.74	$12.74	$12.74
2. Herbicide	27.41	27.41	27.41
3. Insecticide/Fungicide			
4. Fertilizer and Lime	23.27	30.01	35.96
5. Crop Consulting			
6. Crop Insurance			
7. Drying	7.93	9.88	11.70
8. Miscellaneous	8.25	8.25	8.25
9. Custom Hire / Machinery Expense	58.31	62.84	67.07
10. Non-machinery Labor	6.59	7.10	7.58
11. Irrigation			
12. Land Charge / Rent	48.80	61.00	73.20
G. Sub Total	$193.30	$219.24	$243.91
13. Interest on ½ Nonland Costs	6.15	6.68	7.16
H. Total Costs	$199.45	$225.91	$251.07
I. Returns Over Costs (F-H)	**-$16.74**	**-$0.27**	**$14.72**
J. Total Costs/bushel (H/A)	$3.27	$2.97	$2.79
K. Return To Annual Cost (I+13)/G	-5.48%	2.92%	8.97%

7.5 Alfalfa Cost-Return Budget[17]

Table 14. Cost-return projections for alfalfa crops in the Lower Little Blue Watershed, 2006.

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

7.6 Common Cropland BMPs in Lower Little Blue Watershed

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

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

Below are some of the more popular BMPs in use throughout the state of Kansas and in the Lower Little Blue Watershed.

Conservation crop rotations involve growing various crops in the same field in a planned sequence. This may involve growing high residue crops (e.g., corn for grain) in rotation with lower residue crops (e.g., soybeans) or forage/silage crops. The effectiveness of conservation crop rotations depends on many field, climatic, and management factors.

Contour farming[24] is farming the land, tillage and planting of the crop, on the level around the hill. By doing this, each furrow or ridge left by the different implements acts as a miniature dam, trapping water, allowing more to soak into the ground. Each row of crop also slows the water. Combined, less water runs off. Soil is erosion reduced. Crop yields are increased in arid areas.

Grassed waterways[25] are used as outlets to prevent silt and gully formation. The vegetation cover slows the water flow and minimizes channel surface erosion. They can also be used as outlets for water from terraces.

Vegetative buffers[25] are areas of land that are maintained in permanent vegetation to help reduce nutrient and sediment loss from agricultural fields, improve runoff water quality, and provide habitat for wildlife. Because of these societal benefits, there are several federal and state programs that encourage the installation and maintenance of vegetative buffers.

No-till[25] is a form of conservation tillage in which chemicals are used in place of tillage for weed control and seedbed preparation. In other words, the soil surface is never disturbed except for planting or drilling operations in a 100 percent no-till system. Two other forms of tillage, **reduced tillage** and **rotational no-till**, involve a light to moderate use of tillage equipment. These forms of tillage also control erosion and nutrient runoff, but are not as effective as 100 percent no-till.

Terraces[25] are embankments constructed perpendicular to the slope of the field and are designed to reduce the length of a field slope and catch water flowing off the slope. Terraces reduce the rate of runoff and allow soil particles to settle out.

7.7 Economic Contributions of Recreation at Tuttle Creek Lake[26, 27, 28, 29, 30, 31, 32, 33]

This study estimated the regional economic effects arising from recreation at Tuttle Creek Lake (Figure 17). This analysis can help local Watershed Restoration & Protection Strategies leaders and others appreciate the value of preserving recreational amenities at Tuttle Creek Lake.

Tuttle Creek Lake is a 12,617 acre impoundment located in northeastern Kansas at the lower end of the Big Blue River. The watershed supplying the lake is largely agricultural and consists of 9,628 square miles. The majority of the watershed extends north into Nebraska with the lower quarter located in Kansas. Tuttle Creek Lake was built in 1963 by the U.S. Army Corps of Engineers (COE) for flood control, irrigation, water supply, recreation, fish and wildlife, low-flow augmentation, and navigation-flow supplementation for Missouri River barge traffic.

This analysis estimated two types of regional recreation effects associated with Tuttle Creek Lake. The first type includes the economic impact to the region arising from direct recreation expenditures in the area and the associated indirect effects which occur as the money "ripples" throughout the region. This impact is modeled using an economic accounting system that charts the financial connections between businesses, governments and households in the region.

In 2007, the Army COE reported 454,996 visits to Tuttle Creek Lake for a total of 1,781,549 visitor-hours from 10/2006 to 9/2007. Using this data (together with visitor-type and expenditure profiles shown in Tables 15 and 16 and Figure 18) and accounting for imported purchases, it was estimated that visitor expenditures generated $3.74 million (2007$) in direct economic activity (sales) within the regional economy, $1.74 million in all types of income associated with the production of economic activities, and 82 area full- and part-time jobs. After calculating the indirect economic impacts, it was estimated that visitor expenditures were closely associated with $5.18 million (2007$) in overall economic activity, $2.53 million in total income, and 97 jobs in the region. The total economic contributions to the local region are displayed in Table 17.

Not all of the economic effects of recreation are captured by observable market transactions. A second type of economic effect considered here includes certain non-market benefits derived through the self-reported value of participation in recreation activities. This notion acknowledges the value of benefit an individual experiences through participation in an activity exceeds what it actually costs, thereby motivating participation. These benefits are estimated through a process known as non-market valuation. Through surveys, economists have developed general estimates of what people report being willing to pay over and above what they actually are required to spend. This net willingness-to-pay value represents the additional incremental value of benefits afforded to the recreation participant. Net willingness-to-pay has been acknowledged by a U.S. governmental interagency committee as an appropriate measure of the economic benefits associated with outdoor recreation programs. Accepting the legitimacy of purported and generalized willingness-to-pay values and applying them to Tuttle Creek Lake recreation, it was estimated that Tuttle Creek Lake visitors receive up to $4.46 million (2007$) in additional non-market recreation benefits annually. The values by recreation activity are reported in Table 18.

On average, the annual visitation rates for Tuttle Creek Lake has declined slightly from 1996-2007 (Figure 19). Among the 17 Army COE Lakes in Kansas, Tuttle Creek Lake ranked 6th in number of visits and 11th in terms of visitor-hours in 2007. A graphical comparison of visits and visitor-hours for all 17 Army COE reservoirs in Kansas can be found in Figures 20 and 21.

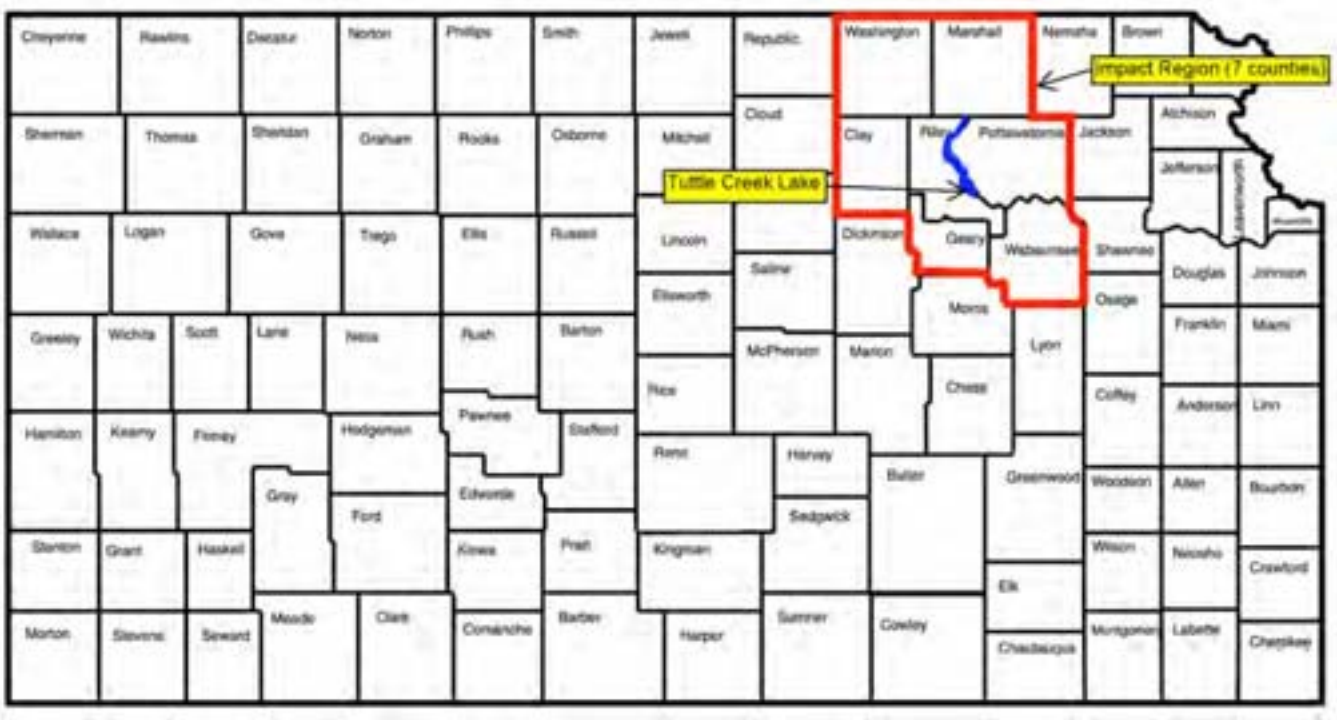

Figure 17. Tuttle Creek Lake economic impact region

Table 15. Visitation and spending for visits made to Tuttle Creek Lake, 2007

Visitation	Camper		Day User		Other Overnight		Total
	Boater	Nonboater	Boater	Nonboater	Boater	Nonboater	
Percent of Total	0.0%	0.2%	5.8%	91.0%	0.2%	2.7%	100.0%
2007 Tuttle Creek visits	68	1,088	26,442	414,240	785	12,365	454,989
Spending	$5,042	$67,991	$592,603	$5,583,416	$74,406	$685,740	$7,009,199

Table 16. Spending categories by visitor type (dollars per visit, 2007$)

Spending Category	Campers		Day Users		Other Overnight		Weighted Average
	Boater	Nonboater	Boater	Nonboater	Boater	Nonboater	
Hotels, motels, cabins, B&B, and rental homes	0.83	0.12	0.00	0.00	19.46	20.17	0.58
Camping fee	15.47	16.01	0.00	0.00	0.11	0.03	0.04
Restaurants, bars, etc.	8.00	9.18	2.66	3.32	14.14	15.84	3.66
Groceries and take out food	20.41	16.62	4.39	4.39	14.71	6.31	4.49
Gas & oil	12.62	8.71	6.96	2.75	15.36	7.39	3.16
Other auto expenses	0.97	1.51	1.70	0.31	6.09	0.00	0.39
Other boat expenses	4.97	0.00	2.13	0.00	12.19	0.00	0.15
Entertainment and recreation fees	2.34	2.91	0.97	0.52	4.35	1.66	0.59
Sporting goods and boat equipment	4.76	1.51	3.09	0.86	4.95	2.37	1.04
Other expenses	3.34	5.94	0.50	1.33	3.37	1.69	1.30
Total (within 30 miles)	**$73.71**	**$62.51**	**$22.41**	**$13.48**	**$94.74**	**$55.46**	**$15.40**

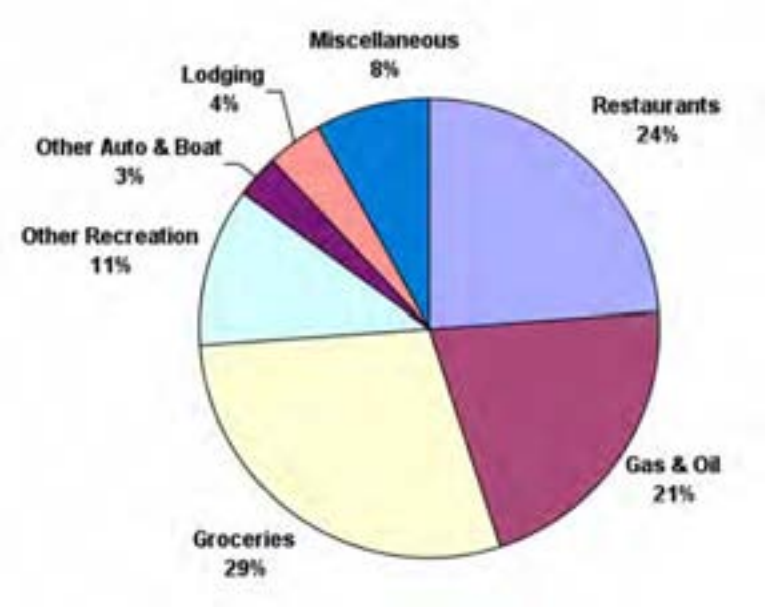

Figure 18. Trip spending by category

Table 17. Tuttle Creek Lake total economic contributions

Impact Measure	Direct	Indirect	Total
Output	$3,743,718	$1,436,971	$5,180,689
Total Value Added	$1,741,255	$790,029	$2,531,284
Employment	82	15	97

Table 18. Non-market benefits of Tuttle Creek Lake recreation, 2007$

Activity	Days Spent in Activity	Activity Value per Day (2007$)	Total Value per Year
Fish	62,651	$38.58	$2,417,139
Swim	33,849	$19.75	$668,456
Camp	18,112	$29.54	$535,017
Boat	12,174	$27.45	$334,143
Picnic	6,978	$30.42	$212,249
Other	14,698	$19.94	$293,045
Total	**148,462**	-------	**$4,460,048**

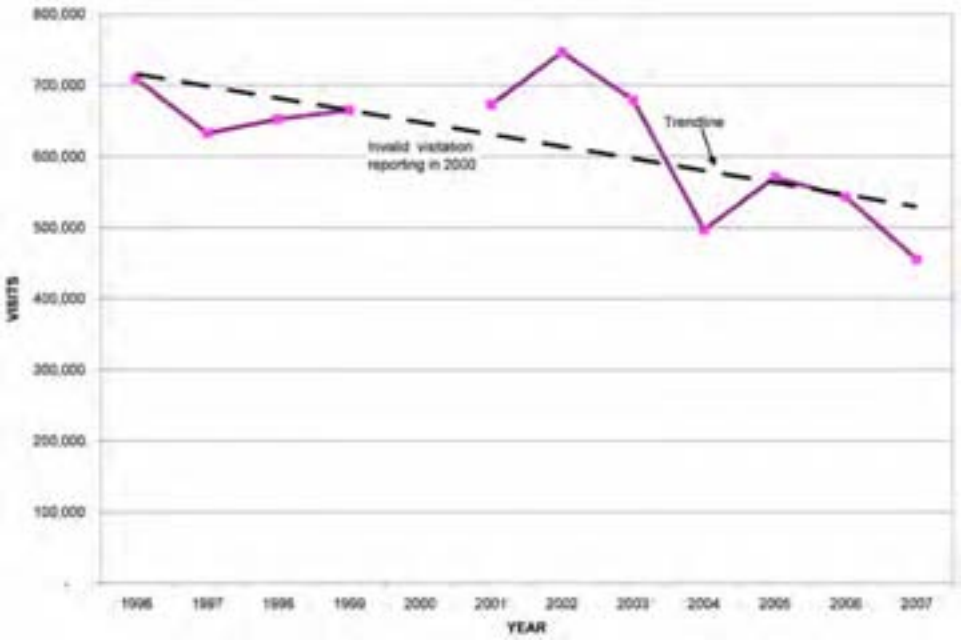

Figure 19. Trends in Tuttle Creek Lake visitation

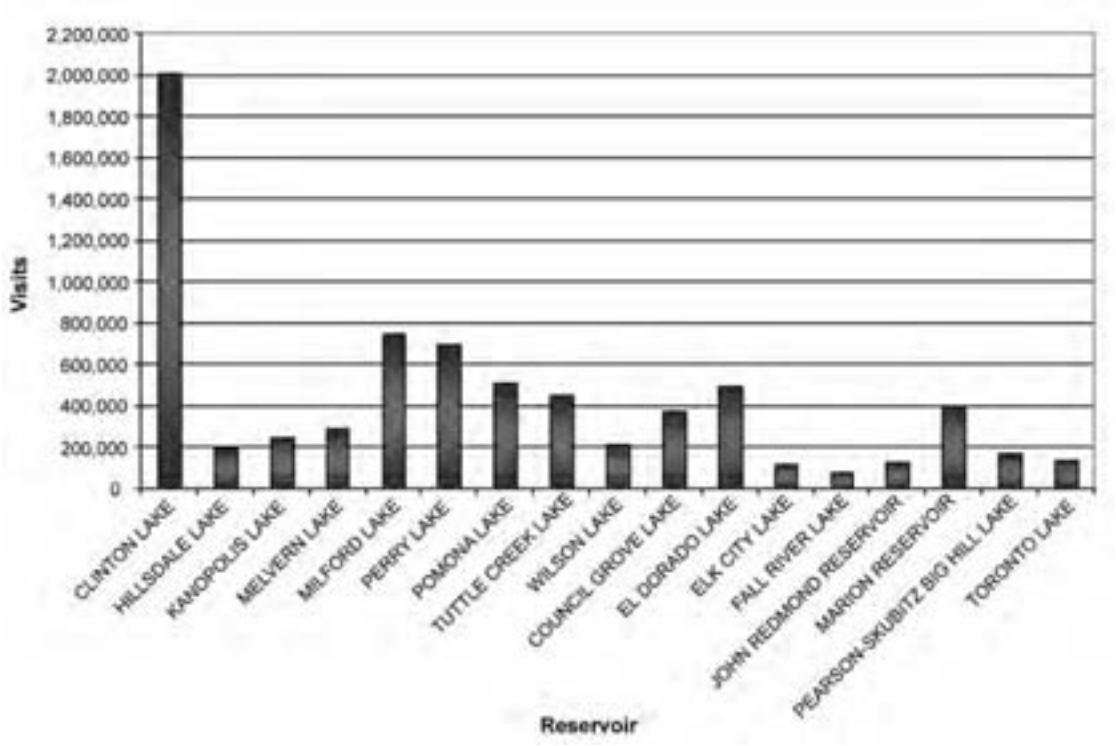

Figure 20. Visits to Kansas Reservoirs in 2007

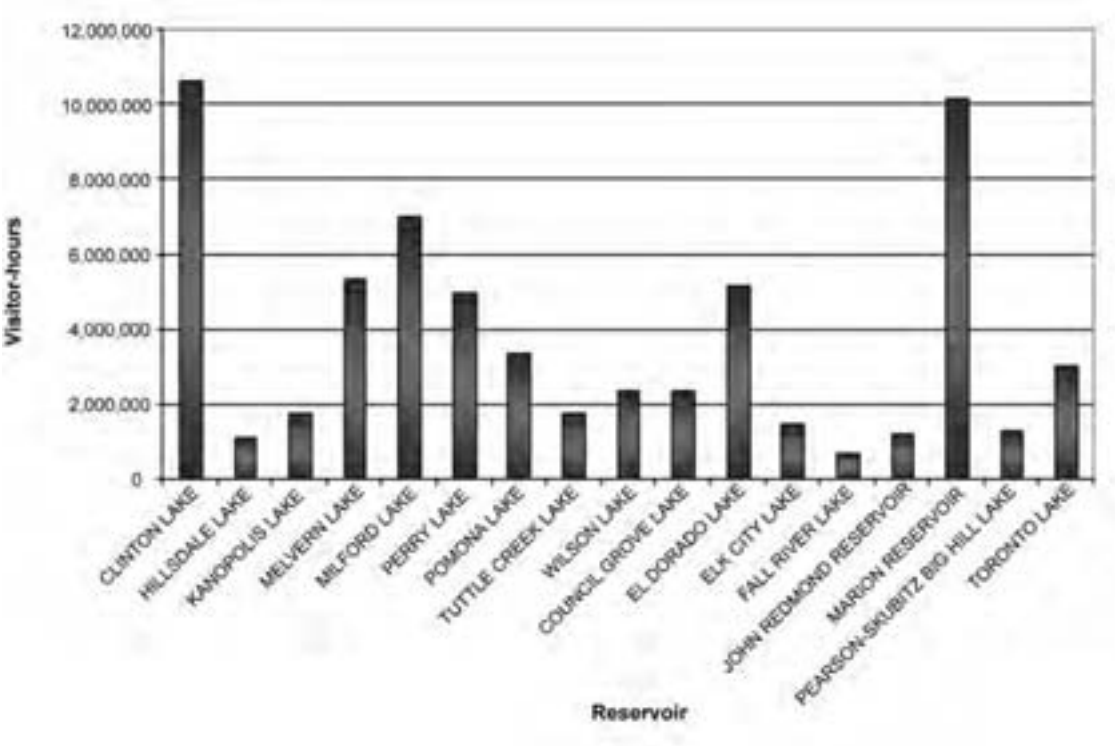

Figure 21: Visitor-hours at Kansas Reservoirs in 2007

7.8 Census Data[18]

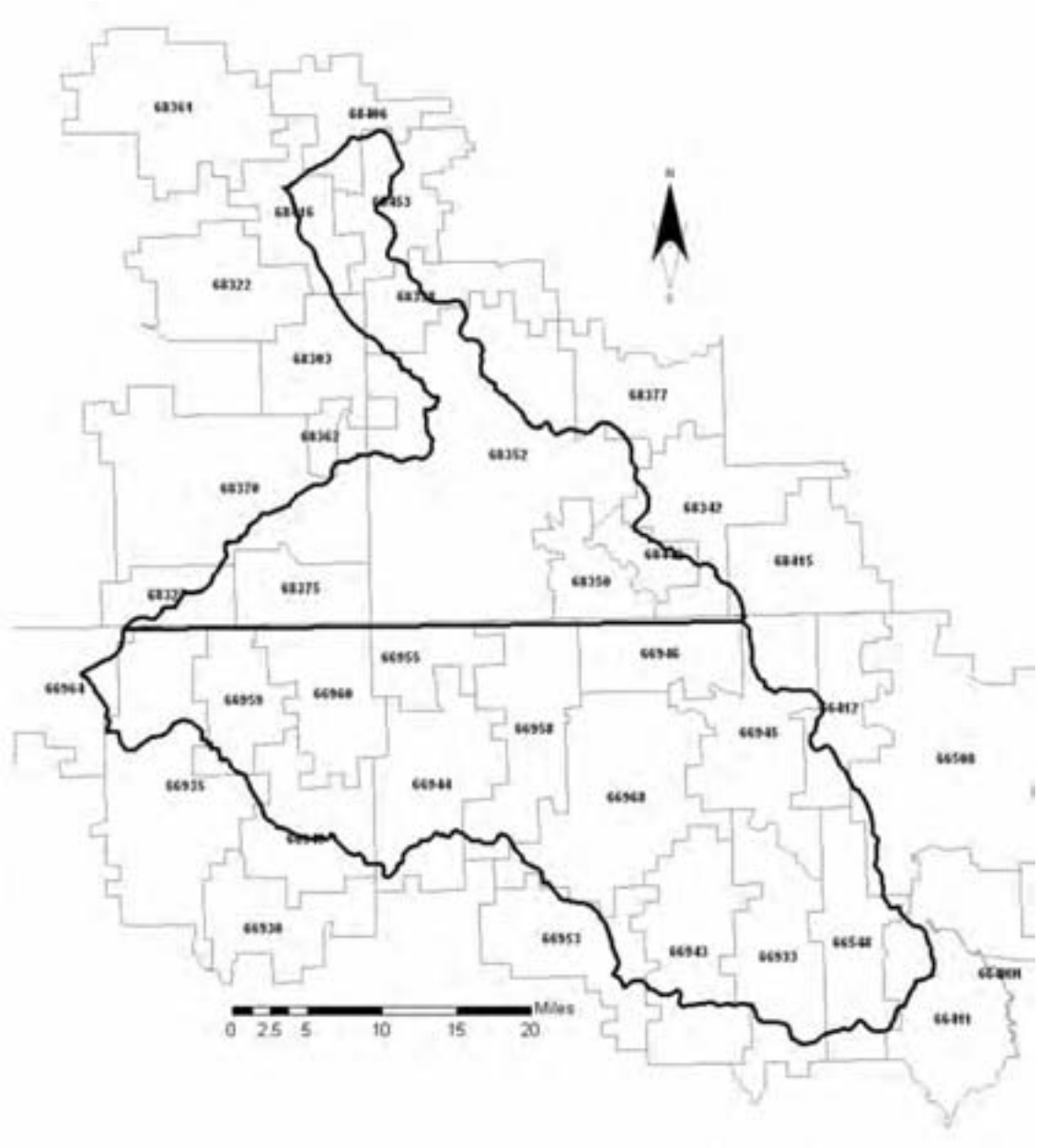

Figure 22. Zip Code Boundary Map.

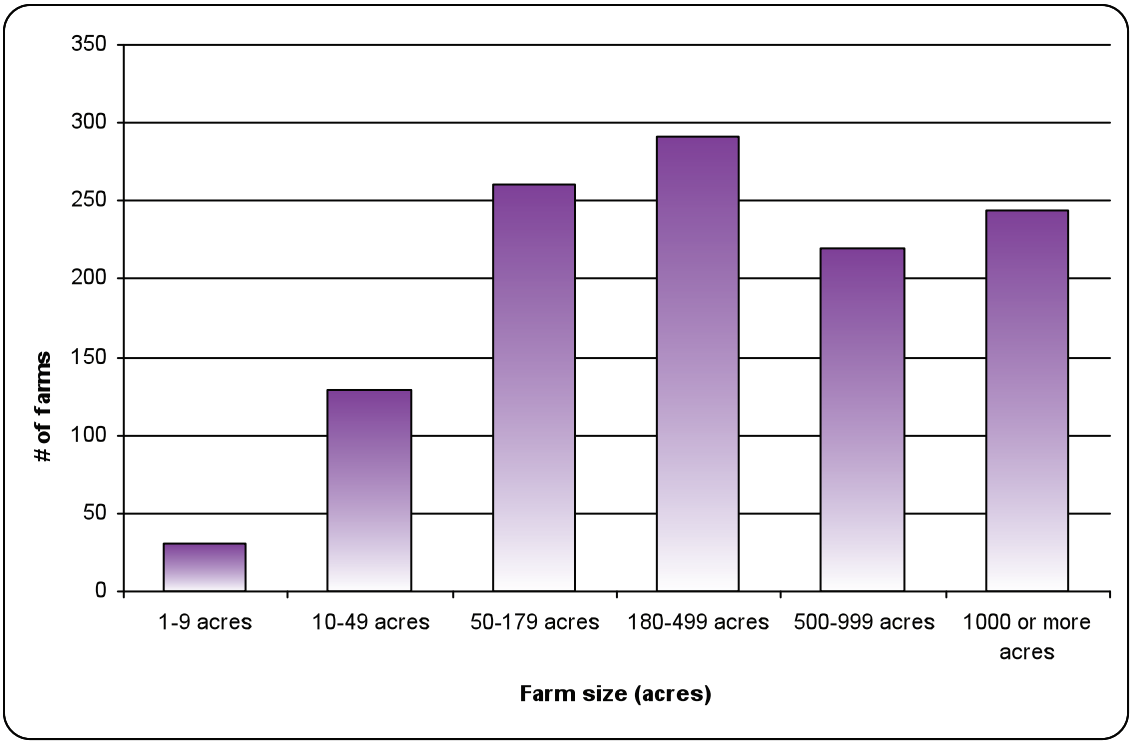

Figure 23. Size Distribution of Farms in Lower Little Blue Watershed, 2002[18]

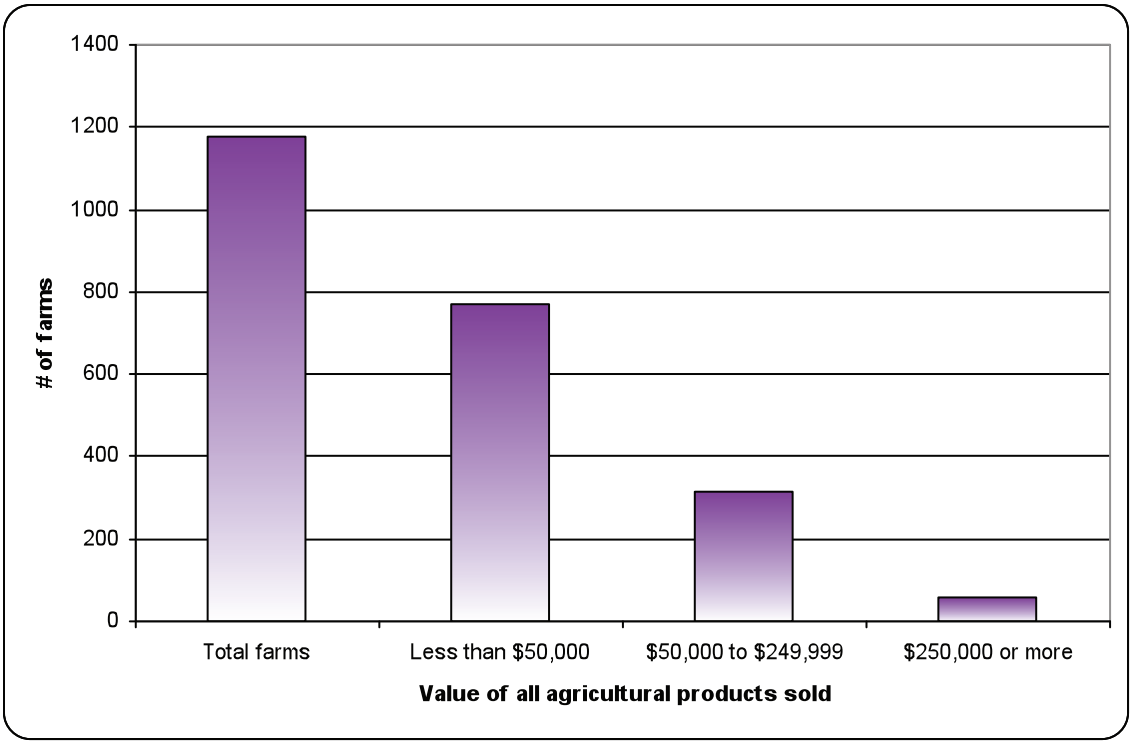

Figure 24. Sales Distribution of Farms in Lower Little Blue Watershed, 2002[18]

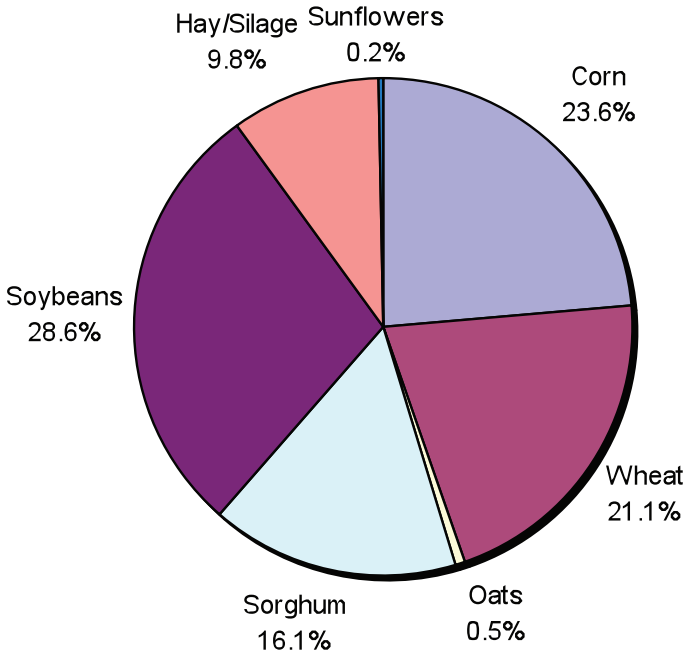

Figure 25. Harvested Crop Acreage in Lower Little Blue Watershed, 2002[18]

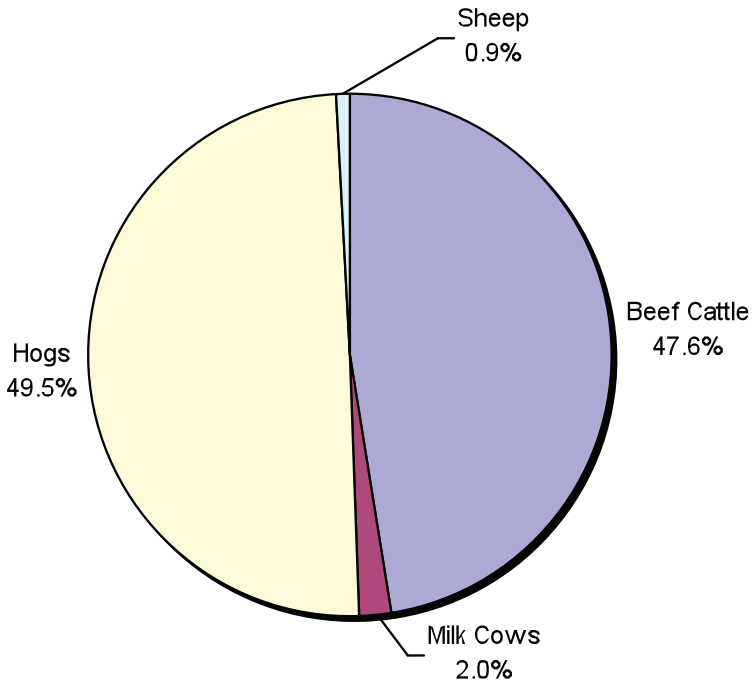

Figure 26. Livestock Number Distribution in Lower Little Blue Watershed, 2002[18]

8.0 Modeling

8.1 Subbasin Map[19]

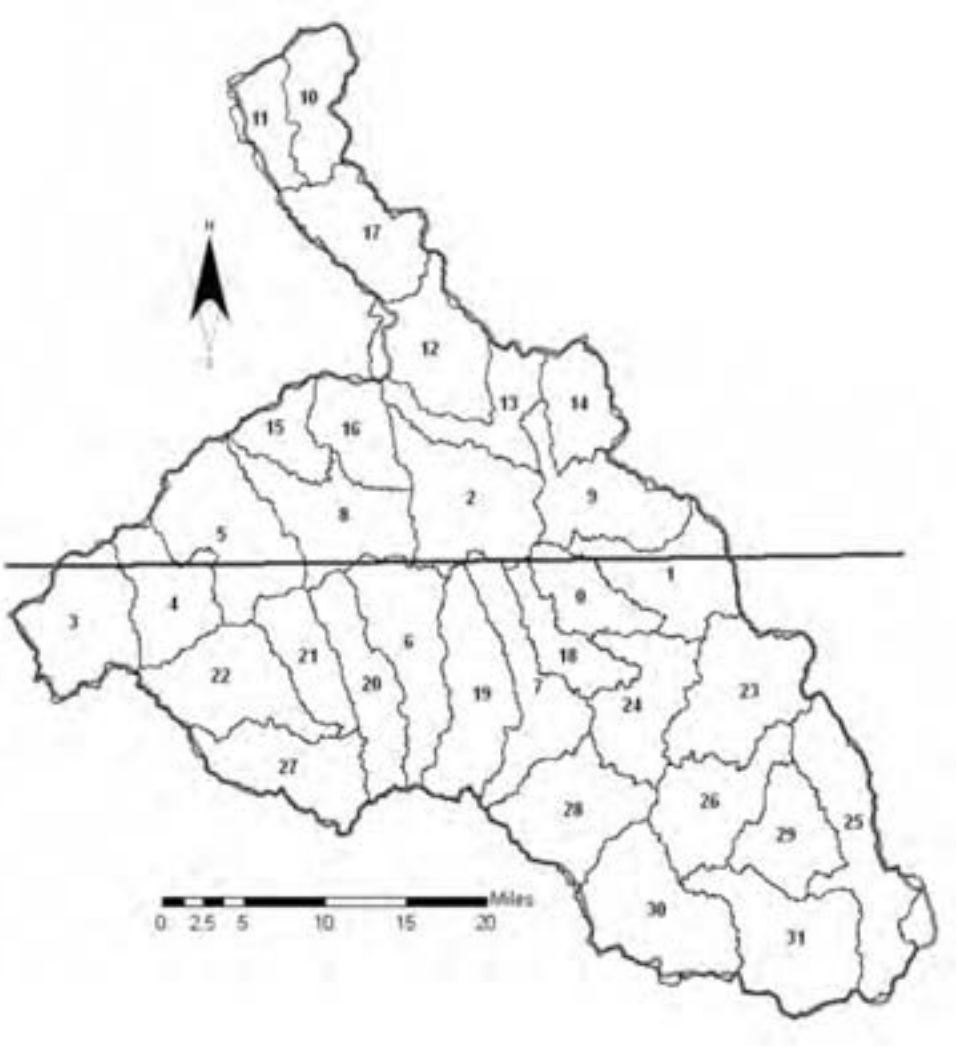

Figure 27. Subbasin Map – Lower Little Blue Watershed.

Table 19. Lower Little Blue Watershed Subbasin Area

Subbasin	State	HUC ID	Area (acres)
0	KS,NE	102702070303	16686
1	KS,NE	102702070304	27487
2	KS,NE	102702070207	37337
3	KS,NE	102702070201	30576
4	KS,NE	102702070202	23366
5	KS,NE	102702070203	37898
6	KS,NE	102702070405	31199
7	KS,NE	102702070502	27232
8	KS,NE	102702070206	30478
9	KS,NE	102702070302	27854
10	NE	102702070101	19902
11	NE	102702070102	14501
12	NE	102702070104	30155
13	NE	102702070105	19979
14	NE	102702070301	17478
15	NE	102702070204	13482
16	NE	102702070205	18912
17	NE	102702070103	27220
18	KS	10270207085040	15329
19	KS	10270207085010	31891
20	KS	10270207075040	24084
21	KS	10270207075020	17940
22	KS	10270207075010	31336
23	KS	10270207090030	35167
24	KS	10270207085050	27006
25	KS	10270207090080	37692
26	KS	10270207090040	27635
27	KS	10270207075030	28160
28	KS	10270207085030	31526
29	KS	10270207090050	21700
30	KS	10270207090060	38465
31	KS	10270207090070	37339
Total			**857012**

8.2 Input Data

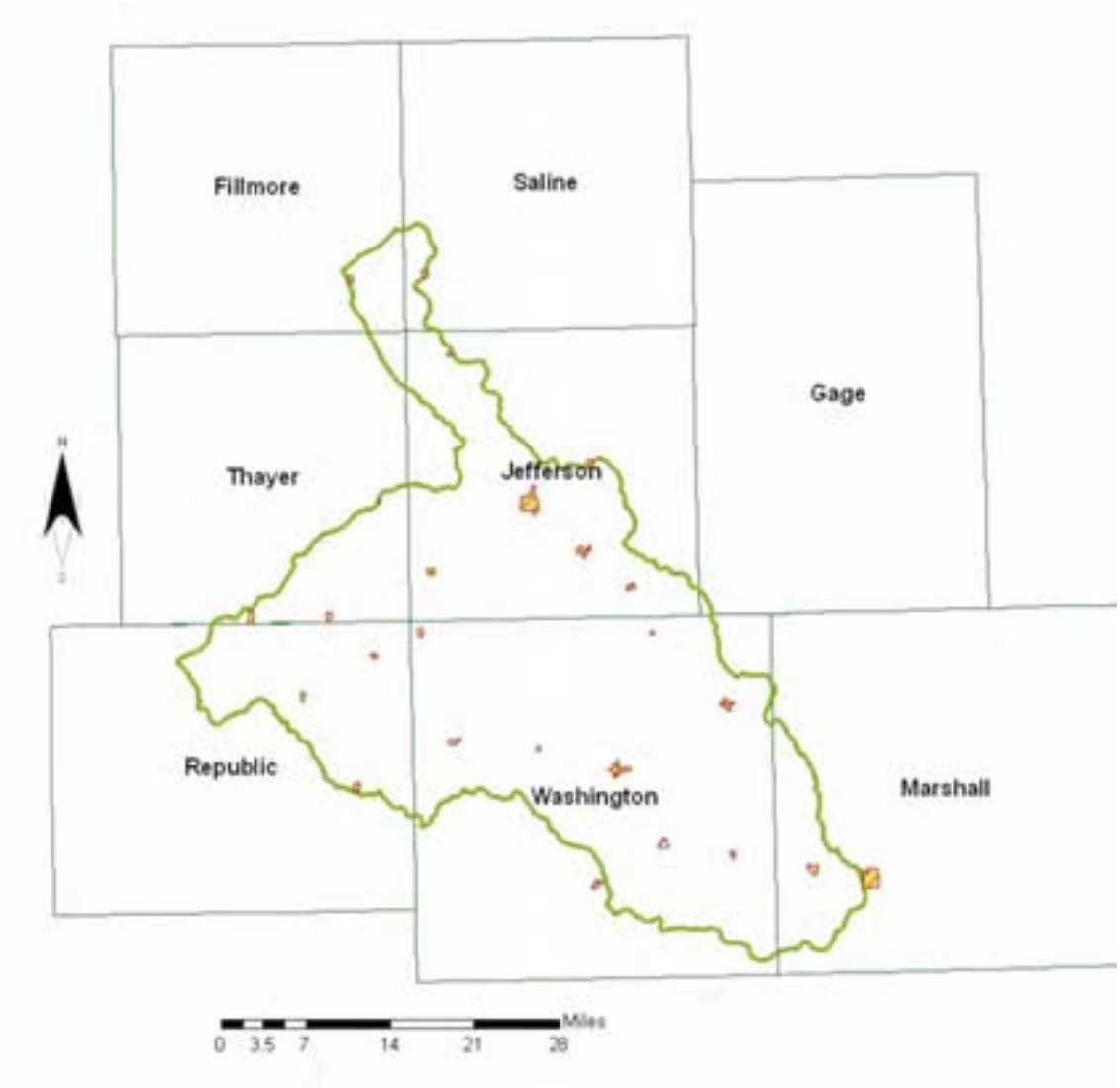

Figure 28. County Map – Lower Little Blue Watershed.

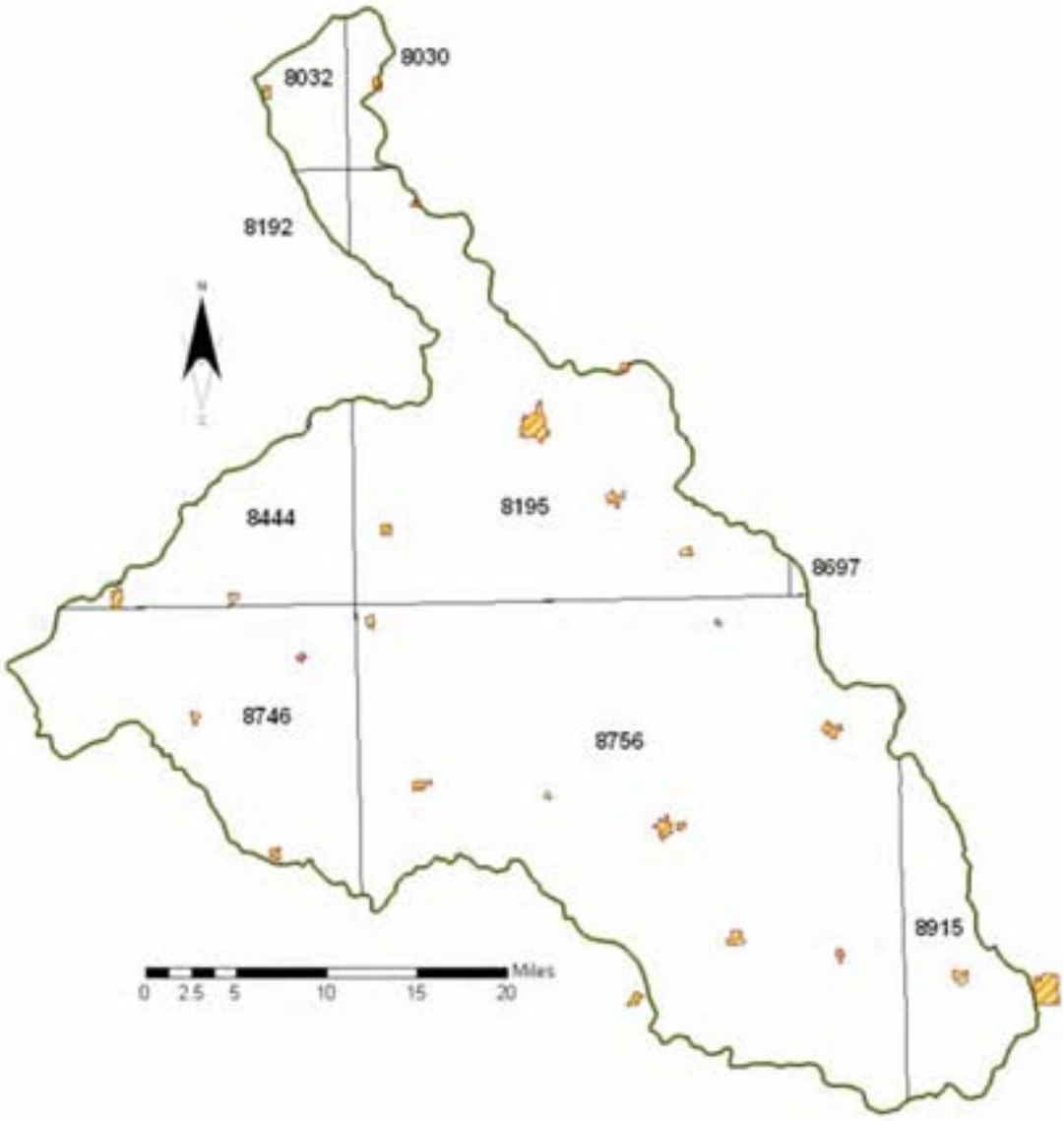

Figure 29. HUCO Map (overlay of county and 8-digit hydrologic unit boundary) – Lower Little Blue Watershed[23]

Table 20. Lower Little Blue Watershed Summary[23]

Polygon ID	County Name	State	HUC	Area (acre)	% in County	% in HUC
8030	Saline	NE	10270207	12098.6	3.20%	1.40%
8032	Fillmore	NE	10270207	22797.98	6.09%	2.64%
8192	Thayer	NE	10270207	3562.4	0.97%	0.41%
8195	Jefferson	NE	10270207	207743.8	56.15%	24.05%
8444	Thayer	NE	10270207	72321.21	19.70%	8.37%
8697	Gage	NE	10270207	1339.1	0.24%	0.16%
8746	Republic	KS	10270207	117970.8	25.33%	13.66%
8756	Washington	KS	10270207	374381.8	65.64%	43.34%
8915	Marshall	KS	10270207	51515.39	8.96%	5.96%

Table 21. Landuse Area (acre)[20]

Polygon ID	Urban/ Transportation	Cropland	Pasture/ Rangeland	Forest	Feedlots	Water	Others
8030	0	0	0	0	0.54	0	0
8032	300	14400	0	0	1.82	0	400
8192	51.64	2009.27	882.58	70.42	0.13	28.17	75.11
8195	5400	97600	82000	4100	14.06	1300	12400
8444	1048.36	40790.73	17917.42	1429.58	2.62	571.83	1524.89
8697	0	0	0	0	0.1	0	0
8746	3300	76500	33200	2600	0.12	400	12400
8756	10300	196400	130800	25800	31.31	6100	36200
8915	1100	31200	14900	1500	1.7	400	3200
Total	**21500**	**458900**	**279700**	**35500**	**52.4**	**8800**	**66200**

Table 22. Agricultural Animals[18]

Polygon ID	Beef Cattle	Dairy Cattle	Swine (Hog)	Sheep	Horse	Chicken	Turkey	Duck
8030	324	10	947	52	10	31	D	0
8032	457	0	4467	41	14	13	0	0
8192	122	5	142	6	3	1	0	0
8195	7045	1710	23172	374	383	0	D	3
8444	2479	114	2891	130	71	22	0	1
8697	36	7	210	1	1	0	D	0
8746	D	D	D	245	75	90	D	2
8756	14062	1895	61964	865	0	191	D	3
8915	1717	90	1703	46	31	30	2	0
Total	**26242**	**3831**	**95496**	**1760**	**588**	**378**	**2**	**9**

D = data withheld to avoid disclosing information for individual farms

Table 23. Septic System[21]

Polygon ID	No. of Septic Systems	Population per Septic System	Septic Failure Rate,%
8030	35	2.4	0.27
8032	55	2.29	0.27
8192	7	2.2	0.27
8195	594	2.15	0.27
8444	152	2.2	0.27
8697	4	2.34	0.27
8746	264	1.97	0.93
8756	737	2.11	0.93
8915	148	2.22	0.93
Total	**1996**	**2.13**	**0.65**

Table 24. Hydrological Soil Group[22]

Polygon ID	Hydrological Group
8030	B
8032	B
8192	B
8195	C
8444	B
8697	C
8746	B
8756	C
8915	C

A = well to excessively drained soil

B = moderately-well to well drained soil

C = poorly drained soil

D = very poorly drained soil

Table 25. Modify the Universal Soil Loss Equation (USLE) parameters[23]

Polygon ID	Land Cover	R	K	LS	C	P
8030	Crop land	150.000	0.344	0.397	0.200	0.967
8032	Crop land	150.000	0.355	0.270	0.200	1.000
8192	Crop land	150.000	0.333	0.651	0.200	0.941
8195	Crop land	175.000	0.338	0.518	0.200	0.919
8444	Crop land	150.000	0.333	0.651	0.200	0.941
8697	Crop land	175.000	0.348	0.544	0.200	0.842
8746	Crop land	175.000	0.337	0.565	0.200	0.915
8756	Crop land	175.000	0.343	0.566	0.200	0.785
8915	Crop land	200.000	0.323	0.324	0.200	0.954
8030	Pasture Land	150.000	0.344	0.397	0.040	1.000
8032	Pasture Land	150.000	0.355	0.270	0.040	1.000
8192	Pasture Land	150.000	0.333	0.651	0.040	1.000
8195	Pasture Land	175.000	0.338	0.518	0.040	1.000
8444	Pasture Land	150.000	0.333	0.651	0.040	1.000
8697	Pasture Land	175.000	0.348	0.544	0.040	1.000
8746	Pasture Land	175.000	0.337	0.565	0.040	1.000
8756	Pasture Land	175.000	0.343	0.566	0.040	1.000
8915	Pasture Land	200.000	0.323	0.324	0.040	1.000
8030	Forest	150.000	0.344	0.397	0.003	1.000
8032	Forest	150.000	0.355	0.270	0.003	1.000
8192	Forest	150.000	0.333	0.651	0.003	1.000
8195	Forest	175.000	0.338	0.518	0.003	1.000
8444	Forest	150.000	0.333	0.651	0.003	1.000
8697	Forest	175.000	0.348	0.544	0.003	1.000
8746	Forest	175.000	0.337	0.565	0.003	1.000
8756	Forest	175.000	0.343	0.566	0.003	1.000
8915	Forest	200.000	0.323	0.324	0.003	1.000

8.3 Model Outputs

Table 26. Total Pollution Load[23]

Polygon ID	N Load (lb/year)	P Load (lb/year)	BOD Load (lb/year)	Sediment Load (t/year)
8030	954.1	191.4	1280.2	0.0
8032	38031.7	7106.8	79259.1	1372.7
8192	7774.0	1361.9	19057.7	441.8
8195	1037754.5	138232.5	2800059.2	21972.2
8444	157797.4	27643.3	386863.0	8968.1
8697	286.6	57.4	383.0	0.0
8746	370064.6	60917.7	932304.9	16978.4
8756	2286172.7	311996.3	6028629.6	41642.4
8915	299832.4	41163.8	775348.5	4642.6
Total	**4198668.1**	**588671.1**	**11023185.1**	**96018.2**

Table 27. Total Load by Land Uses[23]

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban	132869.94	20545.57	518364.24	3049.80
Cropland	2043972.94	381705.08	4275767.20	81147.00
Pastureland	1861245.88	151207.05	6002220.03	11707.27
Forest	10241.67	5078.83	25421.54	114.15
Feedlots	149987.88	29997.58	199983.84	0.00
User Defined	0.00	0.00	0.00	0.00
Septic	349.77	136.99	1428.21	0.00
Gully	0.00	0.00	0.00	0.00
Streambank	0.00	0.00	0.00	0.00
Groundwater	0.00	0.00	0.00	0.00
Total	**4198668.08**	**588671.11**	**11023185.06**	**96018.22**

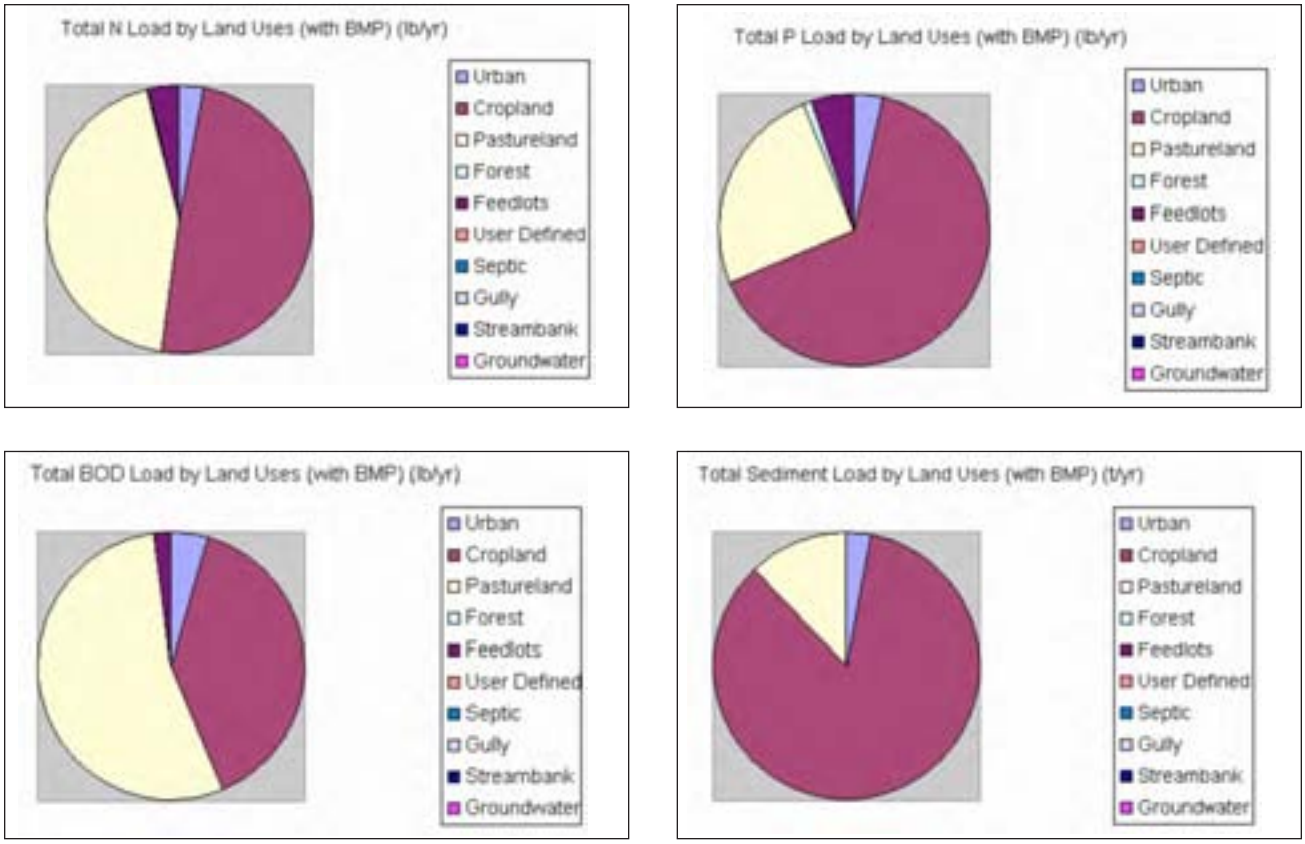

Figure 30. Total Load by Land Uses – Lower Little Blue Watershed.

9.0 Acknowledgment

The authors would like to acknowledge Dr. William Hargrove, Dr. Danny Rogers, Ms. Judy Willingham, and Mr. Don Snethen for their help and comments.

Funding for this project was provided in part by Kansas Water Plan Funds, and EPA 319 funds through Kansas Department of Health and Environment, Watershed Management Section.

10.0 Footnotes/Bibliography

1. *National Land Cover Database 2001 (NLCD 2001)*: "NLCD 2001 products include 21 classes of Land Cover, Percent Tree Canopy and Percent Urban Imperviousness at 30 m cell resolution."
Online reference information available at: *http://www.mrlc.gov/mrlc2k_nlcd.asp*

2. *TMDLs for the Kansas Lower Republican River Basin*: "In 1999, 55 watershed and 38 lake TMDLs were developed. The TMDLs were submitted to EPA on June 30, 1999. The high priority TMDLs were approved on August 9 and the remainder were approved on September 23, 1999."
Online reference information available at: *http://www.kdheks.gov/tmdl/klr.htm*

3. *National Elevation Dataset*: "The USGS National Elevation Dataset (NED) has been developed by merging the highest-resolution, best quality elevation data available across the United States into a seamless raster format. NED is the result of the maturation of the USGS effort to provide 1:24,000-scale Digital Elevation Model (DEM) data for the conterminous US."
Online reference information available at: *http://ned.usgs.gov/*

4. *Precipitation Map*: "Point estimates of precipitation originated from some or all of the following sources: 1) National Weather Service (NWS) Cooperative (COOP) stations, 2) Natural Resources Conservation Service (NRCS) SNOTEL, 3) United States Forest Service (USFS) and Bureau of Land Management (BLM) RAWS Stations, 4) Bureau of Reclamation (AGRIMET) stations, 5) California Data Exchange Center (CDEC) stations, 6) Storage gauges, 7) NRCS Snowcourse stations, 8) Other State and local station networks, 9) Estimated station data, 0) Canadian stations, 10) Upper air stations, and 11) NWS/Federal Aviation Administration (FAA) Automated surface observation stations (ASOS). All COOP station data were subjected to quality control checks by the National Climatic Data Center (NCDC). All COOP, SNOTEL and other data were subjected to further quality control checks by the PRISM Group."
Online reference information available at: h*ttp://prism.oregonstate.edu/docs/meta/ppt_30s_meta.htm#7*

5. *Maximum Temperature Map*: "Point estimates of temperature originated from some or all of the following sources: 1) National Weather Service (NWS) Cooperative (COOP) stations, 2) Natural Resources Conservation Service (NRCS) SNOTEL, 3) United States Forest Service (USFS) and Bureau of Land Management (BLM) RAWS Stations, 4) Bureau of Reclamation (AGRIMET) stations, 5) California Data Exchange Center (CDEC) stations, 6) Storage gauges, 7) NRCS Snowcourse stations, 8) Other State and local station networks, 9) Estimated station data, 0) Canadian stations, 10) Upper air stations, and 11) NWS/Federal Aviation Administration (FAA) Automated surface observation stations (ASOS). All COOP station data were subjected to quality control checks by the National Climatic Data Center (NCDC). All COOP, SNOTEL and other data were subjected to further quality control checks by the PRISM Group."
Online reference information available at: *http://prism.oregonstate.edu/docs/meta/tmax_30s_meta.htm*

6. *Minimum Temperature Map*: "Point estimates of temperature originated from some or all of the following sources: 1) National Weather Service (NWS) Cooperative (COOP) stations, 2) Natural Resources Conservation Service (NRCS) SNOTEL, 3) United States Forest Service (USFS) and Bureau of Land Management (BLM) RAWS Stations, 4) Bureau of Reclamation (AGRIMET) stations, 5) California Data Exchange Center (CDEC) stations, 6) Storage gauges, 7) NRCS Snowcourse stations, 8) Other State and local station networks, 9) Estimated station data, 0) Canadian stations, 10) Upper air stations, and 11) NWS/Federal Aviation Administration (FAA) Automated surface observation stations (ASOS). All COOP station data were subjected to quality control checks by the National Climatic Data Center (NCDC). All COOP, SNOTEL and other data were subjected to further quality control checks by the PRISM Group."
Online reference information available at: *http://prism.oregonstate.edu/docs/meta/tmin_30s_meta.htm*

7. *Land Use (GIRAS 1980s)*: "This is land use/land cover digital data collected by USGS and converted to ARC/INFO by the EPA. This data which resides in EPA's Spatial Data Library (ESDLS), is useful for environmental assessment of land use patterns with respect to water quality analysis, growth management, and other types of environmental impact assessment. GIRAS LU/LC is being used in EPA's, Office of Water/OST BASINS water quality assessment model."
Online reference information available at: *http://www.epa.gov/waterscience/basins/metadata/giras.htm*

8. *National Land Cover Database 1992 (NLCD 1992)*: "Derived from the early to mid-1990s Landsat Thematic Mapper satellite data, the National Land Cover Data (NLCD) is a 21-class land cover classification scheme applied consistently over the United States. The spatial resolution of the data is 30 meters and mapped in the Albers Conic Equal Area projection, NAD 83. The NLCD are provided on a state-by-state basis. The state data sets were cut out from larger "regional" data sets that are mosaics of Landsat TM scenes. At this time, all of the NLCD state files are available for free download as 8-bit binary files and some states are also available on CD-ROM as a Geo-TIFF."
Online reference information available at: *http://landcover.usgs.gov/us_map.php*

9. *River Network*: "The National Hydrography Dataset (NHD) is a comprehensive set of digital spatial data that contains information about surface water features such as lakes, ponds, streams, rivers, springs and wells. The NHD is based upon the content of USGS Digital Line Graph (DLG) hydrography data integrated with reach-related information from the EPA Reach File Version 3 (RF3). The stream network was generated based on the USEPA Reach File, Version 1 and National Hydrography Dataset (NHD)."
Online reference information available at: *http://nhd.usgs.gov/*
USEPA Reach File, Version 1.0.
Online reference information available at: *http://www.epa.gov/*

10. *Hydrologic Soil Groups*: "Field mapping methods using national standards are used to construct the soil maps in the Soil Survey Geographic (SSURGO) database. Mapping scales generally range from 1:12,000 to 1:63,360; SSURGO is the most detailed level of soil mapping done by the Natural Resources Conservation Service (NRCS). SSURGO digitizing duplicates the original soil survey maps. This level of mapping is designed for use by landowners, townships, and county natural resource planning and management. The user should be knowledgeable of soils data and their characteristics."
Online reference information available at: *http://www.ncgc.nrcs.usda.gov/products/datasets/ssurgo/*

11. *Water Quality Observations Stations*: "Field mapping methods using national standards are used to construct the soil maps in the Soil Survey Geographic (SSURGO) database. Mapping scales generally range from 1:12,000 to 1:63,360; SSURGO is the most detailed level of soil mapping done by the Natural Resources Conservation Service (NRCS). SSURGO digitizing duplicates the original soil survey maps. This level of mapping is designed for use by landowners, townships, and county natural resource planning and management. The user should be knowledgeable of soils data and their characteristics."
Online reference information available at: *http://www.ncgc.nrcs.usda.gov/products/datasets/ssurgo/*

12. *USGS Gage Stations*: "Inventory of surface water gaging station data including 7Q10 low and monthly mean stream flow. Better Assessment Science Integrating Point & Nonpoint Sources (BASIN v. 4.0)."
Online reference information available at: *http://www.epa.gov/waterscience/basins/index.html*

13. *Estimated Peak-Streamflow Frequencies*: "Estimated peak-streamflow frequencies for selected gaging stations with at least 10 years of annual peak-discharge data for unregulated, rural streams in Kansas."
Online reference information available at: *http://ks.water.usgs.gov/Kansas/waterwatch/flood/flood-freq.html*

14. *Permitted Point Source Facilities*: "BASINS also includes information on pollutant loading from point source discharges. The location, type of facility, and estimated loading are provided. These loadings are also used to support evaluation of watershed-based loading summaries combining point and nonpoint sources."
Online reference information available at: *http://www.epa.gov/waterscience/basins/index.html*

15. *Confined Animal Feeding Operations*: Obtained from Watershed Planning Section -Kansas Department of Health and Environment.

16. *The 1990 Population and Sewerage by Census Tract*: "Summarizes the selected area by census tract ID. For each census tract, the report lists the population, number of housing units, type of residential sewer system, and spatial percentage of that tract located within the subject watershed area."
Online reference information available at: *http://www.epa.gov/waterscience/basins/index.html*

17. *Cost-Return Budget*: Data acquired from Sarah L. Fogleman and Stewart R. Duncan, for *Different Crop Cost-Return Budget in Northeast Kansas*, Kansas State University.

18. *Census Data:* Data was derived from the 2002 Census of Agriculture. The data presented here serves only as an estimate for agricultural activity in the Lower Little Blue watershed. Since watersheds do not follow political boundaries, the estimates were made based on proportion assumptions of county and zip code census data. Online reference information available at: *http://www.nass.usda.gov/Census_of_Agriculture/index.asp*

19. *Subbasin Map*: "This map was provided based on USGS Hydrologic Unit Level 14 Code Boundaries. United States Department of Agriculture/Natural Resources Conservation Service."
Online reference information available at: *http://www.kansasgis.org/catalog/catalog.cfm*

20. *USDA Natural Resources Conservation Service 1997 National Resources Inventory*.

21. *National Environmental Service Center:* 1992 and 1998 summary of the status of onsite wastewater treatment systems in the United States.

22. *USDA State Soil Geographic (STATSGO) database.*

23. *STEPL v4 model default values*

24. *Shawnee County Conservation District*.
Online reference information available at: *http://www.sccdistrict.com/*

25. Williams, J.R. and C.M. Smith. *A Sedimentation White Paper: Economics of Watershed Protection and Reservoir Rehabilitation*. White Paper developed for the Kansas Water Resources Institute and presentation at the 2007 Water and Future of Kansas Conference. May 2007.

26. Chang, Wen-Huei, D.B. Propst, D.J. Stynes, and R.S. Jackson. 2003, *Recreation Visitor Spending Profiles and Economic Benefit to Corps of Engineers Projects,* US Army Corps of Engineers Environmental Laboratory, Publication ERDC/EL TR-03-21.

27. Franco, Sammy. 2008, *Army Corps of Engineers Operations and Maintenance Business Information Link (OMBIL) visitation data via personal communication*. Engineer Development Research Center.

28. Gaunt, Philip M. 2001, *Water Recreation Needs Assessment Report to the Kansas Water Office*, Wichita State University.

29. Kansas Water Office 2008, *Tuttle Creek Lake Reservoir Fact Sheet*.
Online reference information available at:
http://www.kwo.org/ReservoirInformation/ReservoirFactSheets/Tuttle_Creek_Lake.pdf

30. Loomis, John B. and Richard G. Walsh, 1997, *Recreation Economic Decisions: Comparing Benefits and Costs*, Second Edition. Venture Publishing, Inc.

31. Rosenberger, R.S. and J.B. Loomis, 2001, *Benefit Transfer of Outdoor Recreation Use Values*, USDA Forest Service.

32. Stynes, Daniel, 1996, *Recreation and Tourism Spending and Economic Impact*.
Online reference information available at: *http://www.msu.edu/user/stynes/mirec/index.htm*

33. Smith, C.M, and J.C. Leatherman, 2008, *Economic Contributions of Recreation at Tuttle Creek Lake*.

34. *1992 Land Cover Class Definitions*.
Online reference information available at: *http://www.epa.gov/mrlc/definitions.html#1992*

35. *2001 Land Cover Class Definitions.*
Online reference information available at: *http://www.epa.gov/mrlc/definitions.html#2001*

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