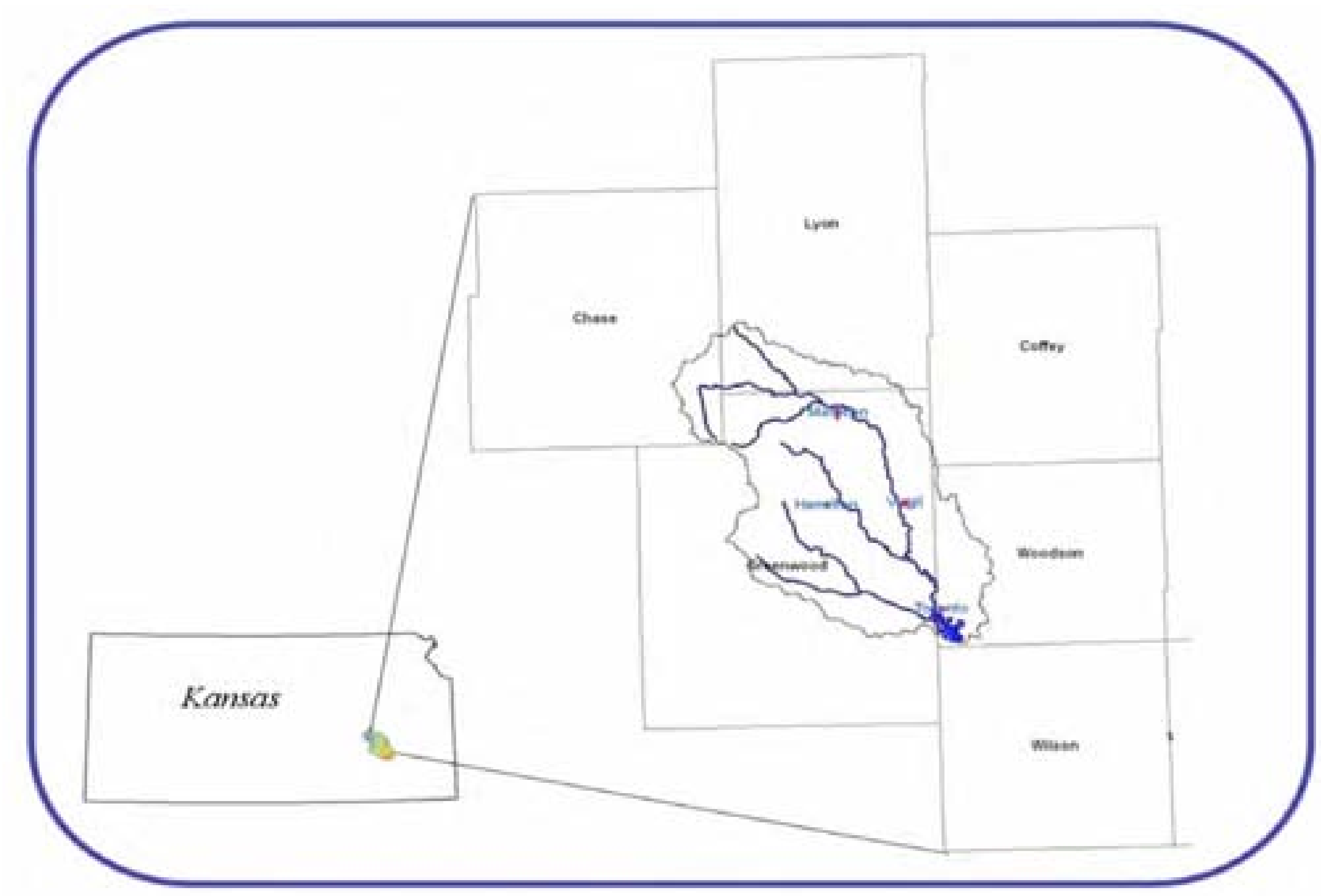
Toronto Lake Watershed Assessment: Preliminary Report



2009

Authors:
A. P. Nejadhashemi, C. M. Smith, K. R. Mankin,
R. M. Wilson, S. P. Brown, and J. C. Leatherman

Publication # EP-139

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

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1.0 Toronto Lake Watershed Assessment

1.1 Watershed Summary

The Upper Verdigris watershed is located in southeastern Kansas. The focus of this WRAPS (Watershed Restoration and Protection Strategy) is the water resources and land area upstream from Toronto Lake in the northern section of the watershed. The watershed drains parts of Chase, Lyon, and Woodson counties with the majority of drainage originating in Greenwood County. Primary waterways are the Verdigris River along with its tributaries, and Walnut and West creeks. The Verdigris River drainage includes the headwaters of the river to the upper end of Toronto Lake. Four major lakes occur in the watershed – Toronto Lake, Eureka City Lake, Minger Lake, and Madison City Lake. The Upper Verdigris Watershed has a Category I designation, indicating the watersheds are in need of restoration and protection to sustain water quality.

Grassland is the predominant land usage (71 percent for the watersheds. Crop production is the second largest land usage at 19 percent. Woodland, water and urban areas constitute the remaining 10 percent of land cover[1].

Figure 1. Major roads and cities – Toronto Lake Watershed

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.

West Creek and Walnut Creek are impacted by low dissolved oxygen. This has resulted in KDHE issuing a high priority TMDL in West Creek and a medium priority TMDL in Walnut Creek. These TMDLs are aimed at increasing dissolved oxygen concentrations to provide full support of aquatic life. The goal of the TMDL is a dissolved oxygen rate of greater than 5 milligrams of oxygen per liter of water. Low dissolved oxygen levels typically occur with an abundance of algae. This causes the population of decomposers to increase, which in turn depletes oxygen in the stream or river. To discourage an overpopulation of algae, nutrient runoff must be minimized. Additionally, low dissolved oxygen is a naturally occurring event in the hot days of summer when there are low water levels and little water movement. Integrating best management practices (known as BMPs) help prevent nutrient runoff. Some examples of BMPs are riparian area restoration, grass buffer strips along streams, proper manure storage and distribution, ensuring adequately functioning septic systems, and applying proper chemical fertilizer rates[2].

Figure 2. Relief Maps – Toronto Lake Watershed[3]

2.0 Climate Mapping System

2.1 Precipitation Map[4]

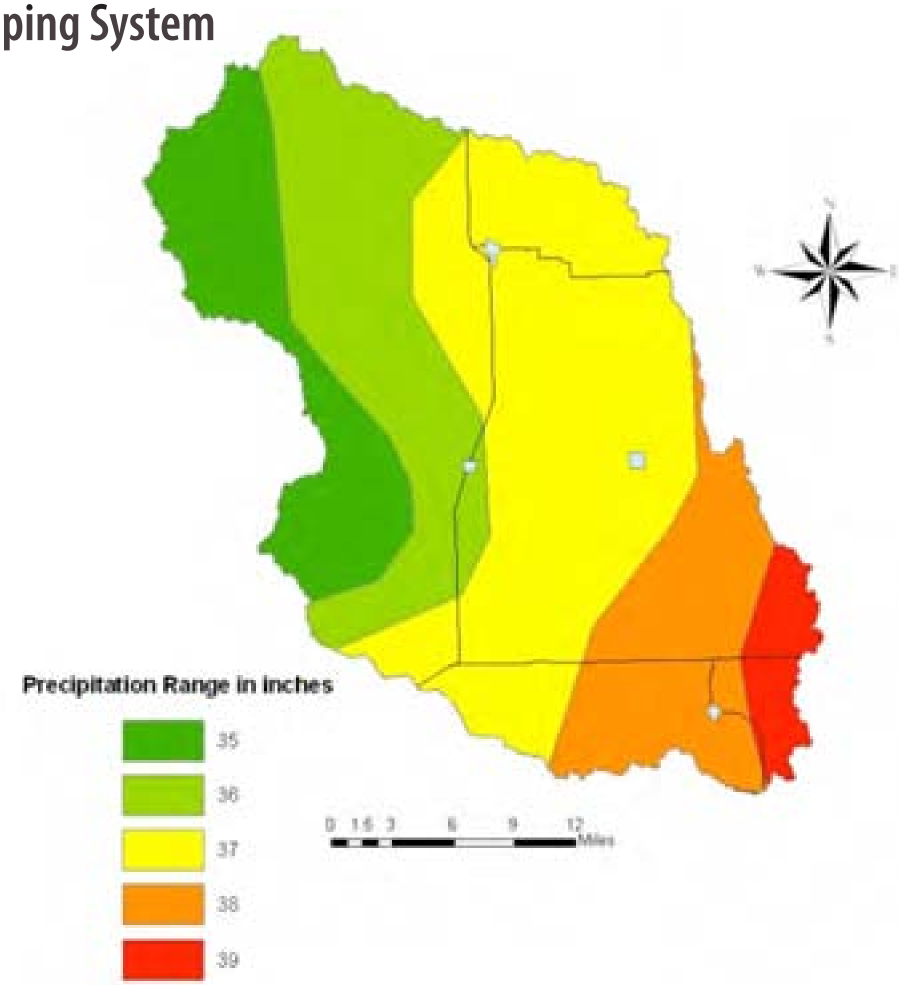

Figure3. 30-year average annual precipitation in inches, 1971–2000.

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

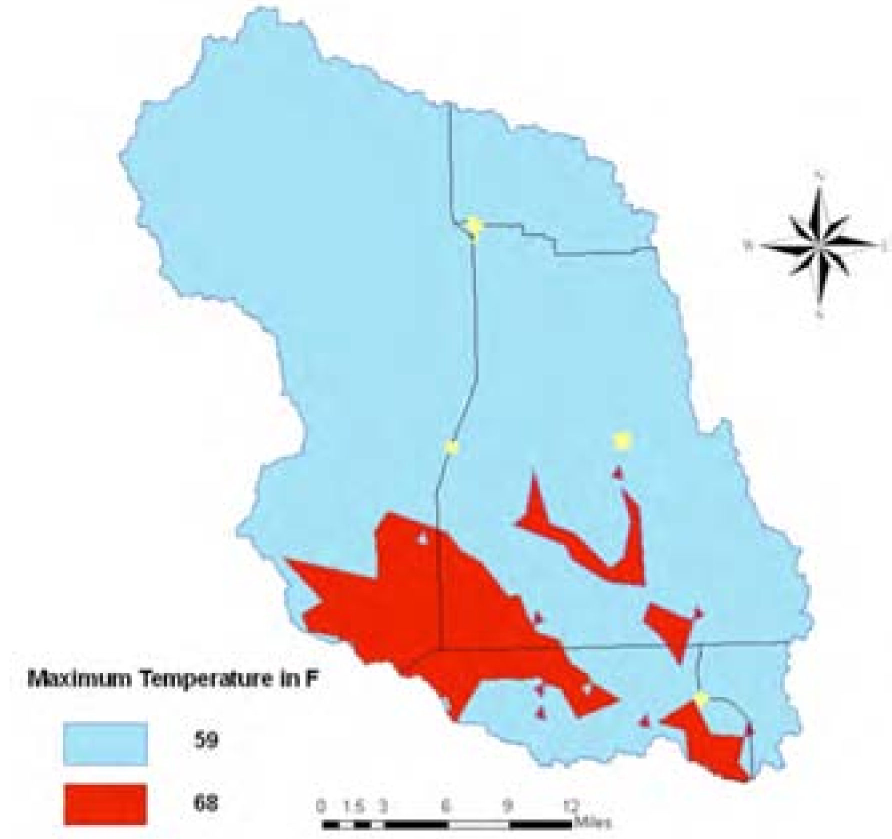

Figure 4. 30-year average daily maximum temperature in degrees Fahrenheit, 1971–2000

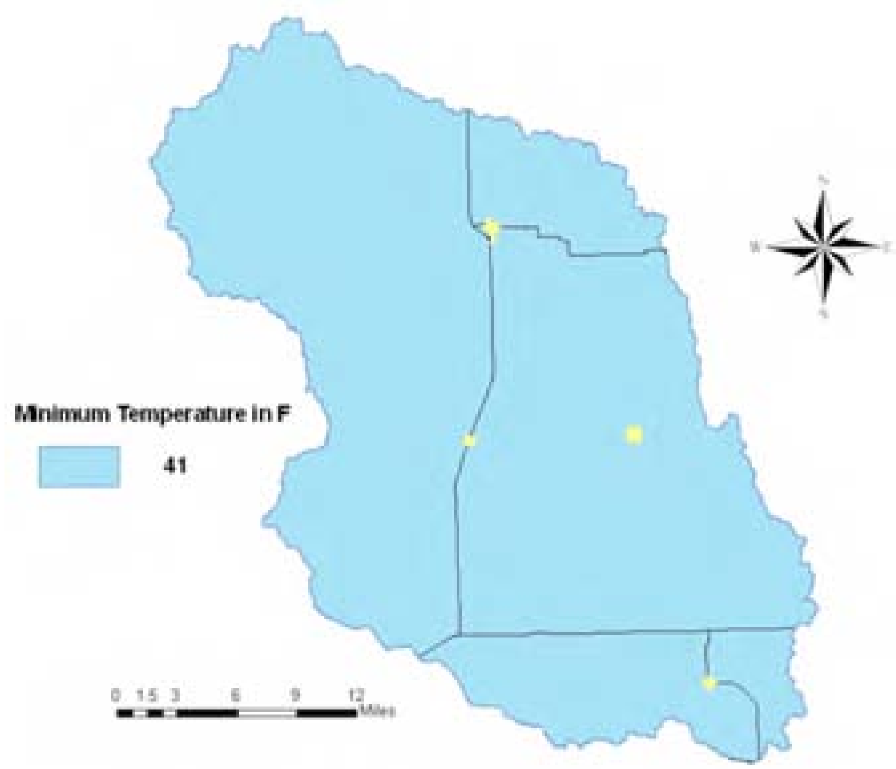

Figure 5. 30-year average daily minimum temperature in degree sFahrenheit, 1971–2000

3.0 Land Use/ Land Cover

3.1 Land Use (GIRAS 1980s)[7]

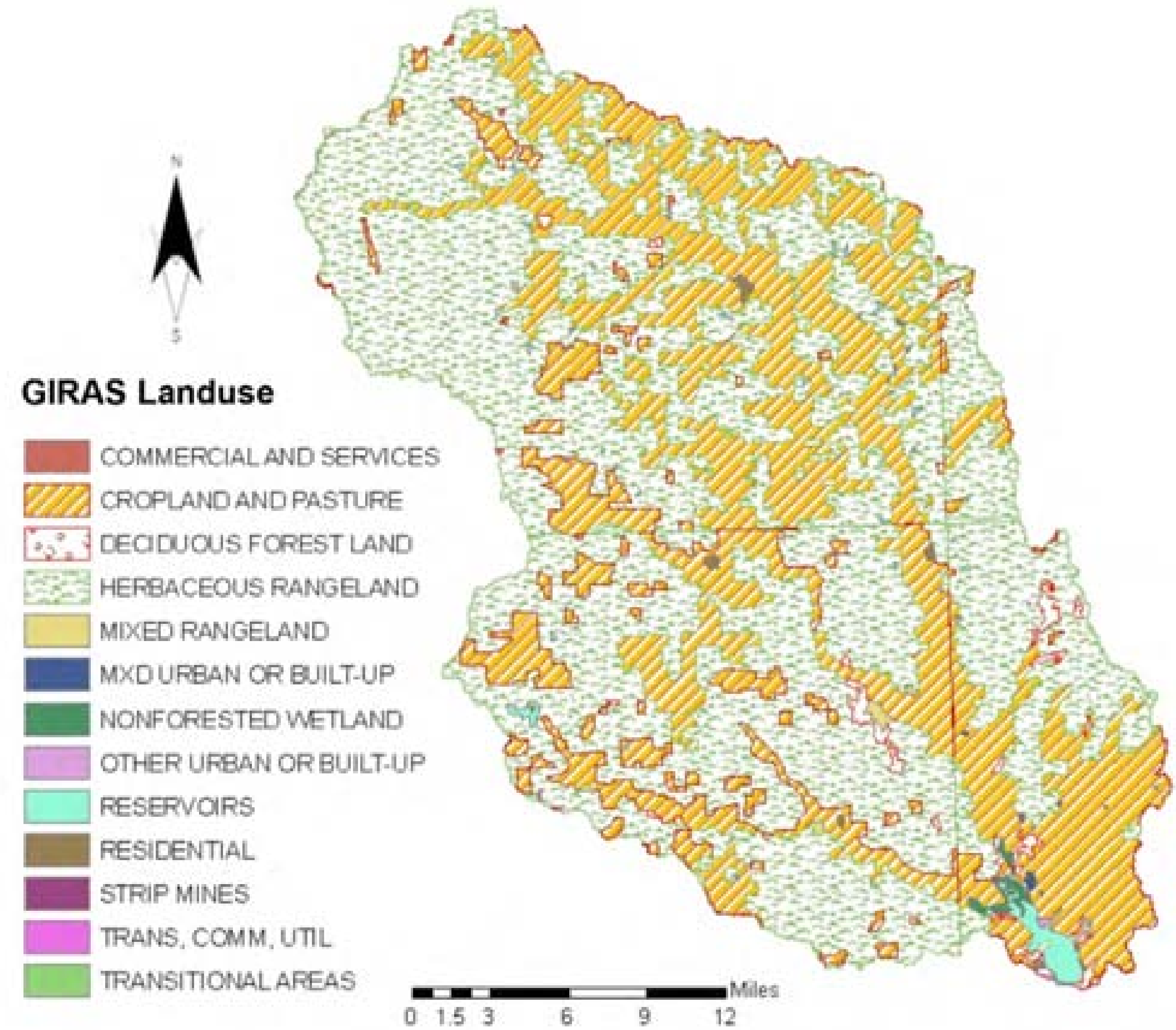

Figure 6. GIRAS 1980s land use classification.

3.2 Land Use (NLCD 1992)[8]

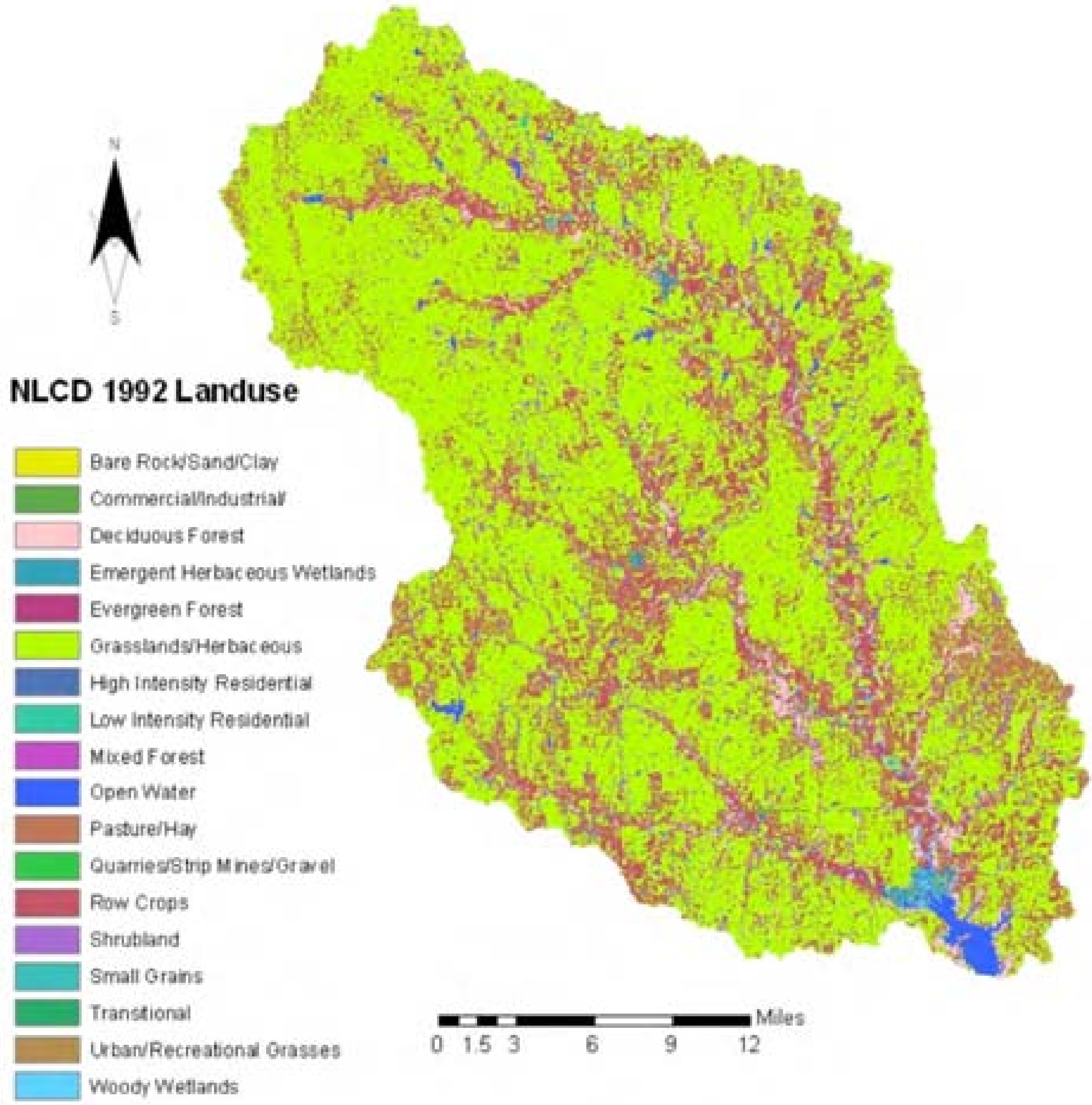

Figure 7. NLCD 1992 land use classification.

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.

22. High Intensity Residential – Includes highly developed areas where people reside in high numbers. Examples include apartment complexes and row houses. Vegetation accounts for less than 20 percent of the cover. Constructed materials account for 80 to100 percent of the cover.

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

31. Bare Rock/Sand/Clay – Perennially barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, beaches, and other accumulations of earthen material.

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

33. Transitional – Areas of sparse vegetative cover (less than 25 percent of cover) that are dynamically changing from one land cover to another, often because of land use activities. Examples include forest clearcuts, a transition phase between forest and agricultural land, the temporary clearing of vegetation, and changes due to natural causes (e.g. fire, flood, etc.)

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

42. Evergreen Forest – Areas dominated by trees where 75 percent or more of the tree species` maintain their leaves all year. Canopy is never without green foliage.

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]

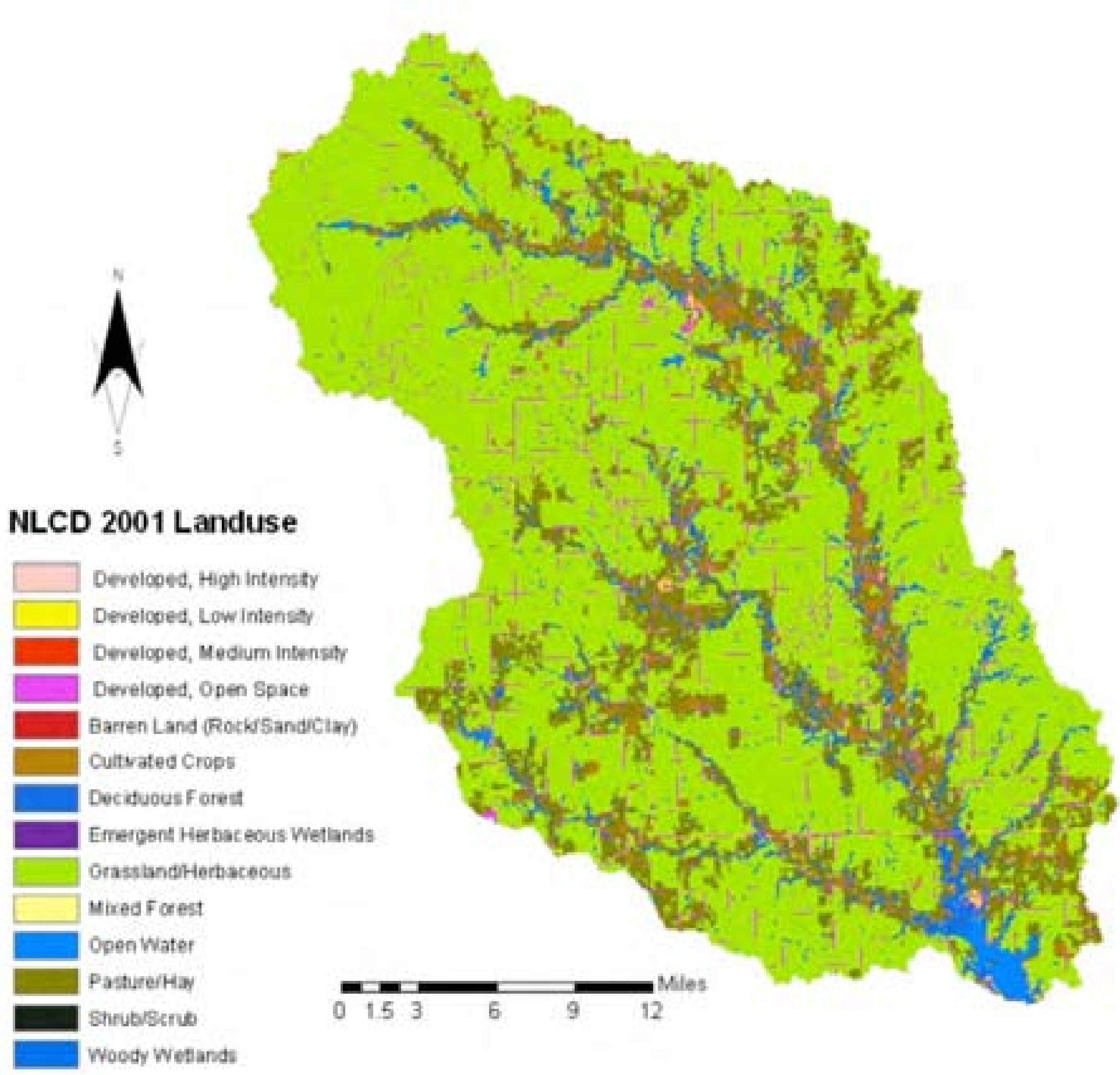

Figure 8. NLCD 2001 land use classification.

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 percent 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.

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	169017		169017	114	3676	279010	1362	4932	0	458111
NLCD 1992	42093	86533	128626	64	13066	287788	1031	13565	14260	458400
NLCD 2001	17844	68435	86279	77	21531	324516	17480	7871	105	457859

4.0 River Network[9]

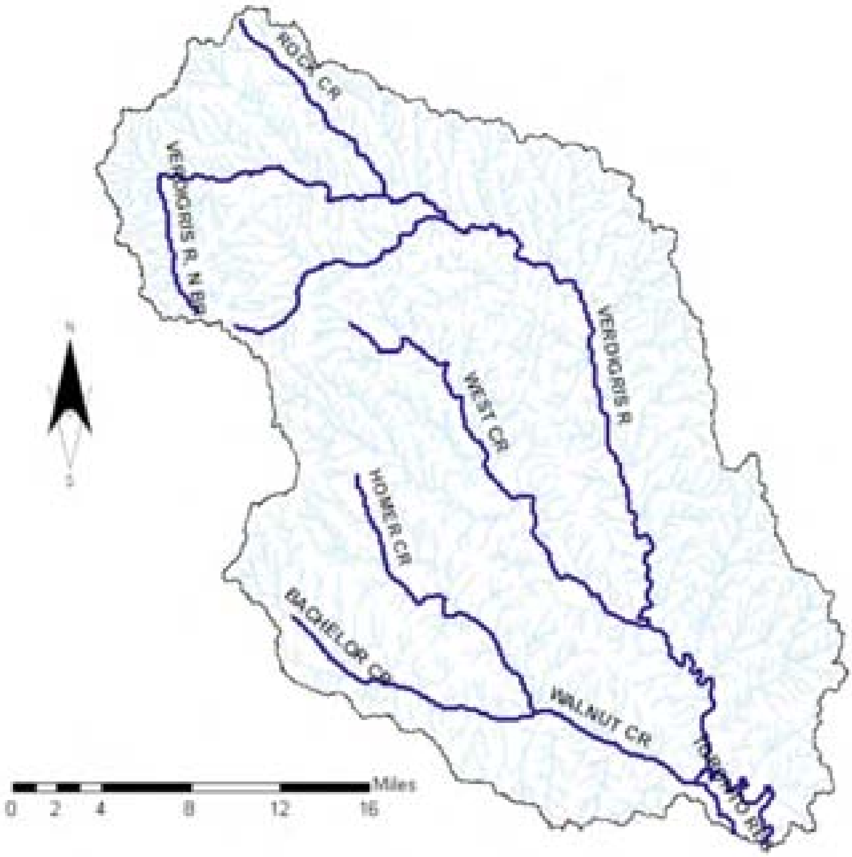

Figure 9. River network – Toronto Lake Watershed.

5.0 Hydrologic Soil Groups[10]

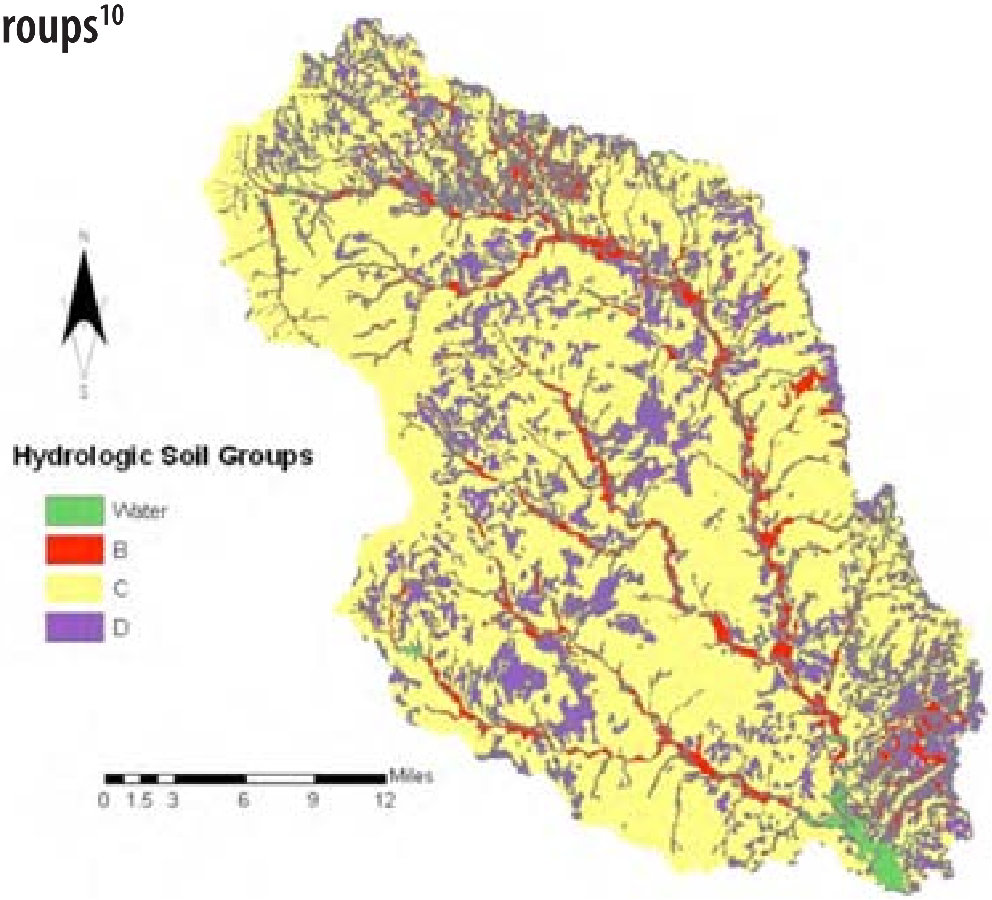

Figure 10. Hydrologic Soil Groups –SSURGO Database- Toronto Lake Watershed.

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.

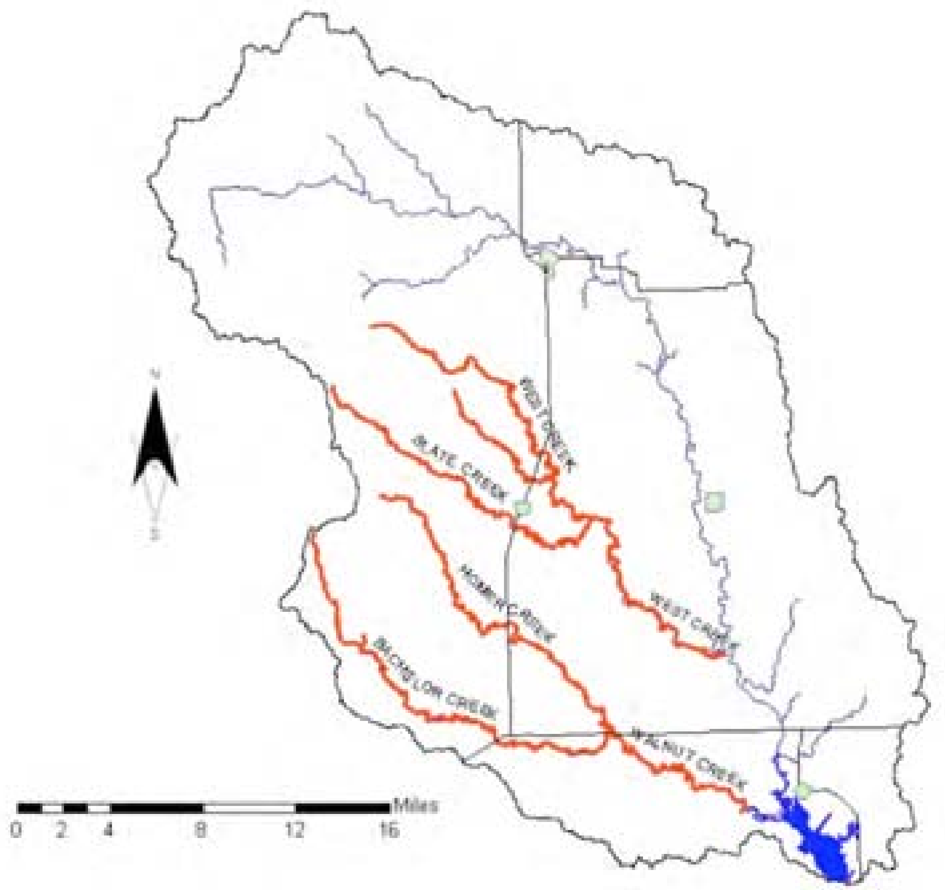

Figure 11. Impaired Waterbodies based on The 303d List – Toronto Lake Watershed.

Table 2. The 303d List of Impaired Waterbodies

Waterbody Name	Impairment
Bachelor Creek	Low Dissolved Oxygen
Homer Creek	Low Dissolved Oxygen
Onion Creek	Low Dissolved Oxygen
Slate Creek	Low Dissolved Oxygen
Walnut Creek	Low Dissolved Oxygen
West Creek	Low Dissolved Oxygen

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.

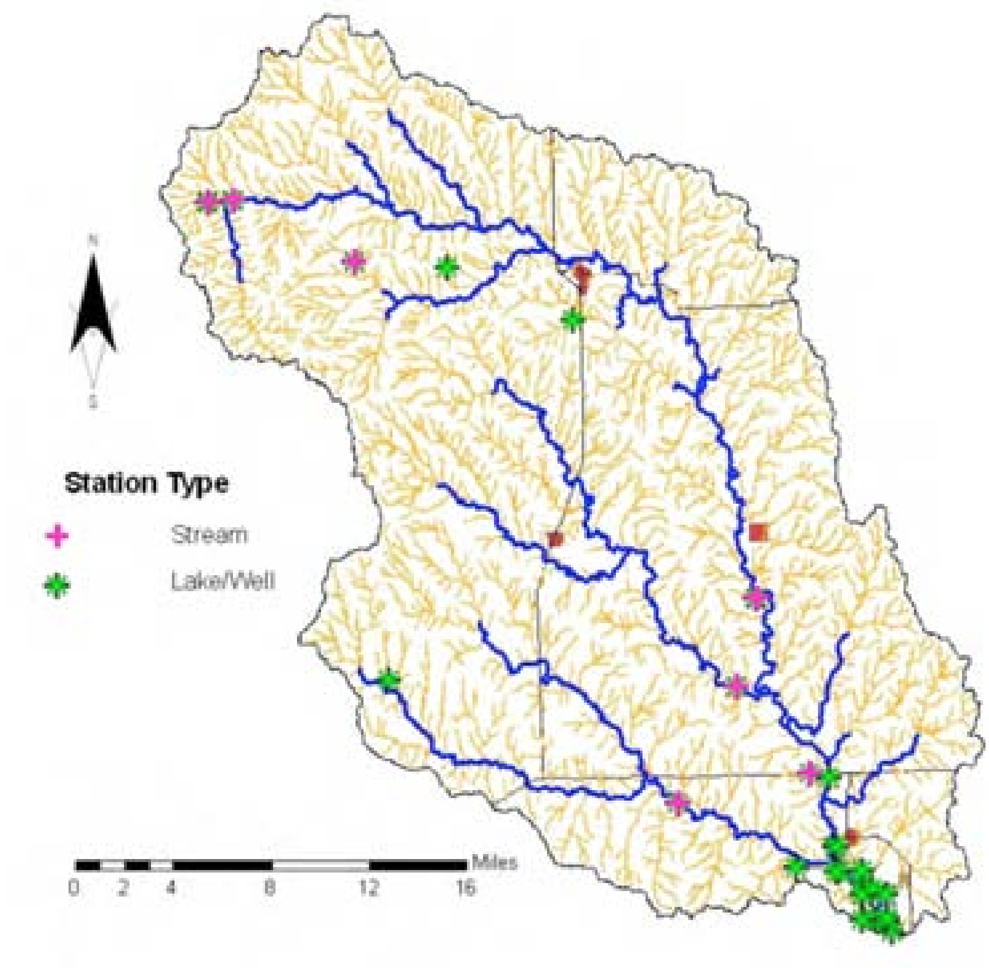

Figure 12. Lakes and Streams Water Quality Observation Stations – Toronto Lake Watershed.

Table 3. Water Quality Observation Station

Station ID	Agency Name	Station Type	Location
07165750	USGS	Stream	Verdigris R Near Virgil, KS
000289	KDHE	Stream	Verdigris River Near Virgil
000290	KDHE	Stream	West Creek Near Quincy
9015L0151	KDHE	Lake	Station 1 Pond 15 U Verdigris Watershed / Arkans
9015L0152	KDHE	Lake	Station 2 Pond 15 U Verdigris Watershed / Arkans
9015L0153	KDHE	Lake	Station 3 Pond 15 U Verdigris Watershed / Arkans
9015L0154	KDHE	Lake	Station 4 Pond 15 U Verdigris Watershed / Arkans
9015L0155	KDHE	Lake	Station 5 Pond 15 U Verdigris Watershed / Arkans
9015L0156	KDHE	Lake	Station 6 Pond 15 U Verdigris Watershed / Arkans
9015SA015	KDHE	Stream	Scs Site 1-5 U Verdigris Riv Ws / Arkansas River
9015SB015	KDHE	Stream	Scs Site 1-5 U Verdigris Riv Ws / Arkansas River
9015SB115	KDHE	Stream	Scs Site 1-5 Upper Verdigris River Ws Chase Co /
9015SD015	KDHE	Stream	Scs Site 1-5 Upper Verdigris River Ws Chase Co /
009602	EPA Region 7	Stream	Unnamed Trib. To S. Br. Verdigris River / /
009635	EPA Region 7	Stream	Unnamed Trib. To South Branch Verdigris River /
KSS0021	Tulsa District Corps of Engineers	Lake	Toronto Lake, KS / South Central Lower Miss / Ver
KSS0022	Tulsa District Corps of Engineers	Lake	Toronto Lake, KS / South Central Lower Miss / Ver
000289	KDHE	Stream	Verdigris River Near Virgil / Arkansas / Verdigr
000290	KDHE	Stream	West Creek Near Quincy / Arkansas / Verdigris Un
000576	KDHE	Stream	Walnut Creek Near Neal / Arkansas River / Verdig
002608	KDHE	Stream	Verdigris River Near Toronto / Arkansas / Verdig
024011	KDHE	Lake	Toronto Lake Inflow Station / Arkansas River / V
040201	KDHE	Lake	Eureka Lake / Arkansas R. / Verdigris R.
051801	KDHE	Lake	Madison City Lake Sta. No.1 / Arkansas River /
SID00030605	KDHE	Well	Madison #3 / Arkansas /
006810	EPA Region 7	Fish/Lake	Toronto Reservoir At Miller Creek Cove / S Cen L
KSS0017	Tulsa District Corps of Engineers	Lake	Toronto Lake, KS / Southcentrallowermissisv / Erd
KSS0018	Tulsa District Corps of Engineers	Lake	Toronto Lake, KS / South Central Lower Miss / Ver
KSS0019	Tulsa District Corps of Engineers	Lake	Toronto Lake, KS / South Central Lower Miss / Ver
KSS0020	Tulsa District Corps of Engineers	Lake	Toronto Lake, KS / South Central Lower Miss / Ve
201301	USEPA	Lake	Toronto Reservoir
201302	USEPA	Lake	Toronto Reservoir
000424	KDHE	Lake	Toronto Reservoir / Arkansas R. Basin / Verdigri
024001	KDHE	Lake	Toronto Reservoir Sta 1 / Arkansas / Verdigris U
024002	KDHE	Lake	Toronto Reservoir Sta 2 / Arkansas / Verdigris U
024003	KDHE	Lake	Toronto Reservoir Sta 3 / Arkansas / Verdigris U
024004	KDHE	Lake	Toronto Reservoir Sta 4 / Arkansas / Verdigris U
024005	KDHE	Lake	Toronto Reservoir Sta 5 / Arkansas / Verdigris U
024006	KDHE	Lake	Toronto Reservoir Sta 6 / Arkansas / Verdigris U
024007	KDHE	Lake	Toronto Reservoir Sta 7 / Arkansas / Verdigris U

6.3. USGS Gage Stations[12]

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

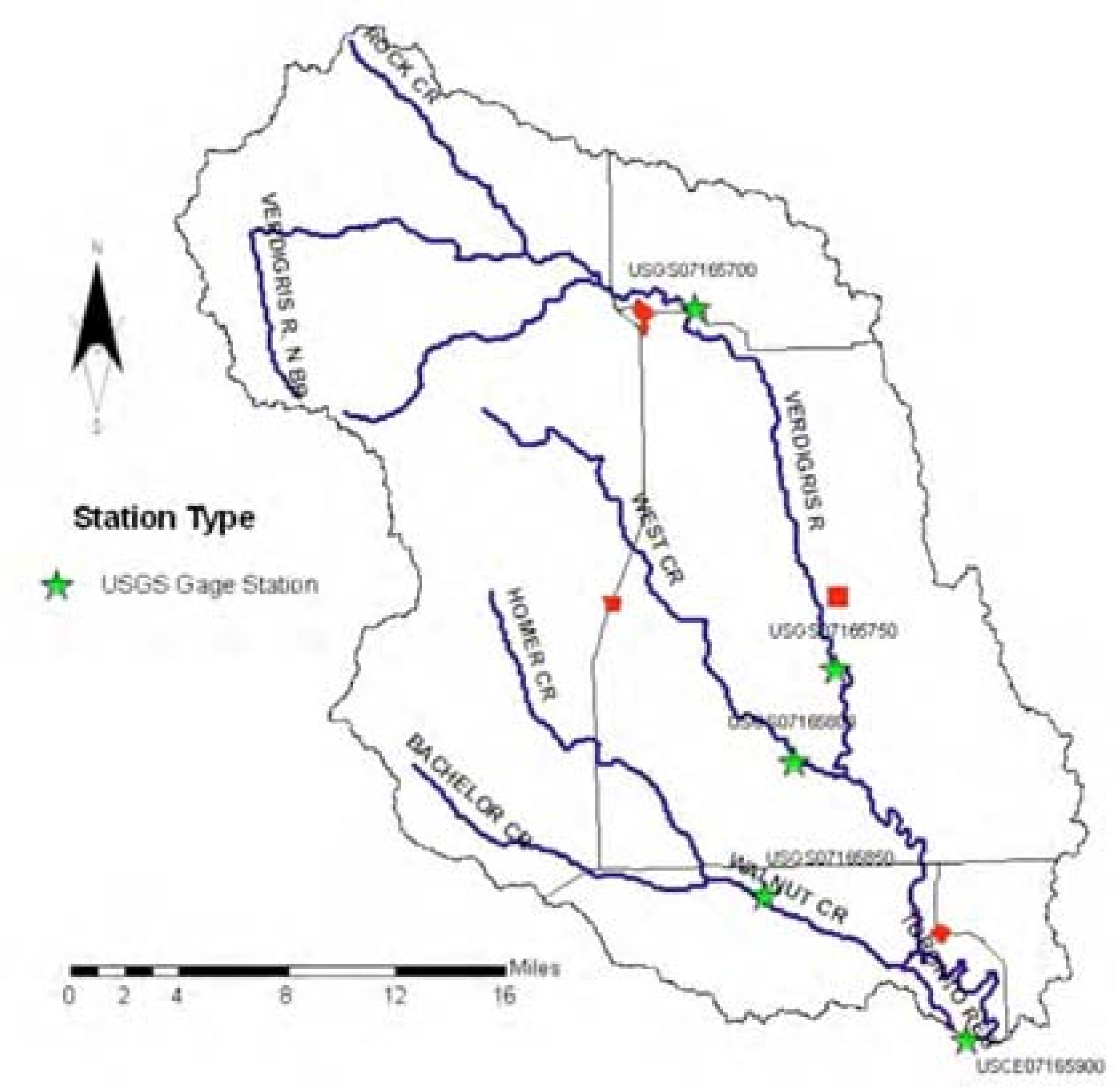

Figure 13. USGS Gage Stations – Toronto Lake Watershed.

Table 4. USGS Gage Station[12]

Gage ID	Stream Flow (cfs)												
	Mean	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
USGS07165700	126.18	81.31	100.30	192.20	155.67	130.36	248.32	137.07	22.53	116.33	148.08	115.48	65.99
USGS07165800	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS07165850	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS07165750	-	-	-	-	-	-	-	-	-	-	-	-	-
USCE07165900	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 5. Estimated peak-streamflow frequencies for USGS gage station 7165700 with at least 10 years of annual peak-discharge data for unregulated, rural streams[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
7165700	Verdigris River near Madison	181	8120	18700	28400	43800	57600	73400	91300

Table 6. USGS gaging stations period of record for Upper Verdigris Watershed[12]

USGS ID	Drainage Area (mi^2)	Period of record	
		Begin	End
07165700	181	10/01/55	09/30/76
07165750	312	10/01/89	09/30/98

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.

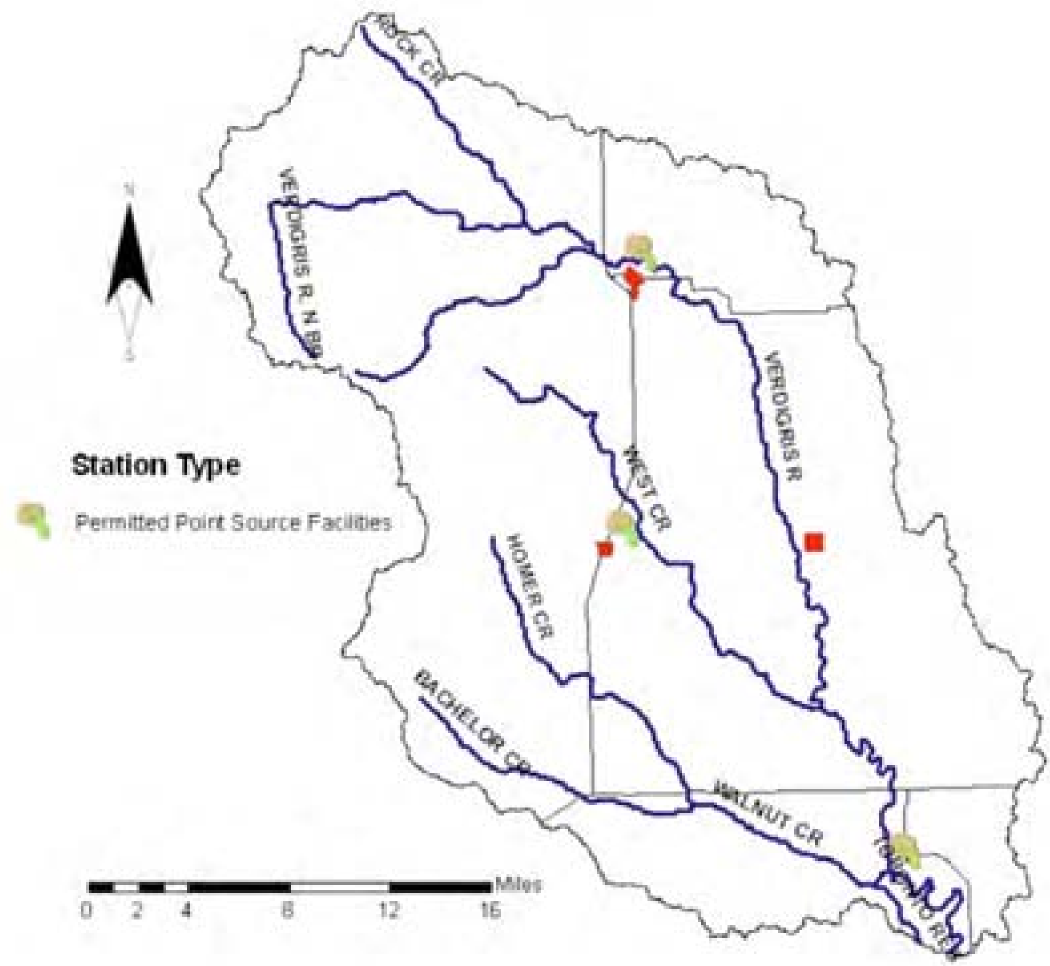

Figure 14. NPDES permit-holding facilities – Toronto Lake Watershed.

Table 7. Permitted Point Source Facilities[14]

NPDES	Facility Name	Ownership	Description	Industrial Classification	City	County	Flow Rate (million gallons/day)
KS0021890	Toronto, City Of Stp	Public	Sewerage Systems	Municipal	Toronto	Woodson	0.05000
KS0030538	Madison, City Of Wwtf	Public	Sewerage Systems	Municipal	Madison	Greenwood	0.00000
KS0046001	Hamilton, City Of Stp	Public	Sewerage Systems	Municipal	Hamilton	Greenwood	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 maps shows the locations and permit numbers for these sites in the Toronto lake watershed.

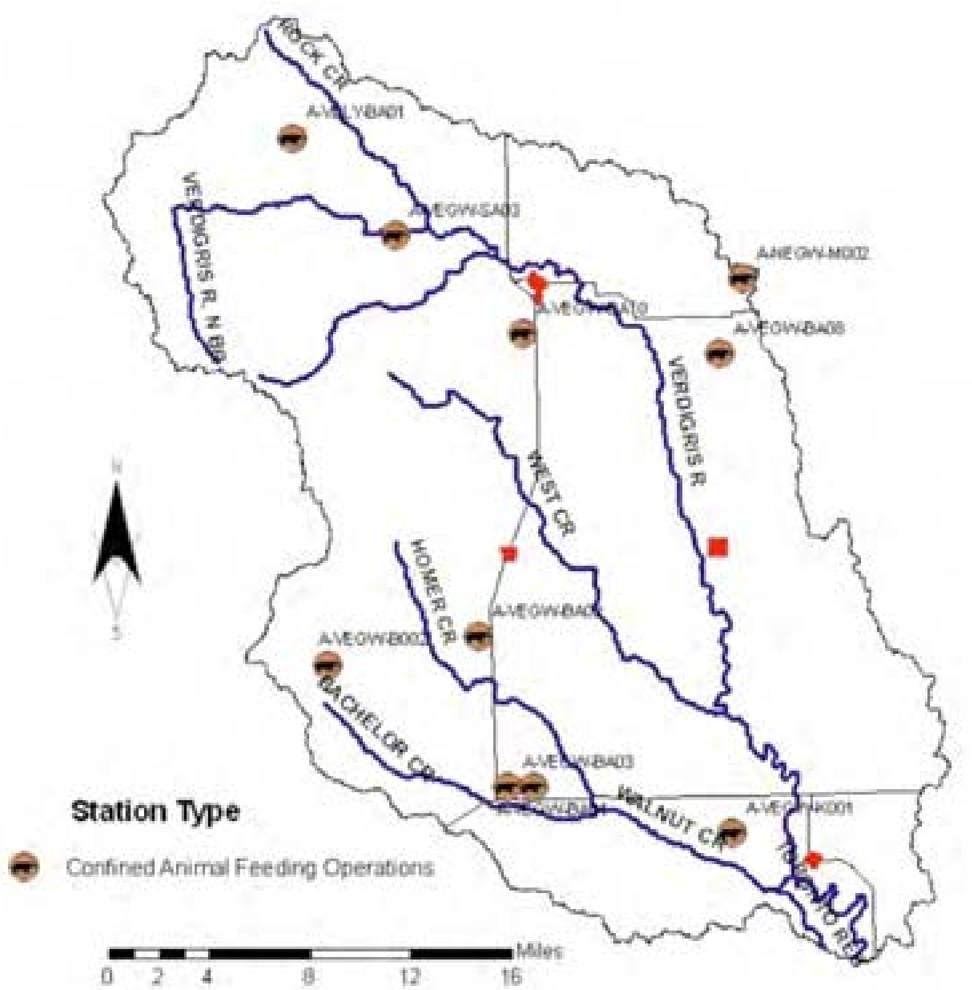

Figure 15. Confined Animal Feeding Operations facilities - Toronto Lake Watershed.

Table 8. Confined Animal Feeding Operations[15]

Permit No.	Total Head	Animal Unit System	Animal Type
A-VEGW-SA03	350	140	Swine
A-VEGW-BA10	475	475	Beef
A-VEGW-BA08	200	200	Beef
A-VEGW-BA02	900	900	Beef
A-VEGW-BA04	180	180	Beef
A-VEGW-BA03	100	100	Beef
A-VELY-BA01	600	600	Beef
A-NEGW-M002	400	560	Dairy
A-VEGW-K001	150	0	Kennel
A-VEGW-B002	120	120	Beef

6.6 1990 Population and Sewerage by Census Trac[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.

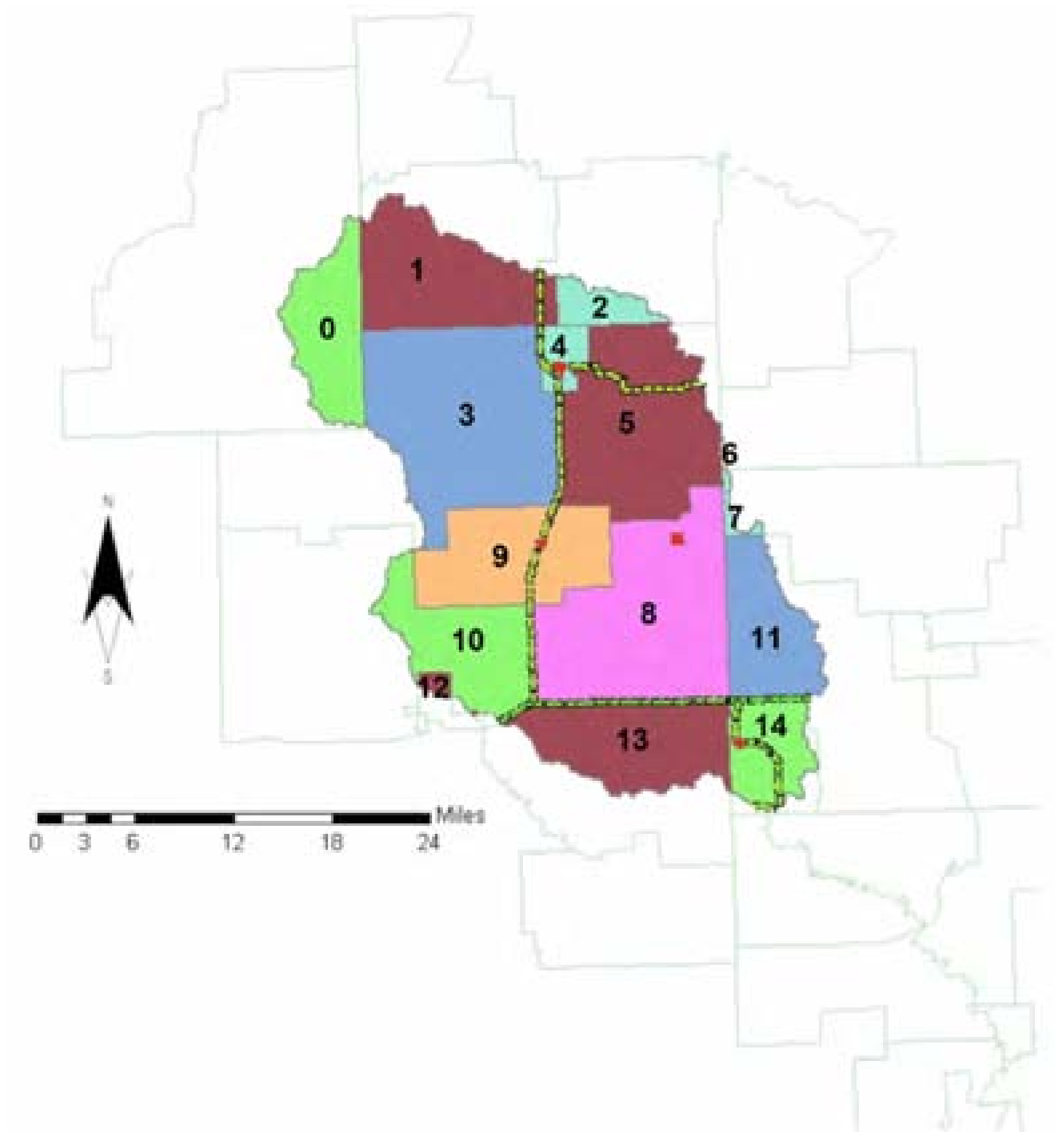

Figure 16. Population and Sewerage by Census – Toronto Lake Watershed.

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

ID	FIPS	TRACT	Population	House Units	Sewerage Public	Sewerage Septic	Sewerage Other
0	20017	990600	370	201	3	161	37
1	20111	000800	1117	429	189	227	13
2	20111	000800	979	359	184	150	25
3	20073	995600	154	82	0	79	3
4	20073	995600	997	452	419	33	0
5	20073	995600	347	141	0	120	21
6	20031	996200	630	295	180	98	17
7	20207	996600	281	120	0	120	0
8	20073	995600	291	149	74	69	6
9	20073	995600	459	252	172	72	8
10	20073	995600	357	280	0	261	19
11	20207	996600	319	145	0	138	7
12	20073	995700	910	412	378	34	0
13	20073	995800	250	144	11	133	0
14	20207	996600	595	485	294	191	0

7.0. Agricultural Economy

7.1 Corn Cost-Return Budget[17]

Table 10. Cost-return projections for corn crops in the Toronto Watershed, 2006.

Corn	Yield Level (bu)		
	80	110	140
Income Per Acre			
A. Yield per acre	80	110	140
B. Price per bushel	$2.70	$2.70	$2.70
C. Net government payment	$10.48	$11.39	$12.30
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$226.48	$308.39	$390.30
Costs Per Acre			
1. Seed	$32.43	$32.43	$36.66
2. Herbicide	33.85	33.85	33.85
3. Insecticide/Fungicide	0.27	0.27	0.27
4. Fertilizer and Lime	37.48	45.40	53.32
5. Crop Consulting			
6. Crop Insurance			
7. Drying			
8. Miscellaneous	7.00	7.00	7.00
9. Custom Hire / Machinery Expense	90.16	98.83	107.50
10. Non-machinery Labor	10.19	11.17	12.15
11. Irrigation			
12. Land Charge/Rent	34.40	43.00	51.60
G. Sub Total	$245.77	$271.94	$302.34
13. Interest on ½ Nonland Costs	9.51	10.30	11.28
H. Total Costs	$255.28	$282.25	$313.63
I. Returns Over Costs (F-H)	**-$28.81**	**$26.14**	**$76.68**
J. Total Costs/bushel (H/A)	$3.19	$2.57	$2.24
K. Return To Annual Cost (I+13)/G	-7.85%	13.40%	29.09%

7.2 Soybean Cost-Return Budget[17]

Table 11. Cost-return projections for soybean crops in the Toronto Watershed, 2006.

Soybeans	Yield Level (bu)		
	25	35	45
Income Per Acre			
A. Yield per acre	25	35	45
B. Price per bushel	$6.08	$6.08	$6.08
C. Net government payment	$10.48	$11.39	$12.30
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$162.48	$224.19	$285.90
Costs Per Acre			
1. Seed	$30.60	$30.60	$32.95
2. Herbicide	8.86	8.86	8.86
3. Insecticide/Fungicide			
4. Fertilizer and Lime	16.41	17.70	21.20
5. Crop Consulting			
6. Crop Insurance			
7. Drying			
8. Miscellaneous	7.00	7.00	7.00
9. Custom Hire / Machinery Expense	73.03	77.25	80.22
10. Non-machinery Labor	8.25	8.75	9.06
11. Irrigation			
12. Land Charge / Rent	34.40	43.00	51.60
G. Sub Total	$178.55	$193.14	$210.89
13. Interest on ½ Nonland Costs	6.49	6.76	7.17
H. Total Costs	$185.03	$199.89	$218.06
I. Returns Over Costs (F-H)	**-$22.56**	**$24.30**	**$67.84**
J. Total Costs/bushel (H/A)	$7.40	$5.71	$4.85
K. Return To Annual Cost (I+13)/G	-9.00%	16.08%	35.57%

7.3 Wheat Cost-Return Budget[17]

Table 12. Cost-return projections for wheat crops in the Toronto Watershed, 2006.

Wheat	Yield Level (bu)		
	35	**45**	**55**
Income Per Acre			
A. Yield per acre	35	45	55
B. Price per bushel	$4.41	$4.41	$4.41
C. Net government payment	$10.48	$11.39	$12.30
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$164.83	$209.84	$254.85
Costs Per Acre			
1. Seed	$9.90	$9.90	$9.90
2. Herbicide	2.75	2.75	2.75
3. Insecticide/Fungicide			
4. Fertilizer and Lime	36.65	43.71	52.06
5. Crop Consulting			
6. Crop Insurance			
7. Drying			
8. Miscellaneous	7.00	7.00	7.00
9. Custom Hire / Machinery Expense	60.61	63.62	66.63
10. Non-machinery Labor	6.85	7.19	7.53
11. Irrigation			
12. Land Charge / Rent	34.40	43.00	51.60
G. Sub Total	$158.16	$177.17	$197.47
13. Interest on ½ Nonland Costs	5.57	6.04	6.56
H. Total Costs	$163.73	$183.20	$204.04
I. Returns Over Costs (F-H)	**$1.10**	**$26.64**	**$50.81**
J. Total Costs/bushel (H/A)	$4.68	$4.07	$3.71
K. Return To Annual Cost (I+13)/G	4.22%	18.44%	29.06%

7.4 Grain Sorghum Cost-Return Budget[17]

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

Grain Sorghum	Yield Level (bu)		
	70	85	110
Income Per Acre			
A. Yield per acre	70	85	110
B. Price per bushel	$2.82	$2.82	$2.82
C. Net government payment	$10.48	$11.39	$12.30
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$207.88	$207.88	$207.88
Costs Per Acre			
1. Seed	$12.29	$12.29	$12.29
2. Herbicide	20.34	20.34	20.34
3. Insecticide/Fungicide	5.90	5.90	5.90
4. Fertilizer and Lime	39.68	43.64	50.24
5. Crop Consulting			
6. Crop Insurance			
7. Drying			
8. Miscellaneous	7.00	7.00	7.00
9. Custom Hire / Machinery Expense	82.39	86.92	94.47
10. Non-machinery Labor	9.31	9.82	10.68
11. Irrigation			
12. Land Charge / Rent	34.40	43.00	51.60
G. Sub Total	$211.30	$228.90	$252.51
13. Interest on ½ Nonland Costs	7.96	8.37	9.04
H. Total Costs	$219.26	$237.27	$261.55
I. Returns Over Costs (F-H)	**-$11.38**	**$13.82**	**$60.95**
J. Total Costs/bushel (H/A)	$3.13	$2.79	$2.38
K. Return To Annual Cost (I+13)/G	-1.62%	9.69%	27.72%

7.5 Alfalfa Cost-Return Budget[17]

Table 14. Cost-return projections for alfalfa crops in the Toronto 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 Toronto 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 Marmaton 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 Toronto Lake [26, 27, 28, 29, 30, 31, 32, 33]

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

Toronto Lake is a 2,580 acre impoundment located in southeastern Kansas in the Verdigris River Basin. The watershed consists of 730 square miles in Chase, Coffey, Greenwood, Lyon and Woodson counties. Toronto Lake was built in 1960 by the U.S. Army Corps of Engineers (COE) for flood control, water supply, water quality, recreation, and fish and wildlife.

This analysis estimated two types of regional recreation effects associated with Toronto 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 141,109 visits to Toronto Lake for a total of 3,036,266 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 $1.89 million (2007$) in direct economic activity (sales) within the regional economy, $0.85 million in all types of income associated with the production of economic activities, and 45 area full- and part-time jobs. After calculating the indirect economic impacts, it was estimated that visitor expenditures were closely associated with $2.43 million (2007$) in overall economic activity, $1.15 million in total income, and 51 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 Toronto Lake recreation, it was estimated that Toronto Lake visitors receive up to $7.60 million (2007$) in additional non-market recreation benefits annually. The values by recreation activity are reported in Table 18.

On average, the annual visitation rates for Toronto Lake have remained stable from 1996-2007 (Figure 19). Among the 17 Army COE Lakes in Kansas, Toronto Lake ranked 14th in number of visits and 8th 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.

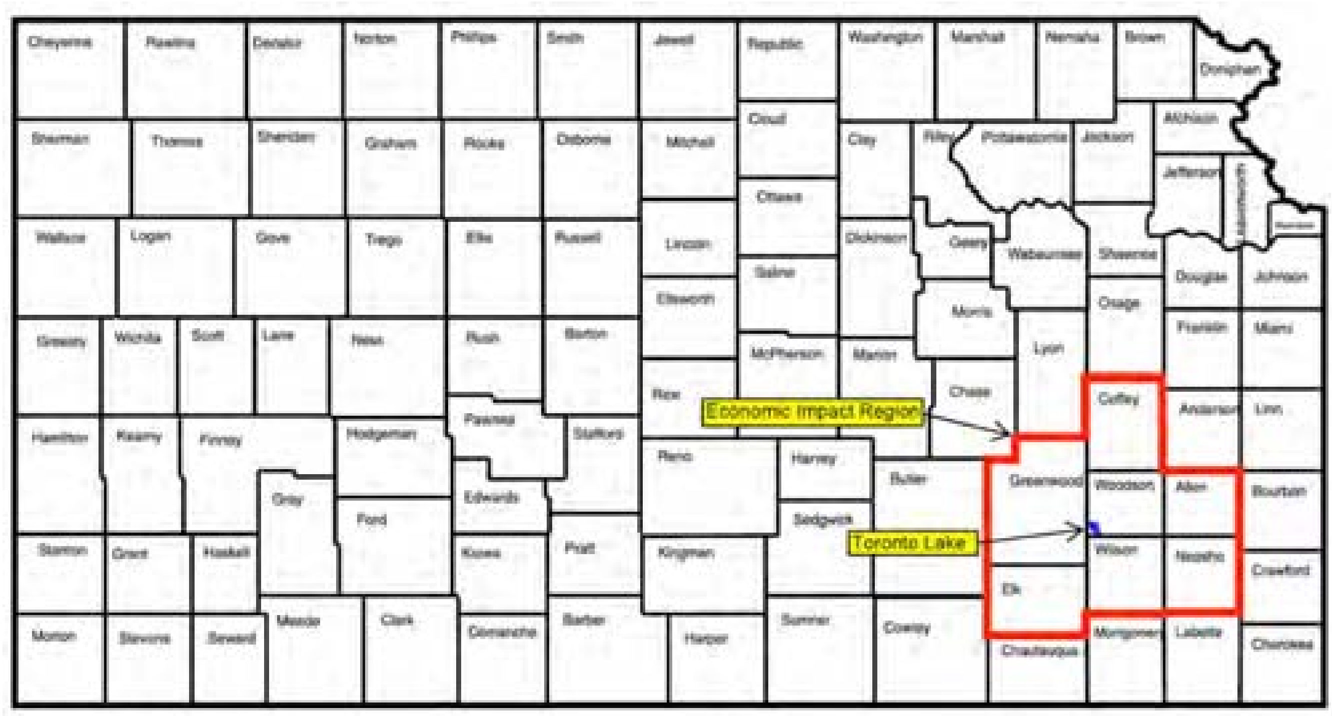

Figure 17. Toronto Lake economic impact region

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

Visitation	Camper		Day User		Other Overnight		Total
	Boater	Nonboater	Boater	Nonboater	Boater	Nonboater	
Percent of Total	0.7%	16.4%	3.2%	77.3%	0.1%	2.3%	100.0%
2007 Toronto visits	970	23,138	4,543	109,068	135	3,256	141,109
Spending	$71,463	$1,446,313	$101,805	$1,470,094	$12,782	$180,553	$3,283,010

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	0.51
Camping fee	15.47	16.01	0.00	0.00	0.11	0.03	2.73
Restaurants, bars, etc.	8.00	9.18	2.66	3.32	14.14	15.84	4.59
Groceries and take out food	20.41	16.62	4.39	4.39	14.71	6.31	6.56
Gas & oil	12.62	8.71	6.96	2.75	15.36	7.39	4.05
Other auto expenses	0.97	1.51	1.70	0.31	6.09	0.00	0.55
Other boat expenses	4.97	0.00	2.13	0.00	12.19	0.00	0.11
Entertainment and recreation fees	2.34	2.91	0.97	0.52	4.35	1.66	0.97
Sporting goods and boat equipment	4.76	1.51	3.09	0.86	4.95	2.37	1.10
Other expenses	3.34	5.94	0.50	1.33	3.37	1.69	2.08
Total (within 30 miles)	**$73.71**	**$62.51**	**$22.41**	**$13.48**	**$94.74**	**$55.46**	**$23.27**

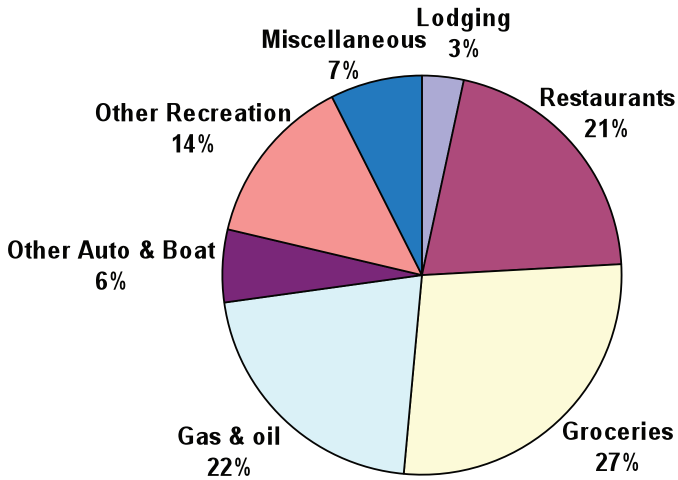

Figure 18. Trip spending by category

Table 17. Toronto Lake total economic contributions

Impact Measure	Direct	Indirect	Total
Output	$1,887,333	$545,201	$2,432,534
Total Value Added	$846,958	$307,661	$1,154,619
Employment	45	6	51

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

Activity	Days Spent in Activity	Activity Value per Day (2007$)	Total Value per Year
Fish	106,775	$38.58	$4,119,491
Swim	57,689	$19.75	$1,139,239
Camp	30,869	$29.54	$911,821
Boat	20,748	$27.45	$569,475
Picnic	11,892	$30.42	$361,732
Other	25,049	$19.94	$499,432
Total	**253,022**	-------	**$7,601,190**

Figure 19. Trends in Toronto Lake visitation

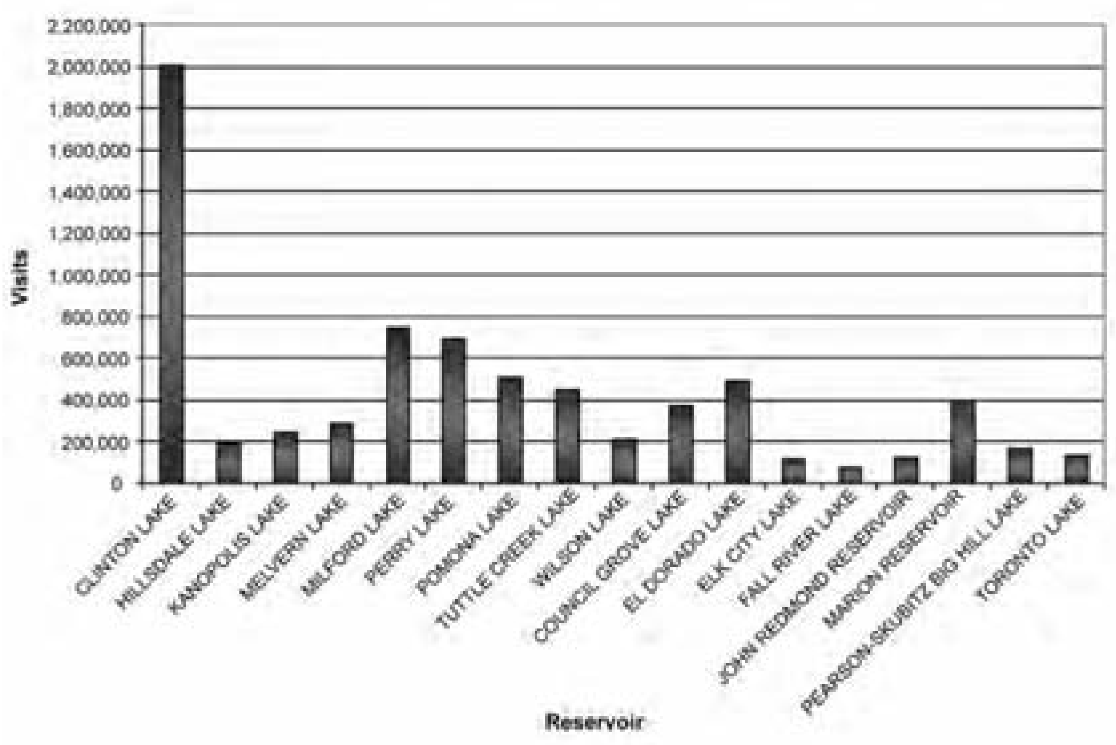

Figure 20. Visits to Kansas Reservoirs in 2007

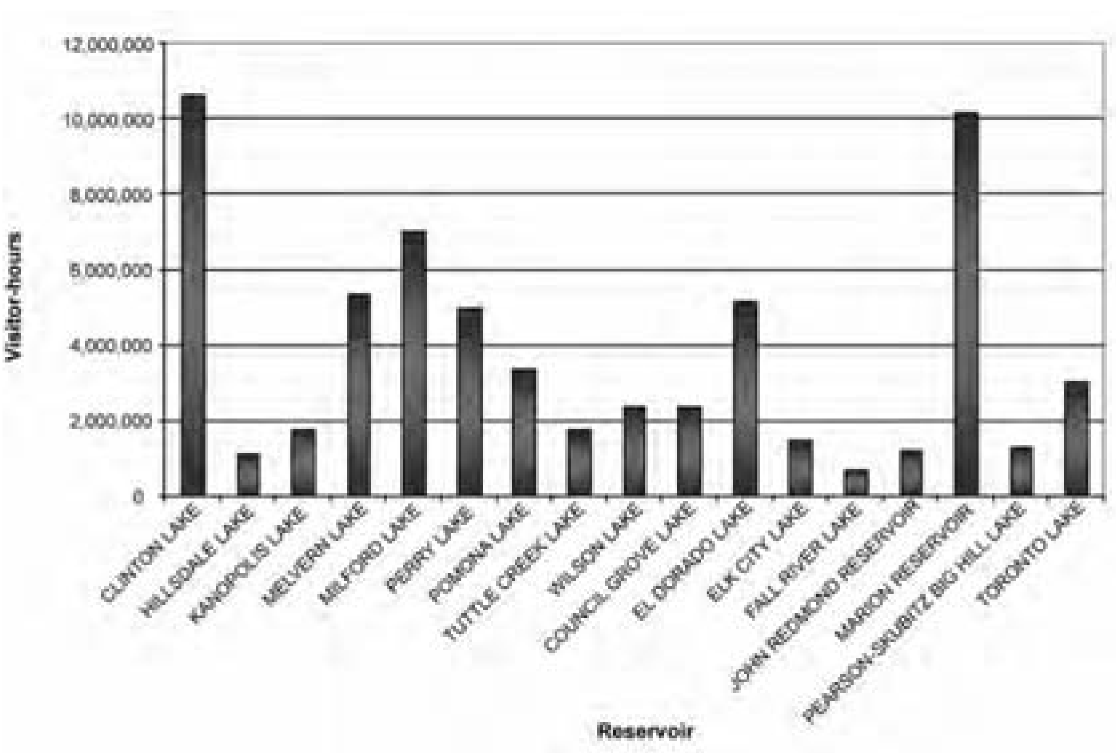

Figure21. Visitor-hours at Kansas Reservoirs in 2007

7.8 Census Data[18]

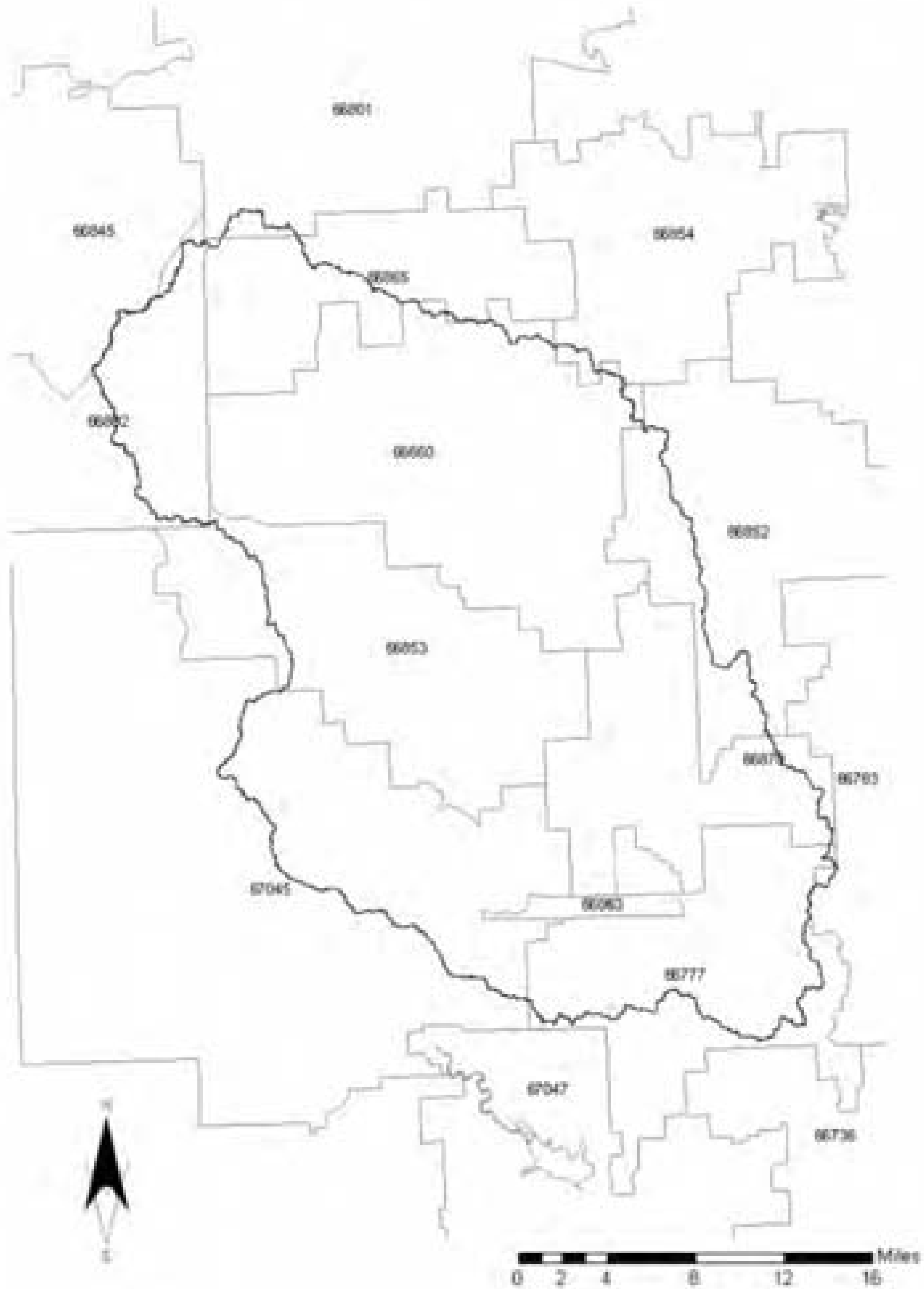

Figure 22. Zip Code Boundary Map.

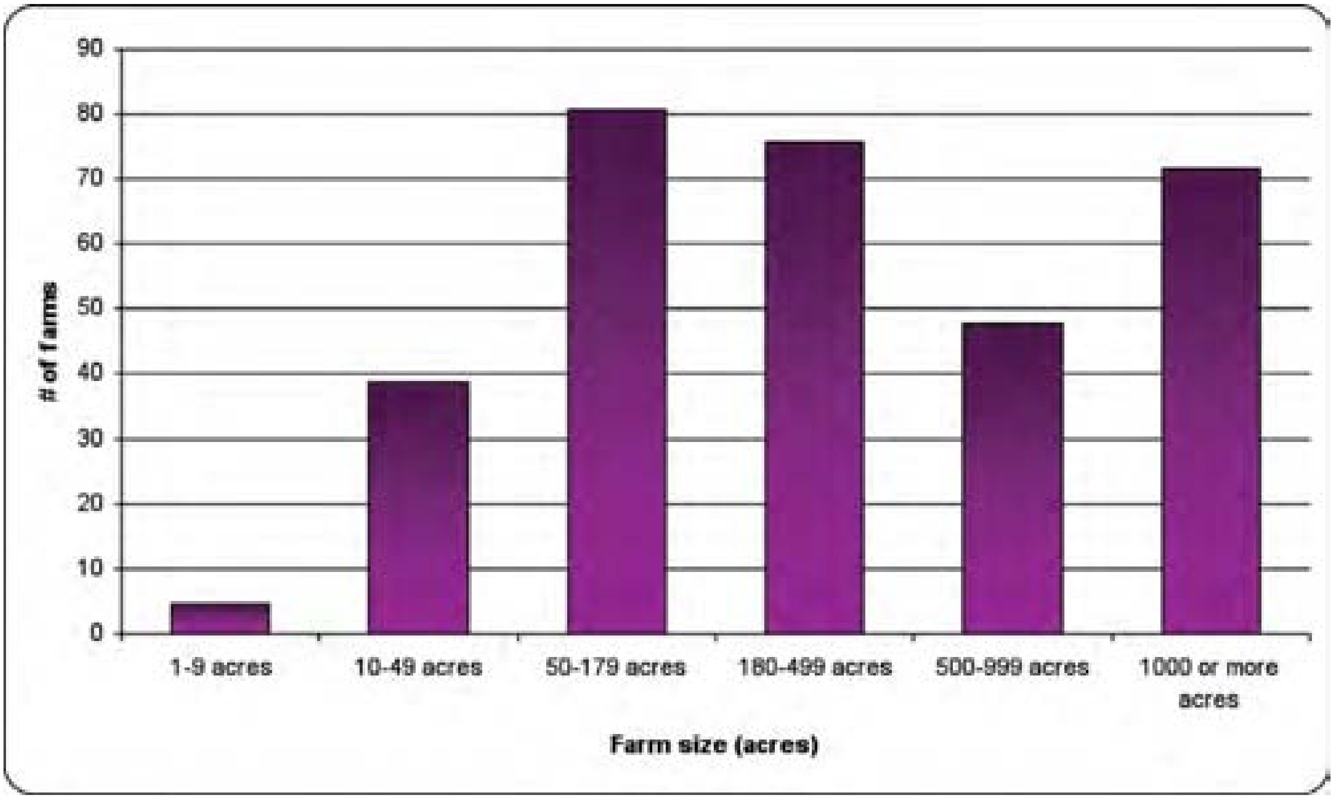

Figure 23. Size Distribution of Farms in Toronto Watershed, 2002[18]

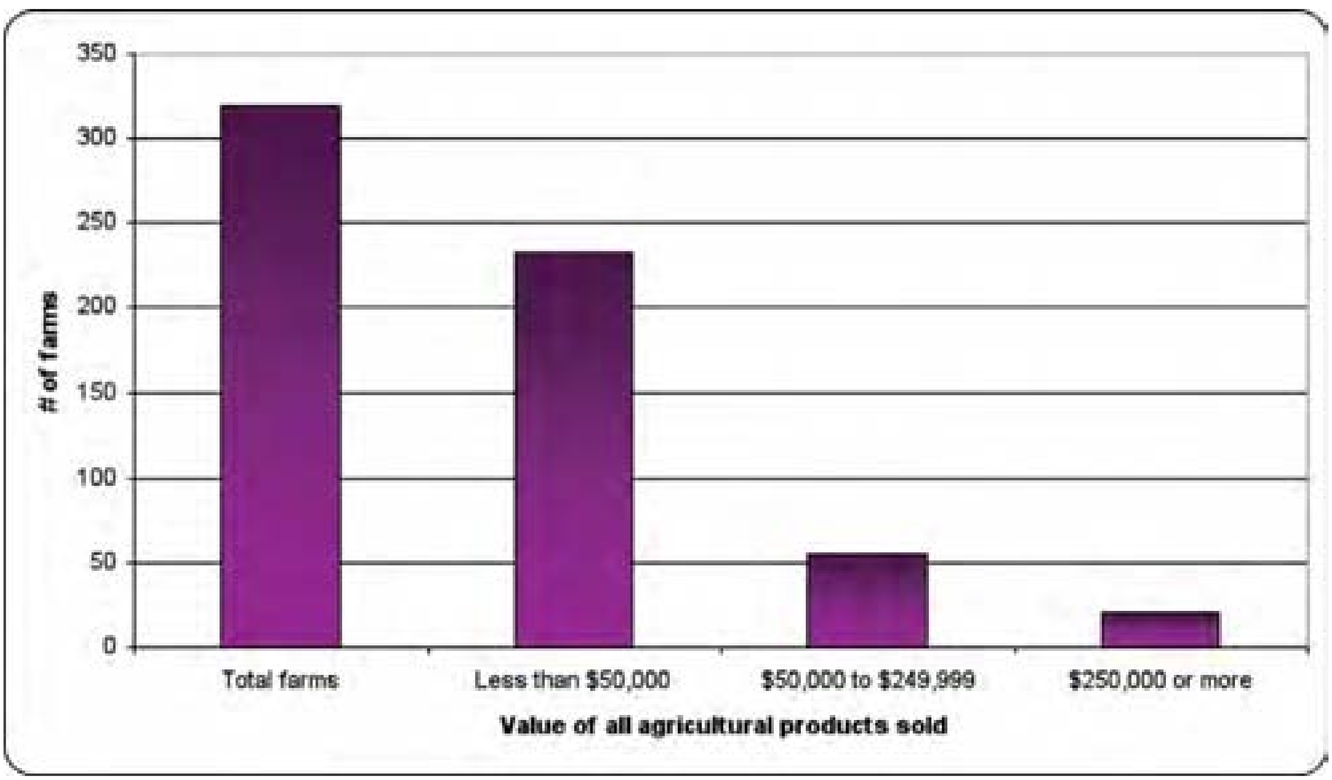

Figure 24. Sales Distribution of Farms in Toronto Watershed, 2002[18]

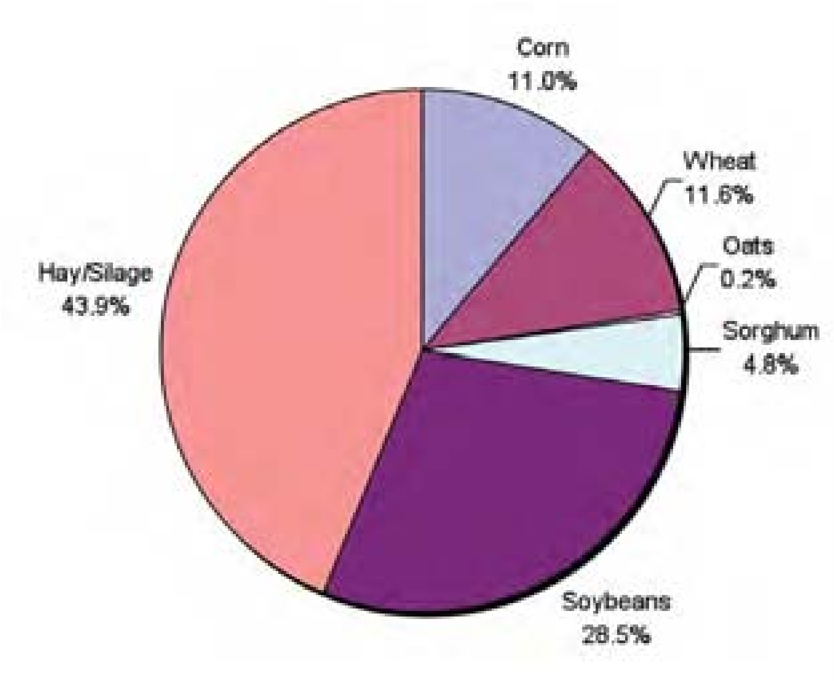

Figure 25. Harvested Crop Acreage in Toronto Watershed, 2002[18]

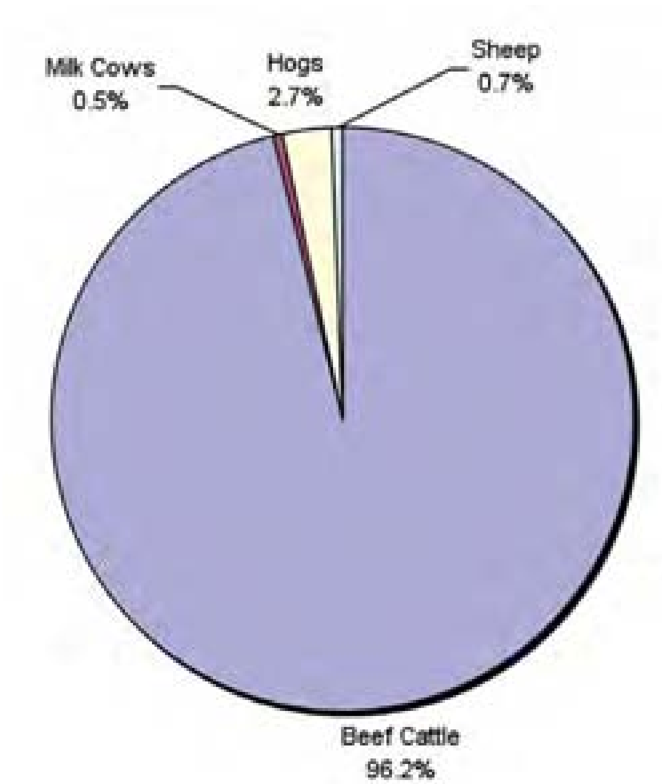

Figure 26. Livestock Number Distribution in Toronto Watershed, 2002[18]

8.0 Modeling

8.1 Subbasin Map[19]

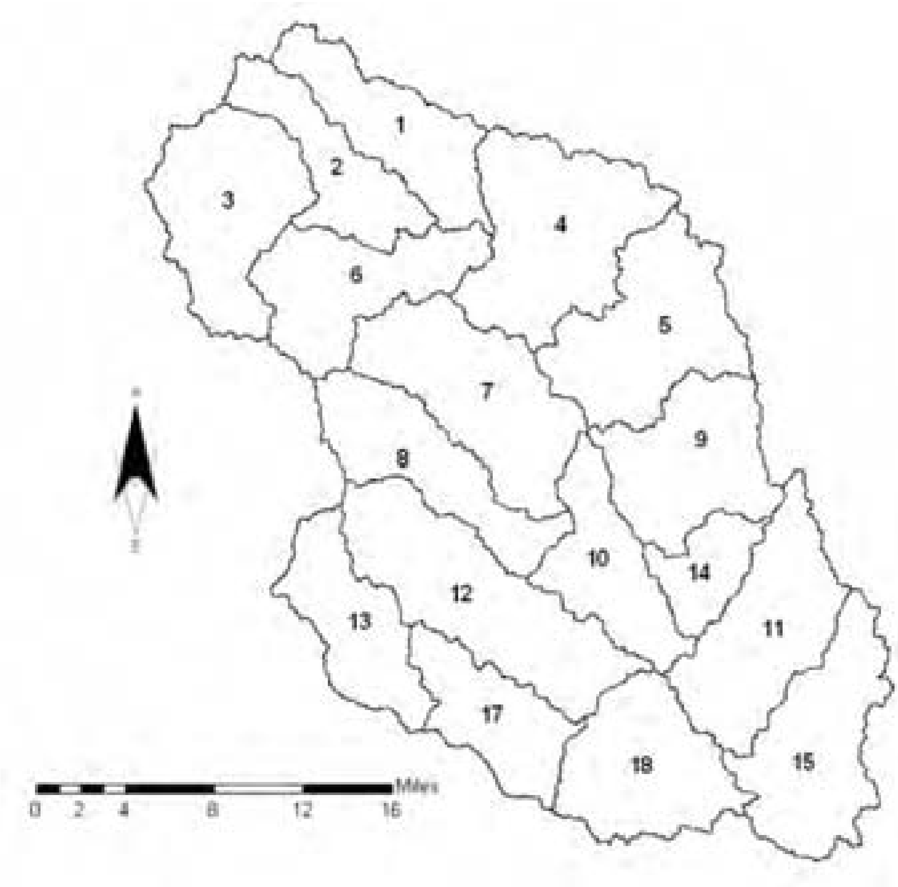

Figure 27. Subbasin Map – Toronto Lake Watershed.

Table 19. Toronto Watershed Subbasin Area

Subbasin	HUC14 ID	Area (acres)
1	11070101010030	23212
2	11070101010020	19097
3	11070101010010	31684
4	11070101010050	37472
5	11070101010060	33480
6	11070101010040	26231
7	11070101020010	34207
8	11070101020020	24448
9	11070101010070	27251
10	11070101020030	21089
12	11070101030020	39309
11	11070101030010	30708
13	11070101030030	21241
14	11070101010080	10976
15	11070101030060	30495
17	11070101030040	19536
18	11070101030050	27767
Total		**458202**

8.2 Input Data

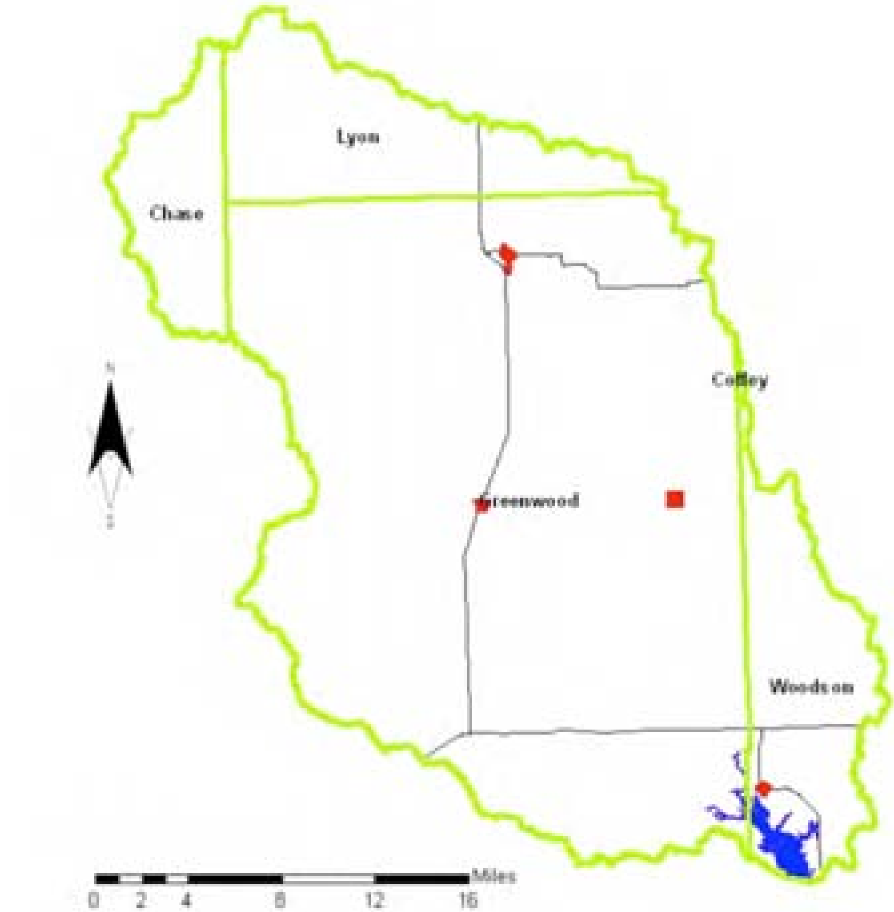

Figure 28. County Map - Toronto Lake Watershed.

Table 20. Landuse Area (acre)[20]

Watershed	Urban/ Transportation	Cropland	Pasture/ Rangeland	Forest	Feedlots	Water	Others
Toronto Lake	6478	38148	352294	26539	9.3	5824	7762

Table 21. Agricultural Animals[18]

Watershed	Beef Cattle	Dairy Cattle	Swine (Hog)	Sheep	Horse	Chicken	Turkey
Toronto Lake	13706	266	1466	325	582	335	5

Table 22. Septic System[21]

Watershed	No. of Septic Systems	Population per Septic System	Septic Failure Rate,%
Toronto Lake	1052	1.98	0.93

Table 23. Hydrological Soil Group[22]

Watershed	Hydrologic Soil Group
Toronto Lake	C

A = well to excessively drained soil

B = moderately-well to well drained soil

C = poorly drained soil

D = very poorly drained soil

Table 24. Modify the Universal Soil Loss Equation (USLE) parameters[23]

Land Cover	R	K	LS	C	P
Crop land	225.000	0.342	0.586	0.200	0.995
Pasture Land	225.000	0.342	0.586	0.040	1.000
Forest	225.000	0.342	0.586	0.003	1.000

8.3 Model Outputs

Table 25. Total Pollution Load[23]

Watershed	N Load (lb/year)	P Load (lb/year)	BOD Load (lb/year)	Sediment Load (t/year)
Toronto Lake	2180090.9	229015.8	6712963.1	46774.1

Table 26. Total Load by Land Uses[23]

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban	38637.63	5950.61	149560.61	886.22
Cropland	184950.10	40839.09	383975.15	16011.91
Pastureland	1921440.83	173578.52	6125850.18	29708.13
Forest	5498.04	2687.25	13476.55	167.85
Feedlots	29316.48	5863.30	39088.64	0.00
User Defined	0.00	0.00	0.00	0.00
Septic	247.83	97.07	1011.97	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	**2180090.91**	**229015.84**	**6712963.10**	**46774.11**

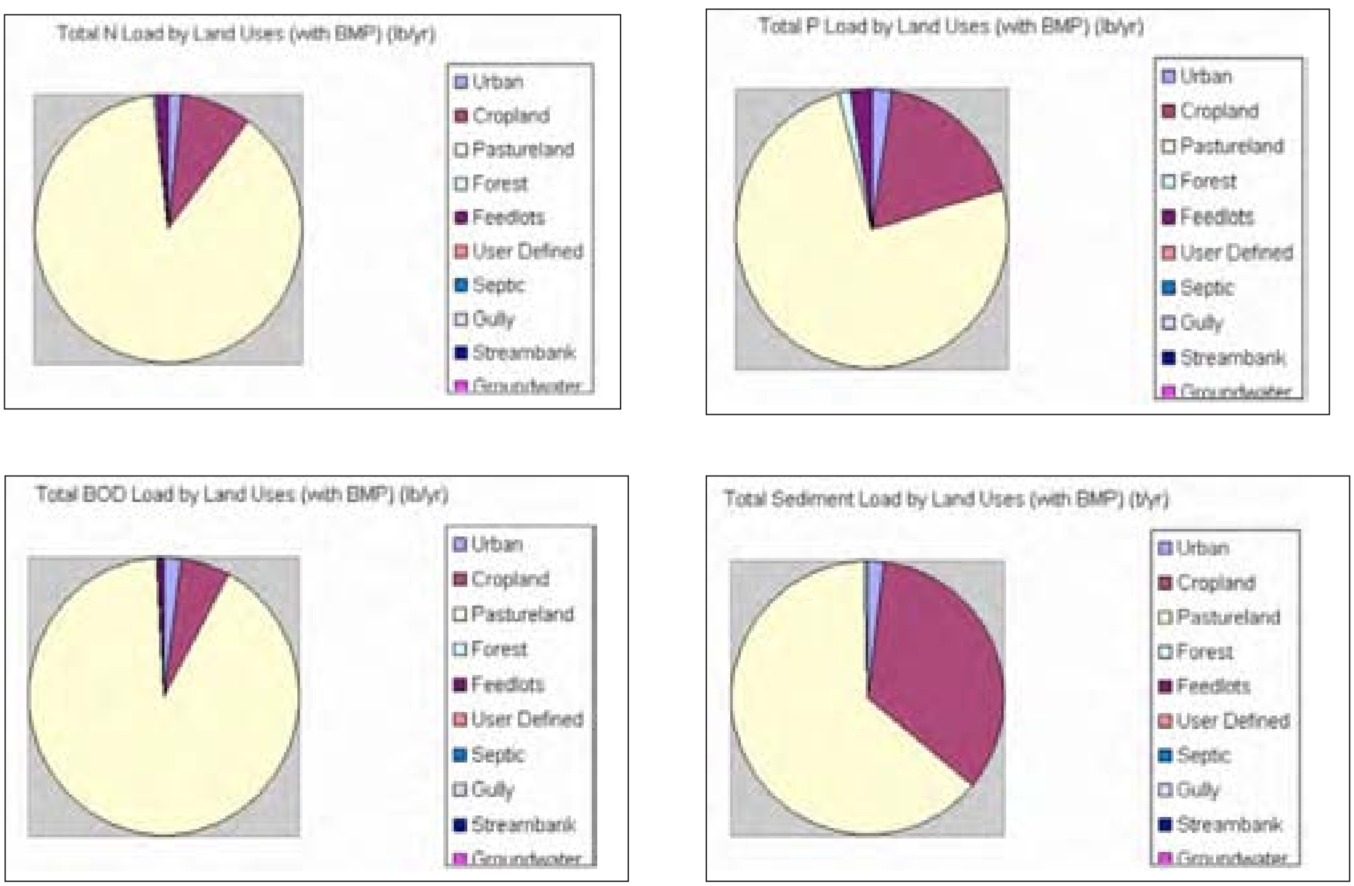

Figure 29. Total Load by Land Uses – Toronto Lake Watershed.

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. *Verdigris Basin TMDLs*: "The Section 303(d) list submitted to and approved by EPA in 1998, identifies 48 river segments and 5 lakes in the Verdigris River Basin as water quality impaired. Among the streams, the greatest number of impairments was caused by excessive levels of fecal coliform bacteria and dissolved oxygen depletion. Among the lakes, eutrophic conditions indicative of excessive algae production and dissolved oxygen depletion were the predominant cause of impairment. Other pollutants limiting the use of the Verdigris River Basin streams include ammonia and nutrient oxygen demand. Additional lake impairments were caused by pH and fecal coliform bacteria. Each parameter causing impairment requires a TMDL. Many of the stream segments, configured in a watershed setting, have a TMDL applied to them as a whole. Fourteen watershed and 6 lake TMDLs have been developed. These TMDLs were submitted to EPA on June 27, 2002 and have been approved."
Online reference information available at: *http://www.kdheks.gov/tmdl/verdigris.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 U.S."
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: *http://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 Gary L. Kilgore, *Cost-Return Budget in South Central and Southeast Kansas*, Kansas State University, October 2006.

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 Toronto 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.
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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*

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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*

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

EP139 February 2009

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