UPPER REPUBLICAN BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody/Assessment Unit: Lower Prairie Dog Creek
Water Quality Impairment: Dissolved Oxygen

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Prairie Dog Creek **County:** Norton and Phillips

HUC 8: 10250015

HUC 11 (HUC 14s)**:** **020** (080)
037 (010, 020, 030, 040 and 050)
047 (010 and 020)

Drainage Area: 333.4 square miles

Main Stem Segment: WQLS: 2 and 4 (Prairie Dog Creek) starting at the Kansas-Nebraska state line and traveling upstream to Norton Lake in central Phillips County (**Figure 1**).

Tributaries: Walnut Cr (13)
Dry Cr (23)
Jack Cr (22)
Battle Cr (24)
Elk Cr (3)
Fancy Cr (19)
Buffalo Cr (21)
Sand Cr (20)
Horse Cr (18)
N. Fk. Prairie Dog Cr (17)
Wildcat Cr (26)
Walnut Cr (25)
Spring Cr (15)
Robinson Cr (16)

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

Impaired Use: Expected Aquatic Life Support

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

Prairie Dog Creek Watershed
Dissolved Oxygen TMDL
HUC and Stream Segment Map

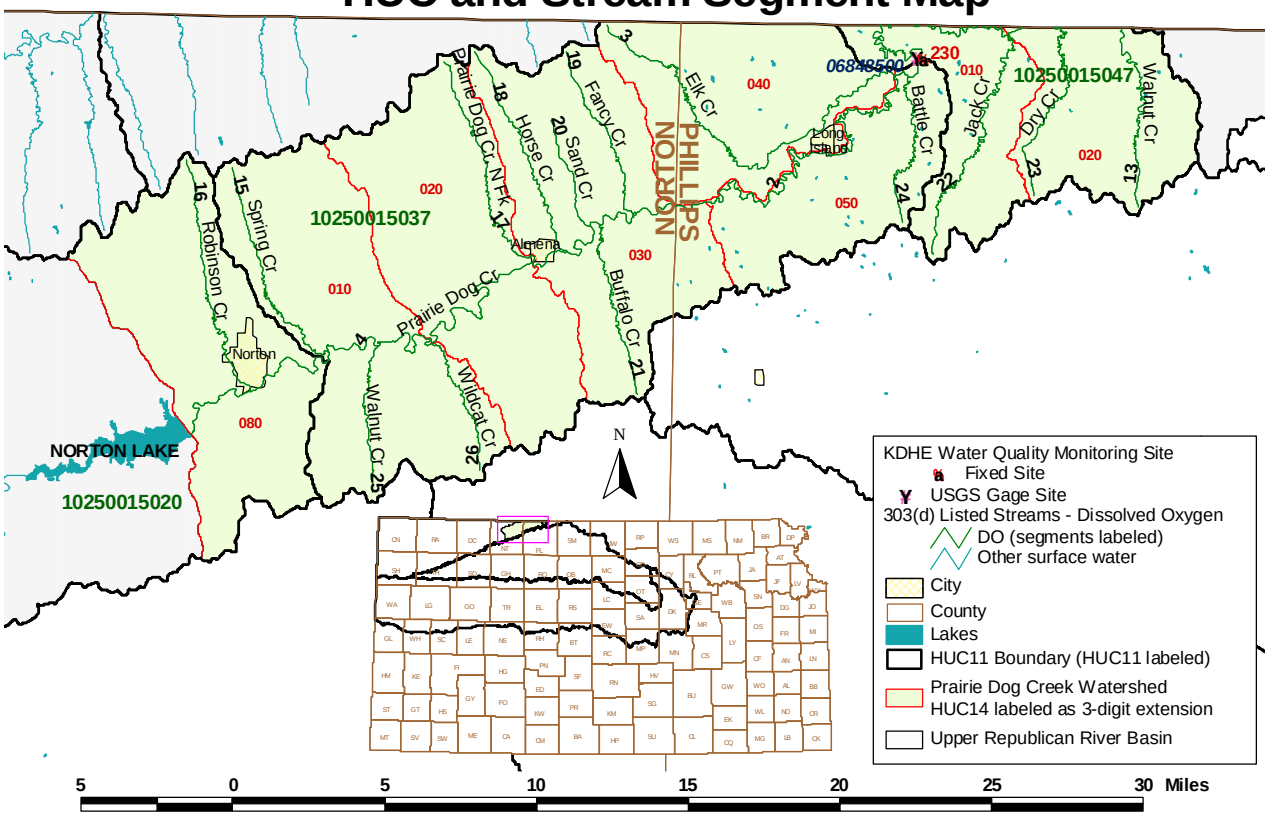


Figure 1

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 2002 303(d): Partially Supporting Aquatic Life

Monitoring Sites: Station 230 near Woodruff

Period of Record Used: 1993 –2001 for Station 230 (**Figure 2**)

Flow Record: Prairie Dog Creek near Woodruff (USGS Station 06848500); 1970-2002.

Long Term Flow Conditions: 10% Exceedance Flows = 16.8 cfs**,** 95% = 0.0 cfs

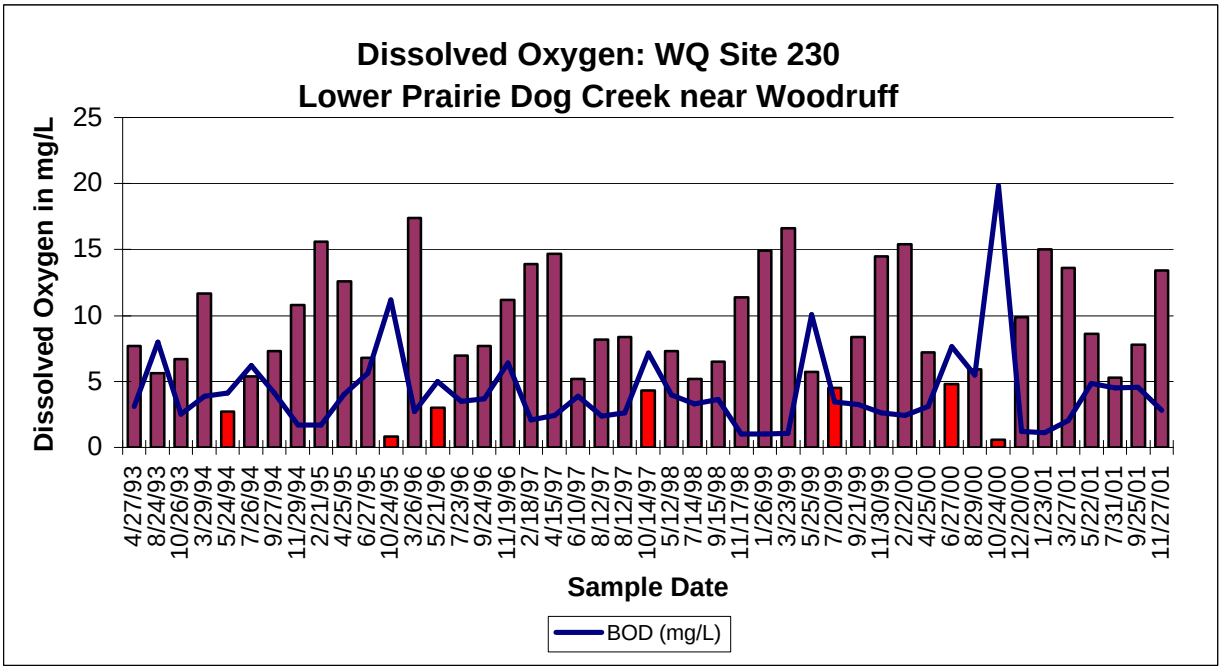


Figure 2

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 Prairie Dog Creek near Woodruff 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 two of the three defined seasons and are outlined in **Table 1**. Twenty-four percent of the Spring samples and 23% of Summer-Fall samples were below the aquatic life criterion. None of the Winter samples were under the aquatic life criterion. Overall, 16% of the samples were under the criterion. This would represent a baseline condition of partial support of the impaired designated use.

Table 1

NUMBER OF SAMPLES UNDER DISSOLVED OXYGEN STANDARD OF 5mg/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.**
Prairie Dog Creek nr Woodruff (230)	Spring	1	1	2	0	No Flow	No Flow	4/17 = 24%
	Summer/Fall	1	0	2	0	No Flow	No Flow	3/13 = 23%
	Winter	0	0	0	0	No Flow	No Flow	0/15 = 0%

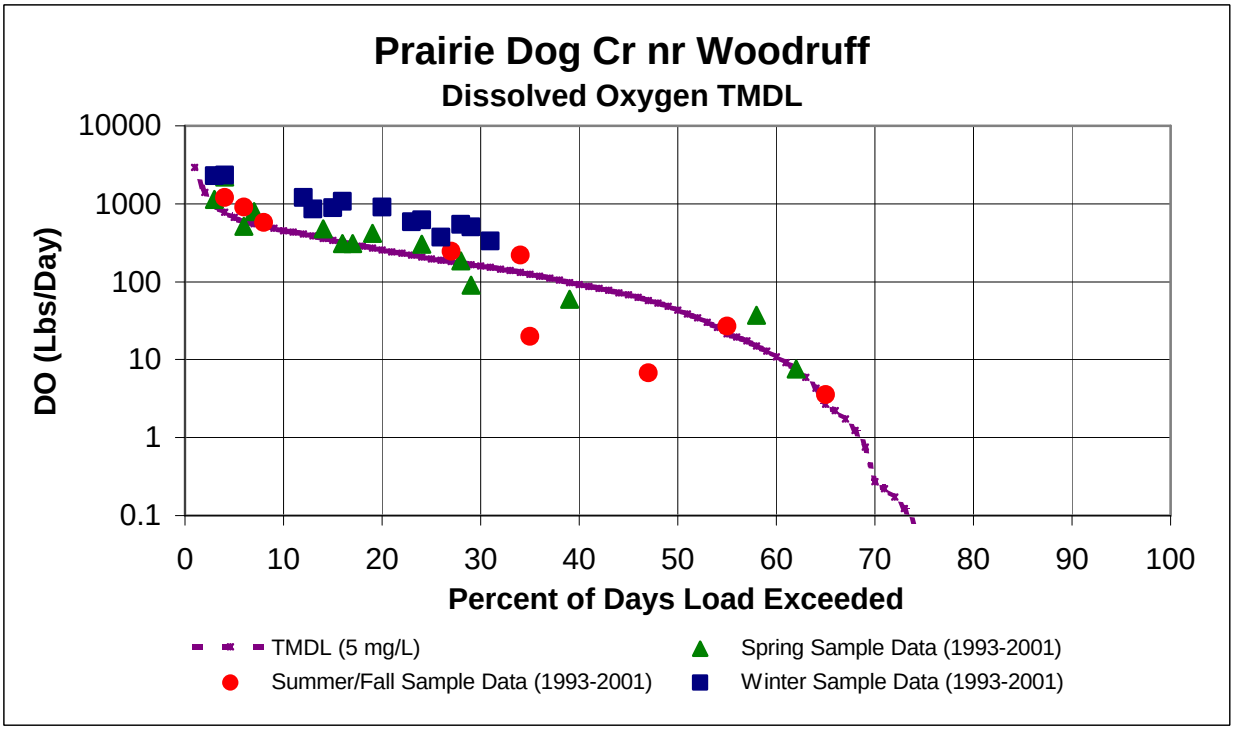


Figure 3

DO violations were encountered across all flows in Prairie Dog Creek, including runoff conditions. Previous experience in developing dissolved oxygen TMDLs in Kansas has shown that low flow conditions have dominated those flow conditions when DO excursions occurred. Although low flow is likely a factor for some of the DO excursions noted at Site 230, a number of the excursions occurred during what can only be considered runoff events.

A watershed comparison approach was taken in developing this TMDL. The Sappa Creek watershed (Water Quality Sampling Site 229 in the watershed was not impaired by low DO) should have similar land use characteristics to the Lower Prairie Dog Creek watershed and is of comparable size.

The relationship of DO to ammonia, biochemical oxygen demand (BOD), fecal coliform bacteria (FCB), water temperature, turbidity, nitrate, phosphorus and pH were used in the comparison. **Table 2 in the Appendix** outlines those water quality data for the samples taken on the same date for the two comparison sites. **Table 3 in the Appendix** is the subset of data from Table 2 for those sample dates when DO was below the aquatic life criterion for sample site 230. From **Table 3**, comparing site 230 to reference site 229, the median phosphorus, ammonia and fecal coliform bacteria concentration were slightly higher than the reference site 229, the median BOD, nitrate and turbidity were slightly lower and the remaining parameters were much the same. Although the median BOD at site 230 was higher than targets set for previous TMDLs developed across the state (2.6-3.7 mg/L BOD are typical target values), it was slightly lower than the median BOD at reference site 229, which was not impaired by low DO.

Because the comparison from Table 3 sheds little light on the cause of DO violations at site 230, **Table 4 in the Appendix** was developed. Table 4 is a subset of data from Table 2 for those sampling dates when there was *no* DO problem at site 230 and the stream temperatures were in the same range as when DO violations did occur at site 230 (12 degrees C or greater). Comparing median values for site 230 from Tables 3 and 4 indicates ammonia, fecal coliform bacteria, phosphorus and BOD values were lower when there was not a DO problem at site 230, indicating 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 Lower Prairie Dog Creek watershed upstream of site 230 and, under certain conditions, is likely a factor influencing the DO violations. Table 4 establishes the target BOD level for site 230.

Additionally, comparison analysis was made for the data at Station 230 between the periods when no dissolved oxygen problems occurred and when dissolved oxygen fell below 5 mg/l. There were significant differences in the average values of ammonia, nitrate, phosphorus, BOD, pH and bacteria. There was no difference between the compliant and impaired conditions in turbidity, temperature or flow. During periods when dissolved oxygen was deficient, ammonia, BOD, phosphorus and bacteria levels were higher, while nitrate and pH levels were lower. This supports the contention that excessive amounts of organic matter were introduced into the stream under varying flow conditions and seasons and is responsible for oxygen depletion.

Desired Endpoints of Water Quality (Implied Load Capacity) at Site 230 over 2008 – 2012

The desired endpoint will be reduced biochemical oxygen demand from artificial sources such that median BOD concentrations remain below 3.9 mg/l in the stream across all flow conditions which should result in no excursions below 5 mg/l of DO detected between 2008 - 2012 attributed to these sources.

This desired endpoint should improve DO concentrations in the creek across all flow conditions. Seasonal variation is accounted for by this TMDL, since the TMDL endpoint is sensitive to the higher stream temperatures occurring in the late May – October 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 organic matter transported to the stream. 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 three NPDES municipal permitted wastewater dischargers within the watershed (**Figure 4**). These systems are outlined below in **Table 5**. The city of Long Island

has a non-discharging lagoon that may contribute an oxygen demanding material load to Segment 2 of Prairie Dog Creek under extreme precipitation events (stream flows associated with such events are typically exceeded only 1-5 % of the time). Such events would not occur at a frequency or of a duration that they would constitute a chronic impairment to the designated uses of the river. All non-discharging lagoon systems are prohibited from discharging to the surface waters of the state. Under standard conditions of these non-discharging facility permits, when the water level of the lagoon rises to within two feet of the top of the lagoon dikes, the permit holder must notify KDHE. Steps may be taken to lower the water level of the lagoon and diminish the probability of a bypass of sewage during inclement weather. Bypasses may be allowed if there are no other alternatives and 1) it would be necessary to prevent loss of life, personal injury or severe property damage; 2) excessive stormwater inflow or infiltration would damage the facility; or 3) the permittee has notified KDHE at least seven days before the anticipated bypass. Any bypass is immediately report to KDHE.

The city of Almena is constructing a three-cell lagoon system with at least 120 day detention times for treatment of their wastewater with completion by July 1, 2003, and permit compliance by Sept 1, 2003. The Norton Correction Facility uses a five-cell lagoon system and at least 120 day detention times for the treatment of their wastewater. Kansas Implementation Procedures - Waste Water Permitting - indicates these lagoons meet standard design criteria. The city of Norton uses a primary sedimentation tank, trickling filter, final clarifier, and sludge digester system to treat its wastewater.

Table 5

Facility	NPDES Permit	Stream Reach	Segment	Design Flow	Type
Norton WTF	M-UR16-OO01	Robinson Cr	16	0.5 mgd	Mech
Norton Correctional Fac.	M-UR16-OO02	Prairie Dog Cr	4	0.109 mgd	Lagoon
Almena WTF (new plant)	M-UR01-OO02	Prairie Dog Cr	4	0.1 mgd	Lagoon
Nelson Hog Farms-Site E	272			Non-discharging	Lagoon
Nelson Hog Farms-Site C	A-URNT-HO04			Non-discharging	Lagoon
Cox, Jerry	A-URPL-HO05			Non-discharging	Lagoon
County Line Feeders	A-URNT-CO02			Non-discharging	Lagoon
Husky Hog Farms-Site A	A-URPL-HO07			Non-discharging	Lagoon
Nelson Farms-Burd Site	A-URNT-HO03			Non-discharging	Lagoon
Nelson Hog Farms-Site A	A-URNT-HO03			Non-discharging	Lagoon
Cox's Valley View Farms	A-URPL-HO03			Non-discharging	Lagoon
Nelson Farms	A-URPL-CO01			Non-discharging	Lagoon
Upland Pork	A-URNT-HO01			Non-discharging	Lagoon
North Wheatridge	A-URPL-HO06			Non-discharging	Lagoon

Monthly effluent monitoring reports by the city of Norton from 1/1999 through 2/2003 were reviewed for compliance with BOD permit limits. This review indicates Norton has remained well within their BOD limits for the time period. The same review was performed for the city of Almena and Norton Correctional Facility. Nineteen percent of the time, during the 1/1999 through 2/2003 period, the city of Almena exceeded their BOD limit. None of these exceedances occurred during the months of the year that DO excursions were noted in Prairie Dog Creek. Thirty eight percent of the time, during the 11/2000 through 2/2003 period, the

Norton Correctional Facility exceeded its BOD limit. Some of these permit exceedances did occur during the months of the year that DO violations were noted in Prairie Dog Creek.

The population projection for Almena to the year 2020 indicates slight declines while the projection for Norton indicates slight growth. Projections of future water use and resulting wastewater for both cities appear to be within the design flows of their current system's treatment capacity.

Livestock Waste Management Systems: Thirty-seven operations are registered, certified or permitted within the watershed. The swine facilities, which comprise the majority of animal units from all facilities, are primarily located across the middle of the watershed (**Figure 4**). Two beef and nine swine facilities are NPDES permitted, non-discharging facilities (**Figure 4, Table 5**) located in the middle third of the watershed in the drainage of Segment 2 of Prairie Dog Creek.

The significant depletions of in-stream dissolved oxygen occurred prior to 1997, perhaps before appropriate controls were installed in NPDES and state permitted CAFOs. Since 1997, the three excursions from the water quality standard have been more modest (DO between 4-5 mg/l) and at higher flows, indicating that point source controls might have been in-place and subsequent violations reflect some non-point source contributions.

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 to retain the 25 year, 24 hour rainfall/runoff event, as well as an anticipated two weeks of normal wastewater from their operations. Such rainfall events typically coincide with stream flows which are exceeded less than 1 - 5 percent of the time. Therefore, events of this type, infrequent and of short duration, are not likely to cause chronic impairment of the designated uses of the waters in this watershed. Requirements for maintaining the water level of the waste lagoons a certain distance below the lagoon berms ensures retention of the runoff from these intense, local storm events. In Norton County, such an event would generate 4.6 inches of rain, yielding 3.5 to 4.3 inches of runoff in a day while in Phillips County the event would generate 4.8 inches yielding 3.7 to 4.5 inches of runoff. The watershed's total potential animal units, for all facilities combined, is 50,268. The actual number of animal units on site is variable, but typically less than potential numbers.

Land Use: Most of the watershed is cropland (55% of the area), grassland (43%), or woodland (1%). Most of the cropland is either along or north of the main stem. According to the NRCS Riparian Inventory, there are about 19,500 acres of riparian area in the watershed, most of which is categorized as pasture land (50%), cropland (15%), forest land (13%), pasture/tree mix (12.5%) and crop/tree mix (6.5%) (**Figure 5**).

On-Site Waste Systems: The lower half of the watershed's population density is low when compared to densities elsewhere in the Upper Republican Basin (2-8 person/mi^2) while the upper half is average to high in density (10-62 persons/mi^2) (**Figure 5**). The rural population projections for Norton and Phillips Counties through 2020 show modest and slight declines (19 and 2.5% decrease, respectively). Based on 1990 census data, about 29% of households in

Norton County and 30% of households in Phillips County are on septic systems. 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.

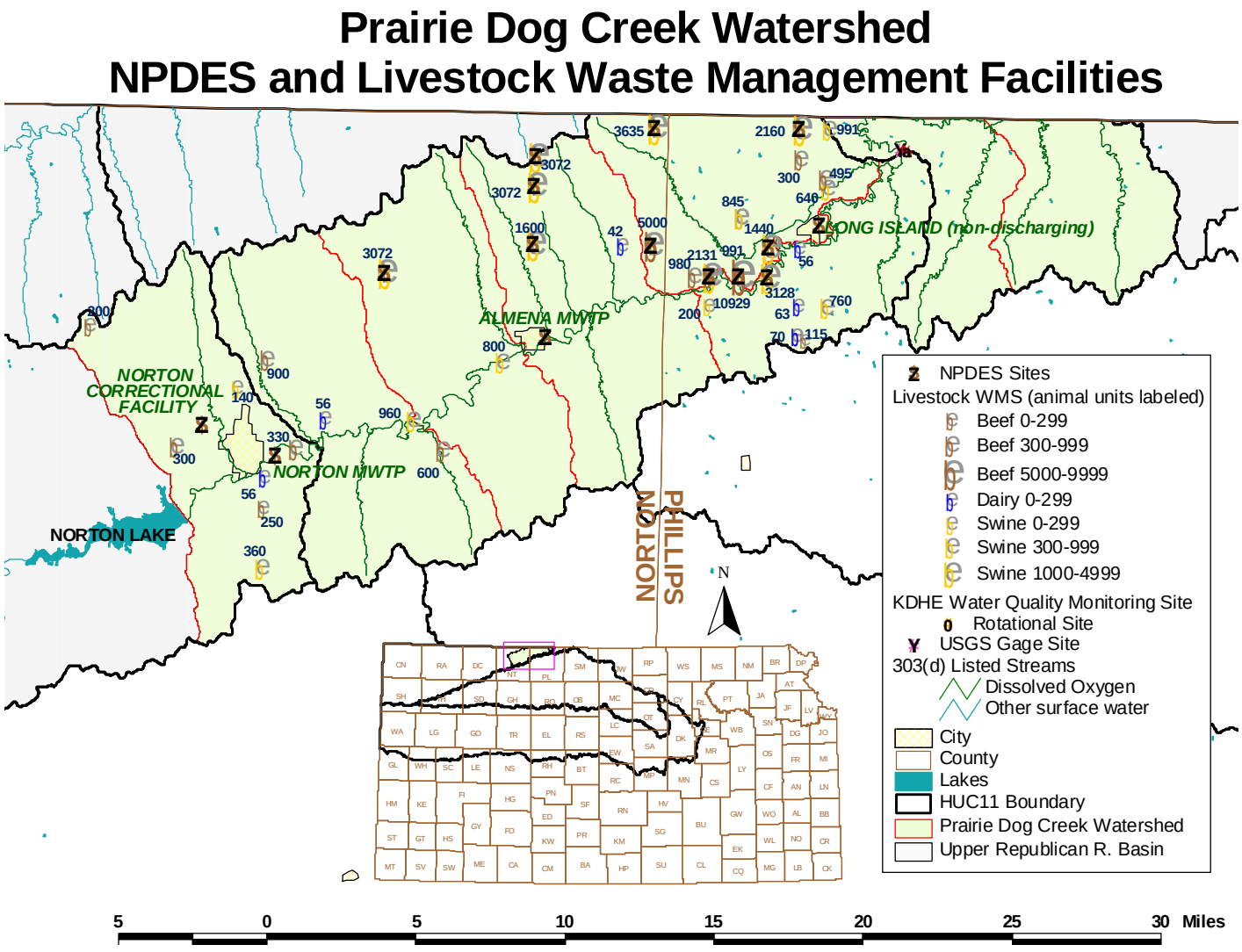


Figure 4

Contributing Runoff: The Prairie Dog Creek watershed's average soil permeability is 1.3 inches/hour according to NRCS STATSGO database. Practically the entire watershed produces runoff even under relatively low (1.71"/hr) potential runoff conditions (99.8%). Under very low (1.14"/hr) potential conditions, this potential contributing area is reduced dramatically to about 5%. Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeabilities. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing less than 0.57"/hr of rain will only generate runoff from 2% of this watershed.

Prairie Dog Watershed
Riparian Inventory, Land Use and Population Density

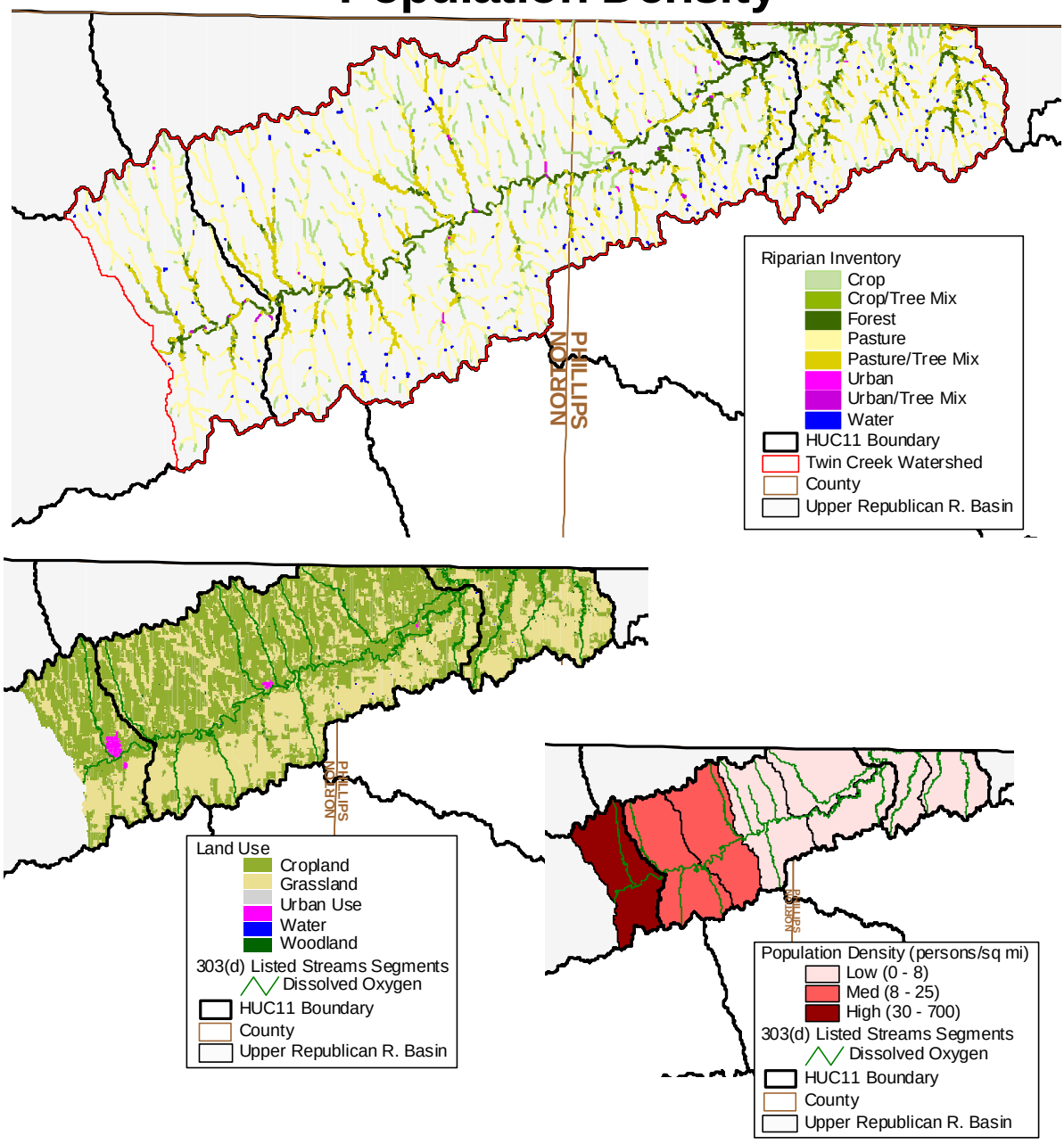


Figure 5

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 streamside vegetation, the loading should be greatest along the main stem 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 Prairie Dog Creek system. These reductions have been based on the relationship between DO and BOD across the flow range for the samples taken at Water Quality Monitoring site 230 in the presence or absence of DO excursions **(Tables 4 and 5 in Appendix)**. Allocations relate to the BOD levels seen in Prairie Dog Creek system at site 230 across all flow conditions and a defined critical temperature condition (greater than 12 degrees C). Based on this relationship, BOD loads at site 230 need to be reduced by almost 50% (so that in stream median BOD is 3.9 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.

For this phase of the TMDL the median condition is considered across the seasons to establish goals of the endpoint and desired reductions. Therefore, the target median BOD levels were multiplied by the average daily flow for Prairie Dog Creek across all hydrologic conditions. This is represented graphically by the integrated area under the BOD load duration curve established by this TMDL (**Figure 6**). 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. This TMDL represents the "Best Professional Judgment" as to the expected relationship between physical factors, organic matter and DO.

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.

Based upon the preceding assessment, only the discharging point sources (Almena, Norton and Norton Correctional Facility) contributing a BOD load in the Lower Prairie Dog Creek watershed upstream of site 230 will be considered in this Wasteload Allocation.

The city of Almena is constructing a new facility with completion by July 1, 2003. This change should reduce its BOD loading to the Lower Prairie Dog Cr watershed. The specifications of new Almena treatment facility and its permit limits were used in developing its WLA under this TMDL.

Streeter-Phelps analyses for these point sources indicate the present BOD permit limits (25-30 mg/L) maintains DO levels above 5 mg/L in the stream when there is no flow upstream of the discharge points (see attached Streeter-Phelps analysis in Appendix).

The combined design flow of the discharging point sources (1.1 cfs) redefines the lowest flow seen at site 230 (17-99% exceedance), and the WLA equals the TMDL curve across this flow condition (**Figure 6**).

From this, the WLA for the Norton Correctional Facility is 27.4 lbs/day BOD, which translates to an instream WLA of 3.56 lbs/day BOD at site 230 across all flow conditions (**Figure 6**). The WLA for the city of Norton is 104.5 – 125.4 lbs/day BOD depending on the month of the year and translates to an instream WLA of 16.3 lbs/day BOD while the city of Almena's WLA is 25.1 lbs/day BOD and translates to an instream WLA of 3.3 lbs/day BOD across all flow conditions. The city of Long Island's non-discharging lagoon has a WLA of zero.

There will be a wasteload allocation of zero for state and NPDES permitted CAFO's within the drainage because of requirements for no discharge of livestock waste except at 25 year, 24 hour storm events. Management of available freeboard and required holding capacities in these livestock waste management systems should ensure rare contribution of organic matter to Prairie Dog Creek, causing depletion of oxygen in the stream.

Non-Point Sources: Based on the prior assessment of sources, the distribution of excursions from water quality standards at site 230 and the relationship of those excursions to runoff conditions and seasons, non-point sources are seen as a contributing factor to the occasional DO excursions in the watershed.

The samples from the Lower Prairie Dog Creek watershed show DO violations occurred across all flow conditions. The Load Allocation assigns responsibility for reducing the in stream BOD levels at site 230 to 3.9 mg/L for all flow conditions. The LA equals zero for flows from 0 - 1.1 cfs (17 - 99% exceedance), since the flow at this condition is entirely effluent created, and then increases to the TMDL curve with increasing flow beyond 1.1 cfs (**Figure 6**). 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 organic matter transported to the stream that may occur during lower flow conditions.

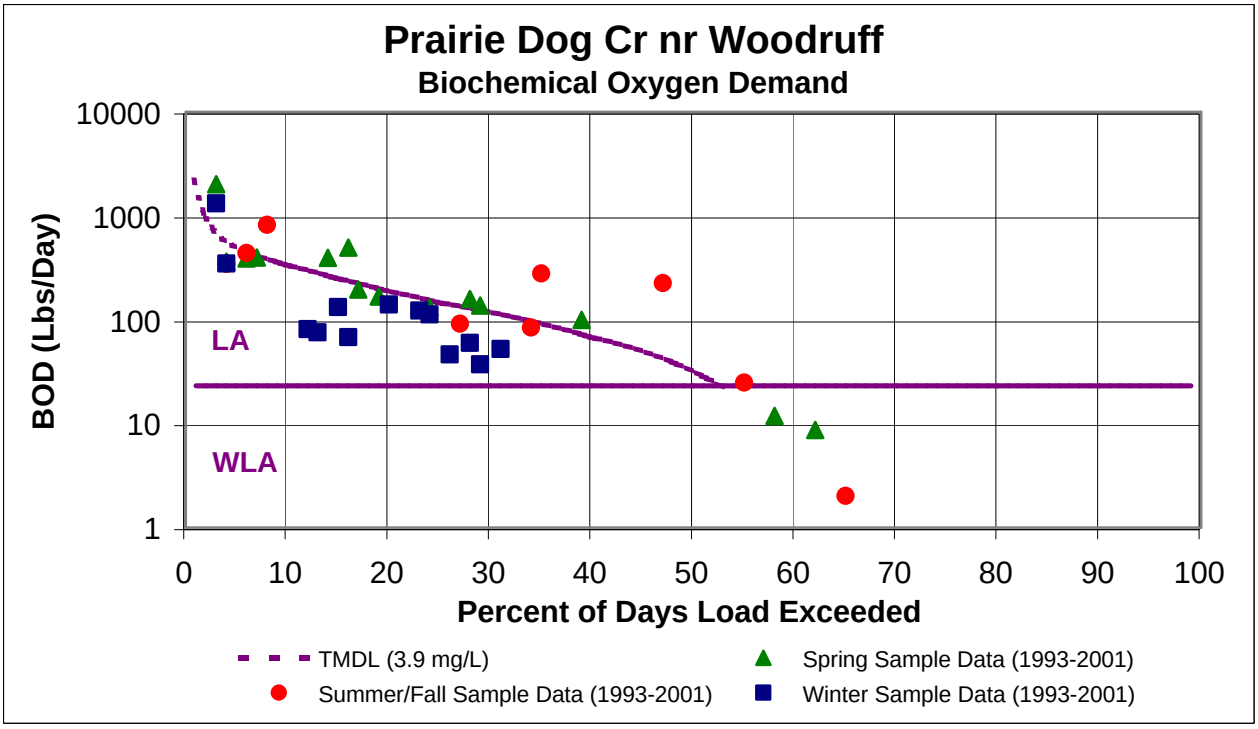


Figure 6

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 and the watershed has multiple impairments (the watershed is also impaired by fecal coliform bacteria), this TMDL will be a High Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Prairie Dog Creek Basin (HUC 8: 10250015) with a priority ranking of 57 (Low Priority for restoration work).

Priority HUC 11s and Stream Segments: Priority focus of implementation prior to 2008 will concentrate on installing best management practices adjacent to main stem segments and flow contributing tributaries.

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.

Implementation Programs Guidance

NPDES and State Permits - KDHE

a. Livestock permitted facilities will be inspected for integrity of applied pollution prevention technologies and adhere the conditions of their permit.
b. Registered livestock facilities with less than 300 animal units will apply pollution prevention technologies.
c. Manure management plans will be implemented to prevent the introduction of organic material to the stream.
d. Lagoons and mechanical plants will adhere to the BOD limits of their permits.

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 within 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 of on-site waste systems close to the priority 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 within the priority subwatersheds over the years 2004-2008, 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 Prairie Dog Creek and 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. Failing on-site waste systems

Some inventory of local needs should be conducted in 2004 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 2008: The year 2008 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 strips or other BMPs, cited in the local assessment, participating in the implementation programs provided by the state. Additionally,

sampled data from site 230 should indicate evidence of improved dissolved oxygen relative to the conditions seen prior to 2003.

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 and KDHE District Offices. On-site waste system inspections will be performed by Local Environmental Protection Program personnel for Norton and Phillips County.

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 Upper Republican Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund, annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollution reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are a 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 prior to 2003, 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 Station 230, including dissolved oxygen samples over each of the three defined seasons, in order to assess progress in implementing this TMDL. During the evaluation period (2008-2012), more intensive sampling may need to be conducted under seasonal flow conditions in order to determine the achievement of the endpoint of this TMDL

Local program management needs to identify its targeted participants of state assistance programs for implementing this TMDL. This information should be collected in 2004 in order to support appropriate implementation projects.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Upper Republican Basin were held October 2, 2002 in Oberlin, January 6, 2003 in Norton and March 4, 2003 in Colby. 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 Upper Republican Basin.

Public Hearing: Public Hearings on the TMDLs of the Upper Republican Basin were held in Atwood on June 3, 2003.

Basin Advisory Committee: The Upper Republican Basin Advisory Committee met to discuss the TMDLs in the basin on October 2, 2002, January 6, March 4, and June 3, 2003.

Milestone Evaluation: In 2008, evaluation will be made as to the degree of implementation that has occurred within the watershed and current condition of Lower Prairie Dog 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 stream will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2008-2012. 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 2004-2008.

Appendix to Lower Prairie Dog Creek Dissolved Oxygen TMDL

Table 2

Date	DO		Ammonia		BOD		FCB		Nitrate		pH		Temp_Cent		Phos		Turb		Flow	
	230	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**2**
4/27/93	7.7	9.6	0.05	0.05	3.1	3.5	100	32	0.03	0.02	8.4	8.4	13	15	0.67	0.44	7.0	12.1	10	ND
8/24/93	5.6	6.5	0.06	0.17	8	10	1100	6000	0.71	1.14	7.9	8.4	21	20	1.19	1.24	115.0	320.0	19	ND
10/26/93	6.7	7.8	0.05	0.05	2.5	1.8	20	100	0.34	0.14	7.9	8	7	8	1.27	0.73	5.0	6.0	6.8	ND
3/29/94	11.7	13.3	0.05	0.06	3.9	2.9	10	10	0.08	0.27	8.5	8.3	3	5	0.81	0.74	6.6	8.7	6.3	ND
5/24/94	**2.7**	6.6	0.76	0.25	4.1	9.3	200	500	0.15	1.14	7.9	8.1	17	20	1.93	1.10	11.0	105.0	6.2	ND
7/26/94	5.4	7	0.05	0.04	6.2	7.7	500	3000	0.45	1.45	8	8.3	20	20	0.87	1.03	42.0	137.0	0.26	ND
9/27/94	7.3	8.7	0.03	0.04	4.14	1.17	200	200	0.01	0.85	8.1	8.2	14	15	0.31	0.59	7.0	15.0	0.09	ND
11/29/94	10.8	9	0.07	0.08	1.7	2.9	10	100	0.58	0.48	8	8.5	0	2	0.61	0.45	2.0	6.0	5.7	ND
2/21/95	15.6	9.2	0.01	0.14	1.7	3	100	10	0.61	0.46	8.3	8.3	0	0	0.36	0.32	0.7	2.4	6.5	ND
4/25/95	12.6	11.3	0.05	0.03	4	1.1	130	10	0.01	0.06	8.5	8.2	12	13	0.62	0.64	2.0	3.0	0.55	ND
6/27/95	6.8	7.7	0.04	0.01	5.6	6.2	1100	300	3.26	1.59	8.1	8	17	19	0.89	1.34	22.0	76.0	13	ND
10/24/95	**0.8**	2.2	0.14	0.111	11.2	10.2	10	10	0.04	0.04	7.4	7.8	5	5	1.00	0.68	6.0	5.0	4.6	6.5
3/26/96	17.4	13.5	0.063	0.151	2.7	4.5	1	1	0.19	0.37	8.4	8	1	1	0.51	0.28	1.6	7.9	9.6	10
5/21/96	**3**	ND	0.841	ND	5	ND	100	ND	0.54	ND	7.8	ND	18	ND	1.63	ND	7.0	ND	3.7	5.7
7/23/96	7	ND	0.284	ND	3.5	ND	1300	ND	1.05	ND	8	ND	19	ND	0.71	ND	30.0	ND	21	50
9/24/96	7.7	ND	0.051	ND	3.7	ND	300	ND	2.62	ND	7.9	ND	13	ND	0.75	ND	28.0	ND	22	16
11/19/96	11.2	8.2	0.17	0.113	6.4	1	9100	200	2.29	0.76	7.8	8.5	4	1	0.72	0.39	9.0	3.0	38	31
2/18/97	13.9	12.5	0.02	0.047	2.07	1.89	20	10	2.16	1.12	8	7.8	1	2	0.42	0.35	3.0	4.0	31	30
4/15/97	14.7	13.4	0.02	0.02	2.4	2.97	60	20	1.06	0.49	8	7.7	8	11	0.58	0.68	3.0	3.1	28	29
6/10/97	5.2	7.7	0.219	0.137	3.87	3.57	700	400	2.05	1.88	7.9	8.4	17	17	1.32	1.11	30.0	60.0	10	24
8/12/97	8.3	7.8	0.02	0.02	2.5	9.45	1150	100	1.09	2.04	7.9	8.3	18	17	0.47	0.82	27.0	81.0	27	8.9
10/14/97	**4.3**	8.7	0.02	0.02	7.17	2.07	13000	900	0.36	0.21	7.8	7.8	12	10	1.26	0.65	7.1	10.0	19	7.8
5/12/98	7.3	ND	0.346	ND	3.96	ND	200	ND	2.02	ND	8	ND	18	ND	1.28	ND	15.0	ND	21	18
7/14/98	5.2	ND	0.054	ND	3.3	ND	140	ND	2.19	ND	8.1	ND	28	ND	0.85	ND	40.0	ND	11	8
9/15/98	6.5	ND	0.02	ND	3.63	ND	220	ND	2.52	ND	8.1	ND	21	ND	0.74	ND	27.0	ND	4.9	3.1
11/17/98	11.4	11.8	0.02	0.022	1	2.88	120	40	2.1	0.54	7.9	8.7	8	8	0.73	0.40	3.0	5.0	14	8.9
1/26/99	14.9	12.9	0.02	0.02	1	2.34	10	30	1.95	0.94	7.9	7.6	1	0	0.47	0.21	1.8	3.9	15	12
3/23/99	16.6	27.2	0.02	0.02	1.05	1	20	10	0.77	0.1	8.4	8.8	9	9	0.48	0.24	3.2	1.7	12	12
5/25/99	5.7	8.4	0.36	0.34	10.1	7.47	4400	660	1.02	1.09	7.5	7.8	19	17	1.6	1.2	280	106	37	10
7/20/99	**4.5**	5	0.08	0.05	3.42	4.74	3500	3000	0.88	1.08	7.7	7.7	26	24	1.15	1.6	180.0	365	21	19
9/21/99	8.4	12.3	0.06	0.05	3.24	3.07	510	1600	1.86	1.19	8.1	8.2	15	14	0.73	0.5	39.0	20.5	4.8	4.9
11/30/99	14.5	15	0.02	0.03	2.64	2.01	40	10	1.01	0.22	8.3	8.3	6	4	0.58	0.33	3.2	2.9	7.9	8.5
2/22/00	15.4	15.6	0.02	0.04	2.4	1.44	30	20	0.85	0.73	8.3	7.7	6	3	0.51	0.32	2.3	5.0	12	14
4/25/00	7.2	12.7	0.15	0.02	3.09	3.42	50	80	0.78	0.01	8.3	7.7	16	16	0.74	0.51	24.0	16.0	7.8	13
6/27/00	**4.8**	9.1	0.14	0.02	7.65	7.56	4500	2000	1.15	1.1	7.7	8.1	20	18	1.01	0.91	176.0	122.0	12	2.5
8/29/00	5.9	10.7	0.1	0.13	5.49	3.63	300	260	0.55	0.39	8.1	7.9	24	24	0.86	0.40	84.0	19.0	0.84	0.88
10/24/00	**0.6**	1.3	0.02	0.02	19.8	17.5	900	1900	0.01	0.01	7.6	7.8	16	15	0.86	0.45	4.9	8.3	2.1	1.3
12/20/00	9.9	7.4	0.04	0.08	1.23	2.67	10	90	2.96	1.05	7.7	7.4	0	0	0.59	0.18	2.5	4.3	7	0.52
1/23/01	15	ND	0.02		1.11		10		2.41		7.9		0		0.67		2.1		6.2	2.7
3/27/01	13.6	13.5	0.2	0.02	2.04	3.15	10	70	1.41	1.27	8.3	8	6	3	0.46	0.34	4.7	1.9	12	6.3
5/22/01	8.6	9.1	0.097	0.249	4.86	6.03	550	230	1.52	1.21	7.9	7.8	15	13	0.97	0.64	16.0	30.0	11	7.5
7/31/01	5.3	5.4	0.079	0.033	4.5	2.31	2200	1500	0.83	0.7	7.9	8.1	27	26	0.84	0.66	95.0	63.0	6.5	4.8
9/25/01	7.8	8.8	0.136	0.029	4.56	2.76	1300	1200	1.37	0.95	7.9	8.3	14	13	0.77	0.67	66.0	63.0	2.2	1.8
11/27/01	13.4	15.4	0.035	0.023	2.79	3.33	300	100	1.85	0.11	8.2	8.1	1	0	0.92	0.25	7.8	5.1	8.1	3.7
Median	7.7	9.1	0.05	0.04	3.57	3.07	200	100	1.02	0.73	8.0	8.1	14	13	0.74	0.59	7.5	8.7	9.8	8.5

Table 3

Date	DO		Ammonia		BOD		FCB		Nitrate		pH		Temp_Cent		Phos		Turb		Flow	
	230	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**
5/24/94	**2.7**	6.6	0.76	0.25	4.1	9.3	200	500	0.15	1.14	7.9	8.1	17	20	1.93	1.10	11.0	105.0	6.2	ND
10/24/95	**0.8**	2.2	0.14	0.111	11.2	10.2	10	10	0.04	0.04	7.4	7.8	5	5	1.00	0.68	6.0	5.0	4.6	6.5
5/21/1996*	**3**	ND	0.841	ND	5	ND	100	ND	0.54	ND	7.8	ND	18	ND	1.63	ND	7.0	ND	3.7	5.7
10/14/97	**4.3**	8.7	0.02	0.02	7.17	2.07	13000	900	0.36	0.21	7.8	7.8	12	10	1.26	0.65	7.1	10.0	19	7.8
7/20/99	**4.5**	5	0.08	0.05	3.42	4.74	3500	3000	0.88	1.08	7.7	7.7	26	24	1.15	1.6	180.0	365	21	19
6/27/00	**4.8**	9.1	0.14	0.02	7.65	7.56	4500	2000	1.15	1.1	7.7	8.1	20	18	1.01	0.91	176.0	122.0	12	2.5
10/24/00	**0.6**	1.3	0.02	0.02	19.8	17.5	900	1900	0.01	0.01	7.6	7.8	16	15	0.86	0.45	4.9	8.3	2.1	1.3
Median*	3.5	5.8	0.11	0.04	7.41	8.43	2200	1400	0.26	0.65	7.7	7.8	17	17	1.08	0.79	9.1	57.5	9.1	6.5
Median**	3.7	6.6	0.14	0.05	7.41	9.30	565	900	0.45	1.08	7.8	7.8	18	18	1.21	0.91	9.1	105.0	9.1	6.5

*** sample was excluded from median calculation and comparison since no concurrent sample was collected at reference site 229**
**** Median for all samples used for comparison between Table 3 and 4 at site 230**

Table 4

Date	DO		Ammonia		BOD		FCB		Nitrate		pH		Temp_Cent		Phos		Turb		Flow	
	230	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**	**230**	**229**
4/27/93	7.7	9.6	0.05	0.05	3.1	3.5	100	32	0.03	0.02	8.4	8.4	13	15	0.67	0.44	7.0	12.1	10	
8/24/93	5.6	6.5	0.06	0.17	8	10	1100	6000	0.71	1.14	7.9	8.4	21	20	1.19	1.24	115.0	320.0	19	
7/26/94	5.4	7	0.05	0.04	6.2	7.7	500	3000	0.45	1.45	8	8.3	20	20	0.87	1.03	42.0	137.0	0.26	
9/27/94	7.3	8.7	0.03	0.04	4.14	1.17	200	200	0.01	0.85	8.1	8.2	14	15	0.31	0.59	7.0	15.0	0.09	
4/25/95	12.6	11.3	0.05	0.03	4	1.1	130	10	0.01	0.06	8.5	8.2	12	13	0.62	0.64	2.0	3.0	0.55	
6/27/95	6.8	7.7	0.04	0.01	5.6	6.2	1100	300	3.26	1.59	8.1	8	17	19	0.89	1.34	22.0	76.0	13	
7/23/96	7		0.284		3.5		1300		1.05		8		19		0.71		30.0		21	50
9/24/96	7.7		0.051		3.7		300		2.62		7.9		13		0.75		28.0		22	16
6/10/97	5.2	7.7	0.219	0.137	3.87	3.57	700	400	2.05	1.88	7.9	8.4	17	17	1.32	1.11	30.0	60.0	10	24
8/12/97	8.3	7.8	0.02	0.02	2.5	9.45	1150	100	1.09	2.04	7.9	8.3	18	17	0.47	0.82	27.0	81.0	27	8.9
5/12/98	7.3		0.346		3.96		200		2.02		8		18		1.28		15.0		21	18
7/14/98	5.2		0.054		3.3		140		2.19		8.1		28		0.85		40.0		11	8
9/15/98	6.5		0.02		3.63		220		2.52		8.1		21		0.74		27.0		4.9	3.1
5/25/99	5.7	8.4	0.36	0.34	10.1	7.47	4400	660	1.02	1.09	7.5	7.8	19	17	1.6	1.2	280	106	37	10
9/21/99	8.4	12.3	0.06	0.05	3.24	3.07	510	1600	1.86	1.19	8.1	8.2	15	14	0.73	0.5	39.0	20.5	4.8	4.9
4/25/00	7.2	12.7	0.15	0.02	3.09	3.42	50	80	0.78	0.01	8.3	7.7	16	16	0.74	0.51	24.0	16.0	7.8	13
8/29/00	5.9	10.7	0.1	0.13	5.49	3.63	300	260	0.55	0.39	8.1	7.9	24	24	0.86	0.40	84.0	19.0	0.84	0.88
Median	7.0	8.6	0.05	0.05	3.87	3.60	300	280	1.05	1.12	8.1	8.2	18	17	0.75	0.73	28.0	40.3	10.0	10

Mann-Whitney Test for Table 4 BOD v. Table 5 BOD at Site 230

Table 4: BOD N = 7 Median = 7.17
Table 5: BOD N = 17 Median = 3.87
Point estimate for ETA1-ETA2 is 2.05
95.4 Percent CI for ETA1-ETA2 is (0.119,7.063)
W = 120
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at **0.0421**

Streeter-Phelps DO Sag Model - LwrPrDogCrDO_NortnCF_Norton_Almena
Single Reach - Single Load

1 cfs = .0283 m^3/s			Dist to	Min	Crit Dist
0.25 mph =0 .11176 m/s		Elev (ft)	230	DO	DO
0.0047827	Design Flow (Norton Corrctnl Fac.)	2330	83.5	6.47	1.65
0.0219042	Design Flow (Norton)	2250	76.6	5.32	8.98
0.0043865	Design Flow (Almena)	2122	46.0	5.38	11.27

Elevation Correction (DO)

Elevation	**2122**	ft
Correctn Factor (DO_{sat})	0.932096	mg/L

Distance (km)

Flow (m^3/s)

Concentration (mg/L)

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

Temp (C)

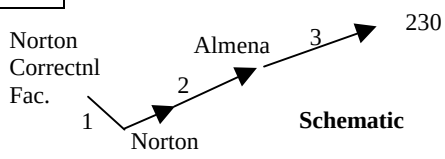
Upstream DO (where appropriate) elevation corrected and set at 90% sat.

Vel (m/s)

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

		Flow	BOD	DO	T	Dist	Slope (ft.mi)	Calc K_r
1	**Norton Correctnl Facility**	0.0047827	30	6.51	23.3	6.9	18.66	5.13
	Upstream	0	-----	-----	-----	-----		
	Result at Norton discharge pt.	0.0047827	24.64	6.6	23.3			
2	**Norton**	0.0219042	25	6.52	22.2	30.60	6.73	1.77
	Upstream (modified by Norton CF)	0.0047827	24.64	6.6	23.3	-----		
	Result at Almena discharge pt.	0.0266869	10.87	6.29	22.2			
3	**Almena**	0.0043865	30	6.55	23.3	46.00	3.64	1.01
	Upstream (modified by 1. and 2.)	0.0266869	10.87	6.29	23.9	-----		
	Result at Dist (WQ Site 230)	0.0310734	3.52	6.68	23.9			

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



Schematic