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Implementation of Kansas TMDLS

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ABSTRACT

In 1995, the Kansas Natural Resource Council and the Sierra Club filed a complaint against the Environmental Protection Agency (EPA), compelling it to enforce Section 303(d) of the Clean Water Act by establishing Total Maximum Daily Loads (TMDLS). Kansas, intervened in the litigation, since the state had lead responsibility for identifying the waters requiring TMDLs and establishing the TMDLs. A settlement was reached and a consent decree approving the settlement was mad on April 13, 1998. The court decree sets out a schedule for the state to submit TMDLs for water quality limited stream segments and lakes in each of the 12 major river basins in Kansas over an eight-year period. Kansas will submit TMDLs only on those waters deemed to need such load determinations consistent with Section 303(d). TMDLs established by Kansas may be done on a watershed basis and may use a pollutant-by-pollutant approach or a bio-monitoring approach or both as appropriate. This paper describes the implementation of the Kansas TMDL process.

INTRODUCTION

Beginning January 31, 1999 and by January 31 of each year thereafter during the effective period of the court decree, EPA and Kansas shall provide the plaintiffs with a written report, jointly if possible, regarding the activities undertaken to comply with the court decree during the previous calendar year. The report includes:

1. The water quality limited segments which had TMDLs established during the year,
2. The TMDLs established during the year; and
3. The water quality limited segments on the 1996 Section 303(d) list that are not on the current Section 303(d) list and an explanation why they are not on the current list.

The court decree also provides for the remedy and scope of judicial review, dispute resolution, modification procedures for the schedule, recognized exceptions in compliance with the court decree, demonstration of good cause and termination of the decree and dismissal of the plaintiff claims.

Kansas intends to use the existing Water Planning Process to create opportunities for coordination with other agencies, interest groups, and the general public. Internally, the Department of Health and Environment will convene appropriate intra-agency work groups to address specific issues of TMDL establishment and implementation. Such work groups include staff from the Bureau of Water (dealing in water quality standards, municipal permits, livestock permits, and nonpoint source pollution) and the Bureau of Environmental Field Services (dealing with monitoring, biomonitoring, use attainability analysis, data analysis, geographic information, and planning). The Planning and Prevention Office will interact with the other state agencies on TMDLs through the coordination functions of the Kansas Water Office, the Kansas Water Authority, and the *Kansas Water Plan*.

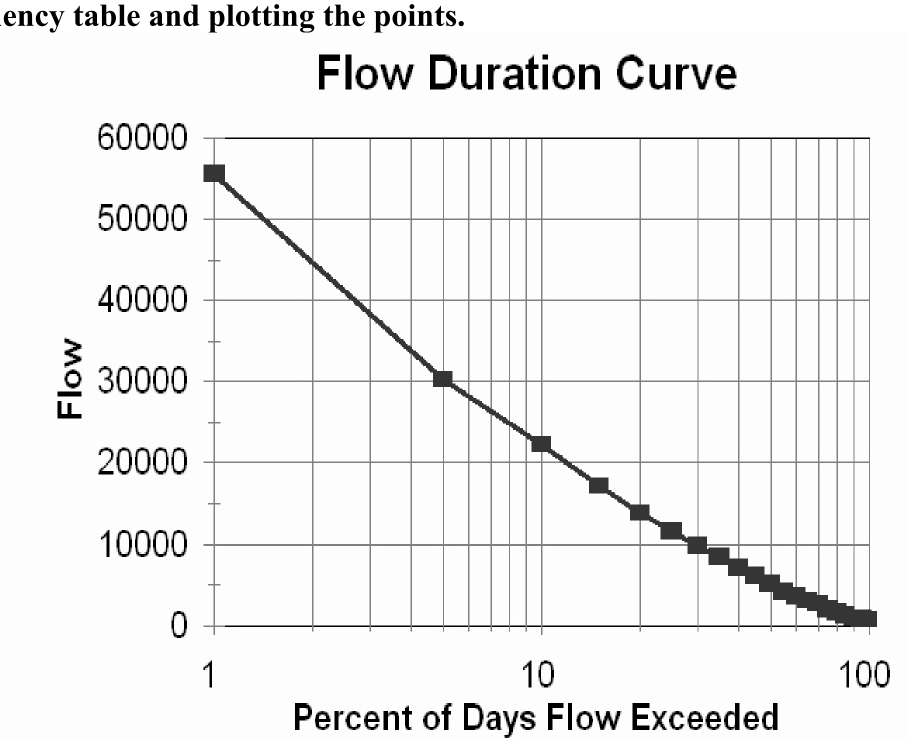
Basin Advisory Committees (BAC) is present in each of the 12 major river basins, appointed by the Kansas Water Authority. They advise the Authority on basin issues and concerns relative to the programs and policies of the *Kansas Water Plan*. The 11 members of the BAC reside in the basin and represent some aspect of water use in the basin. The chief responsibility of the BAC is to advise the Kansas Water Office and the Kansas Water Authority on the issues of the basin, the desired direction of applicable state programs, and guidance of such programs through the provisions of its Basin Plan. Such plans reflect the direction and priorities of the basin relative to issues of water supply, water quality, flooding, environmental protection, fish, wildlife, recreation, water conservation, and data and research. These plans represent the basis for setting priorities through the Annual Implementation Process.

METHODS

The following steps describe data analysis for developing the Kansas TMDL Curve Methodology.

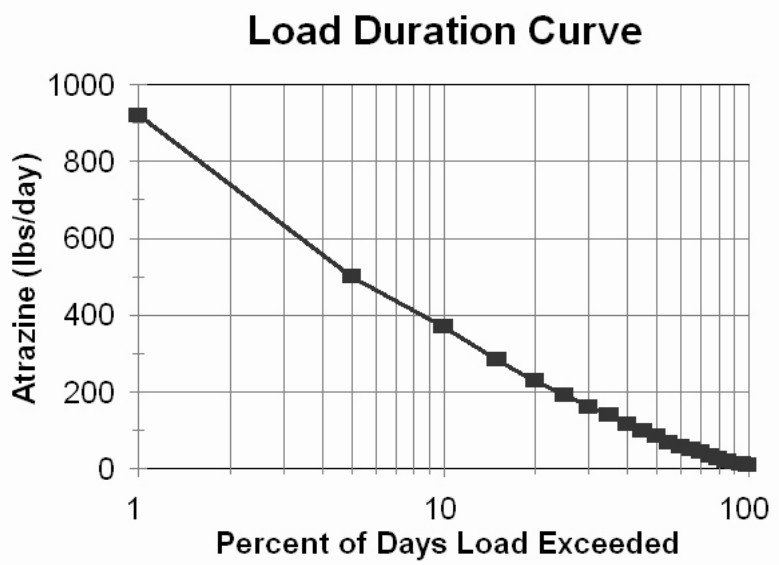
Step 1. A flow duration curve for the gage site of interest is developed. This is done by generating a flow frequency table and plotting the points.

% Exceed	Flow
99	694.2
95	803.3
90	920.2
85	1213.3
80	1629.7
75	2081.3
70	2692.9
65	3130.3
60	3583.3
55	4177.9
50	5092.2
45	6074.7
40	7068.8
35	8398.1
30	9801.8
25	11617.5
20	13838.5
15	17136.8
10	22281.1



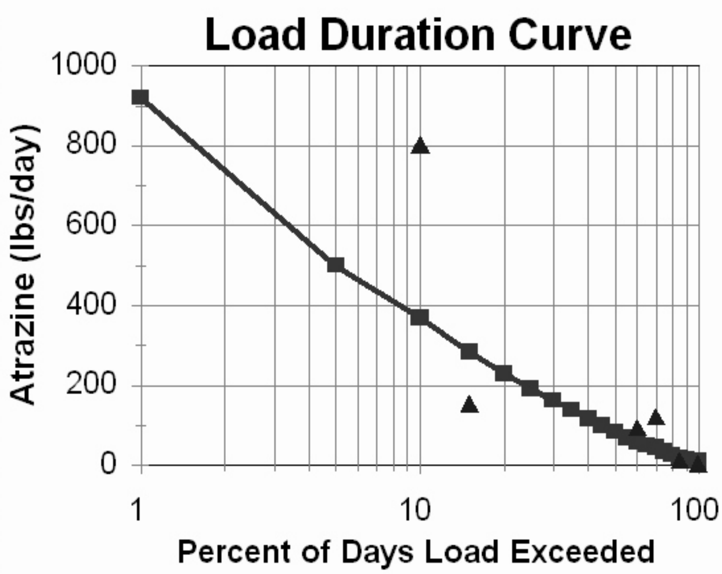
Step 2. The flow curve is translated into a Load Duration (TMDL) Curve. To accomplish this, the flow value is multiplied by the water quality standard and by a conversion factor. The resulting points are graphed.

Prob.	Flow	Atrazine (lbs/day)
99	694.2	11.50
95	803.3	13.31
90	920.2	15.25
85	1213.3	20.10
80	1629.7	27.00
75	2081.3	34.49
70	2692.9	44.62
65	3130.3	51.87
60	3583.3	59.38
55	4177.9	69.23
50	5092.2	84.38
45	6074.7	100.66
40	7068.8	117.13
35	8398.1	139.16
30	9801.8	162.42
25	11617.5	192.50
20	13838.5	229.30
15	17136.8	283.96
10	22281.1	369.20
5	30245.9	501.17
1	55562.3	920.67



Step 3. A water quality sample is converted to a load by multiplying the water quality sample concentration by the average daily flow (on the day the sample was taken). Then, the load is plotted on the TMDL graph.

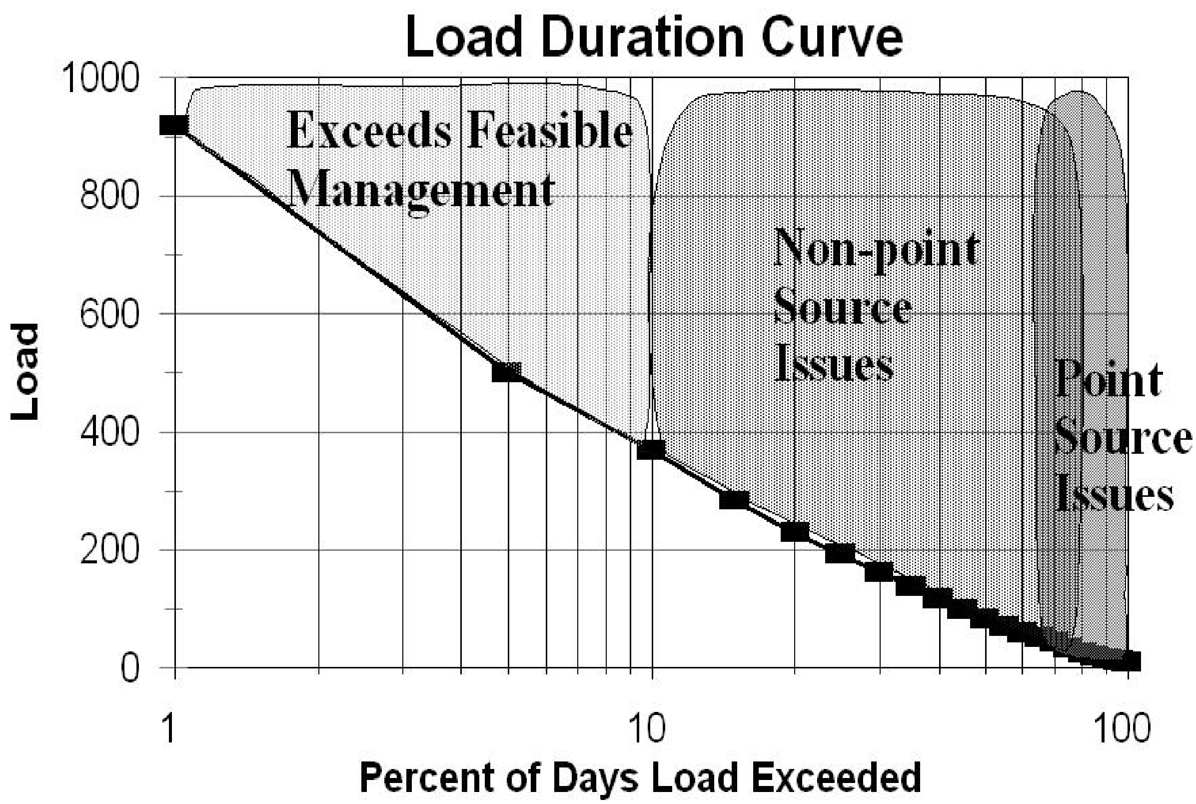
Prob.	Flow	Atrazine (lbs/day)	Atrazine Load
99	694.2	11.50	4.33
95	803.3	13.31	
90	920.2	15.25	
85	1213.3	20.10	12.92
80	1629.7	27.00	
75	2081.3	34.49	
70	2692.9	44.62	122.91
65	3130.3	51.87	
60	3583.3	59.38	95.87
55	4177.9	69.23	
50	5092.2	84.38	
45	6074.7	100.66	
40	7068.8	117.13	
35	8398.1	139.16	
30	9801.8	162.42	
25	11617.5	192.50	
20	13838.5	229.30	
15	17136.8	283.96	154.43
10	22281.1	369.20	804.32
5	30245.9	501.17	
1	55562.3	920.67	



Points plotting above the curve represent deviations from the water quality standard and the permissible loading function. Those plotting below the curve represent compliance with standards and represent adequate quality support for the appropriate designated use. Similar analysis can be done for certain lakes, using cumulative frequency distributions of their volume or elevation.

The following information is provided in these plots:

1. Help to identify the issues surrounding the problem and differentiate between point and nonpoint source problems.
2. Show seasonal water quality effects
3. Address frequency of deviations (how many samples lie above the curve vs. those that plot below); magnitude (how far the deviations plot away from the curve); and duration (potentially how long the deviation is present) questions
4. Compare water quality conditions between multiple watersheds
5. Aid in establishing the level of implementation needed



In this analysis, loads, which plot above the curve in the flow regime defined as being exceeded 85-99 percent of the time, are likely indicative of point source influences on the water quality. Point Source Issues are clearly identified as a discharge from a pipe, ditch, or other well-defined source. Those plotting above the curve over the range of 10-70 percent exceedence likely reflect nonpoint contributions. Nonpoint source issues are pollution associated with runoff or snowmelt from numerous, dispersed sources over an extended area. Some combination of the two source categories lies in the transition zone of 70-85 percent exceedence. Those plotting above the curve at exceedences less than 10 percent or more than 99 percent reflect extreme hydrologic conditions of flood or drought.

TRANSLATION OF KANSAS BACTERIA TMDL TO TRADITIONAL TMDL

The traditional notation of a TMDL is:

TMDL = WLA + LA + MOS or TMDL = $\sum WLA + \sum LA + MOS$, for multiple sources,

where: TMDL is the loading capacity of the stream; WLA is the wasteload allocation for the point source(s); LA is the load allocation for the non-point source(s) and MOS is the margin of safety.

This notation implies a steady state; i.e.; loading at a single flow value (7Q10, Q average). The Kansas approach, however, recognizes the dynamic state of loads; e. g. loading varies directly with flow. Therefore the TMDL equation is written as,

$$TMDL_i = WLA_i + LA_i + MOS_i ,$$

at a given flow duration position, i. The load duration curve developed for bacteria, which represents the TMDL, is a cumulative frequency curve of each individual $TMDL_i$, since

$$TMDL_i = Q_i * WQS * C,$$

where Q_i is the flow associated with the i*th* exceedance position on the frequency curve, WQS is the applicable water quality criterion (2000 colonies/100 ml) and C is the conversion factor necessary to create a bacteria colonies per day loading.

For the entire curve:

$$\sum_{i=99}^{10} TMDL_i = \sum_{i=99}^{10} WLA_i + \sum_{i=99}^{10} LA_i + \sum_{i=99}^{10} MOS_i$$

For wasteloads from point sources:

$$\sum_{i=99}^{10} WLA_i = \sum_{i=99}^{10} (P_I * WQS * C),$$

where P_i is the index of whether point sources are an influence on water quality, which is function of the designated low flow, Q_L. Q_L is the greater of the 7Q10 or 10 times the sum of the design flows of the existing point sources in a watershed. This delineation is a reasonable estimate of the flow condition beyond which point source loading (from actual waste water treatment permit discharges) has negligible effect on ambient stream quality. The Q_L accounts for future growth since actual wastewater discharge is typically less than treatment plant design flows for many years to come. L is actually the exceedance position on the flow (or load) duration curve associated with Q_L. Designation of this low flow caps the amount of flow emanating from point sources at 10 %, and typically the percentage is less. Flows lower than Q_L are influenced by point source flows, those above, are not. Therefore,

$$\text{for } i \geq L,\ P_i = 1;\ \text{for } i < L,\ P_i = 0.$$

For this notation, higher flows relate to lower I values, E. G.; baseflow occurs at I = 85-99; runoff occurs at I = 10-50, etc. This approach combines all the point sources into a single value. If allocation of loads were to be done for individual point sources, the allocation would be proportion to each source's design flow since the WQS (expressed as a permit limit) and C would be the same for each discharger.

Similarly, for non-point sources,

$$\sum_{i=99}^{10} LA_i = \sum_{i=99}^{10} (N_I * Q_i * WQS * C),$$

where N_i is the index of whether non-point sources are an influence on water quality, which is the case for flows higher than the designated low flow, Q_L. Therefore,

$$\text{for } i > L,\ N_i = 0;\ \text{for } i \leq L,\ N_i = 1.$$

The load allocation is bounded on the upper end by the flow exceeded 10% of the time. This high flow exclusion is recognized in the surface water quality standards.

The margin of safety, MOS, represents a hedge against the uncertainty in attaining the water quality standards. For bacteria, the MOS is 100 colonies per 100 ml below the applicable water quality criteria, therefore, the true evaluation would come from comparing samples to values of 2000 colonies per 100 ml standard. The associated load, which accounts for the MOS would be:

$$MOS_i = Q_i * 100 * C;\ \text{and across the entire TMDL curve}$$

$$\sum_{i=99}^{10} MOS_i = \sum_{i=99}^{10} (Q_i * 100 * C).$$

The resulting load duration or TMDL curve would be:

$$\sum_{i=99}^{10} TMDL_i - \sum_{i=99}^{10} MOS_i = \sum_{i=99}^{10} WLA_i + \sum_{i=99}^{10} LA_i;\ \text{or,}$$

$$\sum_{i=99}^{10} (Q_i * (WQS\text{-}100) * C) = \sum_{i=99}^{10} WLA_i + \sum_{i=99}^{10} LA_i.$$

This relationship is described on each TMDL graph. A vertical line is drawn through the TMDL curve at exceedence L, the point demarcating the influence between point and non-point sources. If one integrated the area under the curve, the result would be the total load occurring 100% of the time. The percentage of the area to the left of the vertical line is the load allocation; the percentage of the area to the right of the line is the wasteload allocation.

This procedure delineates the flow condition or regime by which point or non-point sources are responsible for effecting pollution reduction such that future samplings do not rise above the TMDL curve (accounting for the parallel line offset from that curve and representing the margin of safety.

REFERENCES

Stiles, T., B. Liscek and C. Gnau. 1998. Total maximum daily loads. Office of Planning and Prevention. Kansas Department of Health and Environment. Topeka, Kansas.

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