METHODOLOGY FOR THE EVALUATION AND DEVELOPMENT OF THE 2006 SECTION 303(D) LIST OF IMPAIRED WATER BODIES FOR KANSAS

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Kansas Department of Health and Environment
Watershed Planning Section/Bureau of Water/Division of Environment
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1.0 BACKGROUND

1.1 REQUIREMENTS UNDER SECTION 303(D) OF THE FEDERAL CLEAN WATER ACT

Section 303(d) of the Clean Water Act requires that States develop a list of water bodies needing additional work beyond existing controls to achieve or maintain water quality standards. This Section 303(d) list is meant to identify waters that require Total Maximum Daily Loads (TMDLs) because technology-based effluent limitations, more stringent State or local effluent limitations, and other pollution control requirements such as best management practices, are not stringent enough to implement applicable water quality standards. 40 CFR 130.7(b)(1).

A TMDL refers to the "total maximum daily load" of a pollutant that achieves compliance with a water quality standard, therefore a TMDL is essentially a regulatory tool which caps the allowable pollutant load to a water body and a planning tool which directs and guides practices that will bring a water body into compliance with the applicable water quality standard.

Under the current federal rules, States are to submit their 2006 Clean Water Act Section 303(d) lists of impaired waters, as well as the methodologies used to prepare them, by April 1, 2006. On July 29, 2005, the U.S. Environmental Protection Agency issued a guidance document titled, '2006 Integrated Report Guidance' (hereafter called the 'EPA Integrated Report Guidance'), which is a Guidance for 2006 assessment, listing and reporting requirements for the States pursuant to section 303(d), 305(b) and 314 of the Clean Water Act. Because of attention toward completing TMDLs required by the 1998 Court Decree by June 30, 2006 and because supplemental data on bacteria for certain streams identified as impaired in the 2004 303(d) list as Category 3 waters is occurring during April-November of 2006, Kansas will submit its final 303(d) for 2006 in December, 2006.

1.2 WATER QUALITY STANDARDS (STATE OF KANSAS)

Kansas surface water quality standards create the 'yardstick' by which water bodies are measured against. Kansas surface water quality standards are defined by:

1) designating beneficial uses of the water as contained in K.A.R. 26-16-28d;
2) setting criteria necessary to protect the beneficial uses, contained in K.S.A. 28-16-28c; and
3) establishing an antidegradation policy, contained in K.A.R. 28-16-28c(a).

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Beneficial uses of waters in Kansas include aquatic life, domestic water supply, food procurement, groundwater recharge, industrial water supply, irrigation, livestock watering and recreation.

1.3 DESCRIPTION OF 303(D) LIST PURPOSE AND LINKAGE TO 305(B) WATER QUALITY REPORT

The generation of this 303(d) List is an essential planning and guidance tool for the state. The Kansas 2006 303(d) list not only identifies those water bodies from the 2004 303(d) list which still require TMDLs, but also determines those new water bodies and pollutants for which TMDLs will be needed. Water bodies are assigned priority for TMDL development by assessing the frequency, magnitude and duration of impairment by pollutant, as well considering public comment.

The 305(b) report, although based on similar assessment procedures as the 303(d) list, provides an assessment or measure of *all* waters in the state. Any comparisons made to a 305(b) report should be made to other 305(b) reports through time rather than to a list of impaired water bodies. The 305(b) report provides a picture of the water quality within a state from the perspective of a point or, more accurately, a short period in time.

In contrast, although the subsequent 303(d) lists rely on the 305(b) report in identifying impaired water bodies within the state, the assessment procedures used for 303(d) listing, by necessity, are more intensive. The 303(d) list is a subgroup of all surface waters in the state; those water bodies not meeting one or more water quality standards because of pollutants and needing a TMDL. Because of the associated cost to the state in developing and implementing TMDLs, the state must determine the extent a water body is impaired and its relative severity among other water bodies with some degree of confidence. Hence the need for more vigorous assessment prior to listing a water body as impaired.

1.4 RELATIONSHIP OF KANSAS 303(D) LIST TO 2006 INTEGRATED REPORT GUIDANCE

In as much as practicable, the Kansas 2006 303(d) list will be developed and submitted to the EPA in accordance with the July 29, 2005 guidance. The list viewed for public review includes those waters identified in the 2006 Guidance as "Category 5"; those waters requiring development of a TMDL because of impairment by a pollutant. However, the public list will also list Category 2 waters that represent waters delisted from the 2004 303(d) list and Category 3 waters requiring additional information in order to make listing decisions for future 303(d) lists. Waters that now have a TMDL because of impairments identified from the 1998, 2002 and 2004 list are presented to public as are any Category 4B waters, that have addressed their impairment by other means than a TMDL. Definitions of the five Categories for waters provided by the July 29, 2005, Guidance from EPA is provided in **Table 1**.

2.0 ASSESSMENT UNIT DEVELOPMENT

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2.1 DESCRIPTION OF KANSAS AMBIENT SURFACE QUALITY NETWORK

Kansas has an extensive water quality monitoring network consisting of 317 active ambient stream chemistry monitoring sites spanning all the major river basins. Of these, there are 165 core sites visited on a bimonthly basis every year, whereas the remaining 155 sites are monitored using a four-year rotational approach. The biological network of monitoring sites includes 180 monitoring sites. Of these, samples are obtained from 60-65 sites each year, including 45 core stations and 15-20 rotational stations sampled three consecutive years per rotation. Fish tissue samples normally are obtained each year from 15-20 water bodies across the state, which includes nine long-term monitoring sites. Water quality information currently is obtained from 121 lakes and wetlands, which includes all 24 federal reservoirs, most state-administered fishing lakes, various other state, county or locally owned lakes, several privately owned but publicly accessible lakes, and seven state or federally owned marshes. The monitoring networks are illustrated in Figures 1 - 4.

2.2 DELINEATION ASSESSMENT UNITS (CONTRIBUTING AREAS TO MONITORING SITES)

Of the Kansas Department of Health and Environment's (KDHE) 317 ambient stream chemistry monitoring sites, 165 are fixed (permanent) sites sampled bi-monthly every year, and 155 are rotational sites samples bimonthly every four years. Assessment units (AU) were defined within the state by delineating the unique contributing area to each monitoring site. Groupings at the HUC 14 level were used as the basis for unique contributing areas to these monitoring sites. Once grouped by HUC 14, additional alterations to the boundaries were made using the Watershed tool within ArcGIS 9.1 and a digital elevation map (DEM) to create unique boundaries for each monitored area. This process ensures that no area has more than one monitoring station with it and that each AU boundary includes only tributary segments upstream of the monitoring station. The stream segments of the 2004 Kansas Surface Water Register (KSWR) were placed into each AU and a unique watershed name was assigned to each based on the main stem of each AU. The KSWR was also merged to the National Hydrography Dataset (NHD) and this merge can be used as a translator from the AU stream routing structure in KSWR to a routing structure in NHD.

316 stream AUs were created from the 317 ambient stream chemistry monitoring sites. The discrepancy between the number of monitoring sites and AUs is because one monitoring station is located in Missouri, and monitors a watershed completely contained within Missouri.

The 25 largest lakes and the largest wetland by surface area of the 121 monitored lakes and wetlands were also delineated in the same method, complimenting the existing stream AUs previously created. The establishment of these lake AUs creates unique contributing areas to the larger reservoirs in Kansas. The remainder of the monitored lakes and wetlands are identified simply as water bodies without a defined contributing area and have been identified as to which AU they are located within.

Generally, biological and fish tissue collection sites are located near a stream or lake monitoring site, so a best match for these sites were found from the existing AUs.

Based upon the combined area of all defined AUs within the state, almost 97% of the contributing areas of Kansas are monitored by the KDHE water quality monitoring program.

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2.3 MAP AND TABLE FORMATS USED IN DESCRIPTION OF ASSESSMENT UNITS

For TMDL planning purposes, visual clarity and to make the public participation process consistent with the current state water planning process, the state was divided into 12 basins. Maps locating the AUs and monitoring sites were created for each of these 12 basins. Tables of the registered streams in each assessment unit or in the case of a lake AU, streams and the lake itself, were assembled for each of the 12 basins.

3.0 DATA CONSIDERATIONS FOR 2006 LIST

3.1 APPLICATION OF 2004 303(D) LIST

Certain impairments listed in the 2004 303(d) list will be evaluated for delisting during the generation of the 2006 303(d) list. Section 5.4 and 6.5 describes the assessment method for delisting decisions. Error corrections to the 2004 list will be made as set forth in Section 3.2.

3.2 2004 303(D) LIST - ERROR CORRECTIONS

Errors in the 2004 303(d) list will be corrected in the 2006 list. Examples of these corrections to the 2004 list are typographical list errors and water bodies that were never impaired but certain flaws in the original analysis led to the waters being listed.

3.3 2006 305(B) WATER QUALITY REPORT USE

Because of the relatively small number of sample points from the individual biological, lakes/wetlands and fish tissue network monitoring sites through time, the information and best professional judgment used to generate the assessment of these three sections of the 2006 305(b) report will be the primary basis for any associated listings in the 2006 303(d) list. The stream chemistry monitoring network sites have a larger number of samples for each monitoring site. This will allow a more intensive statistical assessment of impairment for these sites that may cause certain discrepancies between the 2006 305(b) report and the 2006 303(d) list.

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3.4 SPATIAL APPLICABILITY OF DATA

AUs have been defined based on contributing areas to ambient stream monitoring and lake stations. If an impairment is determined at a monitoring point, the stream segment or lake/wetland associated with that monitoring point will be listed. In the case of a stream AU, this will always be the main stem of the system within the AU and in the case of a lake/wetland AU, it will always be the lake/wetland. If the lake/wetland AU is defined as just that water body, then reference to potential contributors in the appendix will not be made.

3.5 USE OF DATA (CHEMICAL, BIOLOGICAL, INTERNAL, EXTERNAL)

As required by Section 303(d) of the Clean Water Act and 40 CFR 130.7(b)(5), KDHE will compile and consider "all existing and readily available water quality related data and information" in identifying waters to be listed. Existing and readily available data and information includes, but is not limited to:

- 2004 303(d) List;
- 2006 305(b) Report's waters that are not meeting a designated beneficial use;
- Clean Water Act 319 nonpoint source assessments,
- Drinking water source water assessment under Section 1453 of the Safe Drinking Water Act;
- KDHE fish consumption advisories,
- Data, information, and water quality problems reported from local, State, or Federal agencies (especially the USGS water quality studies), Tribal governments, the public, and academic institutions.

As stated earlier, KDHE operates an extensive water quality monitoring network throughout Kansas and believes it is important that the decision to list a water body be based upon credible evidence. KDHE encourages the submittal of additional data and information from the general public during the list development and public comment period. Data and information can be in the form of analytical results, numeric data or information or narrative/qualitative submittals. When such information is submitted, the observation date, location(s), quality assurance methods and other pertinent information should also be provided. Other pertinent information includes the rationale supporting the observation being considered outside the normal range of conditions. If not verifiable, narrative and qualitative submittals may not be used in the 303(d) process. However, such information will be considered in the planning of future monitoring activities by KDHE.

In order to solicit available data from other entities, KDHE has published public notices in the Kansas Register on August 31 and September 7, 2006 to request data from various agencies and the public prior to creation of the 2006 303(d) list and will accept such data through October 6, 2006.

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4.0 STREAM CHEMISTRY METHODOLOGY

4.1 SAMPLE SIZE REQUIREMENTS – STREAM CHEMISTRY

In most cases, a minimum of 12 samples will be required to make a determination of impairment for ambient stream chemistry monitoring sites and their associated AUs. An exception to the minimum sample size requirement would be the case where a sufficient number of criterion excursions to list an AU as impaired have occurred prior to the collection of all 12 samples. In this case, regardless of the result of the remaining samples required to meet the minimum sample size, the assessment will always determine impairment once the sample size requirement is met.

4.1.1 TEMPORAL BOUNDS OF DATA – STREAM CHEMISTRY

In an effort to meet the sample size requirements in 4.1, data collected from January 1996, through December 2005, will be used for fixed stream chemistry sites or their associated AUs. Data collected from 1990 through December 2005, will be used for rotational chemistry sites or their associated AUs in the assessment of stream chemistry impairment.

4.2 DESIGNATED USE APPLICATIONS – STREAM CHEMISTRY

Where possible, the water quality for use support of all monitored waters will be evaluated for potential inclusion on the 2006 303(d) List. The designated uses of these waters will determine the level of assessment necessary to evaluate impairment. For a complete list of criteria in conjunction with designated uses see K.A.R. 28-16-28e(d) table 1a.

The assessment levels of the designated uses are generally tailored after those suggested in EPA's *Guidelines for the Preparation of the Comprehensive State Water Quality Assessments and 305(b) Reports and Updates: Supplement*, where partial support is defined as excursion rates greater than 10 percent. The nonsupport level (> 25% excursions) is immaterial at this level of screening because additional data analysis will be performed to assign priority within the 2006 303(d) list.

4.2.1 AQUATIC LIFE CONSIDERATIONS

Kansas has two categories of aquatic life support. All parameter standards associated with the *chronic* category of aquatic life support will have an assessment level by percent excursion of:

Not impaired: < 10% or >10% but passes the binomial test (see section 4.3)
Impaired >10% and fails the binomial test (see section 4.3)

The standards associated with the *acute* category will have a dual assessment level depending on the type of sampling site.

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Fixed stream chemistry sites (using10 continuous years of sampling):
Not impaired: 3 or less violations
Impaired > 3 violations

Rotational stream chemistry sites (4 to 6 separate years of sampling in a 15 year period):

Less than six years of samples:	Not impaired 0 or1 violation Impaired > 1 violation
Six or more years of samples:	Not impaired 2 or less violations Impaired > 2 violations

4.2.2 CONTACT RECREATION

As applied to classified stream segments, Kansas has a Primary Contact Recreation (PCR) 'not to exceed' standard derived from a geometric mean calculated from at least five *E. coli* samples collected from separate 24-hour periods within a 30-day period for PCR classes as follows (K.A.R. 28-16-28e (c)(7)(D) (table 1i)):

PCR class A; 160 cfu/100mL (in effect from April 1 through October 31 each year)
PCR class A; 2,358 cfu/100mL (in effect from November 1 through March 31 each year)

PCR class B; 262 cfu/100mL (in effect from April 1 through October 31 each year)
PCR class B; 2,358 cfu/100mL (in effect from November 1 through March 31 each year)

PCR class C; 427 cfu/100mL (in effect from April 1 through October 31 each year)
PCR class C; 3,843 cfu/100mL (in effect from November 1 through March 31 each year)

A Secondary Contact Recreation (SCR) 'not to exceed' standard derived from a geometric mean calculated from at least five E. coli samples collected from separate 24-hours periods within a 30-day period for SCR classes is as follows (K.A.R. 28-16-28e (c)(7)(E)(table 1i)):

SCR class A; 2.358 cfu/100mL (in effect January 1 through December 31)
SCR class B; 3,843 cfu/100mL (in effect January 1 through December 31)

KDHE stream monitoring protocols to date do not collect data to evaluate compliance with the minimum five-sample geometric mean criterion, therefore these designated uses cannot be assessed by any stream monitoring site within the state. However, there were 17 streams identified by the 2004 303(d) list as Category 3 for bacteria because they were previously listed before the water quality standard changed. These 17 streams were sampled in intensive 30 day periods, four times in 2006 to determine if they were impaired under the new standard. Those that violated the applicable geometric mean just once are listed as impaired by bacteria in the 2006 303(d) list. Those that did not exceed the geometric mean in any of the four seasonal samplings (Apr-May, Jun-Jul, Aug-Sept, & Oct-Nov) are identified as Category 2 waters. New Category 3 waters for bacteria are identified based on the routine monitoring data, if they showed excessively high or frequent levels of E.coli bacteria counts.

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4.2.3 DRINKING WATER

Kansas has a suite of parameters used to protect Domestic Water Supply (K.A.R. 28-16-28e(d) table 1a). The nitrate standard assessment levels by percent excursion will be:

Not impaired = 0%
Impaired > 0%

All other parameters (excluding chloride and sulfate which will be assessed at the 10% excursion level) will be reviewed at assessment levels by percent excursion as:

Not impaired 50% or less
Impaired > 50%

4.2.4 AGRICULTURAL USE: IRRIGATION AND LIVESTOCK WATERING

Kansas has a number of parameters used to protect agriculture use of water, which includes livestock watering and irrigation supply (K.A.R. 28-16-28e(d) table 1a). Assessment levels by percent excursion will be:

Not impaired 10% or less
Impaired >10%

4.2.5 FOOD PROCUREMENT

Kansas has a variety of parameters used to protect food procurement use. Assessment levels by percent excursion will be:

Not impaired 10% or less
Impaired >10%

4.2.6 GROUNDWATER RECHARGE

Not assessed by surface water.

4.3 STATISTICAL METHODS FOR LISTING ASSESSMENT – STREAM CHEMISTRY

In evaluating water body monitoring data associated with stream chemistry sites using EPA's historical 305(b) guidelines, no more than 10% of the samples obtained from the water body should exceed a regulatory standard for conventional pollutants. This method, called the raw score method, simply sets an upper bound on the percentage of measurements at a monitoring site that may violate a standard. Unfortunately, the raw score method does not provide sufficient information to properly deal with the uncertainty concerning impairment, especially when dealing with smaller sample sizes (National Research Council, 2001).

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For the Kansas 2006 303(d) list, candidate water bodies will be screened for impairment based on a nonparametric analysis of a confidence limit on a percentile of interest. Where applicable that percentile of the distribution is given by the assessment level of the review above, again based on EPAs 305(b) guidelines of not more that 10% of the samples allowed to exceed a regulatory standard.

Conceptually, an assessment level of 10% excursion is really the same as the upper 90th percentile of the sample distribution. The question to answer in this evaluation is whether the true concentration for a particular constituent in a candidate water body meets or exceeds the assessment level of a regulatory standard. With only a certain number of samples to analyze from a monitoring site, the population's true concentration can never be known with certainty. However, it is possible

to create an interval that will contain a particular percentile of the true concentration distribution with a given level of confidence. The confidence interval approach allows the incorporation of uncertainty in the true parameters of the distribution into a comparison to the regulatory standard.

In evaluating a stream's monitoring site data for impairment this confidence interval for the upper 90th percentile of the distribution can be used to determine, with a certain level of confidence, if a particular pollutant has exceeded the regulatory standard. This determination is based on whether or not the entire confidence interval exceeds the regulatory criterion. More conservatively, a one-sided lower bound on the true 90th percentile of the concentration distribution can be computed as a 100(1 - a)% Lower Confidence Limit (LCL), where for 90% confidence, a = 0.1. Doing so tests the null hypothesis that the true 90th percentile of the concentration distribution is less than or equal to the regulatory criterion. If we reject the null hypothesis, the pollutant level in the water body is deemed to be an impairment to that water body's designated use(s) (Gibbons, 2001).

4.3.1 Binomial Analysis in Determination of Impairments

(Based on Gibbons, 2001 and Lin, 2000)

To construct a nonparametric confidence limit for the 90th percentile of the concentration distribution from a monitoring site, the fact that the number of samples falling below the p(100)th percentile of the distribution (in this case, p = 0.9, where p is between 0 and 1) out of a set of m samples will follow a binomial distribution with parameters m and success probability p, where success is defined as the event that a sample measurement is below the p(100)th percentile. The cumulative binomial distribution (Bin (x; m, p)) represents the probability of getting x or fewer successes in m trials with success probability p, and can be evaluated as

$$Bin(x; m, p) = \sum_{i=0}^{x} \binom{m}{i} p^{i} (1 - p)^{m-i} \qquad \textbf{E4.1}$$

The notation $\binom{m}{i}$ denotes the number of combinations of m things taken i at a time, where

$$\binom{m}{i} = \frac{m!}{i!(m-i)!}$$

and the factorial $m!$ is given by

$$m! = m(m-1)(m-2)\cdots 1$$

Where applicable, KDHE will use a 90% LCL on the 90th percentile of a concentration distribution ($LCL_{0.9,0.9}$) from a stream chemistry monitoring site.

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As an example, to find the minimum number of successes needed to keep a water body off an impaired water body list (or, more importantly, determine the critical number of failures needed to list a water body as impaired), where the number of samples m from a monitoring site is 12. Based on the 90th percentile and with as close to a LCL of 90% as possible, then from E4.1 starting with i = 12 as the first candidate and repeating additional candidates by i - 1 until the cumulative probability is as close to 90% as possible,

$$\binom{12}{12} 0.9^{12}(0.1)^{0} = 0.282$$

$$\binom{12}{11} 0.9^{11}(0.1)^{1} = 0.377 \qquad \text{(cumulative probability is 0.282 + 0.377 = 0.659)}$$

$$\binom{12}{10} 0.9^{10}(0.1)^{2} = 0.230 \qquad \text{(cumulative probability = 0.282 + 0.377 + 0.230 = } \mathbf{0.889}\text{)}$$

$$\binom{12}{9} 0.9^{9}(0.1)^{3} = 0.085 \qquad \text{(cumulative probability = 0.282 + 0.377 + 0.230 + 0.085= 0.974)}$$

Comparing cumulative probabilities with an objective of getting as close to 90% as possible we choose the 0.889 option from the above. From this choice, the minimum number of successes out of 12 trials to keep a water body off an impaired list is 10 (or, conversely, 2 failures out of 12 trials). This is the same as saying that 3 failures out of 12 trials will get a water body listed as impaired (or finding only 9 successes out of 12 trials).

In practice, it is a nuisance calculating binomial probabilities by hand. The Microsoft Excel functions BINOMDIST does most of the work for the analyst. Table 2 was created using this Excel BINOMDIST function. Table 2 shows, using the BINOMDIST function to get as close to 90% confidence as possible, for m = 12 to 65 the minimum number of excursions needed to list a water body as impaired and the confidence level associated with that number.

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4.3.2 Special Considerations in Balancing of Type I and Type II Error

In the case of determining whether or not a water body is impaired, two different kinds of errors can be made. The first is when an unimpaired water body is mistakenly determined to be impaired, called a Type I error. The second is if an impaired water body is erroneously determined to be unimpaired and is called a Type II error. Of special concern to KDHE is Type I error, which could lead to the dedication of time and resources in developing and implementing a TMDL for a water body that was determined to be impaired when it actually is not impaired. In a policy decision, KDHE has chosen to set the acceptable Type I error rate in advance. The 90% confidence limit used by KDHE in its nonparametric method of assessing water bodies for impairment simply means that about 10% of the time a Type I error will occur.

KDHE also has concerns about Type II errors because failure to detect an impairment in a water body when one actually exists also has negative consequences through potential unabated environmental damage stemming from delayed TMDL implementation, and this delay can lead to greater marginal fiscal costs to restore waterbodies. In an effort to reduce the Type II errors associated with the nonparametric method of assessing water bodies, KDHE has added additional balances to minimize it; the choice of a = 0.1 rather than 0.05, minimum sample size requirement and recent trend weighting (explained in 4.3.3).

4.3.3 EMPHASIS OF RECENT TRENDS IN STREAMS

Table 2 shows with as close to 90% confidence as possible for *m* = 12 to 65, the minimum number of excursions needed to list a stream as impaired and the confidence level associated with that number. A final step in the listing methodology will be a check of recent excursions in the samples from a monitoring site. If the number of excursions is within one of the critical number of excursions needed to list a steam as impaired from Table 2, and any one of those excursions occurred in the most recent year of sampling, then that water body will also be placed on the 303(d) list. Doing so emphasizes recent impairments in the sample data and creates the final step to minimize Type II errors.

4.4 STATISTICAL METHODS FOR ESTABLISHING PRIORITY IN LISTINGS – STREAM CHEMISTRY

Although a nonparametric method of analysis will be used to determine whether or not impairment from a pollutant exists for a candidate stream chemistry monitoring station, the priority for TMDL development will be determined by a parametric method of analysis.

Consider two monitoring sites each with 12 samples and each with 3 excursions. The excursions at one site are slightly above the standard and the excursions at the other site are ten times the standard. By the nonparametric method, the sample data from both sites would cause their associated AUs to be listed (Table 2), but the information about the magnitude of the excursions is lost. Clearly, the site whose excursions are ten times the standard should be given a higher priority for TMDL development than the site whose excursions are only slightly above the standard.

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An approach more effective at extracting the information from the available data at each monitoring site will be used to determine the priority for TMDL development of those sites listed by the nonparametric method. This parametric approach not only quantifies the frequency of excursion from criteria but also the magnitude of those excursions for prioritization within the listed AUs by pollutant.

4.4.1 PARAMETRIC ANALYSIS IN ASSIGNING PRIORITY OF LISTED AUS

The comparison by pollutant of the $LCL_{0.9,0.9}$ and the frequency of the impairment violations between listed AUs is the basis for assigning priority for TMDL development in each of the 12 basins in Kansas. The development of the $LCL_{0.9,0.9}$ is described in the remainder of Section 5.

4.4.2 DISTRIBUTION TEST

(Sections 4.4.2 - 4.4.4 based on Gibbons, 2001)

The first step for the parametric analysis will be a sample data distribution test for normality. The Ryan-Joiner (similar to the Shapiro-Wilk) test will be utilized in checking for normal distribution of the sample data. Should the sample data fail this test, it will be log transformed. It has been KDHE's experience to date that the transformed lognormal data typically pass the normality test.

Based on whether or not the sample data needed transformation the following two methods will be applied (4.4.3 and 4.4.4).

4.4.3 NORMALLY DISTRIBUTED SAMPLE DATA

A normal upper tolerance limit for the 90th percentile of the sample distribution will be computed as

$$LCL_{1-a,p} = \bar{x} + K_{a,p}\, s,$$

where $\bar{x}$ is the sample mean of the m measurement from the monitoring site,

$$\bar{x} = \sum_{i=1}^{m} \frac{x_i}{m}$$

and s is the observed sample standard deviation,

$$s = \sqrt{\sum_{i=1}^{m} \frac{(x_i - \bar{x})^2}{m-1}}$$

and $K_{a,p}$ is the one-sided normal tolerance limit factor for (a)100% confidence and p(100)% coverage (Hahn and Meeker, 1991). Table 3 provides values of $K_{0.9,0.9}$ that will be use by KDHE in this analysis. Table 3 was created using *StInt* (Meeker and Chow, 1993) and this command driven DOS program and user's manual is available at: http://www.public.iastate.edu/~wqmeeker/other_pages/wqm_software.html.

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4.4.4 LOGNORMALLY DISTRIBUTED SAMPLE DATA

For lognormal data the same method as described in 4.4.2 applies with exponentiation of the resulting limits.

$$LCL_{1-a,p} = \exp[\bar{y} + K_{a,p}\, s_y]$$

where $\bar{y}$ and s_y are the mean and standard deviation of the natural log transformed data. Table 3 is applied in the same manner as 4.4.2.

4.4.5 DATA BELOW DETECTION LIMITS

Modifications to the equations in 4.4.2 and 4.4.3 for data below detection limits are described in this section.

(Using Gibbons, 2001)
If the data from a monitoring site are normally distributed and nondetects are present, the adjusted mean of the m samples is computed as:

$$\bar{x} = \left(1 - \frac{m_0}{m}\right)\bar{x}'$$

where $\bar{x}'$ is the average of the m - m_0 detected values, and m_0 is the number of samples in which the pollutant was not detected. The adjusted standard deviation is:

$$s = \sqrt{\left(1 - \frac{m_0}{m}\right)(s') + \frac{m_0}{m}\left(1 - \frac{m_0 - 1}{m - 1}\right)(\bar{x}')^2}$$

where s' is the standard deviation of the m - m_0 detected measurements. The normal tolerance limit can then be computed as previously described (4.4.3).

With nondetects in natural log transformed data, replace $\bar{x}'$ with $\bar{y}'$ and s' with s'_y in the respective equations in this section and follow Section 4.4.4.

4.5 OVERVIEW OF 2006 LISTING METHODOLOGY – STREAM CHEMISTRY

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Figure 5 charts the Kansas 2006 Listing Methodology as it applies to the previous discussions. All categories as defined in the July 29, 2005 Report Guidance (category definitions available in Table 1) will be submitted as the Kansas 2006 303(d) List.

4.5.1 STREAM CHEMISTRY ASSESSMENT UNITS - CATEGORIZATION

From Figure 5 after an initial check to make sure the AU is not already on the 2004 303(d) List for the same pollutant, the following ordered steps will apply:

1) Screen for the domestic water supply nitrate criteria where a single excursion provides support for listing in Category 5, 1st priority.

2) Screen for acute aquatic life violations for each monitoring site. If more than 3 samples from a fixed monitoring site (1996-2005 data) exceed acute aquatic life criteria and more than 1 or 2 samples (depending on # of years of data) from a rotational monitoring site (1990 to 2005 data) exceed acute aquatic life criteria, then the monitoring site's AU will be listed on the 2006 303(d) List (Category 5).

3) The EPA 10% raw score will provide the next screen for the conventional pollutant data from monitoring sites. Those sites that fail the raw score test (>10% excursion) will be subject to the binomial test described in Section 4.3.1.

4) If the binomial test indicates impairment then the AU will be placed on the 2006 303(d) List.

5) If the binomial test indicates full support, those sites will be subject to the final screen, a check for evidence of recent excursions in the sample data. If the number of excursions is within one of the critical number of excursions (Table 2) needed to list an AU and any one of those excursions occurred within the most recent year of sampling at the monitoring site, then that AU will also be listed on the 2006 303(d) List.

4.6 STREAM CHEMISTRY PRIORITY METHOD (CATEGORY 5) FOR TMDL DEVELOPMENT

Those AUs found to be impaired by a pollutant and placed on the 2006 303(d) List within category 5 will be prioritized for TMDL development. The resulting $LCL_{0.9,0.9}$ from the methods in Section 4.4 will be ordered from highest to lowest by pollutant.

4.7 STREAM CHEMISTRY ASSESSMENT UNITS - CONSIDERATIONS FOR DELISTING

Kansas will Delist streams on the 2004 303(d) based upon the assessment of data. If the stream no longer meets the listing requirements as discussed in Section 4.0, the stream may be delisted. Typographical errors and listing errors from the 2004 303(d) List will be corrected in the 2006 303(d) List.

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5.0 STREAM BIOLOGY METHODOLOGY

5.1 SAMPLE SIZE REQUIREMENTS AND TEMPORAL BOUNDS OF DATA - BIOLOGY

A minimum of 3 samples will be required to assess biological and fish tissue data. For data collected from biological and fish tissue surveys, the same assessment period that is used in the 2006 305(b) Report will be used for the 2006 303(d) List.

5.2 STREAM BIOLOGY - CATEGORIZATION FOR LISTING

1) Determine if the stream biological impairment appears on 2004 Section 303(d) list and has not had a TMDL developed. If so, list in Category 5.

2) For biological monitoring stations with three or more samples over the latest five years, if one or more of the biological metrics indicate partial or non-support, list in Category 5.

3) If fish tissue samples show excessive amounts of bio-accumulative pollutants (PCB, chlordane, mercury, etc.) for three or more years over the latest five years, list in Category 5.

5.3 STREAM BIOLOGY PRIORITY METHOD FOR TMDL DEVELOPMENT

Use the following biological metrics to assess fully supporting streams from those that are partially supporting or non-supporting:

Table 1	**MBI**	**KBI-NO**	**EPT %**	**Mussel Loss**
Fully Supporting	$\leq$ 4.5	$\leq$ 2.60	$\geq$ 48%	$\leq$ 10%
Partially Supporting	4.51-5.39	2.61-2.99	31%-47%	11%-25%
Non-Supporting	$\geq$ 5.4	$\geq$ 3.0	$\leq$ 30%	$\geq$ 26%

Apply the following criteria on data over the latest five years to determine the priority:

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1) First (High) priority goes to streams with three of the above metrics showing non-support. In addition, for basins with only one or two stations reflecting impairment(s), those stations shall also be designated as first priority.

2) Second (Medium) priority goes to streams with two of the above metrics showing non-support or impairments appearing through fish tissue analysis.

3) Third (Low) priority goes to streams with three or more categories designated as partial support or full support.

4) Streams that have only one to two biological samples from the latest five years and show any designation of less than full support that has not previously had a TMDL developed, will be deemed Category 3.

5) Streams that are listed as fully supporting in the 2004 305(b) list and listed as partially supporting in the 2006 305(b) report, where the impairment is potentially drought linked, shall be listed as Category 3.

5.4 STREAM BIOLOGY ASSESSMENTS - CONSIDERATIONS FOR DELISTING

1) For 2004 listed biological monitoring stations, if the latest five years have three or more samples and indicate full-support for all of the biological metrics, delist.

2) For 2004 listed fish tissue samples, if the latest five years have three or more years of monitoring and indicate compliant amounts of bio-accumulative pollutants (PCB, chlordane, mercury, etc.), delist.

6.0 LAKE AND WETLAND METHODOLOGY

6.1 SAMPLE SIZE REQUIREMENTS AND TEMPORAL BOUNDS OF DATA – LAKE/WETLAND

There are not a minimum number of samples needed for assessing lake/wetland data. For data collected from lakes and wetlands, the assessment period from 1996-2006 will be used in the 2006 303(d) List.

6.2 CONTACT RECREATION – LAKE/WETLAND

As applied to classified lakes and wetlands, Kansas has a Primary Contact Recreation (PCR) 'not to exceed' standard derived from a single sample maximum or a geometric mean calculated from at least five E.coli samples collected beyond the mixing zone from separate 24-hours periods within a 30-day period for PCR classes as follows (K.A.R. 28-16-28e(c)(7)(B) (table 1j)):

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PCR Swimming Beach; 160 cfu/100mL or single sample maximum of 732 cfu/100mL (in effect from April 1 through October 31 each year)
PCR: Swimming Beach; 800 cfu/100mL or single sample maximum of 3655 cfu/100mL (in effect from November 1 through March 31 each year)

PCR: Public Access; 262 cfu/100mL or single sample maximum of 1198 cfu/100mL (in effect from April 1 through October 31 each year)

PCR: Public Access; 1310 cfu/100mL or single sample maximum of 6580 cfu/100mL (in effect from November 1 through March 31 each year)

PCR: Restricted Access; 427 cfu/100mL or single sample maximum of 1950 cfu/100mL (in effect from April 1 through October 31 each year)

PCR: Restricted Access; 2135 cfu/100mL or single sample maximum of 9760 cfu/100mL (in effect from November 1 through March 31 each year)

A Secondary Contact Recreation (SCR) 'not to exceed' standard derived from a single sample maximum or a geometric mean of at least five samples collected beyond the mixing zone during separate 24-hour periods within a 30-day period for SCR classes are as follows (K.A.R 28-16-28e (c)(7)(c) (table1j)):

SCR: Public Access and Restricted Access; 2135 cfu/100mL or single sample maximum of 9760 cfu/100mL (in effect from January 1 through December 31 each year)

6.3 LAKE AND WETLAND ASSESSMENT UNITS - CATEGORIZATION FOR LISTING

1) Determine if the lake or wetland assessment unit appears on the 2004 Section 303(d) list and has not had a TMDL developed or qualify for Delisting for its specified impairment(s). If a TMDL has not been developed and the impairment does not qualify for Delisting, list in Category 5.

2) For lakes not listed in 2004 for eutrophication, if the lake has a designated use of primary contact recreation and the overall chlorophyll a average concentration is greater than 12 ppb or if the chlorophyll a concentration is greater than 12 ppb for more than one sample since 1996 and one of the excursions has been obtained during the two most recent sampling dates, list in Category 5.

3) For lakes not listed in 2004 for eutrophication, if the lake has a designated use of secondary contact recreation and the overall chlorophyll a average concentration is greater than 20 ppb or if the chlorophyll a concentration is greater than 20 ppb for more than one sample since 1996 and one of the excursions has been obtained during the two most recent sampling dates, list in Category 5.

4) If the lake or wetland, for any other parameter, exceeded water quality standards or regional norms for more than one year since 1996 and one of the excursions has been obtained during the two most recent sampling dates, list in Category 5.

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6.4 LAKE PRIORITY (CATEGORY 5) DETERMINATION METHOD FOR TMDL DEVELOPMENT

1) For Lakes previously listed for Eutrophication, but there is no new data since 1996, the lake will be removed from Category 5 and listed as Category 3.

2) For previously and newly listed lakes and wetlands for Eutrophication, priorities will be established based on a comprehensive data evaluation to include a comparison between the overall number of samples over 12 ppb (20 ppb for Secondary Contact Recreation), the recent chlorophyll a averages since 1996 and the overall chlorophyll a average for all available samples. In general, first priority goes to lakes and wetlands with the lowest average chlorophyll a concentrations since 1996 and has existing primary contact recreation uses, generally in the range of 12-18 ppb. Second priority will generally be assigned to lakes with chlorophyll a averages around 18-28ppb. Third priority will generally be assigned to lakes with the highest chlorophyll a averages within their basin.

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3) Should any lakes with new eutrophication impairments also have a problem with deficient dissolved oxygen, their priority will be moved up one priority rank.

4) Should any lakes with new eutrophication impairments also have a problem with elevated pH or siltation, their priority will remain based on the level of chlorophyll a present over the evaluation period.

6) For other pollutants, if excursions appears in three or more years since 1996, place in first priority; if excursions appears in two years since 1996, place in second priority.

6.5 LAKE AND WETLAND ASSESSMENT UNITS - CONSIDERATIONS FOR DELISTING

1) For lakes designated for primary contact recreation and listed for eutrophication on the 2004 list, if the two latest sampling dates have chlorophyll a concentrations less than 12 ppb and no TMDL has yet been developed, delist.

2) For lakes and wetlands designated for secondary contact recreation and listed on the 2004 list for eutrophication, if the two latest samples have chlorophyll a concentrations less than 20 ppb and no TMDL has yet been developed, delist.

3) For lakes and wetlands, if the two latest samples, for any other parameter, attain water quality standards or regional norms, delist.

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7.0 ADDITIONAL CONSIDERATIONS

7.1 ADDITIONAL CONSIDERATIONS IN PRIORITY

Domestic water supply nitrate impairments within category 5 will also be placed in the 1st priority level. First priority of category 5 impairments will also be assigned for all 1998 303(d) listed waters which still require the development of a TMDL. For the primary basins that will have TMDLs written within 2006 – 2008: (Marais des Cygnes, Missouri, Neosho, Verdigris and Walnut), priorities for TMDL development will be displayed in the 303(d) list. For the other seven basins that will not have TMDLs developed until after the 2008 303(d) list is prepared, all impairments will be set as low priority and will be re-evaluated during preparation of the 2008 list.

7.2 CATEGORY 3 WATERS

In addition to streams that are identified as needing more intensive bacteria sampling over the next listing cycle, a number of stream biology and lake stations are identified as Category 3 because they have insufficient data. In the case of stream biology, one additional seasonal sample is necessary to determine its listing status for 2008. For lakes, no data has been collected since 1995, though the data from prior to 1996 indicated some degree of impairment. Contemporary sampling will determine the listing status for these lakes.

7.3 CHRONIC AQUATIC LIFE IMPAIRMENTS - STABLE AND UNSTABLE FLOW ASSESSMENT METHOD FOR DELISTING CONSIDERATION

In 2002, for the first time since Kansas began the 303(d) listing process, an assessment was made to determine whether chronic aquatic life impairments existed in the State's streams. EPA 305(b) Guidance (USEPA, 1995) addresses factors to consider regarding toxicant data and these data's application to chronic aquatic life criteria. EPA states "Grab and composite samples can be used in water quality assessments if taken during stable conditions". This statement created the impetus for the State to assess chronic aquatic life use by means of grab samples for the 2002 303(d) list.

During the 2002 303(d) List development, time did not allow for a review of the hydrologic conditions associated with individual grab samples. It has always been the intent of the State that this review of the hydrologic condition as it existed at the time grab samples were collected should occur prior to TMDL development. 'Stable condition' excursions of chronic aquatic life criteria are true violations, while 'unstable condition' excursions of chronic aquatic life criteria, since they do not meet the definition of a criteria violation as it applies to chronic aquatic life, will be not be assessed as an exceedance. What follows is the method to be employed by the State for making this 'stable versus unstable' determination.

The original premise of EPA guidance on chronic aquatic life assessments was related to a 4-day composite sample. In following the original intent (4-day composite concept), even though Kansas does not collect data in this fashion (only grab samples are collected), the review of hydrologic conditions will be based upon 7 days of flow. These 7 days of flow will be averaged from daily flow values from three days prior to the sample date to the sample date and moving the average by one day with the last average being the sample day up to three days after the date a grab sample was collected. The statistic used is the coefficient of variation (CV), which is found by dividing the standard deviation of each 4-day flow period within the 7 flow days by the mean of the respective 4 flow days. The entire determination of stable or unstable conditions is based upon a statistical measure of the amount of variation during these 7 days of flow.

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The CV is expressed as a percentage (actually, it is the standard deviation that is given as a percentage of the mean). The smaller this percentage, the more stable the condition during the 7 days of interest. Kansas believes that a very conservative demarcation of stable and unstable conditions is a CV of 20%. An unstable condition will be defined as a CV greater than 20% for any individual four day period, and the overall determination of whether the flows were stable when the

grab sample was collected will be made based on a composite evaluation of the four CV percentages.

All potential 303(d) toxicant listings showing impairment for chronic aquatic life will be reviewed during the 2006 303(d) listing process using the method outlined in section 7.3. A grab sample that is determined to have occurred during unstable conditions will be redefined as meeting chronic aquatic life criteria and grab samples that are determined to have occurred during stable flow will continue to be considered excursion from chronic aquatic life criteria. Once the proposed methodology is applied to all grab samples from a previously listed monitoring site that was originally determined to supporting chronic aquatic life criteria in the 2004 303(d) List, the site will be re-assessed following the assessment methodology for the 2006 303(d) List for support of the chronic aquatic life designated use.

If it is found that the revised number of excursions is no longer large enough to support a determination of impairment to chronic aquatic life (Table 2), the AU and impairment will be removed from the 303(d) list and EPA will be supplied the data and findings supporting this action. Kansas believes this delisting is reasonable and correct, since it will be demonstrated that an incomplete analysis of the original data led to the assessment unit be listed and a more recent and accurate analysis of the data shows that the applicable designated uses are supported. If it is found that the revised number of excursions is still large enough to support the determination of impairment the listing will be carried into the 2006 303(d) list, priority for TMDL development will be assigned and a TMDL will be written for the toxicant.

7.4 BASIN ADVISORY COMMITTEE INPUT

In some cases, Basin Advisory Committees associated with the State Water Plan and comprising individuals residing within each of the twelve river basins will offer input to revise the priority listing of certain waters within their basins. Typically, this input serves to elevate a water that was originally not scheduled to have a TMDL developed in the next cycle and direct its TMDL be prepared.

8.0 PUBLIC PARTICIPATION

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The public was invited to comment on this methodology and the draft list generated through this methodology. A draft of this methodology was posted on the KDHE TMDL Web site http://www.kdheks.gov/tmdl/index.htm. The draft list was released on September 15, 2006 for public review and comment. The priorities within the list may be modified based on feedback provided by the Basin Advisory Committees (BACs). BACs set priorities within their basins and these priorities may influence which TMDLs will be developed within the basin.

8.1 PUBLIC HEARING DATES AND LOCATIONS

KDHE will hold three public hearings to receive comments on the proposed 2006 Section 303(d) List. The three hearings will be on October 24-26, 2006 in Topeka, Ottawa, and Neodesha to interested parties in the Marais des Cygnes, Missouri, Neosho, Verdigris and Walnut basins.

8.2 PUBLIC COMMENTS AND AGENCY RESPONSE

Public comments will be taken at the three public hearings through November 17, 2006. Late interest in commenting on the list of impaired waters and the methodology may prompt KDHE to extend the open period. After the public record closes on November 17, 2006, KDHE will consider the received comments, formulate a response to those comments and will post the comments and responses on its TMDL Web site.

9.0 SUBMITTAL TO EPA REGION 7

The finalized Section 303(d) List for 2006, public comments received by KDHE regarding the 303(d) List, and KDHE response to public comments is submitted to EPA Region 7 on December 15, 2006.

10.0 REFERENCES

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