UPPER ARKANSAS RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody / Assessment Unit (AU): Pawnee River

Water Quality Impairments: Dissolved Oxygen

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Pawnee and Buckner

Counties: Pawnee, Hodgeman, Finney, Ford, Ness, Lane, Gary, Scott, Edwards

HUC8: 11030005 **HUC10 (HUC12)**: 01 (01, 02, 03, 04, 05)
02 (01, 02, 03, 04, 05)
03 (01, 02. 03, 04, 05, 06, 07)
04 (01, 02, 03, 04, 05, 06, 07, 08, 09, 10)
05 (01, 02, 03, 04)
06 (01, 02, 03, 04)
07 (01, 02, 03, 04, 05)

11030006 01 (01, 02, 03, 04, 05)
02 (01, 02, 03, 04, 05, 06, 07, 08)
03 (01, 02, 03, 04, 05, 06, 07)

Ecoregion: Central Great Plains, Rolling Plains and Breaks (27b) and Western High Plains-Flat to Rolling Cropland (25d)

Drainage Area: Approximately 2,204 square miles

Water Quality Limited Segments:

Main Stem	**Tributaries**		
Pawnee R (2)	Cocklebur Cr (12)		
	Buckner Cr (1)	Saw Log Cr (3,4)	Elm Cr (5) Duck Cr (8)
	Buckner Cr (2)	Spring Cr (7) Buckner Cr S. Fk (6)	
Pawnee R (3)	Hackberry Cr (4)		
Pawnee R (5)			

Designated Uses: For Main Stem Pawnee River (2): Expected Aquatic Life, Primary Contact Recreation Class C, Domestic Water Supply Use, Food Procurement Use, Groundwater Recharge, Irrigation Watering Use, Industrial Water Supply Use, Livestock Watering Use.

Pawnee River (3, 5): Expected Aquatic Life, Secondary Contact Recreation Class b, Domestic Water Supply Use, Food Procurement Use, Groundwater Recharge, Irrigation Watering Use, Industrial Water Supply Use, Livestock Watering Use.

Buckner Cr (1): Expected Aquatic Life, Secondary Contact Recreation Class b, Food Procurement, and Groundwater Recharge.

Tributaries:
Buckner Cr (2) - Expected Aquatic Life Support, Secondary Contact Recreation Class a, Food Procurement, Groundwater Recharge.

Cocklebur Cr (12), Hackberry Cr (4), Elm Cr (5), Saw Log Cr (4), Spring Cr (7) – Expected Aquatic Life Support, Secondary Contact Recreation Class b.

Buckner Cr, S.Fk (6) – Expected Aquatic Life Support, Primary Contact Recreation Class B.

Saw Log Cr (3) – Expected Aquatic Life Support, Primary Contact Recreation Class C.

Duck Cr (8) - - Expected Aquatic Life Support, Secondary Contact Recreation Class b, Food Procurement, Irrigation Watering Use, Livestock Watering Use.

303(d) Listings: Kansas Stream segments monitored by Station SC585 (Pawnee River near Larned) cited as impaired by Dissolved Oxygen deficiency in the 2004, 2008 and 2010-303(d) list. Stream segments monitored by Station SC586 (Pawnee River near Burdett) cited as impaired by Dissolved Oxygen deficiency in the 2010-303(d) list.

Impaired Use: Expected Aquatic Life is impaired due to dissolved oxygen deficiencies.

Water Quality Criteria: 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).

2.0 CURRENT WATER QUALITY CONDITION AND DESIRED ENPOINT

Level of Support for Designated Uses under 2010-303(d): Not supporting Aquatic Life

Stream Monitoring Sites: Active KDHE permanent Stream Chemistry sampling stations SC585 located on Pawnee River near Larned, and SC586 located on Pawnee River near Burdett.

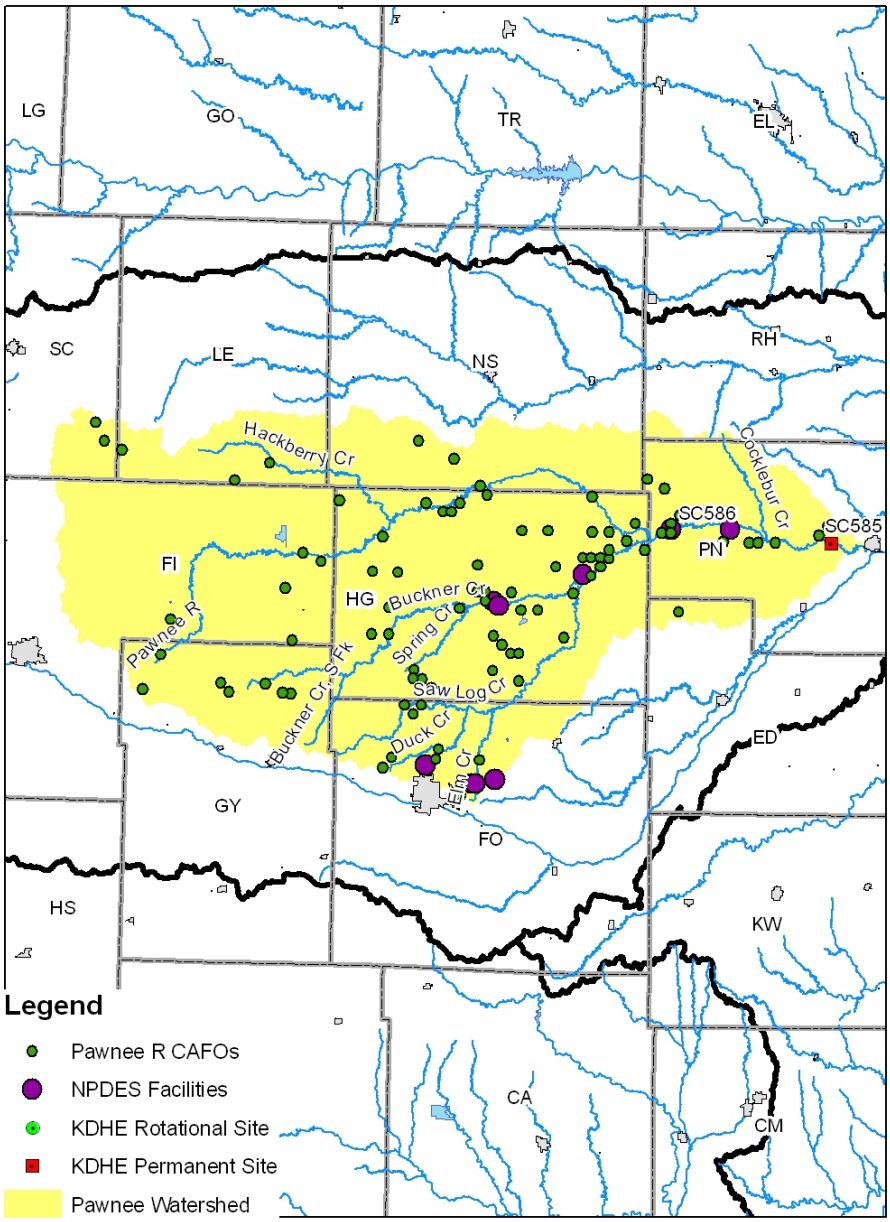
Period of Record: SC585 and SC586: 1990-2011

Flow Record: USGS Gage 07140850 on Pawnee River near Burdett (1982-2011), USGS Gage 07141175 on Buckner Cr near Burdett (1995-2011) and USGS Gage 07141200 on Pawnee River at Rozel (1982-2011) were utilized to establish long term flow conditions for SC585 and SC586. Flow conditions for SC586 were established by the common period of flow conditions from USGS Gage 07140850 and Gage 07141175. For samples collected at SC586 prior to the common flow period for these gages the flow was estimated based on the USGS Gage 07140850. Flow conditions for SC585 were established based on the flow record from USGS Gage 07141200, with adjustments made based on the watershed size of the sampling station relative to this flow gage. To establish consistency the period of record for the flow at SC585 and SC586 are from 1995-2011.

Table 1. Long Term Flow Conditions, including average flow and percent of flow exceedance flow values, in the Pawnee River Watershed.

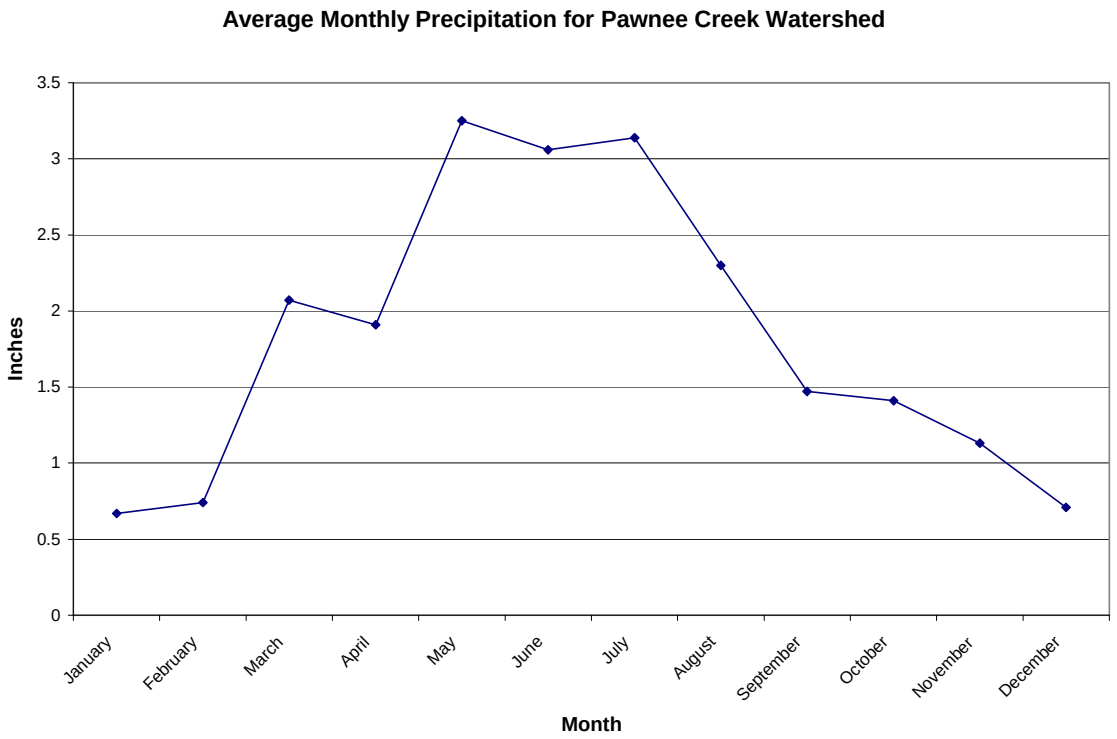
Stream Location	Avg. Q	Percent of Flow Exceedance				
		75%	50%	25%	10%	5%
Pawnee River near Burdett at USGS Gage 07140850 (1982-2011)	9.6	0	0	0.6	7.6	19
Buckner Cr near Burdett at USGS Gage 07141175 (1995-2011)	14.8	0	0	5.3	22	38
Pawnee River at SC586 (1995-2011)	24.2	0	0	8.8	34	68
Pawnee River at Rozell at USGS Gage 07141200 (1982-2011)	28.3	0	0	5.3	32	80
Pawnee River at SC585 (1995-2011)	29.5	0	0	8.9	40.4	96.8

Figure 1. Pawnee River Watershed Base Map .



Precipitation: The average annual rainfall in the watershed is approximately 21.9 inches per year (weather.com). The average monthly precipitation for the watershed is observed in Figure 2.

Figure 2. Average monthly precipitation as reported at Jetmore, KS on weather.com.



Current Conditions: Since loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired concentrations over all flow conditions, rather than fixed at a single value. Sampling data from station SC585 and SC586 was categorized into three defined seasons: Spring (April-June), Summer-Fall (July-October) and Winter (November-March).

Dissolved Oxygen (DO) concentrations on Pawnee Creek are observed in Figure 3 and summarized in Table 2. The majority of the impairments associated with the DO deficiency are observed in the Spring and Summer-Fall seasons during base or low flow conditions. More specifically the majority of the impairments have occurred during the warmer months of June, July and August as seen in Figure 4. The monthly average DO concentrations are below 5 mg/L at both stations during the month of July, and the lowest averages at these stations are observed during the months of June, July, August, and October as seen in Figure 5. Seasonal annual average DO concentrations indicate that concentrations are the lowest in the Summer-Fall season as seen in Figure 6.

Table 2. Seasonal Dissolved Oxygen violations relative to flow condition based on percent of flow exceedance (1990-2011).

Station	Season	High Flow (0-10%)	Normal Flow (11-39%)	Low Flow (40-99%)	Cum. Frequency
SC586 nr Burdett	Spring	0/4	3/13	1/1	4/18 = 22%
	Sum-Fall	0/5	4/10	2/5	6/20 = 30%
	Winter	0/4	0/12	1/1	1/17 = 6%
	All Data	0/13	7/35 (20%)	4/7 (57%)	11/55 = 20%
SC585 nr Larned	Spring	0/7	2/12	1/8	3/27 = 11%
	Sum-Fall	0/6	6/11	4/14	10/31 = 32%
	Winter	0/1	1/13	1/14	2/28 = 7%
	All Data	0/14	9/36 (25%)	6/36 (17%)	15/86 = 17%

Figure 3. Pawnee River DO Concentrations.

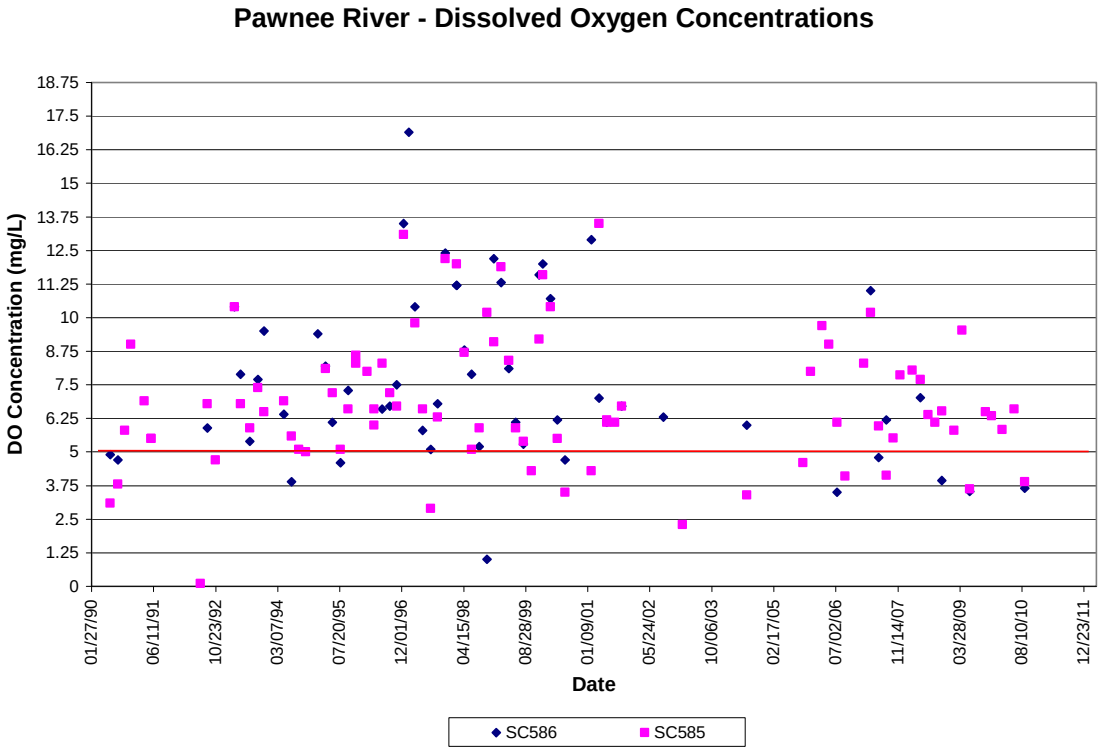


Figure 4. Pawnee River DO concentrations relative to sampling month.

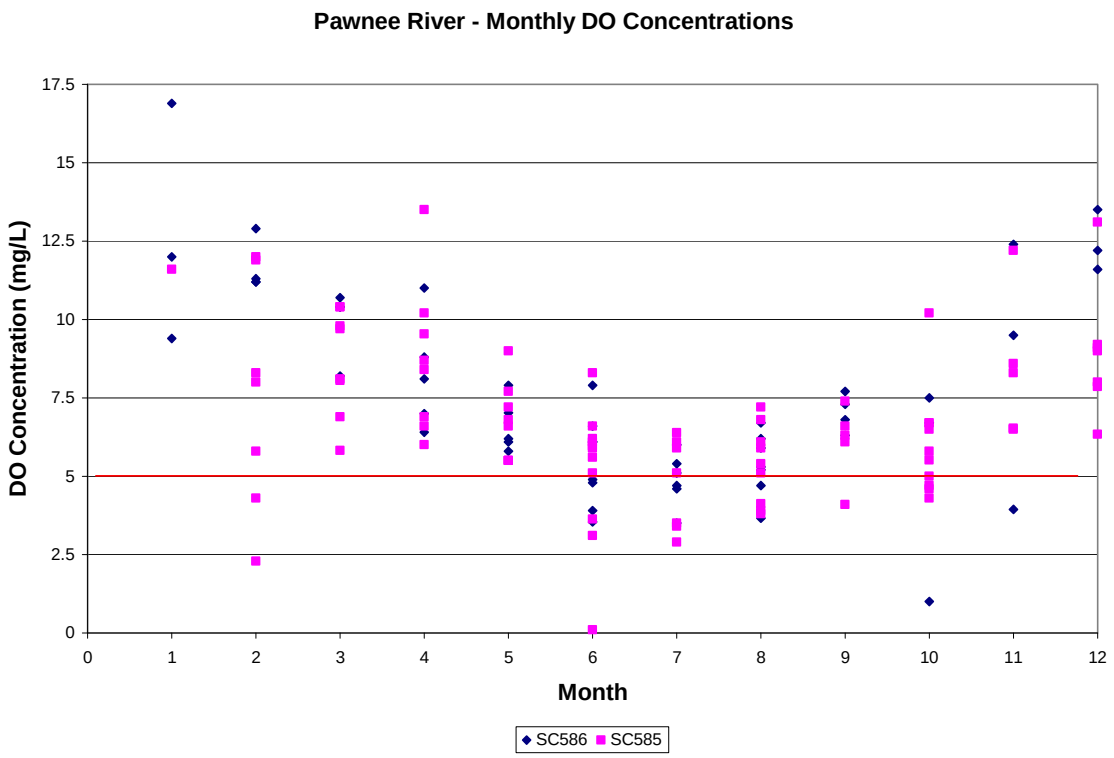
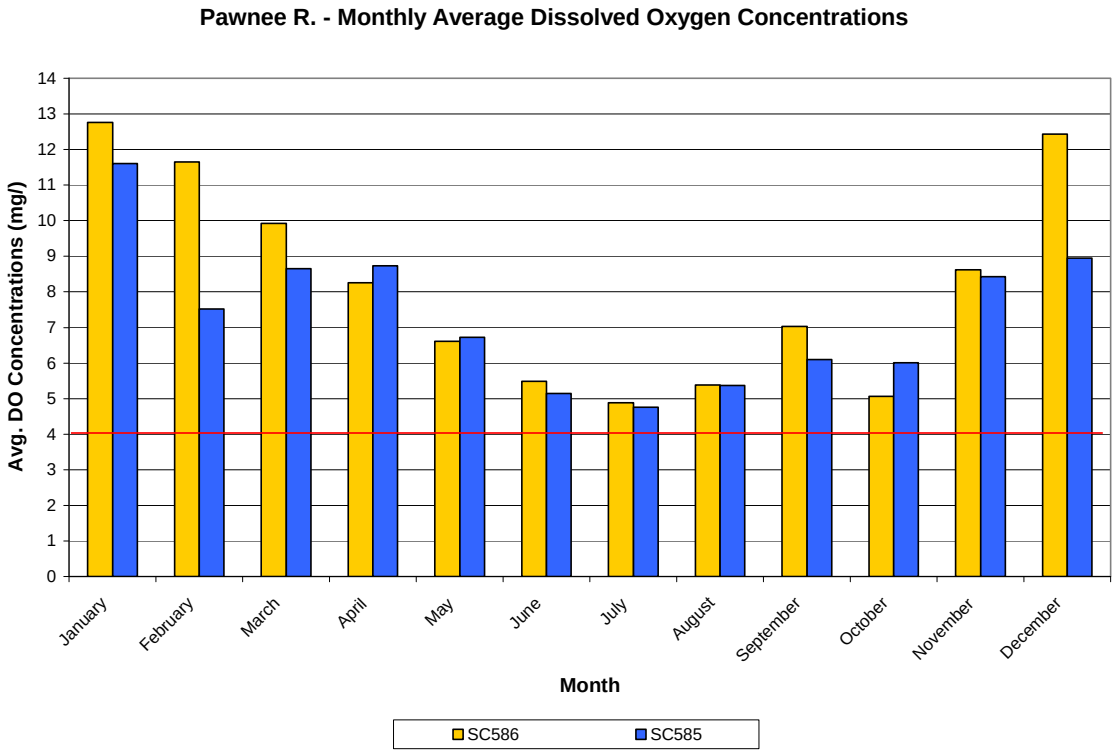


Figure 5. Monthly average DO concentrations.



Overall annual averages were below 5 mg/L during the sampling years of 1990, 2006, 2009, and 2010 at SC586 and during 1992, 2003 and 2004 at SC585 as seen in Tables 3 and 4. The overall seasonal annual averages at both stations is very similar. Comparative data of the samples collected on the same date on Pawnee River at these stations suggest the DO concentrations are very similar at each station during any given time. Of the 51 common sampling dates where samples were collected at both stations, the DO averages at SC585 and SC586 were 7.22 mg/L and 7.30 mg/L respectively. It should be noted that there were an additional 18 common sampling dates that have sampling results for SC585, but no samples were collected at SC586 due to dry conditions. This is likely because flows are sustained within the stream from the release of low flow structures that are located in between the two sampling locations. In addition, there is more water in the stream as it approaches the confluence with the Arkansas River. Figure 7 details the common sampling concentrations on a 1:1 scale. There are five common sampling events when both stations violated the water quality standard. The upstream station, SC586, had six noncompliant samples compared to compliant samples on the same sampling date at the downstream station, SC585. The downstream station, SC585, had four noncompliant samples that compared to compliant samples at the upstream station.

Figure 6. Seasonal Dissolved Oxygen Concentration averages for the Pawnee River.

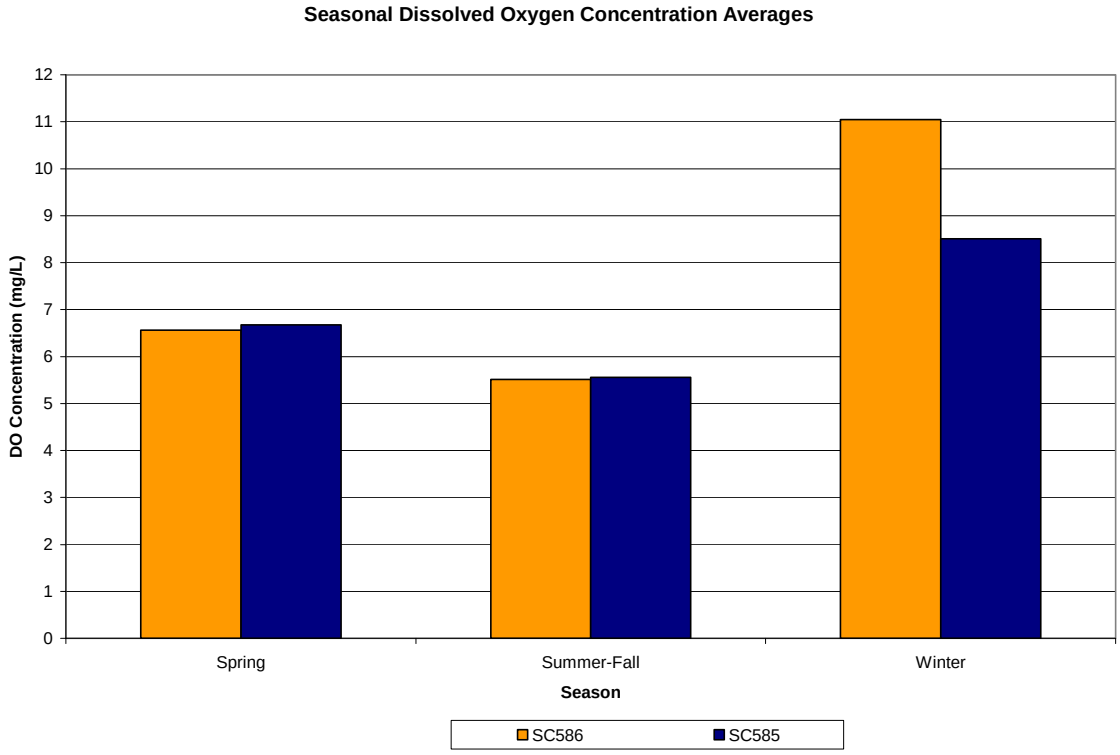


Table 3. Annual DO seasonal averages at SC586.

Sampling Year	Spring Avg. (mg/L)	Summer-Fall Avg. (mg/L)	Winter Avg. (mg/L)	Yearly Average (mg/L)
1990	4.9	4.7		4.8
1991				
1992		5.9		5.9
1993	7.9	6.55	9.95	8.1
1994	5.15			5.15
1995	6.1	5.95	8.8	6.95
1996	6.6	7.1	13.5	9.1
1997	5.8	5.95	13.2	8.3
1998	8.35	3.1	11.7	7.7
2000	6.2	4.7	11.4	7.95
2001	6.55	6.7	12.9	8.7
2002		6.3		6.3
2004		6		6
2006		3.5		3.5
2007	7.9	6.2		7.05
2008	7.02		3.94	5.48
2009	3.54			3.54
2010		3.66		3.66
Average	**6.40**	**5.44**	**10.76**	**6.43**

Table 4. Annual DO seasonal averages at SC585.

Sampling Year	Spring Avg. (mg/L)	Summer-Fall Avg. (mg/L)	Winter Avg. (mg/L)	Yearly Average (mg/L)
1990	3.1	4.8	9	5.6
1991	5.5		6.9	6.2
1992	0.1	5.75		2.9
1993	6.8	6.65	8.45	7.3
1994	6.25	5.05		5.65
1995	7.2	5.85	8.3	7.13
1996	6.97	6.95	10.55	8.16
1997	6.6	4.6	11	7.4
1998	6.9	8.05	10.55	8.5
2000	5.5	3.5	11	6.7
2001	9.8	6.4	4.3	6.8
2003			2.3	2.3
2004		3.4		3.4
2005		4.6	8	6.3
2006	9	6.1	9.7	8.3
2007	8.1	4.8	7.9	6.9
2008	7.7	6.3	7.3	7.1
2009	6.6	6.5	6.1	6.4
2010	6.6	3.9	5.8	5.4
Average	**6.46**	**5.44**	**8.09**	**6.30**

Figure 7. Comparison of DO concentrations between SC586 and SC585 for common sampling dates.

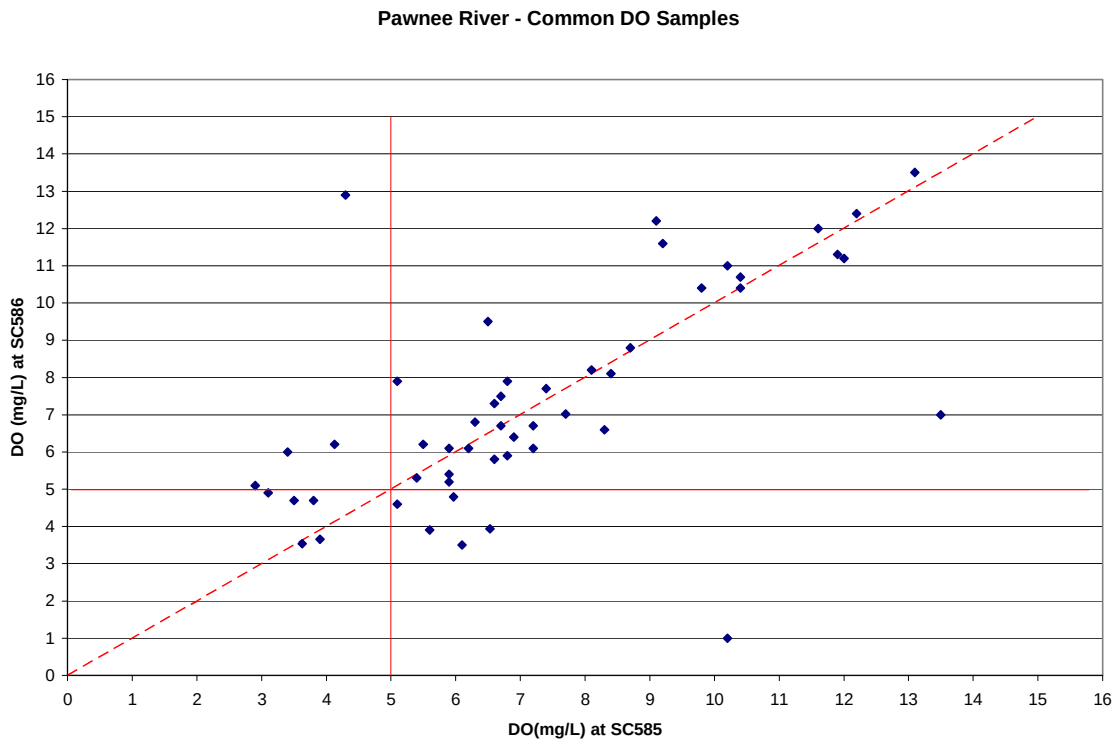
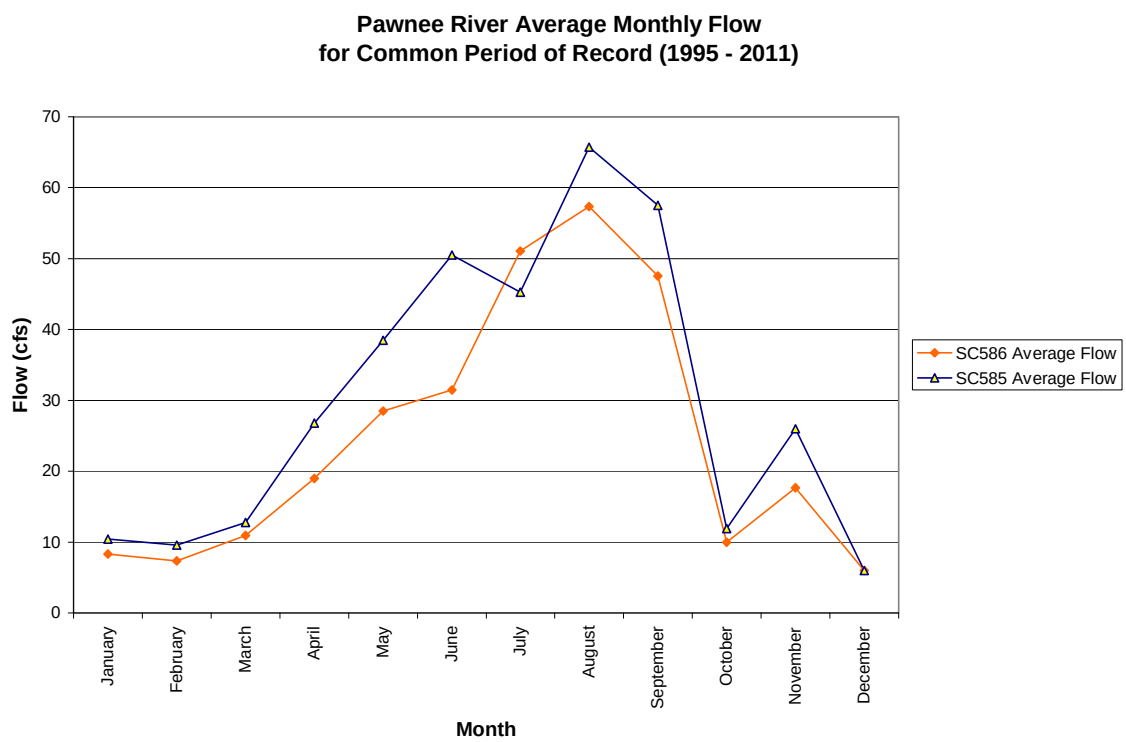


Figure 8. Pawnee River Average Monthly Flow for common dates from 1995-2011.



As seen in Figure 8, average monthly streamflow at the sampling stations is slightly higher at the downstream station, with the exception of July. Average streamflows are the highest during June, July, August, and September. There are prolonged periods of dry conditions on Pawnee River as the median flow condition are zero cfs for all months with the exception May, June, July and August. The highest median flow value is 1.5 cfs during June at SC585, with median flow values for May, July, and August being less than 0.5 cfs at SC585. Median flow values at SC586 for the months of May, June, July, and August are all below 1 cfs.

Flow conditions for each noncompliant sample was analyzed and it is apparent that DO violations are more likely to occur during extreme low flow conditions or during unstable flow conditions when the stream is either aggressively gaining or losing flow within the 4-day period prior to the sampling date (see Appendix B). Streamflow within Pawnee River will increase and decrease substantially in a very short period of time.

Stream temperatures also influence DO concentrations in Pawnee River, where higher temperatures along with the low flow condition are common with DO violations. The DO violations predominately occur when stream temperatures are greater than 20ºC as seen in Table 5. The relationship between DO concentrations and stream temperature are illustrated in Figure 9.

Figure 9. Pawnee River Dissolved Oxygen concentrations relative to stream temperature.

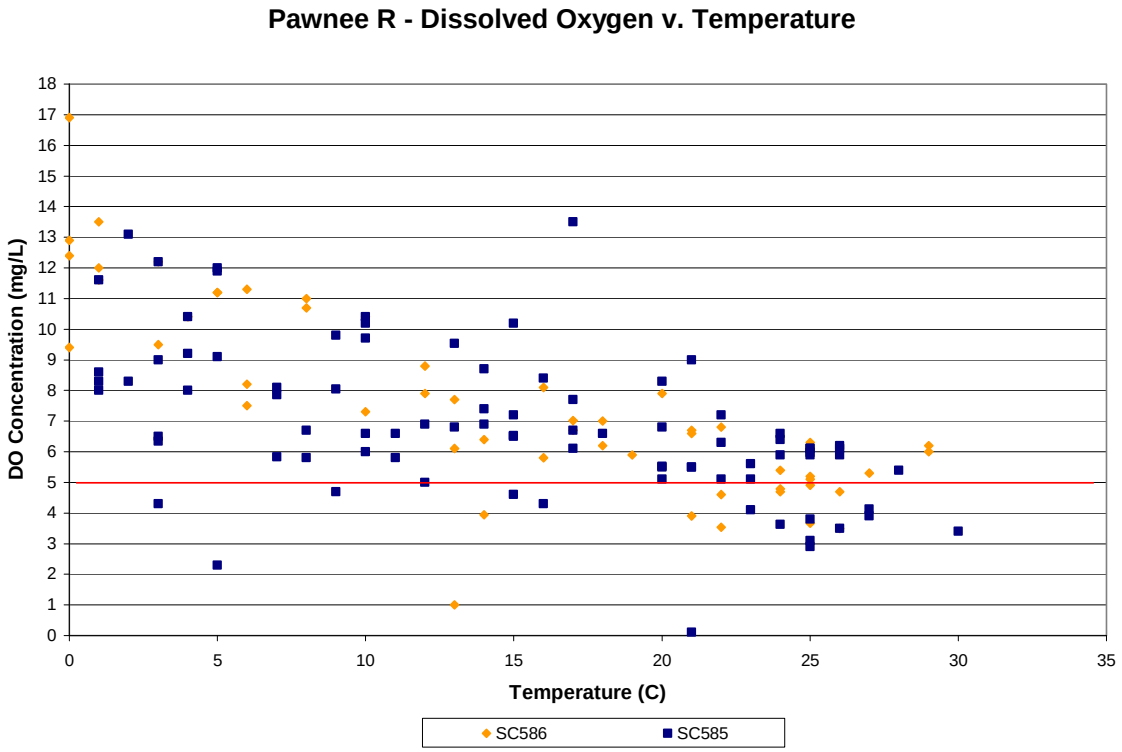


Table 5. Number of DO violations relative to Stream Temperature.

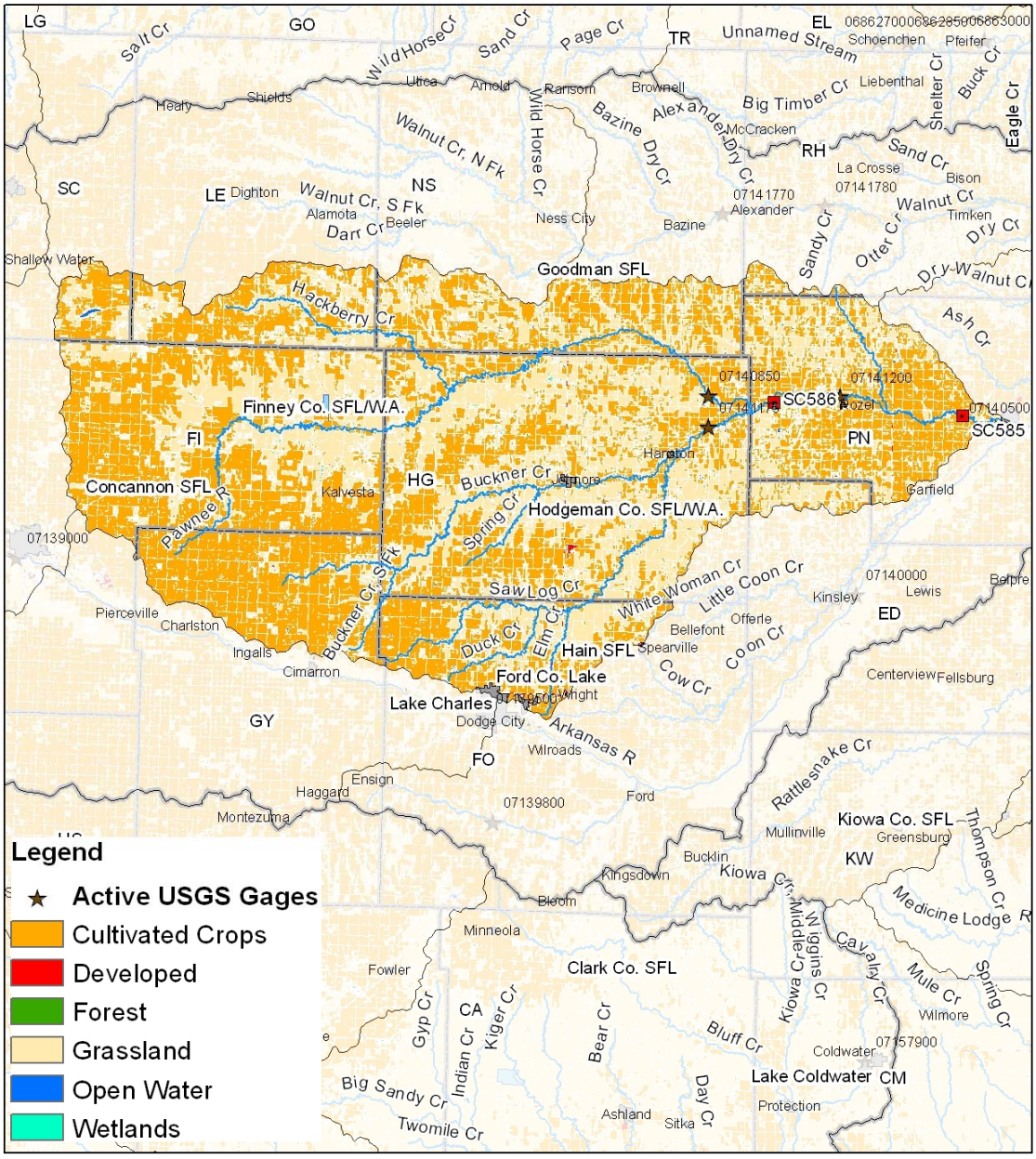
Station	Temperature Range (Degrees C)				
	0-5 º	6-10º	11-15º	16-20º	> 20º
SC586	0	0	2	0	9
SC585	2	1	1	1	10

Desired Endpoint of Water Quality (Implied Load Capacity for Dissolved Oxygen) in Pawnee River: 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. Seasonal variation is accounted for by this TMDL, since the TMDL endpoint is sensitive to the low flow and temperature conditions usually occurring in the Summer-Fall season and higher DO levels occur during the winter when flows are typically more stable. 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.

3.0 SOURCE INVENTORY AND ASSESSMENT:

Land Use: The cover in the Pawnee River watershed includes 60% cropland, 36% grassland, 3% developed, and less than 1% of open water, wetlands, and forest. Landuse for Pawnee River watershed is detailed in Figure 10.

Figure 10. Landuse in Pawnee River Watershed.



Point Sources: There are eight NPDES facilities within the Pawnee River watershed. Of these, three of them are permitted discharging facilities. Dodge City is the largest discharging facility, however this is a new facility that has not reported any discharge. This facility is also designed for effluent irrigation reuse. The facilities within the watershed are detailed in Table 6. The City of Jetmore rarely discharges from the lagoon systems.

Table 6. NPDES Facilities in Pawnee River watershed.

Permit #	Federal NPDES #	Facility Name	Type	Receiving Stream	Design Flow (MGD)	Permit Expires	BOD Limit
I-UA11-NP02	KSJ000481	Koch Nitrogen Co.	Non-Discharging	NA	NA	11/30/2012	NA
I-UA11-NP04	KSJ000615	Darlings International	Non-Discharging	NA	NA	8/31/2015	NA
M-UA06-NO01	KSJ000272	City of Burdett	Non-Discharging	NA	NA	5/31/2012	NA
M-UA35-NO01	KSJ000255	City of Rozel	Non-Discharging	NA	NA	5/31/2012	NA
M-UA43-NO01	KSJ000260	Wright Improvement District	Non-Discharging	NA	NA	7/31/2012	NA
M-UA11-OO02	KS0099830	Dodge City	Mechanical, UV, Activated Sludge, Effluent Reuse	Duck Cr via Unnamed Trib	1.25	12/31/2014	*Varies by Month
M-UA17-OO01	KS0031143	City of Hanston	Mechanical	Buckner Cr	0.04	12/31/2011	Weekly Avg 45 mg/l; Monthly Avg 30 mg/l
M-UA21-OO02	KS0099562	City of Jemore	3-cell Lagoon	Buckner Cr	0.0942	12/31/2012	Weekly Avg 45 mg/l; Monthly Avg 30 mg/l

* - BOD limits for Dodge City vary by month and are as follows:
May through September, Weekly Average of 35 mg/l, Monthly Average of 20mg/l;
April and October, Weekly Average of 40 mg/l, Monthly Average of 25mg/l;
November through March, Weekly Average of 45 mg/l, Monthly Average of 30mg/l.

Livestock Waste Management Systems: There are 59 active certified or permitted confined animal feeding operations (CAFOs) within the Pawnee River watershed (see Appendix A). These facilities are designed to retain a 25-year, 24-hour rainfall/runoff event as well as an anticipated two weeks of normal wastewater from their operations. Typically, this rainfall event coincides with streamflow that occurs less than 1-5% of the time. Though the total potential number of animals is approximately 292,698 head in the watershed, the actual number of animals at the feedlot operations is typically less than the allowable permitted number. It is not anticipated that livestock operations contribute to the impairment in the watershed.

According to the Kansas Agricultural Statistics the estimated number of all cattle and cows for counties that are included within this watershed as of January 1, 2011 are as follows: 90,000 for Pawnee County; 84,000 for Hodgeman County; 260,000 for Finney County; 170,000 for Ford County; 31,000 for Ness County; 63,000 for Lane County; 250,000 for Gray County; 260,000 for Scott County; and 71,000 for Edwards County. The animal waste from both confined and unconfined feeding sites is considered a possible major source of nutrient loading in the Pawnee River watershed. Of particular concern are lands near the riparian areas that are subject to livestock grazing or watering and fertilizer applications.

Contributing Runoff: The watershed of Pawnee River has a mean soil permeability value of 1.02 inches/hour according to the NRCS STATSGO database. According to a USGS open-file report (Juracek, 2000), the threshold soil-permeability values that represents very high, high, moderate, low, very low, and extremely low rainfall intensity, were set at 3.43, 2.86, 2.29, 1.71, 1.14, and 0.57”/hour, respectively. The lower rainfall intensities generally occur more frequently than the higher rainfall intensities. The higher soil-permeability thresholds imply a more intense storm during which areas with higher soil permeability potentially may contribute runoff. Runoff is chiefly generated as infiltration excess with rainfall intensities greater than the soil permeability. As soil profiles become saturated, excess overland flow is produced. For the Pawnee River watershed, approximately 50% of the watershed will produce runoff with rainfall events that produce 1.14 inches/hour of rain. Over 93% of the entire watershed has a low soil permeability value that will produce runoff with rainfall events that produce 1.71 inches/hour of rain. Runoff contributes to the dissolved oxygen deficiencies within the watershed that are observed above the low flow condition.

Nonpoint Sources: The DO violations that occurred in the watershed above the low flow condition are related to brief runoff events that deliver high nutrients and organic material that influences the demand on available oxygen.

Background: The natural hydrologic characteristics of the watershed influence DO concentrations during periods of low flow in the watershed. Pawnee River does not sustain flow throughout the year and also has several low water dams. The flow impediments restrict instream flow and combined with the prolonged periods of dry conditions and warmer temperatures account for the primary cause for the impairments during the low flow condition. Leaf litter and wastes derived form natural wildlife may add to the nutrient load.

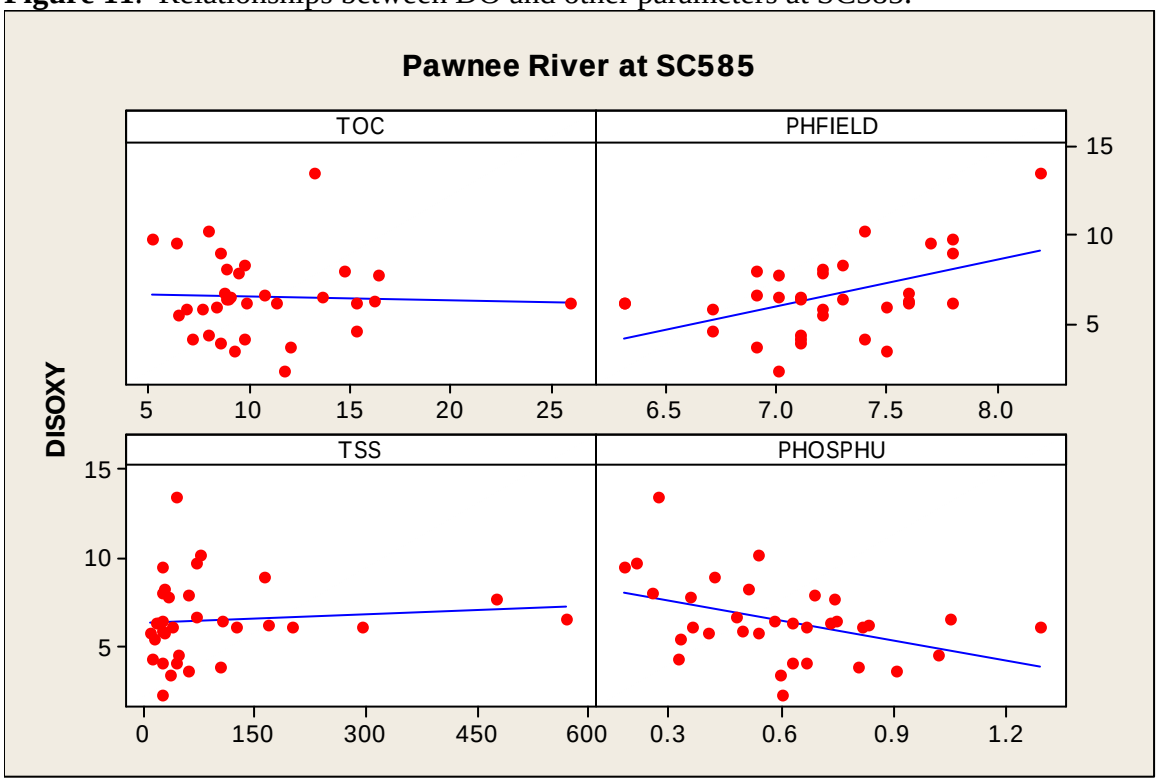
Population: The populations within the watershed is approximately 25,000 people according to the 2000 U.S. Census Tract information, with 15,000 of these folks residing in the portions of Dodge City that lie within the watershed. Population projections for Dodge City, Hanston, and Jetmore indicate populations are anticipated to be relatively stable.

On-Site Waste Systems: Households outside of the municipalities that operate a wastewater treatment facility are presumably utilizing on-site septic systems. There are

approximately 16,476 people living within the municipalities served by wastewater treatment facilities within the watershed, and therefore there are approximately 8,500 people within the watershed utilizing on-site septic systems. Significant nutrient loading may occur if a system fails and it is located near a stream, which would influence and contribute to the dissolved oxygen impairment. However, based on the size of this watershed it is likely that on-site septic systems are an insignificant source contributing to the dissolved oxygen impairment within the Pawnee River watershed.

Relationship with Other Parameters: Based on the assessment it is apparent that DO violations are driven by two main factors. The first factor is driven by low flow conditions and higher stream temperatures. Violations that occur during these conditions are likely natural occurrences based on the hydrodynamics of the stream system since the stream is often dry for prolonged periods of time. During these conditions the aquatic life use is ultimately impaired by the lack of flow, which may be accompanied by the pooling of water above any low water structures within the stream. The second scenario that involves DO violations occurs during normal flow conditions. These violations are driven by brief runoff periods when the watershed is flushing high levels of organic material. Based on the hydrographs of the violations occurring when flow is in the stream, these violations tend to occur during unstable flow conditions as Pawnee River tends to quickly increase and diminish stream flows over a few day period. It is very difficult to discern any statistically significant relationships with other parameters that are meaningful within the watershed due to the predominance of unstable flow conditions within the watershed. An example of these relationships at the terminus of the watershed, SC585, are displayed in Figure 11.

Figure 11. Relationships between DO and other parameters at SC585.



Figures 12, 13, 14, 15, 16, and 17 display comparisons of data sets separated based on compliant and non-compliant DO samples. Based on the comparisons, there are some distinct observations between the two datasets. Temperatures are higher for samples that violated the DO standard at both sampling stations. The pH values for the compliant DO samples are higher than the non-compliant samples for each respective station, which is also indicative of nutrient concentrations. Total Phosphorus Concentrations are higher at both stations for the non-compliant DO samples. Total Organic Carbon (TOC) median concentrations are significantly higher for the non-compliant DO samples at the upstream station compared to the compliant samples at this station. There is less variability with the TOC concentrations at the downstream station, likely because this station is highly influenced by a nearby low water dam, which contributed to this station not being sampled for several dates that the upstream station was sampled. The median TOC concentration at the SC585 for the non-compliant DO samples is slightly higher than the DO compliant samples at this station. There are no DO violations encountered at the high flow condition. There is a large degree of uncertainty with the relationship between these parameters since flow conditions are so volatile, prolonged dry conditions persist and the lack of knowledge of the water quality influence imposed by the low water structures within the watershed.

Figure 12. Temperature comparisons between compliant and noncompliant DO samples at SC586 and SC585.

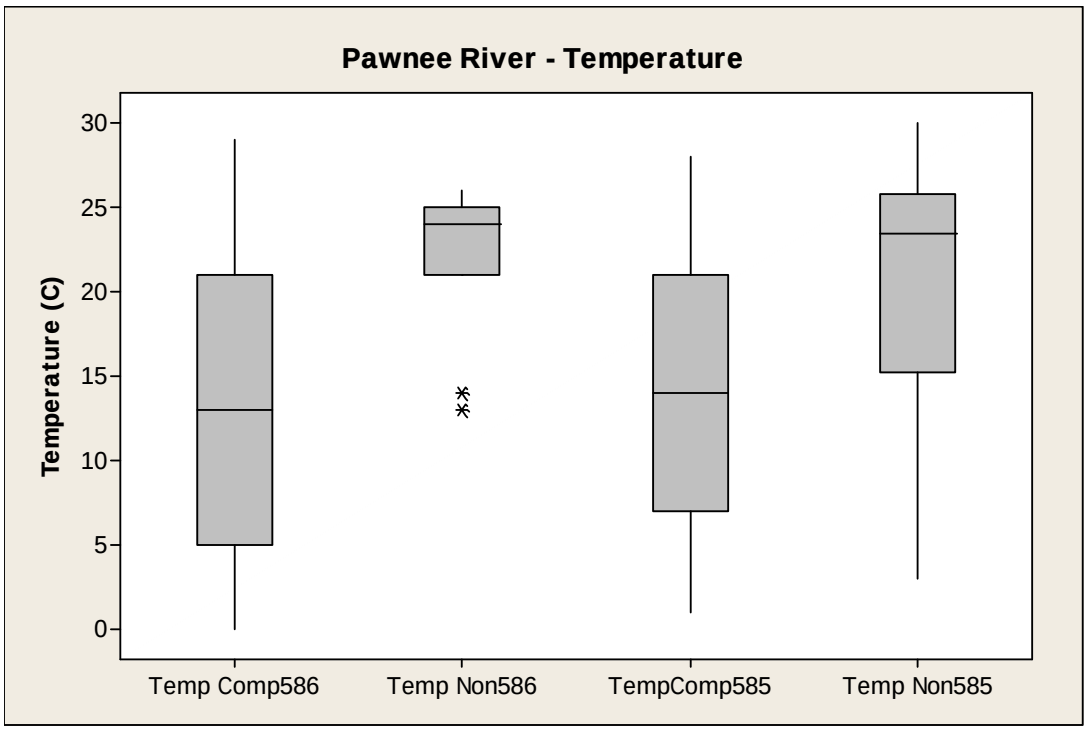


Figure 13. pH comparisons between compliant and noncompliant DO samples at SC586 and SC585.

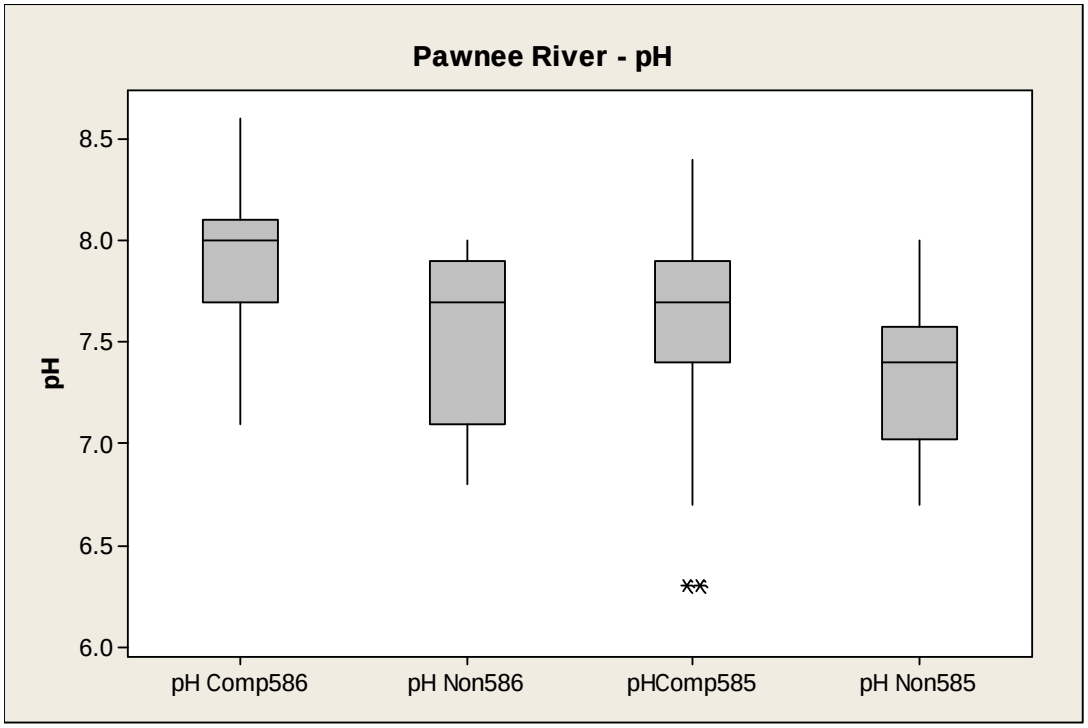


Figure 14. Total Phosphorus concentration comparisons between compliant and noncompliant DO samples at SC586 and SC585.

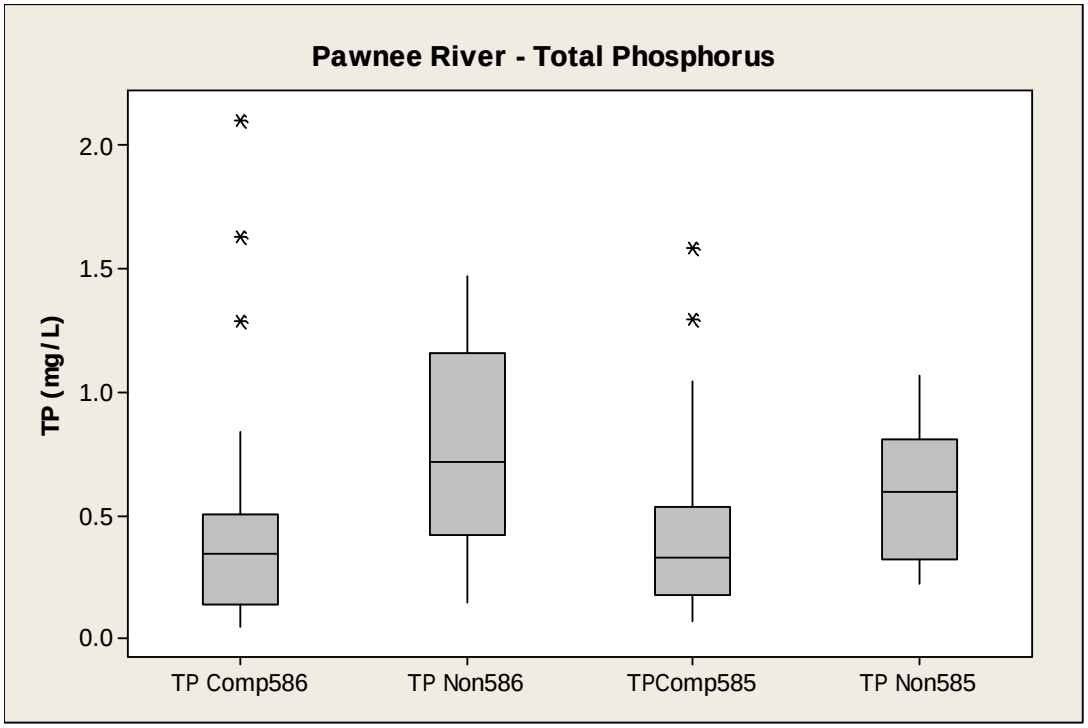


Figure 15. TOC concentration comparisons between compliant and noncompliant DO samples at SC586 and SC585.

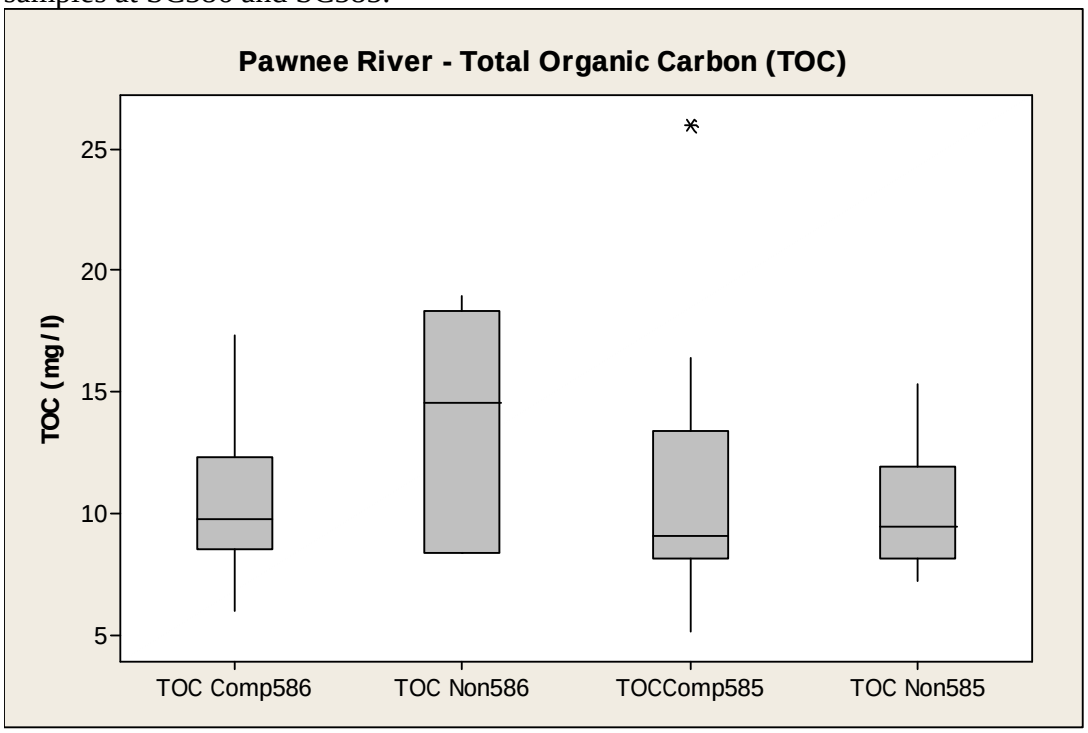


Figure 16. Percent of Flow Exceedance comparisons between compliant and noncompliant DO samples at SC586 and SC585.

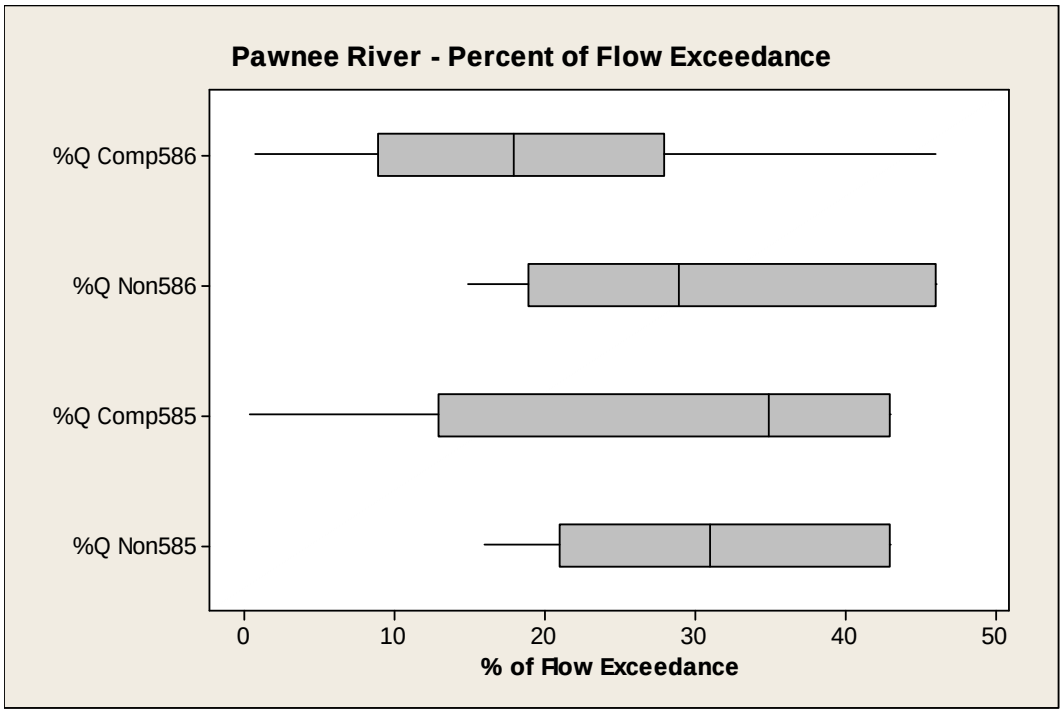
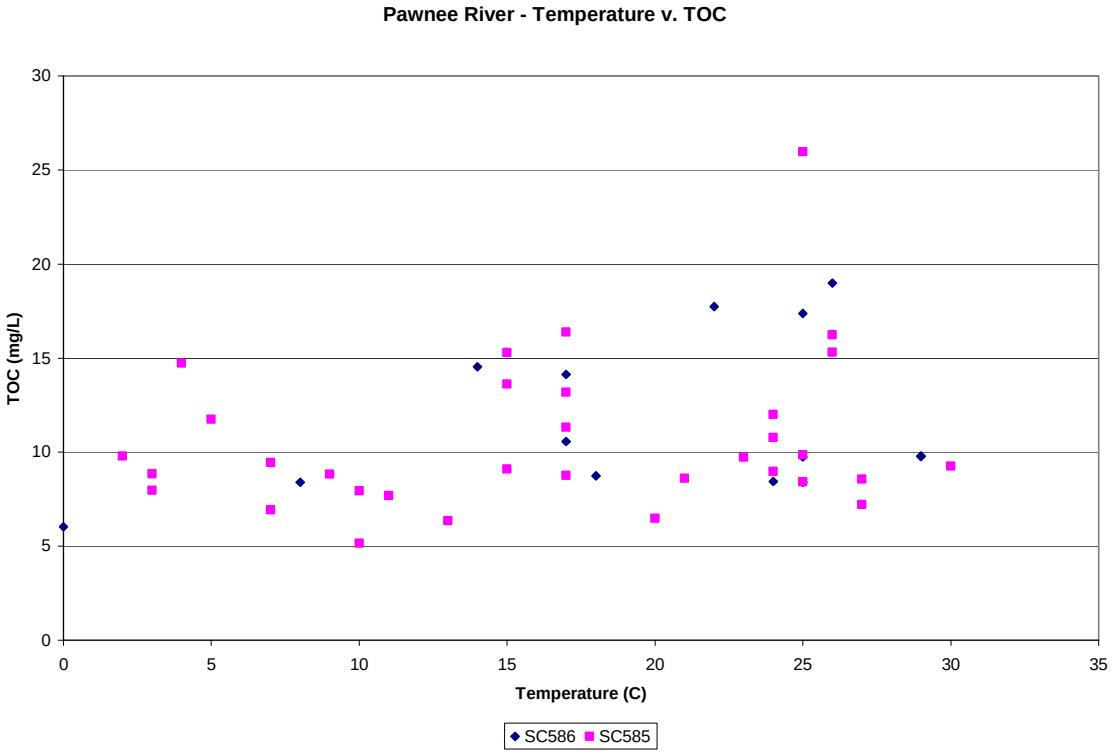


Figure 17. Relationship between Temperature and TOC in Pawnee River.



4.0 ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

The TMDL is a concentration based TMDL, where all stream segments within the watershed must maintain a Dissolved Oxygen Concentration of 5 mg/L or more at all times that the stream has sustained flow. There is some degree of uncertainty on establishing allocations under this TMDL. Total Organic Carbon (TOC) will be allocated under this TMDL as the pollutant to meet the DO TMDL, though ultimately success of this TMDL will be measured through in stream DO compliance.

KDHE discontinued sampling for Biological Oxygen Demand (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 as the population increases among microorganism communities.

TOC will be allocated based on the data set of compliant samples at SC585, with a median TOC concentration of 9.1 mg/L of TOC being allocated under all flow conditions. The compliant samples at SC585 average a Biological Oxygen Demand (BOD) of 4.35 mg/l. There are five compliant samples that have both TOC and BOD analysis, and have an average BOD and TOC ratio of 0.41. The ratio is similar to the arithmetic mean (0.44) for ambient water as seen in the above regression analyses. Based on the BOD and TOC ratio of 0.41, the resulting translating BOD concentration is 3.73 mg/L for the compliant data set. Stream BOD will be allocated for the wasteload allocation based on respective NPDES permit BOD limits at the present time. The ambient BOD can be converted by the site specific ratio of 0.41 to ambient TOC.

Point Sources: Since the DO violations are generally associated with unstable flow conditions associated with brief runoff events and critically low flow events it is conceivable that point sources are not contributing to the DO impairment. In addition, the only facility that has discharged in the watershed recently is the City of Hanston. To be conservative a Wasteload Allocation (WLA) will be assigned to all three facilities. Wasteload Allocations (WLA) will be assigned to all discharging facilities based on 30 mg/L BOD monthly averages for the cities of Hanston and Jetmore and based on 20 mg/L BOD monthly average for Dodge City. It is anticipated these facilities will be well under the assigned WLA throughout the year based on the discharge monitoring reports. The established WLA in the watershed is detailed in table 7a. The total WLA for the watershed is 242.4 lbs/day of BOD, which has an equivalent TOC WLA of 591.5 lbs/day. The full wasteload allocation does not reach the sampling station based on the proximity of the facilities and the assimilative capacity of the watershed, along with the fact that these facilities actually do not continuously discharge. To be conservative it is assumed that the full WLA reaches the sampling stations when flows are greater than 12.5 cfs in Pawnee River.

Table 7a. Wasteload Allocations in the Pawnee River watershed.

Facility	WLA – BOD (lbs/day)	WLA – TOC (lbs/day)
Dodge City	208.8	509.4
City of Jetmore	10.0	24.5
City of Hanston	23.6	57.6
Total	242.4	591.5

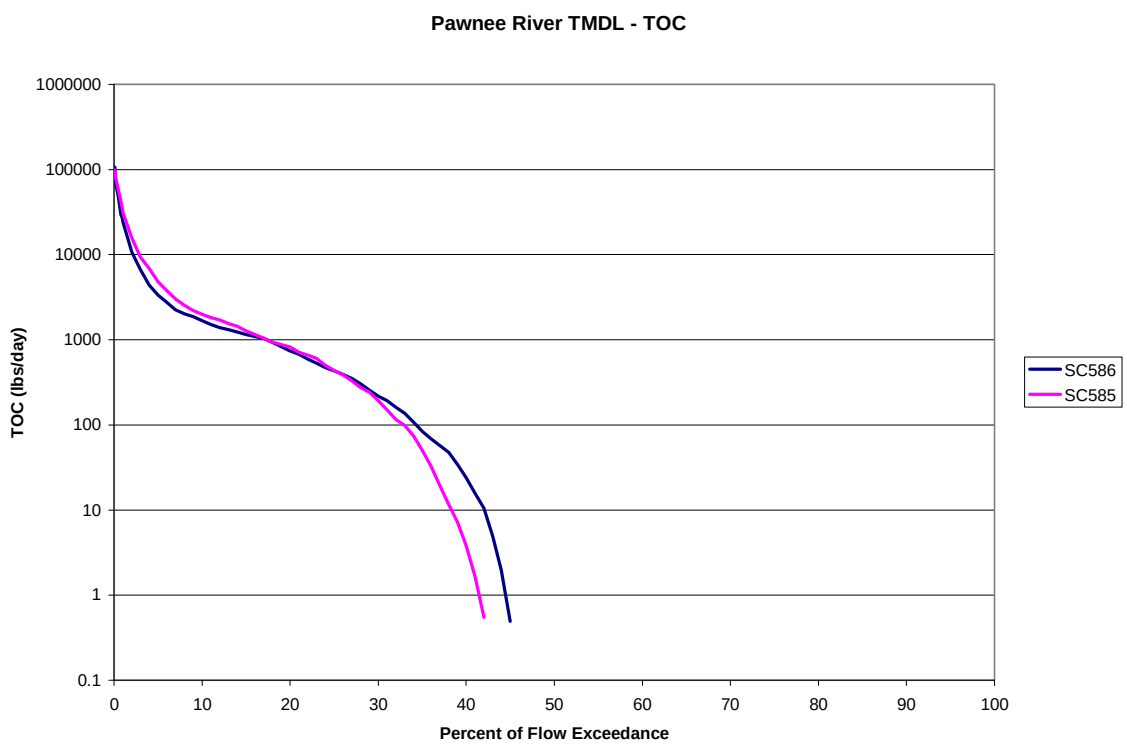
Nonpoint Sources: The TMDL and allocations assigned to the Pawnee River watershed are illustrated in Table 7b. The Load Allocations under average flow conditions are 597.7 lbs/day of TOC at station SC586, which is located on the upper portion of Pawnee River Segment 2 with loads arriving from Pawnee River Segment 3 and Buckner Creek Segment 1. The Load Allocations under average flow conditions are 858.1 lbs/day of TOC at SC585, which is located on the lower portion of Pawnee River segment 2.

Table 7b. Pawnee River DO TMDL, TOC allocations.

Station SC586 Flow Condition	Flow (cfs)	WLA (lbs/day)	LA (lbs/day)	TMDL (lbs/day)
Average Flow	24.2	591.5	597.7	1189.2
25%	8.8	432.4*	0	432.4
10%	34	591.5	1079.3	1670.8
5%	68	591.5	2750.0	3341.5
Station SC585 Flow Condition	Flow (cfs)	WLA (lbs/day)	LA (lbs/day)	TMDL (lbs/day)
Average Flow	29.5	591.5	858.1	1449.6
25%	8.9	437.3*	0	437.3
10%	40.4	591.5	1393.8	1985.3
5%	96.8	591.5	4165.3	4756.8

* Assimilated WLA

Figure 18. Pawnee River Dissolved Oxygen TMDL.



Defined Margin of Safety: The margin of safety provides some hedge against the uncertainty of daily loading that contributes to the impairment of dissolved oxygen deficiencies. This TMDL uses an implicit margin of safety, relying on conservative assumptions since the wasteload allocations are assumed to be reaching the stream when the stream is flowing, when the Dodge City and Jetmore facilities actually rarely discharge. Secondly, the allocations are conservatively set for all flow conditions when the vast majority of the impairment occurs during the low flow condition with higher stream temperatures.

State Water Plan Implementation Priority: Because of the uncertainty of the pollutant sources causing the dissolved oxygen deficiencies in the Pawnee River watershed, this TMDL will be a Low Priority for implementation.

Unified Watershed Assessment Priority Ranking: A portion of this watershed lies within the Buckner Subbasin with a priority ranking of 28 (Medium Priority for restoration work).

Priority HUC 12s and Stream Segments: Because of the lack of certainty regarding potential sources and naturally occurring background concentration in the watershed, no priority subwatershed or stream segment will be identified.

5.0 IMPLEMENTATION

Desired Implementation Activities

1. Install grass buffer strips where needed along streams.
2. Maintain adequate streamflow by ensuring streamflow is not artificially reduced or impeded, particularly during low flow durations.
3. Ensure that labeled application rates of chemical fertilizers are being followed and implement runoff control measures.
4. Implement nutrient management plans to manage manure land applications and runoff potential.
5. Ensure appropriate treatment of wastewater through compliance of NPDES limits.

Implementation Programs Guidance

Nonpoint Source Pollution Technical Assistance-KDHE

a. Support Section 319 demonstration projects for reduction from streambank erosion, sediment runoff, and livestock operations.
b. Provide technical assistance on practices geared to the establishment of vegetative buffer strips.

NPDES and State Permits – KDHE

a. Livestock permitted facilities will be inspected for integrity of applied pollution prevention technologies.
b. Registered livestock facilities with less than 300 animal units will apply pollution prevention technologies.

c. Manure management plans will be implemented.
d. Municipal wastewater is below BOD limits.

Riparian Protection Program – SCC

a. Establish or re-establish natural riparian systems, including vegetative filter strips along small tributaries.

Buffer Initiative Program – SCC

a. Install buffer strips near streams.
b. Work in conjunction with Federal Conservation Reserve Enhancement Program and Conservation Security Program to hold marginal riparian land out of production.

Timeframe for Implementation: Continued monitoring over the years from 2012 to 2021, particularly when Dodge City begins discharging to the watershed.

Milestone for 2016: In accordance with the TMDL development schedule for the State of Kansas, the year 2016 marks the next cycle of 303(d) activities in the Upper Arkansas Basin to review data from the Pawnee River watershed to assess continued incidence of dissolved oxygen deficiencies.

Delivery Agents: The primary delivery agents for program participation will be the Kansas Department of Health and Environment.

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

1. 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.

2. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage 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 -71 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 Upper Arkansas Basin Plan provide guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollutant 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 watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund programs supporting water quality protection through the WRAPS program. This watershed and its TMDL are a Low Priority consideration.

Effectiveness: Buffer strips are publicized as a means to filter sediment before it reaches a stream and riparian restoration project have been acclaimed as a significant means of stream bank stabilization. The key to effectiveness is participation within a targeted area to direct resources to the activities influencing water quality. Secondary wastewater treatment is very effective at reducing BOD in effluent.

6.0 MONTITORING

KDHE will continue to collect samples through 2021 at the permanent stations SC585 and SC586 on the Pawnee River on a quarterly basis every year. Point Source facilities will continue to monitor BOD in their wastewater.

7.0 FEEDBACK

Public Notice: An active internet website was established at http://www.kdheks.gov/tmdl/index.htm 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 September 20, 2012 in Garden City to receive comments on this TMDL.

Basin Advisory Committee: The Upper Arkansas River Basin Advisory Committee met to discuss these TMDLs on April 4, 2012 in Jetmore and September 20, 2012 in Garden City.

Milestone Evaluation: In 2016, evaluation will be made as to the degree of impairment continuing to occur within the watershed. Subsequent decisions will be made regarding the implementation approach, priority of allotting resources for implementation and the need for additional or follow up implementation in this watershed at the next TMDL cycle for this basin in 2016 with consultation from local stakeholders and the BAC.

Consideration for 303(d) Delisting: Pawnee River will be evaluated for delisting under section 303(d), based on the monitoring data over 2012-2021. Therefore, the decision for delisting will come about in the preparation of the 2022-303(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, which will emphasize implementation of WRAPS activities. At that time, incorporation of this TMDL will be made into the WRAPS. Recommendation of this TMDL will be considered in the Kansas Water Plan implementation decisions under the State Water Planning Process for Fiscal Years 2012-2021.

Rev January 17, 2013

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Appendix A. Permitted and Registered CAFOs.

Permit	Facility County	Animal Totals	WLA
A-UAFI-BA03	Finney	999.0	0
A-UAFI-C010	Finney	7500.0	0
A-UAFO-C004	Ford	9950.0	0
A-UAFO-C011	Ford	13500.0	0
A-UAGY-C005	Gray	49000.0	0
A-UAHG-C010	Hodgeman	3500.0	0
A-UAHG-BA06	Hodgeman	700.0	0
A-UAHG-B018	Hodgeman	999.0	0
A-UAHG-M001	Hodgeman	120.0	0
A-UAHG-BA02	Hodgeman	500.0	0
A-UAHG-D001	Hodgeman	3940.0	0
A-UAHG-B008	Hodgeman	900.0	0
A-UAHG-C003	Hodgeman	17000.0	0
A-UAHG-B015	Hodgeman	900.0	0
A-UAHG-C005	Hodgeman	2000.0	0
A-UAHG-B005	Hodgeman	990.0	0
A-UAHG-C004	Hodgeman	4950.0	0
A-UAHG-B002	Hodgeman	900.0	0
A-UAHG-B003	Hodgeman	950.0	0
A-UAHG-C001	Hodgeman	22000.0	0
A-UAPN-B008	Pawnee	750.0	0
A-UALE-B002	Lane	400.0	0
A-UAPN-B002	Pawnee	950.0	0
A-UAPN-B001	Pawnee	600.0	0
A-UAFI-BA06	Finney	500.0	0
A-UAHG-B006	Hodgeman	0.0	0
A-UAPN-B010	Pawnee	990.0	0
A-UAHG-BA18	Hodgeman	500.0	0
A-UAHG-B017	Hodgeman	999.0	0
A-UAGY-C011	Gray	6750.0	0
A-UAHG-B010	Hodgeman	600.0	0
A-UAHG-C011	Hodgeman	1500.0	0
A-UASC-C020	Scott	3500.0	0
A-UAHG-BA17	Hodgeman	500.0	0
A-UAHG-B004	Hodgeman	500.0	0
A-UANS-B001	Ness	900.0	0
A-UAHG-BA14	Hodgeman	800.0	0
A-UAGY-D002	Gray	16650.0	0
A-UAFO-B009	Ford	900.0	0
A-UAGY-H001	Gray	38400.0	0
A-UAHG-C009	Hodgeman	13000.0	0
A-UAPN-BA05	Pawnee	999.0	0
N-UAHG-5779	Hodgeman	975.0	0
A-UAHG-BA15	Hodgeman	900.0	0
A-UAHG-B016	Hodgeman	600.0	0
A-UAHG-BA19	Hodgeman	900.0	0
A-UAFO-B007	Ford	999.0	0
A-UAHG-B009	Hodgeman	800.0	0
A-UAHG-B012	Hodgeman	999.0	0
A-UAGY-D001	Gray	48000.0	0
A-UAHG-BA13	Hodgeman	990.0	0
A-UAFO-BA01	Ford	600.0	0
A-UAHG-B011	Hodgeman	999.0	0
A-UAFI-BA07	Finney	900.0	0
713	Hodgeman	950.0	0
A-UAHG-BA16	Hodgeman	400.0	0
A-UAPN-B009	Pawnee	900.0	0
A-UANS-BA05	Ness	500.0	0
A-UAED-BA03	Edwards	300.0	0

Appendix B.

SC585, Flow Information for days preceding DO violation.

Sampling Date	DO Concentration	Flow	Flow Comment (4 days Flow Preceding Sampling Date)
6/25/1990	3.1	10.4	Unstable, (0.4, 85, 35, 13)
8/27/1990	3.8	8.9	Unstable, (63, 63, 23, 10)
6/23/1992	0.1	0	Low Flow (0, 0, 0, 0)
10/20/1992	4.7	0	Low Flow (0, 0, 0, 0)
7/22/1997	2.9	10.0	Stable, (12, 11, 11, 11)
10/12/1999	4.3	0	Low Flow (0, 0, 0, 0)
7/11/2000	3.5	15.6	Unstable (107, 68, 55, 32)
2/6/2001	4.3	2.3	Stable (2.8, 2.7, 2.6, 2.5)
2/10/2003	2.3	0	Low Flow (0, 0, 0, 0)
7/12/2004	3.4	8.4	Unstable (56, 39, 22, 11)
10/10/2005	4.6	0	Low Flow (0, 0, 0, 0)
9/13/2006	4.1	0	Low Flow (0, 0, 0, 0)
8/13/2007	4.13	0.44	Low Flow, (2.7, 1.9, 1.0, 0.70)
6/15/2009	3.63	9.9	Unstable (0, 2, 27, 9)
8/31/2010	3.9	3.8	Unstable (25, 15, 8, 5)

SC586, Flow information for days preceding DO violations.

Sampling Date	DO Conc	Flow	Flow Comment (4 days Flow Preceding Sampling Date (cfs))
6/25/1990	4.9	23.5	Unstable*
8/27/1990	4.7	15	Unstable*
6/28/1994	3.9	16.947	Unstable*
7/25/1995	4.6	23.5	Unstable*
10/20/1998	1	2.5	Rising, Low Flow (1.6, 1.6, 1.4, 1.9)
7/11/2000	4.7	5.5	Unstable (57, 41, 20, 9.6)
7/10/2006	3.5	0	Low Flow (0, 0, 0, 0)
6/11/2007	4.79	0	Low Flow (0, 0, 0, 0.08)
11/3/2008	3.94	0	Low Flow (1.7, 0.95, 0.5, 0.24)
6/15/2009	3.54	16	Rising (0, 7.8, 2.7, 10)
8/31/2010	3.66	0.11	Unstable (3.4, 1.8, 0.88, 0.32)

* Estimated based on flow hydrograph for station SC585.