SMOKY HILL/SALINE BASIN TOTAL MAXIMUM DAILY LOAD

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

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Lower Smoky Hill **County:** Dickinson and Marion

HUC 8: 10260008

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

Drainage Area: 90.3 square miles

Main Stem Segment: WQLS: 25 (Holland Creek) starting at the confluence with the Smoky Hill River in west-central Dickinson County and traveling upstream to the confluence of East and West Holland Creek in southwest Dickinson County (**Figure 1**).

Tributaries: Holland Cr, West (26)
Holland Cr, East (27)

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

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): Not Supporting Aquatic Life

Monitoring Sites: Station 642 near Sand Springs

Period of Record Used: 1991, 1995 and 1999 for Station 642 (**Figure 2**)

Flow Record: Chapman Creek near Chapman flow duration (USGS Station 06878000; 1970-2002) matched to the unit area discharge flow duration for Lyon Creek near Wreford (Station 06878600) based on drainage area for Holland Creek watershed.

Long Term Flow Conditions: 10% Exceedance Flows = 79.5 cfs**,** 95% = 2.35 cfs

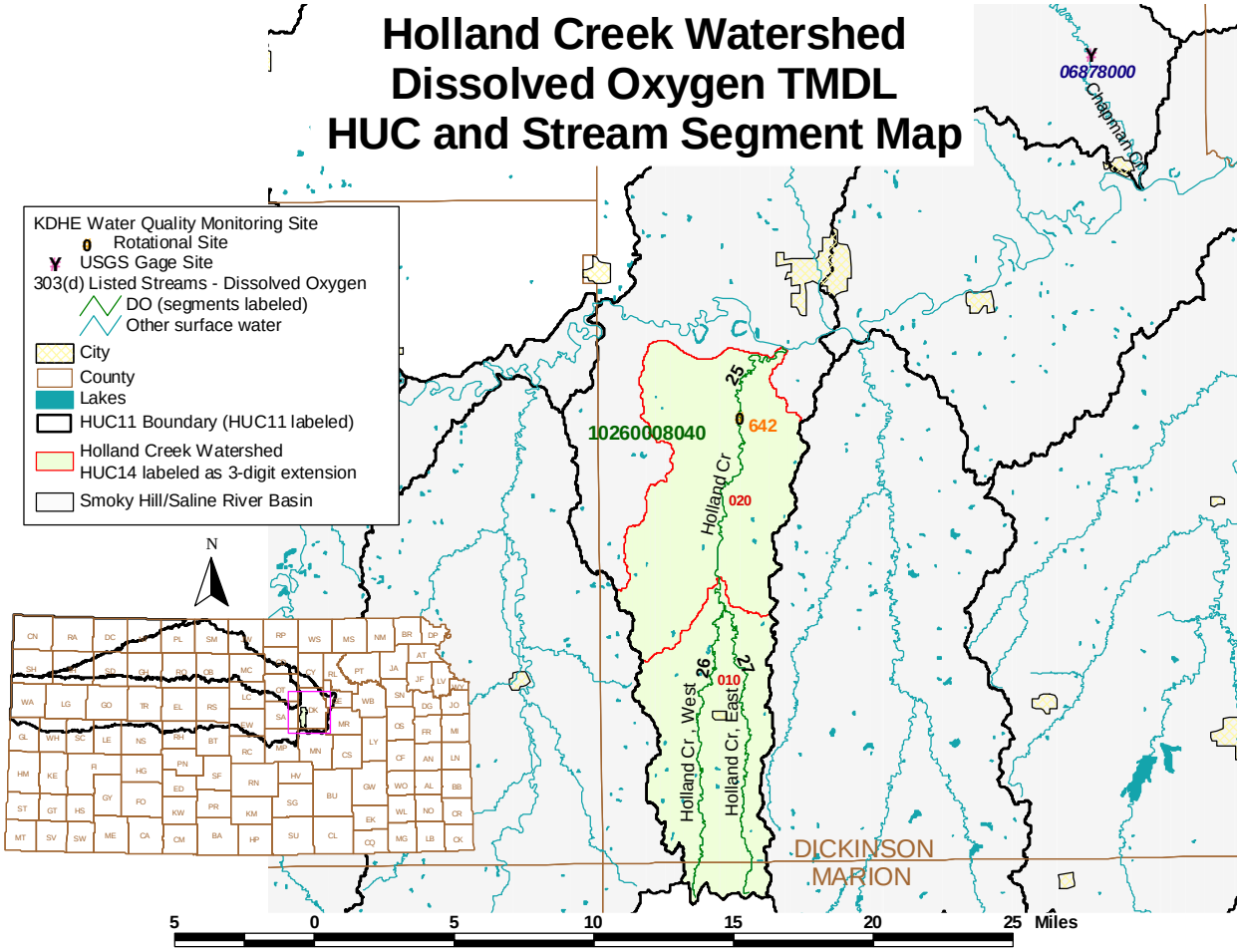

Figure 1

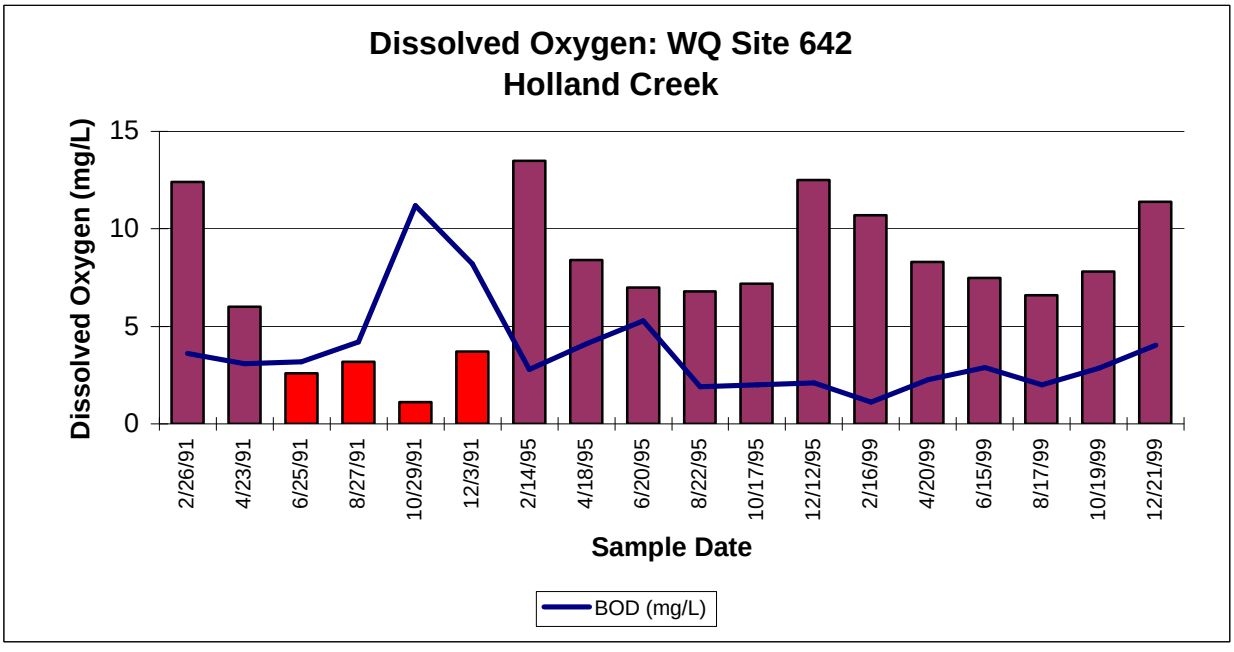

Figure 2

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 Holland Creek near Sand Springs 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**. Thirty-three percent of the Summer-Fall samples and 17% of Spring samples were below the aquatic life criterion. Seventeen percent of the Winter samples were under the aquatic life criterion. Overall, 22% 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.**
Holland Cr nr Sand Springs (642)	Spring	0	0	0	0	0	1	1/6 = 17%
	Summer/Fall	0	0	0	0	0	2	2/6 = 33%
	Winter	0	0	0	0	0	1	1/6 = 17%

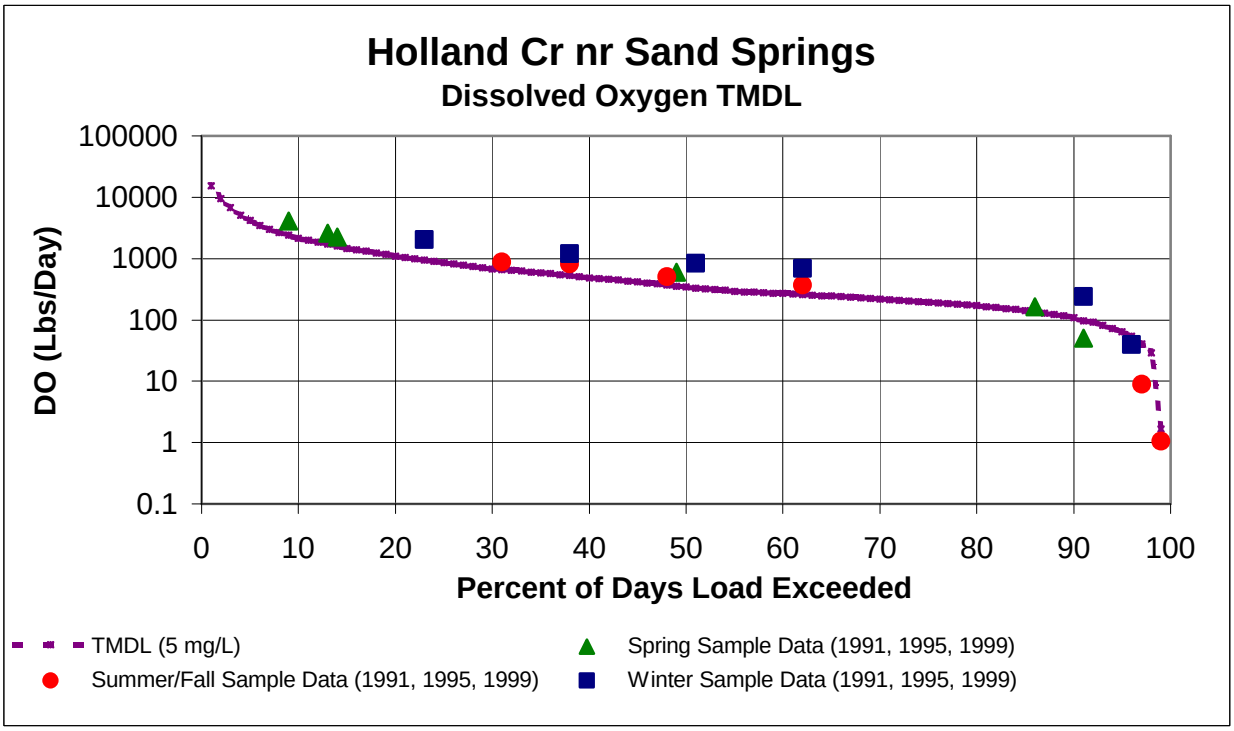

Figure 3

No DO violations have been encountered at flows exceeding 3.6 cfs on Holland Creek near Sand Springs, therefore a critical low flow can be identified on Holland Creek as those flows of 3.6 cfs or less.

A watershed comparison approach was taken in developing this TMDL. The Turkey Creek watershed (Water Quality Sampling Site 644 in the watershed was not impaired by low DO) and the Gypsum Creek watershed (Water Quality Site 641 in the watershed was also not impaired by DO) have roughly similar land use characteristics (**Table 2**) to the Holland Creek watershed. The Turkey and Gypsum Creek watersheds bracket the Holland Creek watershed to the east and west, respectively. The primary difference between Holland Creek and the reference watersheds is drainage area and resulting contributions to baseflow under extended periods of little precipitation. Both reference watersheds are two to more than three times as large as the Holland Creek watershed. Turkey Creek, like Holland Creek, does not have any point source discharges contributing to it. Gypsum Creek does have a three-cell lagoon (0.063 cfs design flow) contributing to its baseflow.

Table 2

Holland Cr Watershed (642)			Turkey Cr Watershed (644)			Gypsum Cr Watershed (641)		
Land Use	Acres	% of Total	Land Use	Acres	% of Total	Land Use	Acres	% of Total
Cropland	32,748	56.69	Cropland	54,601	52.25	Cropland	74,238	45.05
Grassland	24,336	42.13	Grassland	47,926	45.86	Grassland	86,043	52.22
Other	18	0.03	Other	14	0.01	Other	12	0.01
Residential	6	0.01	Residential	7	0.01	Residential	385	0.23
Water	36	0.06	Water	213	0.20	Water	284	0.17
Woodland	622	1.08	Woodland	1,736	1.66	Woodland	3,819	2.32
Total	57,767	100	Total	104,497	100	Total	164,781	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 all three 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 642. From Table 4, comparing site 642 to reference sites 644 and 641, the only clear trend that develops is that there was very little or no flow in any of these watersheds when DO problems occurred. The most reasonable cause for the higher BOD levels at site 642 (**Table 4**) in late October and early December is that of leaf matter decaying in a stream with little, if any, flow. From this it appears that it is most likely that extremely low flow is the primary factor influencing DO violations in the Holland Creek watershed.

Desired Endpoints of Water Quality (Implied Load Capacity) at Site 642 over 2008 – 2012

The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standard of 5 mg/l to fully support Aquatic Life. Seasonal variation is accounted for by this TMDL, since the TMDL endpoint is sensitive to the low flow conditions, usually occurring in the Summer and Fall seasons.

This endpoint will be reached as a result of expected, though unspecified, improvements in tributary buffer strip conditions which will filter sediment before reaching the stream and stream

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

Although anthropogenic sources of BOD are most likely not the controlling factor in the occasional DO excursion at this site (data, season and land use indicate leaf matter is the most likely BOD source), to prevent further BOD loading that might offset the benefits of watershed and stream corridor improvements, the BOD target will be to maintain in stream BOD of 2.8 or less at the sampling site. This target was calculated as the median BOD for those data when DO violations did not occur at site 642.

3. SOURCE INVENTORY AND ASSESSMENT

NPDES: There are no NPDES municipal permitted wastewater dischargers within the watershed (**Figure 4**).

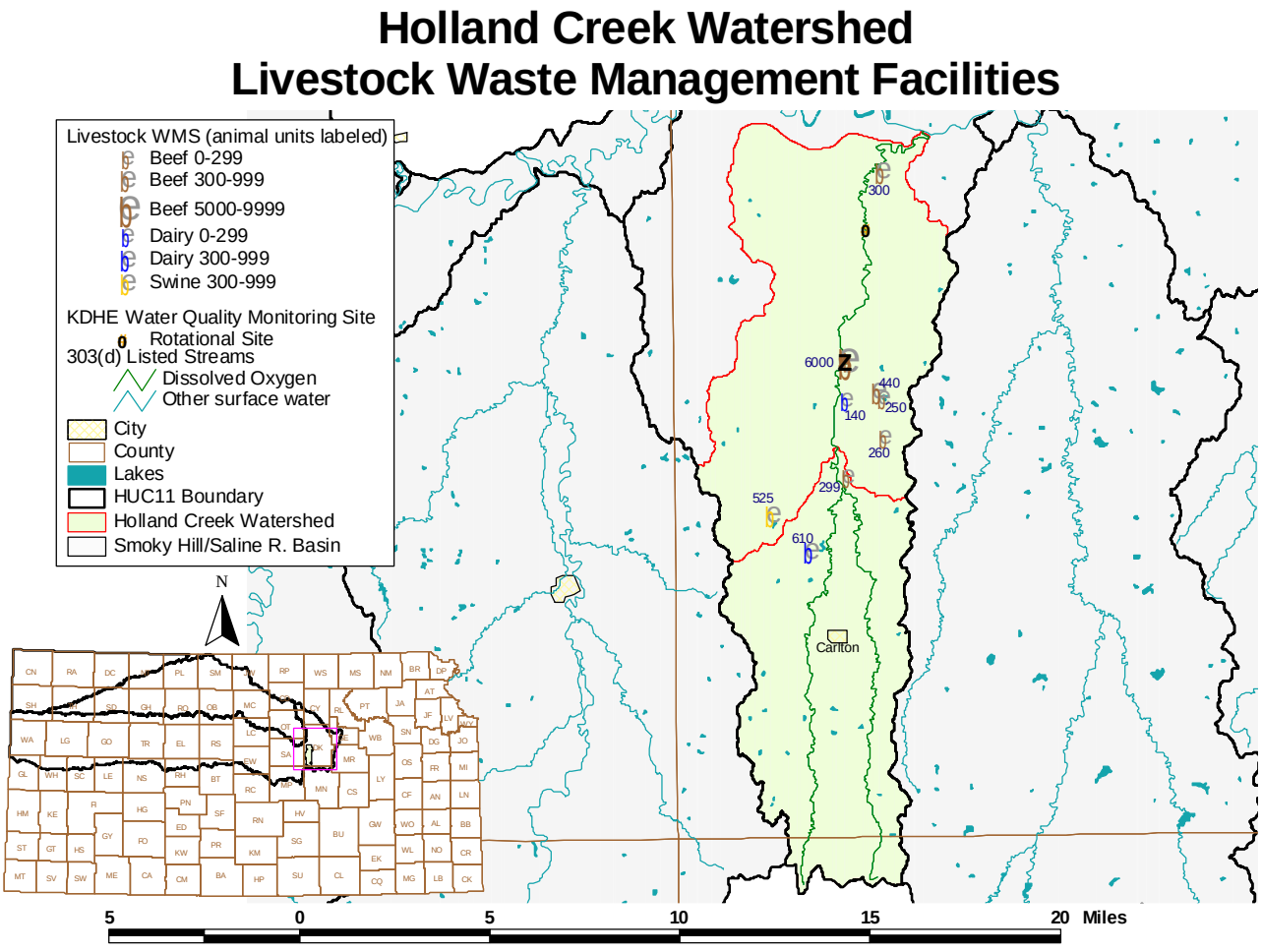

Figure 4

Livestock Waste Management Systems: Nine operations are registered, certified or permitted within the watershed. These facilities (beef, dairy or swine) are primarily located in the middle portion the watershed (**Figure 4**). One beef facility is an NPDES permitted, 6,000 animal unit non-discharging facility (**Figure 4, Table 5**) in the drainage of Segment 25 of Holland Creek. 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 Dickinson County, such an event would generate 5.8 inches of rain, yielding 4.7 to 5.4 inches of runoff in a day. The watershed's total potential animal units, for all facilities combined, is 8,824. The actual number of animal units on site is variable, but typically less than potential numbers.

Table 5

Facility	NPDES Permit	Stream Reach	Segment	Design Flow	Type
Mayden Feedlot	A-SHDK-CO03			Non-discharging	Lagoon

Land Use: Most of the watershed is cropland (57% of the area), grassland (42%), or woodland (1%) (**Table 2**). Most of the cropland is located in the lower two-thirds of the watershed. According to the NRCS Riparian Inventory, there are about 6,509 acres of riparian area in the watershed, most of which is categorized as cropland (45%), forest land (15%), pasture land (15%), crop/tree mix (14%) and pasture/tree mix (9%) (**Figure 5**). Summing those riparian categories with a tree component shows that over two-thirds of the riparian area in the water can contribute leaf material to the organic matter load in the Fall, which supports the assertion that most DO excursions are driven by the decomposition of leaves in the stream.

On-Site Waste Systems: The watershed's population density is low (4 -7 persons/sq mi) when compared to densities elsewhere in the Smoky Hill/Saline Basin (**Figure 5**). The rural population projection for Dickinson County through 2020 shows a slight decline of about 2%. Based on 1990 census data about 30% of households in Dickinson 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.

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.

Holland Creek Watershed
Riparian Inventory, Land Use and Population Density

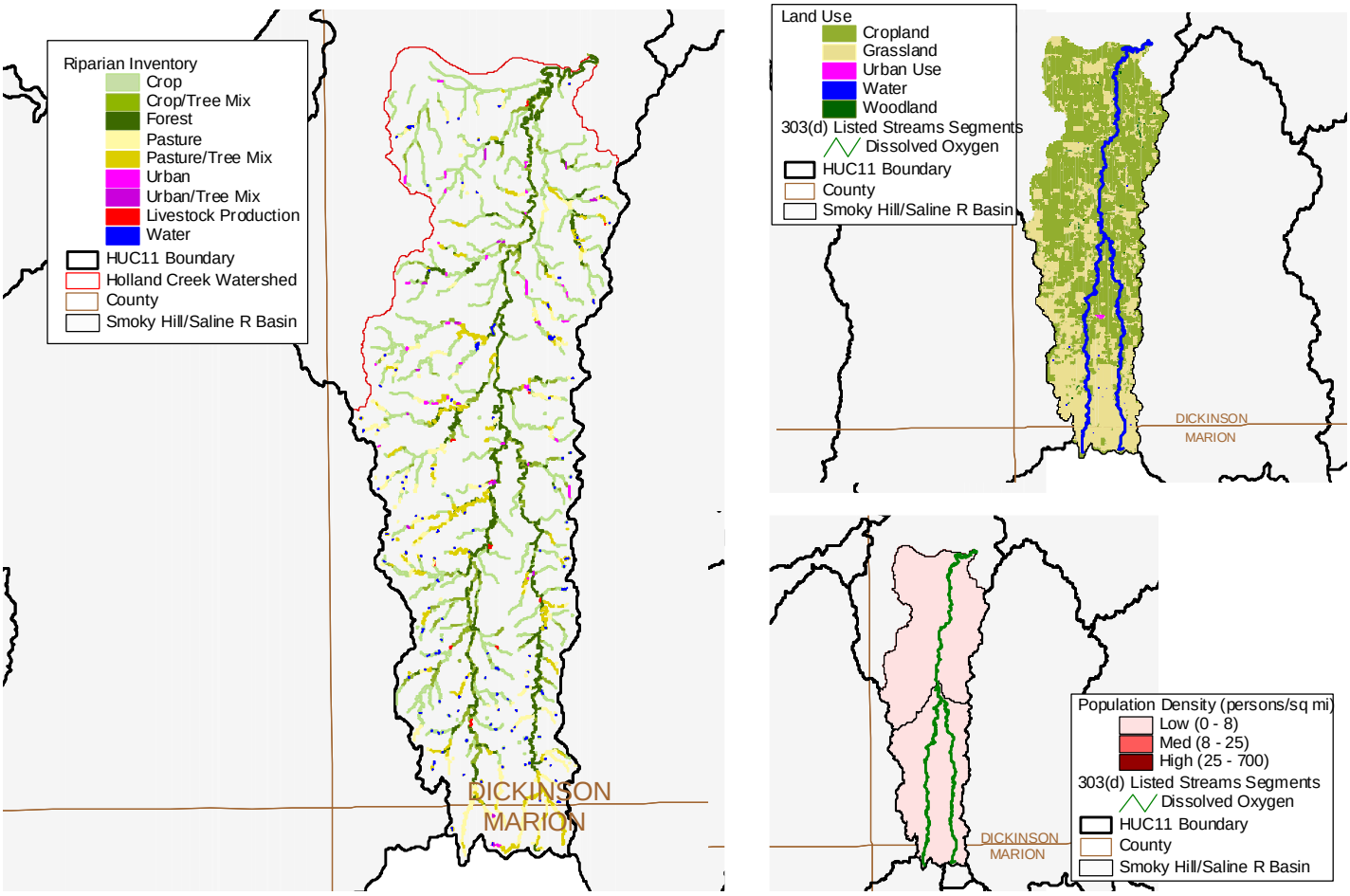

Figure 5

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

This is a phased TMDL. Additional monitoring over time will be needed to further ascertain the relationship between enhancements in stream restoration and tributary buffer strip conditions, which should filter sediment before reaching the stream, reduce sediment oxygen demand and

consequently improve DO levels during the critical flow periods of concern. In Phase One of this TMDL the following allocations apply:

Point Sources: A current Wasteload Allocation of zero is established by this TMDL because of the lack of point sources located upstream of monitoring site 642. 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 Holland Creek, causing depletion of oxygen in the stream.

Non-Point Sources: Again, because the indications that low flow is the driving factor causing the occasional excursion from the water quality standard rather than BOD, non-point sources are not seen as a significant source of DO excursion in the watershed. The Load Allocation assigns responsibility for maintaining the historical median in-stream BOD levels at site 642 to 2.8 mg/L across all flow conditions (**Figure 6**).

To address any artificial sources factoring into the DO violations outlined in **Table 4 of the Appendix** at water quality sampling site 642, buffer strips should be installed on directly contributing tributaries to filter sediment before reaching the stream.

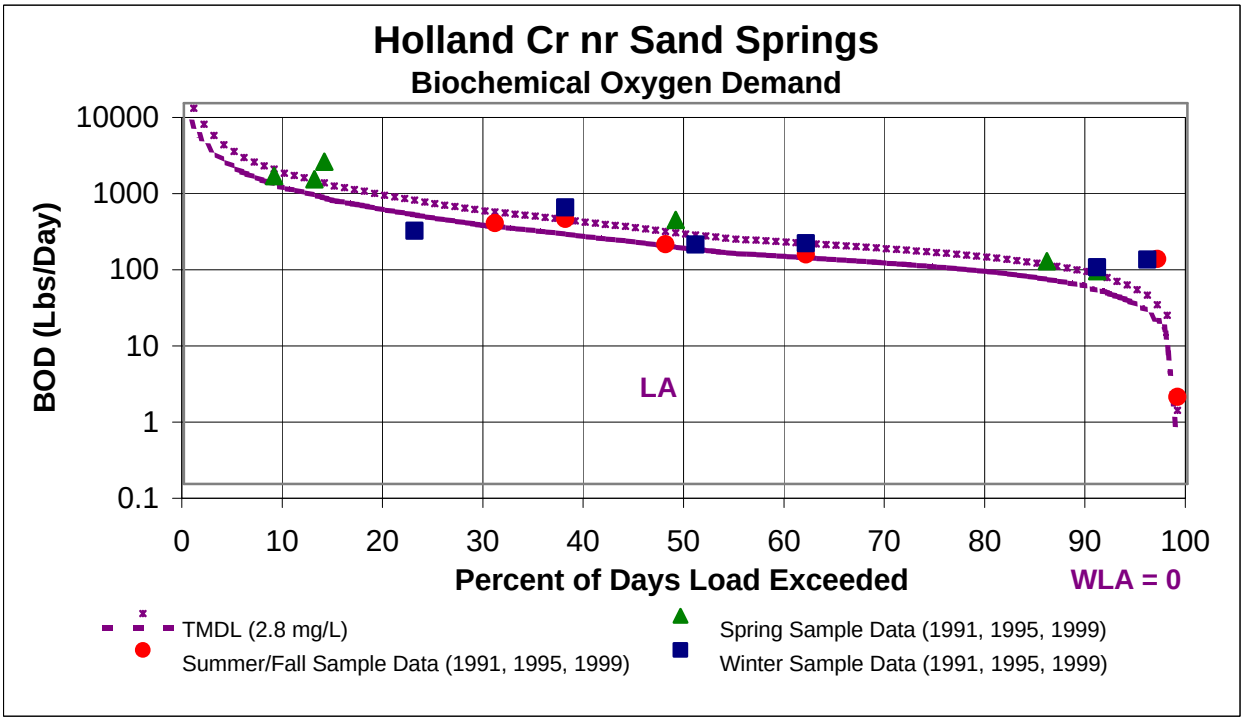

Figure 6

Defined Margin of Safety: The Margin of Safety will be implied based on conservative assumptions used 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 Lower Smoky Hill Basin (HUC 8: 10260008) with a priority ranking of 33 (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. Conduct stream morphology review
2. Where needed, create/restore buffer strips along contributing tributaries.

Implementation Programs Guidance

Stream Restoration Program - SCC

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

Buffer Initiative Program - SCC

a. Install grass buffer strips near streams.

Timeframe for Implementation: Stream morphology assessments/restoration measures and buffer strips should be installed on main steam and directly contributing tributaries over the years 2004-2008.

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

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

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

Some inventory of local needs should be conducted in 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 strip restoration or stream restoration measures, cited in the local assessment, participating in the implementation programs provided by the state.

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

Reasonable Assurances:

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollution.

1. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage into the waters of the state.

2. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.

3. K.A.R. 28-16-69 to -71 implements water quality protection by KDHE through the establishment and administration of critical water quality management areas on a watershed basis.

4. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including 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 Smoky Hill/Saline 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 over 1991, 1995 and 1999 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 642 in 2003 and 2007 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 will be refined and more intensive sampling may need to be conducted under specified lower flow conditions over the period 2008-2012. Use of the real time flow data available at the Chapman Creek near Chapman stream gaging station can help direct these sampling efforts.

A stream restoration review will be conducted in 2005 by the State Conservation Commission to evaluate Holland Creek in terms of morphology and sediment impacts on stream flow patterns and its effect on aeration within the stream as outlined in the implementation guidance.

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

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Smoky Hill/Saline Basin were held October 3, 2002, January 7, 2003 and March 5, 2003 in Hays. 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 Smoky Hill/Saline Basin.

Public Hearing: Public Hearings on the TMDLs of the Smoky Hill/Saline Basin were held in Hays on June 4, 2003.

Basin Advisory Committee: The Smoky Hill/Saline Basin Advisory Committee met to discuss the TMDLs in the basin on October 3, 2002, January 7, March 5, 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 Holland 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 Holland Creek Dissolved Oxygen TMDL

Table 3

Date	DO			Ammonia			BOD			FCB			Nitrate			pH			Temp_Cent			Phosphorus			Turbidity			Flow
	642	**644**	**641**	**642**	**644**	**641**	**642**	**644**	**641**	**642**	**644**	**641**	**642**	**644**	**641**	**642**	**644**	**641**	**642**	**644**	**641**	**642**	**644**	**641**	**642**	**644**	**641**	**642**
2/26/91	12.4	11.2	11.1	0	0	0	3.6	2.3	3.3	10	80		0	0	0.01	8	8.2	8.2	1	1	0	0.06	0.01	0.09	2.5	3.0	7.1	3.60
4/23/91	6	6.7	7.1	0.71	0	0.41	3.1	2.6	3.8	1800	170	80	0.12	0	0.34	7.9	7.9	8	9	9	9	0.52	0.07	0.20	11.6	4.6	33.3	5.00
6/25/91	**2.6**	4.3	0.7	0.33	0.07	0	3.2	4.5	7.8	600	900	100	0.12	0.03	0.02	7.7	8	7.9	23	23	23	0.36	0.22	0.85	13.9	12.7	20.5	3.60
8/27/91	**3.2**	dry	dry	0.08	dry	dry	4.2	dry	dry	400	dry	dry	0.15	dry	dry	7.8	dry	dry	22	dry	dry	0.16	dry	dry	6.4	dry	dry	0.06
10/29/91	**1.1**	dry	dry	0	dry	dry	11.2	dry	dry	700	dry	dry	0	dry	dry	7.6	dry	dry	7	dry	dry	0.39	dry	dry	12.0	dry	dry	1.49
12/3/91	**3.7**	dry	7.2	0	dry	0.05	8.2	dry	17.1	100	dry	700	0	dry	0	7.7	dry	7.9	0	dry	0	0.44	dry	2.02	45.0	dry	411.0	1.99
2/14/95	13.5	12.9	13.3	0.2	0.06	0.04	2.8	1.6	2	10	400	10	1.1	1.13	0.14	8.1	8.1	8.5	0	0	0	0.14	0.01	0.02	2.7	1.3	2.3	9.57
4/18/95	8.4	7.6	8.9	0.13	0.17	0.15	4.1	2.9	3.2	8700	60000	4000	0.86	0.61	0.58	7.6	7.7	7.7	8	8	7	0.29	0.50	0.49	26.0	49.0	92.0	13.18
6/20/95	7	7.1	6.7	0.03	0.01	0.02	5.3	4	3.4	50	200	100	1.43	1.39	1.05	7.9	8	8	19	19	20	0.15	0.15	0.14	4.0	7.0	4.0	59.24
8/22/95	6.8	6.5	6.8	0.04	0.01	0.026	1.9	2.1	1.8	1700	800	100	1.75	1.38	1.06	7.8	8	8	22	22	23	0.13	0.14	0.16	15.0	5.0	11.0	13.73
10/17/95	7.2	7.4	7.5	0.01	0.01	0.01	2	2.3	2	140	100	10	1.22	1.06	0.49	7.8	7.9	7.9	12	12	12	0.11	0.11	0.15	2.0	6.0	13.0	9.57
12/12/95	12.5	ND	14	0.044	ND	0.044	2.1	ND	2.4	20	ND	30	1.61	ND	0.38	7.7	ND	7.9	0	ND	0	0.04	ND	0.05	1.7	ND	1.9	12.28
2/16/99	10.7	10.8	10.9	0.06	0.05	0.04	1.11	1.26	1	100	80	40	1.8	2.08	1.22	7.9	8	8	7	7	7	0.06	0.07	0.09	2.6	5.7	6.3	35.22
4/20/99	8.3	8.3	8.9	0.1	0.14	0.05	2.25	3.99	2.58	1000	2000	550	1.61	1.5	0.94	7.7	7.8	7.8	15	15	15	0.14	0.29	0.27	45.0	61.0	55.0	90.30
6/15/99	7.5	7.5	7.5	0.02	0.02	0.02	2.88	2.19	3.63	3600	800	1900	1.85	2.03	1.32	7.9	8	8	19	20	20	0.15	0.16	0.19	39.0	42.0	48.0	64.29
8/17/99	6.6	6.6	6.9	0.06	0.03	0.02	2.01	2.07	1.92	730	210	130	2.03	2	1.49	7.8	7.9	8	25	25	25	0.14	0.12	0.22	7.6	10.0	18.0	24.56
10/19/99	7.8	8.2	8.8	0.02	0.02	0.02	2.85	2.97	3.02	70	210	80	0.99	0.73	0.37	7.8	7.8	7.9	10	10	10	0.09	0.08	0.11	2.5	3.0	5.6	19.50
12/21/99	11.4	12.7	13.5	1.79	0.07	0.04	4.05	1.3	1.65	2300	60	40	1.85	2.07	0.93	7.6	7.8	7.8	1	0	0	0.26	0.08	0.09	5.6	1.8	5.4	19.50
Median	7.4	7.6	8.2	0.05	0.03	0.03	2.99	2.30	2.80	500	210	100	1.16	1.26	0.54	7.8	8.0	8.0	10	11	10	0.15	0.12	0.15	7.0	5.9	12.0	12.7

Table 4

Date	DO			Ammonia			BOD			FCB			Nitrate			pH			Temp_Cent			Phosphorus			Turbidity			Flow
	642	**644**	**641**	**642**	**644**	**641**	**642**	**644**	**641**	**642**	**644**	**641**	**642**	**644**	**641**	**642**	**644**	**641**	**642**	**644**	**641**	**642**	**644**	**641**	**642**	**644**	**641**	**642**
6/25/91	**2.6**	4.3	0.7	0.33	0.07	0	3.2	4.5	7.8	600	900	100	0.12	0.03	0.02	7.7	8	7.9	23	23	23	0.36	0.22	0.85	13.9	12.7	20.5	3.60
8/27/91	**3.2**	dry	dry	0.08	dry	dry	4.2	dry	dry	400	dry	dry	0.15	dry	dry	7.8	dry	dry	22	dry	dry	0.16	dry	dry	6.4	dry	dry	0.06
10/29/91	**1.1**	dry	dry	0	dry	dry	11.2	dry	dry	700	dry	dry	0	dry	dry	7.6	dry	dry	7	dry	dry	0.39	dry	dry	12.0	dry	dry	1.49
12/3/91	**3.7**	dry	7.2	0	dry	0.05	8.2	dry	17.1	100	dry	700	0	dry	0	7.7	dry	7.9	0	dry	0	0.44	dry	2.02	45.0	dry	411.0	1.99
Median	2.9	-----	4.0	0.04	-----	0.03	6.20	-----	12.45	500	-----	400	0.06	-----	0.01	7.7	-----	7.9	15	-----	11.5	0.38	-----	1.44	13.0	-----	215.8	1.7