

MISSOURI BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody/Assessment Unit (AU): Turkey Creek

Water Quality Impairment: Atrazine

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: South Fork Big Nemaha

County: Marshall, Nemaha

HUC 8: 10240007

HUC 11 (HUC 14s): 10240007021(070, 080, 090, 100)

Ecoregion: Western Corn Belt Plains, Loess and Glacial Drift Hills (47i)

Drainage Area: 86 square miles in Kansas (200 square miles in Nebraska)

Main Stem Segments: Turkey Creek (Segments 4 and 5) (**Table 1 and Figure 1**)

Main Stem Segments with Tributaries by HUC 8 and Watershed/Station Number:

Table 1

HUC8	10240007		
Watershed	Turkey Creek (Bern)		
Station			
601	Turkey Cr (4)	Burger Cr (24)	
		Clear Cr (132)	
		Wolf Cr (12)	Manley Cr (14)
		Wolf Cr (13)	
	Turkey Cr (5)	Wildcat Cr (22)	

Designated Uses: All streams -Expected Aquatic Life Use, Secondary Contact Recreation Use (b),
Turkey Cr - Food Procurement Use
Manley Cr, Wolf Cr – Domestic Water Supply Use, Food Procurement Use, Industrial Water Supply Use, Irrigation Use, Livestock Watering Use

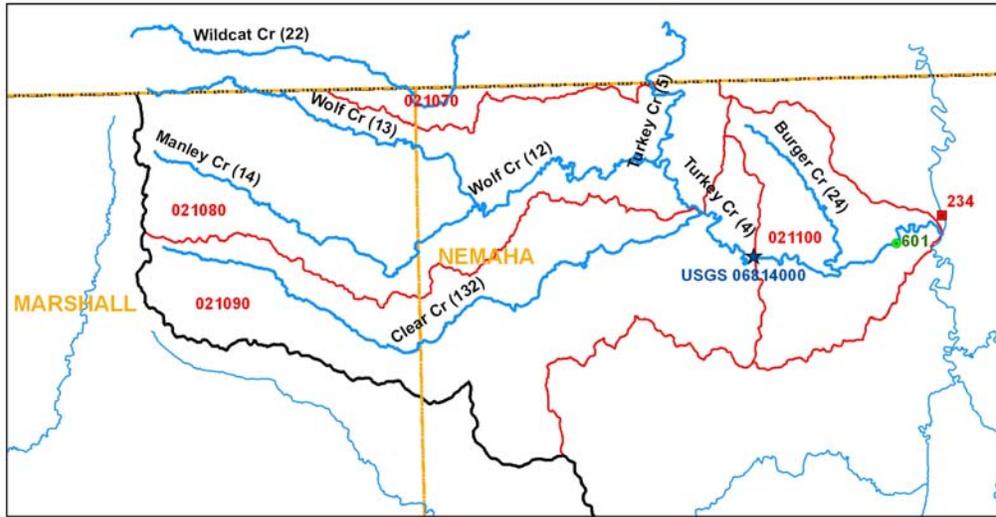
303(d) Listings: 2006 Missouri River Basin

Impaired Use: Chronic Aquatic Life

Water Quality Standard: Aquatic Life Support [Chronic criterion]: 3 µg/l for (KAR 28-16-28e(c)(2)(D)(ii))

Figure 1a. Map of the TMDL Area

Turkey Creek in Kansas



Legend

- ★ USGS Gage Station
- KDHE Rotational Station
- KDHE Permanent Station
- Atrazine Impaired
- Streams
- ▭ Counties
- ⬭ HUC8 10240007
- ⬭ HUC14

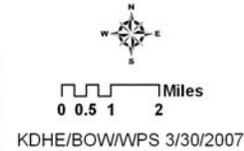
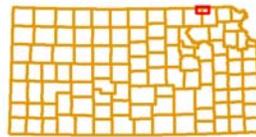
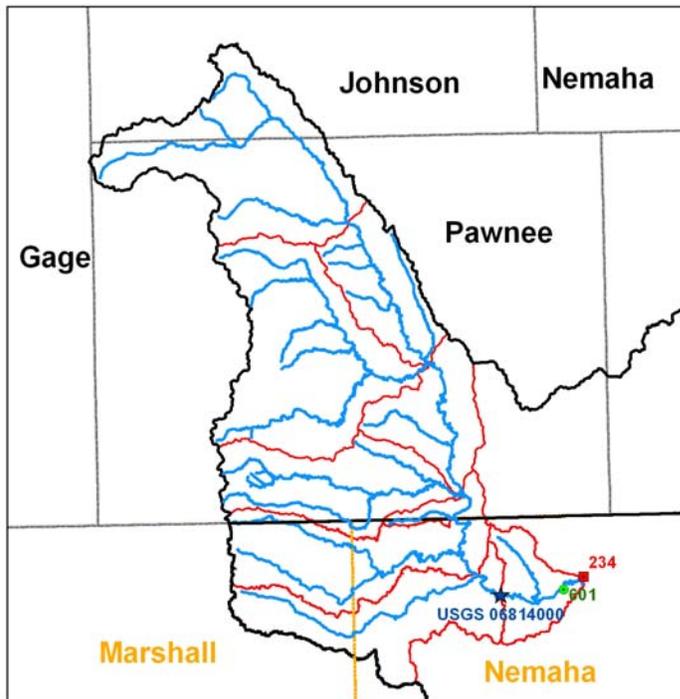


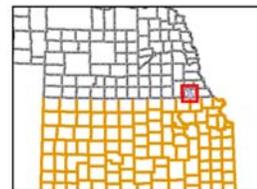
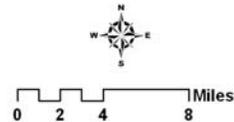
Figure 1b. Drainage Area

Turkey Creek Watershed



Legend

- ★ USGS Gage Station
- KDHE Rotational Station
- KDHE Permanent Station
- Atrazine Impaired
- ▭ Nebraska Counties
- ▭ Kansas Counties
- ⬭ HUC8 10240007
- ⬭ HUC14 (12 in Nebraska)



KDHE/BOW/WPS 3/26/2007

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 2006 303(d): Not Supporting Chronic Aquatic Life

Stream Flow and Water Quality Monitoring Sites: USGS 06814000; KDHE Rotational Station 601; KDHE Permanent Station 234 (**Tables 2-5**)

Period of Record used: 1970-2006 for flow data; 1991-2005 for SC601 (Sampling years – 91, 95, 99, 00, 02, and 05); 1991-2006 for SC234

Long Term Flow Conditions: **Table 5**

Table 2. Water Quality Data Summary - Atrazine

KDHE Sites	Period of Record	Median (µg/L)	Max (µg/L)	# of Samples	# > DL	# > 3 µg/L
SC601 (impaired*)	1991-2005	< 0.3**	49	33	15	5
SC234 (not impaired*)	1991-2006	< 0.3**	14	61	32	8

* According to the 2006 303(d) list

** 0.3 µg/L is the detection limit (DL).

Table 3. Atrazine Exceedances

Date	SC601	SC234
5/29/91	*	13
6/17/92	*	5.8
6/24/98	*	4.9
6/23/99	6.4	6.7
4/27/00	49**	11
6/29/00	3.9	3.9
5/29/02	4.5	4.7
4/27/05	18***	14

* Not sampled

** and *** Highest and 2nd highest Values, respectively

Table 4. April-July Monthly Summary

Station	Month	# of Samples	# > 3 µg/L	Frequency
SC601	April	3	2	2/3
	May	3	1	1/3
	June	3	2	2/3
	July	3	0	0/3
SC234	April	6	2	2/6
	May	6	2	2/6
	June	5	4	4/5
	July	5	0	0/5

Table 5. Flow Data Summary

Site	USGS06814000 (Turkey Creek near Seneca)
Time Period	1970-2006
Drainage Area (square miles)	86
Mean Flow (cfs)	126
10% Flow Exceeded (cfs)	200
25% Flow Exceeded (cfs)	66
Median (50% Flow Exceeded) (cfs)	22
Upper Quartile (75% Flow Exceeded) (cfs)	6.3
Upper Decile (90% Flow Exceeded) (cfs)	2.3
95% Flow Exceeded (cfs)	1.1
99% Flow Exceeded (cfs)	0.13

Hydrology: The Kansas part of the Turkey Creek watershed is relatively small, only 86 square miles in size (**Figure 1**). The rotational station 601 is only sampled every four years and located on Turkey Creek near the end of the watershed. The permanent monitoring station 234 is sampled yearly and located outside the watershed on the South Fork Big Nemaha River (segment 3), approximately one half mile downstream from the confluence north Turkey Creek. The stream flow data near station 601 are summarized in **Table 5**. Flow data from 1999-2005 show clear seasonal patterns, low flows in the Winter months and highest flows occurring in Spring (**Figure 2**). The flow curve also shows an overall declining trend; probably due to the drought condition in the region.

Current Conditions: The atrazine data from the KDHE monitoring stations are summarized in **Tables 2-4**. Sample data were categorized into three seasons: Spring (April-July), Summer-Fall (August-October), and Winter (November-March). All the exceedances from SC601 and SC234 occurred in the months of April to June, the Spring season, either at high flows or medium flows (**Figures 3 and 5**). The concentrations on the SF Big Nemaha River at SC234 were directly attributed to the levels on Turkey Creek at SC601 (**Figure 4**). Though SC234 is not atrazine impaired in the 2006 303(d) List, it is likely to become impaired if the atrazine concentrations at SC601 do not decrease in future Spring seasons.

Desired Endpoints of Water Quality (Implied Load Capacity) at Site 601, over 2007 – 2017

The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standards fully supporting Chronic Aquatic Life Use. Achievement of the endpoints indicates loads are within the loading capacity of the stream, the water quality standards are attained, and full support of the designated uses of the stream has been achieved.

Seasonal variation has been incorporated in this TMDL through the documentation of seasonal patterns of elevated atrazine levels.

Figure 2. Stream Flows from 1999-2005

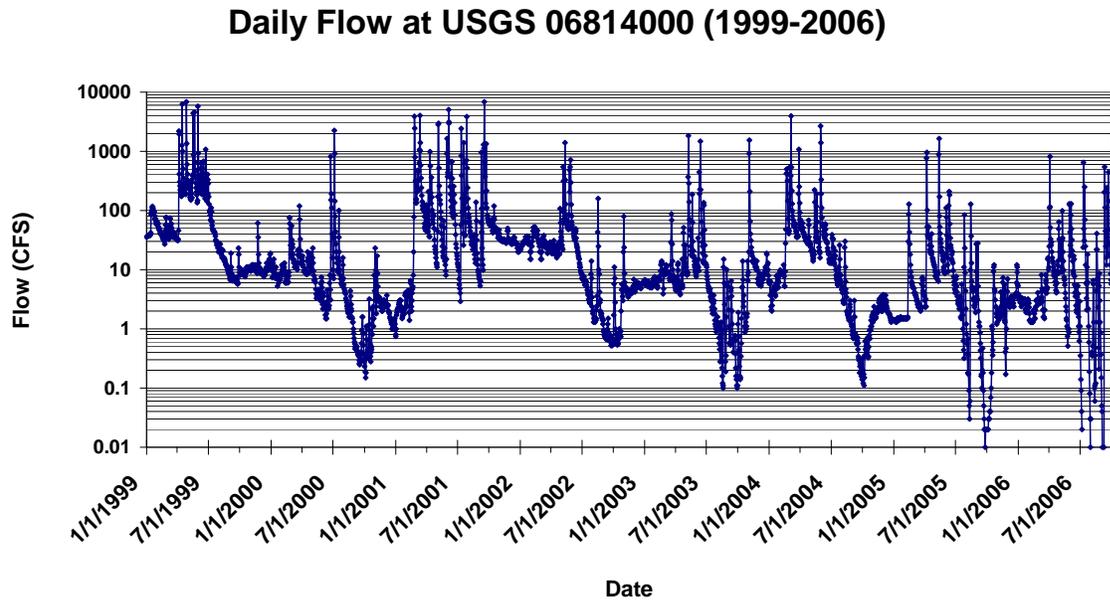


Figure 3. Load Duration Curve for SC601

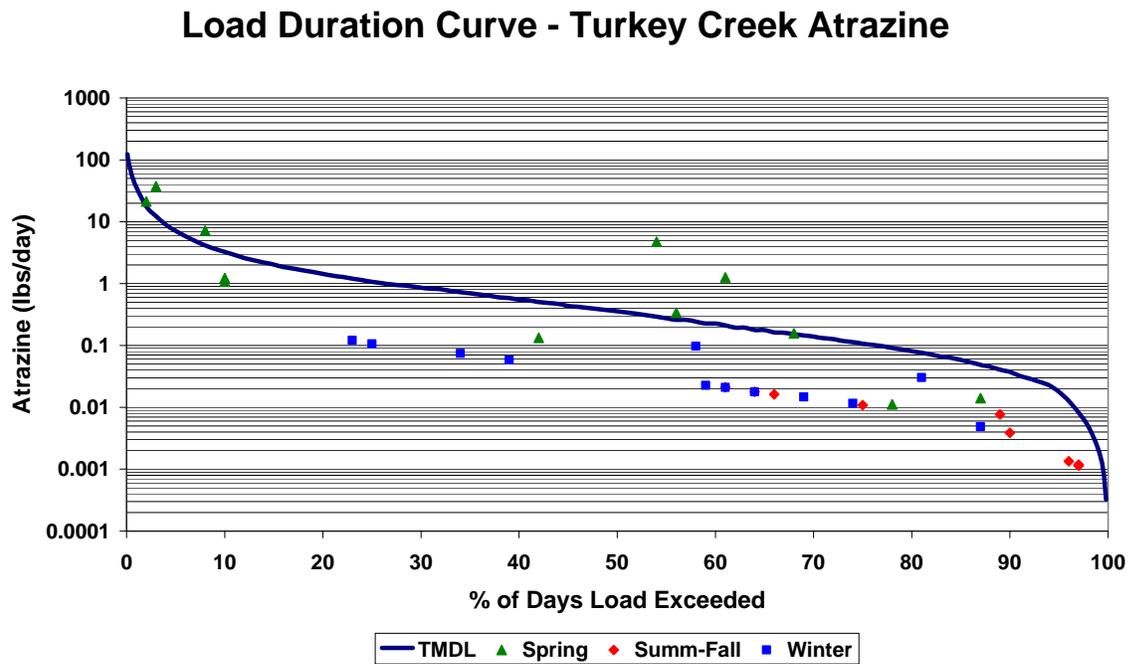


Figure 4. Atrazine Concentrations SC601 vs. SC234

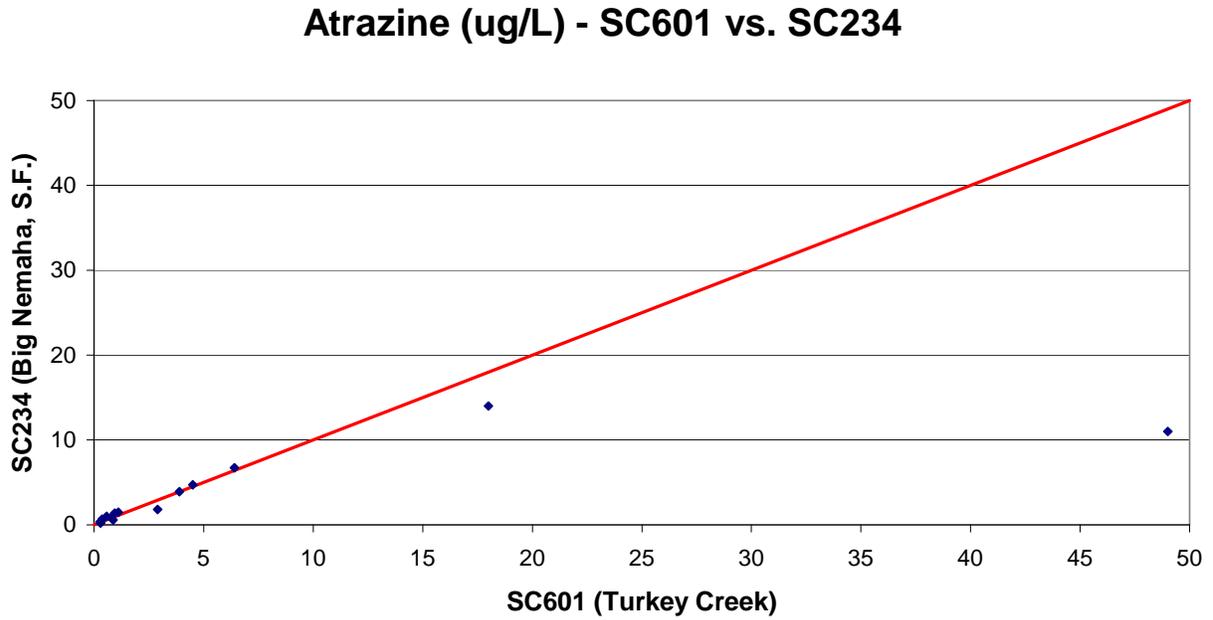
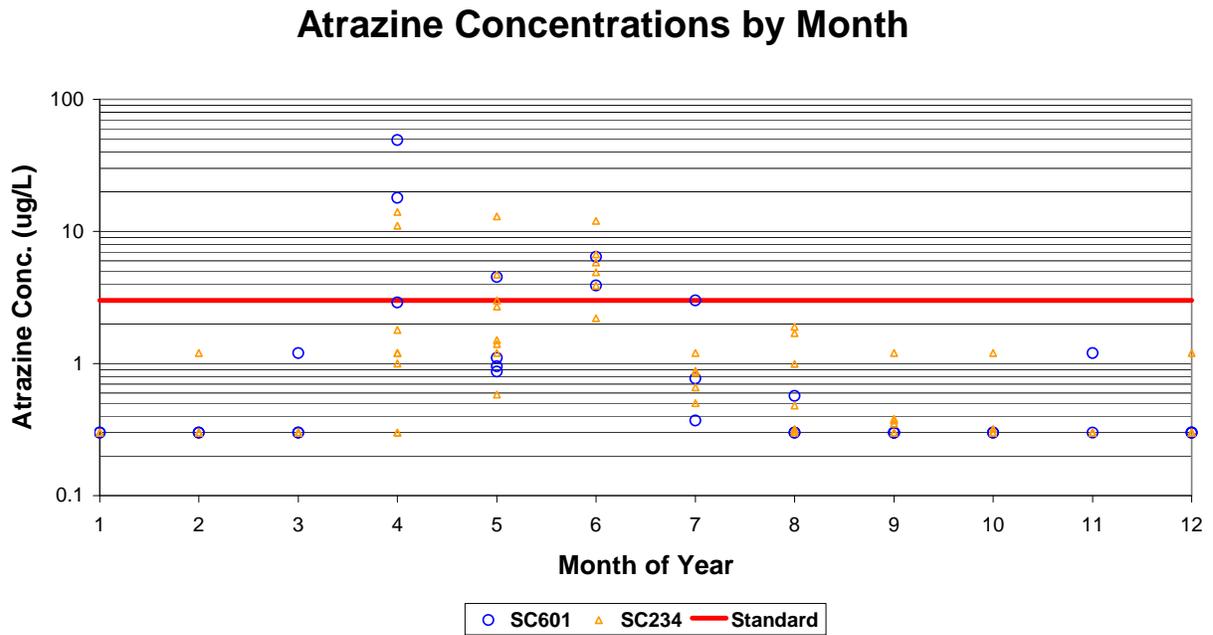


Figure 5. Atrazine Concentrations by Month



3. SOURCE INVENTORY AND ASSESSMENT

Atrazine herbicide has been widely used in Kansas since the 1960's for selective control of broadleaf and grass weeds in corn and grain sorghum¹. It is weakly adsorbed by soil particles and has a relatively long half-life of 60 days. The application rates of atrazine in Kansas are summarized in **Table 6** showing an up-trend from 1990 – 2005.

The contribution of atrazine to the surface water from point sources or irrigation is very minimal. According to the DWR Point of Diversion database, there is no water diversion point in the watershed. The main source of atrazine in the surface water is the runoff from the agricultural fields. Kansas State University studies suggested that annual atrazine runoff losses often range from 1 to 3% of the total applied³. Approximately 90% of atrazine loss occurs in the water portion of runoff and only 10% with the eroding soil particles¹. Months of May to July have the highest runoff potentials for atrazine due to the increased precipitation as well as the planting seasons for corn and sorghum (**Table 7 and Figure 8**).

The 2001 National Land Cover database shows that 26.9% of the Turkey Creek watershed is cultivated cropland (**Table 8 and Figure 9**). The Kansas portion of the watershed has a higher percentage of cropland (36.8%) and lower percentage of grassland comparing to the whole watershed. About two thirds of the cropland (68%) in the watershed or more than half (57%) in the Kansas portion is located within a half mile of the streams. The runoff from these fields can easily enter the streams during and following a precipitation event. The suggested planting dates in this region of Kansas are April 15 - May 20 for corn, and May 15 – June 20 for sorghum (**Table 7**). The periods of violations coincided with the planting seasons for corn and sorghum. Specifically, the exceedances occurring in April are likely caused by atrazine applications during the corn planting season; the exceedances occurred in late May and June are likely caused by atrazine applications during the sorghum planting season. The higher magnitude of exceedances in April probably reflects more acres of corn planted and “first-flush” of early spring runoff in the streams (**Figures 6 and 7**).

Table 6. Application Rates of Atrazine in Kansas

Year	Corn				Sorghum			
	Area Planted (1000 acres)	Area Applied %	# of Applications	Total Applied (1000 lbs)	Area Planted (1000 acres)	Area Applied %	# of Applications	Total Applied (1000 lbs)
1990	1600	74	1.0	1385				
1991	1800	74	1.1	1596	3400	71	1.1	2675
1992	1850	78	1.0	1555				
1993	2000	79	1.0	1778				
1994								
1995	2150	77	1.3	2085				
1996	2500	79	1.1	2303				
1997								
1998	3000	83	1.1	2763	3500	82	1.1	3572
1999	3150	89	1.1	3046				
2000	3450	81	1.1	2910				
2001	3450	81	1.3	4244				
2002								
2003	2900	72	1.1	2296	3600	79	1.1	3707
2004								
2005	3700	59	1.3	2767				

Source of data: Agricultural Chemical Usage Field Crops Summary 1991 to 2006, Agricultural Statistics Board, NASS, USDA⁵

Table 7. Planting dates for Corn and Sorghum

Crop	Planting Dates (Zone 2)
Corn	April 15 – May 20
Sorghum	May 15 – June 20

Source: Kansas Crop Planting Guide²

Figure 6. Total Acres Planted – Marshall County (Source: USDA National Agricultural Statistics Service – Quick Stats on-line⁶)

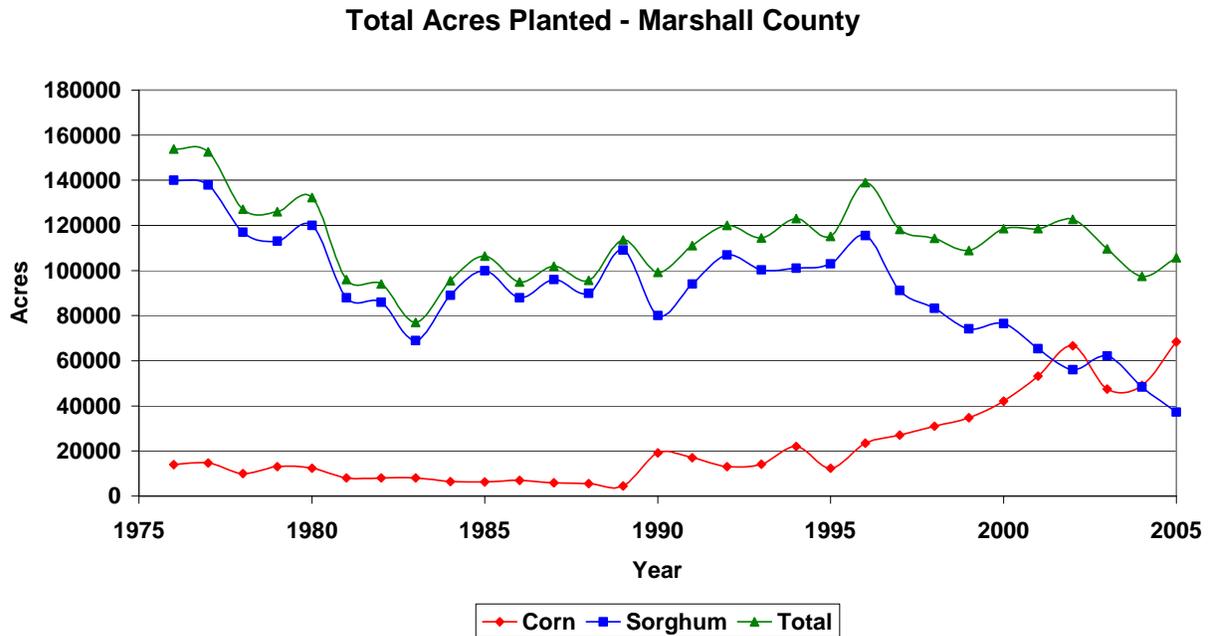


Figure 7. Total Acres Planted – Nemaha County (Source: USDA National Agricultural Statistics Service – Quick Stats on-line⁶)

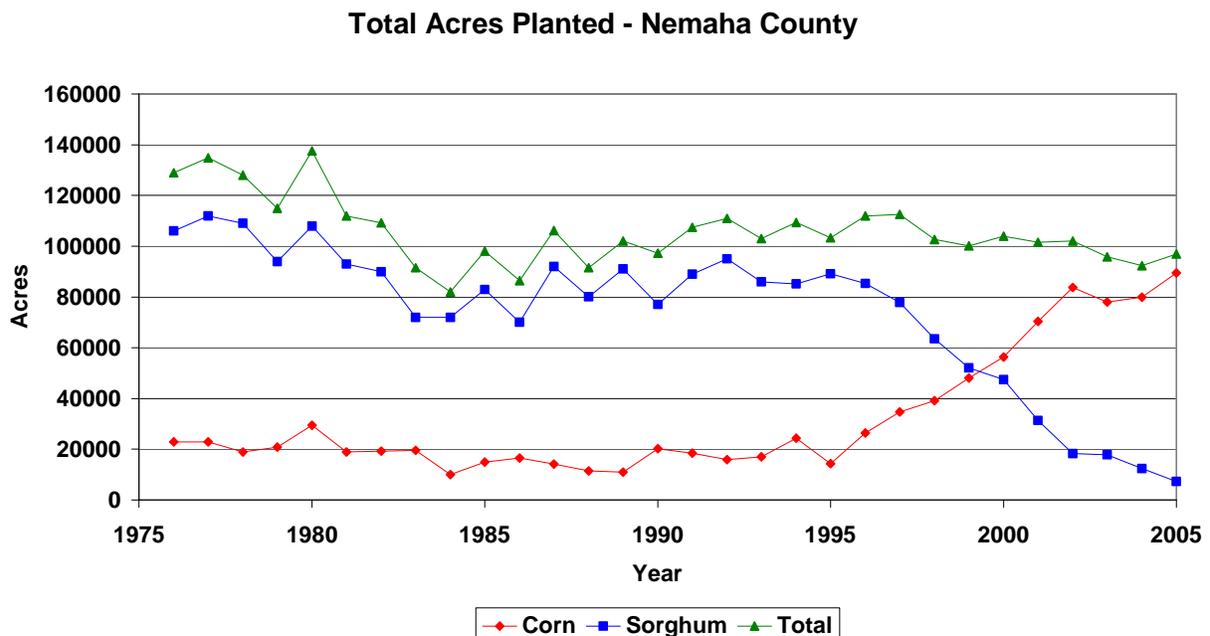


Figure 8. Average Annual Runoff and Erosion Losses in Northeastern Kansas (percentage of annual total) (Source: Managing to Minimize Atrazine Runoff¹)

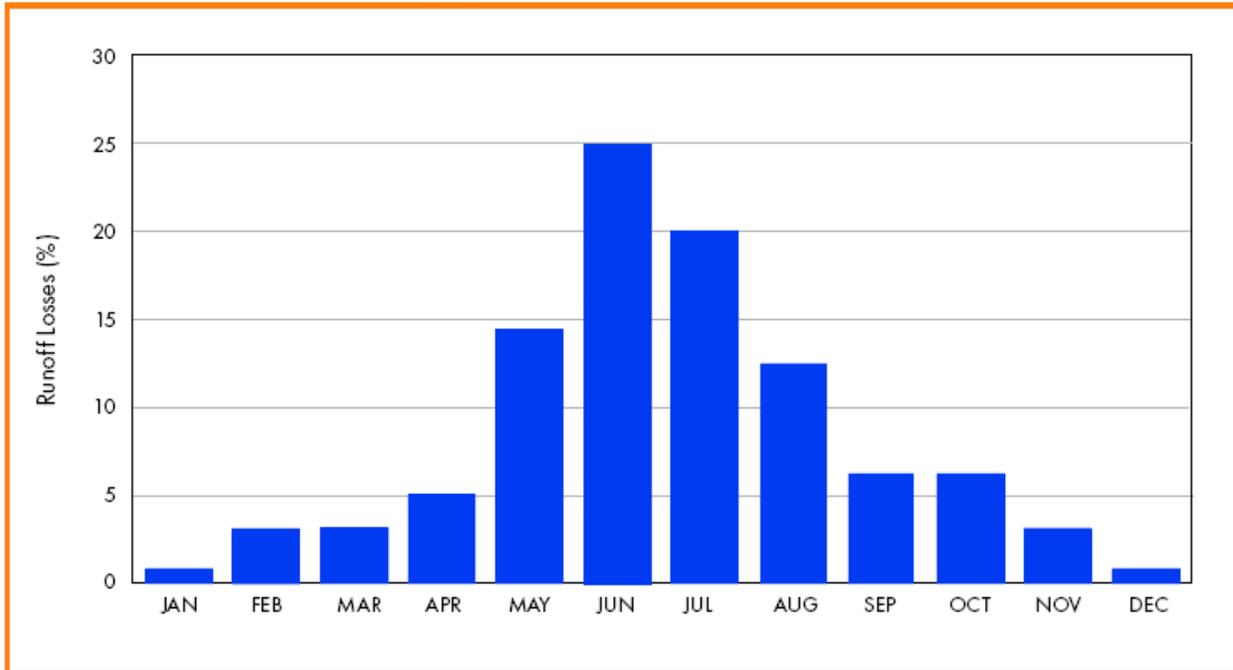


Figure 9. Land Cover Map

Turkey Creek Watershed

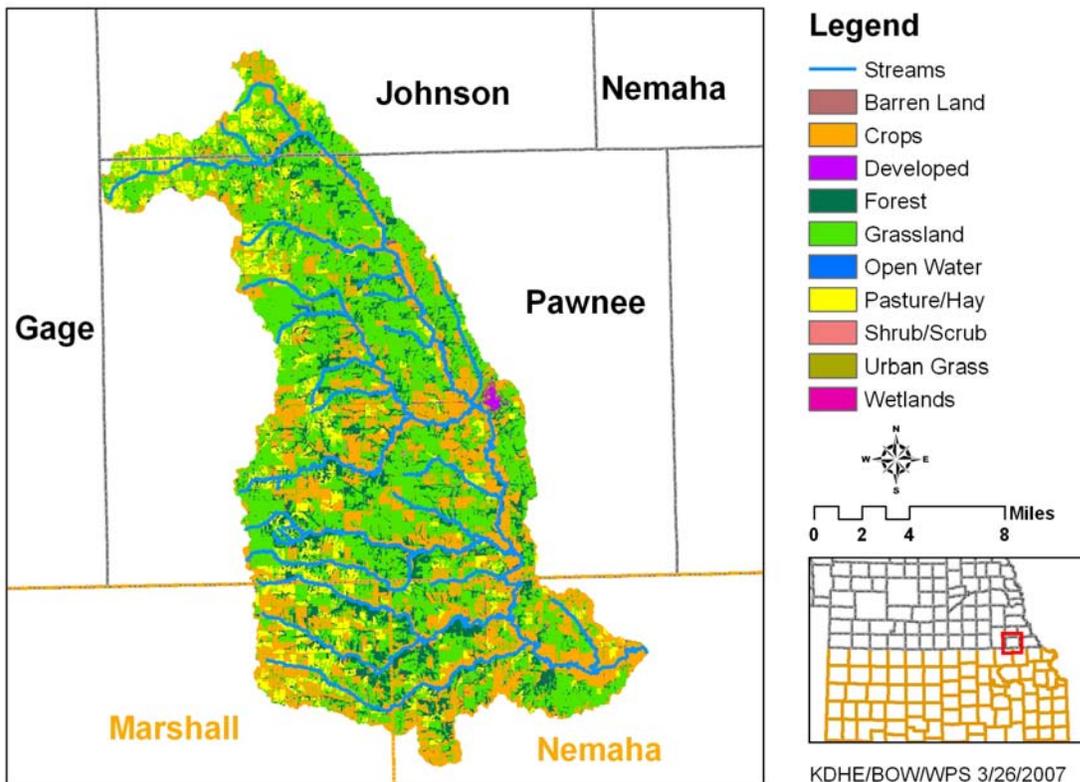


Table 8. Land Cover Percentages

Type	Watershed	Kansas Portion
Grassland	44.1%	32.9%
Crops	26.9%	36.8%
Forest	14.3%	16.1%
Pasture/Hay	9.8%	9.7%
Urban Grass	3.4%	3.2%
Open Water	0.6%	0.5%
Wetlands	0.6%	0.7%
Developed	0.3%	0.0%
Shrub/Scrub	0.1%	0.0%
Barren Land	0.0%	0.0%

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

Point Sources: Due to the nature of atrazine impairment, a Wasteload Allocation of zero will be assigned to any point sources for atrazine under this TMDL.

Non-point Sources: The runoff from agricultural fields is the main contributor of atrazine to the streams in the watershed. The Load Allocations for atrazine are expressed as the average load reduction from the current daily loads of all events seeing exceedances (**Table 8**). Maximum daily loads under different flow conditions are summarized in **Table 9**.

Table 8. Load Reductions

Date	Atrazine ($\mu\text{g/L}$)	Daily Flow (cfs)	Load (lb/day)	Desired Load (lb/day)	Load Reduction
6/23/99	6.4	1080	37.3	17.5	213%
4/27/00	49	18	4.8	0.3	1630%
6/29/00	3.9	16	3.4	0.3	130%
5/29/02	4.5	296	7.2	4.8	150%
4/27/05	18	13	1.3	0.2	597%
				Average Load Reduction during Runoff Events	544%

Table 9. Daily Loads Allocations

Flow Exceedance (%)	Maximum Daily Load (lbs/day)
10	3.2
25	1.1
50	0.4
75	0.1
90	0.04

Defined Margin of Safety: The Margin of Safety is implicitly set because the average reduction is based on the events where runoff and exceedances occur, and does not consider the conditions before April and after June.

State Water Plan Implementation Priority: The United State Environmental Protection Agency (EPA) is currently considering to revise the chronic life criteria for atrazine. This TMDL will be a Medium Priority for implementation.

Unified Watershed Assessment Priority Ranking: The watershed lies within the Missouri Basin (HUC 8: part of 10240007) with a priority for restoration work ranking of 9.

Priority HUC 11s and Stream Segments: The whole watershed is located within a single HUC11, no priority sub-watersheds will be identified. The following stream segments in Kansas are identified as having the highest priority due to the high density and close proximity of cropland to the rivers: Turkey Creek (segments 4 and 5), Clear Creek (segment 132), and Pole Creek (segment 12).

5. IMPLEMENTATION

Desired Implementation Activities

1. Monitor atrazine levels in the streams during the planting seasons for corn and sorghum
2. Employ Best Management Practices (BMPs) on cropland to minimize atrazine runoff⁴.
3. Encourage addressing this TMDL through the Missouri Basin WRAPS.

Implementation Programs Guidance

Non-Point Source Pollution Technical Assistance – KDHE and K-State Agricultural Extension Service

- a. Provide technical assistance on the Best Management Practices.
- b. Coordinate with Nebraska to ensure bi-state reduction in atrazine loadings.
- c. Educate corn and grain sorghum producers on pesticide management.
- d. Incorporate atrazine reduction as a goal of the Missouri Basins WRAPS.

Water Quality Standards and Assessment - KDHE

- a. Incorporate revised atrazine criteria into the Kansas Surface Water Quality Standards once EPA finalizes the criteria.

Kansas Department of Agriculture – Pesticides Program

- a. Conduct an educational program on atrazine reduction and usage with Nebraska targeted to row crop producers in both states.

Timeframe for Implementation: Voluntary Best Management Practices should be encouraged. The timeframe for implementation will be determined through the Missouri WRAPS and adjusted once EPA finalizes the atrazine aquatic life criteria.

Targeted Participants: Primary participant for implementation will be grain sorghum and corn producers operating within the watershed.

Milestone for 2012: In 2012, sampled data from the watersheds should indicate no evidence of increasing atrazine levels relative to the conditions seen in 1991-2005. Should the case of impairment remain, source assessment, allocation and implementation activities will ensue.

Delivery Agents: The primary delivery agent for program participation will be the conservation district for programs of the State Conservation Commission and the Natural Resources Conservation Service. Producer outreach and awareness will be delivered by Kansas State Extension and agricultural interest groups, such as the Kansas Corn Growers Association and the Kansas Grain Sorghum Producers Association.

Reasonable Assurances:

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

1. K.S.A. 2-2439 empowers the Secretary of Agriculture to oversee pesticide management, registration and use in the state.
2. K.S.A. 2-2472 empowers the Secretary of Agriculture to establish Pesticide Management Areas to protect public health, safety and welfare and the natural resources of the state from pesticide pollution.
3. 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.
4. 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.
5. 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.
6. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan*.
7. The *Kansas Water Plan* and the Missouri 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.
8. The Federal Insecticide, Fungicide and Rodenticide Act authorizes the state to initiate the process of making label changes on the use, application and provision of environmental protection of pesticides.

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 TMDL is a Medium Priority consideration.

Effectiveness: Pesticide management has proven to be effective in reducing atrazine levels in Perry and Hillsdale lakes. Many voluntary approaches were promoted through the Pesticide Management Area established on the Delaware River Subbasin. Most of those producers raised corn. The key to effectiveness will be equivalent participation by grain sorghum producers in the Turkey Creek watershed. Equally important is similar participation by agricultural producers in Nebraska. Employing Best Management Practices can greatly reduce atrazine loss.

6. MONITORING

KDHE will continue to collect samples at Stations 601 and 234, in each of the three defined seasons over 2007-2011. Based on that sampling, the priority status for implementation will be evaluated in 2012. Should impaired status continue, the desired endpoints under this TMDL will be refined and more intensive sampling may need to be conducted over the period of 2012-2015 to assess progress in this TMDL's implementation.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Missouri Basin have been held since 2001. An active Internet Web site was established at www.kdheks.gov/tmdl/ to convey information to the public on the general establishment of TMDLs in the Missouri Basin and these specific TMDLs.

Public Hearing: A Public Hearing on these Missouri Basin TMDLs was held in Hiawatha on May 30, 2007.

Basin Advisory Committee: The Missouri Basin Advisory Committee met to discuss these TMDLs on June 26, 2006 in Atchison, December 1, 2006 and January 26, 2007 in Highland, March 16, 2007 in Atchison and May 14, 2007 in Hiawatha.

Milestone Evaluation: In 2012, evaluation will be made as to implementation of management practices to minimize the non-point source runoff contributing to this impairment. Subsequent decisions will be made regarding the implementation approach, priority of allotting resources for implementation and the need for additional or follow up implementation in this watershed at the next TMDL cycle for this basin in 2012.

Consideration for 303d Delisting: The river will be evaluated for delisting under Section 303d, based on the monitoring data over the period 2008-2015. Therefore, the decision for delisting will come about in the preparation of the 2016 303d list. Should modifications be made to the applicable water quality criteria during the 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 would come in 2007 which will emphasize revision of the Water Quality Management Plan. 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 2008-2015.

Revised 10/18/2007

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