LOWER ARKANSAS RIVER BASIN TOTAL MAXIMUM DAILY LOAD

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

1. INTRODUCATION AND PROBLEM IDENTIFICATION

Subbasin: Little Arkansas

Counties: Harvey and Marion

HUC 8: 11030012

Ecoregion: Central Great Plains, Wellington-McPherson Lowland (27d), and Flint Hills (28)

Drainage Area: Approximately 95.2 square miles

Main Stem Segments: WQLS: **4** (Sand Cr) starting at the confluence with Little Arkansas River in southern Harvey County and traveling upstream to headwaters in south-western Marion County (**Figure 1**).

Tributary Segments: Mud Cr (16)
Beaver Cr (26)

Designated Uses: Expected Aquatic Life Support, Primary Contact Recreation "B" and Food Procurement Use for Main Stem Segment. Tributary segments designed uses are Expected Aquatic Life Support and Secondary Contact Recreation "b" for Mud and Beaver Creeks.

2002, 2004, 303(d) Listing: Lower Arkansas River Basin streams -- Sand Creek (Segment 4)

Impaired Use: Expected Aquatic Life Support

Water Quality Standard: In surface waters designated for the Aquatic Life Support, the concentrations of dissolved oxygen (DO) shall not be lowered by the influence of artificial sources of pollution. DO: 5 mg/L – Aquatic Life Support criteria are provided in table 1g of KAR 28-16-28e(d).

Nutrients – Narratives: The introduction of plant nutrients into streams, lakes or wetland from artificial sources shall be controlled to prevent the accelerated succession or replacement of aquatic

biota or the production of undesirable quantities or kinds of aquatic life (KAR 28-16-28e(c)(2)(A)).

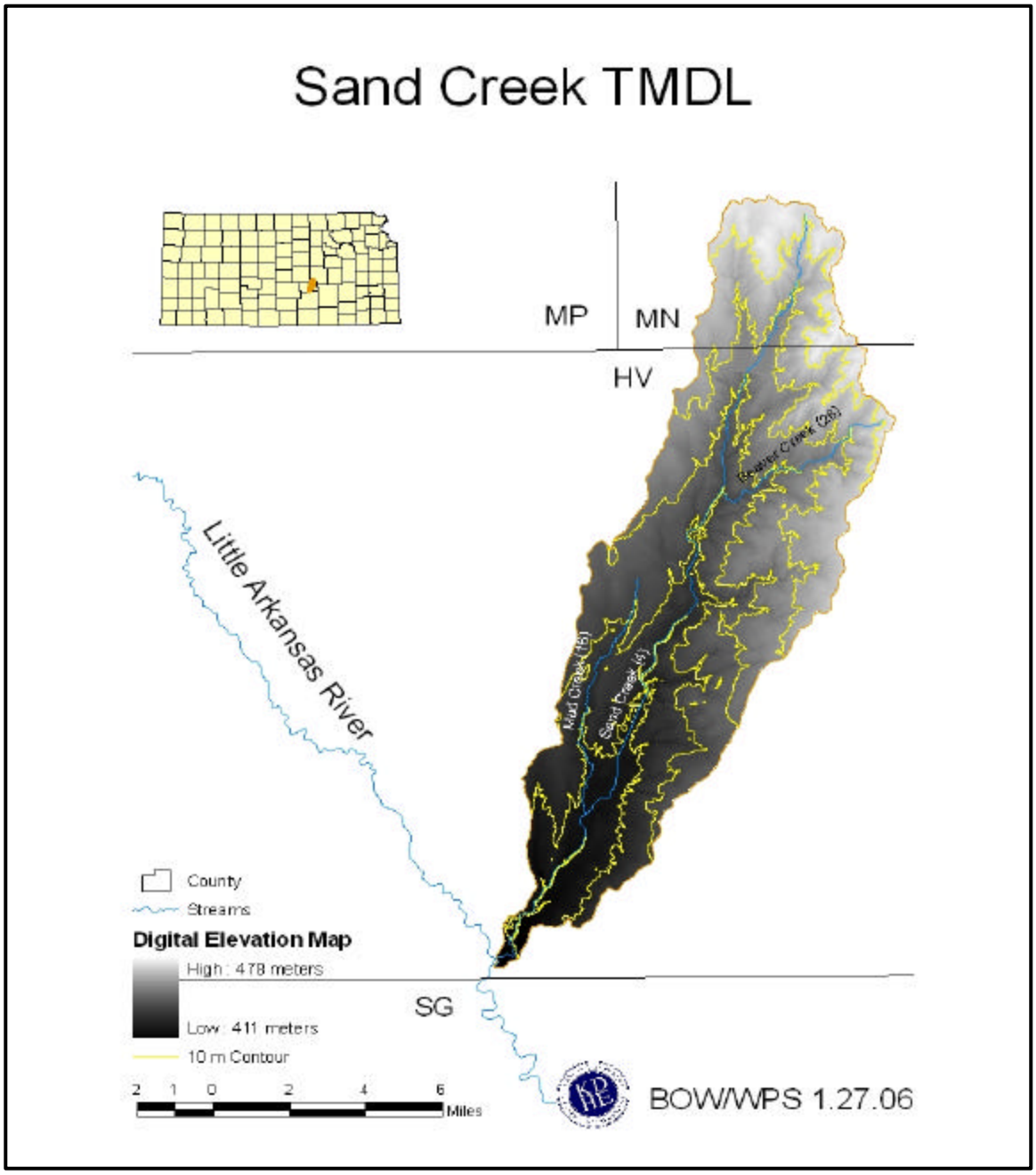

Figure 1. A DEM map of Sand Creek watershed.

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 2004 303(d): Not Supporting Aquatic Life

Monitoring Site: Ambient Stream Water Quality Monitoring Station (Site 535) near Newton.

Period of Record Used: 1990 – 2006 for Station/Site 535 (4-yr rotational monitoring site).

Flow Record: Little Arkansas River near the city of Newton (USGS Station 07143665; 1973 – 2006) and USGS Water Resources Investigation Report 01-4142 (Estimated Flow – Duration Curves for Selected Ungaged Sites in Kansas) were used to estimate flow in the Sand Creek watershed.

Long Term Flow Conditions: Median Flow = 7.8 cfs; 10% Exceedance Flow = 61.4 cfs, 95% Exceedance Flow = 3.5 cfs

Current Conditions: **Figure 2** and **Table 1** show monthly and seasonal average DO concentrations for KDHE ambient stream monitoring station Site 535, respectively. In general, seasonal average DO values were similar between spring (5.5 mg/L) and summer/fall (5.8 mg/L). The seasonal maximum concentrations were 7.5 mg/L in spring, 8.9 mg/L in summer-fall and 12.50 mg/L in winter.

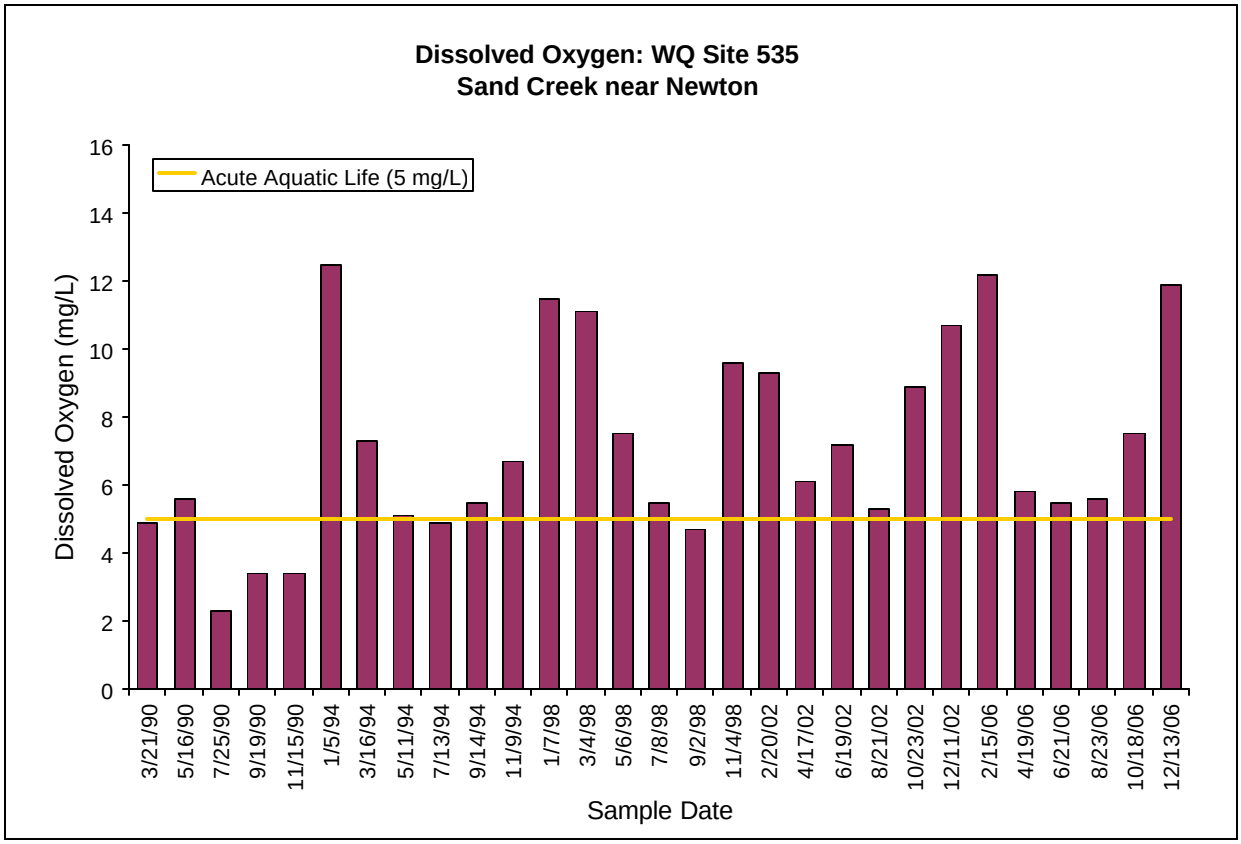

Figure 2. Dissolved oxygen concentrations at Site 535 during 1990 – 2006.

Table 1. Seasonal DO values at Site 535 during 1990 – 2006.

Parameter / Season	Average (median) (mg/L)	Standard Error (mg/L)	Minimum (mg/L)	Maximum (mg/L)
Spring	5.5 (5.6)	0.4	2.3	7.5
Summer-Fall	5.8 (5.5)	0.7	3.4	8.9
Winter	9.3 (10.2)	0.9	3.4	12.5

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. Sample data for the sampling sites were categorized for each of the three defined seasons: Spring (Apr – Jul), Summer-Fall (Aug – Oct) and Winter (Nov – Mar). High flows and runoff equate to lower flow durations; baseflow and point source influences generally occur in the 75-99% range. Historic excursions from water quality standards (WQS) are seen as plotted points *below* the 5 mg/L curve. Water quality standards are met for those points plotting *above* the 5 mg/L curve (**Figure 3**).

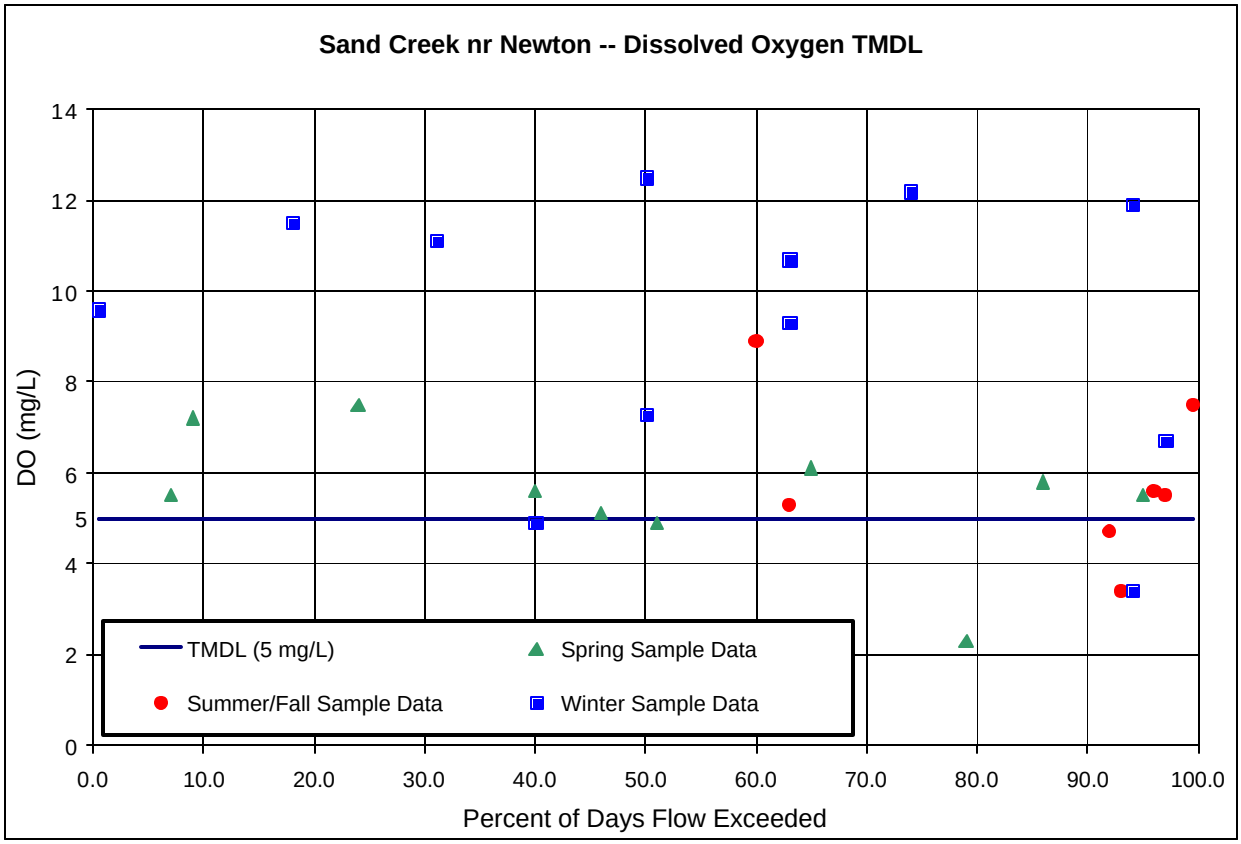

Figure 3. Dissolved oxygen concentrations at Site 535 during 1990 – 2006.

There were a total of six DO excursions (or violations) recorded during the period from 1990 – 2006 (**Table 2**). The percentage of DO exceedance over the criteria in the summer/fall months was about 29%, whereas relatively low DO exceedances occurred in the spring (20%) and winter months (17%). Over the period of all the ambient water quality records, most of the DO exceedance incidences (83%) occurred during the flow conditions ranging between 50-100% flow exceedance.

Table 2. Number of samples below the Aquatic Life Criteria (5 mg/L) by flow exceedance.

Flow / Season	Number of samples above the Aquatic Life Criterion						
	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum. Freq
Spring	0	0	0	1	1	0	2/10 = 20%
Summer/Fall	0	0	0	0	0	2	2/7 = 29%
Winter	0	0	1	0	0	1	2/12 = 17%

A watershed comparison approach was taken in developing this TMDL. The Emma Creek watershed has similar land use characteristics to the Sand Creek watershed, is of similar size and is located west of the Sand Creek watershed in the Little Arkansas River Basin. The relationship of DO to biochemical oxygen demand (BOD), ammonia, nitrate, total phosphorus (TP), total suspended solids (TSS) and water temperature were used in the comparison. **Table 3** summarizes those water quality data for the samples taken on the same day for the two sites of interest. With the exception of nitrate and TP, the average ammonia, BOD and water temperature values measured at Site 535 were similar as compared to those at Site 534. However, BOD at Sand Creek averaged 6.8 mg/L during the six DO excursions, about 69% higher than the overall average on Emma Creek and 36% higher than the overall average on Sand Creek. The Emma Creek only averaged 3.7 mg/L of BOD during the same period. Though the impaired DO values were closely associated with high BOD readings at Site 535, nutrients (e.g., ammonia, nitrate and TP), in particular, and other natural factors (e.g., low flow and high temperature) may also play an important role that led to the DO excursions or violations.

Table 3. Comparison summary of percent of flow exceedance and selected water quality parameters for Sites 535 and 534 during the period from 1990 to 2006. ND indicates the parameter levels not detected by their associated laboratory instruments. The overall average values calculated using the half of the instrument detection levels for ND values.

Date	% flow	DO		BOD		Ammonia		Nitrate		Total P		TSS		Temperature	
	Exceed	535	534	535	534	535	534	535	534	535	534	535	534	535	534
3/21/1990	**40.0**	**4.9**	**8.6**	**10.3**	**4.1**	**0.87**	**0.44**	**4.99**	**1.04**	**2.40**	**1.85**	**27**	**72**	**10**	**9**
5/16/1990	40.0	5.6	3.4	6.3	13.6	0.06	0.49	0.58	2.50	2.07	2.01	100	240	18	20
7/25/1990	**79.0**	**2.3**	**5.2**	**9.1**	**2.9**	**0.67**	**0.02**	**2.77**	**0.06**	**2.95**	**0.91**	**64**	**34**	**22**	**20**
9/19/1990	**93.0**	**3.4**	**6.3**	**9.8**	**4.4**	**0.94**	**0.08**	**3.79**	**0.01**	**1.74**	**0.87**	**92**	**48**	**18**	**16**
11/15/1990	**94.0**	**3.4**	**6.4**	**4.3**	**2.0**	**0.34**	**0.03**	**5.19**	**0.00**	**4.54**	**0.75**	**19**	**16**	**9**	**10**
1/5/1994	50.0	12.5	12.5	2.4	1.9	0.05	ND	8.84	1.58	1.64	0.21	2	2	0	0
3/16/1994	50.0	7.3	7.9	5.7	5.0	0.12	0.08	4.57	0.30	1.94	0.58	29	13	7	7
5/11/1994	46.0	5.1	5.8	9.2	7.3	0.07	0.55	13.09	0.56	2.05	0.90	72	72	16	16
7/13/1994	**51.0**	**4.9**	**6.4**	**4.5**	**5.6**	**0.04**	**0.08**	**6.00**	**0.62**	**1.67**	**0.78**	**96**	**168**	**22**	**21**
9/14/1994	97.0	5.5	4.3	3.1	4.2	ND	0.18	14.29	0.07	3.40	0.93	40	76	22	19
11/9/1994	97.0	6.7	7.1	2.4	5.5	ND	0.11	10.82	0.04	2.97	0.72	29	32	9	6
1/7/1998	18.0	11.5	11.9	4.1	2.9	0.13	0.09	2.99	3.20	0.56	0.47	28	35	2	2
3/4/1998	31.0	11.1	12.4	5.5	2.2	ND	0.05	3.54	1.49	0.90	0.40	20	4	4	3
5/6/1998	24.0	7.5	8.0	5.2	3.7	0.18	0.04	3.32	2.33	0.87	0.53	76	60	18	17
7/8/1998	7.0	5.5	6.1	4.2	4.4	ND	0.09	1.27	1.02	0.74	0.94	155	430	28	26
9/2/1998	**92.0**	**4.7**	**6.2**	**2.6**	**3.0**	**0.05**	**0.03**	**12.48**	**0.21**	**3.20**	**0.63**	**56**	**96**	**24**	**24**
11/4/1998	0.5	9.6	9.7	ND	ND	ND	0.02	1.59	1.85	0.58	0.51	152	82	10	10
2/20/2002	63.0	9.3	11.5	4.0	1.9	0.08	0.02	9.79	0.91	2.07	0.28	14	9	9	9
4/17/2002	65.0	6.1	7.6	5.5	4.3	ND	0.63	9.30	0.49	2.00	1.12	38	41	20	21
6/19/2002	9.0	7.2	7.1	5.0	4.7	ND	0.10	0.85	0.66	0.79	0.66	93	67	22	22
8/21/2002	63.0	5.3	6.6	5.9	4.9	ND	0.12	8.37	0.13	3.96	0.88	51	35	25	25
10/23/2002	60.0	8.9	9.9	4.2	2.9	ND	ND	11.07	1.28	2.72	0.44	21	60	10	9
12/11/2002	63.0	10.7	11.9	3.3	1.6	ND	ND	7.41	0.58	1.70	0.43	10	5	5	5
2/15/2006	74.0	12.2	12.3	2.6	1.4	ND	ND	9.57	0.52	2.46	0.44	11	10	5	5
4/19/2006	86.0	5.8	7.9	5.6	4.1	ND	ND	4.61	ND	2.40	1.10	20	5	15	14
6/21/2006	95.0	5.5	7.5	5.8	4.4	0.11	ND	2.52	ND	1.50	1.34	43	15	24	24
8/23/2006	96.0	5.6	-	5.7	-	ND	-	6.20	-	2.36	-	47	-	25	-
10/18/2006	99.5	7.5	-	4.8	-	ND	-	11.06	-	3.50	-	41	-	13	-
12/13/2006	94.0	11.9	-	2.8	-	ND	-	12.51	-	3.18	-	12	-	5	-
Exceed. Ave		*3.9*	*6.5*	*6.8*	*3.7*	*0.49*	*0.11*	*5.87*	*0.32*	*2.75*	*0.97*	*59*	*72*	*18*	*17*
Overall Ave		*7.2*	*8.1*	*5.0*	*4.0*	*0.15*	*0.13*	*6.67*	*0.82*	*2.17*	*0.80*	*50*	*66*	*14*	*14*

Desired Endpoint of Water Quality at Sand Creek:

The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standard of 5 mg/L in order to fully support Aquatic Life. 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 and fall seasons (**Table 2**). As indicated earlier, while BOD is not considered a single dominant factor leading to the DO excursions at Site 535, it has been evaluated during low DO periods and the BOD target will be to maintain the historical range of a 4-5 mg/L BOD associated with adequate DO on Sand Creek at Site 535. State Nutrient Reduction Goals (TN = 8 mg/L and TP =1.5 mg/L) will be also used to ensure stream DO levels about the aquatic life support standard.

3. SOURCE INVENTORY AND ASSESSMENT

NPDES: Though there are eleven NPDES permitted facilities within the watershed (**Figure 4**), only two municipal wastewater treatment plants (Newton and Walton) discharge to Sand Creek and contribute significant nutrient loads that could affect downstream water quality at Site 535 (**Table 4**). The Newton – Sand Creek facility, upgraded in 1993, relies on a trickling filter followed by an activated sludge process treatment system to treat its wastewater with a nitrification process and is considered the primary nutrient source to Sand Creek. The plant uses a cascade re-aeration wall to oxygenate its effluent. The design flow of this treatment plant is 3 MGD (4.67 cfs). Monthly maximum permit limits for discharging BOD during 2005 – 2007 are 30 mg/L during December and January, and 25 mg/L during February, March and November, and 20 mg/L for the warm season from April through October. The selected effluent seasonal water quality values are shown in **Table 5**. The Walton – Sand Creek facility uses a three cell wastewater stabilization lagoon system, with a design flow of 0.0379 MGD (0.059 cfs), to treat its wastewater from 284 people according to the 2000 U.S. Census data. The BOD limit for Walton is 30 mg/L. All facilities are listed in **Appendix A**.

Table 4. Characteristics of municipal permitted wastewater treatment plants located upstream from Site 535 in the Sand Creek Watershed.

WWTP	Permit #	Stream Reach	Segment	Design Flow	Type	Permit Expired
Newton	M-LA13-IO01	Sand Creek	4	3.00 mgd	Trickling Filter	12–31–2007
Walton	M-LA17-OO01	Sand Creek	4	0.0379 mgd	3-Cell Lagoon	7–31–2007

Table 5. Seasonal summary of selected effluent water quality parameters measured at Newton – Sand Creek wastewater treatment facility during the period from 2000 to 2006.

Newton WWTP facility	Maximum	Average (Median)	Minimum
Spring (Apr-Jul)			
DO (mg/L)	9.20	7.92 (7.90)	6.50
BOD (mg/L)	7.14	3.13 (3.23)	1.00
TN (mg/L)	26.54	17.91 (18.05)	9.21
Ammonia (mg N/L)	1.75	0.13 (0.02)	0.01
Nitrate (mg N/L)	24.40	15.85 (15.70)	7.40
TP (mg/L)	4.75	3.12 (3.35)	0.50
Summer/Fall (Aug-Oct)			
DO (mg/L)	8.60	7.42 (7.45)	6.00
BOD (mg/L)	11.37	2.87 (2.41)	1.00
TN (mg/L)	28.89	19.20 (19.48)	10.78
Ammonia (mg N/L)	4.10	0.30 (0.03)	0.01
Nitrate (mg N/L)	26.40	16.48 (16.60)	5.05
TP (mg/L)	4.45	3.61 (3.87)	2.13
Winter (Nov-Mar)			
DO (mg/L)	9.80	8.62 (8.70)	6.50
BOD (mg/L)	10.94	4.31 (3.86)	1.00
TN (mg/L)	26.85	18.34 (17.23)	10.02
Ammonia (mg N/L)	14.35	0.75 (0.08)	0.01
Nitrate (mg N/L)	23.80	15.81 (15.95)	8.40
TP (mg/L)	6.07	3.99 (4.03)	1.92

Results of stream water quality analysis indicated that DO levels were associated with BOD and ammonia concentrations in the stream. Dissolved Oxygen levels were consistently near or below 5 mg/L when BOD (**Figure 5**) and ammonia (**Figure 6**) concentrations passed the threshold values of 8.5 mg/L and 0.3 mg N/L, respectively, but varied highly with temperature (**Figure 7**), TSS (**Figure 8**) and flow conditions when BOD and/or ammonia concentrations were below the threshold values. To assist identifying seasonal DO patterns associated with nutrients in the Sand Creek, locally weighted scatterplot smooth (LOWESS) technique was utilized in the data analyses. LOWESS is a fitting technique, similar to the moving average in time series analysis, which uses a linear regression equation for generating a smoothing curve to a dataset that contains a large degree of noisy signals. As indicated in **Figure 8**, under low flow conditions (TSS < 60 mg/L), DO concentrations appeared to be negatively associated with TSS values, suggesting that if the organic material comprises a large part of TSS, DO values will be lowered. However, four of the six violations are associated with low flow (75% exceedance flow). Similarly, four of the violations are associated with high temperature values (>18°C). Thus, TSS generally is a poor indicator of low DO. Since the design flow of Newton wastewater treatment plant dictates the critical flow condition exceeded 75% of the time seen at Site 535, the extent of DO excursions was primarily driven by the nutrient and BOD levels from the Newton's effluent, and influenced by flow and temperature conditions.

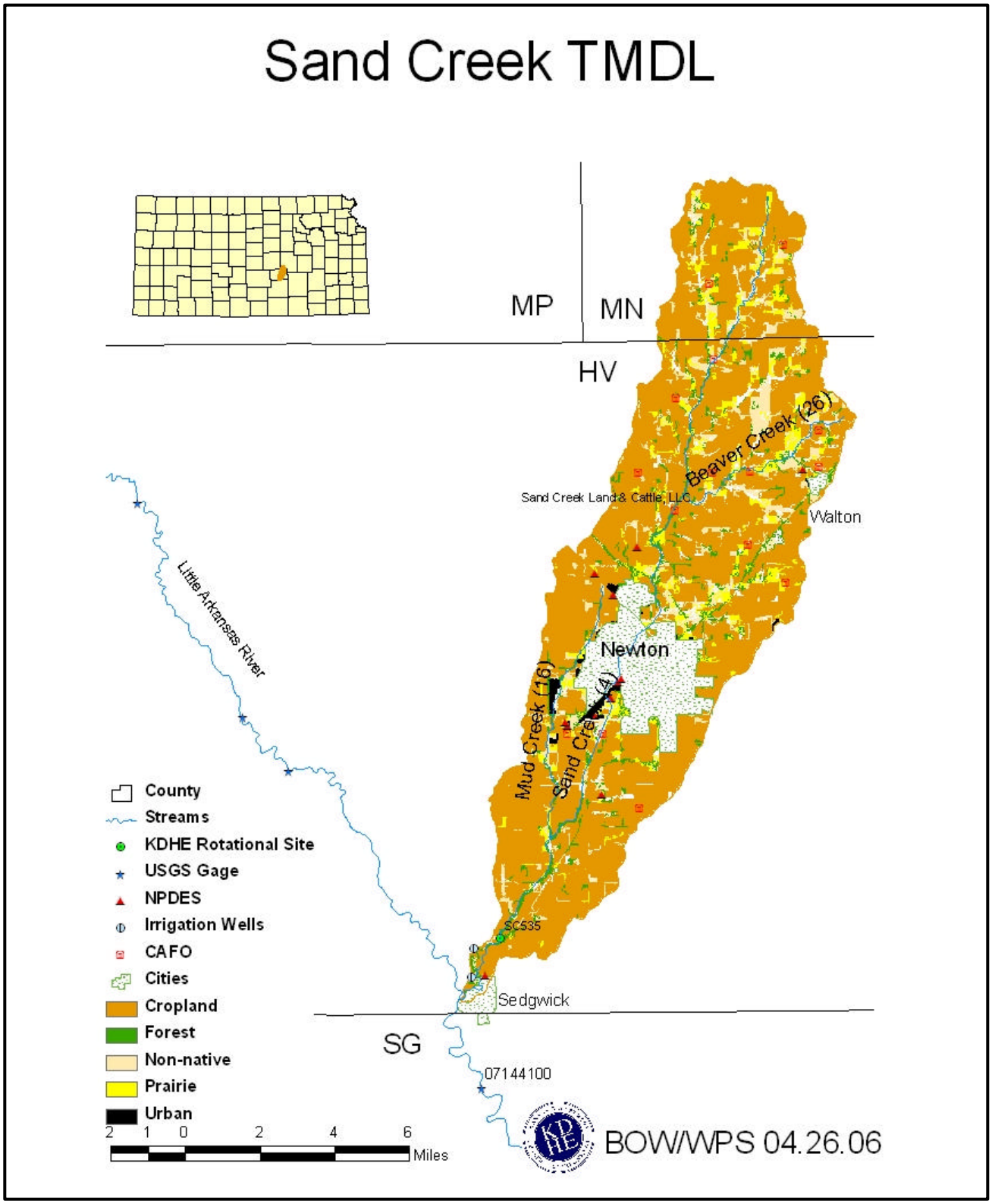

Figure 4. A watershed map of Sand Creek.

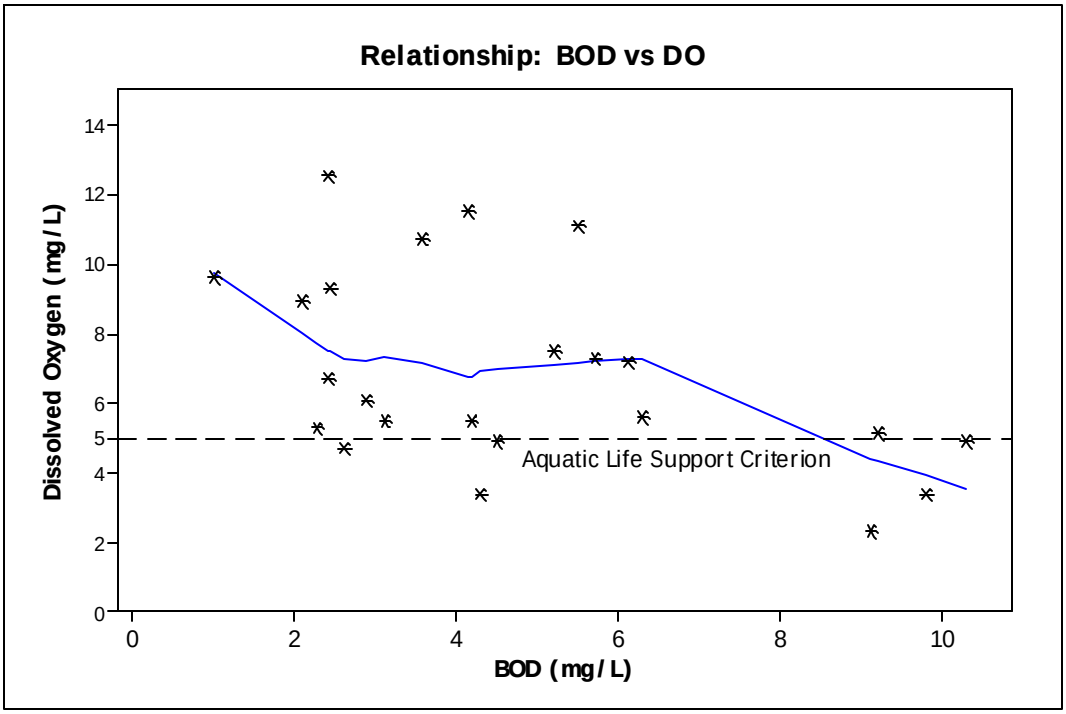

Figure 5. BOD – DO relationship at Site 535 during the period from 1990 to 2002.

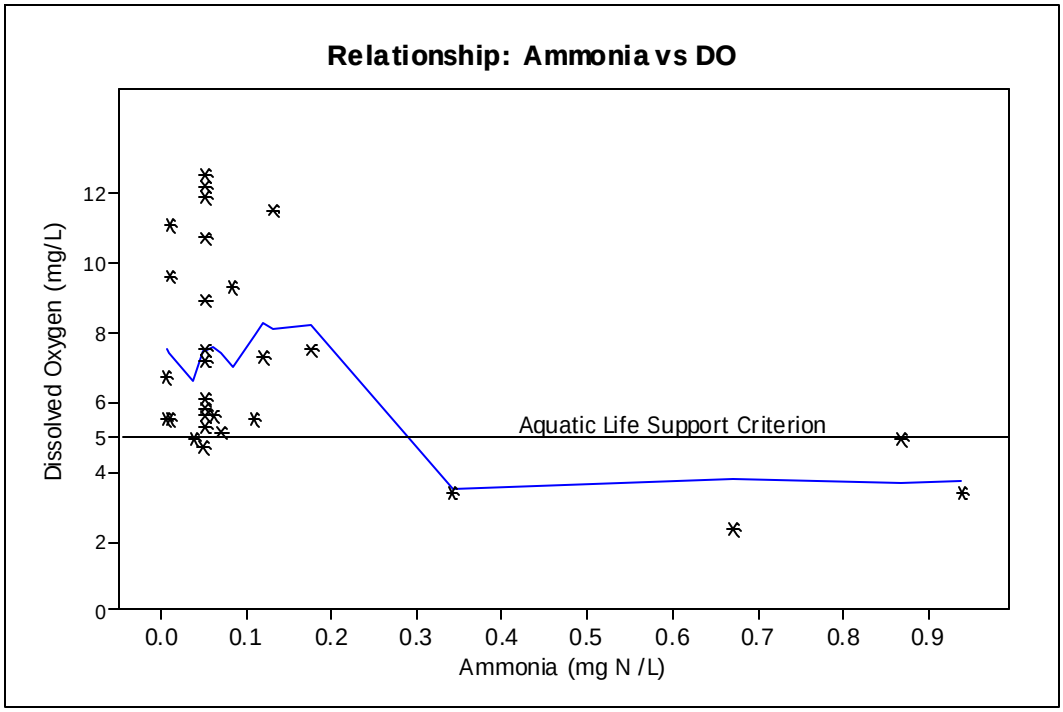

Figure 6. Ammonia – DO relationship at Site 535 during 1990 – 2006.

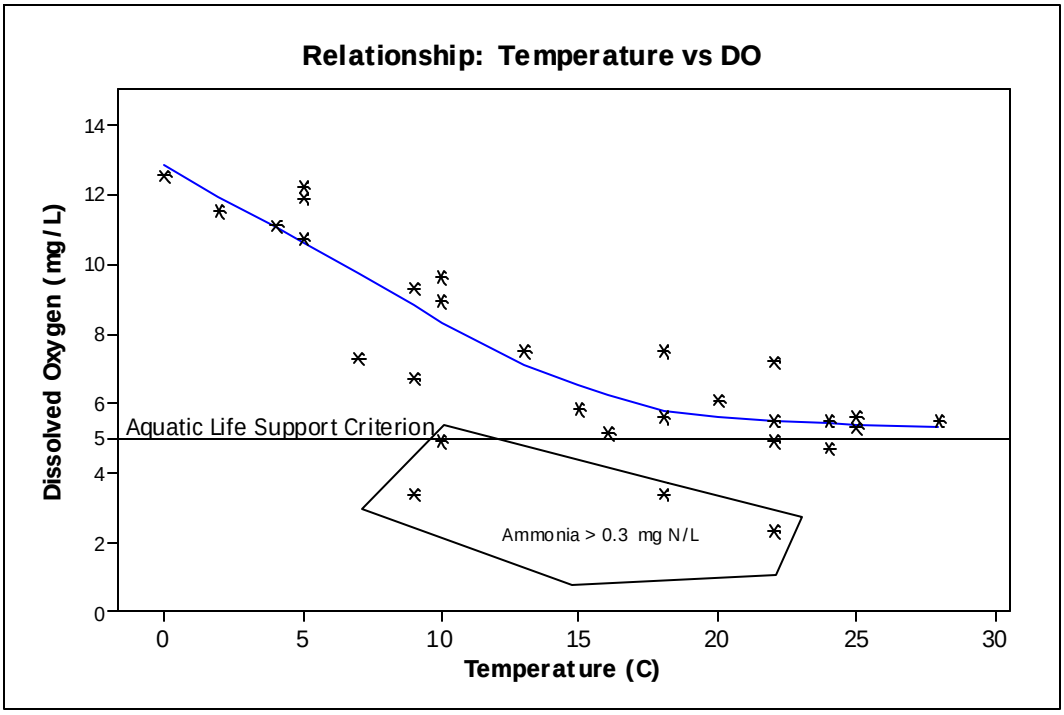

Figure 7. Temperature – DO relationship at Site 535 during 1990 – 2006.

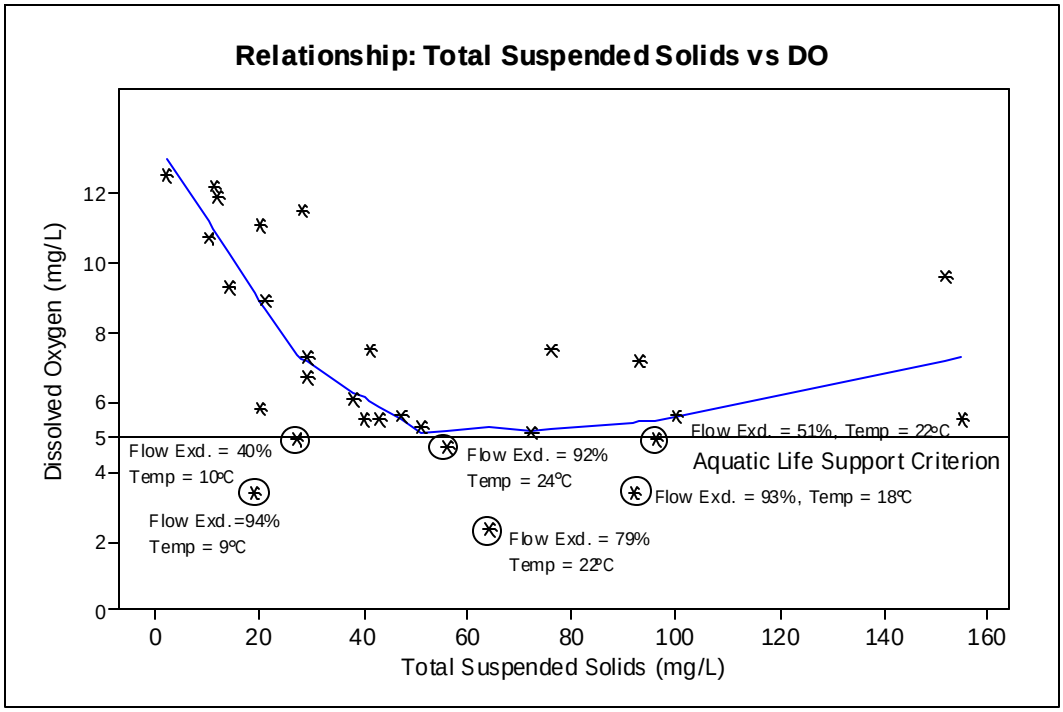

Figure 8. TSS – DO relationship at Site 535 during 1990 – 2006.

Figures 9 and 10 illustrate nitrate and TP relationships with DO, respectively. As indicated in **Figure 9**, when nitrate levels are high, DO values are high. High nitrate concentrations do not contribute to low DO values. However, when TP concentrations exceed 1.5 mg/L, in concert with other factors such as flow and temperature, can lead to low DO values (**Figure 10**).

Nutrient reduction plans that lead to upgrade of Newton's wastewater treatment plant will result in TP concentrations below 1.5 mg/L, and secondarily, improve DO conditions over 5 mg/L. Detailed nitrate information is shown in Sand Creek's Nitrate TMDL document.

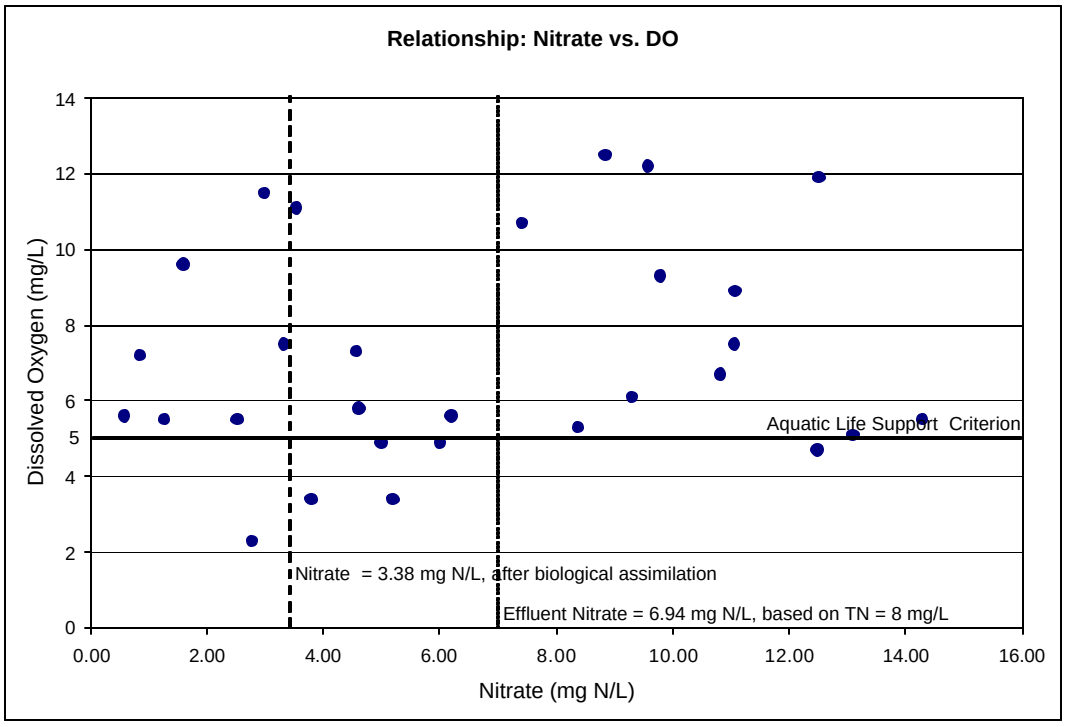

Figure 9. Nitrate – DO relationship at Site 535 during the period from 1990 to 2006.

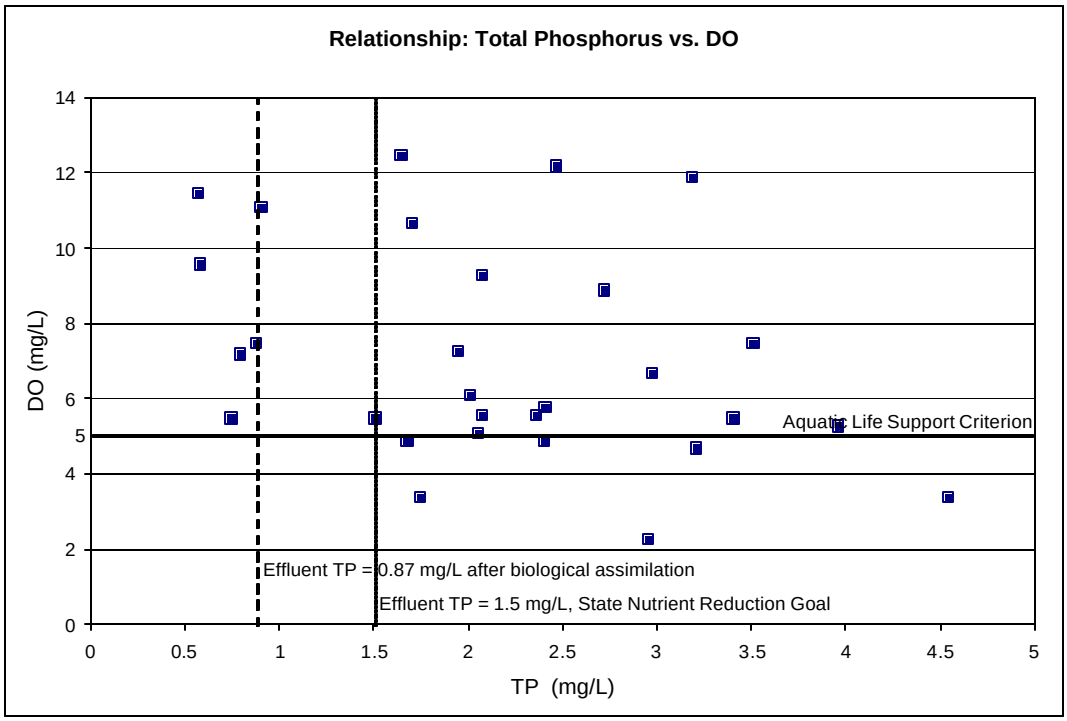

Figure 10. TP – DO relationship at Site 535 during the period from 1990 to 2006.

Land Use: The predominant land use is cultivated cropland, which accounts for 70% of the total land area in the watershed. Urban area, such as residential, commercial and industrial uses, comprises 7% of the watershed. Approximately 3% of the land is occupied by Ash-Elm Hackberry floodplain forest, whereas 6% is tall grass prairie. The area under the Conservation Reserve Program (CRP) only accounts for about 4% (2,207 acres) of the entire watershed. There are about 3,612 acres of riparian area (30-meter buffer along the stream system) in the watershed and the cropland occupies 41% of the total riparian buffer area. Ash-Elm Hackberry floodplain forest, mix prairie and non-native grassland account for about 9%, 2% and 8%, respectively. Urban areas occupy another 5% of the riparian area and approximately 6% of the stream buffer area is CRP (205 acres). The riparian-related land use information was derived from KDHE rivershed data.

Livestock Waste Management Systems: Fifteen confined animal feedlot operations are registered, certified or permitted within the watershed. Four of these facilities (2 beef, 1 swine and 1 dairy) are located within the 30-meter buffer area along streams (**Table 6**), two of which are located along Sand Creek (**Figure 4**). One facility (Permit No. A-LAHV-C004) is of sufficient size to warrant NPDES permitting. The permitted livestock facilities have waste management systems designed to minimize runoff entering their operation or detain 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 streamflow that exceeds less than 1-5% of time. Therefore, events of this type, higher flows that are infrequent and of short duration, are not the types of flows associated with nitrate (and/or ammonia) excursions in the Sand Creek watershed. Requirements of maintaining the water level of a waste lagoon at a sufficient depth (e.g., 6 ft) below the lagoon berm ensures retention of the runoff from such intense, local storm events. Though the total potential animals are 5,980 heads in the watershed, of which 3,580 heads are within the 30-meter riparian buffer area. However, the actual number of animals is typically less than the potential number.

Table 6. Characteristics of four animal feedlot operations in Sand Creek Watershed.

Permit #	Stream Segment	Type	Head
A-LAHV-C004†	Sand Creek	Beef	2,000
A-LAHV-SA06†	Sand Creek	Swine	200
A-LAHV-BA17	Unnamed tributary to Sand Cr.	Dairy	980
A-NEMN-BA32*	Unnamed tributary to Sand Cr.	Beef	400

*(Note: † indicates the animal feedlot operations are located within the 30-meter riparian buffer from the stream main stems. * Although identified as a Neosho Basin facility, any discharge from the facility would flow to Sand Creek.)*

On-Site Waste Systems: According to the 2000 census data from the U.S Census Bureau, the population of the entire watershed was 21,413 people, of which 17,190 people live within the city limits of Newton. As a results, the watershed population density is relatively high (206 people/sq. mile) when compared to the density of Harvey County (61 people/sq. mile). County-wise estimation indicates that the population has increased by approximately 15% since 1990 (**Table 7**). Based on the 1990 census data, about 15% of the households in Harvey County are on septic systems. Though many houses are currently connected to a public sewage system,

failing on-site systems can contribute significant nitrogen (ammonia and nitrate) loadings, given the low flows associated with the excursions in the watershed.

Table 7. Summary of urban and rural community comparisons between 1990 and 2000 for Harvey County (the decennial data was from the U.S. Census Bureau).

Type	Description	1990[†]	2000
Urban	Inside urbanized areas	0	0
	Inside urban clusters (Outside urbanized areas[†])	19,712	22,599
Rural	Farm	1,739	1,461
	Non-farm	9,577	8,089

Contributing Runoff: The Little Arkansas River Basin's average soil permeability is 2.8 inches/hour according to NRCS STATSGO data base. About 82% of the watershed produces runoff even under relative low (1.5"/hr) potential runoff conditions. Under very low (< 1"/hr) potential conditions, this potential contributing area is greatly reduced (74%). Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeabilities. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing less than 0.5"/hr of rain will generate runoff from only 4% of this watershed, chiefly along the stream channels.

Background Levels: Some organic enrichment may be associated with environmental background levels, including contributions from wildlife and streamside vegetation, but it is likely that the density of animals such as deer is fairly dispersed across the watershed and that the loading of oxygen demanding material is constant along the stream. In the case of wildlife, this loading should result in minimal loading to the streams below the levels necessary to violate the water quality standards. DO demanding loading will be greater in the streams if streamside vegetation contains a larger portion of forests in the watershed due to input of organic materials such as woody debris and leaves.

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

BOD is a measure of the amount of oxygen required to stabilize organic matter in a stream. As such, BOD is used as a benchmark measure to anticipate DO levels while it measures the total concentration of DO that will be demanded as organic matter degrades in a stream. As mentioned earlier in Section 3, the DO excursions were associated with wastewater BOD and nutrient levels from the Newton wastewater treatment plant along with flow and temperature. The plant completed its upgrade in 1993, and since then no BOD levels greater than 8 mg/L have been recorded at Site 535 (**Table 3**). However, nutrients (i.e., nitrate and TP) remain in excess levels that affect stream DO concentrations. Though it is presumed that the maintenance of historical BOD loads will reduce DO excursions under certain critical flow conditions, nutrients, particularly TP, should be also regulated to ensure DO values above 5 mg/L.

Point Sources: Point sources are responsible for maintaining their systems in proper working condition and appropriate capacity to handle anticipated wasteloads of their respective populations. The State and NPDES permits will continue to be issued at 5 year intervals, with inspection and monitoring requirements and conditional limits on the quality of effluent released from these facilities. Ongoing inspections and monitoring of the systems will be made to ensure that minimal contributions have been made by this source.

As indicated earlier in Section 3, low flow is one of the primary factors causing the occasional excursions from the water quality standard, and BOD and nutrients have been also seen as significant sources of DO excursions. Streeter-Phelps analysis indicates the present 20 mg/L of BOD permit limit (warm season) set at Newton's wastewater treatment plant maintains DO levels above 5 mg/L in the stream based on the Newton's average DO (7.7 mg/L) and stream temperature (25°C) (**Appendix B** - Streeter-Phelps analysis). Likewise, the present 30 mg/L of BOD cold season limit at the plant also maintains DO levels above 5 mg/L in the stream. Therefore, it is assumed that these BOD limits correspond to maintaining the historical average BOD concentration of 5.0 mg/L or less at monitoring Site 535 across the defined flow condition and achieves the Aquatic Life Support Criterion of DO of 5 mg/L.

The combined design flow of the Newton and Walton (4.70 cfs) redefine the lowest flow seen at Site 535 (75% exceedance). **Figure 11** illustrates Newton and in-stream Wasteload Allocation (WLA). The average effluent BOD concentration for the Newton plant during the period of 2000 – 2006 was 4.98 mg/L, ranging from 2.77 mg/L for the summer/fall and 4.20 mg/L for the winter months. The WLAs for the city of Newton are set to 501.2 lbs/day BOD for Apr – Oct (warm weather), 626.5 lbs/day BOD for Feb, Mar and Nov, and 751.8 lbs/day for Jan and Dec. These seasonal WLAs at Newton's wastewater treatment plant result in the in-stream WLA of 125.3 lbs/day BOD (**Figure 11**).

The Kansas Surface Water Nutrient Reduction Plan calls for nutrient reduction in total nitrogen and phosphorus for major dischargers (> 1 MGD) through installation of Biological Nutrient Removal (BNR) technology at the treatment plants. The expectation of using BNR is to achieve an annual average effluent value of 8 mg N/L of TN and 1.50 mg/L of TP. The average nitrate level in Newton effluent over 2000 – 2006 was 15.99 mg N/L, total Kjeldahl nitrogen levels averaged 2.38 mg/L, and TP values averaged 3.60 mg/L.

The BNR nutrient reduction to 8 mg/L of TN equates to a 57% reduction, which at worst would have 6.94 mg N/L of nitrate (and 0.02 mg N/L of nitrite). BNR nutrient reduction to 1.5 mg/L of TP also equates to a 58% reduction from the current conditions. Therefore, the wasteload allocation of 174.0 lbs N/day (**Figure 12**) and 37.6 lbs P/day (**Figure 13**) should be assigned to Newton at the outfall of its Sand Creek plant. Because there are hydrologic influence and downstream assimilation of nitrogen that occurs along the lower reach of Sand Creek below the treatment plant, the expected nitrate level at Site 535, after receiving the effluent nitrate concentration of 6.94 mg N/L upstream 12.5 miles, is estimated to be reduced 49% to 3.38 mg N/L. Likewise, the expected total phosphorus level at Site 535, after receiving the effluent TP concentration of 1.50 mg P/L upstream 12.5 miles, is estimated to be reduced 58% to 0.87 mg P/L. The instream wasteload allocation for nitrate and TP at the monitoring station are 84.7 lbs N/day and 21.8 lbs P/day, respectively. These wasteload allocation calculations are strictly based on the design flow (4.64 cfs) of the Newton wastewater treatment plant. Wasteload allocations of 2.2 lbs N/day and 0.6 lbs P/day for Walton WWTP are calculated based on its designed flow (0.0379 MGD) and average TN concentration (7 mg/L) and TP values (2 mg/L) for lagoon systems in Kansas and assuming all TN is nitrate (**Appendix A,** written communication with Mike Take, BOW, KDHE). These wasteloads, upstream of Newton, are assumed to be assimilated before reaching Site 535.

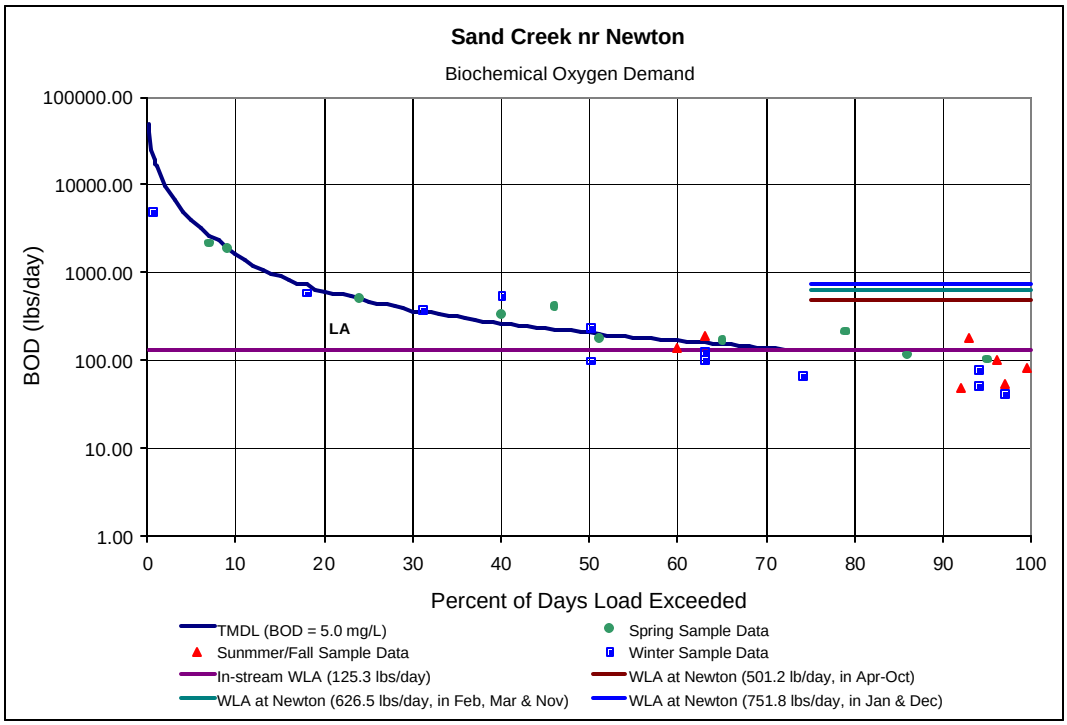

Figure 11. BOD TMDL and its load allocation components as well as seasonal loading at Site 535 during 1990 – 2006 (LA represents load allocation).

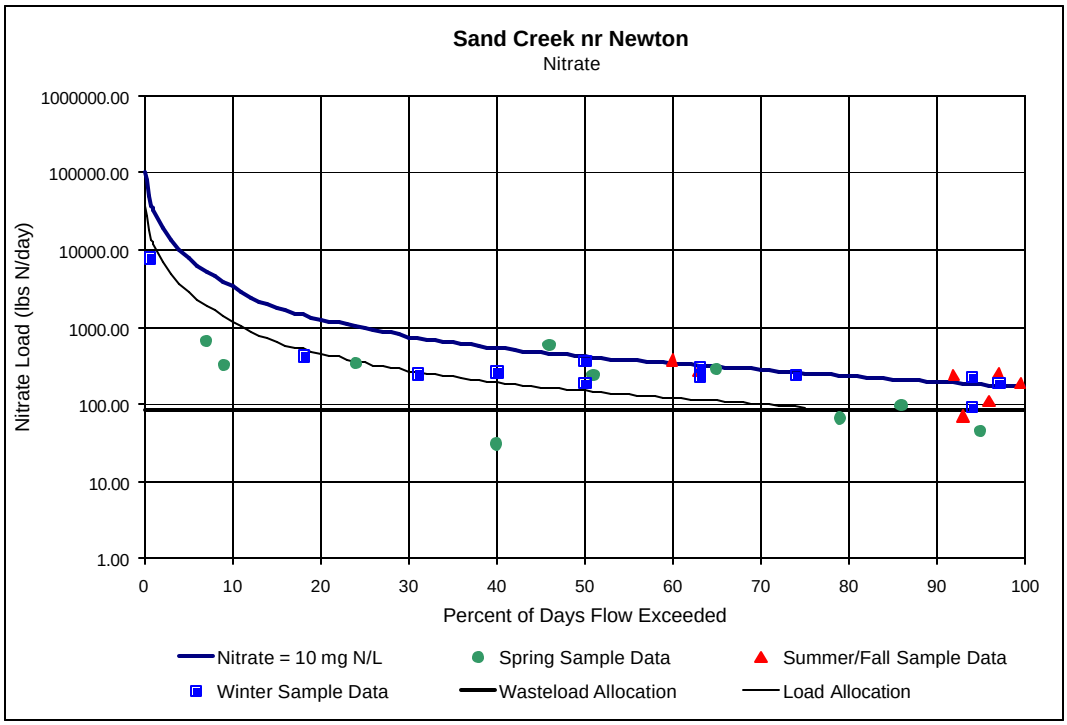

Figure 12. Nitrate wasteload and load allocation at Site 535 during 1990 – 2006.

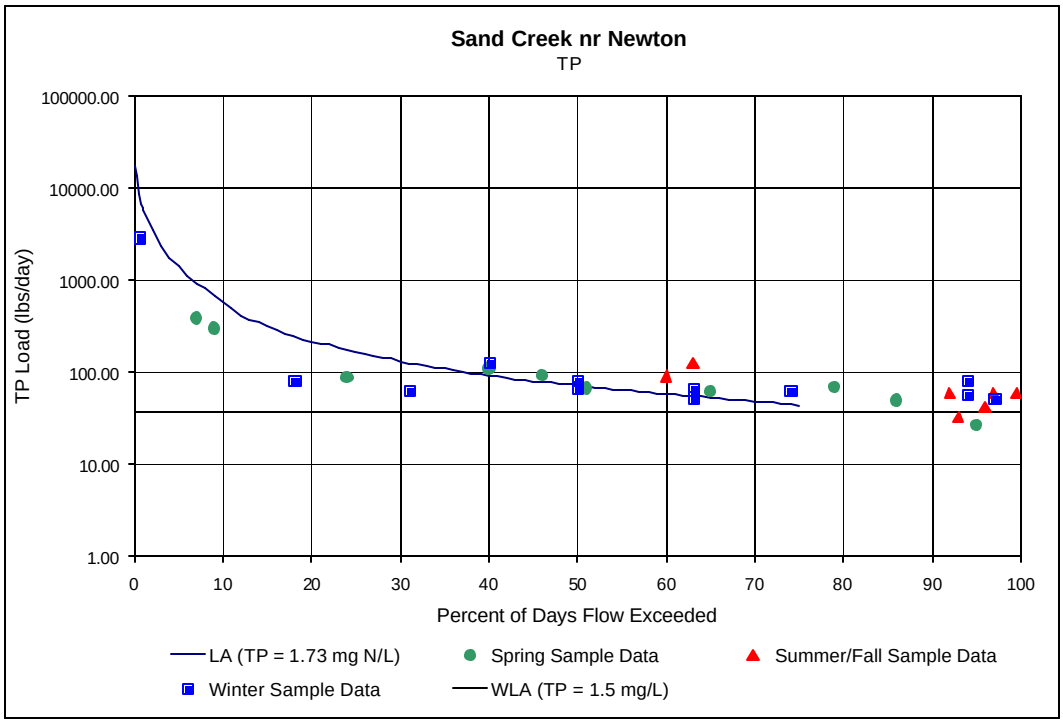

Figure 13. TP wasteload and load allocation at Site 535 during 1990 – 2006.

Non-Point Sources: Low flow is an important driving factor that causes a majority of the excursions from the water quality criterion. BOD, nitrate, and TP input from non-point sources are not seen as significant sources of DO excursions in the watershed. Thus, the Load Allocation assigns responsibility for maintaining the historical runoff average in-stream BOD, nitrate and TP levels at Site 535 to 4.94 mg/L, 3.58 mg/L, and 1.73 mg/L for flows greater than 4.64 cfs (0 – 74% exceedance), respectively. These LAs equal zero for flows from 0 – 4.64 cfs (75 – 99 % exceedance), since the flow at this flow condition is entirely effluent created, and then increase to the TMDL curve with increasing flow beyond 4.64 cfs. The Load Allocation at 50%, 25%, and 10% exceedance flow are 210.4 lbs/day, 477.2 lbs/day and 1656.5 lbs/day for BOD, 150.7 lbs N/day, 341.7 lbs N/day and 1186.1 lbs N/day for nitrate, and 72.8 lbs/day, 165.1 lbs/day, and 573.2 lbs/day for TP, respectively (**Figures 11, 12, and 13**).

Defined Margin of Safety: The Margin of Safety will be implicit based on conservative assumptions used in the permitting of the point source discharges including coincidence of low flow with maximum discharge from the treatment plant, BOD, nutrients, temperature of the effluent, adequate stream velocity and the better than permitted performance of the treatment plant in producing effluent with BOD, nitrate and TP well below the targets under critical seasonal conditions.

State Water Plan Implementation Priority: Because this watershed had indicated few problems recently with DO and may have been wholly addressed by upgrades to Newton's wastewater facility, this TMDL will be a Medium Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Little Arkansas Basin (HUC 8: 11030012) with a priority ranking of 14 (High Priority for restoration work).

5. IMPLEMENTATION

Desired Implementation Activities

1. Newton's permit compliance in removing BOD materials.
2. Upgrade operations at the Newton wastewater treatment facility to reduce nutrient loads in its effluent discharging to Sand Creek.
3. Abate any agricultural non-point source or urban storm-water contribution of nutrients to Sand Creek.

Implementation Programs Guidance

NPDES - Municipal Program – KDHE

a. Ensure compliance with BOD limits by Newton and Walton.
b. Issue renewed NPDES permit for Newton with schedule of compliance directing any operational training on treatment plant upgrades, including biological nutrient removal, that are necessary to reduce long-term, average nitrogen and TP loading in order to meet water quality standards.
c. Evaluate influence of nutrient levels in Newton wastewater on downstream nutrient levels monitored at Station 535.
d. Once, treatment upgrades are in place and operating, establish an average annual limit of 8 mg/L for total nitrogen and 1.5 mg/L for TP for the Newton – Sand Creek plant.
e. Review and approve necessary plans and specifications for treatment plant upgrades in order to achieve nutrient reduction.

Time frame for Implementation: The year 2008 marks the renewal period for the NPDES permit at the Newton facility. At that point in time, a schedule of compliance will be issued to establish timelines necessary for plant upgrades to meet final total nitrogen and phosphorus limits in 2015.

Targeted Participants: City of Newton.

Milestone for 2011: The year 2011 marks the third cycle of TMDL development in the Lower Arkansas River Basin. At that point in time, any necessary plant upgrades should be planned for construction.

Delivery Agents: KDHE – Municipal Program.

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 to -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 non-point 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*.

9. The *Kansas Water Plan* and the Lower Arkansas River Basin Plan provide the 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 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 watersheds 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 Medium Priority consideration.

Effectiveness: Improvements in reducing oxygen demanding substance loads to streams can be accomplished through appropriate management and control systems, including buffer strips and riparian restoration projects.

6. MONITORING

KDHE will continue to collect bimonthly samples in 2010 at rotational Station 535 in order to assess the DO levels under this TMDL. Ongoing WRAPS sampling by Kansas State University will occur on Sand Creek over 2007 – 2010. Synoptic-intra-watershed sampling by USGS will occur at these locations on Sand Creek over 2007 – 2008. Based on these samplings, the status of impairment will be evaluated in 2011. Should impaired status continue, sampling in 2014 will be used to assess the status of Sand Creek after any upgrades at Newton are complete.

7. FEEDBACK

Public Meetings: An active Internet site was established at http://www.kdheks.gov/tmdl/public.htm to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Lower Arkansas Basin.

Public Hearing: A Public Hearing on the TMDL of the Lower Arkansas Basin was held in Hutchinson, KS on September 13, 2006.

Basin Advisory Committee: The Lower Arkansas Advisory Committee met to discuss the TMDLs in the basin on March 8, June 7, and October 12, 2006.

Discussion with Interest Groups: The staff of Municipal Programs of Kansas Department of Health and Environment met to discuss the implications of this TMDL with the City Engineer from the City of Newton on March 8, 2006.

Milestone Evaluation: In 2011, evaluation will be made as to the progress in upgrading the Newton - Sand Creek wastewater treatment plant with biological nutrient removal. Additionally, any implementation activities that have occurred within the watershed and developed areas of Newton and the levels of DO seen in lower Sand Creek will be assessed. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The stream will be evaluated for delisting under Section 303(d), based on the monitoring data in 2010. Therefore, the decision for delisting could come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water quality criteria during the intervening implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may 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 (CPP), the next anticipated revision will come in 2007 which will emphasize revision of the Water Quality Management Plan. At that time, incorporation of this TMDL will be made into the CPP. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process after Fiscal Years 2008 – 2011.

Revised March 1, 2007

Bibliography

Studley, S.E., 2001. Estimated flow-duration curves for selected ungaging sites in Kansas. USGS Water-Resources Investigations Report 01-4142; 90 p.

Appendix A. Wasteload Allocation (WLA) for WWTP and CAFO facilities. Although two facilities, indicated by *, are located in another basin, they discharge to Sand Creek and the Little Arkansas Subbasin.

Facility	Permit #	Wasteload Allocation		
		BOD (lbs/day)	Nitrate (lbs N/day)	TP (lbs/day)
WWTP				
Newton (Major facility)	M-LA13-IO01	501.2 (Apr-Oct) 626.5 (Feb, Mar, Nov) 751.8 (Jan, Dec)	174.0	37.6
Walton (Minor facility)	M-LA17-OO01	9.5	2.2	0.6
Minor facility	C-LA13-NO08	0	0	0
Minor facility	C-LA13-NO09	0	0	0
Minor facility	C-LA13-NO10	0	0	0
Minor facility	I-LA13-NO03	0	0	0
Minor facility	I-LA13-NO05	0	0	0
Minor facility	I-LA13-NO06	0	0	0
Minor facility	I-LA13-NO08	0	0	0
Minor facility	I-LA13-NO09	0	0	0
Minor facility	I-LA13-PO01	0	0	0
CAFO				
Beef (Total head: 400)	A-LAHV-BA02	0	0	0
Beef (100)	A-LAHV-BA04	0	0	0
Beef (450)	A-LAHV-BA06	0	0	0
Beef (50)	A-LAHV-BA07	0	0	0
Beef (50)	A-LAHV-BA12	0	0	0
Beef (980)	A-LAHV-BA17	0	0	0
Beef (2,000)	A-LAHV-C004	0	0	0
Dairy (120)	A-LAHV-M011	0	0	0
Swine (400)	A-LAHV-S032	0	0	0
Swine (300)	A-LAHV-S036	0	0	0
Swine (250)	A-LAHV-SA05	0	0	0
Swine (200)	A-LAHV-SA06	0	0	0
Beef (180)	A-LAMN-BA03	0	0	0
Beef (400)	A-NEMN-BA32*	0	0	0
Beef (100)	A-WAHV-BA08*	0	0	0

Appendix B

Streeter-Phelps DO Analysis

Streeter-Phelps DO Sag Model - Sand Creek nr Newton
Single Reach - Single Load

1 cfs = .0283 m^3/s
0.25 mph =0.11176 m/s

0.1314000 Design Flow (Newton)

	Elev (ft)	Dist (km) to Site 535	Min DO	Crit Dist DO
	1410.4	12.50	5.51	4.84

Elevation Correction (DO)

Elevation	**1410.4**	ft
Correctn Factor (DO_{sat})	0.9548672	mg/L

Unless modified by upstream pt. source, upstream BOD set as target for basin
Upstream DO (where appropriate) elevation corrected and set at 90% sat.

Distance (km)
Flow (m^3/s)
Concentration (mg/L)
Temp (C)
Vel (m/s)

Velocity	0.04638		
BOD coef	0.23	Theta	1.056
O2 coef	(see Calc K_r)	Theta	1.024

		Flow	BOD	DO	T	Dist (km)	Slope (ft.mi)	Calc K_r	
1	**Newton**	0.1314000	20	8	25	12.50	4.01	1.09	
	Upstream	0	0	0	0	-----			
	Result at Dist (Sand Creek)	0.1314	15.63	6.94	25				Elev = 1379.24 ft

Kr Values (Foree 1977) using	0.42 (0.63 + 0.4S^1.15)
for q < 0.05 where q = cfs/mi^2 and	S (ft/mile)