NEOSHO BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: Labette Creek
Water Quality Impairment: Dissolved Oxygen

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Middle Neosho River **County:** Labette, and Neosho

HUC 8: 11070205

HUC 11 (HUC 14s)**:** **040** (020, 030, and 040)
050 (010, 020, 030, 040 and 050)

Drainage Area: 331.3 square miles

Main Stem Segments: WQLS: 20, 21 (Labette Creek) starting at confluence with the Neosho River and traveling upstream to confluence with Little Labette Creek in north-central Labette County (**Figure 1**).
Non-WQLS: 22 (Labette Creek)

Tributary Segments: WQLS: Little Labette Creek (23)
Non-WQLS: Turkey Creek (29)
Lake Creek (24)
Deer Creek (27)
Hackberry Creek (460)
Spring Creek (30)
Unnamed Streams (298, 303, 304 and 305)
Bachelor Creek (396)
Tolen Creek (39)

Designated Uses: Special Aquatic Life Support on Main Stem Segment 20, Expected Aquatic Life Support on Main Stem Segment 21, Primary Contact Recreation, Domestic Water Supply; Food Procurement; Ground Water Recharge; Industrial Water Supply Use; Irrigation Use; Livestock Watering Use for Main Stem Segments 20 and 21.

Expected Aquatic Life Support, Secondary Contact Recreation and Food Procurement on Little Labette Creek (23).

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))

Labette Creek Watershed
Dissolved Oxygen TMDL
HUC and Stream Segment Map

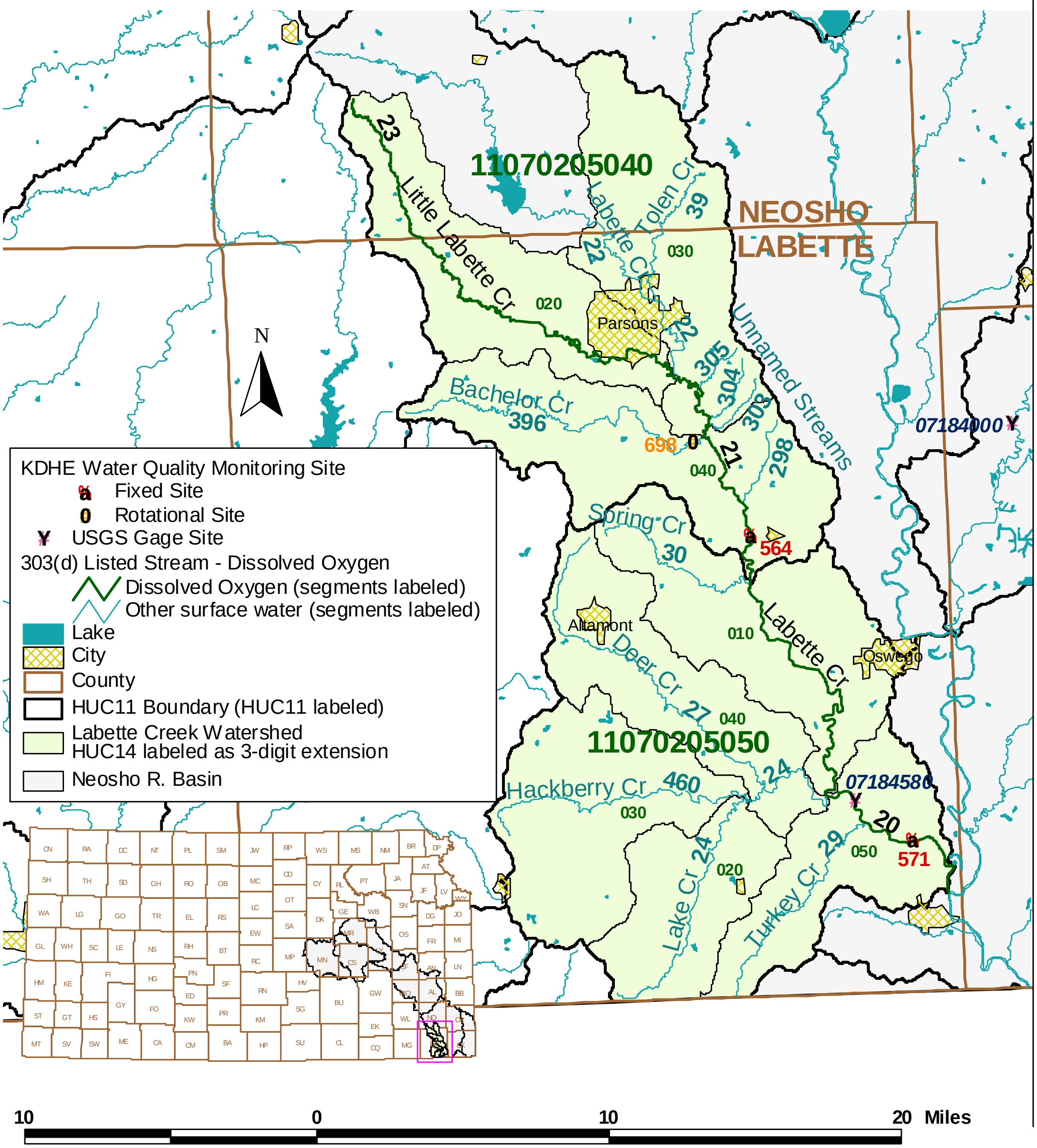


Figure 1

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 564 near Labette; Station 571 near Chetopa.

Period of Record Used: 1990-2000 for Stations 564 and 571 (**Figures 2 and 3**).

Flow Record: Lightning Creek near McCune (USGS Station 07184000) matched to Labette Creek watershed at Labette Creek near Chetopa (USGS 07184580).

Long Term Flow Conditions: 10% Exceedance Flows = 388.3 cfs, 7Q10 = 0.03 cfs

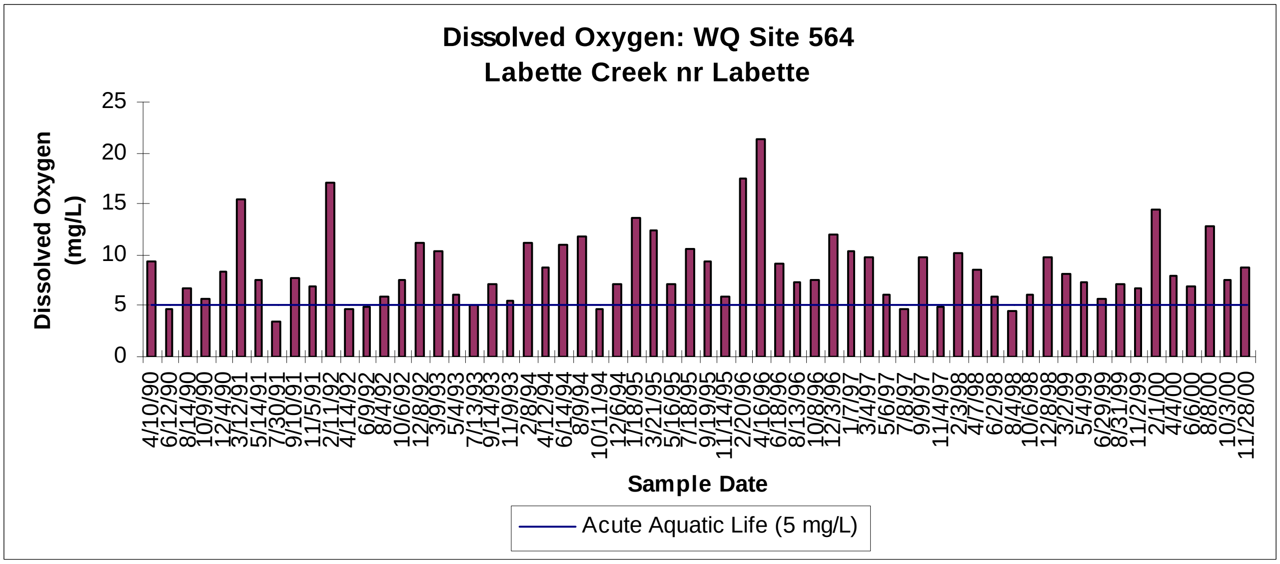


Figure 2

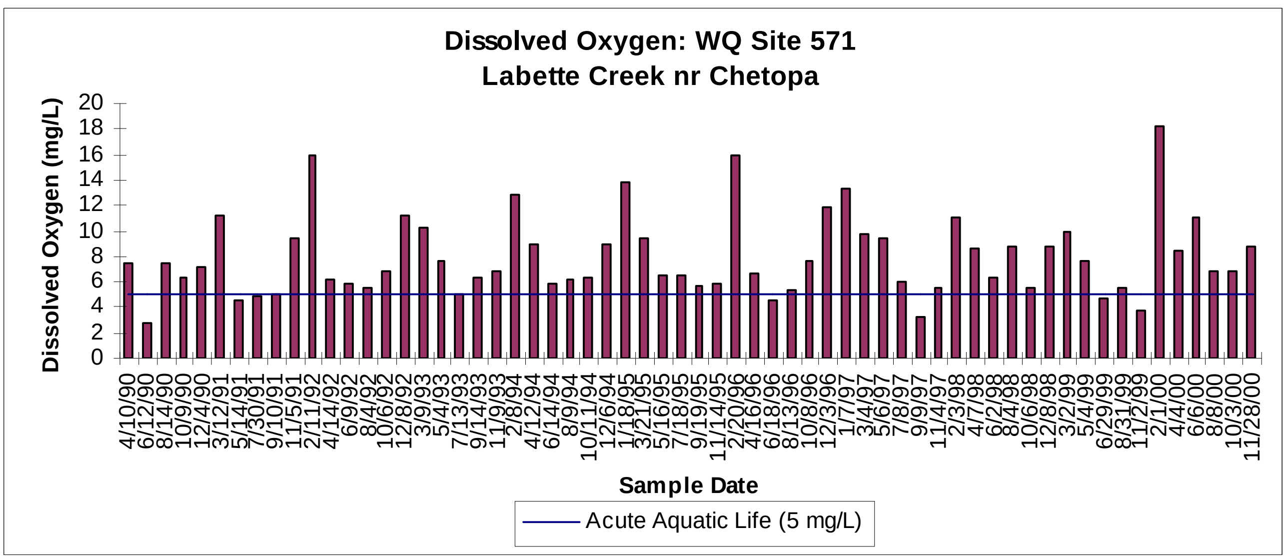


Figure 3

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 Labette Creek near Chetopa 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 4 and 5**).

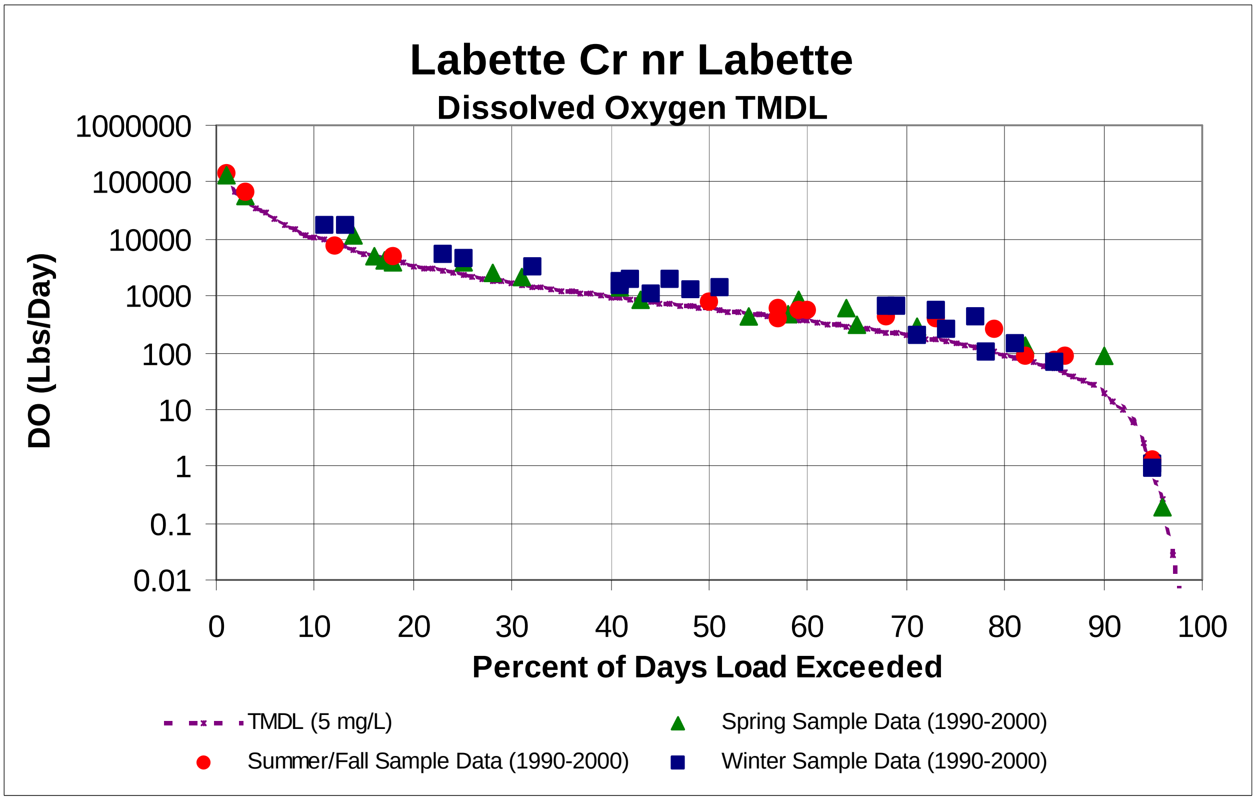


Figure 4

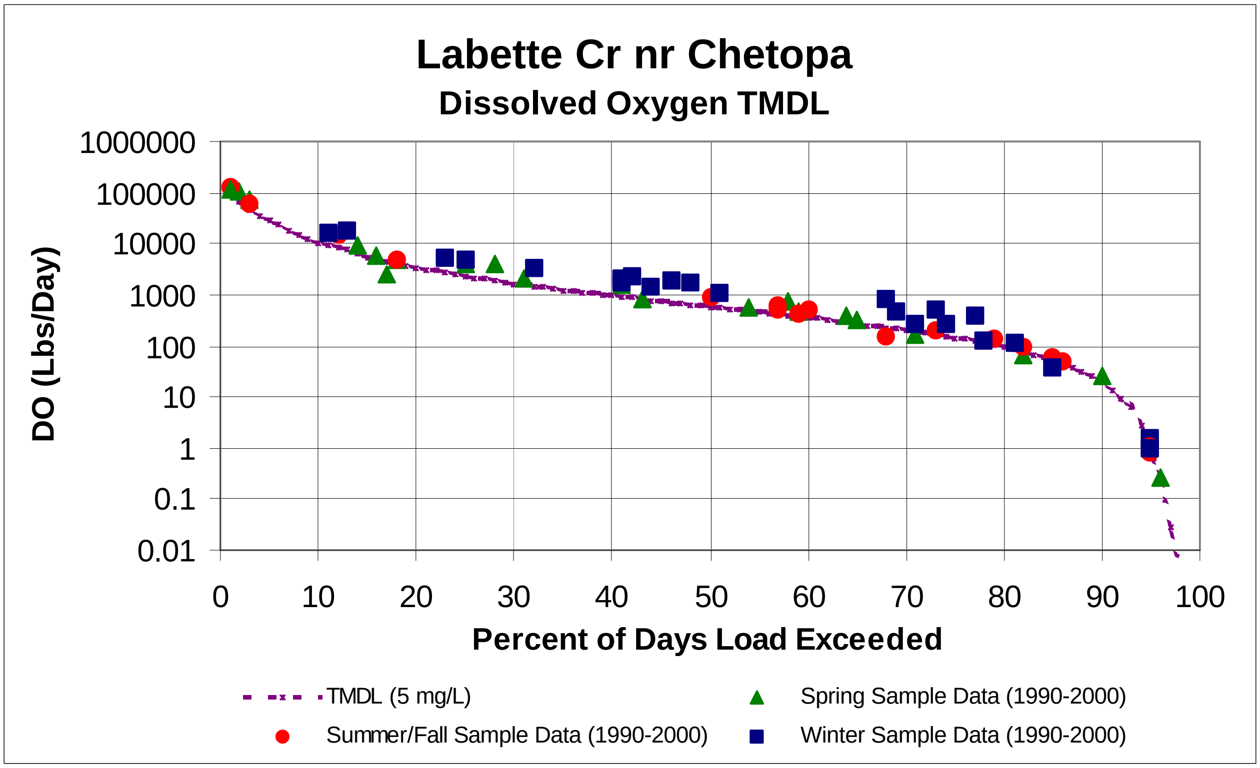


Figure 5

At Site 564 (Figure 4) excursions were seen in all seasons and are outlined in **Table 1**. Twelve percent of the Summer-Fall samples and 23% of Spring samples were below the aquatic life criterion. Four percent of the Winter samples were under the aquatic life criterion. Overall, 13% of the samples were under the criterion. This would represent a baseline condition of partial support of the impaired designated use.

Most of the DO violations were encountered at flows less than 18 cfs on Labette Creek near Labette (Site 564), therefore a critical low flow can be identified on Labette Creek as those flows of 18 cfs or less. In addition to these lower flow driven DO excursions, higher flow DO violations were noted at Site 564 (notably on 6/12/90 and 6/9/92 in **Figure 2**).

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.
Labette Creek near Labette (564)	Spring	0	3	0	1	0	1	5/22 = 23%
	Summer	0	1	0	1	0	0	2/17 = 12%
	Winter	0	0	0	0	0	1	1/23 = 4%

At Site 571 (Figure 5) excursions were seen in all seasons and are outlined in **Table 2**. Six percent of the Summer-Fall samples and 23% of Spring samples were below the aquatic life criterion. Four percent of the Winter samples were under the aquatic life criterion. Overall, 11% of the samples were under the criterion. This would also represent a baseline condition of partial support of the impaired designated use.

Most of the DO violations were encountered at flows less than 8.4 cfs on Labette Creek near Chetopa (Site 571), therefore a critical low flow can be identified on Labette Creek as those flows of 8.4 cfs or less. In addition to these lower flow driven DO excursions, higher flow DO violations were again noted at Site 571 (notably on 6/12/90 and 6/29/99 in **Figure 3**).

Table 2

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.
Labette Creek near Chetopa (571)	Spring	1	1	0	1	1	1	5/22 = 23%
	Summer	0	0	0	1	0	0	1/17 = 6%
	Winter	0	0	0	0	1	0	1/23 = 4%

A watershed comparison approach was taken in developing this TMDL. The Lightning Creek watershed (Water Quality Sampling Site 565 in the watershed was not impaired by low DO) has roughly similar land use characteristics (**see Table 3 in Appendix**) to the Labette Creek watershed, is of similar area and is located immediately east of the Labette Creek watershed. Also the Bachelor Creek subwatershed located within the Labette Creek watershed (Rotational Water Quality Sampling Site 698) was added in this comparison. 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.

<u>**Site 564**</u>: **Table 4 in the Appendix** outlines those water quality data for the samples taken on the same date for the four sites of interest. **Table 5 in the Appendix** is the subset of data from Table 4 for those sample dates when DO was below the aquatic life criterion for either sample site 564 or sample site 571 under lower flow conditions. From Table 5 for site 564 when DO was less than 5.0 mg/L (see row **Avg (DO@564<5)**) the average ammonia, BOD, nitrate and phosphorus were higher than the reference site 565, while the FCB, temperature, TSS and turbidity were comparable for both sites. This indicates that, in addition to the naturally driven factor of lower flow which can contribute to the occasional DO excursions, a probable oxygen demanding substance load is being added to the Labette Creek watershed upstream of site 564 and, under certain lower flow conditions, is likely a factor influencing the DO violations.

Table 6 in the Appendix is a subset of data from Table 4 for those sample dates when DO was below the aquatic life criterion for either sample site 564 or sample site 571 and flow conditions were high. From Table 6 for site 564 the average of all comparison factors were about the same as site 565.

<u>Site 571</u>: **Table 4 in the Appendix** outlines those water quality data for the samples taken on the same date for the four sites of interest. **Table 5 in the Appendix** is the subset of data from Table 4 for those sample dates when DO was below the aquatic life criterion for either sample site 564 or sample site 571 under lower flow conditions. From Table 5 for site 571 when DO was less than 5.0 mg/L (see row **Avg (DO@571<5)**) the average ammonia, BOD, nitrate and phosphorus were slightly higher than the reference site 565, while the FCB, temperature, TSS and turbidity were about the same for both sites. This indicates that, in addition to the naturally driven factor of lower flow which can contribute to the occasional DO excursions, a probable oxygen demanding substance load is being added to the Labette Creek watershed upstream of site 571 and, under certain lower flow conditions, is likely a factor influencing the DO violations.

Table 6 in the Appendix is a subset of data from Table 4 for those sample dates when DO was below the aquatic life criterion for either sample site 564 or sample site 571 and flow condition were high. From Table 6 for site 571 the average of all comparison factors were about the same as or less than site 565.

Desired Endpoints of Water Quality at Site 564 over 2007 - 2011

The desired endpoint will be reduced biochemical oxygen demand from artificial sources such that average BOD concentrations remain below 3.4 mg/l in the stream under the critical flow conditions which results in no excursions below 5 mg/l of DO detected between 2006 - 2011 attributed to these sources.

This desired endpoint should improve DO concentrations in the creek at the critical lower flows (0 - 18 cfs). Seasonal variation is accounted for by this TMDL, since the TMDL endpoint is sensitive to the low flow usually occurring in the June-November months.

This endpoint will be reached as a result of expected, though unspecified, reductions in organic loading from the various sources in the watershed resulting from implementation of corrective actions and Best Management Practices, as directed by this TMDL (see Implementation - Section 5). Sediment control practices such as buffer strips and grassed waterways should help reduce the non-point source BOD load under higher flows which, in turn, should help reduce the oxygen demand exerted by the sediment transported to the stream that may occur during the critical flow period. Achievement of this endpoint will provide full support of the aquatic life function of the creek and attain the dissolved oxygen water quality standard.

Desired Endpoints of Water Quality at Site 571 over 2007 - 2011

The desired endpoint will be reduced biochemical oxygen demand from artificial sources such that average BOD concentrations remain below 3.05 mg/l in the stream under the critical flow conditions which results in no excursions below 5 mg/l of DO detected between 2006 - 2011 attributed to these sources.

This desired endpoint should improve DO concentrations in the creek at the critical lower flows (0 - 8.4 cfs). Seasonal variation is accounted for by this TMDL, since the TMDL endpoint is sensitive to the low flow usually occurring in the June-November months.

This endpoint will be reached as a result of expected, though unspecified, reductions in organic loading from the various sources in the watershed resulting from implementation of corrective actions and Best Management Practices, as directed by this TMDL (see Implementation - Section 5). Sediment control practices such as buffer strips and grassed waterways should help reduce the non-point source BOD load under higher flows which, in turn, should help reduce the oxygen demand exerted by the sediment transported to the stream that may occur during the critical flow period. Achievement of this endpoint will provide full support of the aquatic life function of the creek and attain the dissolved oxygen water quality standard.

3. SOURCE INVENTORY AND ASSESSMENT

NPDES: There are five discharging NPDES permitted wastewater facilities within the watershed (**Figure 6**). These systems are outlined below in **Table 7**. Additionally there are three non-discharging facilities located within the watershed (**Figure 6**) which, under extreme precipitation events (flow durations exceeded under 5 percent of the time) may contribute an oxygen demanding substance loads to Segment 21 of Labette Cr. Such events are not related to the lower flow conditions associated with some of the DO violations in this watershed. These sources will be reviewed during the water quality special study (see Implementation - Section 5) where probable causes of violations occurring at high flow conditions will be explored.

Table 7

DISCHARGING FACILITY	STREAM REACH	SEGMENT	DESIGN FLOW	TYPE
Parsons WTF	Labette Cr.	21	3.5 mgd	Mech.
K.A.A.P (outfall 004)	Labette Cr.(via trib)	21	0.092 mgd	Mech.
Oswego WTF	Labette Cr (via trib)	21	0.305 mgd	Lagoon
Altamont WTF	Labette Cr (via trib)	20	0.145 mgd	Lagoon
Bartlett WTF	Labette Cr (via trib)	20	0.03 mgd	Lagoon

The cities of Oswego, Altamont and Bartlett rely on three cell lagoon systems with 120 day detention time for treatment of their wastewater. Kansas Implementation Procedures - Waste Water Permitting - indicates these lagoon systems meet standard design criteria. The City of Parsons uses a mechanical plant to treat its wastewater (grit chamber, primary clarifier, trickling filter - 1st stage, intermediate clarifier, trickling filter - 2nd stage, final clarifier, primary and secondary digesters and sludge storage).

The population projections for Altamont and Oswego to the year 2020 indicate slight growth. Projection for Parsons for the same period indicate slight declines while projection for Bartlett show little change. Projections of future water use and resulting wastewater appear to be within the design flows for all of the current system's treatment capacity. Examination of 1998, 1999, 2000 and 2001 effluent monitoring of the cities of Altamont, Oswego and the Kansas Army Ammunition Plant (KAAP) indicate that BOD discharges are usually well within permit limits. In the case of Oswego, effluent monitoring indicates BOD discharges in excess of permit limits occurred only twice, while Altamont and KAAP never exceeded their BOD limit during this time period. Examination of the 1999, 2000 and 2001 effluent monitoring of the cities of Bartlett and Parsons also indicate that BOD discharges are usually well within permit limits. In the case of

Bartlett, effluent monitoring indicates BOD discharges in excess of permit limits occurred three times and Parsons never exceeded their permit limit during this period.

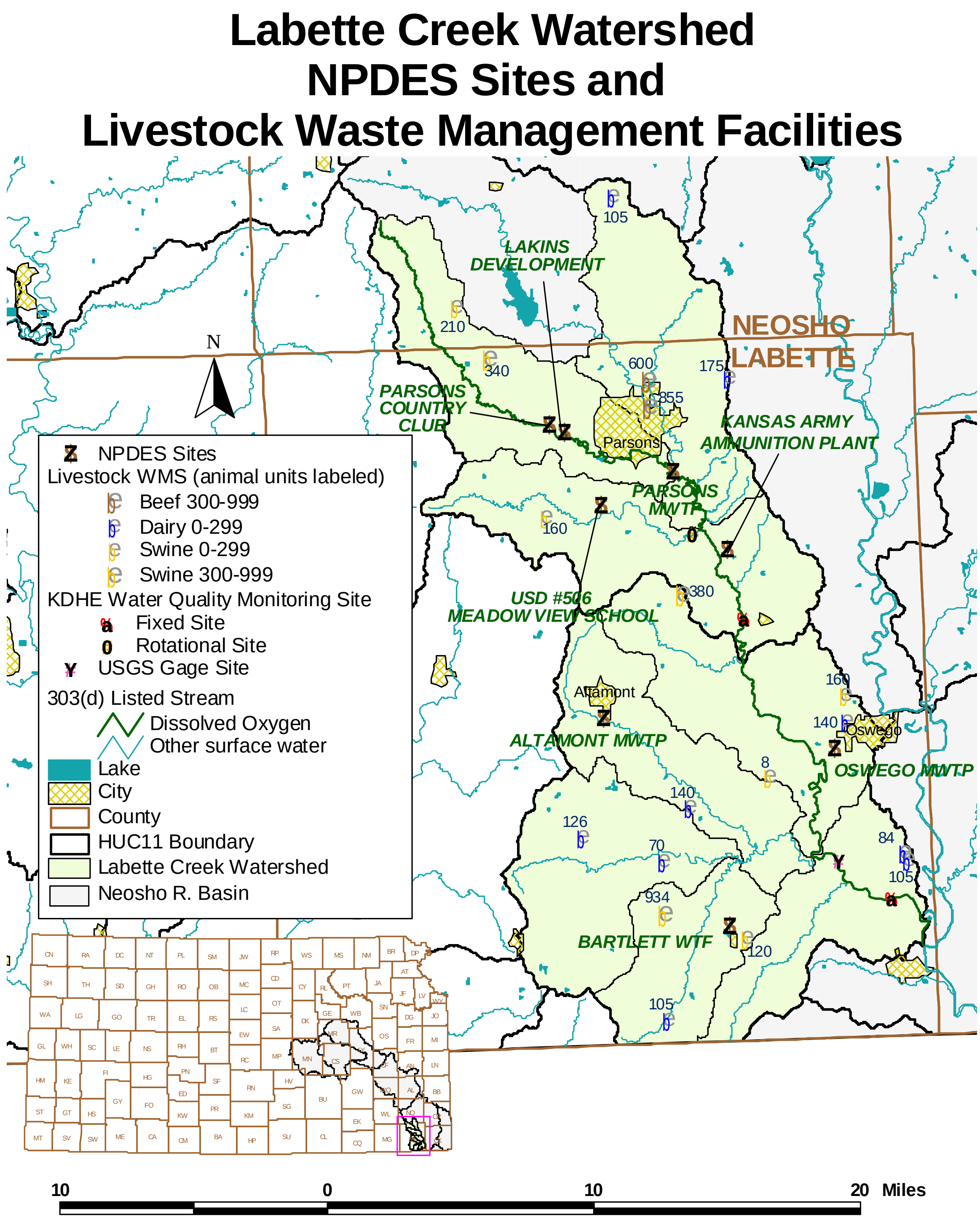


Figure 6

Labette Creek Watershed
Land Use, Population and Grazing Density

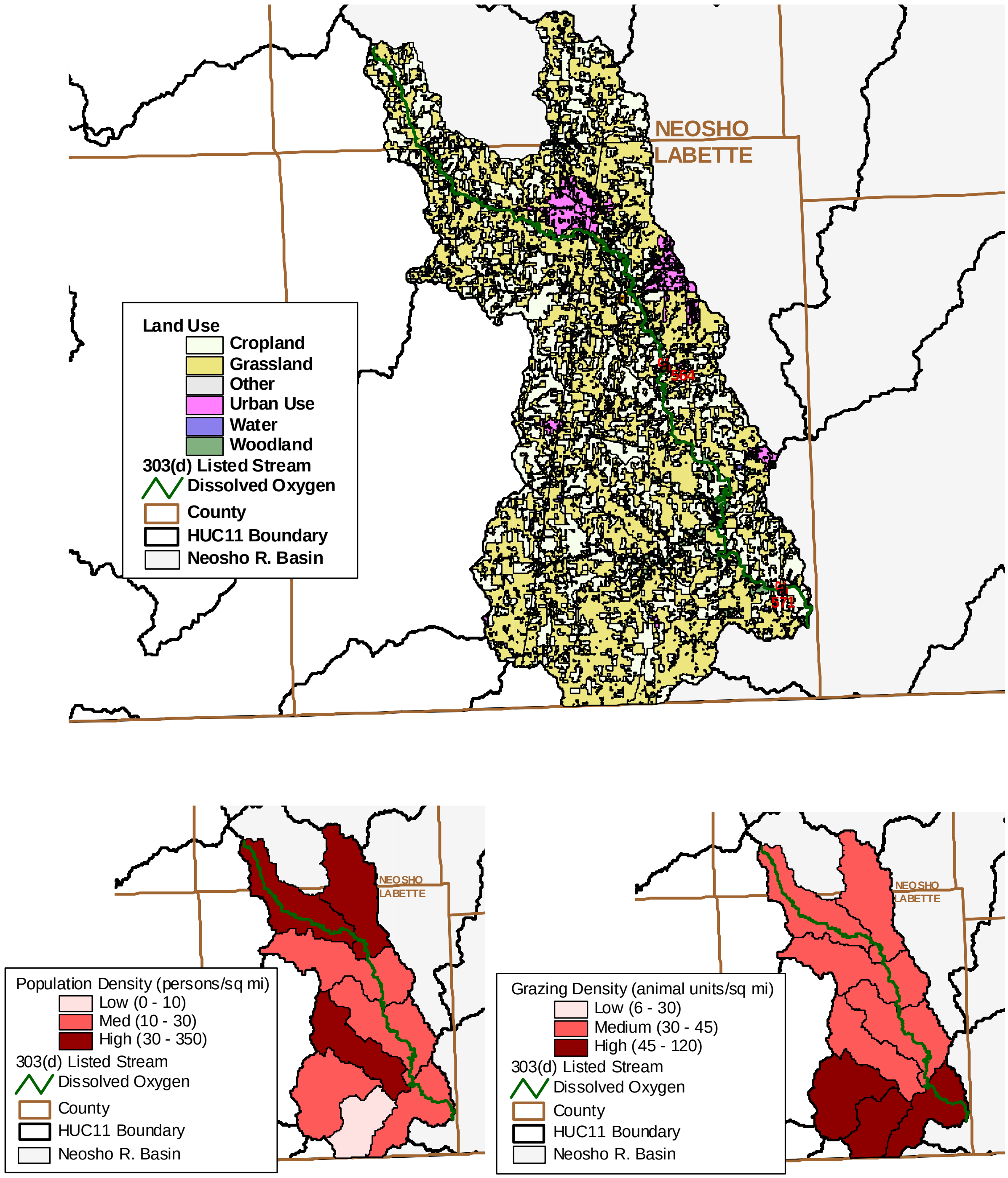


Figure 7

Livestock Waste Management Systems: Nineteen operations are registered, certified or permitted within the watershed. These facility types are beef, dairy or swine and are evenly distributed across the watershed(**Figure 6**). 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 in the watershed is 4,817 . The actual number of animal units on site is variable, but typically less than potential numbers.

Land Use: Most of the watershed is grassland (51% of the area), cropland (41%), or woodland (3%). The cropland also appears to be evenly distributed across the watershed. The grazing density estimate is average in the upper three fourths of the watershed (39-42 animal units/mi^2) and high in the lower fourth of the watershed (49-57 animal units/mi^2) when compared to densities elsewhere in the Neosho Basin (**Figure 7 and Table 2 in Appendix**).

On-Site Waste Systems: The watershed's population density is high primarily in the upper third of the watershed (107-169 persons/mi^2) and average in the lower two thirds of the watershed (11-28 person/mi^2) when compared to densities elsewhere in the Neosho Basin (**Figure 7**). The rural population projections for Labette and Neosho Counties through 2020 show slight to modest growth (3-22% increase, respectively). While failing on-site waste systems can contribute oxygen demanding substance loadings, their impact on the impaired segments is generally limited, except in the upper third of the watershed, given the relative size of the rural population in this area.

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 greater toward the upper and lower third of the watershed with its larger proportion of woodland near the stream.

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 reductions in BOD loads will reduce DO excursions under certain critical flow conditions. Therefore, any allocation of wasteloads and loads will be made in terms of BOD reductions. Yet, because DO is a manifestation of multiple factors, the initial pollution load reduction responsibility will be to decrease the BOD over the critical range of flows encountered on the Labette Creek system. These reductions have been based on the relationship between DO and BOD for the samples taken at Water Quality Monitoring sites 564 and 571 as compared to the reference Lightning Creek watershed and its water quality monitoring site 565. Allocations relate to the BOD levels seen in the Labette Creek system at sites 564 and 571 relative to site 565 for the critical lower flow conditions (0-18 cfs at Site 564 and 0-8.4 cfs at Site 571). Based on this relationship, BOD loads at site 654 need to be reduced by 38% (so that in stream average

BOD is 3.4 mg/L or less) and BOD loads at site 571 need to be reduced by 19% (so that in stream average BOD is 3.05 mg/L or less). Additional monitoring over time will be needed to further ascertain the relationship between BOD reductions of non-point sources, flow conditions, and DO levels along the stream under these critical flow ranges.

For this phase of the TMDL the average condition is considered across the seasons to establish goals of the endpoint and desired reductions. Therefore, the target average BOD level was multiplied by the average daily flow for Labette Creek across all hydrologic conditions. This is represented graphically by the integrated area under the BOD load duration curve established by this TMDL. For each monitoring site, the area is segregated into allocated areas assigned to point sources (WLA) and nonpoint sources (LA). Future growth in wasteloads should be offset by reductions in the loads contributed by nonpoint sources. This offset along with appropriate limitations is expected to eliminate the impairment within the critical flow range. This TMDL represents the "Best Professional Judgment" as to the expected relationship between physical factors, organic matter and DO.

Higher flow DO excursions were also noted at both monitoring sites on Labette Creek. BOD is presently not believed to be a source driving these excursions. Additional study and monitoring is needed to further ascertain the cause(s) and source(s) responsible for DO violations under these higher flow conditions (see Section 5 - Implementation Programs Guidance).

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.

<u>Site 564</u>: Based upon the preceding assessment, only the discharging point sources (Parsons and KAAP) contributing a BOD load to the Labette Creek watershed upstream of site 564 will be considered in this Wasteload Allocation.

Streeter-Phelps analysis for the city of Parsons indicates the present BOD permit limit (20 - 25 mg/L) for the months of May through October causes DO levels to drop below 5 mg/L in the stream when there is no flow upstream of the discharge point. A permit limit of 14 - 15 BOD during this period maintains DO above 5mg/L (see attached Streeter-Phelps analysis). Streeter-Phelps analysis for the KAAP outfall #004 indicates the present BOD permit limit (30 mg/L) for this point sources 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). Pending further definition of the DO/BOD relationship during the May through October period, compliance with a 14 - 15 mg/L BOD permit limit for the city of Parsons and 30 mg/L BOD for KAAP should maintain an average BOD of less than 3.4 mg/L at the sampling site across this flow condition and achieves the Kansas Water Quality Standard for DO of 5 mg/L during these months.

Streeter-Phelps analyses using stream temperatures below 16.5º C indicate a BOD limit of 20 mg/L for the city of Parsons maintains DO levels above 5 mg/L for the months of November through April.

The combined design flow of the point sources (5.54 cfs) redefines the lowest flow seen at site 564 (75-99% exceedance), and the WLA equals the TMDL curve across this flow condition (**Figure 8**).

For periods of zero flow in receiving streams during May through October, the WLA for the city of Parsons is 439.4 lbs/day BOD, otherwise, during periods when receiving flow is present or anytime during the November through April period the WLA for Parsons is 585.9 lbs/day. The WLA for KAAP outfall #004 is 23.1 lbs/day BOD. These limits translate to an in stream WLA of 99.6 lbs/day BOD at sampling site 564 for the city of Parsons and a WLA of 2.6 lbs/day BOD for KAAP outfall #004 at sampling site 564 (**Figure 8**).

<u>Site 571</u>: Based upon the preceding assessment, only the discharging point sources (Oswego, Altamont, and Bartlett) contributing a BOD load to Labette Creek between Sites 564 and site 571 will be considered in this Wasteload Allocation.

Streeter-Phelps analyses for the cities of Altamont and Bartlett indicate the present BOD permit limit (30 mg/L) for these point sources causes DO levels to drop below 5 mg/L in the stream when there is no flow upstream of these discharge points. A BOD permit limit of 25 mg/L for both point sources maintains DO levels above 5 mg/L (see attached Streeter-Phelps analysis). Streeter-Phelps analysis for the city of Oswego indicates its present BOD permit limit (30 mg/L) maintains DO levels above 5 mg/L in the stream when there is no flow upstream of the discharge point. Pending further definition of the DO/BOD relationship during the months of May through October, compliance with a 25 mg/L BOD limit for the cities of Altamont and Bartlett and 30 mg/L for Oswego should maintain an average BOD of less than 3.05 mg/L at the sampling site across this flow condition and achieves the Kansas Water Quality Standard for DO of 5 mg/L for the months with the warmest water temperatures in the year (May - October).

KDHE will review options to initiate a research project and/or series of pilot studies to determine cost effective options to improve the effluent quality from wastewater treatment lagoons. Several approaches will be considered, including solar-powered mixers at several locations in the state, including Altamont and Bartlett to reduce the BOD levels of wastewater discharged to the Labette Creek stream system during warm weather months (May-October). This technology should ensure that the reduced BOD limits imposed by this TMDL will be achieved.

Streeter-Phelps analyses for all three point sources using stream temperatures below 16.5º C indicate the present BOD permit limit (30 mg/L) for all three point sources maintain DO levels above 5 mg/L in the stream when there is no flow upstream of the discharge point during November through April.

The sum of the design flows of the point sources (0.75 cfs) redefines the lowest flow seen at site 571 (90-99% exceedance), and the WLA equals the TMDL curve across this flow condition (**Figure 9**).

For periods of zero flow in receiving streams during May through October, the WLA will be 30.34 lbs/day BOD for Altamont, 6.3 lbs/day BOD for Bartlett and 76.6 lbs/day BOD for

Oswego. Otherwise, during periods when receiving flow is present or anytime during the November through April time period the WLA for the city of Altamont is 36.4 lbs/day BOD, 7.5 lbs/day BOD for Bartlett while Oswego remains at 76.6 lbs/day BOD. These loads translate to an in stream WLA of 3.7 lbs/day BOD for the city of Altamont, 0.8 lbs/day BOD for the city of Bartlett and 7.8 lbs/day BOD for the city of Oswego at sampling site 571 (**Figure 9**).

Non-Point Sources: Based on the prior assessment of sources, the distribution of excursions from water quality standards at site 6 and the relationship of those excursions to runoff conditions and seasons, non-point sources are also seen as a contributing factor to the occasional DO excursions in the watershed.

Site 564: The samples from the Labette Creek watershed at site 564 show there were no DO violations at flows in excess of 18 cfs. The Load Allocation assigns responsibility for reducing the in stream BOD levels at site 564 to 3.4 mg/L across the 5.4 - 18 cfs range of the critical flow condition (54 - 74% exceedance) and maintaining the in stream BOD levels at site 564 to the historical levels of 4.9 mg/L for flows in excess of 18 cfs (which is 90^{th} percentile of BOD samples for flows in Labette Creek above 18 cfs near Labette (Site 564)). The LA equals zero for flows from 0 - 5.4 cfs (75 - 99% exceedance), since the flow at this condition is entirely effluent created, and then increases to the TMDL curve with increasing flow beyond 5.4 cfs (**Figure 8**). Sediment control practices such as buffer strips and grassed waterways should help reduce the non-point source BOD load under higher flows as well as reduce the oxygen demand exerted by the sediment transported to the stream that may occur during the critical flow period.

Site 571: The samples from the Labette Creek watershed at site 571 show there were no DO violations at flows in excess of 8.4 cfs. The Load Allocation assigns responsibility for reducing the in stream BOD levels at site 571 to 3.05 mg/L across the 0.75 - 8.4 cfs range of the critical flow condition (68 - 89% exceedance) and maintaining the in stream BOD levels at site 571 to the historical levels of 6.5 mg/L for flows in excess of 8.4 cfs (which is 90^{th} percentile of BOD samples for flows in Labette Creek above 8.4 cfs near Chetopa (Site 571)).   The LA equals zero for flows from 0 - 0.75 cfs (90 - 99% exceedance), since the flow at this condition is entirely effluent created, and then increases to the TMDL curve with increasing flow beyond 0.75 cfs (**Figure 9**). Sediment control practices such as buffer strips and grassed waterways should help reduce the non-point source BOD load under higher flows as well as reduce the oxygen demand exerted by the sediment transported to the stream that may occur during the critical flow period.

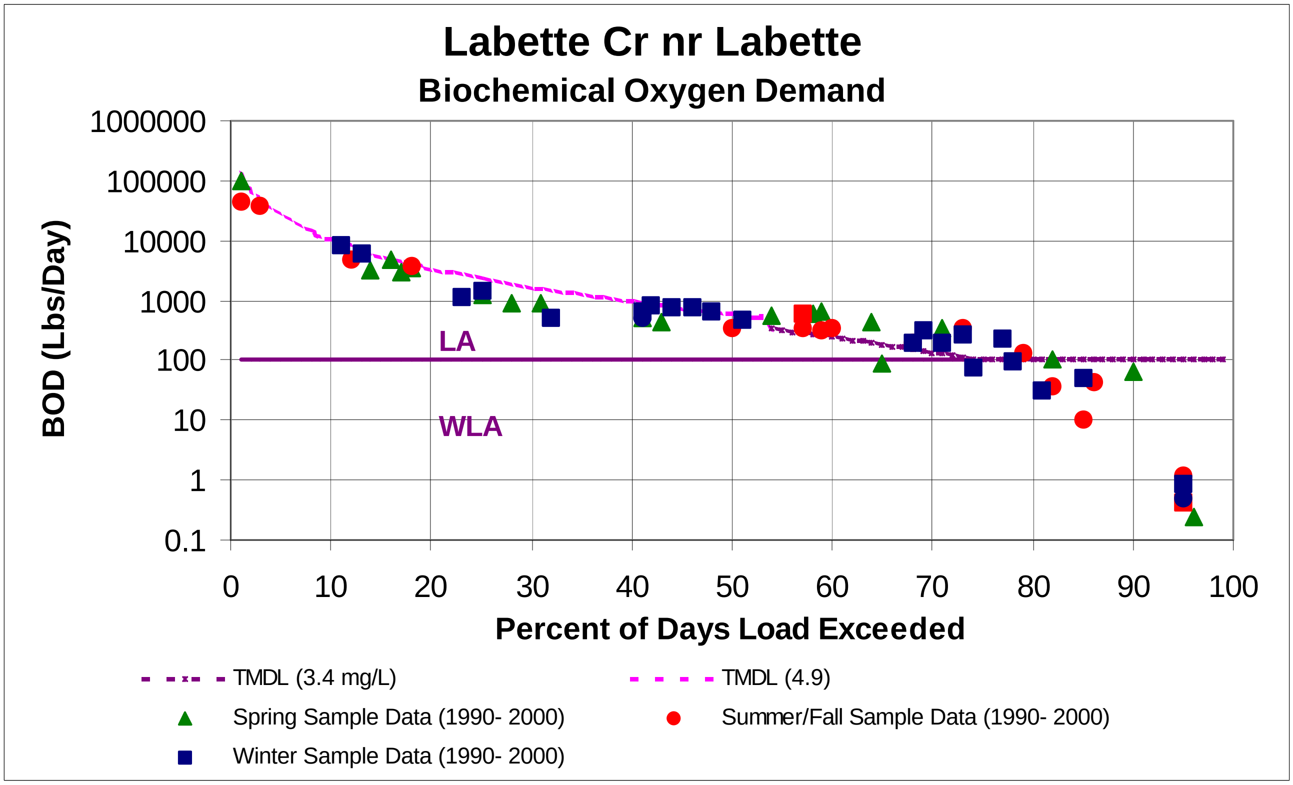

Labette Cr nr Labette
Biochemical Oxygen Demand
BOD (Lbs/Day)
1000000
100000
10000
1000
100
10
1
0.1
LA
WLA
0
10
20
30
40
50
60
70
80
90
100
Percent of Days Load Exceeded
TMDL (3.4 mg/L)
TMDL (4.9)
Spring Sample Data (1990- 2000)
Summer/Fall Sample Data (1990- 2000)
Winter Sample Data (1990- 2000)

Figure 8

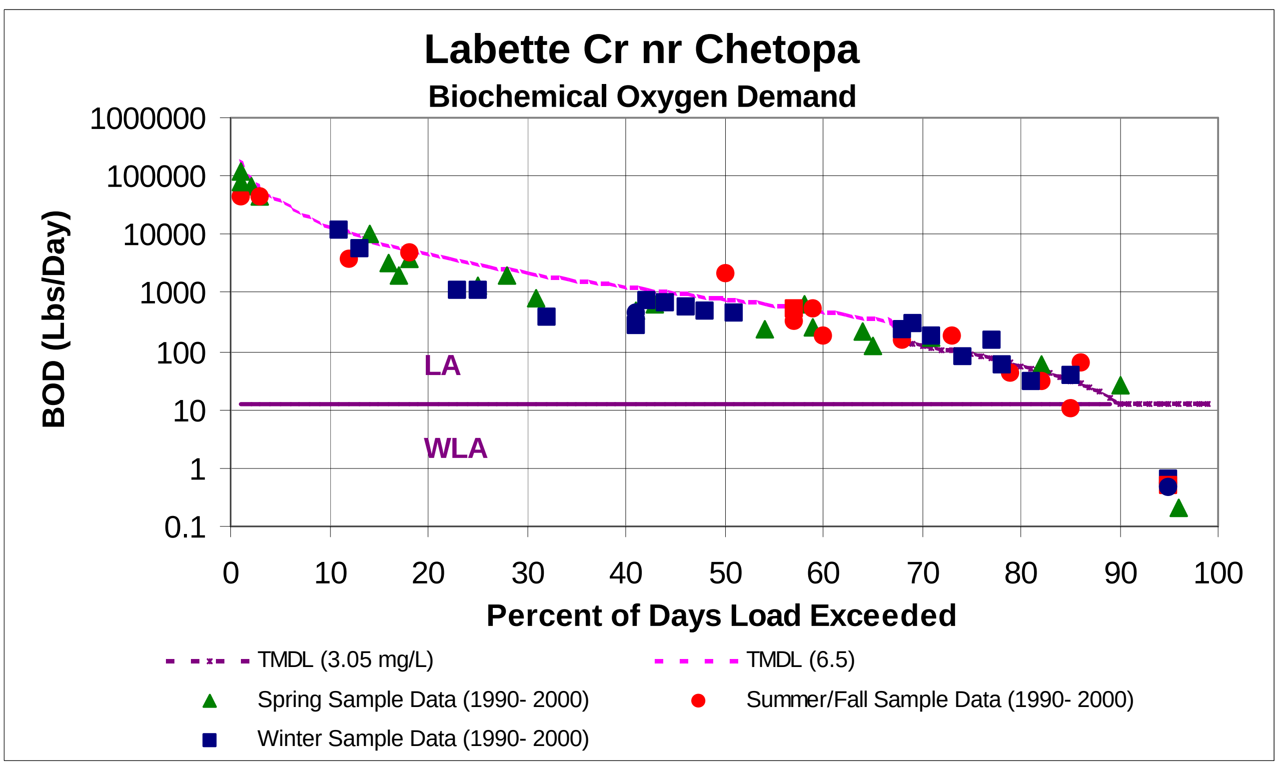

Labette Cr nr Chetopa
Biochemical Oxygen Demand
BOD (Lbs/Day)
1000000
100000
10000
1000
100
10
1
0.1
LA
WLA
0
10
20
30
40
50
60
70
80
90
100
Percent of Days Load Exceeded
TMDL (3.05 mg/L)
TMDL (6.5)
Spring Sample Data (1990- 2000)
Summer/Fall Sample Data (1990- 2000)
Winter Sample Data (1990- 2000)

Figure 9

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 Middle Neosho Basin (HUC 8: 11070205) with a priority ranking of 24 (Medium Priority for restoration work).

Priority HUC 11s and Stream Segments: Priority should be directed toward baseflow gaining stream segments along the main stem of Labette Creek (20 and 21) including Little Labette Creek (23).

5. IMPLEMENTATION

Desired Implementation Activities

1. Where needed, restore riparian vegetation along target stream segments.
2. Install grass buffer strips where needed along streams.
3. Renew state and federal permits and inspect permitted facilities for permit compliance
4. Install proper manure and livestock waste storage.
5. Insure proper on-site waste system operations in proximity to targeted streams.
6. Insure that labeled application rates of chemical fertilizers are being followed.
7. Evaluate stormwater management options to reduce urban runoff contributions to stream

Implementation Programs Guidance

NPDES and State Permits - KDHE

a. Municipal permits for facilities in the watershed will be renewed after 2006 with DO and BOD monitoring and permit limits preventing excursions in these criteria, including lower effluent BOD levels (25 mg/l for Altamont and Bartlett and 15 mg/L for Parsons) during periods of zero flow in the warm weather months between May and October.

b. Develop a pilot study on the use of aerators in lagoon systems to lower BOD levels of wastewater discharged from the lagoon treatment facilities during warm weather months.
c. Livestock permitted facilities will be inspected for integrity of applied pollution prevention technologies.
d. Registered livestock facilities with less than 300 animal units will apply pollution prevention technologies.
e. Manure management plans will be implemented to prevent introduction of organic material to the stream.

Stormwater Management - KDHE
a. Review and support urban stormwater management permits and plans, including data collection efforts to isolate runoff contributions of sediment and organic matter to stream.
b. Assist city with evaluation of Best Management Practices which will lead to reduction in sediment and organic matter loading from urban settings during runoff.

Water Quality Special Studies - KDHE - BEFS
a. Initiate a study of dissolved oxygen on Labette Creek to ascertain probable causes of violations occurring at high flow conditions.
b. Sample stormwater runoff for Parsons and Kansas Army Ammunition Plant for oxygen demanding substances.

Non-Point Source Pollution Technical Assistance - KDHE
a. Support Section 319 demonstration projects for pollution reduction from livestock operations in watershed.
b. Provide technical assistance on practices geared to small livestock operations which minimize impact to stream resources.
c. Guide federal programs such as the Environmental Quality Improvement Program, which are dedicated to priority subbasins through the Unified Watershed Assessment, to priority stream segments identified by this TMDL.

Water Resource Cost Share & Non-Point Source Pollution Control Programs - SCC
a. Provide alternative water supplies to small livestock operations.
b. Develop improved grazing management plans.
c. Reduce grazing density on overstocked pasturelands.
d. Install livestock waste management systems for manure storage.
e. Implement manure management plans.
f. Install replacement on-site waste systems close to streams.
g. Coordinate with USDA/NRCS Environmental Quality Improvement Program in providing educational, technical and financial assistance to agricultural producers.

Riparian Protection Program - SCC

a. Develop riparian restoration projects along targeted stream segments, especially those areas with baseflow.

b. Design winter feeding areas away from streams.

Buffer Initiative Program - SCC

a. Install grass buffer strips near streams.

b. Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

Extension Outreach and Technical Assistance - Kansas State University

a. Educate livestock producers on riparian and waste management techniques.

b. Educate chemical fertilizer users on proper application rates and timing.

c. Provide technical assistance on livestock waste management design.

d. Continue Section 319 demonstration projects on livestock management.

Agricultural Outreach - KDA

a. Provide information on livestock management to commodity advocacy groups.

b. Support Kansas State outreach efforts.

Local Environmental Protection Program - KDHE

a. Inspect and repair on-site waste systems within 500 feet of priority stream segments.

Timeframe for Implementation: Pollution reduction practices should be installed along Labette Creek and base flow gaining tributaries 2003-2007, with follow up implementation thereafter.

Targeted Participants: Primary participants for implementation will be the identified point sources and landowners immediately adjacent to the priority 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. Areas of denuded riparian vegetation along Labette Creek, Little Labette Creek and their contributing tributaries.
2. Facilities with inadequate water quality controls
3. Unbuffered cropland adjacent to stream
4. Sites where drainage runs through or adjacent livestock areas
5. Sites where livestock have full access to stream and stream is primary water supply
6. Poor riparian sites
7. Sites which have an urban runoff component
8. Failing on-site waste systems
9. Uncontrolled entry points for urban runoff

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 riparian restoration or buffer strips, cited in the local assessment, participating in the implementation programs provided by the state. Additionally, sampled data from sites 564 and 571 should indicate evidence of improved dissolved oxygen levels at the critical flow conditions (below 18 cfs for site 564 and below 8.5 cfs for site 571) relative to the conditions seen over 1990-2000. Information on the ability of aerators to improve lagoon effluent quality should be available in 2007.

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. On-site waste system inspections will be performed by Local Environmental Protection Program personnel for primarily Labette county. KDHE Bureau of Water is responsible for working with the cities of Parsons, Altamont and Bartlett to limit the water quality impact of their effluent, including initiating a study, in the case of Altamont and Bartlett, using aerator technology to reduce BOD levels of wastewater discharged from lagoons during warm weather months.

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 riparian areas.

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 1990-2000, 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 will continue to collect bimonthly samples at Stations 564 and 571 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 may need to be conducted under specified low flow conditions over the period 2007-2011. Use of the real time flow data available at the Lightning Creek near McCune stream gaging station can help direct these sampling efforts.

KDHE will initiate a study as conditions allow in 2003 and 2004 of the dissolved oxygen violations on Labette Creek under high flow conditions. This study will include concurrent monitoring site sampling and sampling runoff from the city of Parsons and the Kansas Army Ammunition Plant for oxygen demanding substances (as set forth in the implementation programs guidance).

Monitoring of BOD levels in effluent will continue to be a condition of NPDES and state permits for facilities. This monitoring will continually assess the functionality of the systems in reducing organic levels in the effluent released to the streams.

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 Meeting: The public meeting 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 Hearings: A Public Hearing on the TMDLs of the Neosho Basin was held in Burlington 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 Labette 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.

Table 3

Labette Cr Wtrshd (567) Land Use	Acres	% of Total	Labette Cr Wtrshd (571) Land Use	Acres	% of Total	Lightning Cr Wtrshd (611) Land Use	Acres	% of Total
Cropland	35937	39.2	Cropland	87093	41.1	Cropland	83779	56.1
Grassland	45611	49.7	Grassland	108067	51.0	Grassland	49647	33.2
Urban Use	6369	6.9	Urban Use	7533	3.6	Urban Use	1626	1.1
Water	860	0.9	Water	2128	1.0	Water	3174	2.1
Woodland	2954	3.2	Woodland	7180	3.4	Woodland	11168	7.5
Total	91732	100	Total	212001	100	Total	149393	100

Table 4

COL_DATE	DISOXY				AMMONIA				BOD				FECCOLI				NITRATE			
	564	571	698	565	564	571	698	565	564	571	698	565	564	571	698	565	564	571	698	565
4/10/90	9.3	7.5		8.5	0.010	0.260		0.030	2.60	8.00		2.70	200	45000		100	1.25	0.94		0.31
6/12/90	**4.6**	**2.8**		5.8	0.040	0.050		0.030	3.20	2.20		2.70	300	500		1300	1.09	0.58		0.47
8/14/90	6.8	7.4		9.9	0.040	0.010		0.020	3.00	17.60		2.20	100	80		110	2.59	0.00		0.00
10/9/90	5.6	6.3		11.1	0.080	0.050		0.010	2.40	2.00		2.30	300	900		80	2.31	0.66		0.03
12/4/90	8.4	7.2		10.5	0.020	0.020		0.040	1.90	1.90		1.70	60	250		70	0.99	0.28		0.11
3/12/91	15.4	11.3		9.5	0.030	0.020		0.000	7.30	7.40		2.40	10	10		20	4.41	0.02		0.02
5/14/91	7.5	**4.6**		8.4	0.030	0.010		0.000	8.90	4.70		3.20	600	300		160	1.58	0.44		0.05
7/30/91	**3.5**	**4.8**		----	0.140	0.080		----	4.60	4.00		----	300	1900		----	1.37	1.26		----
2/11/92	17	15.9		14.8	0.000	0.000		0.000	8.20	----		4.80	10	10		10	4.02	2.26		1.94
4/14/92	**4.6**	6.1		7.3	0.180	0.080		0.130	4.20	4.60		5.50	300	5000		2000	0.71	1.41		1.10
6/9/92	**4.9**	5.8		7.5	0.050	0.050		0.050	4.70	3.20		2.80	6000	100		100	1.03	1.66		2.36
8/4/92	5.8	5.6		6	0.050	0.050		0.050	4.60	5.80		3.80	11000	31000		1800	0.23	0.34		0.18
10/6/92	7.5	6.8		11.2	0.050	0.050		0.050	4.60	2.50		1.90	200	200		80	1.87	0.34		0.11
3/9/93	10.4	10.2		11	0.050	0.050		0.050	3.20	2.50		2.30	220	10		10	1.00	0.80		0.47
5/4/93	6	7.7		6.5	0.150	0.050		0.050	5.50	4.50		5.90	4600	9200		13500	0.75	0.58		0.46
7/13/93	5	5.1		7.7	0.050	0.050		0.050	2.70	4.00		1.70	800	4700		5400	0.79	0.62		0.59
9/14/93	7.2	6.4		6.6	0.090	0.050		0.050	4.10	4.70		4.50	42000	5000		18000	0.46	0.80		0.61
11/9/93	5.5	6.9		8.9	0.050	0.050		0.050	5.10	4.80		4.30	40	10		20	3.29	0.66		0.03
2/8/94	11.1	12.9		11.8	0.210	0.050		0.050	4.80	4.40		5.10	100	60		20	1.58	0.89		0.39
6/14/94	11	5.9		8.2	0.270	0.050		0.050	8.70	3.40		3.50	100	90		500	1.19	0.02		0.69
8/9/94	11.8	6.1		8.4	0.055	0.030		0.010	10.00	5.40		5.60	2000	20		2000	0.94	0.01		0.01
10/11/94	**4.7**	6.4		8.7	0.360	0.030		0.010	4.10	3.90		2.80	800	5300		1700	1.95	0.17		0.01
12/6/94	7.1	9		10.3	0.180	0.080		0.050	4.70	4.30		4.00	400	50		100	1.98	0.90		0.36
3/21/95	12.3	9.4		9.1	0.010	0.010		0.010	4.20	4.20		2.60	----	40		10	1.37	0.31		0.01
5/16/95	7.1	6.5		8.7	0.080	0.110		0.050	2.80	2.60		2.30	190	1090		200	0.96	0.67		0.44
7/18/95	10.5	6.5		6	0.030	0.010		0.010	7.70	3.70		2.20	2400	200		100	0.73	0.28		0.04
9/19/95	9.4	5.7		9.6	0.399	0.354		0.298	4.70	6.90		2.00	100	100		200	1.41	0.04		0.04
11/14/95	5.8	5.9		11	0.057	0.033		0.032	3.10	2.90		5.30	100	60		10	1.22	0.04		0.06
2/20/96	17.5	16		11	3.027	0.063		0.033	9.30	6.70		2.70	1	1		1	4.01	0.32		0.05
4/16/96	21.3	6.7		10.5	0.138	0.075		0.010	15.70	6.50		4.80	1	6		1	0.75	0.04		0.03
6/18/96	9.2	**4.5**		8.5	0.148	0.059		0.010	6.90	3.90		3.40	50	110		70	1.79	0.06		0.07
8/13/96	7.4	5.4		8.1	0.148	0.071		0.118	4.20	7.30		2.90	50	90		430	0.71	0.01		0.61
10/8/96	7.5	7.6		11.3	0.334	0.057		0.020	7.30	6.60		6.80	100	90		90	1.46	0.51		0.09
12/3/96	12	11.8		12	0.044	0.020		0.020	4.10	3.80		4.30	800	700		300	0.82	0.71		0.64
1/7/97	10.3	13.3	10.4	13.5	0.132	0.020	0.020	0.020	5.01	3.96	4.56	2.79	10	30	10	40	2.74	0.70	0.06	0.01
3/4/97	9.8	9.7	9.2	10.4	0.064	0.026	0.041	0.048	2.13	2.16	1.83	2.28	110	110	110	90	0.98	0.94	1.01	0.58
5/6/97	6.1	9.5	7.4	9	0.020	0.020	0.020	0.020	7.47	7.86	10.62	3.48	20	90	70	30	2.04	0.04	0.21	0.01
7/8/97	**4.6**	6	4.3	8.9	0.041	0.038	0.135	0.020	5.88	2.55	3.33	5.25	7000	1000	21000	500	0.80	0.55	0.30	0.16
9/9/97	9.7	**3.3**	4.5	11.8	0.020	0.020	0.100	0.020	4.41	3.48	2.25	2.40	500	30	500	150	1.53	0.07	0.22	0.15
11/4/97	**4.8**	5.6	3.9	12.5	0.020	0.020	0.020	0.020	4.38	2.73	5.31	2.40	230	150	250	70	1.83	0.63	0.54	0.16
2/3/98	10.1	11		13	0.112	0.020		0.020	3.57	1.50		2.61	120	10		60	1.98	1.18		0.38
4/7/98	8.5	8.6		9.4	0.210	1.998		0.512	2.73	2.82		2.37	300	200		300	1.03	0.85		0.51
6/2/98	5.8	6.3		10.5	0.030	0.115		0.030	1.71	2.31		3.90	170	240		50	1.00	0.73		0.05
8/4/98	**4.5**	8.8		6.8	0.074	0.020		0.022	2.82	2.34		2.43	1200	40		11000	1.02	0.22		0.50
12/8/98	9.7	8.8		9.1	0.020	0.020		0.020	4.56	6.51		6.27	16000	----		23000	0.52	0.45		0.34
3/2/99	8.2	9.9		11.5	0.030	0.030		0.030	2.76	2.43		3.15	40	110		10	1.34	0.83		0.05
6/29/99	5.7	**4.7**		5.2	0.020	0.020		0.020	4.11	3.27		4.23	10000	4900		9000	0.44	0.40		0.95
8/31/99	7.2	5.6		10.8	0.020	0.020		0.020	1.00	1.00		1.00	70	80		10	0.32	0.01		0.10
11/2/99	6.8	**3.8**		11.1	0.040	0.020		0.020	4.95	3.78		3.18	150	40		10	2.11	0.03		0.03
2/1/00	14.4	18.2		13	0.090	0.020		0.020	4.17	5.19		3.54	10	10		10	5.32	0.98		0.01
4/4/00	8	8.5		12.3	0.030	0.020		0.020	2.85	2.82		3.54	350	70		100	1.08	0.63		0.06
6/6/00	7	11.1		6.9	0.020	0.020		0.030	2.31	5.19		3.93	190	60		2000	2.05	0.28		1.04
8/8/00	12.9	6.9		8.1	0.020	0.020		0.020	6.36	2.01		2.88	360	30		10	0.86	0.01		0.06
10/3/00	7.5	6.9		8.8	0.050	0.020		0.020	2.67	3.15		2.55	410	10		60	0.54	0.02		0.03
11/28/00	8.8	8.8		15.5	0.020	0.020		0.020	2.52	2.70		3.24	20	40		10	3.62	0.56		0.01
Avg	8.57	7.82	6.62	9.68	0.14	0.08	0.06	0.04	4.75	4.27	4.65	3.38	2065	2212	3657	1759	1.56	0.52	0.39	0.33

Appendix (Labette Creek DO TMDL)

Table 4 (continued)

COL_DATE	PHFIELD				TEMP_CENT				PHOSPHU				TSS				TURBIDITY			
	564	571	698	565	564	571	698	565	564	571	698	565	564	571	698	565	564	571	698	565
4/10/90	7.7	7.5		7.7	13	13		12	0.280	0.470		0.120	37	320		92	17.0	93.0		33.0
6/12/90	7.5	7.3		7.6	23	24		23	0.270	0.230		0.210	52	66		120	37.0	38.5		61.0
8/14/90	7.7	8.1		8.3	25	23		29	0.960	0.190		0.180	27	48		211	23.9	23.0		54.0
10/9/90	7.3	7.4		8.3	13	13		9	0.680	0.140		0.060	32	55		25	26.6	39.5		17.5
12/4/90	7.6	8.3		7.4	4	3		6	0.630	0.190		0.070	9	28		28	10.8	28.0		25.2
3/12/91	9.6	8.8		8.2	11	10		12	1.660	0.160		0.060	22	40		16	9.2	17.2		7.4
5/14/91	7.9	7.6		8.2	24	22		29	0.590	0.210		0.080	79	46		33	39.8	26.9		19.8
7/30/91	7.0	7.1		----	23	21		----	0.460	0.420		----	130	264		----	89.0	183.0		----
2/11/92	9.0	8.9		8.5	5	4		5	0.770	0.110		0.050	11	10		9	6.1	6.0		6.4
4/14/92	7.5	7.7		7.5	16	15		15	0.310	0.250		0.410	37	69		195	28.0	35.7		172.0
6/9/92	6.2	7.5		7.7	20	20		21	0.300	0.200		0.140	146	61		48	68.0	34.3		30.1
8/4/92	7.4	7.1		7.4	20	19		21	0.360	0.710		0.250	190	798		134	85.0	195.0		84.0
10/6/92	7.6	7.5		8.1	16	16		18	0.380	0.170		0.080	35	39		14	25.7	34.8		10.5
3/9/93	7.7	7.5		7.8	9	7		9	0.300	0.130		0.080	32	25		23	29.0	32.0		21.0
5/4/93	7.5	7.3		7.0	15	15		14	0.290	0.180		0.520	68	76		500	30.0	47.0		250.0
7/13/93	7.5	7.2		7.9	25	23		26	0.300	0.350		0.120	64	168		96	54.0	118.0		22.0
9/14/93	7.1	7.2		6.8	18	18		18	0.410	0.890		0.740	184	410		720	114.0	150.0		300.0
11/9/93	7.3	7.3		7.5	6	5		6	0.510	0.080		0.070	12	12		13	4.0	5.0		6.0
2/8/94	7.6	7.7		7.8	0	0		0	0.260	0.120		0.050	23	29		18	17.0	20.0		16.5
6/14/94	8.4	7.9		8.1	26	24		26	0.310	0.090		0.120	74	20		62	22.0	11.0		34.0
8/9/94	8.7	7.6		8.4	26	24		27	0.320	0.085		0.077	136	25		35	39.0	13.0		10.0
10/11/94	7.3	7.3		7.8	16	12		15	0.460	0.100		0.060	21	37		35	9.0	15.0		10.0
12/6/94	7.4	7.5		7.8	6	6		6	0.270	0.110		0.050	32	21		13	20.0	17.0		6.0
3/21/95	8.6	8.0		8.2	16	14		15	0.340	0.050		0.060	24	11		18	8.0	4.0		5.0
5/16/95	7.4	7.4		7.8	20	19		20	0.170	0.140		0.080	25	22		20	7.0	14.0		4.0
7/18/95	8.3	7.7		7.8	26	25		26	0.330	0.120		0.180	90	36		56	45.0	27.0		7.0
9/19/95	8.0	7.7		8.3	20	20		19	0.298	0.117		0.143	24	29		13	9.0	12.0		5.0
11/14/95	7.6	7.5		8.1	7	5		7	0.734	0.077		0.291	5	10		856	3.0	5.0		27.0
2/20/96	8.4	8.2		8.1	6	4		11	1.284	0.096		0.050	10	19		42	4.7	8.4		2.9
4/16/96	9.5	7.7		8.3	14	12		13	0.905	0.131		0.078	32	29		60	6.0	13.0		12.0
6/18/96	7.5	7.1		7.9	26	23		28	0.310	0.108		0.092	54	40		33	17.0	23.0		15.0
8/13/96	7.7	7.7		7.7	24	23		25	0.102	0.175		0.216	27	58		87	10.0	28.0		60.0
10/8/96	7.4	7.6		8.2	16	14		15	0.244	0.178		0.078	20	35		13	12.0	22.0		6.0
12/3/96	7.4	7.4		7.4	6	5		5	0.202	0.226		0.180	29	32		33	53.0	52.0		37.0
1/7/97	7.7	8.1	7.5	8.2	7	4	5	5	0.414	0.085	0.066	0.050	12	14	6	11	7.1	5.3	4.6	4.7
3/4/97	7.4	7.4	7.4	7.6	10	8	9	10	0.220	0.190	0.160	0.150	40	45	34	31	51.0	45.0	47.0	34.0
5/6/97	7.6	7.8	7.6	8.0	19	17	18	20	0.296	0.071	0.077	0.053	21	27	14	23	8.0	12.0	8.0	8.5
7/8/97	7.1	7.0	6.9	8.0	25	24	24	27	0.341	0.245	0.281	0.133	124	42	72	70	72.0	67.0	57.0	39.0
9/9/97	7.6	7.0	7.1	8.2	27	24	27	29	0.365	0.142	0.111	0.129	18	35	12	31	13.0	20.0	12.0	25.0
11/4/97	7.3	7.5	7.0	8.2	10	10	10	12	0.415	0.306	0.289	0.152	36	41	36	11	28.0	41.0	36.0	15.0
2/3/98	7.6	7.7		7.9	5	5		5	0.260	0.090		0.050	17	12		17	10.0	9.4		10.0
4/7/98	7.5	7.9		7.5	15	15		15	0.230	0.200		0.170	56	56		52	47.0	51.0		47.0
6/2/98	7.5	7.7		8.3	29	27		32	0.280	0.148		0.120	32	38		59	17.0	23.0		17.0
8/4/98	7.4	8.0		7.4	28	28		27	0.300	0.110		0.320	42	19		144	28.0	45.0		93.0
12/8/98	7.5	7.4		7.5	11	9		10	0.300	0.375		0.290	64	116		88	67.0	90.0		63.0
3/2/99	8.2	8.0		7.9	12	12		11	0.220	0.120		0.070	37	32		20	18.0	16.0		7.9
6/29/99	7.4	7.4		7.1	25	26		24	0.440	0.495		0.550	272	160		428	158.0	86.0		100.0
8/31/99	8.0	8.0		8.3	28	30		29	0.200	0.090		0.070	20	23		29	8.8	10.0		11.0
11/2/99	7.6	7.5		8.2	14	14		15	0.850	0.130		0.100	30	20		11	7.6	9.7		7.9
2/1/00	8.1	8.5		8.1	4	2		4	0.940	0.140		0.080	6	16		20	6.1	5.9		8.9
4/4/00	7.6	7.7		8.2	12	14		14	0.230	0.170		0.110	43	36		32	28.0	28.0		15.0
6/6/00	7.8	8.7		7.8	24	27		23	0.360	0.160		0.250	31	29		187	16.0	20.0		47.0
8/8/00	8.5	7.8		8.3	31	33		35	0.250	0.070		0.090	35	19		22	12.0	9.7		9.3
10/3/00	7.6	7.8		8.4	24	24		27	0.300	0.070		0.040	25	15		5	13.0	7.9		2.2
11/28/00	7.5	7.5		8.4	8	7		10	0.450	0.160		0.090	11	6		20	4.0	4.8		4.5
Avg	7.72	7.67	7.25	7.91	16.53	15.65	15.50	16.94	0.43	0.19	0.16	0.15	50.27	68.89	29.00	92.26	29.06	36.33	27.43	36.06

Appendix (Labette Creek DO TMDL)

Table 5

COL_DATE	DISOXY				AMMONIA				BOD				FECCOLI				NITRATE			
	564	571	698	565	564	571	698	565	564	571	698	565	564	571	698	565	564	571	698	565
5/14/91	7.5	**4.6**		8.4	0.030	0.010		0.000	8.90	4.70		3.20	600	300		160	1.58	0.44		0.05
7/30/91	**3.5**	**4.8**		----	0.140	0.080		----	4.60	4.00		----	300	1900		----	1.37	1.26		----
4/14/92	**4.6**	6.1		7.3	0.180	0.080		0.130	4.20	4.60		5.50	300	5000		2000	0.71	1.41		1.10
10/11/94	**4.7**	6.4		8.7	0.360	0.030		0.010	4.10	3.90		2.80	800	5300		1700	1.95	0.17		0.01
6/18/96	9.2	**4.5**		8.5	0.148	0.059		0.010	6.90	3.90		3.40	50	110		70	1.79	0.06		0.07
7/8/97	**4.6**	6	4.3	8.9	0.041	0.038	0.135	0.020	5.88	2.55	3.33	5.25	7000	1000	21000	500	0.80	0.55	0.30	0.16
9/9/97	9.7	**3.3**	4.5	11.8	0.020	0.020	0.100	0.020	4.41	3.48	2.25	2.40	500	30	500	150	1.53	0.07	0.22	0.15
11/4/97	**4.8**	5.6	3.9	12.5	0.020	0.020	0.020	0.020	4.38	2.73	5.31	2.40	230	150	250	70	1.83	0.63	0.54	0.16
8/4/98	**4.5**	8.8		6.8	0.074	0.020		0.022	2.82	2.34		2.43	1200	40		11000	1.02	0.22		0.50
11/2/99	6.8	**3.8**		11.1	0.040	0.020		0.020	4.95	3.78		3.18	150	40		10	2.11	0.03		0.03
Avg	5.99	5.39		9.33	0.105	0.038		0.028	5.11	3.60		3.40	1113	1387		1740	1.47	0.48		0.25
Avg (DO@564<5)	4.40	5.70	4.10	10.03	0.140	0.042	0.078	0.017	4.74	3.30	4.32	3.44	2083	2088	10625	757	1.49	0.65	0.42	0.11
Avg (DO@571<5)	7.34	4.20	4.50	9.95	0.076	0.038	0.100	0.013	5.95	3.97	2.25	3.05	320	476	500	98	1.68	0.37	0.22	0.08

COL_DATE	PHFIELD				TEMP_CENT				PHOSPHU				TSS				TURBIDITY			
	564	571	698	565	564	571	698	565	564	571	698	565	564	571	698	565	564	571	698	565
5/14/91	7.9	7.6		8.2	24	22		29	0.590	0.210		0.080	79	46		33	39.8	26.9		19.8
7/30/91	7.0	7.1		----	23	21		----	0.460	0.420		----	130	264		----	89.0	183.0		----
4/14/92	7.5	7.7		7.5	16	15		15	0.310	0.250		0.410	37	69		195	28.0	35.7		172.0
10/11/94	7.3	7.3		7.8	16	12		15	0.460	0.100		0.060	21	37		35	9.0	15.0		10.0
6/18/96	7.5	7.1		7.9	26	23		28	0.310	0.108		0.092	54	40		33	17.0	23.0		15.0
7/8/97	7.1	7.0	6.9	8.0	25	24	24	27	0.341	0.245	0.281	0.133	124	42	72	70	72.0	67.0	57.0	39.0
9/9/97	7.6	7.0	7.1	8.2	27	24	27	29	0.365	0.142	0.111	0.129	18	35	12	31	13.0	20.0	12.0	25.0
11/4/97	7.3	7.5	7.0	8.2	10	10	10	12	0.415	0.306	0.289	0.152	36	41	36	11	28.0	41.0	36.0	15.0
8/4/98	7.4	8.0		7.4	28	28		27	0.300	0.110		0.320	42	19		144	28.0	45.0		93.0
11/2/99	7.6	7.5		8.2	14	14		15	0.850	0.130		0.100	30	20		11	7.6	9.7		7.9
Avg ALL	7.42	7.38		7.93	20.9	19.3		21.9	0.440	0.202		0.164	57.1	61.3		62.6	33.1	46.6		44.1
Avg (DO@564<5)	7.18	7.23	6.95	8.00	18.5	16.8	17.0	18.0	0.419	0.268	0.285	0.115	77.8	96.0	54.0	38.7	49.5	76.5	46.5	21.3
Avg (DO@571<5)	7.52	7.26	7.10	8.13	22.8	20.8	27.0	25.3	0.515	0.202	0.111	0.100	62.2	81.0	12.0	27.0	33.3	52.5	12.0	16.9

Table 6

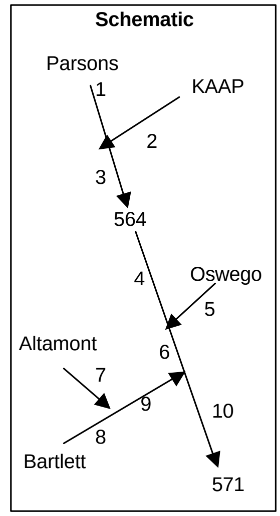
COL_DATE	DISOXY				AMMONIA				BOD				FECCOLI				NITRATE			
	564	571	698	565	564	571	698	565	564	571	698	565	564	571	698	565	564	571	698	565
6/12/90	**4.6**	**2.8**		5.8	0.040	0.050		0.030	3.20	2.20		2.70	300	500		1300	1.09	0.58		0.47
6/9/92	**4.9**	5.8		7.5	0.050	0.050		0.050	4.70	3.20		2.80	6000	100		100	1.03	1.66		2.36
6/29/99	5.7	**4.7**		5.2	0.020	0.020		0.020	4.11	3.27		4.23	10000	4900		9000	0.44	0.40		0.95
Avg ALL	5.07	4.43		6.17	0.037	0.040		0.033	4.00	2.89		3.24	5433	1833		3467	0.85	0.88		1.26

COL_DATE	PHFIELD				TEMP_CENT				PHOSPHU				TSS				TURBIDITY			
	564	571	698	565	564	571	698	565	564	571	698	565	564	571	698	565	564	571	698	565
6/12/90	7.5	7.3		7.6	23	24		23	0.270	0.230		0.210	52	66		120	37.0	38.5		61.0
6/9/92	6.2	7.5		7.7	20	20		21	0.300	0.200		0.140	146	61		48	68.0	34.3		30.1
6/29/99	7.4	7.4		7.1	25	26		24	0.440	0.495		0.550	272	160		428	158.0	86.0		100.0
Avg ALL	7.03	7.40		7.47	22.7	23.3		22.7	0.337	0.308		0.300	156.7	95.7		198.7	87.7	52.9		63.7

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

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

		Elev (ft)	Dist to 564	Dist to 571	Min DO	Crit Dist DO	
0.1535275	Design Flow (Parsons)	850	16.20	----	6.44	11.00	9.9424
0.0040356	Design Flow (KAAP)	850	9.50	----	6.78	0.00	82
0.0133788	Design Flow (Oswego)	870	----	16.70	6.98	0	
0.0063534	Design Flow (Altamont)	880	----	30.00	6.23	7.04	8.247506
0.0013160	Design Flow (Bartlett)	870	----	22.25	6.49	0	



Elevation Correction (DO)

Elevation	**788**	ft
Correctn Factor (DO_{sat})	0.974784	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	*see below*	Theta	1.024

Monitoring Site 564

		Flow	BOD	DO	T	Dist	Slope (ft/mi)	Calc K_r	
1	**Parsons**	0.1535275	14	7.23	21.6	7.7	4.39	1.19	
	Upstream	0	0	0	0	-----			
	Result at Dist (Jcn with KAAP)	0.1535275	11.46	6.48	21.6				
2	**KS Army Ammun. Plant**	0.0040356	30	6.78	21.6	1	33.8	~~9.89~~	
	Upstream	0	0	0	0	-----		3.64	
	Result at Dist	0.0040356	29.23	6.79	21.6				
3	**KAAP Jcn at Labette Cr**	0.0040356	29.23	6.79	21.6	8.5	1.325	0.50	Elev = 829ft
	Upstream (mod. by Parsons)	0.1535275	11.46	6.48	21.6	-----			
	Result at Dist (site 564)	0.1575631	9.55	5.38	21.6				Elev = 822ft

Monitoring Site 571

		Flow	BOD	DO	T	Dist	Slope (ft/mi)	Calc K_r	
4	**From Site 564 at Oswego Jcn.**	0.1575631	6.01	5.32	21.6	17.8	1.54	0.54	Elev = 822ft
5	**Oswego**	0.0133788	30	6.98	21.6	5	20.9	~~5.80~~	
	Upstream	0	0	0	0	-----		4.56	
	Result at Dist	0.0133788	26.34	7.1	21.6				
6	**Oswego Jcn to Labette Cr**	0.0133788	26.34	7.1	21.6	4.6	2.45	0.74	Elev = 805ft
	Upstream (Mod. by Pt Sources Site 564)	0.1575631	6.01	5.32	21.6	-----			
	Result at Dist	0.1709419	6.74	5.7	21.6				
7	**Altamont**	0.0063534	25	6.92	21.6	16	8.24	2.16	
	Upsteam	0	0	0	0	-----			
	Result at Dist	0.0063534	19.72	6.12	21.6				
8	**Bartlett**	0.0013160	25	6.49	21.6	8	14.48	~~3.90~~	
	Upstream	0	0	0	0	-----		3.49	
	Result at Dist	0.001316	24.37	6.76	21.6				Elev = 798ft
9	**Bartlett Jcn to Labette Cr**	0.001316	24.37	6.76	21.6	7.1	2.27	0.70	Elev = 788ft
	Upstream (Altamont Jcn to Labette Cr)	0.0063534	19.72	6.12	21.6	-----			
	Result at Dist	0.0076693	14.26	5.18	21.6				
10	**Lake Cr discharge**	0.0076693	14.26	5.18	21.6	7.1	1.81	0.60	Elev = 780ft
	Upstream (Labette Cr discharge)	0.1709419	6.74	5.7	21.6	-----			
	Result at Dist (571)	0.1786112	5.89	5.87	21.6				

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)

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

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

		Elev (ft)	Dist to 564	Dist to 571	Min DO	Crit Dist DO	
0.1535275	Design Flow (Parsons)	850	16.20	----	6.67	10.38	9.9424
0.0040356	Design Flow (KAAP)	850	9.50	----	6.78	0.00	82
0.0133788	Design Flow (Oswego)	870	----	16.70	6.98	0	
0.0063534	Design Flow (Altamont)	880	----	30.00	6.82	3.66	8.247506
0.0013160	Design Flow (Bartlett)	870	----	22.25	6.49	0	

Elevation Correction (DO)

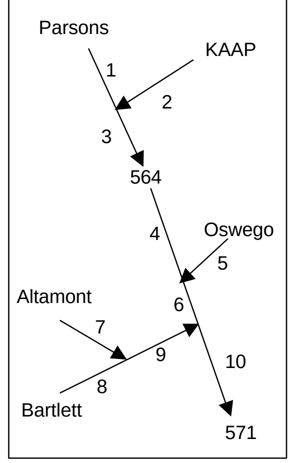
Elevation	**780**	ft
Correctn Factor (DO_{sat})	0.97504	mg/L

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

Velocity	0.11176		
BOD coef	0.23	Theta	1.056
O2 coef	*see below*	Theta	1.024

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

Schematic



Monitoring Site 564

		Flow	BOD	DO	T	Dist	Slope (ft/mi)	Calc K_r	
1	**Parsons**	0.1535275	20	7.23	16.5	7.7	4.39	1.19	
	Upstream	0	0	0	-----	-----			
	Result at Dist (Jcn with KAAP)	0.1535275	17.19	6.7	16.5				
2	**KS Army Ammun. Plant**	0.0040356	30	6.78	16.5	1	33.8	~~9.89~~	
	Upstream	0	0	0	-----	-----		2.28	
	Result at Dist	0.0040356	29.42	6.78	16.5				
3	**KAAP Jcn at Labette Cr**	0.0040356	29.42	6.78	16.5	8.5	1.325	0.50	Elev = 829ft
	Upstream (mod. by Parsons)	0.1535275	17.19	6.7	16.5	-----			
	Result at Dist (site 564)	0.1575631	14.81	5.43	16.5				Elev = 822ft

Monitoring Site 571

		Flow	BOD	DO	T	Dist	Slope (ft/mi)	Calc K_r	
4	**From Site 564 at Oswego Jcn.**	0.1575631	10.43	5.09	16.5	17.8	1.54	0.54	Elev = 822ft
5	**Oswego**	0.0133788	30	6.98	16.5	5	20.9	~~5.80~~	
	Upstream	0	0	0	-----	-----		2.46	
	Result at Dist	0.0133788	27.19	7.08	16.5				
6	**Oswego Jcn to Labette Cr**	0.0133788	27.19	7.08	16.5	4.6	2.45	0.74	Elev = 805ft
	Upstream (Mod. by Pt Sources Site 564)	0.1575631	10.43	5.09	16.5	-----			
	Result at Dist	0.1709419	10.73	5.56	16.5				
7	**Altamont**	0.0063534	30	6.92	16.5	16	8.24	2.16	
	Upsteam	0	0	0	-----	-----			
	Result at Dist	0.0063534	21.9	7.2	16.5				
8	**Bartlett**	0.0013160	30	6.49	16.5	8	14.48	~~3.90~~	
	Upsteam	0	0	0	-----	-----		2.06	
	Result at Dist	0.001316	25.63	6.71	16.5				Elev = 798ft
9	**Bartlett Jcn to Labette Cr**	0.001316	25.63	6.71	16.5	7.1	2.27	0.70	Elev = 788ft
	Upstream (Altamont Jcn to Labette Cr)	0.0063534	21.9	7.2	16.5	-----			
	Result at Dist	0.0076693	19.6	5.69	21.6				
10	**Lake Cr discharge**	0.0076693	19.6	5.69	16.5	7.1	1.81	0.60	Elev = 780ft
	Upstream (Labette Cr discharge)	0.1709419	10.73	5.56	16.5	-----			
	Result at Dist (571)	0.1786112	9.66	5.7	16.5				

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)