SOLOMON BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody/Assessment Unit: Limestone Creek
Water Quality Impairment: Dissolved Oxygen

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Solomon River **County:** Jewell, Mitchell and Smith

HUC 8: 10260015

HUC 11 (HUC 14s)**:** **010** (040, 050, 060, 070 and 080)

Drainage Area: 203.6 square miles

Main Stem Segment: WQLS: 18 and 19 (Limestone Creek) starting at confluence with Solomon River just below Waconda Lake in northwest Mitchell County and traveling upstream to headwaters in central Jewell County (**Figure 1**).

Tributaries:
Disappointment Cr (35)
West Limestone Cr (20)
Middle Limestone Cr (21)
West Limestone Cr (22)
Elm Cr (59)

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 (Limestone Creek).

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 2002 303(d): Partially Supporting Aquatic Life

Monitoring Sites: Station 667 near Glen Elder

Period of Record Used: 1991 –1997, 1999 and 2001 for Station 667 (**Figure 2**)

Flow Record: White Rock Creek near Burr Oak (USGS Station 06853800; 1970-2002) flow duration matched to Limestone Creek at Glen Elder (USGS Site 06875820)

Long Term Flow Conditions: 10% Exceedance Flows = 29.5 cfs**,** 95% = 0.004 cfs

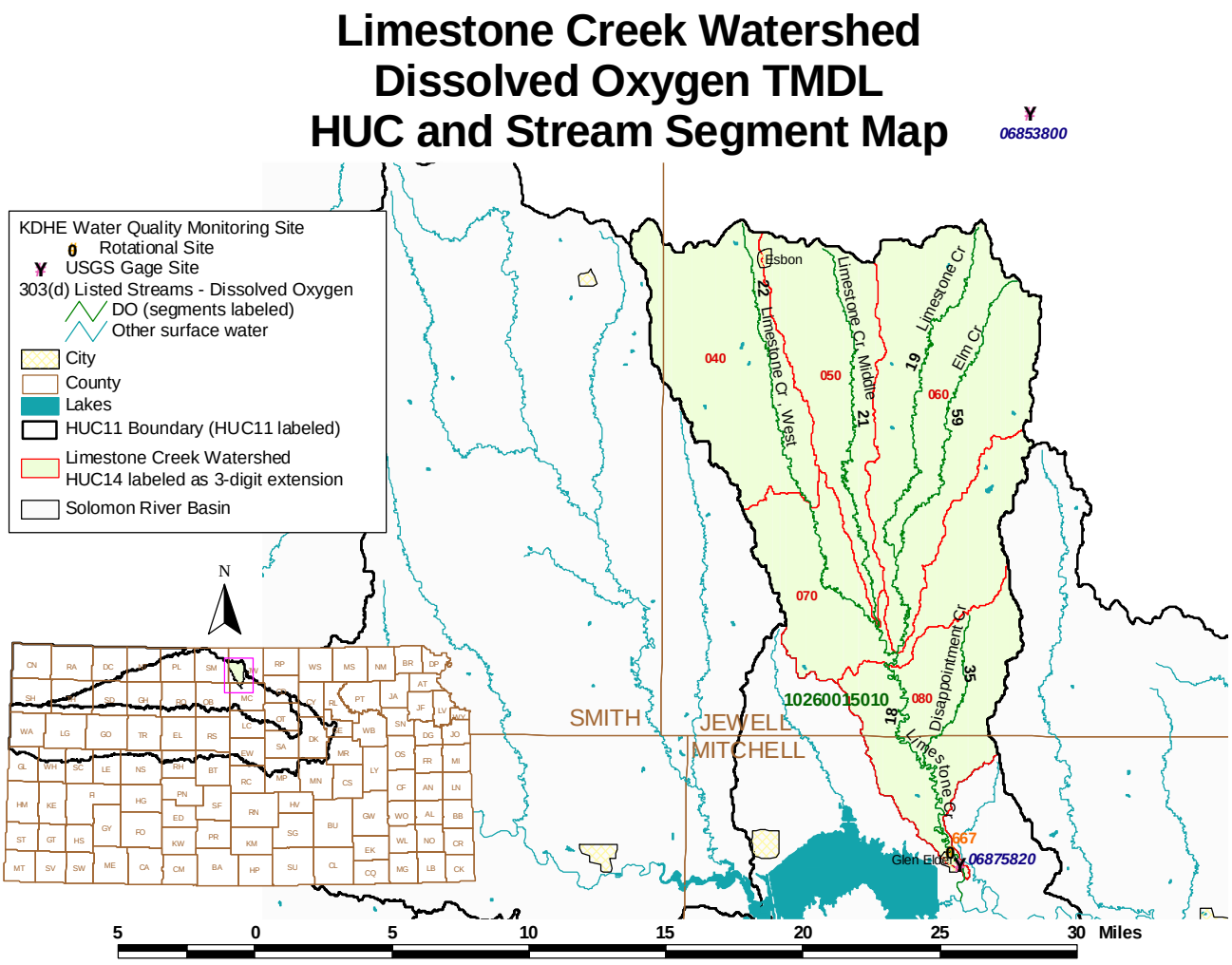

Figure 1

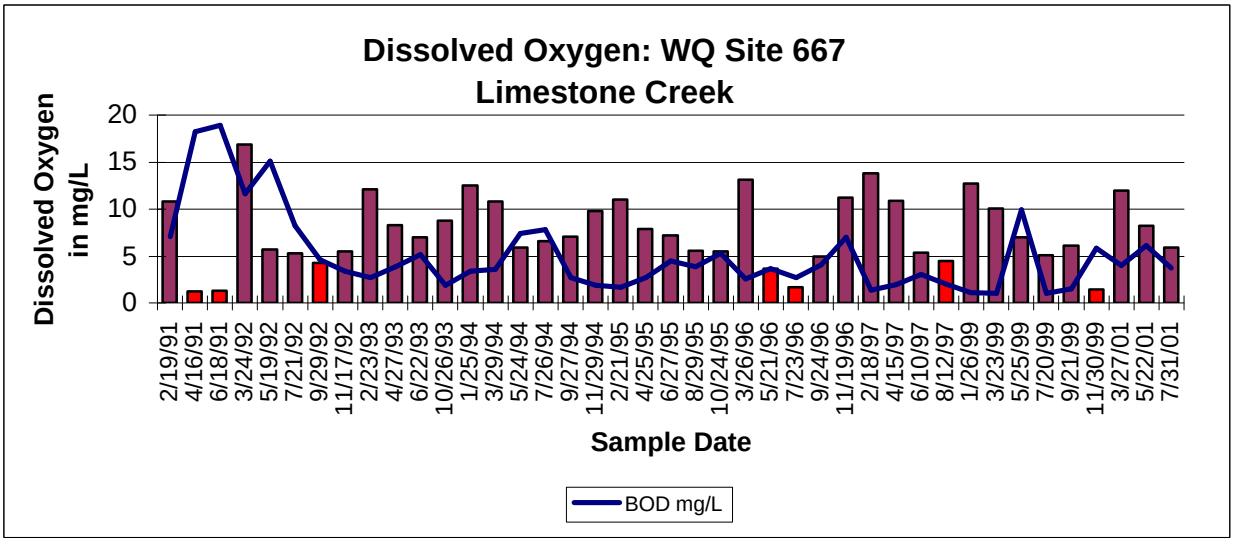

Figure 2

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 Limestone Creek at Glen Elder along the curve by the applicable water quality criterion and converting the units to derive a load duration curve of pounds of DO per day. This load curve graphically displays the TMDL since any point along the curve represents water quality at the standard at that flow. Historic excursions from water quality standards (WQS) are seen as plotted points *below* the load curves. Water quality standards are met for those points plotting *above* the applicable load duration curves (**Figure 3**).

Excursions were seen in each of the three defined seasons and are outlined in **Table 1**. Twenty-two percent of the Spring samples and 25% of Summer-Fall samples were below the aquatic life criterion. Seven percent of the Winter samples were under the aquatic life criterion. Overall, 17% 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.**
Limestone Creek nr Glen Elder (667)	Spring	1	0	1	1	0	1	4/18 = 22%
	Summer/Fall	0	0	0	1	1	0	2/8 = 25%
	Winter	0	0	0	1	0	0	1/15 = 7%

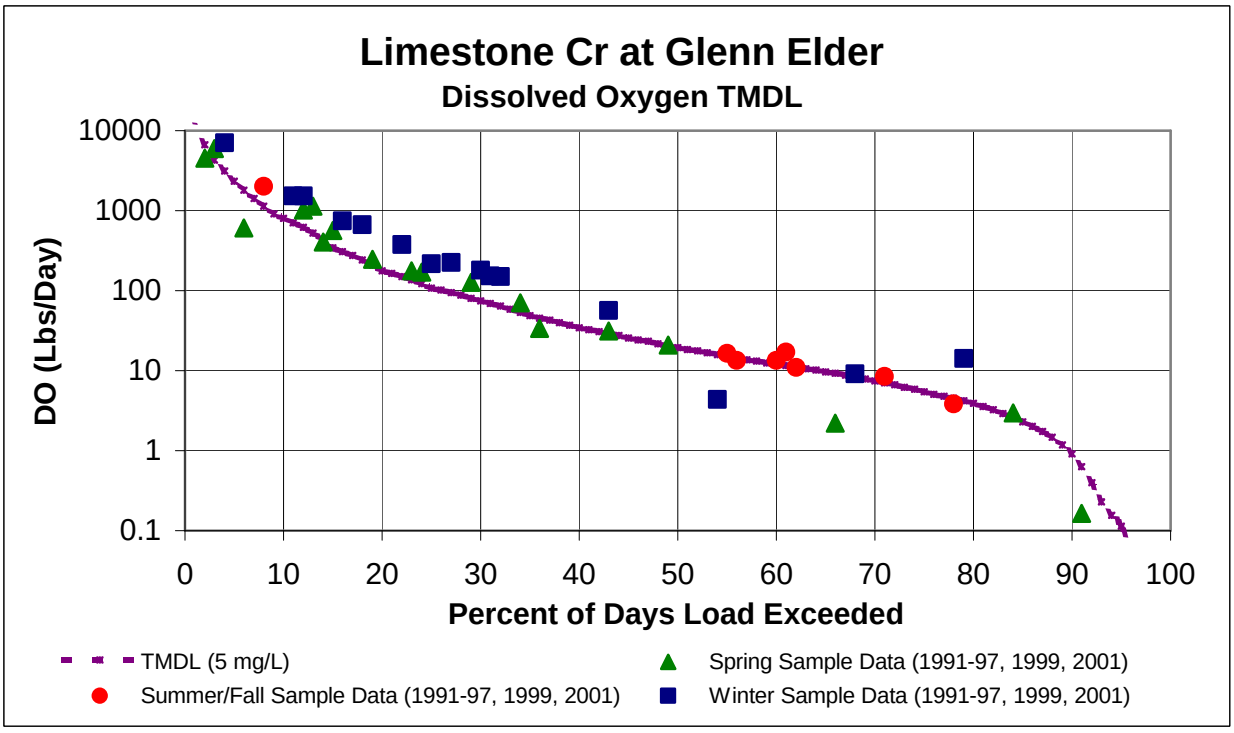

Figure 3

DO violations were encountered across all flows on Limestone Creek, but primarily those violations occurred when flows were 1.7 cfs or less (6 out of 7 excursions). Therefore, a critical low flow can be identified on Limestone Creek as those flows of 1.7 cfs or less.

A watershed comparison approach was taken in developing this TMDL. The Oak Creek watershed (Water Quality Sampling Site 544 in the watershed was not impaired by low DO) has similar land use characteristics (**Table 2**) to the Limestone Creek watershed and is of comparable size. The Oak Creek watershed is located immediately to the west of the Limestone Creek watershed.

Table 2

Limestone Cr Watershed (667)			Oak Cr Watershed (544)		
Land Use	Acres	% of Total	Land Use	Acres	% of Total
Cropland	75,763	58.14	Cropland	67,964	54.87
Grassland	49,620	38.08	Grassland	52,540	42.41
Other	0	0.00	Other	0	0.00
Residential	193	0.15	Residential	132	0.11
Water	272	0.21	Water	334	0.27
Woodland	4,470	3.43	Woodland	2,904	2.34
Total	130,318	100	Total	123,875	100

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 3 in the Appendix** outlines those water quality data for the samples taken on the same date for the two comparison sites. **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 667. From **Table 4**, comparing site 667 to reference site 544, the median phosphorus concentration was higher than the reference site 544, the median nitrate and turbidity were lower while all other parameters, including BOD, were similar. Although the median BOD at site 667 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 similar to the median BOD at reference site 544, which was not impaired by low DO.

Because the comparison from Table 4 is, at best, inconclusive, **Table 5 in the Appendix** was developed. Table 5 is a subset of data from Table 3 for those sampling dates when there was *no* DO problem at site 667, but the flows on the sampling date occurred within the critical flow range (1.7 cfs or less). Comparing median values for site 667 from Tables 4 and 5 indicates ammonia, phosphorus and BOD values were lower when there was not a DO problem at site 667, 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 Limestone Creek watershed upstream of site 667 and, under certain conditions, is likely a factor influencing the DO violations. Table 5 establishes the target BOD level for site 667.

Additionally, comparison analysis was made for the data at Station 667 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 and pH. There was no difference between the compliant and impaired conditions in bacteria, turbidity, temperature or flow. During periods when dissolved oxygen was deficient, ammonia,

BOD and phosphorus 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 667 over 2008 – 2012

The desired endpoint will be reduced biochemical oxygen demand from artificial sources such that median 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 2008 - 2012 attributed to these sources.

This desired endpoint should improve DO concentrations in the creek at the critical lower flows (0 - 1.7 cfs). Seasonal variation is accounted for by this TMDL, since the TMDL endpoint is sensitive to the low flow usually occurring in the June – 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 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 no NPDES municipal permitted wastewater dischargers within the watershed that would contribute an oxygen demanding material load to Site 667 (**Figure 4**). The city of Glen Elder is located within the watershed and has an NPDES permit, but its outfall is located downstream of Site 667 and therefore, cannot be considered a source contributing to the impairment at the monitoring site. The city of Esbon has a non-discharging lagoon that may contribute an oxygen demanding material load to Middle Limestone Creek (Segment 21) 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. They are also unrelated to the critical hydrologic conditions outlined in this TMDL. 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.

Limestone Creek Watershed
NPDES and Livestock Waste Management Facilities

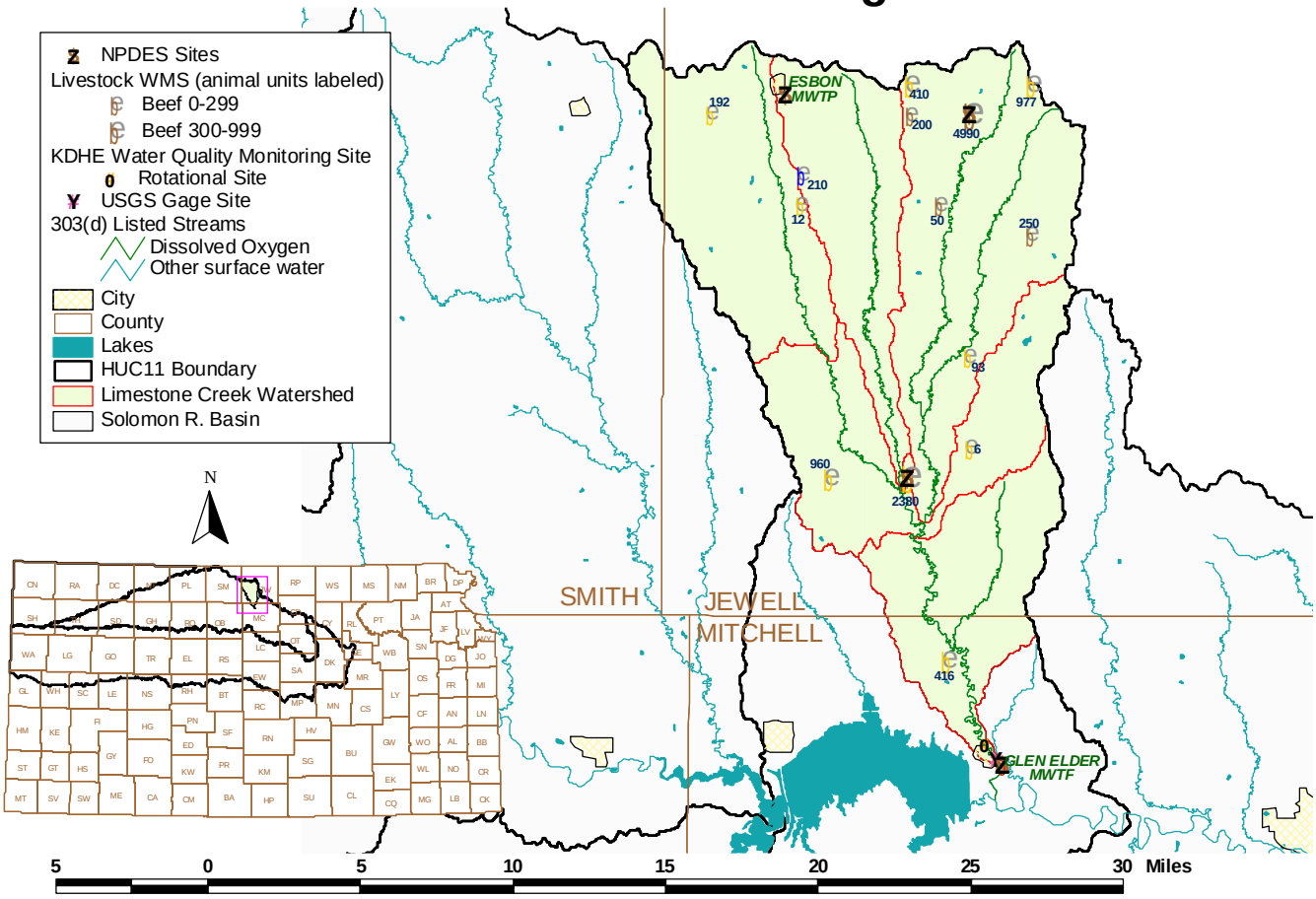

Figure 4

Livestock Waste Management Systems: Fourteen operations are registered, certified or permitted within the watershed. These facilities (beef, dairy or swine) are primarily located toward the upper end or near the middle of the watershed (**Figure 4**). Two facilities in the watershed, one beef facility located near the upper end and the other, a swine facility located in the middle of the watershed along the main stem, are NPDES permitted, non-discharging facilities (4,990 and 2,380 animal units, respectively) (**Figure 4, Table 6**).

Table 6

Facility	NPDES Permit	Stream Reach	Segment	Design Flow	Type
Jewell County Feeders	A-S0JW-CO01			Non-discharging	Lagoon
Rose Pork	A-SOJW-HO01			Non-discharging	Lagoon

The depletions of in-stream dissolved oxygen occurred prior to 2000, with most of the significant (less than 4 mg/l) events occurring in 1991 and 1996. It is possible that this was a time before appropriate controls were installed in NPDES and state permitted CAFOs. Since 2000, there

have been no excursions from the water quality standard across a variety of flows, indicating that point source controls might have been in-place and effective.

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 that 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, especially under the critical low flow condition outlined previously. 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 Jewell County, such events would generate 5.2 inches of rain, yielding 4.1 to 4.9 inches of runoff in a day. The watershed's total potential animal units, for all facilities combined, is 12,285. The actual number of animal units on site is variable, but typically less than potential numbers.

Land Use: Most of the watershed is cropland (58% of the area), grassland (38%) or woodland (3.5%). Most of the cropland is located in the upper and lower third of the watershed with the grassland either in the middle third of watershed or around the subwatershed boundaries. According to the NRCS Riparian Inventory, there are about 15,250 acres of riparian area in the watershed, most of which is categorized as pasture land (32%), cropland (27%), forest land (19%), pasture/tree mix (13%) and crop/tree mix (8%) (**Figure 5**).

On-Site Waste Systems: Most of the watershed's population density is low when compared to densities elsewhere in the Solomon Basin (2-6 person/mi^2) (**Figure 5**). The rural population projection for Jewell County through 2020 shows a modest decline (about 19% decrease). Based on 1990 census data, about 44% of the households in Jewell 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.

Contributing Runoff: The Limestone Creek watershed's average soil permeability is 1.1 inches/hour according to NRCS STATSGO database. Essentially the entire watershed produces runoff even under relatively low (1.71"/hr) potential runoff conditions (99.6%). Under very low (1.14"/hr) potential conditions, this potential contributing area is reduced to about 58%. 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 8% of this watershed, chiefly from the lower half of 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 streamside vegetation, the loading should be greatest along the main stem of the watershed with its larger proportion of woodland near the stream.

Limestone Creek Watershed
Riparian Inventory, Land Use and Population Density

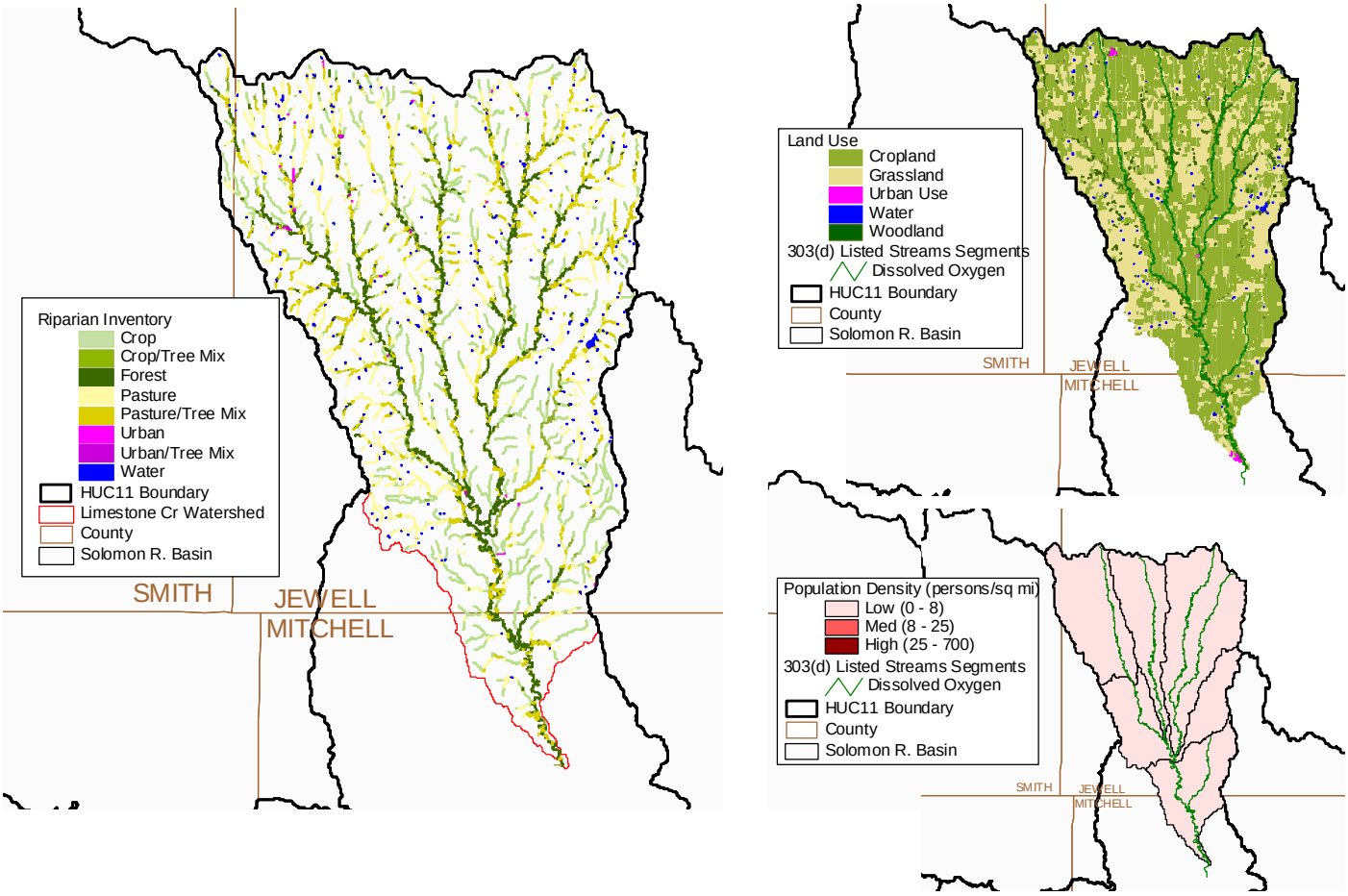

Figure 5

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 Limestone Creek system. These reductions have been based on the relationship between DO and BOD across a critical flow range for the samples taken at Water Quality Monitoring site 667 in the presence or absence of DO excursions **(Tables 4 and 5 in Appendix)**. Allocations relate to the BOD levels seen in the Limestone Creek system at site 667 for the critical lower

flow conditions (0-1.7 cfs). Based on this relationship, BOD loads at site 667 need to be reduced by 26% (so that in stream median BOD is 3.4 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 median BOD levels were multiplied by the average daily flow for Limestone 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: A current Wasteload Allocation of zero is established by this TMDL because of the lack of discharging point sources located upstream of monitoring site 667. Should future point sources be proposed in the watershed and discharge into the impaired segments, the current Wasteload Allocation will be revised by adjusting current load allocations to account for the presence and impact of these new point source dischargers (**Figure 6**).

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 Limestone 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 667 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 Limestone Creek watershed show most DO violations occurred at flows less than 1.7 cfs. The Load Allocation assigns responsibility for reducing the in stream BOD levels at site 667 to 3.4 mg/L across the 0.0 - 1.7 cfs range of the critical flow condition (36 - 99% exceedance) and maintaining the in stream BOD levels at site 667 to the historical levels of 3.7 mg/L for flows in excess of 1.7 cfs (which is median of BOD samples for flows in the Limestone Creek above 1.7 cfs at Glen Elder)(**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.

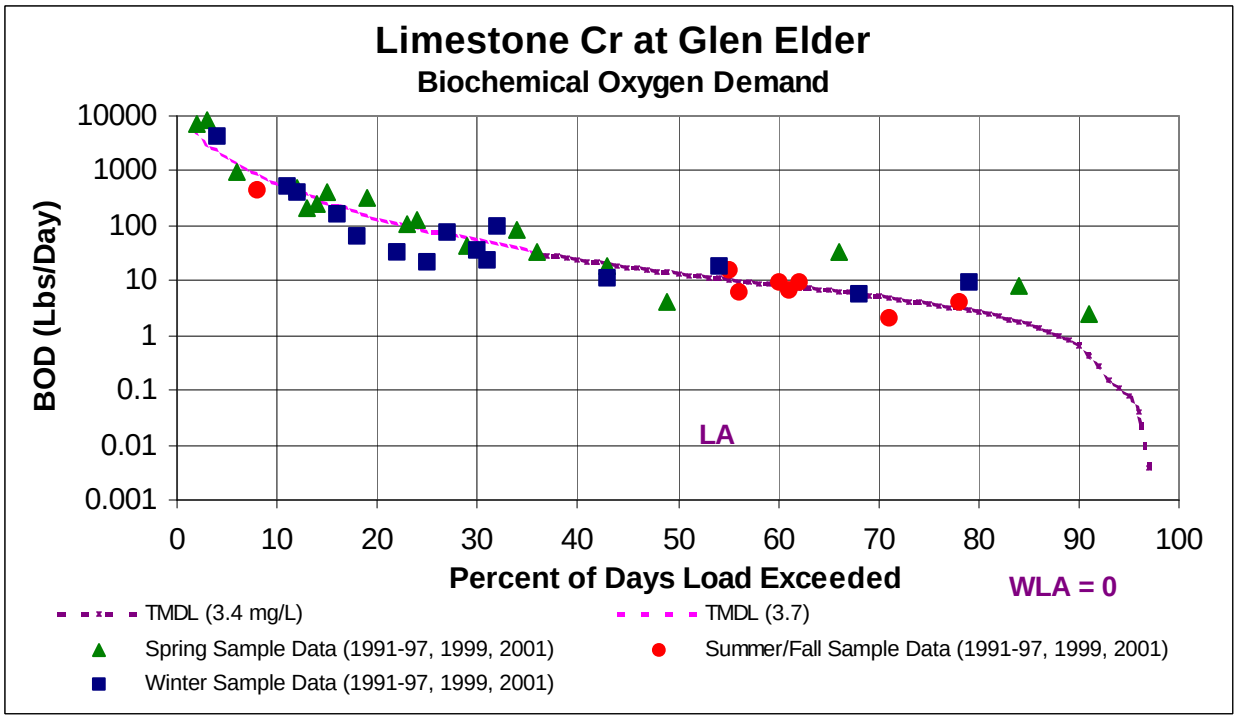

Figure 5

Defined Margin of Safety: The Margin of Safety will be implied based on conservative assumptions used to set the target BOD concentration, 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 Solomon Basin (HUC 8: 10260015) with a priority ranking of 23 (Medium 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 to the conditions of their permits.
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 in 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 most likely be:

1. Areas of denuded riparian vegetation along the Limestone 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 667 should indicate evidence of improved dissolved oxygen levels at the critical flow conditions below 1.7 cfs 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 primarily Jewell 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 Solomon 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 rotational Station 667 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 2008-2012. Use of the real time flow data available at the White Rock Creek near Burr Oak stream gaging station can direct these sampling efforts.

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 Solomon Basin were held October 3, 2002, January 7 and March 3, 2003 in Stockton. 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 Solomon Basin.

Public Hearing: Public Hearings on the TMDLs of the Solomon Basin were held in Stockton on June 2, 2003.

Basin Advisory Committee: The Solomon Advisory Committee met to discuss the TMDLs in the basin on October 2, 2002, January 6, March 3, and June 2, 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 Limestone 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

Appendix to Limestone Creek Dissolved Oxygen TMDL

Table 3

Date	DO		Ammonia		BOD		FCB		Nitrate		pH		Temp_Cent		Phos		Turb		Flow
	667	**544**	**667**	**544**	**667**	**544**	**667**	**544**	**667**	**544**	**667**	**544**	**667**	**544**	**667**	**544**	**667**	**544**	**667**
2/19/91	10.8	11.6	0.36	0.05	7.1	1	6000	20	0.09	2.28	7.9	7.8	0	0	0.30	0.07	3.6	5.2	2.55
4/16/91	**1.2**	7.3	0.06	0.05	18.2	5	19000	700	0.01	0.01	7.8	7.9	10	9	2.98	0.16	54.0	20.0	0.34
6/18/91	**1.3**	3.8	1.82	0.05	18.9	9.5	3800	14000	0.07	0.54	7.5	7.9	21	20	2.70	0.46	8.7	73.9	0.02
3/24/92	16.9	8.1	0.05	0.05	11.6	10.7	100	10	2.65	0.05	7.8	7.9	7	0	0.67	0.38	46.6	7.0	0.15
5/19/92	5.7	11.1	0.05	0.05	15.1	3.5	100	100	0.02	0.02	7.8	7.9	18	17	1.08	0.07	47.8	6.0	0.10
7/21/92	5.3	11.5	0.08	0.05	8.2	5.6	20000	10	1.61	0.02	7.7	8.4	19	5	1.72	0.11	620	13.5	158.25
9/29/92	**4.3**	6.2	0.15	0.23	4.6	3.1	200	200	0.89	0.29	7.5	7.9	12	17	0.37	0.19	11.0	21.4	0.17
11/17/92	5.5	5.8	0.14	0.09	3.4	8.6	90	80000	0.51	1.13	7.6	7.7	4	18	0.49	2.09	10.4	1180	0.31
2/23/93	12.1	8.4	0.15	0.05	2.7	3.5	20	200	1.82	1.47	7.9	8.1	0	11	0.21	0.14	16.0	17.0	11.44
4/27/93	8.3	9.7	0.05	0.05	3.9	1.9	60	160	0.78	1.47	8.2	8.1	13	4	0.10	0.11	17.6	8.3	22.79
6/22/93	7	8.7	0.05	0.05	5.2	3.1	3700	290	1.57	2.05	8.2	8.1	20	13	0.48	0.10	47.0	20.0	4.52
10/26/93	8.8	7	0.05	0.05	1.9	6.4	100	1800	4.07	2.26	8	8.3	8	20	0.13	0.42	8.0	69.0	42.20
1/25/94	12.5	10.5	0.05	0.05	3.4	7	100	10	6.04	0.42	8	8.2	0	11	0.07	0.07	1.6	5.0	22.79
3/29/94	10.8	10.9	0.06	0.05	3.6	2.6	1200	80	3.15	6.43	8.2	8.2	4	4	0.16	0.12	9.7	15.0	26.16
5/24/94	5.9	6.7	0.27	0.1	7.4	5.3	300	200	2	3.49	8.1	8.1	18	18	0.43	0.43	43.0	105.0	7.76
7/26/94	6.6	5.9	0.21	0.12	7.8	7.1	60000	12000	2.87	3.44	8	8	19	20	0.58	0.36	50.0	54.0	1.98
9/27/94	7.1	8.9	0.04	0.01	2.73	1	300	400	3.05	8.13	7.9	8.1	12	10	0.30	0.24	17.0	39.0	0.44
11/29/94	9.8	11.7	0.09	0.06	1.9	2.9	170	300	1.91	5.6	8	8	1	1	0.16	0.06	5.0	4.0	1.08
2/21/95	11	11.9	0.1	0.04	1.7	2	20	100	4.22	6	8	7.9	2	3	0.11	0.07	4.6	3.8	2.55
4/25/95	7.9	10.5	0.09	0.07	2.7	2.7	280	200	0.41	2.35	7.9	8	10	9	0.12	0.15	4.0	6.0	3.00
6/27/95	7.2	2.8	0.07	0.2	4.5	4.4	800	10	2.07	0.31	8.1	7.7	17	22	0.32	0.41	11.0	2.0	4.52
8/29/95	5.6	7	0.088	0.024	3.9	3.4	600	900	2.01	5.77	8	8.1	22	22	0.35	0.24	14.0	15.0	0.44
10/24/95	5.5	9.2	0.125	0.156	5.3	4.6	10	10	1.31	3.03	7.8	8	5	4	0.19	0.08	6.0	8.0	0.55
3/26/96	13.1	15.5	0.04	0.087	2.6	2.2	134	8	1	3.97	7.9	8	0	0	0.06	0.03	2.4	2.6	2.55
5/21/96	**3.7**	5.6	0.412	0.58	3.7	9.1	300	100	0.97	2.16	7.9	7.9	19	17	0.32	0.55	4.0	29.0	1.69
7/23/96	**1.7**	7.2	0.485	0.261	2.7	6.8	1600	2200	0.37	1.49	7.6	7.8	21	20	0.42	0.76	11.0	380.0	66.47
9/24/96	5	8.1	0.155	0.088	4.1	4.7	700	960	1.29	2.7	7.6	8.1	14	13	0.48	0.34	174	87.0	0.41
11/19/96	11.2	11.2	0.24	0.255	7	4.4	6800	2800	2.62	3.24	7.8	7.8	5	4	0.72	0.32	220	58.0	116.05
2/18/97	13.8	13	0.023	0.037	1.35	1.29	200	30	3.1	4.02	7.9	8	1	0	0	0.1	2	2	8.99
4/15/97	10.9	10.8	0.02	0.02	1.98	1.89	140	800	0.58	2.03	7.9	7.8	7	7	0.06	0.1	6.3	23	19.41
6/10/97	5.4	6.6	0.097	0.105	3.09	6.63	900	800	1.19	2.33	7.8	8	18	18	0.27	0.4	28.0	104	1.08
8/12/97	**4.5**	5.3	0.028	0.403	2.01	3.72	200	50	0.37	1.33	7.8	7.7	19	19	0.18	0.24	18.0	39.0	0.55
1/26/99	12.7	13.3	0.02	0.02	1.08	1	90	20	1.62	3.91	7.7	7.8	0	1	0.03	0.06	1.5	1.0	5.53
3/23/99	10.1	12.3	0.038	0.044	1.02	1	60	10	0.14	1.6	8.1	8.1	8	8	0.04	0.02	3.6	2.2	4.01
5/25/99	7	7.2	0.38	0.17	9.9	7.74	3800	30000	0.65	0.94	7.7	7.8	19	19	0.97	0.77	475	335.0	158.25
7/20/99	5.1	7.4	0.06	0.02	1	1	1300	830	0.42	1.94	8.1	8.1	27	27	0.28	0.24	11.0	57.0	0.76
9/21/99	6.1	9.3	0.07	0.04	1.53	1	20	1000	0.08	2.24	7.9	8.2	17	15	0.36	0.16	10.0	31.0	0.26
11/30/99	**1.4**	13.8	0.04	0.08	5.85	1.98	220	20	0.08	1.93	7.7	8.2	5	5	1.00	0.07	6.9	2.4	0.58
3/27/01	12	12	0.03	0.07	3.99	1.59	10	60	0.81	2.32	8	8.1	6	6	0.30	0.16	12.0	11.0	3.50
5/22/01	8.2	8.9	0.035	0.057	6.12	5.73	400	1400	0.21	1.68	7.9	8	17	16	0.38	0.33	20.0	60.0	12.66
7/31/01	5.9	6.3	0.064	0.048	3.75	3.39	1600	8000	0.48	0.95	7.9	8	26	27	0.59	0.55	105	170.0	12.66
Median	7.0	8.9	0.07	0.05	3.75	3.50	280	200	1.00	2.05	7.9	8.0	12	11	0.32	0.16	11.0	20.0	2.6

Table 4

Date	DO		Ammonia		BOD		FCB		Nitrate		pH		Temp_Cent		Phos		Turb		Flow
	667	**544**	**667**	**544**	**667**	**544**	**667**	**544**	**667**	**544**	**667**	**544**	**667**	**544**	**667**	**544**	**667**	**544**	**667**
4/16/91	**1.2**	7.3	0.06	0	18.2	5	19000	700	0.01	0.01	7.8	7.9	10	9	2.98	0.16	54.0	20.0	0.34
6/18/91	**1.3**	3.8	1.82	0	18.9	9.5	3800	14000	0.07	0.54	7.5	7.9	21	20	2.70	0.46	8.7	73.9	0.02
9/29/92	**4.3**	6.2	0.15	0.23	4.6	3.1	200	200	0.89	0.29	7.5	7.9	12	17	0.37	0.19	11.0	21.4	0.17
5/21/96	**3.7**	5.6	0.412	0.58	3.7	9.1	300	100	0.97	2.16	7.9	7.9	19	17	0.32	0.55	4.0	29.0	1.69
7/23/96	**1.7**	7.2	0.485	0.261	2.7	6.8	1600	2200	0.37	1.49	7.6	7.8	21	20	0.42	0.76	11.0	380.0	66.47
8/12/97	**4.5**	5.3	0.028	0.403	2.01	3.72	200	50	0.37	1.33	7.8	7.7	19	19	0.18	0.24	18.0	39.0	0.55
11/30/99	**1.4**	13.8	0.04	0.08	5.85	1.98	220	20	0.08	1.93	7.7	8.2	5	5	1.00	0.07	6.9	2.4	0.58
Median	1.7	6.2	0.15	0.2	4.60	5.0	300	200.0	0.37	1.3	7.7	7.9	19	17	0.42	0.2	11.0	29.0	0.5

Table 5

Date	DO		Ammonia		BOD		FCB		Nitrate		pH		Temp_Cent		Phos		Turb		Flow
5/19/92	5.7	11.1	0.05	0.05	15.1	3.5	100	100	0.02	0.02	7.8	7.9	18	17	1.08	0.07	47.8	6.0	0.10
3/24/92	16.9	8.1	0.05	0.05	11.6	10.7	100	10	2.65	0.05	7.8	7.9	7	0	0.67	0.38	46.6	7.0	0.15
9/21/99	6.1	9.3	0.07	0.04	1.53	1	20	1000	0.08	2.24	7.9	8.2	17	15	0.36	0.16	10.0	31.0	0.26
11/17/92	5.5	5.8	0.14	0.09	3.4	8.6	90	80000	0.51	1.13	7.6	7.7	4	18	0.49	2.09	10.4	1180	0.31
9/24/96	5	8.1	0.155	0.088	4.1	4.7	700	960	1.29	2.7	7.6	8.1	14	13	0.48	0.34	174.0	87.0	0.41
9/27/94	7.1	8.9	0.04	0.01	2.73	1	300	400	3.05	8.13	7.9	8.1	12	10	0.30	0.24	17.0	39.0	0.44
8/29/95	5.6	7	0.088	0.024	3.9	3.4	600	900	2.01	5.77	8	8.1	22	22	0.35	0.24	14.0	15.0	0.44
10/24/95	5.5	9.2	0.125	0.156	5.3	4.6	10	10	1.31	3.03	7.8	8	5	4	0.19	0.08	6.0	8.0	0.55
7/20/99	5.1	7.4	0.06	0.02	1	1	1300	830	0.42	1.94	8.1	8.1	27	27	0.28	0.24	11.0	57.0	0.76
11/29/94	9.8	11.7	0.09	0.06	1.9	2.9	170	300	1.91	5.6	8	8	1	1	0.16	0.06	5.0	4.0	1.08
6/10/97	5.4	6.6	0.097	0.105	3.09	6.63	900	800	1.19	2.33	7.8	8	18	18	0.27	0.4	28.0	104	1.08
Median	5.6	8.1	0.09	0.1	3.4	3.5	170	800.0	1.29	2.3	7.8	8.0	14	15	0.35	0.2	14.0	31.0	0.5