NEOSHO BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: Allen (Dows*) Creek
Water Quality Impairment: Dissolved Oxygen

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Neosho Headwaters **County:** Lyon

HUC 8: 11070201

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

Drainage Area: 124.4 square miles

Main Stem Segments: WQLS: 3* and 5 (Allen Creek) starting at confluence with the Neosho River and traveling upstream to headwaters in north-central Lyon County (**Figure 1**).

** segment 3 incorrectly named Dows Creek in 1998 303(d) list.*

Tributary Segments: WQLS: Dow Creek (4)**
Stillman Creek (44)
Non-WQLS: Taylor Creek (46)

*** segment 4 incorrectly named Dows Creek in 1998 303(d) list.*

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

Expected Aquatic Life Support, Secondary Contact Recreation and Food Procurement on Dows Creek; Expected Aquatic Life Support and Secondary Contact Recreation on Stillman Creek.

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

Impaired Use: Expected Aquatic Life Support

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

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

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

Monitoring Sites: Station 628 near Emporia

Period of Record Used: 1992, 1996 and 2000 for Station 628: Some 2000 and all 2001 Kansas Biological Survey Data (**Figure 2**)

Flow Record: Marais des Cygnes near Reading (USGS Station 06910800) matched to Allen Creek near Emporia (USGS 07179740).

Long Term Flow Conditions: 10% Exceedance Flows = 105.3 cfs**,** 95% = 0 cfs

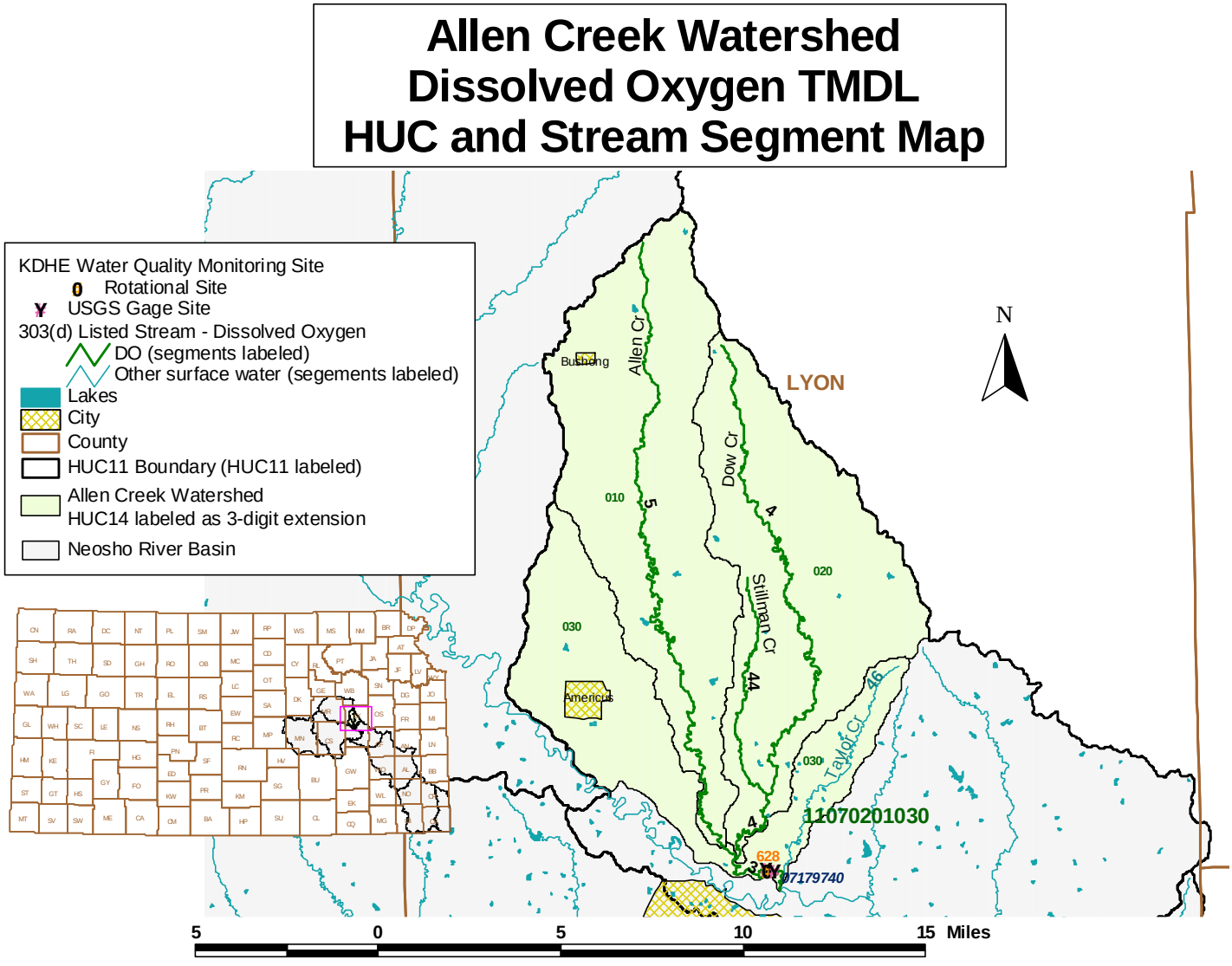


Figure 1

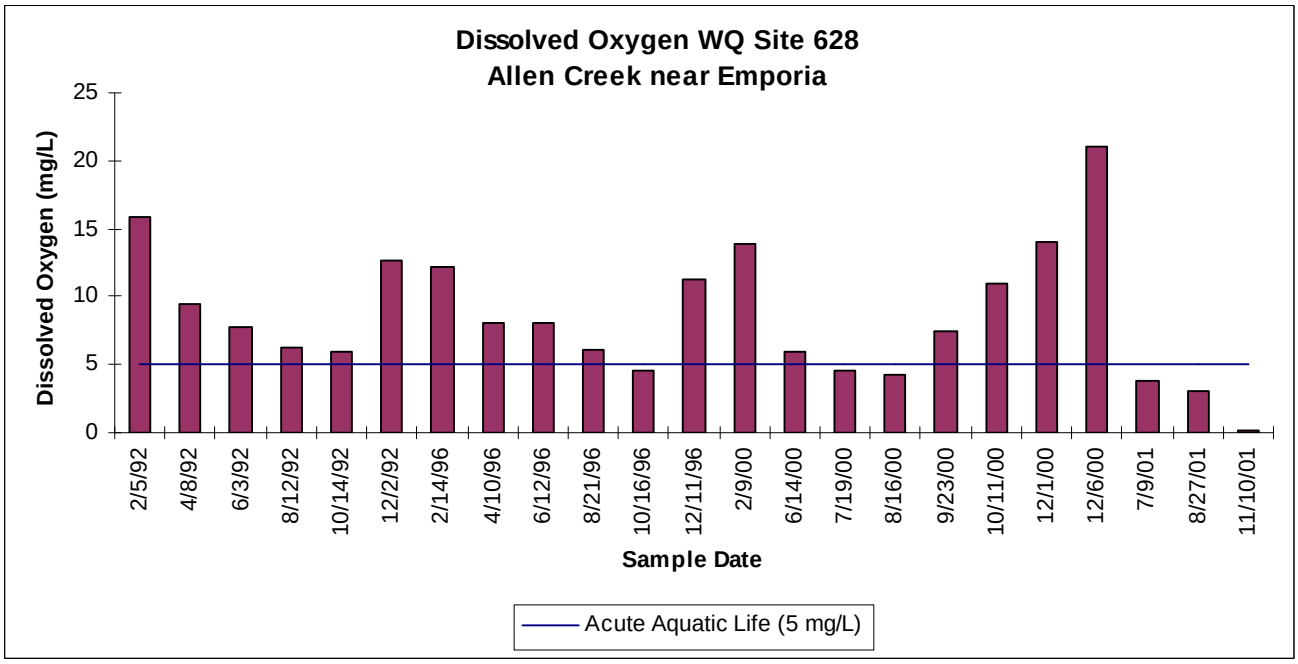


Figure 2

Current Conditions: Since loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired loads over all flow conditions, rather than fixed at a single value. Sample data for the sampling site were categorized for each of the three defined seasons: Spring (Apr-Jul), Summer-Fall (Aug-Oct) and Winter (Nov-Mar). High flows and runoff equate to lower flow durations; baseflow and point source influences generally occur in the 75-99% range. Load curves were established for the Aquatic Life criterion by multiplying the flow values for Allen Creek near Emporia 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**).

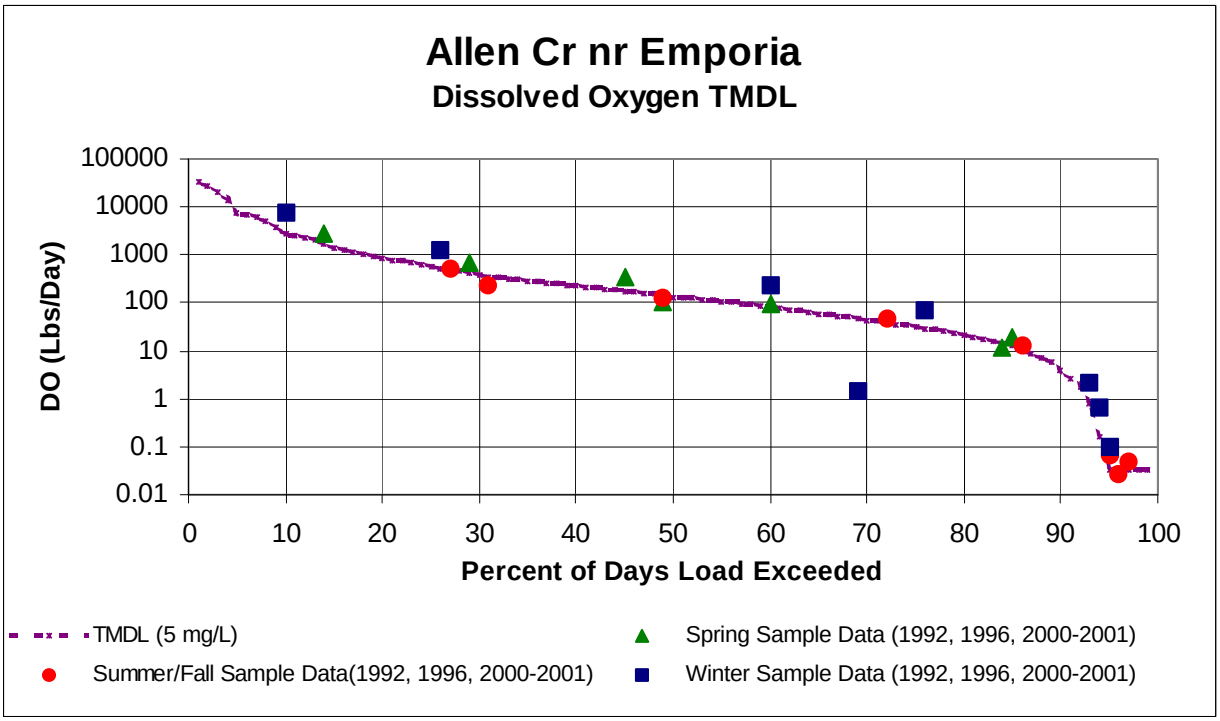


Figure 3

Excursions were seen in each of the three defined seasons and are outlined in **Table 1**. Thirty eight percent of the Summer-Fall samples and 29% of the Spring samples were below the aquatic life criterion. Thirteen percent of the Winter samples were under the aquatic life criterion. Overall, 26% of the samples were under the criterion. This would represent a baseline condition of non-support of the impaired designated use.

Most DO violations occurred at flows less than 5.3 cfs on Allen Creek near Emporia, therefore a critical low flow can be identified on Allen Creek as those flows of 5.3 cfs or less.

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.
Allen Creek near Emporia (628)	Spring	0	0	1	0	1	0	2/7 = 29%
	Summer	0	0	2	0	0	1	3/8 = 38%
	Winter	0	0	0	1	0	0	1/8 = 13%

A watershed comparison approach was taken in developing this TMDL. The Rock Creek watershed (Water Quality Sampling Site 629 in the watershed was not impaired by low DO) has roughly similar land use characteristics (**see Table 2 in Appendix**) to the Allen Creek watershed,

is of similar size and is located immediately north of the Allen Creek watershed. The relationship of DO to ammonia, biochemical oxygen demand (BOD), fecal coliform bacteria (FCB), water temperature, turbidity, nitrate, phosphorus, pH and total suspended solids (TSS) were used in the comparison.

Table 3 in the Appendix outlines those water quality data for the samples taken within one day of each other for the two sites of interest. **Table 4 in the Appendix** is the subset of data from Table 3 for those sample dates when DO was below the aquatic life criterion for sample site 628. From Table 4 at site 628 the average ammonia and nitrate were lower than the reference site 629 while all other parameters were comparable. For one of these comparison dates (8/6/00), even the reference site experienced low DO.

In addition to the comparison provided in Table 4 there were samples dates **(see Table 5 in Appendix**) at site 628 in Table 3 when the flow was within the critical flow range yet DO was not violated. A comparison of site 628 averages between Tables 4 and 5 shows BOD and phosphorus were higher in Table 5 than Table 4, while other parameters were about the same or lower (notably temperature). Although the average temperature in Table 5 is substantially lower than Table 4, which could account for at least a portion of the difference in DO between Tables 4 and 5, the difference in BOD between the two tables appears to indicate 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 Allen Creek watershed upstream of site 628 and, under certain conditions, is likely a factor influencing the DO violations.

Desired Endpoints of Water Quality at Site 628 over 2007 - 2011

The desired endpoint will be a biochemical oxygen demand from artificial sources such that average BOD concentrations remain below 3.2 mg/l in the stream under the critical flow conditions which results in no excursions below 5 mg/l of DO detected between 2007 - 2011 attributed to these sources.

This desired endpoint should improve DO concentrations in the creek at the critical lower flows (0 - 5.3 cfs). Seasonal variation is accounted for by this TMDL, since the TMDL endpoint is sensitive to the low flow usually occurring in the July-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 two NPDES permitted wastewater dischargers within the watershed (**Figure 4**). These systems are outlined below in **Table 6**.

Table 6

DISCHARGING FACILITY	STREAM REACH	SEGMENT	DESIGN FLOW	TYPE
Americus WTF	Allen Cr (via trib.)	3	0.195 mgd	Lagoon
KTA - Emporia Service Area	Stillman Cr.	44	0.0082 mgd	Lagoon

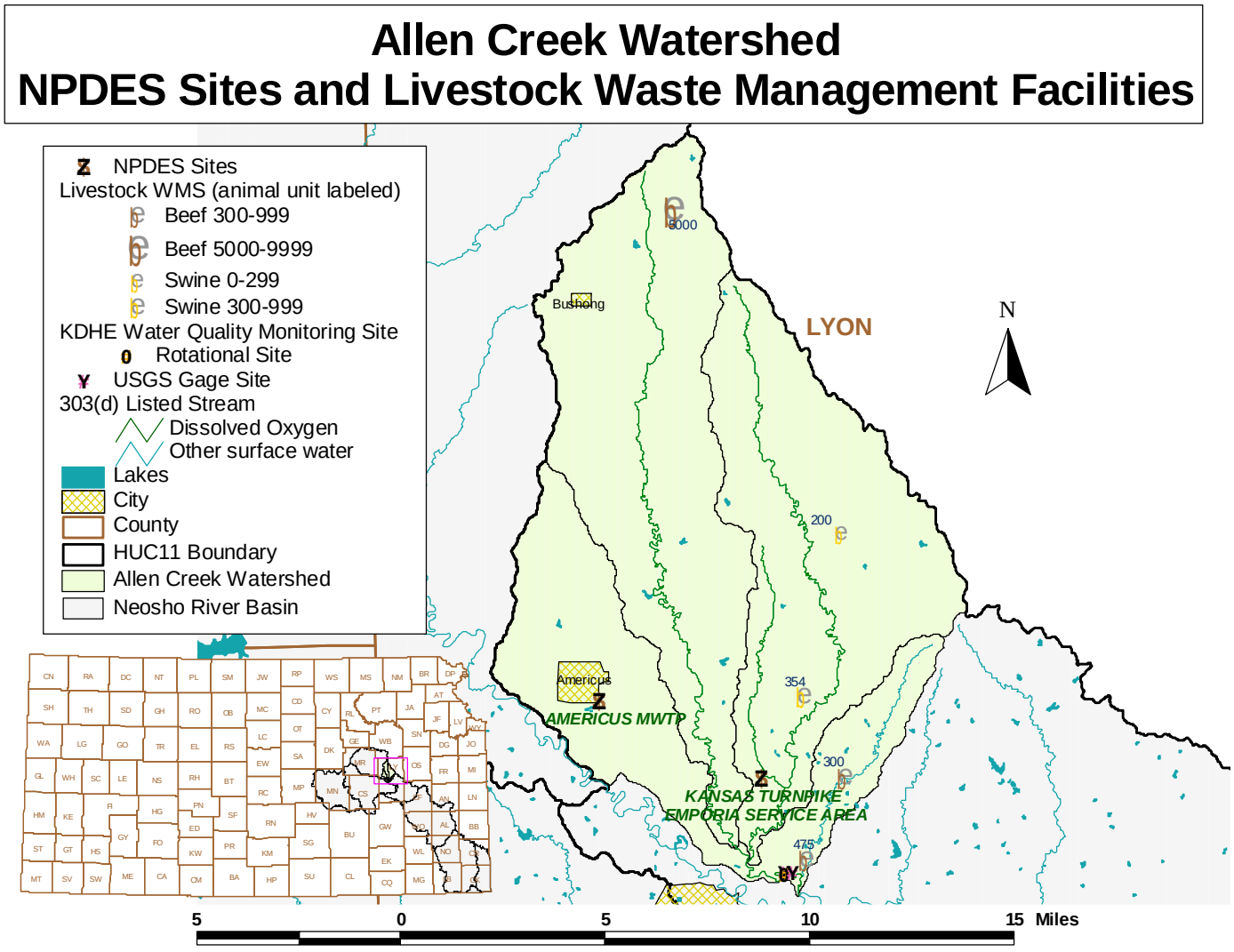


Figure 4

The city of Americus relies on a three cell lagoon system with 120 day detention times for

treatment of their wastewater. Kansas Implementation Procedures - Waste Water Permitting - indicates this lagoon meets standard design criteria..

The population projection for Americus to the year 2020 indicates little change. Projections of future water use and resulting wastewater appear to be within the design flows for of the current system's treatment capacity. Examination of 1998, 1999, 2000 and 2001 effluent monitoring of the city of Americus indicates that BOD discharges are usually within permit limits. The KTA Emporia Service Area Facility rarely meets its BOD permit limit. The KTA - Emporia Service Area is constructing a new non-discharging facility with completion by January 1, 2003. This non-discharging lagoon may contribute an organic substance load to Segment 44 of Stillman Creek under extreme precipitation events (flow durations exceeded under 5 percent of the time). Such events are not even remotely related to the flow conditions associated with the DO violations in this watershed.

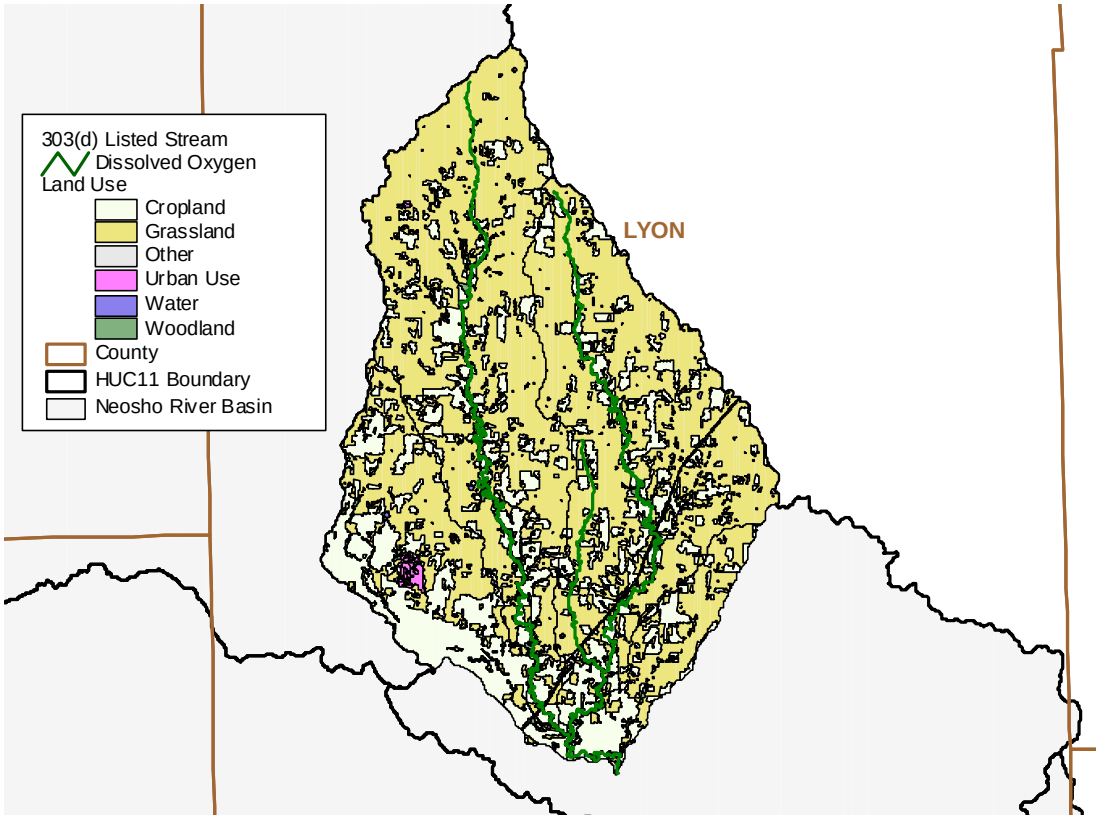
Livestock Waste Management Systems: Five operations are registered, certified or permitted within the watershed. Three of these facilities are located within one mile of a listed stream in the watershed (**Figure 4**). One of these three facilities is an NPDES permitted, non-discharging beef facility with 5,000 animal units near upper end of Allen Creek (segment 5). All permitted livestock facilities have waste management system plans 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. Such events are not related to the flow conditions associated with the DO violations in this watershed. Total potential animal units in the watershed for all these facilities is 6,329. The actual number of animal units on site is variable, but typically less than potential numbers.

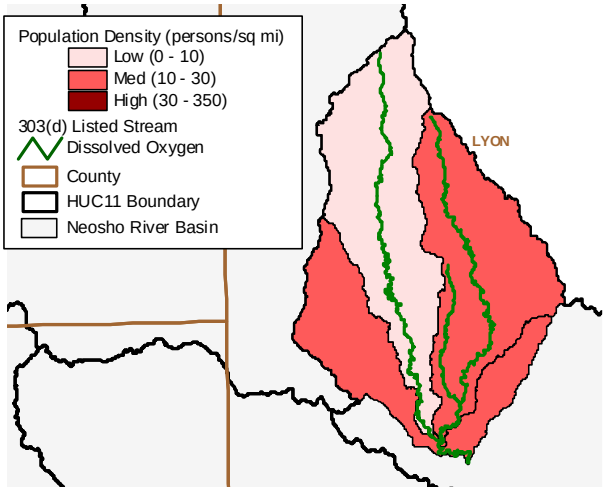
Land Use: Most of the watershed is grassland (66% of the area), cropland (31%), or woodland (2%). Most of the cropland is located toward the west side of the lower half of the watershed. The grazing density estimate is low to average in the watershed when compared to densities elsewhere in the Neosho Basin (19-31 animal units/mi^2) (**Figure 5 and Table 2 in Appendix**).

On-Site Waste Systems: The watershed's population density is low to average when compared to densities across the Neosho Basin (8-19 person/mi^2) (**Figure 5**). The rural population projection for Lyon County through 2020 shows slight to modest growth (8% increase). While failing on-site waste systems can contribute oxygen demanding substance loadings, their impact on the impaired segments is generally limited, given the small size of the rural population and magnitude of other sources in the watershed.

Background Levels: Some organic enrichment may be associated with environmental background levels, including contributions from wildlife and stream side vegetation, but it is likely that the density of animals such as deer is fairly dispersed across the watershed and that the loading of oxygen demanding material is constant along the stream. In the case of wildlife, this loading should result in minimal loading to the streams below the levels necessary to violate the water quality standards. In the case of stream side vegetation, the loading should be greater in the lower two-thirds of the watershed with its larger proportion of woodland near the stream.

Allen Creek Watershed
Land Use, Population and Grazing Density





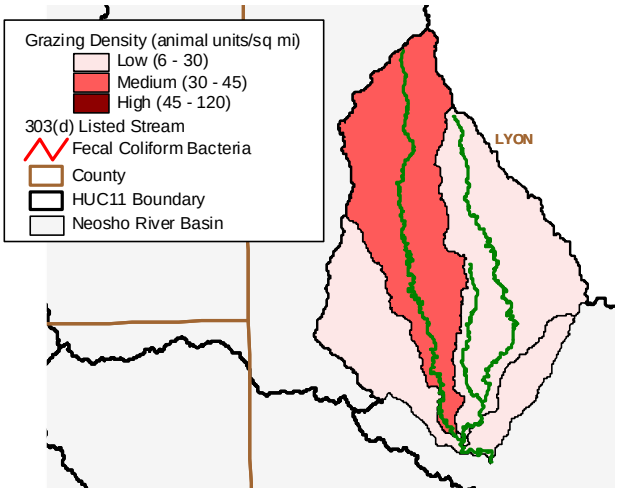


Figure 5

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 Allen Creek system. These reductions have been based on the relationship between DO and BOD for the samples taken at Water Quality Monitoring site 628 for flows less than 5.3 cfs when DO was less than 5 mg/L versus when DO was greater than or equal to 5 mg/L. Allocations relate to the average BOD levels seen in the Allen Creek system at site 628 for the critical lower flow conditions (0 - 5.3 cfs). Based on this relationship, BOD loads at site 628 needs to be reduced so that in stream average BOD is 3.2 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 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 Allen Creek across all hydrologic conditions. This is represented graphically by the integrated area under the BOD load duration curve established by this TMDL. 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.

The KTA - Emporia Service Area is constructing a new non-discharging facility with completion by January 1, 2003. Not only will this change address its historical BOD permit limit violations, but also the non-discharging nature of the new facility warrants its removal from the WLA.

Based upon the preceding assessment, only the discharging point source (Americus) contributing a BOD load in the Allen Creek watershed upstream of site 628 will be considered in this Wasteload Allocation.

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

The design flow of the discharging point source (0.2 cfs) redefines the lowest flow seen at site 628 (89-99% exceedance), and the WLA equals the TMDL curve across this flow condition (**Figure 6**).

From this, the WLA for the city of Americus is 31.6 lbs/day BOD, which translated to an instream WLA of 3.37 lbs/day BOD at site 638 across all flow conditions (**Figure 6**).

Non-Point Sources: Based on the prior assessment of sources, the distribution of excursions from water quality standards at site 628 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.

The samples from the Allen Creek watershed show most DO violations occurred at flows less than 5.3 cfs. The Load Allocation assigns responsibility for reducing the in stream BOD levels at site 628 to 3.2 mg/L across the 0.2 - 5.3 cfs range of the critical flow condition (88 - 48% exceedance) and maintaining the in stream BOD levels at site 628 to the historical levels of 6.6 mg/L for flows in excess of 5.3 cfs (which is 90^{th} percentile of BOD samples for flows in Allen Creek above 5.3 cfs near Emporia). The LA equals zero for flows from 0 - 0.2 cfs (89 - 99% exceedance), since the flow at this condition is entirely effluent created, and then increases to the TMDL curve with increasing flow beyond 0.21 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 sediment transported to the stream that may occur during the critical flow period.

Defined Margin of Safety: The Margin of Safety will be implied based on conservative assumptions used in the permitting of the point source discharges including coincidence of low flow with maximum discharge from the treatment plant, associated CBOD content, temperature of the effluent, higher than expected stream velocity and the better than permitted performance of the treatment plant in producing effluent with BOD well below permit limits under critical seasonal conditions.. Additionally, the target BOD concentration has been set at a conservative value since sampling data indicates exceeding this value has seldom led to a dissolved oxygen violation.

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

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

Priority HUC 11s and Stream Segments: Priority should be directed toward baseflow gaining stream segments along the main stem of Allen Creek (3, 5) including Dow Creek (4) and Stillman Creek (44).

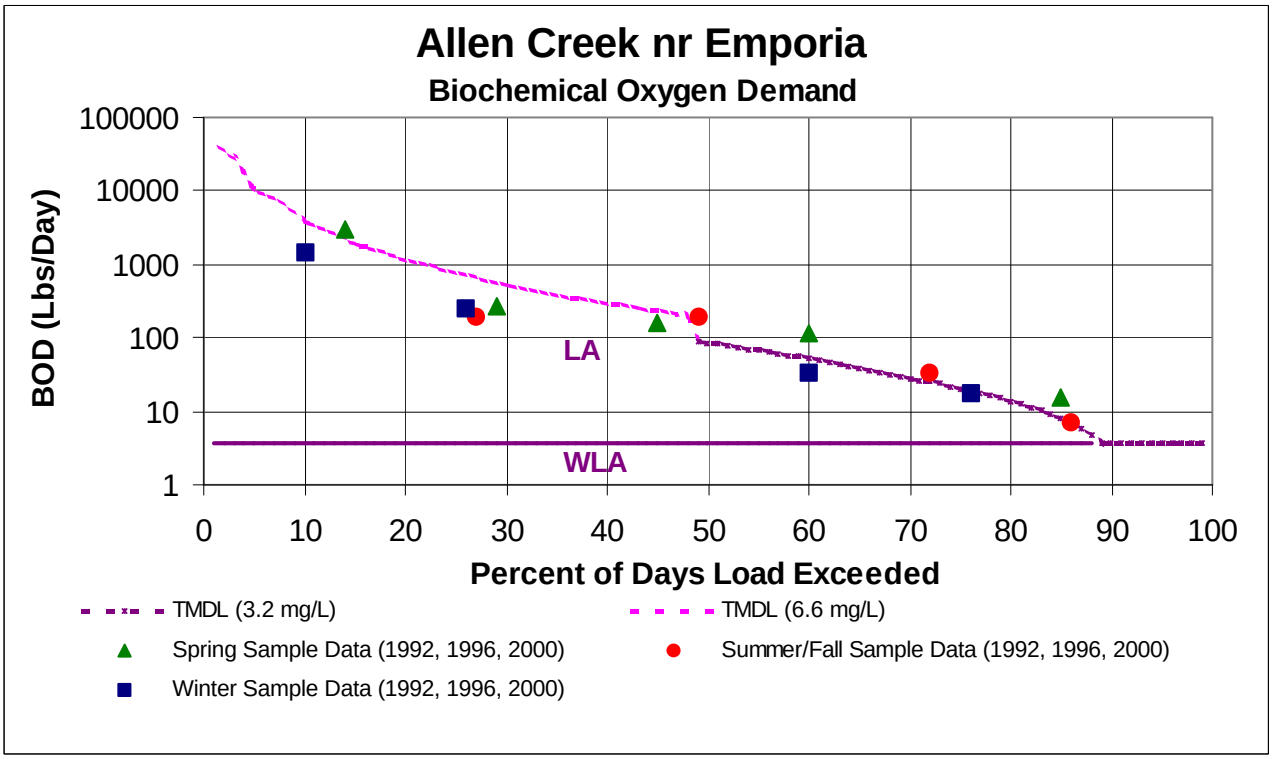


Figure 6

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. 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.

b. Develop a pilot study on the use of aerators to lower BOD levels in lagoon system effluent.

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.

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 on-site waste systems close to listed 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. Provide technical assistance on livestock waste management design.
c. 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 Allen Creek and base flow conducting tributaries in 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 Allen Creek, Dow Creek and Stillman 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. Failing on-site waste systems

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 site 628 should indicate evidence of improved dissolved oxygen levels at the critical flow conditions below 5.3 cfs relative to the conditions seen over 1992, 1996 and 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 Lyon 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 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 1992, 1996 and 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 rotational Station 628 in 2004 and 2008 including dissolved oxygen samples in order to assess progress and success in implementing this TMDL toward reaching its endpoint. Should impaired status remain, the desired endpoints under this TMDL may be refined and more intensive sampling 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 Marais des Cygnes near Reading stream gaging station can help direct these sampling efforts.

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

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

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

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

Consideration for 303(d) Delisting: The creek will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2007-2011. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water quality criteria during the ten year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2003 which will emphasize implementation of TMDLs. At that time, incorporation of this TMDL will be made into both documents. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2003-2007.

Appendix (Allen Creek DO TMDL)

Table 2

Allen Cr Watershed (628)			Rock Creek Watershed (629)		
Land Use	Acres	% of Total	Land Use	Acres	% of Total
Cropland	24657	31.0	Cropland	8984	11.4
Grassland	52418	65.8	Grassland	66509	84.3
Urban Use	575	0.7	Urban Use	12	0.0
Water	254	0.3	Water	210	0.3
Woodland	1733	2.2	Woodland	3207	4.1
Total	79636	100	Total	78922	100

Table 3

COL_DATE	DISOXY		AMMONIA		BOD		FECCOLI		NITRATE		PHFIELD		TEMP_CENT		PHOSPHU		TSS		TURBIDITY		FLOW
	628	629	628	629	628	629	628	629	628	629	628	629	628	629	628	629	628	629	628	629	628
2/5/92	15.8	11.9	0.050	0.050	6.00	24.70	10	10	0.12	0.08	8.3	8.0	2	3	0.05	0.45	7	143	5.8	26.0	0.001
4/8/92	9.5	9	0.050	0.050	4.70	1.50	200	100	0.10	0.06	7.7	8.1	12	12	0.09	0.07	42	40	20.8	15.4	6.4
6/3/92	7.8	7.4	0.100	0.050	8.50	4.50	9000	1000	8.55	1.44	7.6	8.0	14	15	0.72	0.16	757	155	281.0	40.0	63.2
8/12/92	6.2	7.1	0.050	0.050	2.30	2.30	500	9900	0.43	0.30	7.7	7.8	21	20	0.20	0.18	65	117	40.0	56.0	15.4
10/14/92	6	8.3	0.050	0.050	3.20	2.00	100	20	0.82	0.07	7.6	8.0	13	12	0.11	0.07	19	15	9.2	8.2	0.4
12/2/92	12.7	11.7	0.050	0.050	2.60	1.90	1000	2100	1.04	0.60	7.8	8.1	0	1	0.20	0.09	60	49	35.0	27.0	105.3
2/14/96	12.2	16.3	0.010	0.010	3.00	3.90	10	10	0.11	0.33	7.7	7.7	0	0	0.07	0.05	2	10	2.2	1.9	1.1
6/12/96	8.1	7.8	0.010	0.010	3.20	1.50	180	270	0.55	1.12	7.7	7.8	19	21	0.35	0.15	180	49	115.0	18.0	15.4
8/21/96	6.1	6.4	0.335	0.175	4.30	3.40	2900	2000	0.47	0.39	7.1	7.7	20	22	0.46	0.32	292	200	156.0	121.0	1.5
10/16/96	**4.5**	8	0.132	0.232	7.10	6.50	120	130	0.23	0.52	7.5	7.9	16	17	0.20	0.11	14	12	6.0	5.0	5.2
12/11/96	11.3	12.1	0.092	0.020	2.20	1.80	140	240	0.88	0.74	8.0	8.1	3	4	0.09	0.06	17	9	8.1	3.0	19.7
2/9/00	13.8	14.5	0.030	0.020	1.98	2.04	30	10	0.14	0.14	8.1	8.1	4	4	0.04	0.03	12	4	3.1	1.6	3.0
6/14/00	5.9	6.2	0.020	0.040	6.84	3.96	17000	5400	1.85	0.68	7.5	7.9	21	23	0.79	0.33	928	210	475.0	154.0	3.0
8/16/00	**4.2**	4.8	0.020	0.020	4.50	5.31	10	60	0.10	0.41	7.6	7.4	27	26	0.12	0.20	23	21	13.4	12.0	0.001
10/11/00	10.9	8	0.020	0.020	4.71	3.60	10	100	0.60	1.73	8.0	7.3	10	12	0.08	0.23	18	12	8.4	5.9	0.001
Avg	9	9.3	0.068	0.056	4.34	4.59	2081	1423	1.07	0.57	7.7	7.9	12	13	0.24	0.17	162	69.7	78.6	33.0	16.0

Table 4

COL_DATE	DISOXY		AMMONIA		BOD		FECCOLI		NITRATE		PHFIELD		TEMP_CENT		PHOSPHU		TSS		TURBIDITY		FLOW
	628	629	628	629	628	629	628	629	628	629	628	629	628	629	628	629	628	629	628	629	628
10/16/96	**4.5**	8	0.132	0.232	7.10	6.50	120	130	0.23	0.52	7.5	7.9	16	17	0.20	0.11	14	12	6.0	5.0	5.2
8/16/00	**4.2**	**4.8**	0.020	0.020	4.50	5.31	10	60	0.10	0.41	7.6	7.4	27	26	0.12	0.20	23	21	13.4	12.0	0.001
Avg	4.4	6.4	0.076	0.126	5.80	5.91	65	95	0.17	0.47	7.6	7.7	22	22	0.159	0.156	19	17	9.70	8.50	2.6

Table 5

COL_DATE	DISOXY		AMMONIA		BOD		FECCOLI		NITRATE		PHFIELD		TEMP_CENT		PHOSPHU		TSS		TURBIDITY		FLOW
	628	629	628	629	628	629	628	629	628	629	628	629	628	629	628	629	628	629	628	629	628
10/14/92	6	8.3	0.050	0.050	3.20	2.00	100	20	0.82	0.07	7.6	8.0	13	12	0.11	0.07	19	15	9.2	8.2	0.4
2/14/96	12.2	16.3	0.010	0.010	3.00	3.90	10	10	0.11	0.33	7.7	7.7	0	0	0.07	0.05	2	10	2.2	1.9	1.1
2/9/00	13.8	14.5	0.030	0.020	1.98	2.04	30	10	0.14	0.14	8.1	8.1	4	4	0.04	0.03	12	4	3.1	1.6	3.0
10/11/00	10.9	8	0.020	0.020	4.71	3.60	10	100	0.60	1.73	8.0	7.3	10	12	0.08	0.23	18	12	8.4	5.9	0.001
Avg	10.7	11.8	0.028	0.025	3.22	2.89	38	35	0.42	0.57	7.9	7.8	7	7	0.074	0.095	13	10	5.73	4.40	1.1

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

1 cfs = .0283 m^3/s
0.25 mph =0 .11176 m/s
0.0055185 Design Flow (Americus)

	Elev (ft)	Dist to 628	Min DO	Crit Dist DO
	1140	14.80	6.83	0.05

Elevation Correction (DO)

Elevation	**1140**	ft
Correctn Factor (DO_{sat})	0.96352	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	4.5300	Theta	1.024

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

		Flow	BOD	DO	T	Dist	Slope (ft.mi)	Calc K_r	
1	**Americus**	0.0055185	30	6.83	22	14.8	16.6	4.53	
	Upstream	0	0	0	0	-----			
	Result at Dist	0.0055185	20.25	7.27	24				Elev = 987 ft

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