KANSAS-LOWER REPUBLICAN BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: **White Rock Creek**
Water Quality Impairment: Sulfate

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Middle Republican **Counties:** Jewell and Smith

HUC 8: 10250016
HUC 10 (12): 07 (01, 02, 03, 04, 05)

Ecoregion: Central Great Plains, Rolling Plains and Breaks (27b)

Drainage Area: 247 square miles

Main Stem Water Quality Limited Segment: White Rock Creek (50) in Smith County, White Rock Creek (49) in Smith and Jewell Counties, and White Rock Creek (47, 45) in Jewell County.

HUC 8: 10250016:

White Rock Creek (50)	Tributaries:	Cora Creek (51)
White Rock Creek (49)	Tributaries:	North Branch White Rock Creek (60) Ash Creek (65)
White Rock Creek (47)	Tributaries:	Burr Oak Creek (48)
White Rock Creek (45)	Tributaries:	Walnut Creek (46) Wolf Creek (67) Antelope Creek (66) Long Branch (68) Korb Creek (72)

Designated Uses: For White Rock Creek (45) and Korb Creek (72): Primary Contact recreation "C" (stream segment is not open to and accessible by the public under Kansas Law); Expected Aquatic Life Support; Domestic Water Supply; Food Procurement; Ground Water Recharge; Industrial Water Supply; Irrigation Use; Livestock Watering Use. White Rock Creek (50) has the same designated uses with the exception of Secondary Contact recreation "b" (stream segment is not open to and accessible by the public under Kansas Law).

For White Rock Creek (49): Secondary Contact recreation "b" (stream segment is not open to and accessible by the public under Kansas Law); Expected Aquatic Life Support; Food Procurement; Ground Water Recharge; Irrigation Use; Livestock Watering Use. White Rock White Rock Creek (47) has the same designated uses with the exception of it

does not support Food Procurement.

For Cora Creek (51) and Walnut Creek (46): Secondary Contact recreation "b" (stream segment is not open to and accessible by the public under Kansas Law); Expected Aquatic Life Support; Domestic Water Supply; Ground Water Recharge; Industrial Water Supply; Irrigation Use; Livestock Watering Use.

For North Branch White Rock Creek (60): Secondary Contact recreation "b" (stream segment is not open to and accessible by the public under Kansas Law); Expected Aquatic Life Support; Ground Water Recharge use. Antelope Creek (66) has the same designated uses with the exception of Ground Water Recharge use.

For Ash Creek (65): Secondary Contact recreation "b" (stream segment is not open to and accessible by the public under Kansas Law); Expected Aquatic Life Support; Ground Water Recharge; Livestock Watering Use. Long Branch Creek (68) has the same designated uses with the exception of Ground Water Recharge use.

For Burr Oak Creek (48): Secondary Contact recreation "b" (stream segment is not open to and accessible by the public under Kansas Law); Expected Aquatic Life Support; Ground Water Recharge; Irrigation Use; Livestock Watering Use.

For Wolf Creek (67): Secondary Contact recreation "b" (stream segment is not open to and accessible by the public under Kansas Law); Expected Aquatic Life Support; Food Procurement; Ground Water Recharge.

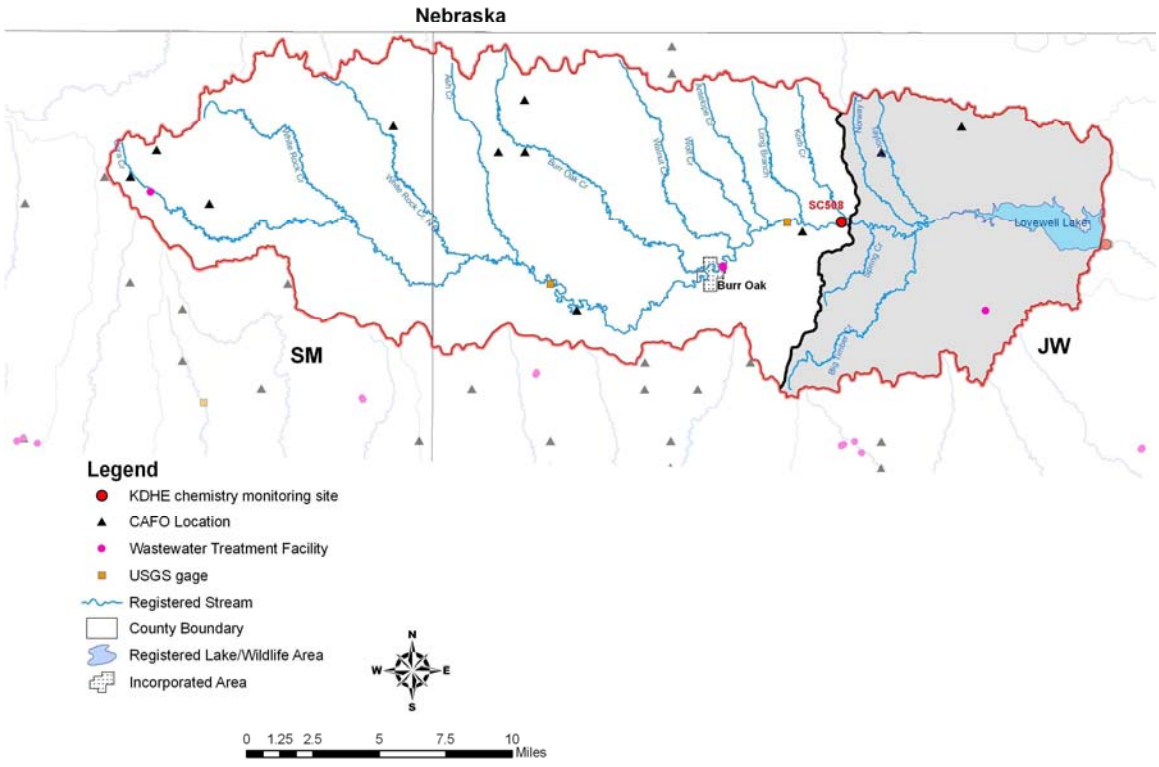
303(d) Listings: Kansas Stream Segments monitored by Station SC508 cited as impaired in the 2002, 2004, 2008 and 2010-303(d) lists for the Middle Republican Basin.

Impaired Use: Domestic Water Supply

Water Quality Standard: 250 mg/L for Domestic Water Supply

In stream segments where background concentrations of naturally occurring substances, including chlorides, sulfates and selenium, exceed the water quality criteria listed in Table 1a of KAR 28-16-28e(d), at ambient flow, the existing water quality shall be maintained, and the newly established numeric criteria shall be the background concentration, as defined in KAR 28-16-28b(e). Background concentrations shall be established using the methods outlined in the "Kansas implementation procedures: surface water," dated June 1, 1999... (KAR 28-16-28e(b)(9)).

Figure 1. White Rock Creek watershed includes only the segments above (West of) sampling station SC508.



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 2002 303(d): Not supporting Domestic Water Supply.

Monitoring Site: KDHE rotational ambient Stream Chemistry sampling station SC508 located 5 miles east and 2 miles north of Burr Oak.

Period of Record Used: 1990, 1994, 1998, 2002, 2006 and 2010 for KDHE Station 508.

Flow Record: White Rock Creek near Burr Oak, KS (USGS Station 06853800) for the period of record 1957 – 2010.

Long Term Flow Conditions: Median Flow = 6.8 cfs

Table 1. Actual Long Term Flow Conditions at USGS 06853800 gage for January 1970 thru October 2010. Flows at station SC508 were calculated using the ratio of drainage area at SC508 to drainage area at USGS 06853800. Flow Duration Values are in cubic feet per second (cfs) for the indicated percentage of time flow equaled or exceeded.

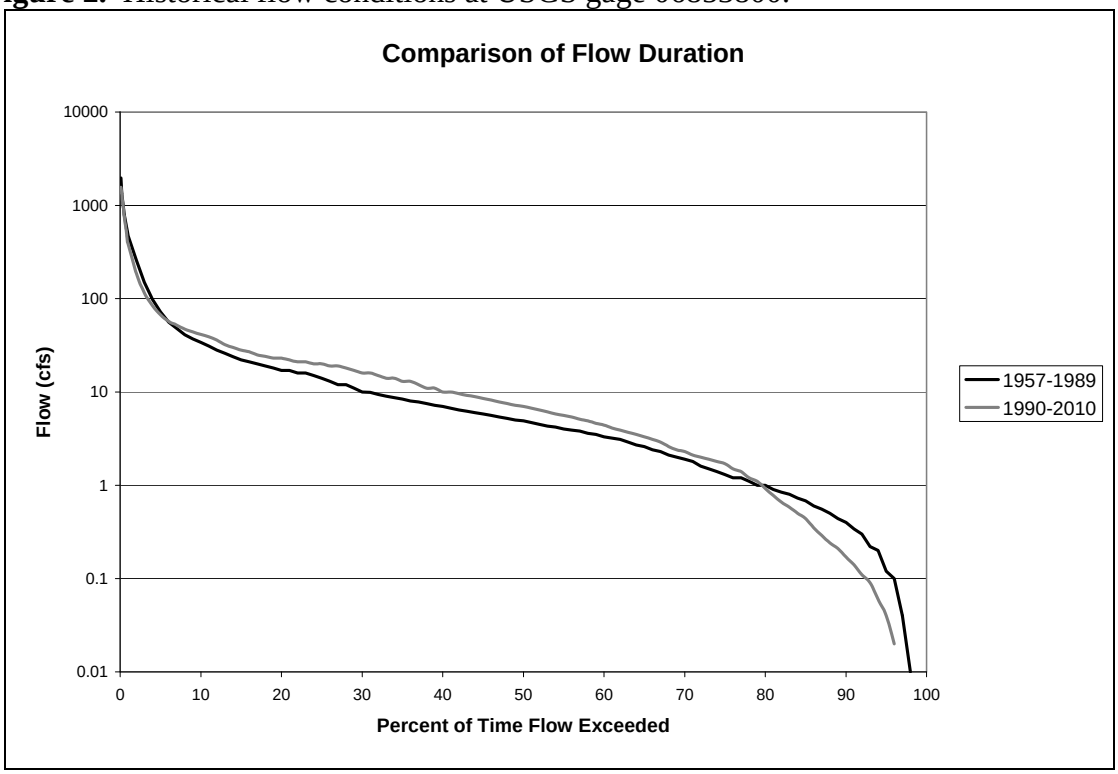
Location	Drainage Area	Average Flow	90%	75%	50%	25%	10%
White Rock Creek near Burr Oak (USGS 06853800)	227	26.9	0.37	2.0	6.8	18.0	39.0
White Rock Creek at SC508	247	29.3	0.40	2.2	7.4	19.6	42.5

Table 2. Estimated flow-duration values, mean flow values, and peak-discharge frequency values for stream segments upstream of USGS Station 06853800. (Perry, C.A., D.M. Wolock and J.C. Artman, 2004)

Stream Name	HUC 12	USGS Segment	Drainage Area	Estimated Mean Flow	90%	75%	50%	25%	10%
Cora Creek (51)	01	254	32.6	3.97	0	0	0.42	1.05	3.10
N. Branch White Rock Creek (60)	02	290	25.3	3.91	0	0	0.57	1.22	3.31
Ash Creek (65)	03	300	19.8	3.26	0	0	0.46	0.89	2.53
Burr Oak Creek (48)	04	310	36.4	6.81	0.01	0.21	1.47	3.27	7.61
Walnut Creek (46)	04	282	18.9	3.41	0	0	0.59	1.10	2.90
Wolf Creek (67)	05	267	5.62	0.45	0	0	0	0	0
Antelope Creek (66)	05	245	8.28	1.06	0	0	0	0	0
Long Branch (68)	05	239	10.4	1.67	0	0	0.01	0.01	0.56
Korb Creek (72)	05	238	10.9	1.77	0	0	0.03	0.05	0.67

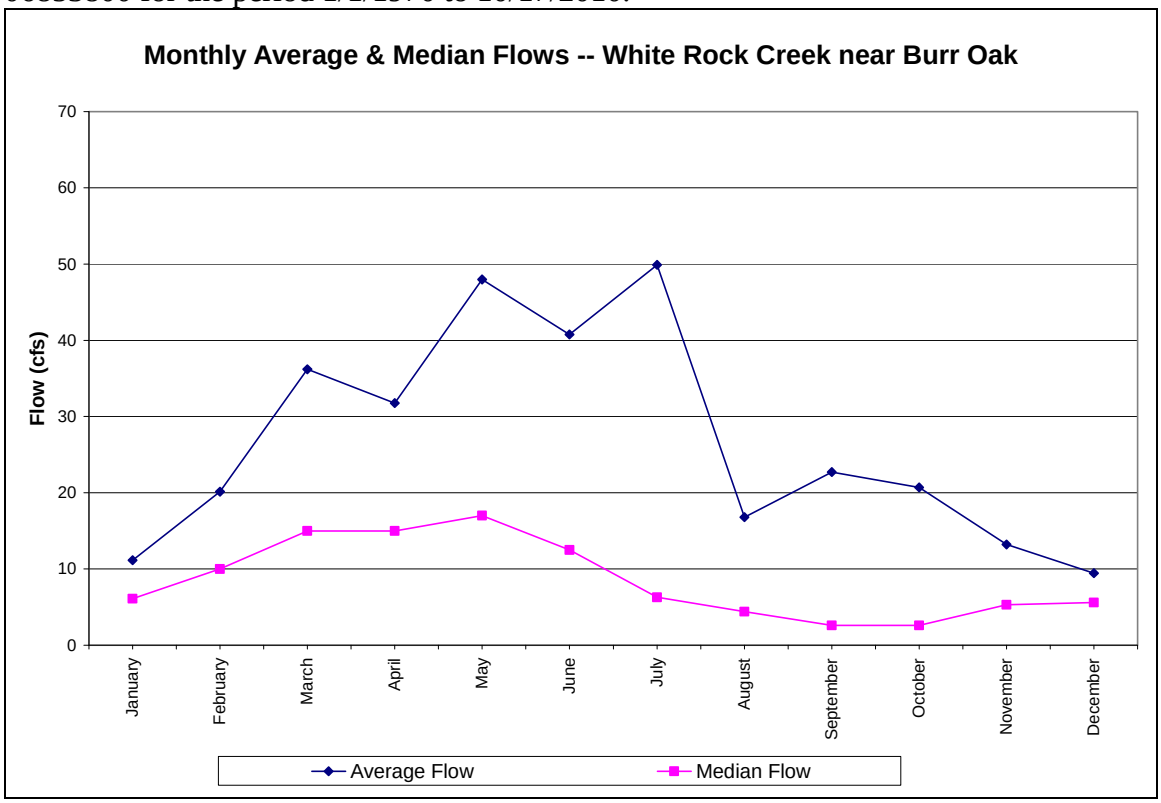
Historical flow data for the time periods 1957 thru 1989 and 1990 thru 2010 indicates the base flow in White Rock Creek has increased over time while flow during both high and low flow events has decreased (Figure 2).

Figure 2. Historical flow conditions at USGS gage 06853800.



The variability of the monthly average flows at USGS gage 06853800 for the period of record is typical for seasonal fluctuations in rainfall amounts. The high average flows in May, June and July reflect seasonal high intensity rainfall events while the high median flows during March, April and May reflect snow melt and more frequent spring rainfalls.

Figure 3. Monthly average and median flows for White Rock Creek at USGS gage 06853800 for the period 1/1/1970 to 10/17/2010.



Based on annual average and median flows in Figure 4, it is clear there is considerable variability in annual stream flow. Average flows exceed median flow every year with the size of the discrepancy indicating the frequency and magnitude of high precipitation, high run off events during the year. Years where the average and median flows are similar indicate years that experienced more consistent, sustainable flows throughout the year, indicative of fewer high intensity runoff events or drier years.

The average and median sulfate level for the period of record are 210 mg/L and 208 mg/L, respectively. Of the 32 samples taken from March 1990 to August 2010, 10 exceeded the sulfate standard of 250 mg/L, with exceedances occurring in every sampling year. The average sulfate level of samples exceeding the standard is 283 mg/L.

Figure 4. Yearly average and median flows for White Rock Creek at USGS gage 06853800 for the period 1/1/1970 to 10/17/2010.

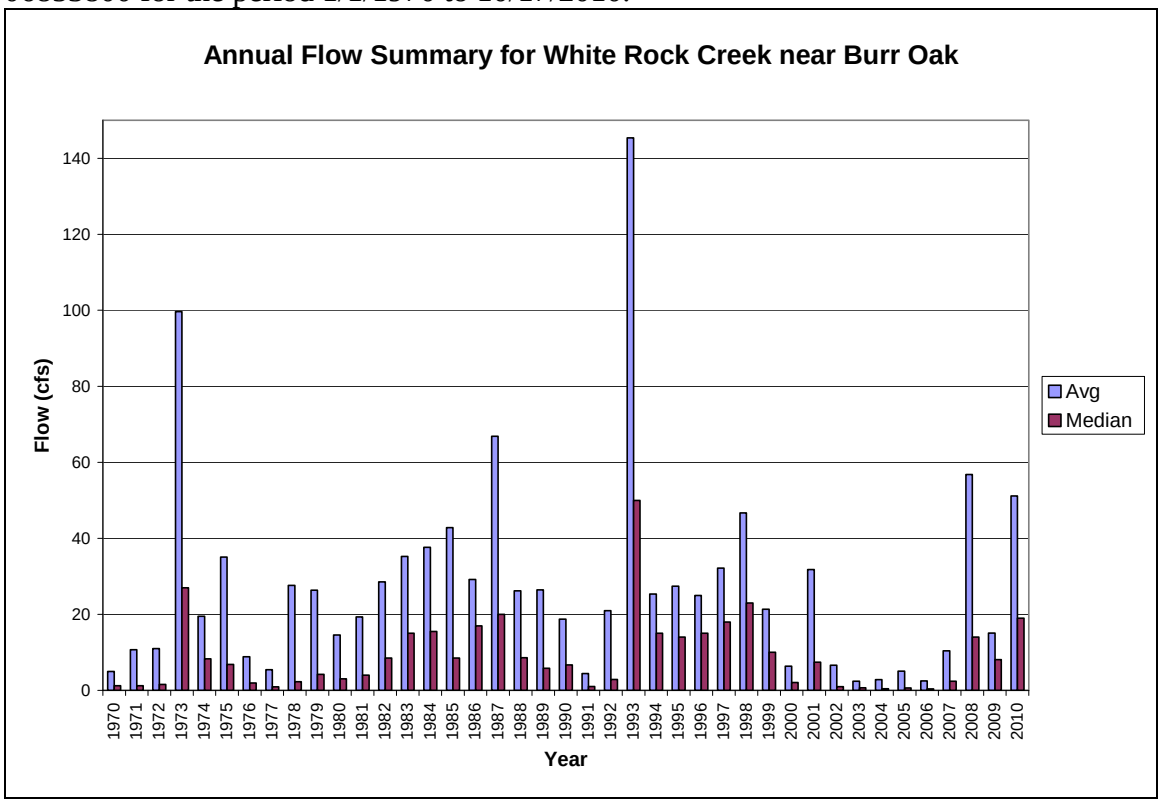
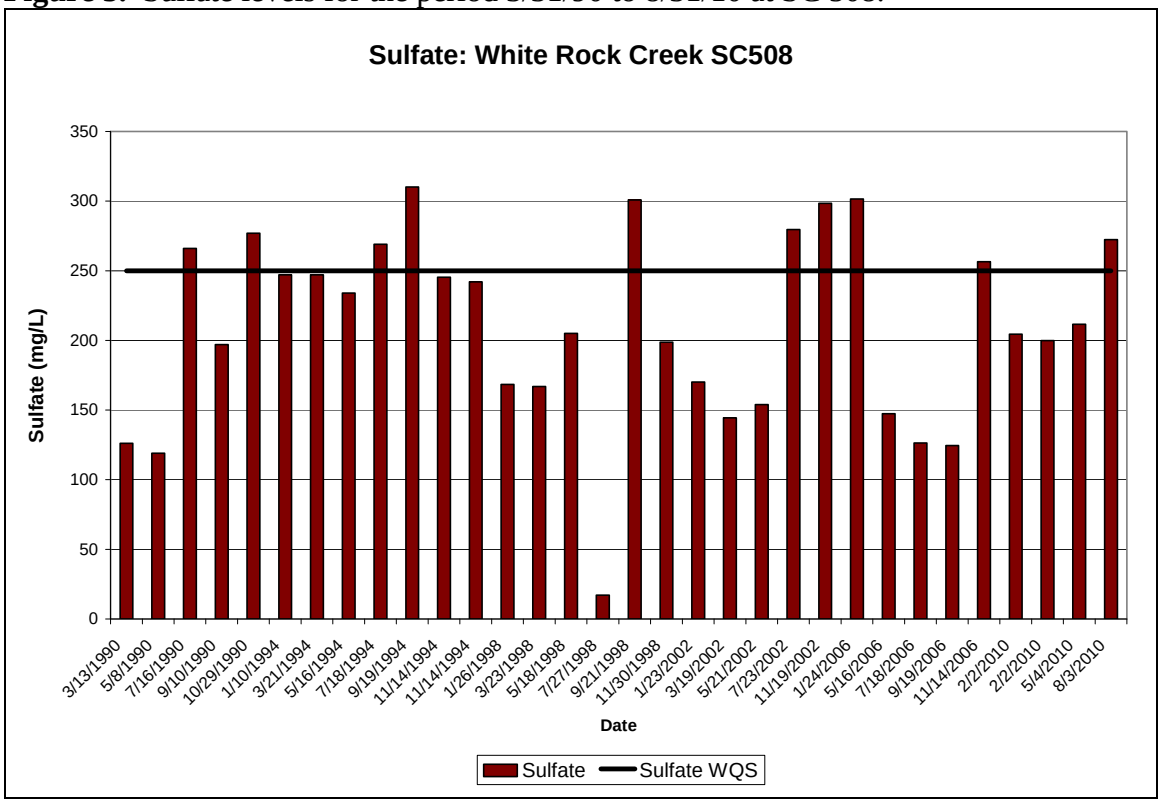


Figure 5. Sulfate levels for the period 3/31/90 to 8/31/10 at SC 508.



Sulfate concentrations varied by month with excursions above the standard occurring most frequently in July with 67% of samples exceeding 250 mg/L (Table 3). The variability within the month of July is reflected in Figure 6 with the average being skewed low due to a sample concentration of 17.2 mg/L that occurred during a high flow event in 1998. 50% of the samples taken in September and November exceeded the sulfate water quality standard with the September average and median falling slightly below the standard while the November average and mean slightly exceeded the 250 mg/L water quality standard (Table 4).

Table 3. Number of samples over the sulfate WQS/number of samples taken by percent exceedance.

Station	Month	0 to 10%	11 to 25%	26 to 50%	51 to 75%	76 to 90%	91 to 100%	Cum. Freq.
White Rock Creek near Burr Oak (SC 508)	January	0/0	0/2	0/3	0/0	1/1	0/0	1/6 = 17%
	March	0/2	0/0	0/2	0/0	0/0	0/0	0/4 = 0%
	May	0/2	0/1	0/2	0/1	0/0	0/0	0/6 = 0%
	July	0/1	0/0	2/2	1/1	0/0	1/2	4/6 = 67%
	September	0/0	0/0	1/1	1/1	0/1	0/1	2/4 = 50%
	November	0/0	0/1	0/2	1/1	1/1	1/1	3/6 = 50%
	Total All Months	0/5 = 0%	0/4 = 0%	3/12 = 25%	3/4 = 75%	2/3 = 66%	2/4 = 50%	10/32 = 31%

Figure 6. Boxplot of Sulfate concentration by month at SC508.

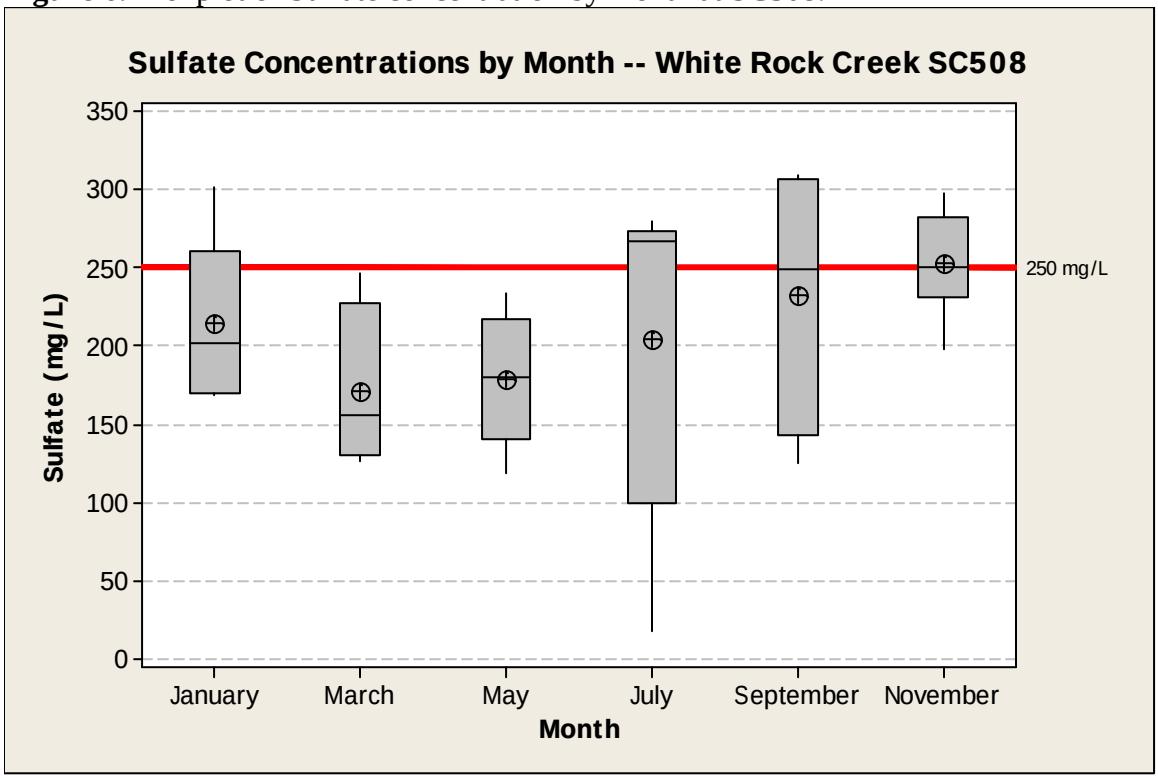


Table 4. Sulfate concentration by month and percent exceedance.

Month	Stream Flow (% Exceedance)						Monthly Avg.	Monthly Median
	0 to 10%	11 to 25%	26 to 50%	51 to 75%	76 to 90%	91 to 100%		
January	No Data	208	191	No Data	301	No Data	215	202
March	207	No Data	135	No Data	No Data	No Data	171	156
May	220	212	136	147	No Data	No Data	178	180
July	17.2	No Data	269	266	No Data	203	205	268
September	No Data	No Data	287	310	197	125	233	249
November	No Data	199	244	277	298	256	253	251
Average	174	206	204	250	266	197	210	208
Median	205	205	202	272	298	191	208	

Although flow is not a good predictor of sulfate levels (Figure 7), all excursions above 250 mg/L occurred when White Rock Creek at SC508 was at or below 20 cfs (Figure 8). Average and median sulfate concentrations for flows below 20 cfs are 218 and 227 mg/L respectively.

Figure 7. Sulfate versus Flow with low sulfate, high flow event removed (17.2 mg/L, 718 cfs).

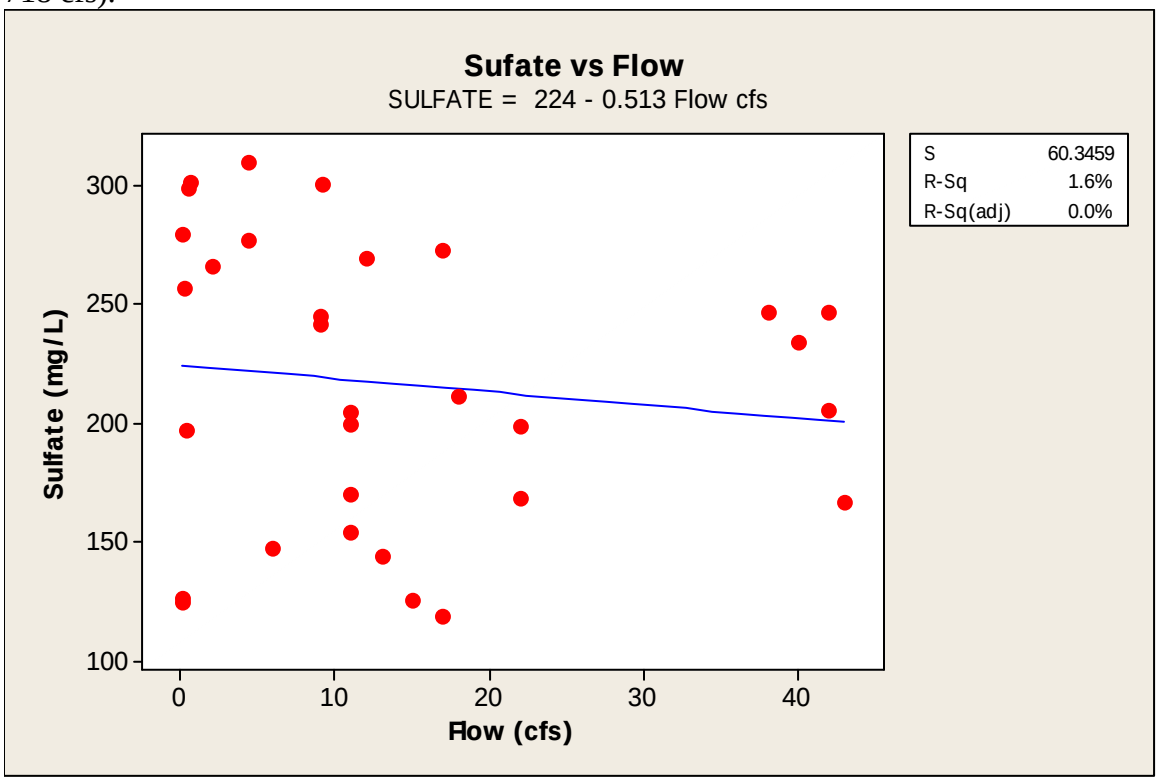
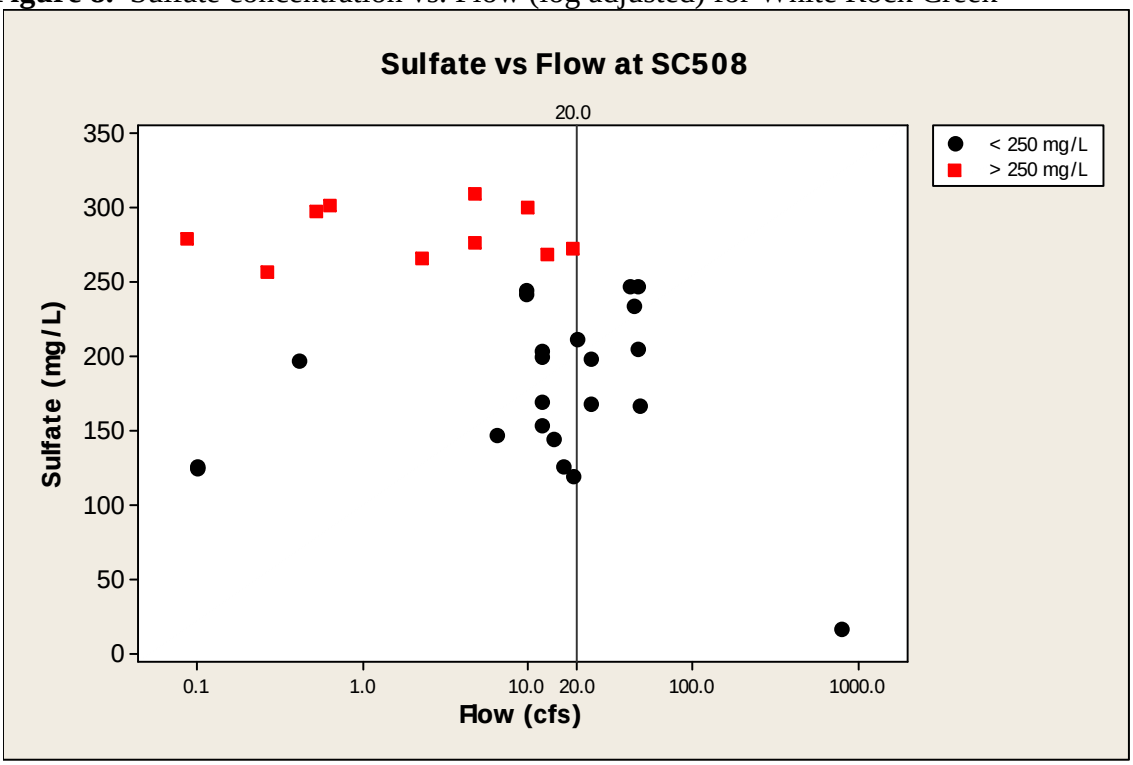


Figure 8. Sulfate concentration vs. Flow (log adjusted) for White Rock Creek



Desired Endpoints of Water Quality (Implied Load Capacity) at Site 508

The endpoint for this TMDL will be to maintain the concentration below the existing criterion of 250 mg/L.

The mean background concentration based on data over 1990-2010 at flows at or below the median flow of 7.4 cfs is 235 mg/L, below the existing sulfate standard (Table 5). Therefore, over 2011-2015, no more than 10% of the samples should be greater than 250 mg/L.

Table 5. Sulfate data for White Rock Creek (SC508) on days with flows $\leq$ median flows

Sampling Date	Sulfate (mg/L)	Daily Average Flow
7/16/1990	266	2.3
9/10/1990	197	0.41
10/29/1990	277	4.8
9/19/1994	310	4.8
7/23/2002	280	0.09
11/19/2002	298	0.52
1/24/2006	301	0.63
5/16/2006	147	6.4
7/18/2006	126	0.10
9/19/2006	125	0.10
11/14/2006	256	0.26
Average	235	

3. SOURCE INVENTORY AND ASSESSMENT

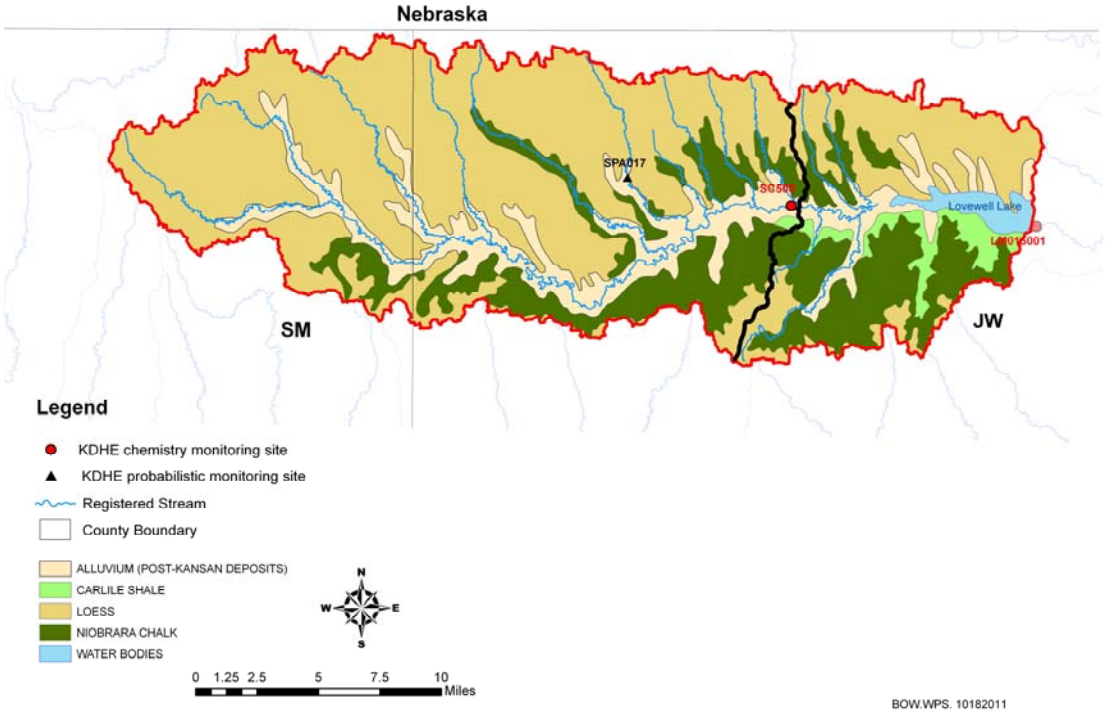
Point Sources: There are two NPDES permitted facilities in the White Rock Creek watershed. Both facilities are non-overflowing lagoon systems that are prohibited from discharging and would only contribute a sulfate load under extreme precipitation or flooding events. Such events would not occur at a frequency or for duration sufficient to cause impairment in the watershed.

Table 6. NPDES permitted facilities in White Rock Creek Watershed (SC508)

Discharging Facility	NPDES Permit #	State Permit #	Type	Expiration Date
Burr Oak WWTP	KSJ000380	M-LR04-NO01	2 Cell Lagoon Non-Overflowing	April 30, 2014
Global Country World of Peace	KSJ000651	C-SO23-NO01	1 Cell Lagoon Non-Overflowing	September 30, 2014

Geology: The Niobrara Chalk is the bedrock that outcrops and subcrops under unconsolidated sediments in most of the drainage area of White Rock Creek (Figure 9). Fort Hays limestone is the basal part of the Niobrara formation and it forms an escarpment that trends northeastward from the southwestern part of the county toward Lovewell reservoir. Northwest of the escarpment the Niobrara formation is exposed with the best exposures being along the divide and valley wall south of White Rock Creek. The Smoky Hill chalk member which overlies the Fort Hays limestone member is the upper unit of the Niobrara formation. South of White Rock Creek the Smoky Hill chalk member has been eroded and is well exposed. Near Burr Oak, there are long slopes on the Smoky Hill chalk member that extend from the drainage divide a few miles south of White Rock Creek to the low terraces bordering the stream. The Smoky Hill chalk member of the Niobrara Chalk contains several layers of clay, shale and chalk including thin veins of gypsum (hydrous calcium sulfate) and selenite (a crystalline from of gypsum). (Fishel, V.C and Leonard, Alvin R., 1955. Geology and Ground-water Resources of Jewell County, Kansas)

Figure 9. White Rock Creek watershed surface geology.

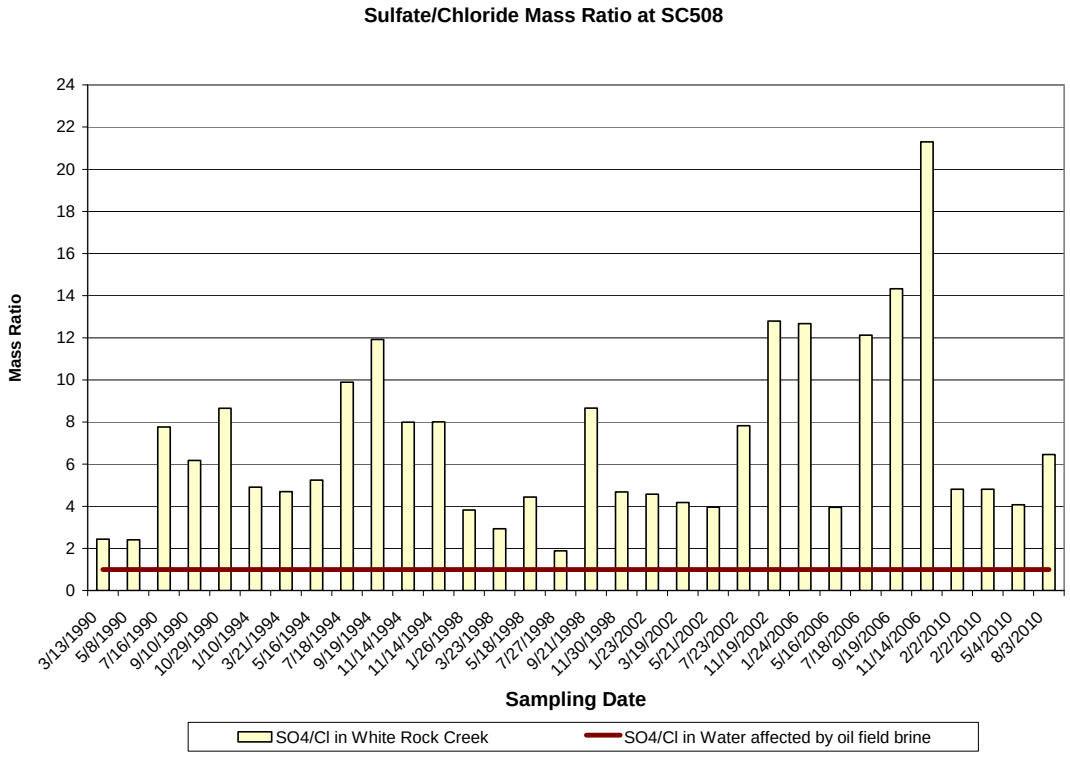


Background: Historical ground water monitoring in Jewell County details sulfate concentrations as high as 1,700 mg/L in the 1940s. The City of Burr Oak treats water from a well located near White Rock Creek for public water supply and has reported sulfate levels as high as 532 mg/L in untreated water and 500 mg/L in finished water.

KDHE's Stream Probabilistic Monitoring Program sampled Walnut Creek, a tributary to White Rock Creek in Smith County (Figure 9) in May of 2006 producing a sulfate concentration of 35.2 mg/L in Walnut Creek. Walnut Creek is located well outside the area of the watershed where the Niobrara Chalk member dominates the geology (Figure 9) and the low concentration of sulfate found there is evidence of the effect the dissolution of gypsum in the Niobrara Chalk has on sulfate concentrations in White Rock Creek.

Oil field brine is a potential source of sulfate in ground and surface water. However, a comparison of the sulfate to chloride ratio in White Rock Creek to the ratio typically seen in water influenced by oil field brine in Kansas makes it an unlikely source of sulfate in the creek. Typically, waters influenced by oil field brine have sulfate to chloride ratios of less than one; however, White Rock Creek consistently has a high sulfate to chloride ratio (Figure 10). High sulfate to chloride mass ratio combined with the presence of gypsum in the bedrock points to natural dissolution as the primary source of sulfate in White Rock Creek (Whittemore, Donald, 2004, 2006).

Figure 10. Sulfate to Chloride Mass Ratio in samples taken at SC508



Livestock Waste Management Systems: There are nine active confined animal feeding operations (CAFOs) within the White Rock Creek watershed amounting to 2275 head of cattle and 1400 head of swine (Table 7). All of these 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.

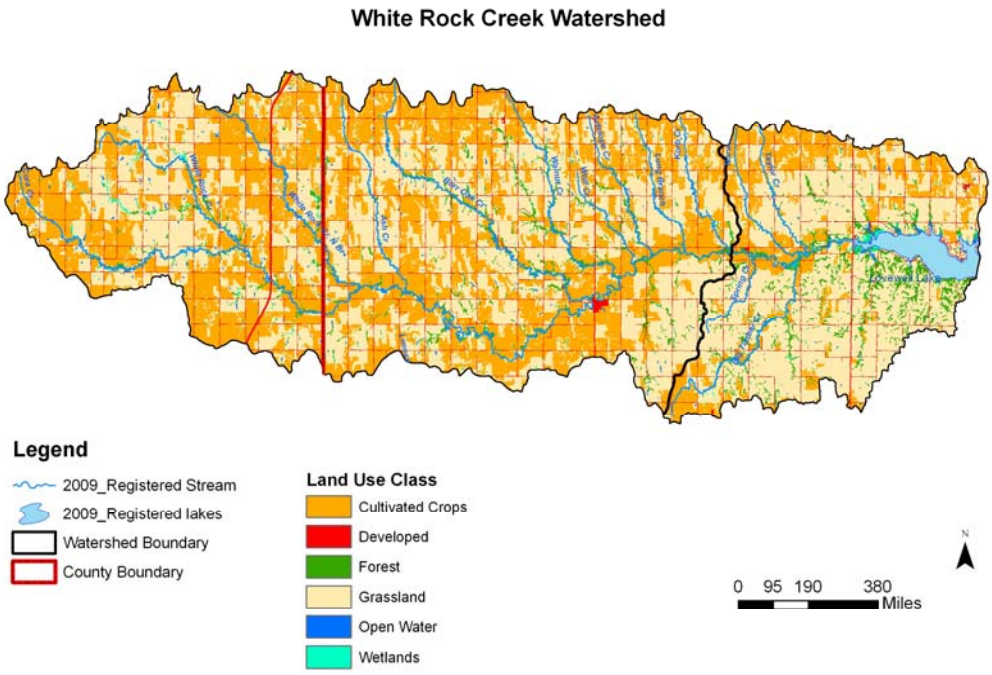
Table 7. CAFOs within the White Rock Creek watershed.

Permit Number	Type	County	Animal Total
A-LRSM-BA01	Beef	Smith	500
A-LRSM-BA02	Beef	Smith	400
A-LRJW-B004	Beef	Jewell	600
A-LRJW-B003	Beef	Jewell	500
N-LRJW-6621	Beef	Jewell	100
A-LRSM-M001	Beef	Smith	175
N-LRJW-4927	Swine	Jewell	100
A-LRJW-S008	Swine	Jewell	950
A-SOSM-SA02	Swine	Smith	350

Land Use: The predominant land uses in the White Rock Creek Watershed are grassland (46%) and cultivated cropland (45%), according to 2001 National Land Cover Data. Together they account for 91% of the total land area in the watershed. Approximately

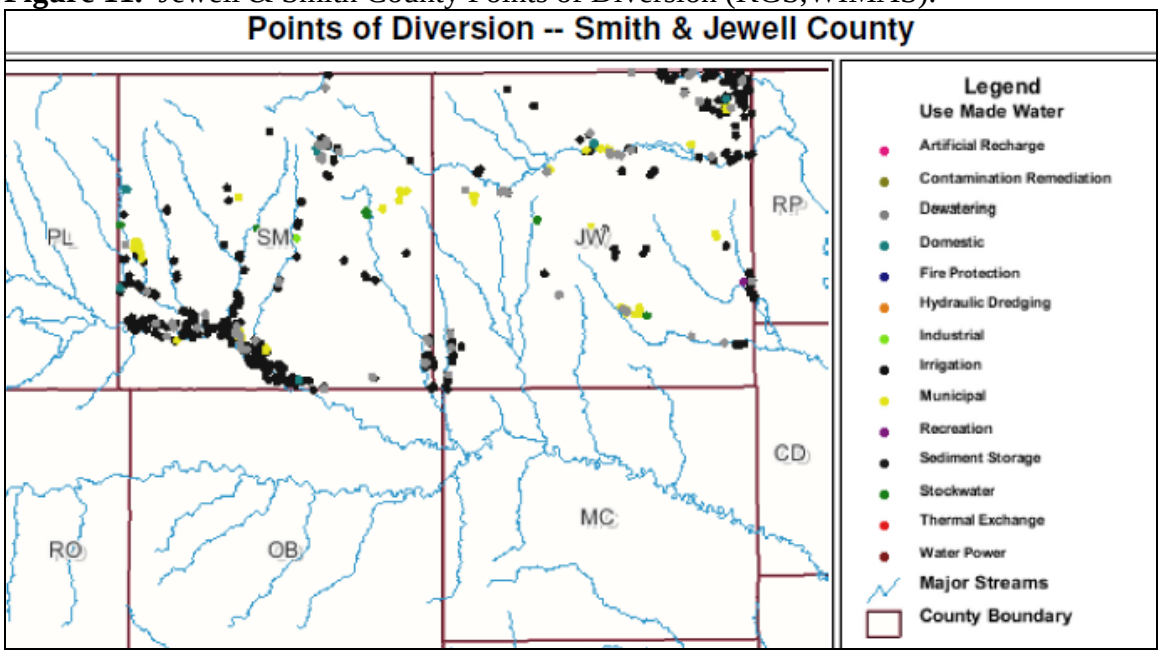
4% of the land is deciduous forest, where as open water and wetlands account for 1%. Developed areas, such as residential, commercial and industrial land as well as roads, makes up about 4% of the watershed (Figure 10).

Figure 10. Land use in the Lovewell Lake watershed.



Points of Diversion: There are 115 and 210 unique points of diversion in Jewell and Smith Counties, respectively. However, the majority of the points of diversion are located outside of this watershed and likely have little effect on sulfate concentration in the White Rock Creek watershed (Figure 11).

Figure 11. Jewell & Smith County Points of Diversion (KGS,WIMAS).



4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

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

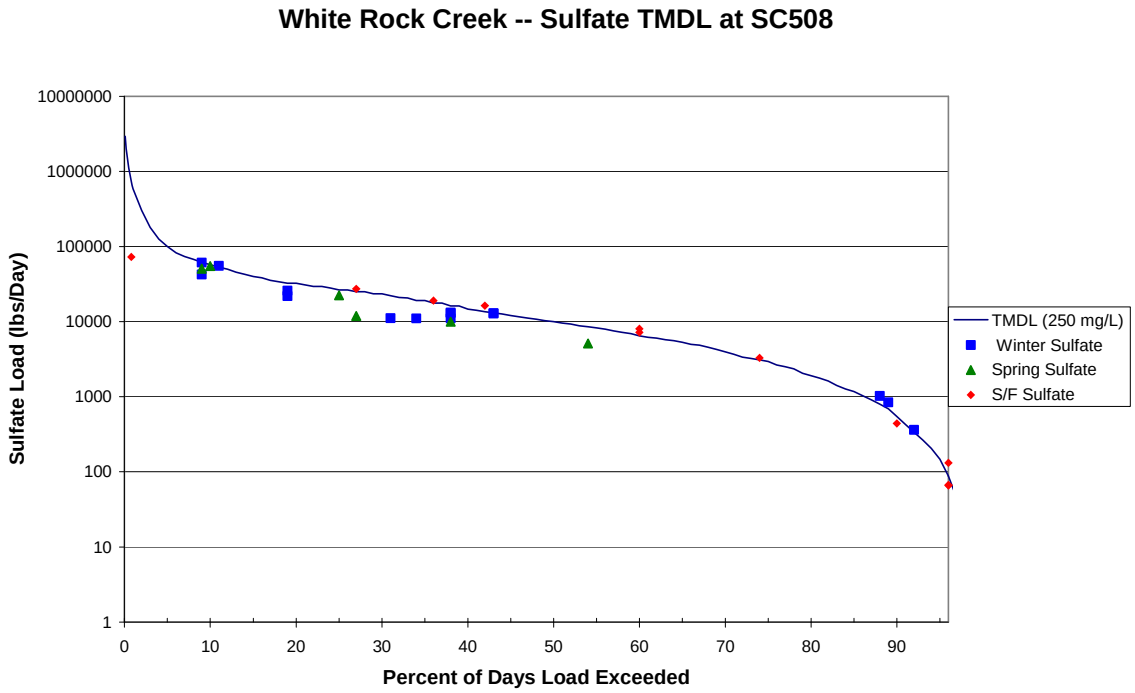
Non-Point Sources: The elevated sulfate concentrations predominately stem from geologic sources and groundwater contribution to stream flow.

The Load Allocation is based on the existing sulfate water quality standard of 250 mg/L (Figure 12) and applies to all flow conditions. The associated sulfate Load Allocations estimated at site SC508 are indicated in Table 8.

Table 8. White Rock Creek TMDL for various flow conditions

Flow Condition	Load Allocation (lbs/day)	Margin of Safety (lbs/day)	Sulfate TMDL (lbs/day)
Mean Flow (29.3 cfs)	35,599	3,956	39,555
10% (42.5 cfs)	51,637	5,738	57,375
25% (19.6 cfs)	23,814	2,646	26,460
50% (7.4 cfs)	8,991	999	9,990
75% (2.2 cfs)	2,673	297	2,970
90% (0.40 cfs)	486	54	540

Figure 12. White Rock Creek Sulfate TMDL at Station SC508.



Defined Margin of Safety: The Margin of Safety provides some hedge against the uncertainty of variable sulfate loads and the endpoints of the TMDL. The margin of safety is explicitly set at 10% of the calculated total sulfate load, 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 8.

State Water Plan Implementation Priority: Because the sulfate impairment in the White Rock Creek watershed is due to geologic sources, this TMDL will be a Low Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Middle Republican Basin (HUC 8: 10250016) with a priority ranking of 48 (Medium Priority for restoration work).

Priority HUC 12: No HUC 12 priority watersheds are identified since implementation is not anticipated.

5. IMPLEMENTATION

Desired Implementation Activities

1. Identify any anthropogenic contributions of sulfate loading to river.
2. Assess likelihood of stream being used for domestic uses.

Implementation Program Guidance

Non-point Source Pollution Technical Assistance – KDHE

a. Evaluate any potential anthropogenic activities which might contribute sulfate to the river.

Use Attainability Analysis – KDHE

a. Consult with Division of Water Resources on locating existing or future domestic points of diversion on the White Rock Creek for drinking water purposes.

Timeframe for Implementation: Pollutant source assessment should be attempted with each year of sampling. If any anthropogenic sources are identified, pollution reduction practices and implementation activities should be initiated over 2012 to 2020.

Targeted Participants: Primary participants for implementation will be KDHE.

Milestone for 2015: In accordance with the TMDL development schedule for the State of Kansas, the year 2015 marks the next cycle of 303(d) activities in the Kansas-Lower Republic Basin. At that point in time, data from 2014 at site SC508 should indicate evidence of improved sulfate levels at base flow conditions. Data from 2018 at SC508 will be re-examined to confirm the impairment status of the stream in 2020.

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

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 to quarterly samples in 2014 and 2018 at site SC508. Based on the sampling data, the status of the 303(d) listing will be evaluated in 2020.

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.

Milestone Evaluation: In 2015, evaluation will be made to confirm the magnitude of

sulfate excursions at low flows in White Rock Creek.

Consideration for 303(d) Delisting: White Rock Creek will be evaluated for delisting under section 303(d), based on the monitoring data over 2011-2019. Therefore, the decision for delisting will come about in the preparation of the 2020-303(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 February 11, 2011
Revised October 28, 2011

References

Perry, C.A., D.M. Wolock and J.C. Artman, 2004. Estimates of Flow Duration , Mean Flow and Peak-Discharge Frequency Values for Kansas Stream Locations, USGS Scientific Investigation Report, 2004-5033.

Kansas Surface Water Quality Standards and Supporting Materials found at: http://www.kdheks.gov/water/download/kwqs_plus_supporting.pdf

Kansas Water Plan Atlas
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