NEOSHO BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: Eagle Creek
Water Quality Impairment: Dissolved Oxygen

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Neosho Headwaters **County:** Lyon, Coffey and Greenwood

HUC 8: 11070201

HUC 11 (HUC 14s)**:** **040** (030, 040 and 050)

Drainage Area: 113.6 square miles

Main Stem Segment: WQLS: 25 (Eagle Creek) starting at confluence with the Neosho River and traveling upstream to headwaters in south-central Lyon County (**Figure 1**).

Tributary Segments: Non-WQLS: South Eagle Creek (47)
Fourmile Creek (48)

Designated Uses: Expected Aquatic Life Support, Secondary Contact Recreation and Food Procurement for Main Stem Segment.

1998 303(d) Listing: Table 1 - Predominant Non-point Source and Point Source Impacts

Impaired Use: Expected Aquatic Life Support

Water Quality Standard: Dissolved Oxygen (DO): 5 mg/L (KAR 28-16-28e(c)(2)(A))

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 1998 303(d): Not Supporting Aquatic Life

Monitoring Sites: Station 634 near Olpe

Period of Record Used: 1993, 1997 and 2001 for Station 634; 2000 and some 2001 collected by Kansas Biological Survey (**Figure 2**).

Flow Record: Pottawatomie Creek near Garnett (USGS Station 06914000) matched to Big Creek near Le Roy (USGS 07182710) whose runoff was proportioned to Eagle Creek near Olpe.

Long Term Flow Conditions: 10% Exceedance Flows = 44 cfs**,** 95% = 0.02 cfs

Eagle Creek Watershed
Dissolved Oxygen TMDL
HUC and Stream Segment Map

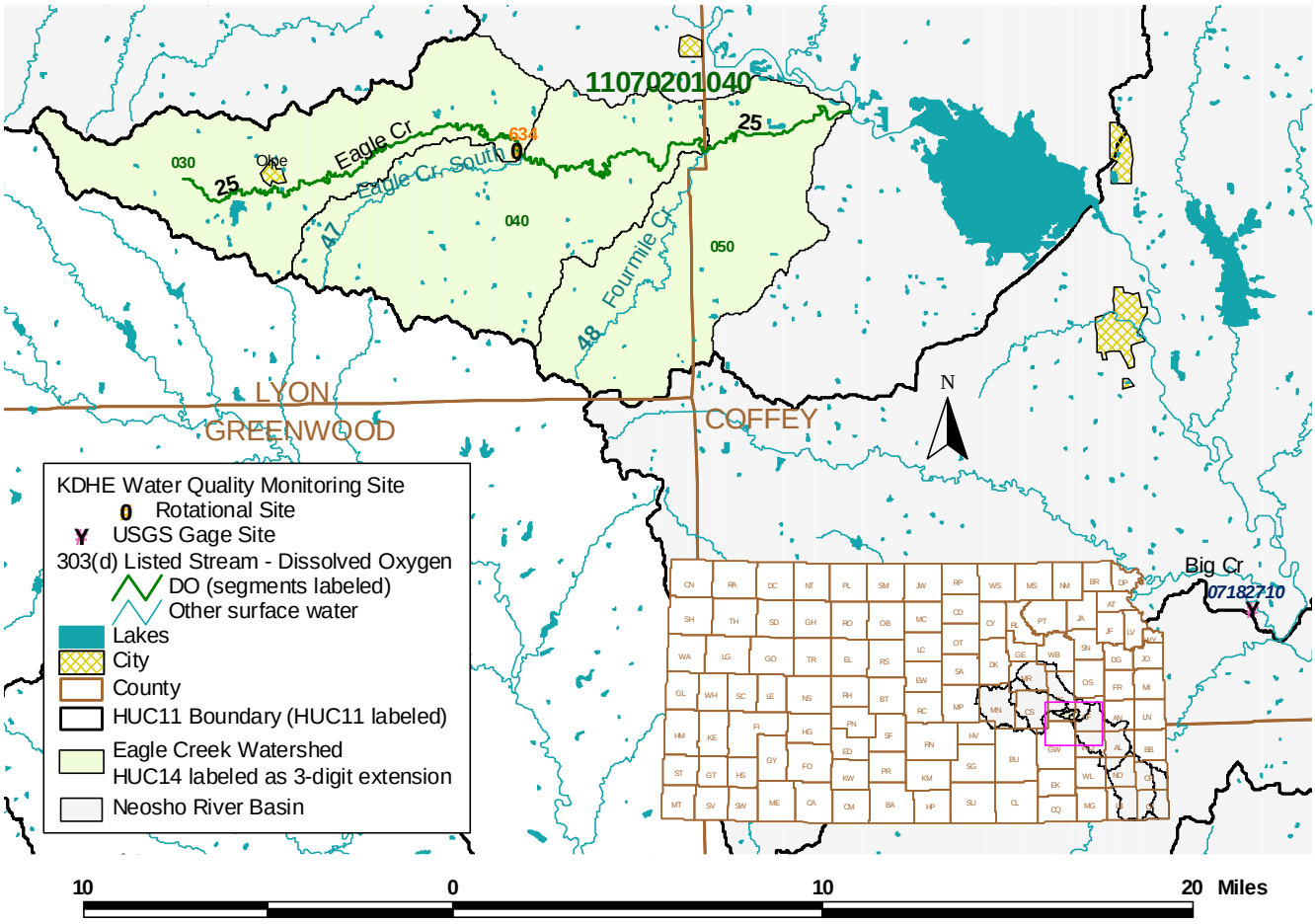


Figure 1

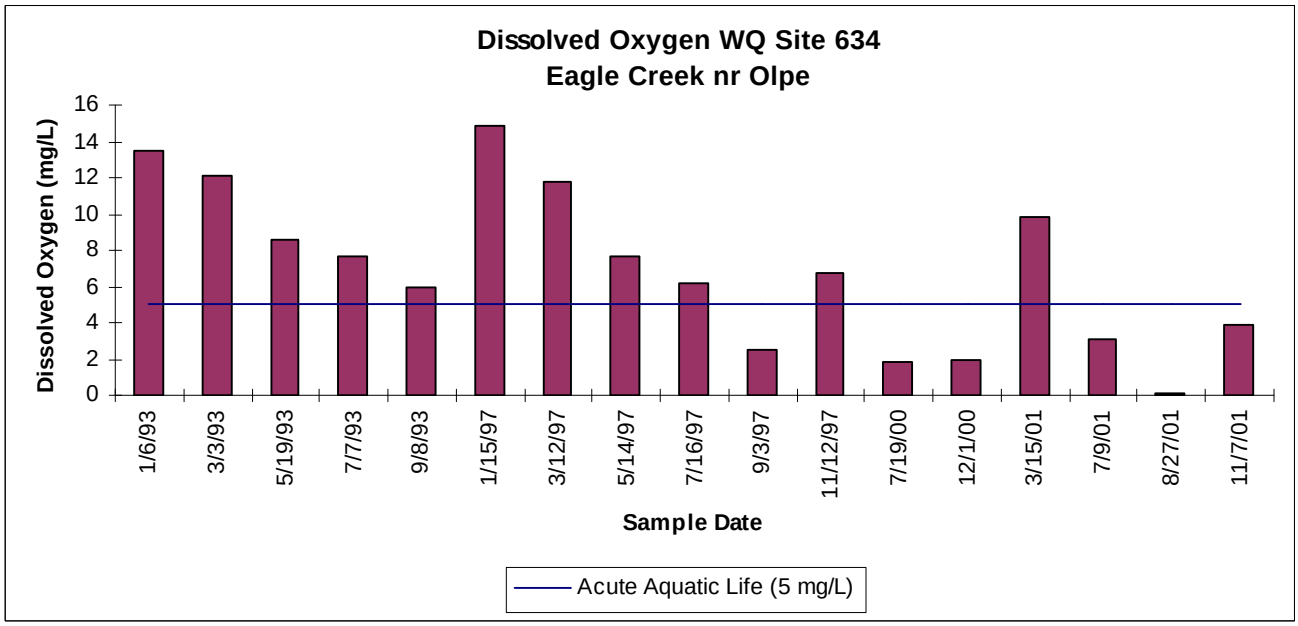


Figure 2

Current Conditions: Since loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired loads over all flow conditions, rather than fixed at a single value. Sample data for the sampling site 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. Load curves were established for the Aquatic Life criterion by multiplying the flow values for Eagle Creek near Olpe along the curve by the applicable water quality criterion and converting the units to derive a load duration curve of pounds of DO per day. This load curve graphically displays the TMDL since any point along the curve represents water quality at the standard at that flow. Historic excursions from water quality standards (WQS) are seen as plotted points *below* the load curves. Water quality standards are met for those points plotting *above* the applicable load duration curves (**Figure 3**).

Excursions were seen in each of the three defined seasons and are outlined in **Table 1**. Sixty seven percent of the Summer-Fall samples and 33 % of the Spring samples were below the aquatic life criterion. Twenty five percent of the Winter samples were under the aquatic life criterion. Overall, 35% of the samples were under the criterion. This would represent a baseline condition of non-support of the impaired designated use.

No DO violations have been encountered at flows exceeding 1.1 cfs on Eagle Creek near Olpe, therefore a critical low flow can be identified on Eagle Creek as those flows of 1.1 cfs or less.

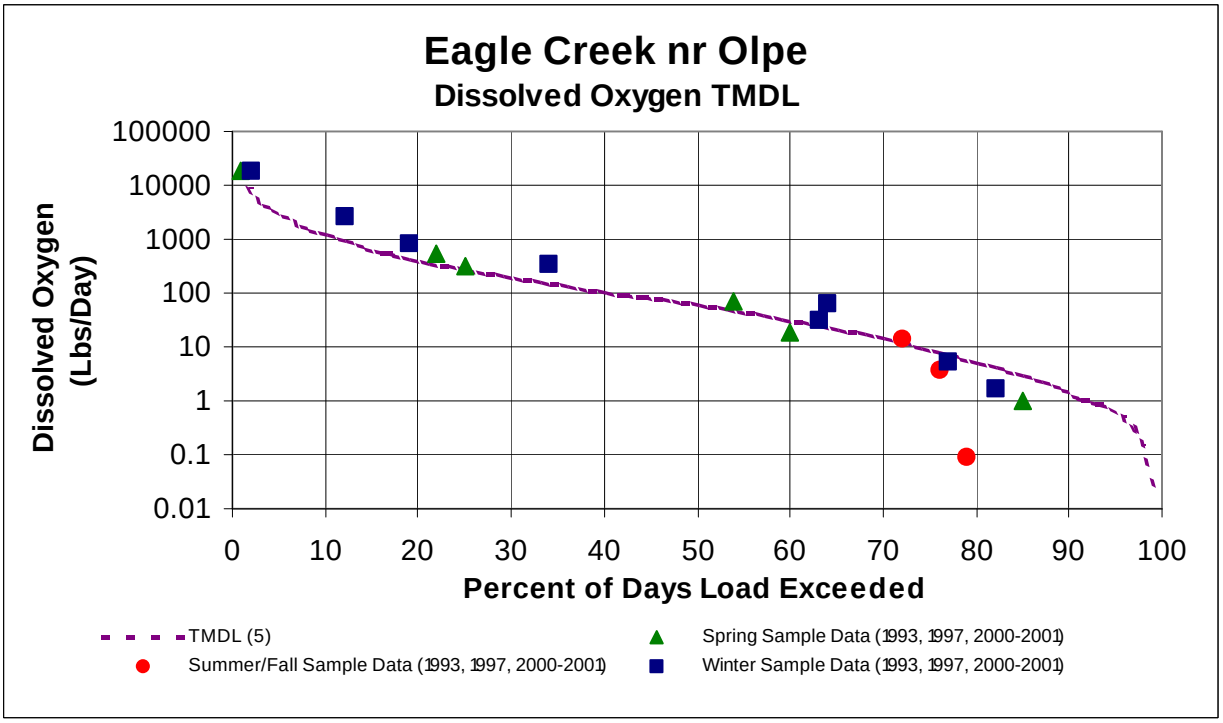


Figure 3

Table 1
NUMBER OF SAMPLES UNDER DISSOLVED OXYGEN STANDARD OF 5 mg/L BY FLOW

Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum Freq.
Eagle Creek near Olpe (634)	Spring	0	0	0	1	1	0	2/6 = 33%
	Summer	0	0	0	0	2	0	2/3 = 67%
	Winter	0	0	0	0	2	0	2/8 = 25%

A watershed comparison approach was taken in developing this TMDL. The North Cottonwood River watershed (Water Quality Sampling Site 636 in the watershed was not impaired by low DO) has roughly similar land use characteristics (**see Table 2 in Appendix**) to the Eagle Creek watershed, is of similar size and is located west of the Eagle Creek watershed in the Neosho River Basin. The relationship of DO to ammonia, biochemical oxygen demand (BOD), fecal coliform bacteria (FCB), water temperature, turbidity, nitrate, phosphorus, pH and total suspended solids (TSS) were used in the comparison.

Table 3 in the Appendix outlines those water quality data for the samples taken on the same day for the two sites of interest. Kansas Biologic Survey (KBS) samples from site 634 in 2000 and 2001 could not be compared to the reference site because KBS did not collect concurrent samples from the North Cottonwood River watershed. A single excursion (9/3/97) from the DO standard

could be compared to the reference site. The phosphorus, TSS and turbidity were higher at site 634 than the comparison site 636 on this date, while all other parameters were either the same or less at site 634 than site 636. The calculated flow at site 634 on this date was very low; less than 0.3 cfs. The 2000 and 2001 KBS data which accounted for all other DO violations at site 634 also occurred under extremely low flow conditions (1.1 - 0.15 cfs). Based on the data available, it is likely that low (or no) flow is the primary factor influencing DO violations in the Eagle Creek watershed.

Desired Endpoints of Water Quality at Site 634 over 2007 - 2011

The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standard of 5 mg/l to fully support Aquatic Life.

Seasonal variation is accounted for by this TMDL, since the TMDL endpoint is sensitive to the low flow conditions, usually occurring in the July through October months.

This endpoint will be reached as a result of expected, though unspecified, improvements in tributary buffer strip conditions which will filter sediment before reaching the stream and stream morphology assessments which will be used to determine if enhancement to reaeriation of flow within the stream is needed. Improvements to buffer strip conditions will result from implementation of corrective actions and Best Management Practices, as directed by this TMDL. Achievement of this endpoint will provide full support of the aquatic life function of the creek and attain the dissolved oxygen water quality standard.

Since BOD is not considered a factor in the occasional DO excursion at this site, the BOD target will be to maintain the historical average in stream BOD of 3.4 mg/L or less at the sampling site.

3. SOURCE INVENTORY AND ASSESSMENT

NPDES: There is one NPDES permitted wastewater discharger within the watershed (**Figure 4**) upstream of site 634. The system is outlined below in **Table 4**.

Table 4

DISCHARGING FACILITY	STREAM REACH	SEGMENT	DESIGN FLOW	TYPE
Olpe WTF	Eagle Creek (25)	25	0.05 mgd	Lagoon

The city of Olpe relies on a three cell lagoon system with 120 day detention times for treatment of their wastewater. Kansas Implementation Procedures - Waste Water Permitting - indicates this lagoon meets standard design criteria which have been shown to consistently meet or exceed the bacteria standard.

The population projection for Olpe to the year 2020 indicates slight a increase. Projections of future water use and resulting wastewater appear to be within the design flows for of the current system's treatment capacity. Examination of 1998, 1999, 2000 and 2001 effluent monitoring of the city of Olpe indicates that when the city does discharge, BOD discharges are usually within permit limits. The city monitors quarterly. BOD monitoring shows the city was in compliance with permit limits during the months in which DO violations occurred at site 634.

Eagle Creek Watershed
NPDES Sites and Livestock Waste Management Facilities

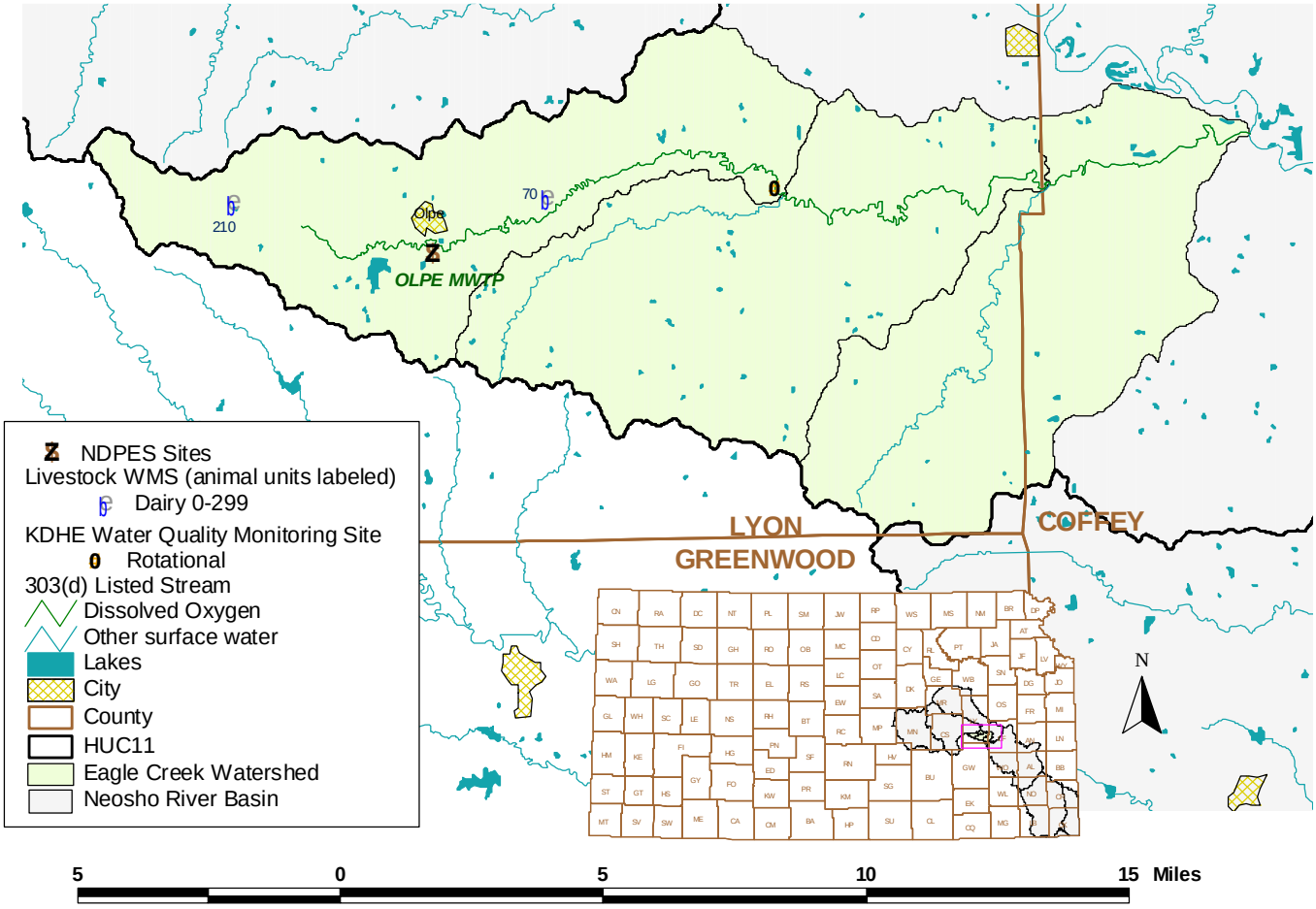
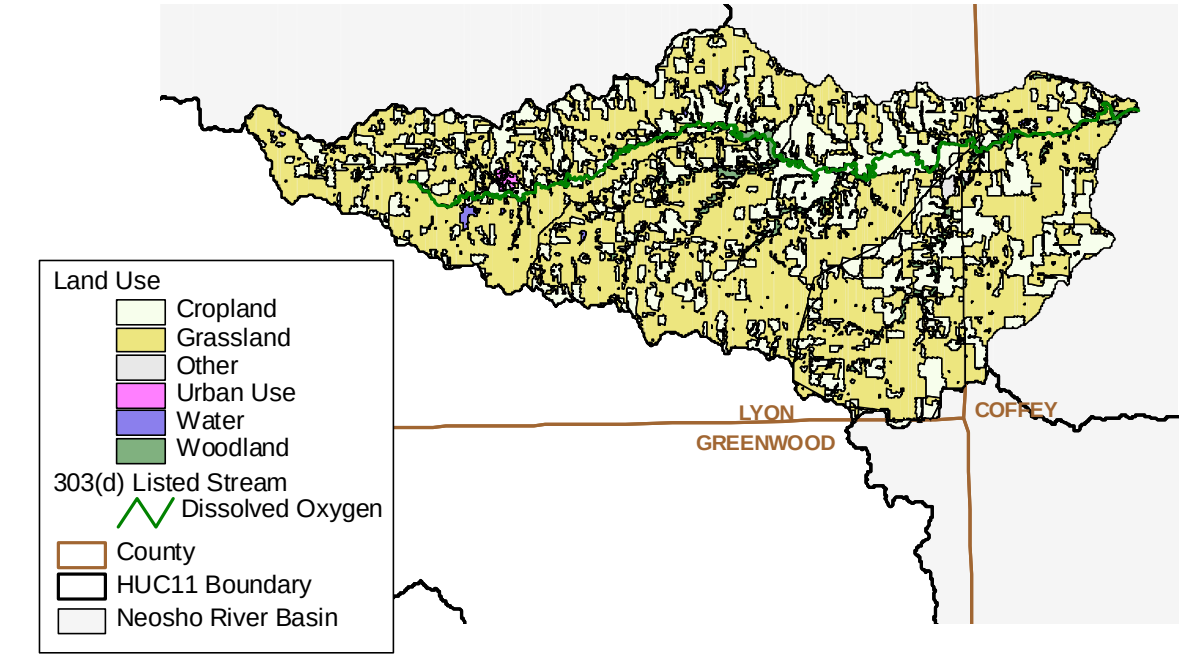


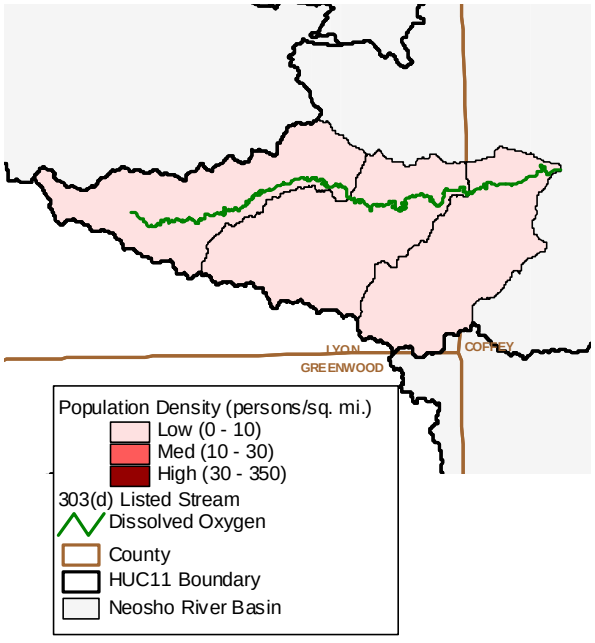
Figure 4

Livestock Waste Management Systems: Three operations are registered, certified or permitted within the watershed upstream of Site 634. These facilities (dairy or chicken) are located within one mile of a listed stream in the watershed (**Figure 4**). All permitted livestock facilities have waste management systems designed to minimize runoff entering their operations or detaining runoff emanating from their areas. Such systems are designed for the 25 year, 24 hour rainfall/runoff event, which typically coincide with stream flows exceeded less than 1 - 5 % of the time. NPDES permits, also non-discharging, are issued for facilities with more than 1,000 animal units. None of the facilities in the watershed are of this size. Total potential animal units for all facilities is 2,260. The actual number of animal units on site is variable, but typically less than potential numbers.

Land Use: Most of the watershed is grassland (61% of the area), cropland (35%), or woodland (3%). The cropland in the watershed appears to be concentrated near the main stem. The grazing density estimate is low in the watershed when compared to densities elsewhere in the Neosho Basin (25-26 animal units/mi^2) (**Figure 5 and Table 2 in Appendix**).

Eagle Creek Watershed
Land Use, Population and Grazing Density





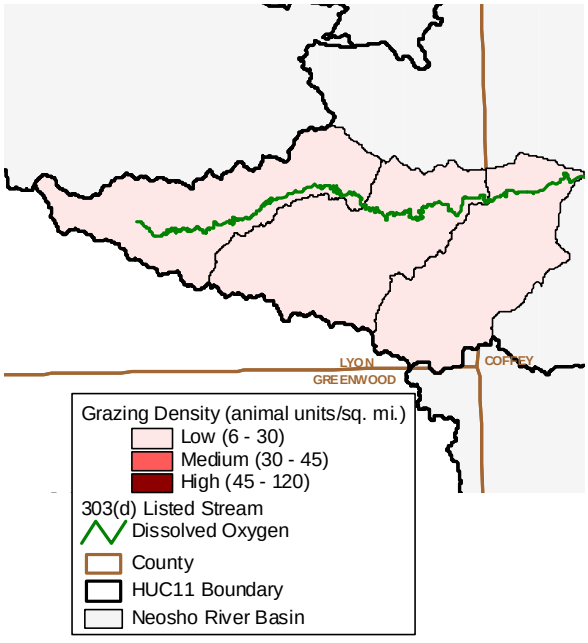


Figure 5

On-Site Waste Systems: The watershed's population density is low when compared to densities across the Neosho Basin (7-10 person/mi^2) (**Figure 5**). The rural population projections for Lyon County through 2020 show slight to modest growth (8% increase). While failing on-site waste systems can contribute oxygen demanding substance loadings, their impact on the impaired segments is generally limited, given the small size of the rural population and magnitude of other sources in the watershed.

Background Levels: Some organic enrichment may be associated with environmental background levels, including contributions from wildlife and stream side 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. In the case of stream side vegetation, the loading should be fairly constant along the main stem of the watershed since the woodland is evenly distributed along it.

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. It is presumed that the maintenance of historical BOD loads with improvements to tributary buffers and any stream restoration projects cited by local assessments will reduce DO excursions under certain critical flow conditions. Therefore, any allocation of wasteloads and loads will be made in terms of BOD.

This is a phased TMDL. Additional monitoring over time will be needed to further ascertain the relationship between enhancements through stream restoration and tributary buffer strip conditions which should filter sediment before reaching the stream, reduce sediment oxygen demand and consequently improve DO levels during the critical flow periods of concern. In Phase One of this TMDL the following allocations apply:

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 on 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.

Because of the indications that low flow is the primary factor causing the occasional excursion from the water quality standard rather than BOD, point sources are not seen as a significant source of DO excursions.

Streeter-Phelps analyses for this point source indicates the present BOD permit limit (30 mg/L) for it maintains DO levels above 5 mg/L in the stream when there is no flow upstream of the discharge point (see attached Streeter-Phelps analysis).

The design flow of the point source (0.078 cfs) redefines the lowest flow seen at site 634 (88 - 99% exceedance), and the WLA equals the TMDL curve across this flow condition (**Figure 6**).

From this, the WLA for the city of Olpe is 12.6 lbs/day BOD which translates to an in stream WLA of 1.42 lbs/day BOD at Site 634 (**Figure 6**).

Non-Point Sources: Again, because the indications that low flow is the driving factor causing the occasional excursion from the water quality standard rather than BOD, non-point sources are also not seen as a significant source of DO excursion in the watershed. The Load Allocation assigns responsibility for maintaining the historical average in-stream BOD levels at site 634 to 3.4 mg/L for flows greater than 0.09 cfs (0-87% exceedance). The LA equals zero for flows from 0 - 0.08 cfs (88 - 99 % exceedance), since the flow at this condition is entirely effluent created, and then increases to the TMDL curve with increasing flow beyond 0.08 cfs.(**Figure 6**).

To address any artificial sources factoring into the DO violations outlined in **Table 4 of the Appendix** at water quality sampling site 634, buffer strips should be installed on directly contributing tributaries to filter sediment before reaching the stream.

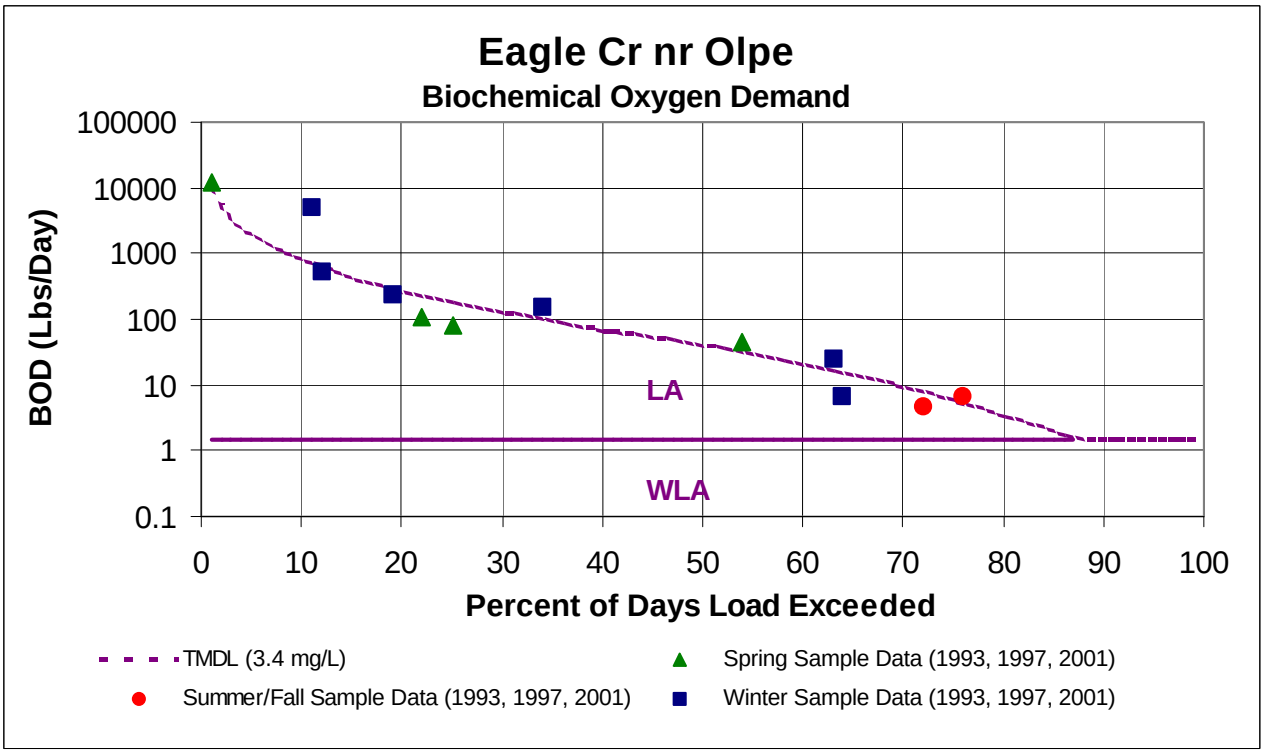


Figure 6

Defined Margin of Safety: The Margin of Safety will be implied 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, associated CBOD content, temperature of the effluent, higher than expected stream velocity and the better than permitted performance of

the treatment plant in producing effluent with BOD well below permit limits under critical seasonal conditions. Additionally, the target BOD concentration has been set at a conservative value since sampling data indicates exceeding this value has seldom led to a dissolved oxygen violation.

State Water Plan Implementation Priority: Because this watershed has indicated some problem with dissolved oxygen which has short term and immediate consequences for aquatic life, this TMDL will be a High Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Neosho Headwaters Basin (HUC 8: 11070201) with a priority ranking of 38 (Medium Priority for restoration work).

Priority HUC 11s and Stream Segments: Priority should be directed toward baseflow gaining stream segments including the main stem of Eagle Creek and any other baseflow gaining tributaries upstream of site 634.

5. IMPLEMENTATION

Desired Implementation Activities

1. Conduct stream morphology review.
2. Where needed, create/restore buffer strips along contributing tributaries.

Implementation Programs Guidance

Stream Restoration Program - SCC

a. Conduct a stream morphology evaluation along the stream reaches in the vicinity of the monitoring station.
b. Assess the degree to which sediment is altering stream flow patterns in the channel, including reducing slopes and aeration capability along the stream bed.
c. Ascertain probable sources of sediment deposition in stream, should it be a primary factor in influencing stream aeration or exerting oxygen demand.
d. Plan, design and install stream restoration measures which will restore stream flow conveyance and sediment transport capability to the target stream reaches.

Buffer Initiative Program - SCC

a. Install grass buffer strips near streams.

Timeframe for Implementation: Stream morphology assessments/restoration measures and buffer strips should be installed on main steam and baseflow gaining tributaries over the years 2003-2007.

Targeted Participants: Primary participants for implementation will be landowners immediately adjacent to the listed stream segments. Implemented activities should be targeted to

those stream segments with greatest potential contribution to baseflow. Nominally, this would be most likely be :

1. Unbuffered cropland adjacent to contributing tributaries.
2. Unstable stream banks and modified channels.

Some inventory of local needs should be conducted in 2003 to identify such activities. Such an inventory would be done by local program managers with appropriate assistance by commodity representatives and state program staff in order to direct state assistance programs to the principal activities influencing the quality of the streams in the watershed during the implementation period of this TMDL.

Milestone for 2007: The year 2007 marks the mid-point of the ten year implementation window for the watershed. At that point in time, milestones should be reached which will have at least two-thirds of the landowners responsible for buffer strip restoration or stream restoration measures, cited in the local assessment, participating in the implementation programs provided by the state.

Delivery Agents: The primary delivery agents for program participation will be the conservation districts for programs of the State Conservation Commission and the Natural Resources Conservation Service. Producer outreach and awareness will be delivered by Kansas State County staff managing.

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.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.

4. 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 areas where buffer strips may be needed.

5. 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.

6. 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.

7. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan.*

8. The *Kansas Water Plan* and the Neosho 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 TMDL is a High Priority consideration.

Effectiveness: Buffer strips are touted as a means to filter sediment before it reaches a stream and riparian restoration projects have been acclaimed as a significant means of stream bank stabilization. The key to effectiveness is participation within a finite subwatershed to direct resources to the activities influencing water quality. The milestones established under this TMDL are intended to gauge the level of participation in those programs implementing this TMDL.

Should participation significantly lag below expectations over the next five years or monitoring indicates lack of progress in improving water quality conditions from those seen over 1993, 1997, and 2001 the state may employ more stringent conditions on agricultural producers and urban runoff in the watershed in order to meet the desired endpoints expressed in this TMDL. The state has the authority to impose conditions on activities with a significant potential to pollute the waters of the state under K.S.A. 65-171. If overall water quality conditions in the watershed deteriorate, a Critical Water Quality Management Area may be proposed for the watershed, in response.

6. MONITORING

KDHE should collect bimonthly samples at rotational Station 634 in 2004 and 2008 including dissolved oxygen samples, in order to assess progress and success in implementing this TMDL toward reaching its endpoint. Should impaired status remain, the desired endpoints under this TMDL may be refined and more intensive sampling will need to be conducted under specified lower flow conditions over the period 2007-2011. Use of the real time flow data available at the Pottawatomie Creek near Scipio stream gaging station can help direct these sampling efforts.

A stream restoration review will be conducted in 2004 by the State Conservation Commission to evaluate Eagle Creek in terms of morphology and sediment impacts on stream flow patterns and its effect on aeration within the stream as outlined in the implementation guidance.

Local program management needs to identify its targeted participants of state assistance programs for implementing this TMDL. This information should be collected in 2003 in order to support appropriate implementation projects.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Neosho Basin were held January 9, 2002 in Burlington and March 4, 2002 in Council Grove. An active Internet Web site was established at http://www.kdhe.state.ks.us/tmdl/ to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Neosho Basin.

Public Hearing: Public Hearings on the TMDLs of the Neosho Basin were held in Burlington and Parsons on June 3, 2002.

Basin Advisory Committee: The Neosho Basin Advisory Committee met to discuss the TMDLs in the basin on October 2, 2001, January 9 and March 4, 2002.

Milestone Evaluation: In 2007, evaluation will be made as to the degree of implementation which has occurred within the watershed and current condition of Eagle Creek. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The creek will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2007-2011. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water quality criteria during the ten year 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, the next anticipated revision will come in 2003 which will emphasize implementation of TMDLs. At that time, incorporation of this TMDL will be made into both documents. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2003-2007.

Appendix (Eagle Creek DO TMDL)

Table 2

Eagle Cr Watershed (634)			N. Cottonwood River Wtrshd (636)		
Land Use	Acres	% of Total	Land Use	Acres	% of Total
Cropland	25435	34.9	Cropland	47511	55.8
Grassland	44568	61.2	Grassland	35946	42.2
Urban Use	320	0.4	Urban Use	115	0.1
Water	461	0.6	Water	119	0.1
Woodland	2037	2.8	Woodland	1461	1.7
Total	72820	100	Total	85152	100

Table 3

COL_DATE	DISOXY		AMMONIA		BOD		FECCOLI		NITRATE		PHFIELD		TEMP_CENT		PHOSPHU		TSS		TURBIDITY		FLOW
	634	636	634	636	634	636	634	636	634	636	634	636	634	636	634	636	634	636	634	636	634
1/6/93	13.5	13.0	0.060	0.060	2.90	2.80	250	40	0.73	0.82	7.4	7.9	0	0	0.110	0.080	26	7	32.0	5.8	35.24
3/3/93	12.1	12.2	0.050	0.110	3.50	3.70	700	700	0.97	1.35	7.5	7.4	1	0	0.320	0.490	212	327	118.0	180.0	273.00
5/19/93	8.6	6.5	0.050	0.120	1.60	3.00	120	660	1.28	0.81	7.8	7.6	13	15	0.090	0.240	23	60	19.9	44.0	12.08
7/7/93	7.7	6.5	0.050	0.050	5.00	6.40	49000	25500	1.92	0.70	7.4	7.2	18	19	0.620	0.580	490	428	225.0	182.0	451.36
9/8/93	6.0	6.4	0.050	0.050	2.10	3.10	400	160	0.39	1.27	7.5	7.8	16	17	0.080	0.240	17	68	8.0	16.0	0.43
1/15/97	14.9	10.8	0.079	0.020	1.50	3.45	10	10	0.39	0.26	7.5	7.8	0	13	0.029	0.079	7	20	2.5	9.8	0.83
3/12/97	11.8	6.6	0.020	0.118	5.34	4.77	70	1300	0.39	0.88	7.8	7.7	10	17	0.057	0.176	18	67	4.6	32.0	5.46
5/14/97	7.7	6.4	0.020	0.020	5.01	2.19	300	400	0.82	0.64	7.5	7.5	15	26	0.086	0.204	24	29	13.0	17.0	1.69
7/16/97	6.2	6.3	0.020	0.020	1.62	2.31	500	100	0.75	0.64	7.4	7.5	25	26	0.154	0.220	58	40	46.0	21.0	9.46
9/3/97	**2.5**	**5.8**	**0.020**	**0.020**	**4.47**	**5.88**	**200**	**600**	**0.08**	**0.41**	**7.3**	**7.6**	**23**	**24**	**0.422**	**0.201**	**260**	**36**	**76.0**	**15.0**	**0.28**
11/12/97	6.8	8.5	0.020	0.020	5.25	2.67	70	10	0.19	0.47	7.5	7.9	3	4	0.257	0.114	45	4	17.0	3.7	0.90
3/15/01	9.8	10.1	0.080	0.200	2.91	3.03	----	----	1.82	3.00	7.8	7.6	11	11	0.250	0.505	26	36	60.5	200.0	15.58
Avg	9.0	8.3	0.043	0.067	3.43	3.61	4693	2680	0.81	0.94	7.5	7.6	11	14	0.206	0.261	100	94	51.88	60.53	67.2

Streeter-Phelps DO Sag Model - Stream - EagleCrDO_Olpe
Single Reach - Single Load

1 cfs = .0283 m^3/s
0.25 mph =0 .11176 m/s

		Elev (ft)	Dist to 634	Min DO	Crit Dist DO
0.0021933	Design Flow (Olpe)	1180	19.90	5.44	8.52

Elevation Correction (DO)

Elevation	**1180**	ft
Correctn Factor (DO_{sat})	0.96224	mg/L

Distance (km)
Flow (m3/s)
Concentration (mg/L)
Temp (C)
Vel (m/s)

Unless modified by upstream pt. source, upstream BOD set as target for basin

Upstream DO (where appropriate) elevation corrected and set at 90% sat.

Velocity	0.11176		
BOD coef	0.23	Theta	1.056
O2 coef	1.9100	Theta	1.024

		Flow	BOD	DO	T	Dist	Slope (ft.mi)	Calc K_r	
1	**Olpe**	0.0021933	30	6.67	21.6	19.9	7.27	1.91	
	Upstream	0	0	0	0	-----			
	Result at Dist (site 634)	0.0021933	17.89	5.93	23.3				Elev = 1090 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)