KANSAS/LOWER REPUBLICAN BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody/Assessment Unit: Coal Creek
Water Quality Impairment: Dissolved Oxygen

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Lower Kansas River **County:** Douglas

HUC 8: 10270104

HUC 10 (12): 02 (03)

Drainage Area: 37.9 square miles

Ecoregions: Central Irregular Plains, Osage Cuestas 40b

Main Stem Water Quality Limited Segment: Coal Creek (80) starting at the confluence with the Wakarusa River in east-central Douglas County and traveling upstream to the headwaters southeast Douglas County.

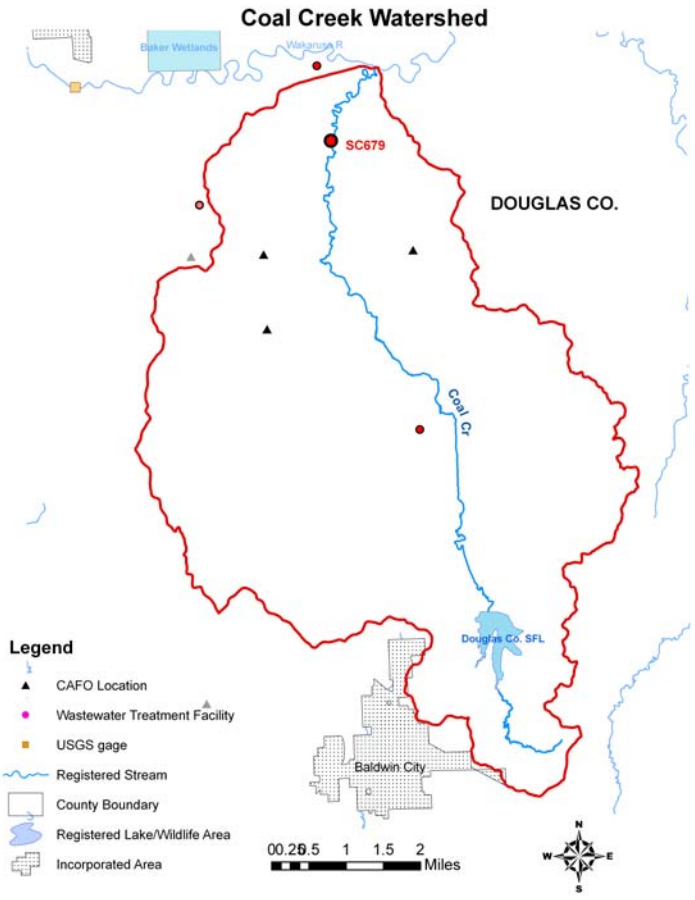
Designated Uses: Expected Aquatic Life Support, Primary Contact Recreation 'C'; Food Procurement; Ground Water Recharge; Industrial Water Supply; Irrigation Use; Livestock Watering Use.

303(d) Listings: Kansas Stream Segment monitored by Station SC679 cited as impaired in the 2004, 2008 and 2010 303(d) lists for Lower Kansas River Basin.

Impaired Use: Expected Aquatic Life Support

Water Quality Standard: The concentration of Dissolved Oxygen in surface waters shall not be lowered by the influence of artificial sources of pollution. Dissolved Oxygen (DO): 5 mg/L (K.A.R. 28-16-28e(d), Table 1g).

`Figure 1. Coal Creek near Sibleyville, SC679.



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 2010 303(d): Not Supporting Aquatic Life.

Monitoring Sites: Station 679, ½ mile east of Sibleyville, KS.

Period of Record Used: 1996, 2000, 2004 and 2008 for Rotational Station 679.

Flow Record: Drainage area flow duration estimated from USGS Gaging Station 06914950 on Big Bull Creek near Edgerton, KS (1996-2010).

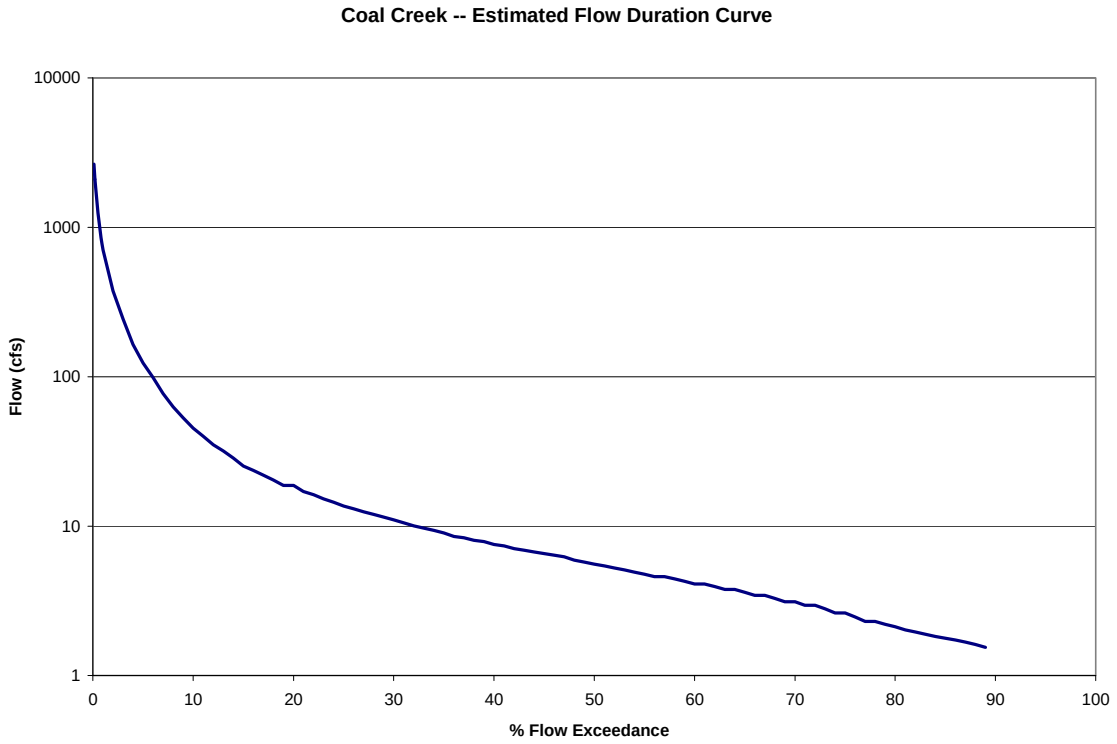
Long Term Flow Conditions: The estimated Mean Flow established by USGS is 29.4 cfs (Perry, 2004).

Table 1. Estimated flow-duration values and mean flow value for Coal Creek in Douglas County. (Perry, C.A., D.M. Wolock and J.C. Artman, 2004). All flow values in units of cfs.

Stream Name	CUSEGA #	Drainage Area	Estimated Mean Flow	90%	75%	50%	25%	10%
Coal Creek near Sibleyville	80	32.6	29.4	0	1.31	5.76	17.2	44.3

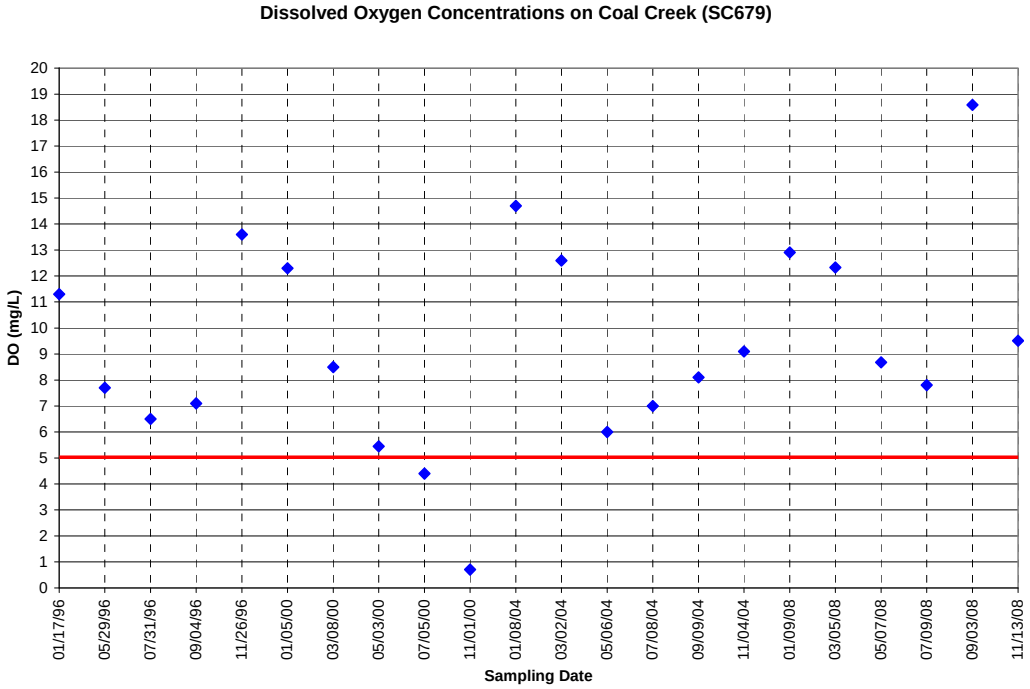
Estimated monthly stream flow along Coal Creek, derived from flow data from USGS Gaging Station 06914950 along Big Bull Creek, is illustrated in Figure 2.

Figure 2. Flow Duration Curve for Coal Creek.



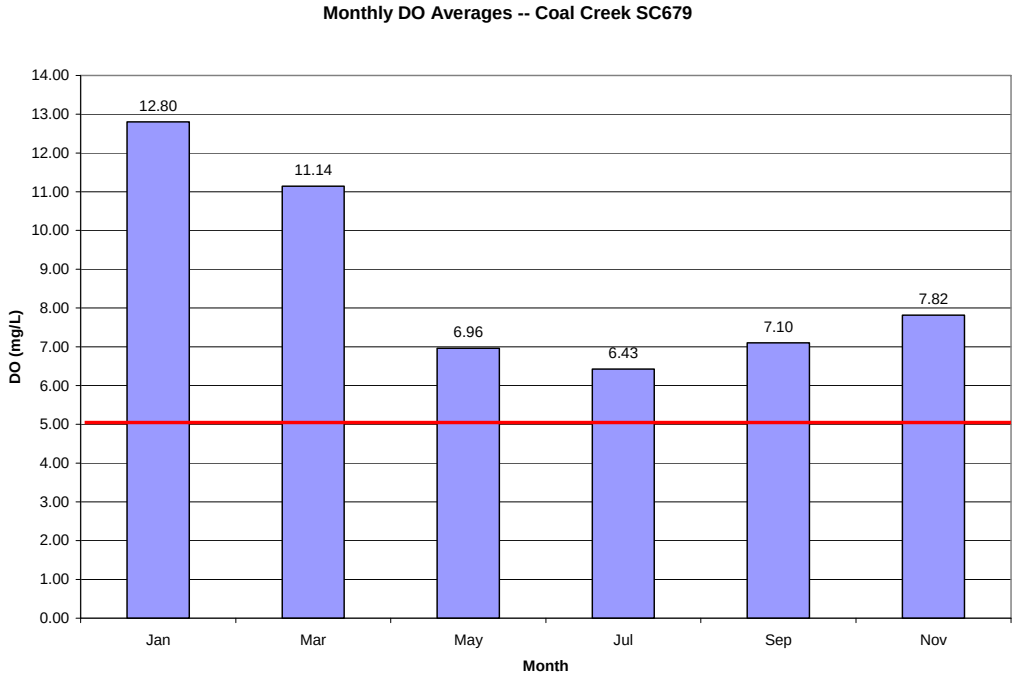
Current Conditions: Sampling station SC679 is a rotational station that is typically sampled bimonthly for one year, every four years. Of the 22 samples analyzed for dissolved oxygen over the period of record, there were two samples in 2000 that fell below the water quality standard of 5.0 mg/L for dissolved oxygen. The first occurred on July 5, 2000 with a DO value of 4.4 mg/L and the second occurred on November 1, 2000 with a DO value of 0.7 mg/L (Figure 3). It must be noted that although the November 1, 2000 sample technically falls into the winter season (Nov thru Mar) it is actually reflecting the effect of the conditions in the summer-fall season (Jul-Oct) as the sampling took place on the first day of the defined winter season.

Figure 3. DO concentrations on Coal Creek at Station 679.



For the period of record at SC679, the spring month of May has the lowest average dissolved oxygen concentration (6.96 mg/L), while January, with lower winter stream temperatures, has the highest average concentration at 12.8 mg/L (Figure 4).

Figure 4. Monthly dissolved oxygen average (mg/L) for KDHE sampling station SC679.



Sampling data has been categorized into three defined seasons: Spring (April-June), Summer-Fall (July-October) and Winter (November-March). Seasonal dissolved oxygen concentrations are higher during the winter season while the increase in leaf litter during the summer-fall season is likely contributing to the decline in concentrations seen during those months (Figure 5). The year 2000, with the two DO violations, has the lowest average dissolved oxygen concentration of any year sampled during the period of record at 6.27 mg/L (Table 2).

Figure 5. Seasonal and yearly averages for KDHE sampling station SC679.

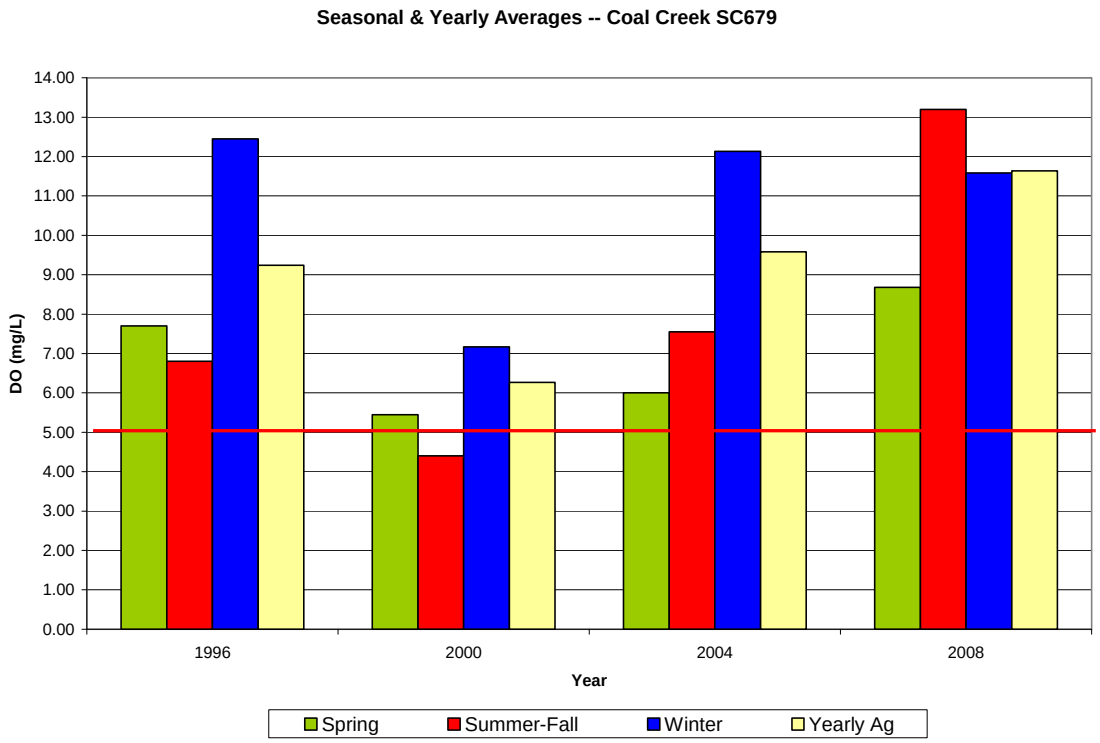


Table 2. DO averages by season for Coal Creek at SC679.

Sampling Year	Seasonal DO Avg. (mg/L)			Yearly Average (mg/L)
	Spring	Summer/Fall	Winter	
1996	7.70	6.80	12.5	9.24
2000	5.45	4.40	7.17	6.27
2004	6.00	7.55	12.1	9.58
2008	8.68	13.2	11.6	11.6
Seasonal Avg.	7.70	8.50	10.7	

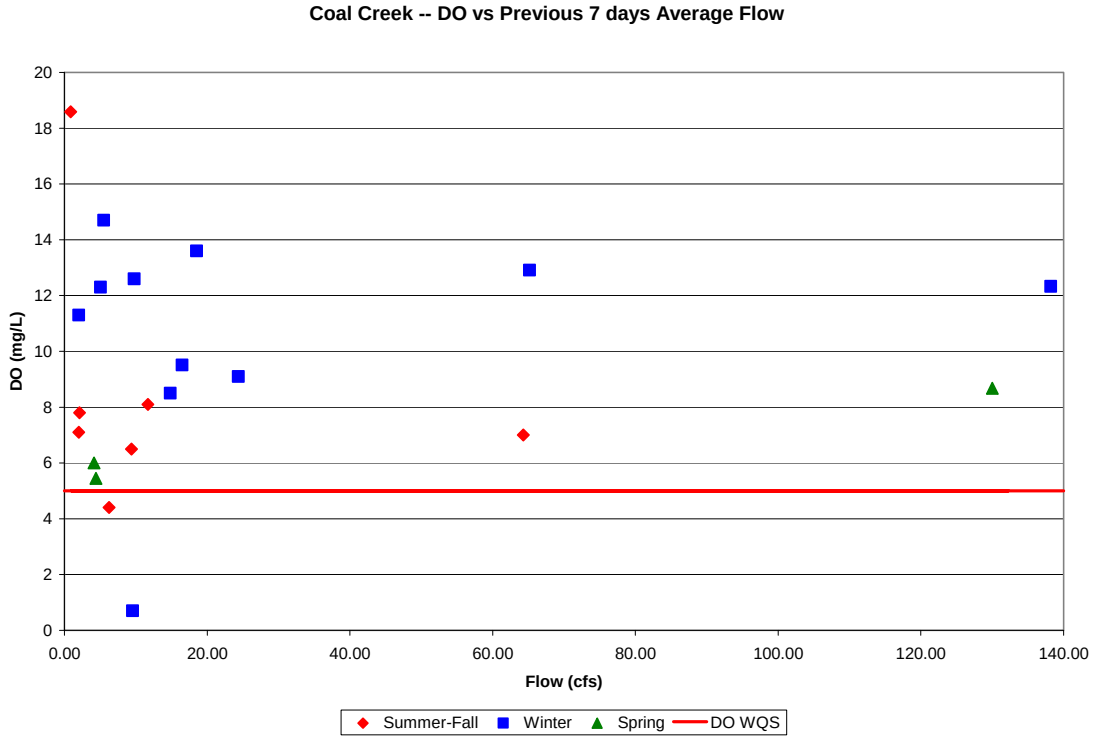
As observed in Table 3, DO violations occurred in the summer-fall season and the winter season in Coal Creek during normal flow conditions (11-75% flow duration). There were no violations observed during high flow (0-10% flow duration), low flow (76-100% flow duration) or the spring season. In total, there were 22 observations for dissolved oxygen concentration in Coal Creek, 9% of which were in violation of the water quality standard of 5 mg/L.

Table 3. Number of samples under the dissolved oxygen standard of 5 mg/L by season & flow.

NUMBER OF SAMPLES UNDER DISSOLVED OXYGEN STANDARD OF 5mg/L BY FLOW					
Station	**Season**	**High Flow ≥ 45.3 cfs**	**Normal Flow 2.64-45.2 cfs**	**Low Flow ≤ 2.63 cfs**	**Cum. Freq.**
Coal Cr near Sibleyville (SC 679)	Spring	0/0	0/3	0/1	0/4 = 0%
	Summer/Fall	0/0	1/5	0/2	1/7 = 14%
	Winter	0/2	1/8	0/1	1/11 = 9%
	Total All Seasons	0/2	2/16	0/4	2/22 = 9%

A comparison of the average of the previous seven days of estimated flow at SC679 with dissolved oxygen at the site (Figure 6) reveals both the winter and summer-fall violations occurred following periods where the average flow prior to sampling was moderate at 6.24 cfs and 9.54 cfs, respectively.

Figure 6. DO vs. previous 7 days of flow at KDHE sampling station SC679.



Estimated monthly streamflow along Coal Creek, derived from flow data from USGS Gaging Station 06914950 along the Big Bull Creek, is illustrated in Figure 7. Months with the least amount of flow occur during the summer-fall and winter season and correspond with the months with the lower average DO concentrations. Flows during summer-fall and winter of 2000 were the lowest for the period of record as indicated in Table 4, corresponding to the DO violations that occurred in July and November of 2000.

Figure 7. Monthly average flow in Coal Creek.

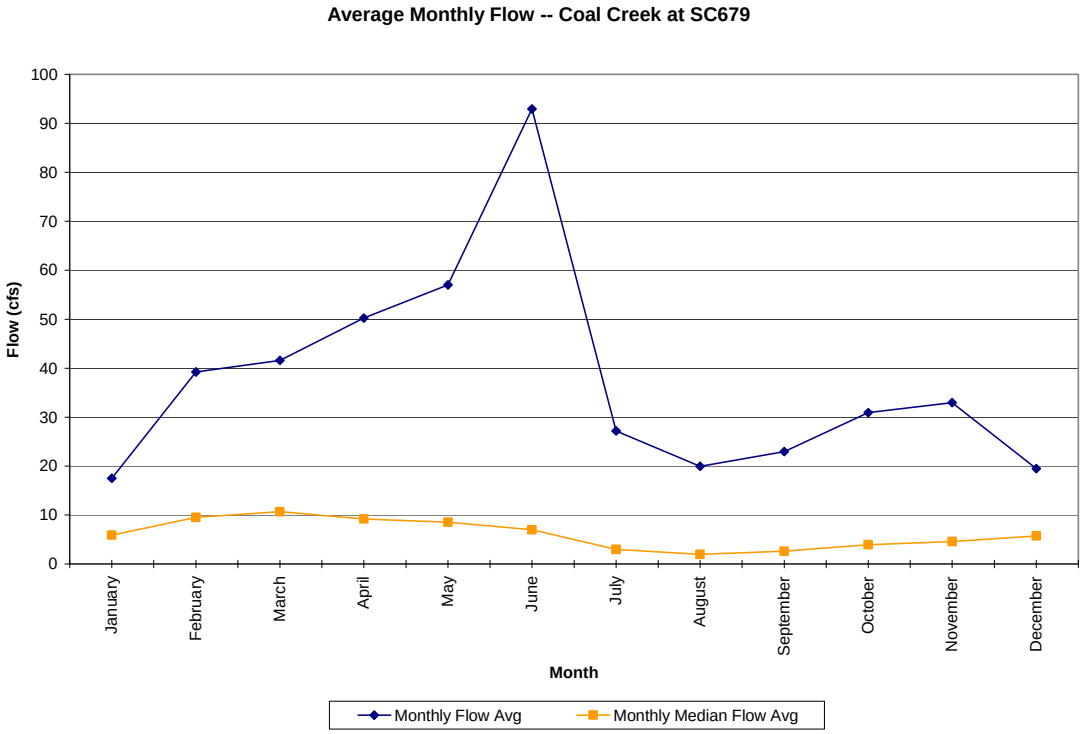


Table 4. Average Annual Seasonal flows on Coal Creek in cfs.

Sampling Year	Seasonal Flow Avg. (cfs)			Yearly Average (cfs)
	Spring	Summer-Fall	Winter	
1996	85.9	30.8	25.6	38.4
2000	27.4	4.6	9.2	15.9
2004	28.5	52.3	30.6	43.0
2008	104	19.0	20.4	50.6

Relationships: The effect of stream temperature on dissolved oxygen concentration can be seen in Figure 8 with lower temperatures generally leading to higher dissolved oxygen concentrations in Coal Creek. The summary in Table 5 reveals the summer-fall season has the highest average stream temperature at 22.3^{o} C and the winter season has the lowest average stream temperature at 8.2^{o} C. 2008, with the highest average dissolved oxygen concentration for the period of record (11.6 mg/L), has the lowest average temperature at 14.0^{o} C. Both instances of violations below the water quality standard of 5 mg/L for dissolved oxygen occurred in 2000, the year with the highest average stream temperature of 15.6^{o} C (Figure 9). Higher stream temperatures are prevalent during low flow conditions during the hotter months.

Figure 8. Coal Creek DO vs. Stream Temperature at SC679.

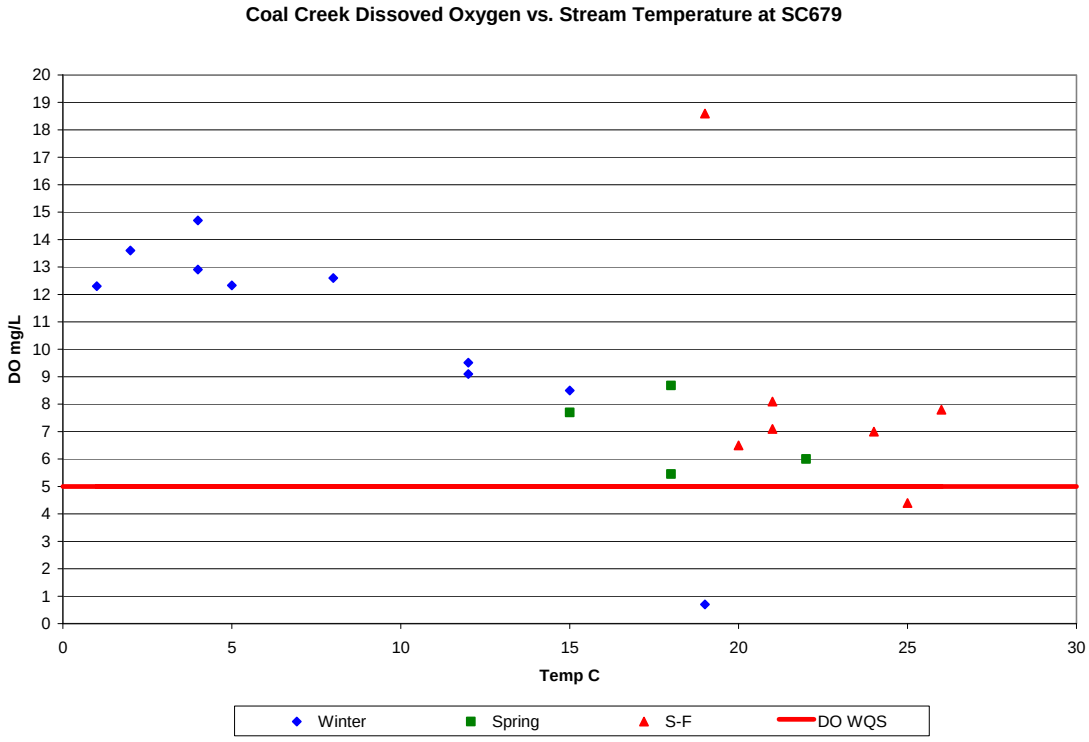
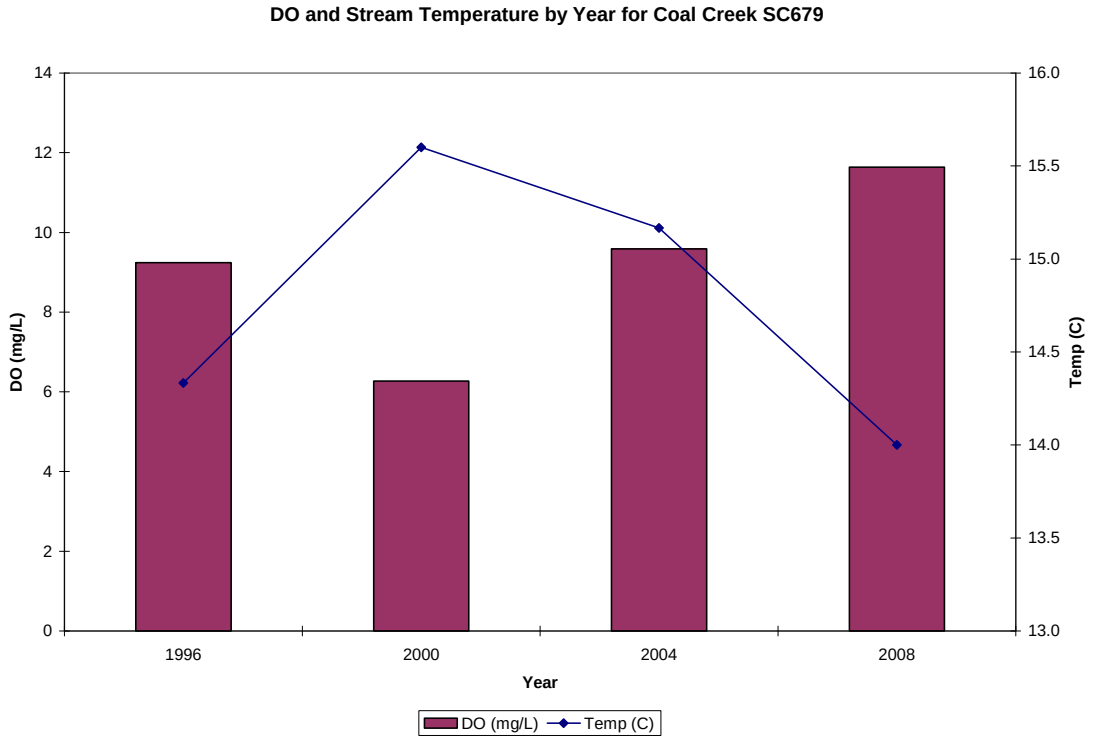


Table 5. Stream temperature by season for Coal Creek at SC679.

Sampling Year	Seasonal Temperature Avg. (^{o}C)			Yearly Average (^{o}C)
	Spring	Summer/Fall	Winter	
1996	15.0	20.5	2.0	14.5
2000	18.0	25.0	11.7	15.6
2004	22.0	22.5	8.0	15.2
2008	18.0	22.5	7.0	14.0
Seasonal Avg.	18.3	22.3	8.2	

Figure 9. Average yearly DO concentration and stream temperature for Coal Creek at SC679.



Analysis of DO compliant samples reveals an average dissolved oxygen concentration of 11.2 mg/L when stream temperatures are below 20^{o} C with a corresponding total organic carbon average of 6.7 mg/L. Average dissolved oxygen concentration when Coal Creek is at or above 20^{o} C is markedly lower at 7.1 mg/L with a corresponding total organic carbon average of 6.0 mg/L (Table 6).

Table 6. Average temperature, DO and TOC for DO compliant samples when stream temperature was $\geq 20^{o}$ C and $< 20^{o}$ C in Coal Creek. The BOD/TOC ratio of all DO compliant samples in Coal Creek (0.38) for the period of record was used to convert 1996 and 2000 data to TOC values.

< 20°C Stream Temperature			
Collection Date	**Temp (°C)**	**DO (mg/L)**	**TOC (mg/L)**
5/29/96	15	7.7	4.5
11/26/96	2	13.6	3.5
1/5/00	1	12.3	2.5
3/8/00	15	8.5	6.6
5/3/00	18	5.5	8.5
1/8/04	4	14.7	7.5
3/2/04	8	12.6	8.0
11/4/04	12	9.1	11.0
1/9/08	4	12.9	8.4
3/5/08	5	12.3	5.9
5/7/08	18	8.7	4.8
9/3/08	19	18.6	7.7
11/13/08	12	9.5	7.2
Average	**10.2**	**11.2**	**6.7**
≥20°C Stream Temperature			
Collection Date	**Temp (°C)**	**DO (mg/L)**	**TOC (mg/L)**
7/31/96	20	6.5	10.4
9/4/96	21	7.1	5.3
5/6/04	22	6.0	4.6
7/8/04	24	7.0	6.0
9/9/04	21	8.1	4.8
7/9/08	26	7.8	4.3
Average	**22.3**	**7.1**	**6.0**

KDHE discontinued sampling for BOD in 2001 and began utilizing Total Organic Carbon (TOC) analyses in late 2000 in lieu of BOD. KDHE conducted analyses in 2000 to determine if TOC concentrations could be utilized as a surrogate for BOD and whether a statistical translation could be made for this expression. KDHE utilized 675-paired sets of data in the analyses and concluded that there are relationships in the stream data. "The data suggest that, for effluent and point source related waters, the BOD/TOC ratio is almost one-to-one. Ambient waters have much lower ratios, suggesting that a portion of the TOC is in more refractory substances (i.e., cell walls, lignin, cellulose, etc.)"(Carney, 2000). The analysis of the paired ambient stream data was utilized for this report. The regression analyses for this group is summarized as follows:

R square = 0.34
P Value = <0.0001
For a TOC value of 10mg/L the most likely BOD concentration = 4.31 mg/L
Lower 95% BOD = 3.34 mg/L
Upper 95% BOD = 5.29 mg/L
BOD/TOC Ratio:

Arithmetic Mean = 0.44
Geometric Mean = 0.35
Median = 0.37

Generally, higher BOD and TOC concentrations indicate that more oxygen will be consumed by an ecosystem, which may result in an oxygen deficient stream system as the population increases among microorganism communities.

For Coal Creek at SC679, BOD was reported for samples collected in 1996 and 2000 while TOC was reported for samples collected in 2004 and 2008. The BOD/TOC ratio of all DO compliant samples in Coal Creek, for the period of record, was calculated at 0.38 and, as the Coal Creek BOD/TOC ratio is supported by the paired BOD/TOC analyses performed by KDHE in that it lies between the arithmetic mean and the median of the 2000 study, the 0.38 ratio was used to convert 1996 and 2000 Coal Creek BOD values to TOC values.

As Figure 10 and Table 7 illustrate, the November 2000 sample resulting in a DO water quality violation also had elevated levels of BOD (20.6 mg/L), Total Phosphorus (1.07 mg/L) and Total Nitrogen (3.06 mg/L) at 26% flow exceedance, indicating either a runoff event following a fall fertilizer application or animal waste runoff from a livestock operation in the Coal Creek watershed. The July 2000 violation with a DO concentration of 4.4 mg/L had a BOD concentration in the normal range at 2.8 mg/L indicating the cause of the violation is more likely linked to stream temperature than organic matter loading. The average BOD for samples without DO violations is 2.6 mg/L.

Figure 10. Dissolved Oxygen vs. Biological Oxygen Demand in Coal Creek at SC679.

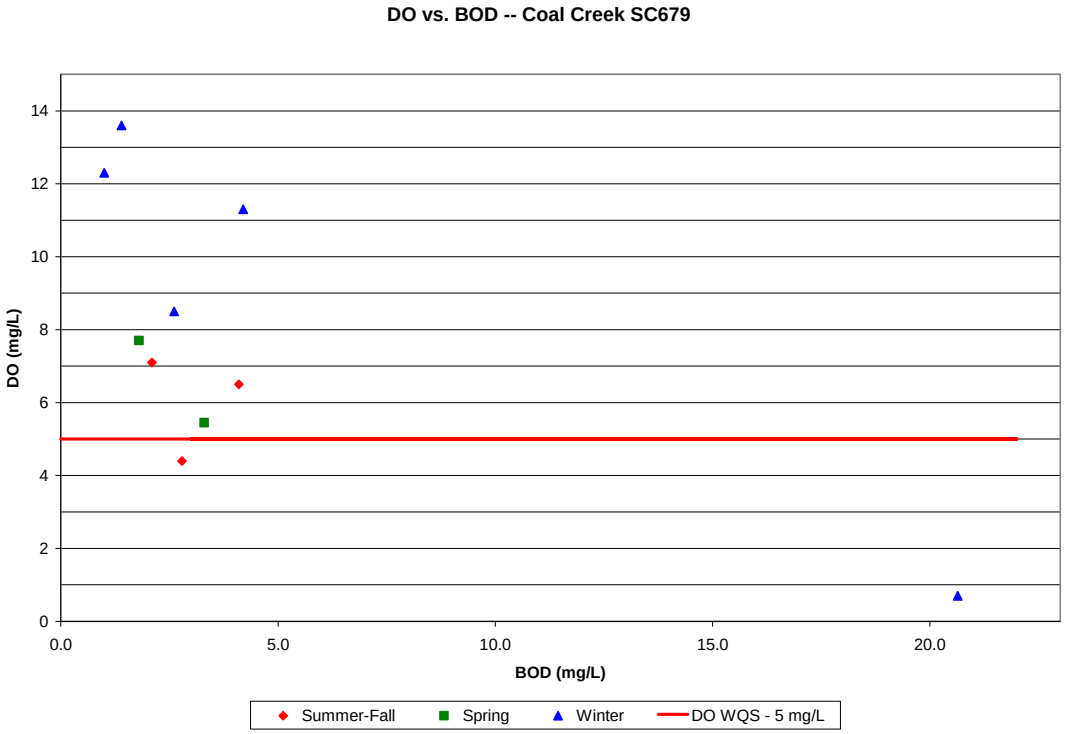


Table 7. Sample data from Coal Creek at SC679 for 1996 and 2000 sampling periods.

Collection Date	Temp (^{o}C)	DO (mg/L)	BOD (mg/L)	TN (mg/L)	TP (mg/L)
1/17/96	*	11.3	4.2	*	0.17
5/29/96	15	7.7	1.8	*	0.17
7/31/96	20	6.5	4.1	*	0.04
9/4/96	21	7.1	2.1	*	0.09
11/26/96	2	13.6	1.4	*	0.07
1/5/00	1	12.3	1.0	0.88	0.07
3/8/00	15	8.5	2.6	0.39	0.08
5/3/00	18	5.5	3.3	1.25	0.11
7/5/00	25	4.4	2.8	1.14	0.14
11/1/00	19	0.7	20.6	3.06	1.07
Avg.	15.1	7.8	4.4	1.34	0.20

***Data Not Available**

There were no water quality violations during the 2004 and 2008 sampling periods resulting in average TOC concentration of 6.7 mg/L (Table 8). Higher TOC concentrations (Figure 11) can be seen during the winter season indicating organic loading from leaf litter or livestock waste and slower decomposition rates of organic matter due to colder temperatures (Figure 12).

Figure 11. Dissolved Oxygen vs. Total Organic Carbon in Coal Creek at SC679.

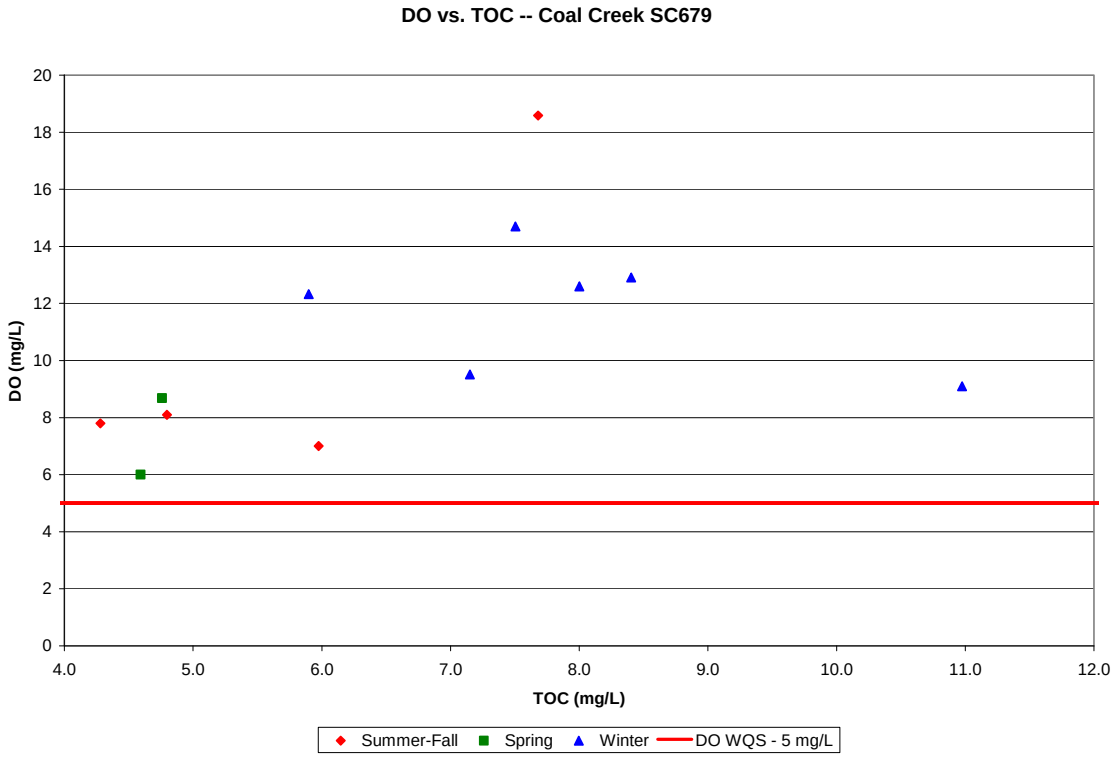


Figure 12. Total Organic Carbon vs. Temperature in Coal Creek at SC 679.

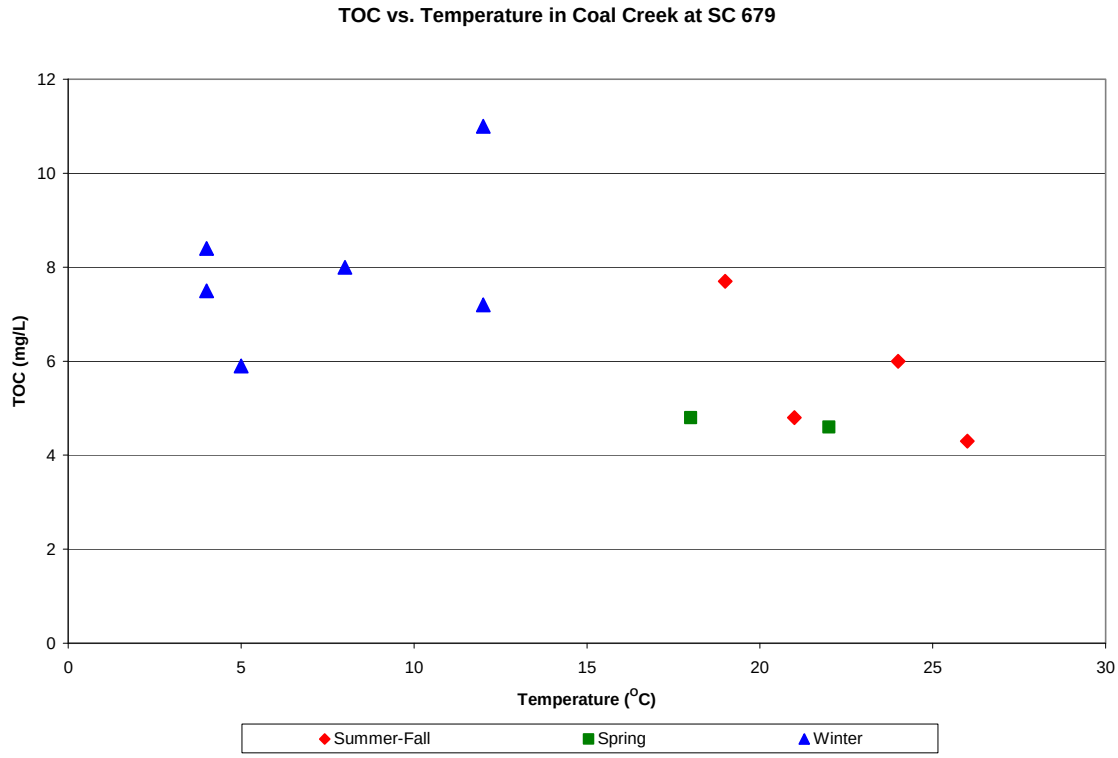


Table 8. Sample data from Coal Creek at SC679 for 2004 and 2008 sampling periods.

Collection Date	Temp (°C)	DO (mg/L)	TOC (mg/L)	TN (mg/L)	TP (mg/L)
1/8/04	4	14.7	7.5	1.08	0.11
3/2/04	8	12.6	8.0	1.65	0.09
5/6/04	22	6.0	4.6	0.89	0.07
7/8/04	24	7.0	6.0	1.35	0.17
9/9/04	21	8.1	4.8	0.89	0.09
11/4/04	12	9.1	11.0	1.92	0.37
1/9/08	4	12.9	8.4	1.67	0.14
3/5/08	5	12.3	5.9	1.71	0.16
5/7/08	18	8.7	4.8	0.92	0.08
7/9/08	26	7.8	4.3	0.66	0.08
9/3/08	19	18.6	7.7	0.88	0.12
11/13/08	12	9.5	7.2	0.81	0.09
Avg.	14.6	10.6	6.7	1.20	0.13

The average BOD and TOC concentrations for the period of record including violations and under all flow conditions are 4.4 mg/L and 6.7 mg/L, respectively (Table 9).

Figure 13. BOD vs. percent of flow exceedance for Coal Creek at SC679.

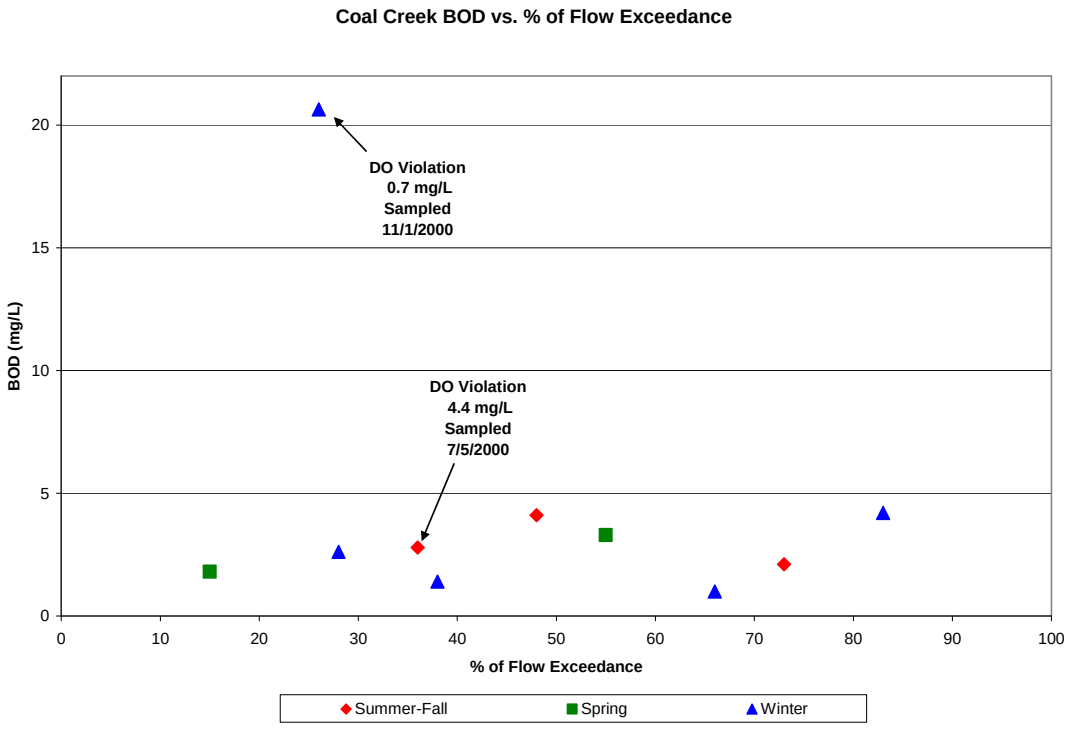


Figure 14. TOC vs. percent of flow exceedance for Coal Creek at SC679. TOC was reported in 2004 & 2008 during which there were no DO violations below the 5 mg/L water quality standard.

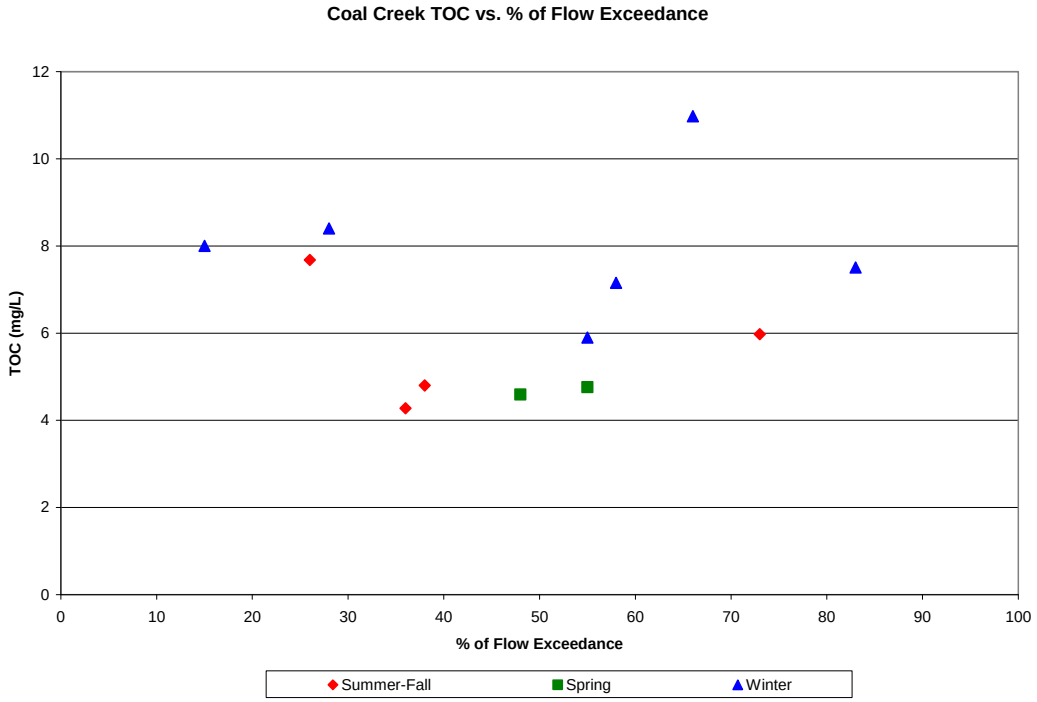


Table 9. Average BOD & TOC values by % of flow exceedance.

	0 to 10%	11 to 25%	26 to 50%	51 to 75%	76 to 90%	91 to 100%	Avg.
BOD (mg/L)	No Data	1.8	6.3	2.1	4.2	No Data	4.4
TOC (mg/L)	9.7	5.9	6.4	6.0	6.0	No Data	6.7

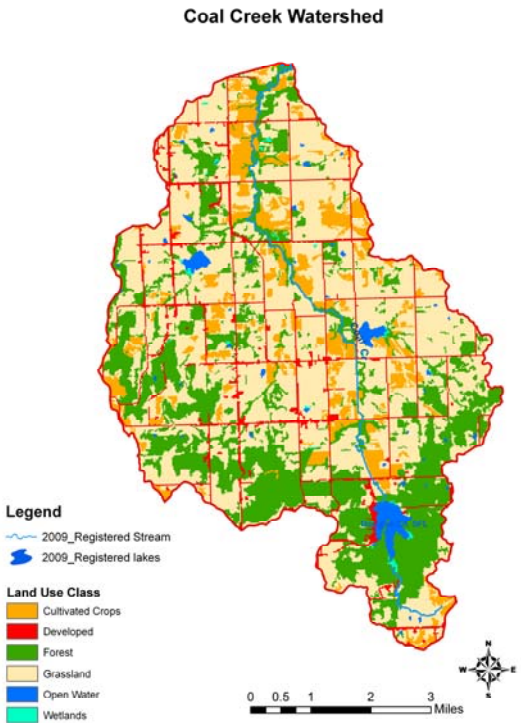
Desired Endpoints of Water Quality (Implied Load Capacity) for Coal Creek at Site 679: The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standards fully supporting Aquatic Life, indicated by dissolved oxygen concentrations of 5 mg/L or more. To achieve this endpoint, a temperature based, two pronged allocation of Total Organic Carbon (TOC) will be established based on the average TOC concentration of DO compliant samples at warm and cool stream temperature across all flow conditions. Samples collected when stream temperature is equal to or above 20^{o} C will have a TOC endpoint of 6.0 mg/L, the average TOC value for DO compliant samples (1996-2008) when stream temperature was equal to or above 20^{o} C. Samples collected when stream temperature is below 20^{o} C will have a TOC endpoint of 6.7 mg/L, the average TOC value for DO compliant samples (1996-2008) when stream temperature was less than 20^{o} C.

Achievement of the endpoint indicates any loads of oxygen-demanding substance are within the loading capacity of the stream, water quality standards are attained and full support of the designated uses of the stream has been restored.

3. SOURCE INVENTORY AND ASSESSMENT

Land Use: The predominant land uses in the Coal Creek watershed are forest (45%) and grassland (38%), with cropland accounting for 7.0% of the watershed, according to 2001 National Land Cover Data as seen in Figure 15. An accounting of the 45-meter buffer of the 2007 Registered Streams in the Coal Creek watershed shows the predominant riparian land cover is forest (65%), grassland (20%) and cropland (10%). The forested riparian area, at nearly two-thirds, is likely to contribute to the organic matter load with decomposing leaves in the stream leading to lower dissolved oxygen concentrations, particularly during the leaf fall periods.

Figure 15. Coal Creek Watershed Land Use Map.



Livestock Waste Management Systems: According to the USDA National Agricultural Statistics Service, on January 1, 2010, cattle inventory for Douglas County was 21,000 head. The Coal Creek watershed is comprised of HUC 12: 102701040203 and according U.S. Census of Agriculture there were 1,235 head of livestock in the watershed in 2002 (Table 10). There are also three active certified or permitted confined animal feeding operations (CAFOs) within the Coal Creek watershed amounting to nearly 300 head of dairy cattle (Table 11). These certified or permitted livestock facilities have waste management systems designed to minimize runoff entering their operation or detaining runoff emanating from their facilities. In addition, they are designed to retain a 25-year, 24-hr rainfall/runoff event as well as an anticipated two weeks of normal wastewater from their operations. Typically, this rainfall event coincides with stream flow occurring less than 1-5% of the time.

Table 10. Livestock figures for the Coal Creek watershed (HUC 12: 102701040203).

Livestock	Number of Head in the Watershed
Beef Cattle	933
Dairy Cattle	72
Hogs	15
Sheep	62
Horse	80
Chickens	71
Turkey	1
Duck	1

Table 11. CAFOs within the Coal Creek watershed.

Permit Number	Type	County	Animal Total
A-KSDG-MA11	Dairy -- Certified	Douglas	140
A-KSDG-MA14	Dairy -- Certified	Douglas	35
A-KSDG-M005	Dairy -- Permitted	Douglas	121

Point Sources: There is one NPDES permitted facility in the Coal Creek watershed (Table 12). The facility is a non-overflowing lagoon system that is prohibited from discharging and would only contribute a BOD/TOC load under extreme precipitation or flooding events. Such events would not occur at a frequency or for duration sufficient to cause impairment to the watershed.

Table 12. NPDES permitted facility in the Coal Creek Watershed (SC679).

Discharging Facility	NPDES Permit #	State Permit #	Type	Expiration Date
USD 348 Vinland Elementary	KS0095630	M-LR04-NO01	2 Cell Lagoon Non-Overflowing	9/30/2011

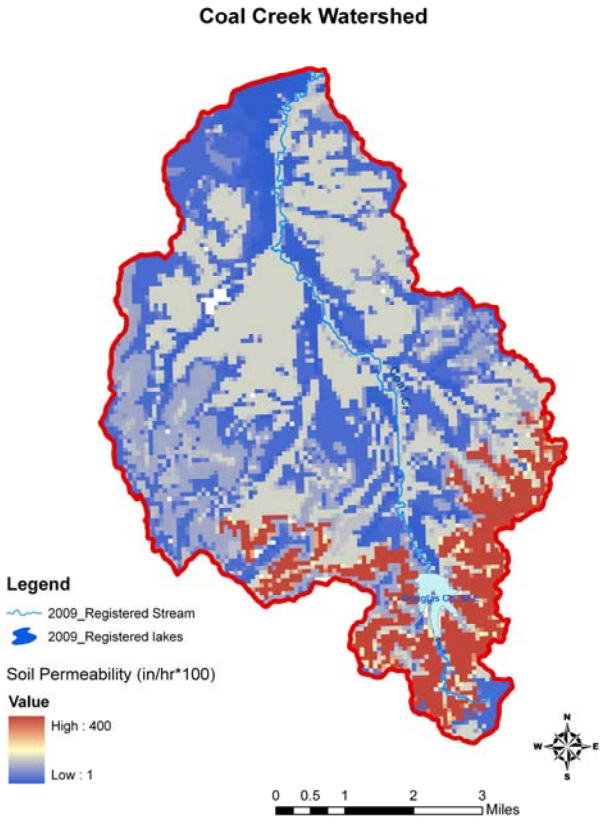
Background/Natural Contributions: Leaf litter and wastes derived from natural wildlife may add to the nutrient load. Much of the forested land cover buffers the streams within the watershed and may have significant effects on the DO concentrations within the stream during the fall and early winter months when significant leaf accumulations within the streambed are likely.

On-Site Waste Systems: According to the 2000 U.S. Census, the Coal Creek watershed's population is about 1,471 people with a density of about 39 people per square mile. Approximately 12.4% of the population in Douglas County lives outside of municipalities that operate wastewater treatment facilities and are presumably utilizing on-site septic systems (KWO, 2002). The population in rural Douglas County is projected to grow by nearly 16% by 2020 and 36% by 2040. Failing on-site waste systems can influence and contribute to the dissolved oxygen impairment.

Contributing Runoff: The watershed of Coal Creek has a mean soil permeability value of 0.88 inches/hour, ranging from 0.01 inches/hour to 4.0 inches/hour according to NRCS STATSGO database. About 34% of the watershed has a permeability value of 1.29 inches/hour, which contributes to runoff during very low to low rainfall intensity events while about 34% of the

watershed has a very high permeability threshold of 4.0 inches/hour. According to a USGS open-file report (Juracek, 2000), the threshold soil-permeability values are set at 3.43 inches/hour for very high, 2.86 inches/hour for high, 2.29 inches/hour for moderate, 1.71 inches/hour for low, 1.14 inches/hour for very low, and 0.57 inches/hour for extremely low soil-permeability. Runoff is primarily generated as infiltration excess with rainfall intensities greater than soil permeability. As the watersheds' soil profiles become saturated, excess overland flow is produced. As seen in Figure 16, the majority of the runoff will be contributed to the central and northern portions of the watershed.

Figure 16. Soil permeability in the Coal Creek watershed.

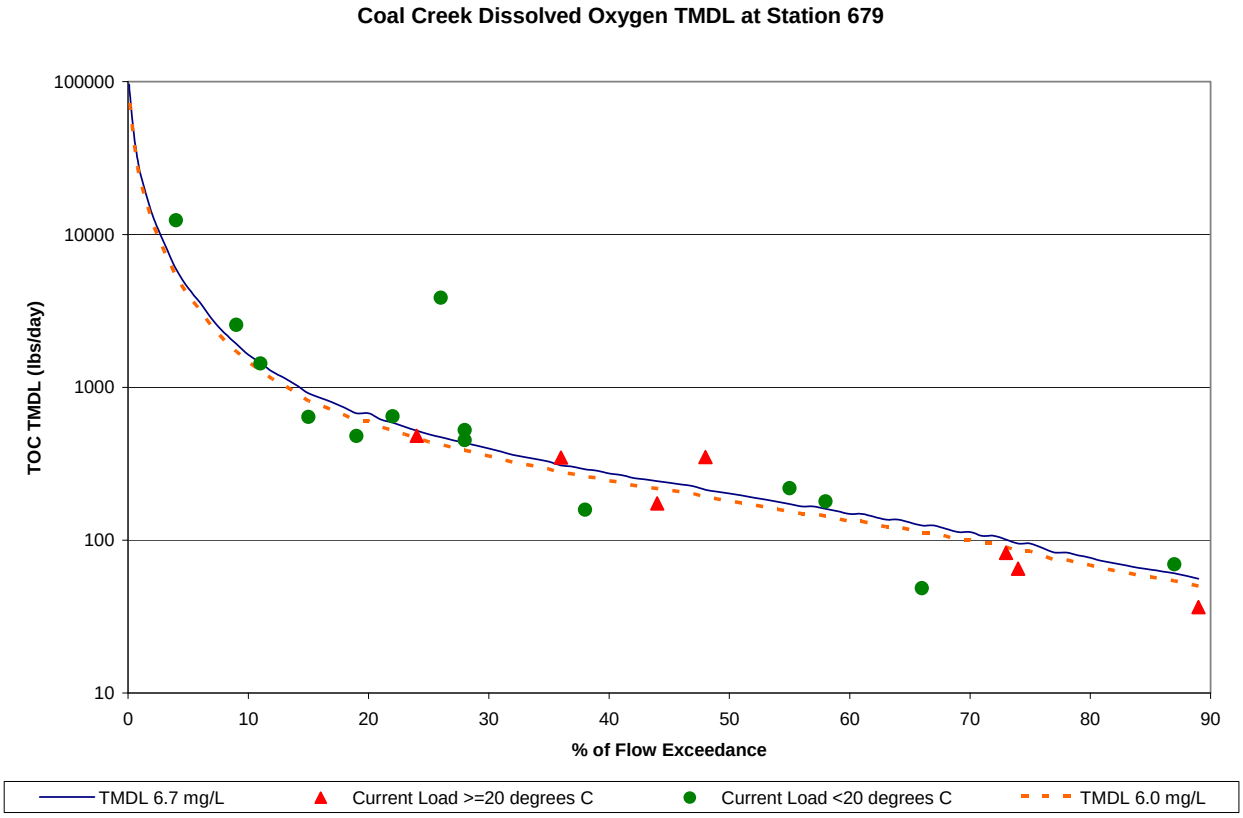


4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

The lack of sufficient dissolved oxygen is caused by a combination of BOD loading and warmer stream temperatures. BOD is a measure of the amount of oxygen required to stabilize organic matter in a stream and, as such, BOD is a benchmark measure to anticipate DO levels. However, as KDHE discontinued sampling for BOD in 2001 and began using Total Organic Carbon (TOC) in lieu of BOD, this allocation of loads will be made in terms of TOC. This TMDL also considers the effect of stream temperature on dissolved oxygen concentration in Coal Creek by assigning a TOC concentration of 6.7 mg/L to samples collected when stream temperature is

below 20° C and a TOC concentration of 6.0 mg/L to samples collected when stream temperature is at or above 20° C with both levels applicable across all flow conditions (Figure 17).

Figure 17. Coal Creek TMDL Load Duration Curve. BOD values were converted to TOC using the ratio of BOD/TOC (0.38) in DO compliant samples in Coal Creek for the period of record.



Point Sources: Since there are no discharging point sources in the watershed, a Wasteload Allocation of zero will be set under this TMDL.

Non-Point Sources: The introduction of organic matter into Coal Creek from runoff events combined with warm stream temperature is likely the principal source causing the incidents of low dissolved oxygen. Beginning in 2001, TOC concentration replaced BOD concentration as an indicator of organic loading in Kansas waters. Prior to converting, however, KDHE performed a paired analyses study of ambient streams in which a BOD/TOC ratio of 0.37 was determined (Carney, 2000). The BOD/TOC ratio for compliant samples in Coal Creek at SC679 is 0.38 and is supported by the paired analyses of performed by KDHE in 2000.

Analysis of the DO excursions in Coal Creek at SC679 reveals the November 1, 2000 excursion is due to heavy organic loading as illustrated by high BOD and nutrient concentrations while the July 5, 2000 deviation is probably due to warm stream temperature. As there were no DO excursions in 2004 and 2008 when TOC concentrations were first determined for the stream, this TMDL will target the organic loading in Coal Creek by assigning responsibility for maintaining the TOC levels at 6.0 mg/L when stream temperature is equal to or greater than 20° C and a TOC

concentration of 6.7 mg/L when stream temperature is less than 20° C under all flow conditions (Table 13).

Table 13. Coal Creek TMDL, Daily Load Allocation at Station 679. Flow values are estimated flows based flow at USGS Gage 06914950, Bull Creek near Edgerton.

Flow Condition	Load Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Stream Temp < 20° C, TOC = 6.7 mg/L			
Mean Flow (25.8 cfs)	839	93.3	933
10% (45.3 cfs)	1,474	164	1,638
25% (13.6 cfs)	443	49.3	493
50% (5.58 cfs)	181	20.2	202
75% (2.63 cfs)	85.5	9.51	95.1
90% (0.0 cfs)	0.0	0.0	0.0
Stream Temp ≥ 20° C, TOC = 6.0 mg/L			
Mean Flow (25.8 cfs)	752	83.6	836
10% (45.3 cfs)	1320	147	1,467
25% (13.6 cfs)	396	44.1	441
50% (5.58 cfs)	162	18.1	181
75% (2.63 cfs)	76.5	8.51	85.1
90% (0.0 cfs)	0.0	0.0	0.0

Defined Margin of Safety: The Margin of Safety provides some hedge against the uncertainty of variable TOC loads and the endpoints of the TMDL. The margin of safety is explicitly set at 10% of the calculated TOC loads, which compensates for the lack of knowledge about the relationship between the allocated loadings and the resulting water quality. The margin of safety is expressed in Table 13.

State Water Plan Implementation Priority: Short term and immediate consequences for aquatic life are attributed to dissolved oxygen violations. However, since the frequency of dissolved oxygen violations is low and limited to one sampling year, this TMDL will be Low Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Lower Kansas Basin (HUC 8: 10270104) with a priority ranking of 1 (Highest Priority for restoration work).

Priority HUC 12: Priority focus of implementation will concentrate on installing livestock management practices adjacent to Coal Creek near Sibleyville.

5. IMPLEMENTATION

Desired Implementation Activities

1. Install grass buffer strips where needed along stream and drainage channels in the watershed.
2. Maintain conservation tillage and contour farming to minimize cropland erosion.
3. Ensure proper on-site waste system operations in proximity to targeted stream.
4. Ensure that labeled application rates of chemical fertilizers are being followed.
5. Implement nutrient management plans to manage manure land applications and runoff potential.

Implementation Programs Guidance

Non-Point Source Pollution Technical Assistance - KDHE

a. Support Section 319 demonstration projects for pollution reduction from livestock operations in watershed.
b. Provide technical assistance on practices geared to the establishment of vegetative buffer strips.
c. Provide technical assistance on practices geared to small livestock operations which minimize impact to stream resources.
d. Guide federal programs such as the Environmental Quality Improvement Program, which are dedicated to priority subbasins through the Unified Watershed Assessment, to priority stream segments identified by this TMDL.

Water Resource Cost Share & Non-Point Source Pollution Control Programs – KDA Division of Conservation

a. Establish or reestablish natural riparian systems, including vegetative filter strips and streambank vegetation.
b. Apply conservation farming practices and/or erosion control structures, including no-till, terraces and contours, sediment control basins and constructed wetlands.
c. Re-evaluate nonpoint source pollution control methods.
d. Install livestock waste management systems for manure storage.
e. Implement manure management plans.

Riparian Protection Program – KDA Division of Conservation

a. Develop riparian restoration projects.

Buffer Initiative Program – KDA Division of Conservation

a. Install grass buffer strips near streams.
b. Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

Extension Outreach and Technical Assistance - Kansas State University

a. Educate agricultural producers on sediment, nutrient, and pasture management.
b. Educate livestock producers on livestock waste management and manure applications and nutrient management planning.

c. Provide technical assistance on livestock waste management systems and nutrient management planning.
d. Provide technical assistance on buffer strip design and minimizing cropland runoff.
e. Encourage annual soil testing to determine capacity of field to hold phosphorus.
f. Continue to educate residents, landowners, and watershed stakeholders and nonpoint source pollution.

Local Environmental Protection Program - KDHE

a. Inspect on-site waste systems within one mile of priority stream segments.

Division of Water Resources – KDA

a. Ensure future water use or management activities in the watershed do not reduce or impede streamflow during low flow conditions.

Timeframe for Implementation: Dissolved oxygen will be measured in Coal Creek in 2012 and 2016 and if there are no violations for dissolved oxygen it will be considered for delisting. If there are dissolved oxygen violations implementation will be required after 2016 in order to achieve the endpoints of this TMDL.

Targeted Participants: The primary participants for implementation will be agricultural and livestock operations immediately adjacent to Coal Creek. Conservation district personnel and county extension agents should conduct a detailed assessment of sources adjacent to streams within the watershed after 2016. Implementation activities should target those areas with the greatest potential to impact DO conditions. Nominally, this would most likely be:

1. Areas of denuded riparian vegetation along Coal Creek.
2. Unbuffered cropland adjacent to the stream.
3. Sites where drainage runs through or adjacent to livestock areas.
4. Sites where livestock have full access to stream and stream is primary water supply.
5. Poor riparian sites.
6. Failing on-site waste systems.

Milestone for 2020: In accordance with the TMDL development schedule for the State of Kansas, the year 2020 marks a future cycle of 303(d) activities in the Kansas-Lower Republican Basin. At that point in time, data from 2012, 2016 and 2020 at site SC679 can be evaluated to assess improved condition in the stream and possibly delist. Should the impairment remain in 2020 allocation and implementation activities may begin.

Delivery Agents: The primary delivery agents for program participation will be KDHE and the Kansas Department of Agriculture, Division of Conservation.

Reasonable Assurances:

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollution:

1. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage into the waters of the state.

2. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.

3. K.S.A. 2002 Supp. 82a-2001 identifies the classes of recreation use and defines impairment for streams.

4. K.A.R. 28-16-69 through 071 implements water quality protection by KDHE through the establishment and administration of critical water quality management areas on a watershed basis.

5. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.

6. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control nonpoint source pollution.

7. K.S.A. 82a-901, et. seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.

8. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan*, including selected Watershed Restoration and Protection Strategies.

9. The Kansas Water Plan and the Kansas-Lower Republican Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic area of the state for high priority in implementation.

Funding: The State Water Plan annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollution reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watershed and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are a Low Priority consideration and should not receive funding.

Effectiveness: Minimal control can be exerted on natural contributions to loading.

6. MONITORING

KDHE will continue to collect bimonthly samples at rotational Station 679 in 2012 and 2016 including dissolved oxygen samples, in order to assess progress and success in implementing this TMDL toward reaching its endpoint. Based on sampling data, the status of the 303(d) listing will be evaluated in 2018.

7. FEEDBACK

Public Notice: An active Internet Web site was established at www.kdheks.gov/tmdl/ to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Kansas-Lower Republican Basin.

Public Hearing: A Public Hearing on this TMDL was held on August 31, 2011 in Topeka to receive comments on this TMDL

Basin Advisory Committee: The Kansas-Lower Republican Basin Advisory Committee met to discuss the TMDLs in the basin on September 30, 2010 in Lawrence, March 17, 2011 in Manhattan, June 16, 2011 in Lawrence and September 29, 2011 in Topeka.

Watershed Restoration and Protection Strategy Group: This TMDL was reviewed in Tonganoxie on July 29, 2011 by the Lower Kansas Subbasin WRAPS group.

Milestone Evaluation: In 2016, evaluation will be made to confirm the magnitude of DO excursions in Coal Creek.

Consideration for 303(d) Delisting: Coal Creek will be evaluated for delisting under section 303(d), based on the monitoring data in 2012 and 2016. Therefore, the decision for delisting will come about in the preparation of the 2018-303(d) list. Should modifications be made to the applicable water quality criteria during the implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities might be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality, Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision would come in 2012. Recommendations of this TMDL will be considered in the Kansas Water Plan implementation decisions under the State Water Planning Process for Fiscal Years 2012-2020.

Developed 3/2/12

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