



# Total Maximum Daily Load (TMDL) For Big Creek

## Pollutant: Sediment

**Name:** Big Creek

**Location:** Cass, Johnson, Jackson and Henry  
Counties, Missouri

**Hydrologic Unit Code (HUC):** 10290108-  
060, 070, 080, 160, 150

**Water Body Identifications (WBID):** 1250

**Missouri Stream Classification:** Class P<sup>1</sup>

### Beneficial Uses<sup>2</sup>:

- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life  
and Human Health associated with Fish Consumption
- Whole Body Contact Recreation – Category B

**Impairment:** Protection of Warm Water Aquatic Life

**Size of Impaired Segment:** 49 miles

**Location of Impaired Segment:** From (upstream) Section 29, T46N, R30W to (downstream)  
its mouth at the South Grand River in Section 34, T42N, R27W

**Pollutant Source:** Agricultural Nonpoint Sources

**Pollutant:** Sediment

**TMDL Priority Ranking:** High



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<sup>1</sup> Class P streams are streams that maintain permanent flow even in drought periods, see Missouri Water Quality Standards (WQS) 10 Code of State Regulations 20-7.031(1)(F). The WQS can be found at the following uniform resource locator (URL): [www.dnr.mo.gov/env/wpp/rules/index.html#Chap7](http://www.dnr.mo.gov/env/wpp/rules/index.html#Chap7).

<sup>2</sup> For Beneficial uses see 10 CSR 20-7.031(1)(C) and Table (H).

## 1. Introduction

This Big Creek Total Maximum Daily Load (TMDL) for sediment is being established in accordance with Section 303(d) of the Clean Water Act, because the State determined on the 1998 and 2002 303(d) lists of impaired waters that the water quality standards (WQS) for Big Creek were exceeded due to sediment. To meet the milestones of the 2001 Consent Decree, *American Canoe Association, et al. v. EPA*, No. 98-1195-CV-W in consolidation with No. 98-4282-CV-W, February 27, 2001, EPA is establishing this TMDL.

Big Creek was placed on the Missouri 303(d) list due to sedimentation. Little sediment data exists to directly document sediment as a significant impact to the stream. General fisheries data and the effect of sediment on fish were the initial data used to consider Big Creek for 303(d) listing. For this TMDL, sediment targets were derived using generalized information from the ecological drainage unit (EDU).

The purpose of a TMDL is to determine the pollutant loading a waterbody can assimilate without exceeding the WQS for that pollutant. The TMDL also establishes the pollutant load necessary to meet the WQS established for each waterbody based on the relationship between pollutant sources and in-stream water quality conditions. The TMDL consists of a wasteload allocation (WLA), a load allocation (LA), and margin of safety (MOS). The WLA is the fraction of the total pollutant load apportioned to point sources. The LA is the fraction of the total pollutant load apportioned to nonpoint sources. The MOS is a percentage of the TMDL that accounts for the uncertainty associated with the model assumption and data inadequacies.

## 2. Background and Water Quality Problems

### *Background*

Big Creek originates in southern Jackson County near Greenwood, approximately two miles from the Jackson/Cass County line. It flows southeast through Cass and Johnson Counties to its confluence with the South Grand River in Henry County. Big Creek is a sixth order stream with 76 stream miles, 61.3 miles of which are permanent stream. The lower 49 miles of Big Creek are listed as impaired by sediment. The Big Creek watershed is approximately 538 mi<sup>2</sup> with predominant landuse of approximately 41% grassland, 33% cropland and 12% deciduous forest (Appendix A).

Big Creek watershed lies within the South Grand Watershed, which lies within the Central Plains/Osage/South Grand EDU. The Osage Plains is comprised of gently rolling plains with scattered escarpments, low mounds and a low relative relief of 50-150 feet.<sup>3</sup> The South Grand Watershed occurs primarily within the Cherokee Prairies Soil Region which is described as "... underlain with shale, sandstone, and limestone. Soils formed in residuum from shale are deep claypan soils. Soils formed from sandstone and limestone are more loamy, but in places on

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<sup>3</sup> South Grand Watershed Inventory and Assessment, Missouri Department of Conservation West Plains, Missouri, June, 2004, <http://mdc.mo.gov/fish/watershed/sgrand/contents/360cotxt.htm>.

the ridges soils are shallow. Narrow bands of soils formed in deep loamy alluvium are adjacent to streams.” Historical land cover within the uplands of the South Grand Watershed primarily consisted of prairie with oak savannas and open oak woodlands in the more dissected areas along and near streams. Historic land cover in the wide alluvial plains in the valleys of some of the larger streams in the watershed, such as Big Creek, included a large amount of bottomland prairie with numerous wetlands such as marshes, shrub swamps, and oxbow lakes.<sup>4</sup> Most of Big Creek is typical of streams in the Central Plains/Osage/South Grand EDU with mostly steep banks and soft substrates littered with woody debris.<sup>5</sup> Precipitation from gage stations at Lee’s Summit, Appleton City, and Clinton indicates an estimated average annual precipitation of 41 inches within the South Grand Watershed for the period of 1915-1994.

### ***Water Quality Problems***

Big Creek was placed on the Missouri 303(d) list due to sedimentation. The number one pollutant entering Missouri’s waters is sediment, with about 59 million tons of soil eroding from Missouri’s land each year.<sup>6</sup> Sedimentation occurs when wind or water runoff carries soil particles from an area and transports them to a stream or lake. Excessive sedimentation clouds the water, which reduces the amount of sunlight reaching aquatic plants; covers fish spawning areas and food supplies; and clogs the gills of fish. In addition, other pollutants like phosphorus, pathogens, and heavy metals are often attached to the soil particles and wind up in the streams with the sediment.<sup>7</sup> Since little sediment data exists to directly document sediment as a significant impact to Big Creek, two Biological Assessments on Big Creek were conducted by MDNR’s Environmental Services Program (ESP) in fall 2003 and 2004 and spring 2004 and 2005; the data is shown in Appendix B.

The quality and quantity of habitat for aquatic life have been affected generally in Missouri. A combination of natural geology and land use in the prairie portions of the state (where Big Creek is located) is believed to have reduced the amount and impaired the quality of habitat for aquatic life. The major problems are excessive rates of sediment deposition due to stream bank erosion and sheet erosion from agricultural lands, loss of stream length and loss of stream channel heterogeneity due to channelization, and changes in basin hydrology that have increased flood flows and prolonged low flow conditions. Loss of tree cover in riparian zones has caused elevated water temperatures in summer and a reduction in woody debris, a critical aquatic habitat component in prairie streams. The most compelling evidence of loss or impairment of aquatic habitat is the historical change in distribution of fishes in Missouri. Many species of fish no longer appear in portions of the state where they once lived.

All waters of the State, as per Missouri WQS, must provide suitable conditions for aquatic life. The conditions include both the physical habitat and the quality of the water. TMDLs are not written to address habitat, but are written to correct water quality conditions.

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<sup>4</sup> South Grand Watershed Inventory and Assessment, Missouri Department of Conservation West Plains, Missouri, June, 2004, <http://mdc.mo.gov/fish/watershed/sgrand/contents/360cotxt.htm>.

<sup>5</sup> MDNR, Biological Assessment Report, Lower Big Creek, September 2004-March 2005.

<sup>6</sup> Missouri Soil and Water Districts Commission, March 2003, Needs Assessment, Plan To Address Identified Needs & A Summary To Date, <http://www.dnr.mo.gov/env/swcp/2003%20needs%20assessment.pdf>.

<sup>7</sup> Agricultural Nonpoint Source (AgNPS), Special Area Land Treatment (SALT) Program, NPS Problems, [http://www.dnr.mo.gov/env/swcp/service/Salt/nps\\_problems.htm#improper%20animal%20waste%20management](http://www.dnr.mo.gov/env/swcp/service/Salt/nps_problems.htm#improper%20animal%20waste%20management).

Because the water body addressed by this TMDL was assessed as to its biological function, many factors may have contributed to the impairment. The state of Missouri continues to do field evaluation, and in the future, may define the role sediment is playing in the potential biological impairment of Big Creek. However, the water quality condition for which Big Creek is currently listed is sedimentation; therefore, this TMDL addresses sediment. The state of Missouri may submit and EPA may approve another TMDL or a modified 303d listing for this water at a later time to address new information on the impairment.

### 3. Description of Sources

#### *Point Sources*

The human population within the South Grand Watershed was estimated to be 110,855 persons, according to the 2000 census. Population density in 2000 was approximately fifty-four persons per square mile as compared to the overall population density for Missouri which was approximately eighty-one persons per square mile. Influences on the Big Creek watershed from human activities include discharges associated with industrial and commercial activity, discharge from municipal separate storm sewer systems (MS4), the presence of trash from littering/dumping, and discharge or infiltration of sewage into the stream. Thirty-one water pollution incidents have been investigated in the South Grand Watershed since 1990. Fourteen of the thirty-one incidents resulted in fish kills. Half of the fish kills were associated with discharges from sewage treatment facilities. Five fish kills occurred on Middle Big Creek from 1992-1996, with causes documented as raw or partially treated sewage, elevated ammonia, low dissolved oxygen, and dewatering of the stream.<sup>8</sup> There are five Wastewater treatment facilities (WWTF) within the Big Creek Watershed with permits through the National Pollution Discharge Elimination System (NPDES): Kingsville Waste Water Stabilization Lagoon, Trophy Estates – Sanitary Sewer Dist #103, Pleasant Hill WWTF, Garden City Municipal WWTF, and Chilhowee Municipal WWTF (Appendix C).

Additional potential point sources of sediment include other NPDES-permitted facilities, including Concentrated Animal Feeding Operations (CAFO) (Table 1), quarries, and landfills, in the watershed. Suspended silts and small flakes of limestone were present in Big Creek during sampling after a rain event in spring 2004. The sampling data suggests that sediments may be entering Big Creek from stormwater runoff. Two potential point sources were identified: Dupuis Redi-Mix Concrete and Martin-Marietta Quarries.<sup>9</sup> Appendix C lists NPDES-permitted facilities within the Big Creek Watershed.

**Table 1.** NPDES-permitted CAFOs in Big Creek watershed.

Facility	NPDES Permit #	Livestock and Poultry	Design Animal Units
Howerton, John	MOG010364	Chicken broilers	996
Hunt, Jeff	MOG010030	Hogs and pigs	2595

<sup>8</sup> South Grand Watershed Inventory and Assessment, Missouri Department of Conservation, West Plains, Missouri, June, 2004.

<sup>9</sup> MDNR, Biological Assessment Report, Lower Big Creek, September 2003-March 2004.

## Nonpoint Sources

The main source of sediment is believed to be runoff from agricultural nonpoint sources. Problems from agricultural runoff include turbidity, sedimentation, low dissolved oxygen (DO), high nitrogen and phosphorous concentrations, high ammonia and high fecal coliform counts. Approximately one-third of the land cover in the Big Creek Watershed is cropland. Much of the impaired segment of Big Creek is near or adjacent to cropland (Appendix A) which could contribute to sediment loading of the streams. The agricultural areas of the basin also contain livestock which are not held in permitted CAFOs, see Table 2. The settling of solids in Big Creek may be increased by debris dams and hydrologic alterations causing deposition during low flow. General observations during sampling in the fall of 2003 revealed what appeared to be organic fine sediment in the stream substrate below a large debris dam.<sup>10</sup>

**Table 2.** Agriculture Census County Summary for Cass, Henry, Johnson and Jackson Counties, 2002<sup>11</sup>.

Livestock and Poultry	Animal Units per County			
	Cass	Henry	Johnson	Jackson
Cattle and calves	51,923	66,521	78,942	16,149
Beef cows	25,617	33,110	39,195	(D)
Milk cows	795	1,007	1,306	(D)
Hogs and pigs	24,773	46,653	4,835	470
Sheep and lambs	404	282	1,161	372
Layers 20 wks old and older	1,562	19,845	(D)	1,320
Broilers sold	226	(D)	2,354	8,044

(D) Withheld to avoid disclosing data for individual farms.

Hydrology and channel form of streams in the basin have been altered. Within the South Grand Watershed in Missouri, potential nonpoint sources of impairment of aquatic life include:

- 129 dams , nearly all of which are reinforced earth structures with heights ranging from 10 to 64 feet,
- 42 miles of levees associated with the flood plains of fourth order and larger streams, most of which are located in the agricultural areas of the Lower South Grand and Big Creek flood plains,
- and approximately 172 miles of channelized streams , the majority of these streams are located in the Middle South Grand and Lower Big Creek hydrologic units. The longest channelized stream sections occur on the main stems of the South Grand River and Big Creek.<sup>12</sup>

Big Creek was identified on the 303d list as having significant amounts of channelization. Soil conservation activities and implementation of Best Management Practices (BMP) has resulted in

<sup>10</sup> MDNR, Biological Assessment Report, Lower Big Creek, September 2003-March 2004.

<sup>11</sup> Census of Agriculture, Volume 1 Chapter 2: Missouri County Level Data, 2002, <http://www.nass.usda.gov/census/census02/volume1/mo/index2.htm>

<sup>12</sup> South Grand Watershed Inventory and Assessment, Missouri Department of Conservation West Plains, Missouri, June, 2004, <http://mdc.mo.gov/fish/watershed/sgrand/contents/360cotxt.htm>.

an annual decline in soil erosion in Missouri since 1982.<sup>13</sup> Soil conservation activities (as of 2002) in the South Grand Watershed, of which Big Creek is part, include: 3 Special Area Land Treatment Projects (SALT) with 11,013 acres being treated, a total of 21,753 acres are enrolled in the Conservation Reserve Program (CRP) or Conservation Reserve Enhancement Program (CREP), and 1,673 acres enrolled in the Wetlands Reserve Program.<sup>14</sup>

#### **4. Description of the Applicable Water Quality Standards and Numeric Water Quality Targets**

##### ***Beneficial Uses***

The designated uses of Big Creek, WBID 1250, are:

- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life and Human Health associated with Fish Consumption
- Whole Body Contact Recreation – Category B

The stream classifications and designated uses may be found at 10 CSR20-7.031(1)(C) and (F) and Table H.

##### ***Use that is impaired***

- Protection of Warm Water Aquatic Life

##### ***Anti-degradation Policy***

Missouri's WQS include the U.S. Environmental Protection Agency's (EPA) "three-tiered" approach to anti-degradation, and may be found at 10 CSR 20-7.031(2).

Tier 1 – Protects existing uses and provides the absolute floor of water quality for all waters of the United States. Existing instream water uses are those uses that were attained on or after November 29, 1975, the date of EPA's first WQS Regulation, or uses for which existing water quality is suitable unless prevented by physical problems such as substrate or flow.

Tier 2 – Protects the level of water quality necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water in waters that are currently of higher quality than required to support these uses. Before water quality in Tier 2 waters can be lowered, there must be an antidegradation review consisting of: (1) a finding that it is necessary to accommodate important economical or social development in the area where the waters are

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<sup>13</sup> Missouri Soil and Water Districts Commission, March 2003, Needs Assessment, Plan To Address Identified Needs & A Summary To Date, <http://www.dnr.mo.gov/env/swcp/2003%20needs%20assessment.pdf>.

<sup>14</sup> South Grand Watershed Inventory and Assessment, Missouri Department of Conservation West Plains, Missouri, June, 2004, <http://mdc.mo.gov/fish/watershed/sgrand/contents/360cotxt.htm>.

located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and BMPs for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the “fishable/swimmable” uses and other existing uses.

Tier 3 – Protects the quality of outstanding national resources, such as waters of national and state parks, wildlife refuges and waters of exceptional recreational or ecological significance. There may be no new or increased discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality (with the exception of some limited activities that result in temporary and short-term changes in water quality).

### ***Specific Criteria***

The impairment of this waterbody is based on exceedence of the general, or narrative, criteria contained in Missouri’s WQS, 10 CSR 20-7.031(3)(A), (C) and (G).

- (A) Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses.
- (C) Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor or prevent full maintenance of beneficial uses.
- (G) Waters shall be free from physical, chemical or hydrologic changes that would impair the natural biological community.

When the WQS is expressed as a narrative value, a measurable indicator of the pollutant may be selected to express the narrative as a numeric value. There are many quantitative indicators of sediment, such as, total suspended solids (TSS), turbidity, and bedload sediment, which are appropriate to describe sediment in rivers and streams.<sup>15</sup> TSS was selected as the numeric target for this TMDL because it enables the use of the highest quality data available, including permit conditions and monitoring data.

## **5. Calculation of Load Capacity**

Load capacity (LC) is defined as the maximum pollutant load that a waterbody can assimilate and still attain WQS. This total load is then divided among a WLA for point sources, a LA for nonpoint sources and a MOS. The LC for this TMDL has been defined as a curve over the range of flows for Big Creek, see Figure 1, where the solid (red) curve is the TMDL. Turbidity measurements taken during the biological assessment were used to estimate TSS concentrations using relationships developed by Doisey and Rabeni (2004)<sup>16</sup>. These estimates,

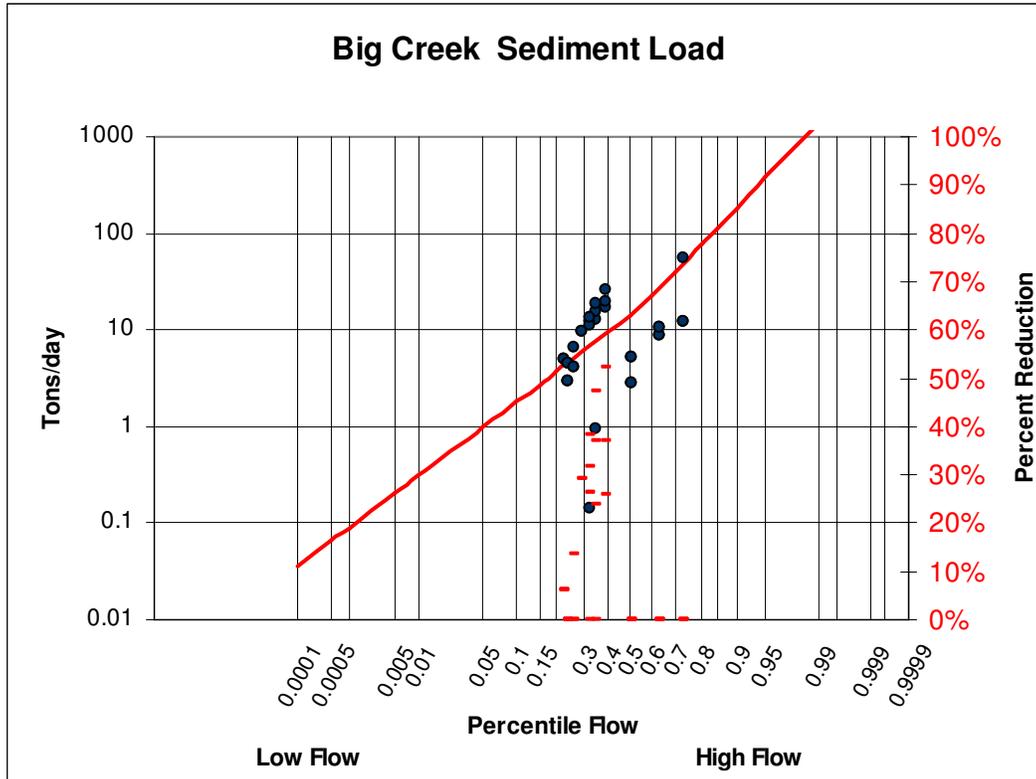
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<sup>15</sup> Framework for Developing Suspended and Bedded Sediments (SABS) Water Quality Criteria, U.S. Environmental Protection Agency, EPA-822-R-06-001, May 2006.

<sup>16</sup> Effects of Suspended Sediment on Native Missouri Fishes: A Literature Review and Synthesis, K.E. Doisey and C.F. Rabeni, 2004, University of Missouri.

along with measured TSS concentrations, are shown in figure 1, where the round (black) points are loads calculated from the estimated concentrations and the corresponding horizontal bars (red) points are percent reduction to meet the TMDL.

**Figure 1.** TMDL curve over the range of flows.



### ***Modeling Approach***

In cases where pollutant data for the impaired stream is not available a reference approach is used. In this approach, the target for pollutant loading is the 25<sup>th</sup> percentile of the current EDU condition calculated from all data available within the EDU in which the waterbody is located. Therefore, the 25<sup>th</sup> percentile is targeted as the TMDL load duration curve. For a full description of the development of suspended sediment targets using reference load duration curves refer to Appendix D. For Big Creek flow estimate and source data for the reference EDU refer to Appendix E.

### **6. Load Allocation (Nonpoint Source Loads)**

LA is the allowable amount of the pollutant that can be assigned to nonpoint sources. The LA is set at 90% of the TMDL, leaving 10% of the TMDL as a MOS. For example, at median flow (0.5 percentile flow) the TMDL is approximately 14 tons/day, so the LA would be approximately 12.6 tons/day.

## 7. Waste Load Allocation (Point Source Loads)

WLA is the allowable amount of the pollutant that can be assigned to point sources. The WLA is set to the lesser of current permit limits or technology based effluent limits (TBELs). TBELs are defined in a permit based on facility type. Mechanical WWTFs' permit limits are a weekly average TSS concentration of 45 mg/L and a monthly average TSS concentration of 30 mg/L. Secondary equivalent WWTFs' permit limits are a weekly average TSS concentration of 60 mg/L and a monthly average TSS concentration of 45 mg/L. Waste water treatment lagoon facilities' permit limits are up to a weekly average TSS concentration of 120 mg/L and a monthly average TSS concentration of 80 mg/L. Additionally, permits can be written to target lower limits if the specific facility is capable of performance exceeding TBELs. Table 3 lists the permitted point sources in the watershed and WLAs based on their current permit limits and permitted design flows. In addition, any general permits need evaluation to determine if a site specific permit is needed to address sediment loading. Based on the assessment of sources, point sources do not contribute to water quality impairment relative to sediment impacts on stream biology. Thus, the WLAs are zero percentage net reduction in sediment load. These facilities' WLAs are set at the current permit limits and conditions. The WLAs listed in this TMDL do not preclude the establishment of future point sources of sediment loading in the watershed. Any future point sources should be evaluated in light of the TMDL established and the range of flows into which any additional load will impact.

All permitted CAFOs are non-discharging permits and therefore their WLAs are set at zero.

The small MS4 permit for the City of Lee's Summit (NPDES permit #MOR040016) has only one outlet that discharges to Big Creek. The permit conditions of the MS4 contain BMPs that are designed to reduce pollutant loads to the maximum extent practicable. The WLA for the MS4 is therefore set at current conditions plus inclusion of the BMPs.

There are six quarries in the Big Creek watershed (Table 3). These operations are not expected to contribute to the sediment impairment if they are following a well conceived sediment control plan. BMPs should clearly be implemented as part of the permit conditions. The existing state "General Permit" for quarries requires sediment and erosion control sufficient to prevent pollution to waters of the state and comply with the effluent limitations and other permit conditions. This may require the construction of properly designed sediment basins or other treatment structures. However, site-specific BMPs are not currently defined; future permits should reflect BMPs to achieve the general permit requirements.

The City of Lee's Summit has a landfill (NPDES permit #MO-0110876) that discharges stormwater to Tributary of Big Creek. This operation is not expected to significantly contribute to the sediment impairment if it's following a well conceived sediment control plan. BMPs should clearly be implemented as part of the permit conditions.

**Table 3.** Waste Load Allocations for point sources of sediment in Big Creek watershed.

Facility	NPDES Permit	Design Flow (MGD)	WLA (tons/day) d/w/m*
<b>WWTF</b>			
Kingsville WW Stabilization Lagoon	MO-0025844	0.051	NA / 0.0234 / 0.0149
Pleasant Hill WWTF	MO-0058629	0.73	NA / 0.1370 / 0.0913
Chilhowee Municipal WWTF	MO-0096091	0.06	NA / 0.0300 / 0.0200
Garden City Municipal WWTF	MO-0046647	0.144	NA / 0.0661 / 0.0420
East Lynne WW Stab Lagoon	MO-0099961	0.038	Under Review**
<b>Landfill</b>			
Lee's Summit Landfill	MO-0110876	44	inclusion of BMPs
<b>Quarry / Concrete</b>			
Dupuis Redi Mix Concrete	MOG490315	Limestone and rock quarries	non-storm water discharges TSS 70mg/L, storm water discharges SS*** daily max. 1.5mL/L/Hr, inclusion of BMPs
Martin-Marietta, Greenwood Quarry	MOG490060		
Whistle Redi Mix	MOG490283		
Geiger Ready Mix Inc	MOG490796		
Hilty Quarries Inc	MOG490964		
Limpus Quarries Inc #3	MOG490095		
<b>CAFO</b>			
Howerton, John	MOG010364	Non-discharging	0
Hunt, Jeff	MOG010030	Non-discharging	0
<b>Cass County – Other Facilities</b>			
Garden City Water Treatment Plant	MOG640086	Water treatment plant filter backwash	Max. daily SS 1.0mL/L/Hr, inclusion of BMPs
E Z Stop Inc	MOG350114	Above ground storage of petroleum products	Storm water discharge, implementation of Storm water pollution prevention plan (SWPP) required
Truninger Bros Septic Tank	MOG821060	Land application of domestic septage onto agricultural land	Non-discharging
Truninger Bros Septic Tank	MOG821061		
Country Creek Estates WWTP	MO-0112461	0.01375	NA / 0.0063 / 0.0040
MEP, Pleasant Hill – Aries Power Plant	MO-0124940	1.8	0.7506 / NA / 0.3753
<b>Jackson County – Other Facilities</b>			
Trophy Est. Sanitary Sewer Dist #103	MO-0107476	0.021	NA / 0.0039 / 0.0026
Butterbaugh MHP	MO-0089931	0.024	NA / 0.0110 / 0.0070
Lee's Summit Elem School #14	MO-0125351	0.009492	NA / 0.0018 / 0.0012
Lee's Summit Yard Waste	MOG970004	Yard waste composting	Non-discharging, 110 <sub>d</sub> /70 <sub>m</sub> TSS, storm water, inclusion of BMPs
Raintree Lake Community Swimming Pool	MOG760038	Swimming pool drainage	Non-discharging filter wash
Pfizer, Inc – Animal Health	MO-0118125		Under Review
Lee's Summit Small MS4, outfall #9	MOR040016	Small MS4	inclusion of BMPs

\*Permit limits based on current design loads where d=daily, w=weekly average, m=monthly average.

\*\*Permit currently under review by Missouri Department of Natural Resources.

\*\*\*Settleable Solids.

## 8. Margin of Safety

A MOS is added to a TMDL to account for the uncertainties inherent in the calculations and data gathering. The MOS is intended to account for such uncertainties in a conservative manner. Based on EPA guidance, the MOS can be achieved through one of two approaches:

- (1) Explicit – Reserve a numeric portion of the loading capacity as a separate term in the TMDL.
- (2) Implicit – Incorporate the MOS as part of the critical conditions for the waste WLA and the LA calculations by making conservative assumptions in the analysis.

Available data for Big Creek shows instances where load exceeds the TMDL (Figure 1). To account for uncertainties in the modeling an explicit 10% MOS is assigned to this TMDL.

## 9. Seasonal Variation

The TMDL curve represents all flow conditions, hence all seasons. Bioassessment data used in this TMDL was generated by MDNR's ESP; invertebrate sampling was collected for two seasons, fall 2003 and 2004 and spring 2004 and 2005 (Appendix B).

## 10. Monitoring

No future monitoring has been scheduled for Big Creek at this time. However, Missouri Department of Natural Resources will routinely examine physical habitat, water quality, invertebrate community, and fish community data collected by the Missouri Department of Conservation under its Resource Assessment and Monitoring (RAM) Program. This program randomly samples streams across Missouri on a five to six year rotating schedule.

## 11. Public Participation

EPA regulations, 40 CFR 130.7, require that TMDLs be subject to public review. EPA is providing public notice of this TMDL for Big Creek on the EPA, Region 7, TMDL website: [http://www.epa.gov/region07/water/tmdl\\_public\\_notice.htm](http://www.epa.gov/region07/water/tmdl_public_notice.htm). The response to comments and final TMDL will be available at: <http://www.epa.gov/region07/water/apprtmdl.htm#Missouri>.

This water quality limited segment of Big Creek in Cass, Johnson, Jackson and Henry Counties, Missouri, is included on the approved 1998 and 2002 303(d) lists for Missouri. This TMDL is being produced by EPA to meet the requirements of the 2001 Consent Decree, *American Canoe Association, et al. v. EPA*, No. 98-1195-CV-W in consolidation with No. 98-4282-CV-W, February 27, 2001. EPA is developing this TMDL in cooperation with the State of Missouri, and EPA is establishing this TMDL at this time to fulfill the *American Canoe* consent decree obligations. Missouri may submit and EPA may approve another TMDL for this water at a later time.

As part of the public notice process, MDNR will assist EPA by providing a distribution list of interested persons to which EPA will provide an announcement of the Big Creek TMDL. Groups that receive the public notice announcement will include the Missouri Clean Water Commission, the Missouri Water Quality Coordinating Committee, Stream Team Volunteers in the counties, county legislators, and potentially impacted cities, towns and facilities. The EPA public noticed this TMDL from August 25, 2006, to September 25, 2006, and the Summary of response to Comment(s) is posted on the EPA website:  
<http://www.epa.gov/region07/water/apprtmdl.htm#Missouri>.

## 12. References

- Agricultural Nonpoint Source (AgNPS), Special Area Land Treatment (SALT) Program, NPS Problems,  
[http://www.dnr.mo.gov/env/swcp/service/Salt/nps\\_problems.htm#improper%20animal%20waste%20management](http://www.dnr.mo.gov/env/swcp/service/Salt/nps_problems.htm#improper%20animal%20waste%20management).
- Biological Assessment, Big Creek, Cass County, Missouri, 2003-2004, Missouri Department of Natural Resources.
- Biological Assessment, Lower Big Creek, Henry, Johnson, and Cass Counties, September 2004-March 2005, Missouri Department of Natural Resources.
- Effects of Suspended Sediment on Native Missouri Fishes: A Literature Review and Synthesis, K.E. Doisey and C.F. Rabeni, 2004, University of Missouri.
- Framework for Developing Suspended and Bedded Sediments (SABS) Water Quality Criteria, U.S. Environmental Protection Agency, EPA-822-R-06-001, May 2006.
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<http://www.dnr.mo.gov/env/swcp/2003%20needs%20assessment.pdf>.
- South Grand Watershed Inventory and Assessment, Missouri Department of Conservation West Plains, Missouri, June, 2004,  
<http://mdc.mo.gov/fish/watershed/sgrand/contents/360cotxt.htm>.

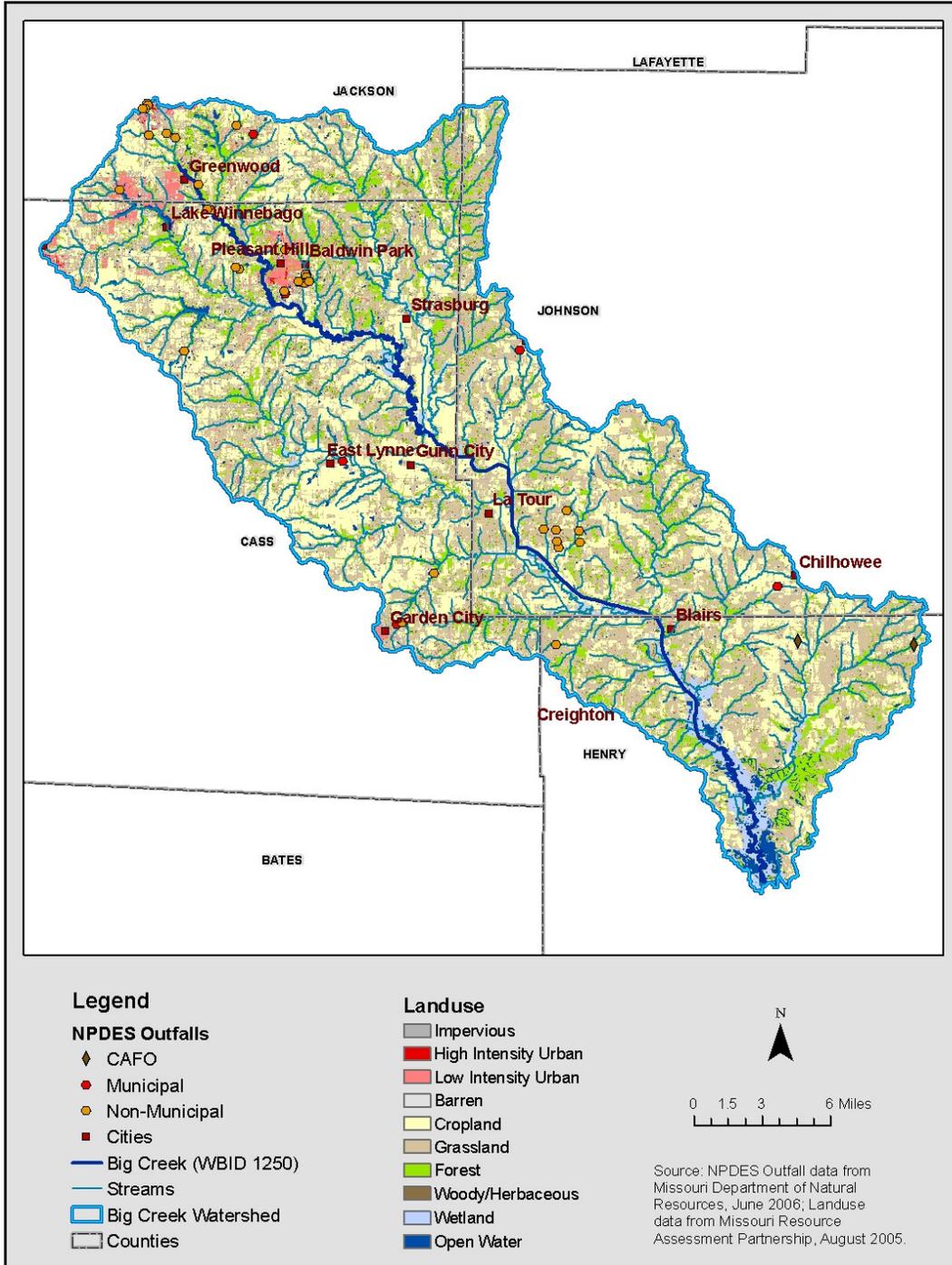
## 13. Appendices

- Appendix A – Map Of Big Creek Watershed And Impaired Segment – WBID 1250  
Appendix B – Big Creek Invertebrate Data  
Appendix C – Facilities with NPDES permits in Big Creek Watershed  
Appendix D – Development of Pollutant Targets using Reference Load Duration Curves  
Appendix E – Big Creek Flow Estimate and Source Data for Reference EDU

Appendix F – Missouri Department of Natural Resources Total Maximum Daily Load  
Information Sheet For Streams with Aquatic Habitat Loss that are Listed for Sediment

# Appendix A

## Map Of Big Creek Watershed And Impaired Segment – WBID 1250



## Appendix B

### Big Creek Invertebrate Data

Location; Site #	Year	Season	Score
Sec.30,46,30; 1	2003	Fall	18
Sec.30,46,30; 1	2004	Spring	16
Sec.18,46,30; 2	2003	Fall	12
Sec.18,46,30; 2	2004	Spring	16
Sec. 2,46,31; 3	2003	Fall	18
Sec. 2,46,31; 3	2004	Spring	18
Sec. 7,45,29; n/a	1998	Spring	20
Sec. 7,45,29; n/a	1998	Fall	20
Sec. 36, 46,30; 6	2004	Fall	20
Sec. 36, 46,30; 6	2005	Spring	18
Sec. 7,45,29; 5	2004	Fall	20
Sec. 7,45,29; 5	2005	Spring	18
Sec. 35,45,29; 4	2004	Fall	20
Sec. 35,45,29; 4	2005	Spring	20
Sec.29,44,28; 3	2004	Fall	20
Sec.29,44,28; 3	2005	Spring	20
Sec.30, 43,27; 2	2004	Fall	20
Sec.30, 43,27; 2	2005	Spring	18
Sec.16,42,27; 1	2004	Fall	20
Sec.16,42,27; 1	2005	Spring	16

Invertebrate scores of 16 or greater are judged to indicate unimpaired streams. Scores less than 16 are judged to be impaired.

## Appendix C

### Facilities with NPDES permits in Big Creek Watershed

<b>Facility</b>	<b>NPDES Permit #</b>	<b>Design Flow (MGD)</b>
<b>WWTF</b>		
Kingsville WW Stabilization Lagoon	MO-0025844	0.051
Pleasant Hill WWTF	MO-0058629	0.73
Chilhowee Municipal WWTF	MO-0096091	0.06
Garden City Municipal WWTF	MO-0046647	0.144
East Lynne WW Stab Lagoon	MO-0099961	0.038*
<b>Landfill</b>		
Lee's Summit Landfill	MO-0110876	44
<b>Quarry / Concrete</b>		
Dupuis Redi Mix Concrete	MOG490315	Limestone and rock quarries, concrete, glass and asphalt
Martin-Marietta, Greenwood Quarry	MOG490060	
Whistle Redi Mix	MOG490283	
Geiger Ready Mix Inc	MOG490796	
Hilty Quarries Inc	MOG490964	
Limpus Quarries Inc #3	MOG490095	
<b>CAFO</b>		
Howerton, John	MOG010364	Non-discharging
Hunt, Jeff	MOG010030	
<b>Cass County – Other Facilities</b>		
Garden City Water Treatment Plant	MOG640086	Water treatment plant filter backwash
E Z Stop Inc	MOG350114	Above ground storage of petroleum products
Truninger Bros Septic Tnk	MOG821060	Land application of domestic septage onto agricultural land
Truninger Bros Septic Tnk	MOG821061	
Country Creek Est WWTP	MO-0112461	0.01375
MEP, Pleasant Hill – Aries Power Plant	MO-0124940	1.8
<b>Jackson County – Other Facilities</b>		
Trophy Estates – Sanitary Sewer Dist #103	MO-0107476	0.021
Butterbaugh MHP	MO-0089931	0.024
Lee's Summit Elem School #14	MO-0125351	0.009
Lee's Summit Yard Waste	MOG970004	Yard waste composting
Raintree Lake Community S	MOG760038	Swimming pool drainage
Pfizer, Inc – Animal Health	MO-0118125	*
Lee's Summit Small MS4, outfall #9	MOR040016	Small MS4

\*Permit currently under review by MDNR

## **Appendix D**

### **Development of Pollutant Targets using Reference Load Duration Curves**

#### **Overview**

This procedure is used when a lotic system is placed on the 303(d) impaired waterbody list for a pollutant and the designated use being addressed is aquatic life. In cases where pollutant data for the impaired stream is not available a reference approach is used. The target for pollutant loading is the 25<sup>th</sup> percentile calculated from all data available within the ecological drainage unit (EDU) in which the waterbody is located. Additionally, it is also unlikely that a flow record for the impaired stream is available. If this is the case a synthetic flow record is needed. In order to develop a synthetic flow record calculate an average of the log discharge per square mile of USGS gaged rivers for which the drainage area is entirely contained within the EDU. From this synthetic record develop a flow duration from which to build a load duration curve for the pollutant within the EDU.

From this population of load durations follow the reference method used in setting nutrient targets in lakes and reservoirs. In this methodology the average concentration of either the 75<sup>th</sup> percentile of reference lakes or the 25<sup>th</sup> percentile of all lakes in the region is targeted in the TMDL. For most cases available pollutant data for reference streams is also not likely to be available. Therefore follow the alternative method and target the 25<sup>th</sup> percentile of load duration of the available data within the EDU as the TMDL load duration curve. During periods of low flow the actual pollutant concentration may be more important than load. To account for this during periods of low flow the load duration curve uses the 25<sup>th</sup> percentile of EDU concentration at flows where surface runoff is less than 1% of the stream flow. This results in an inflection point in the curve below which the TMDL is calculated using this reference concentration.

#### **Methodology**

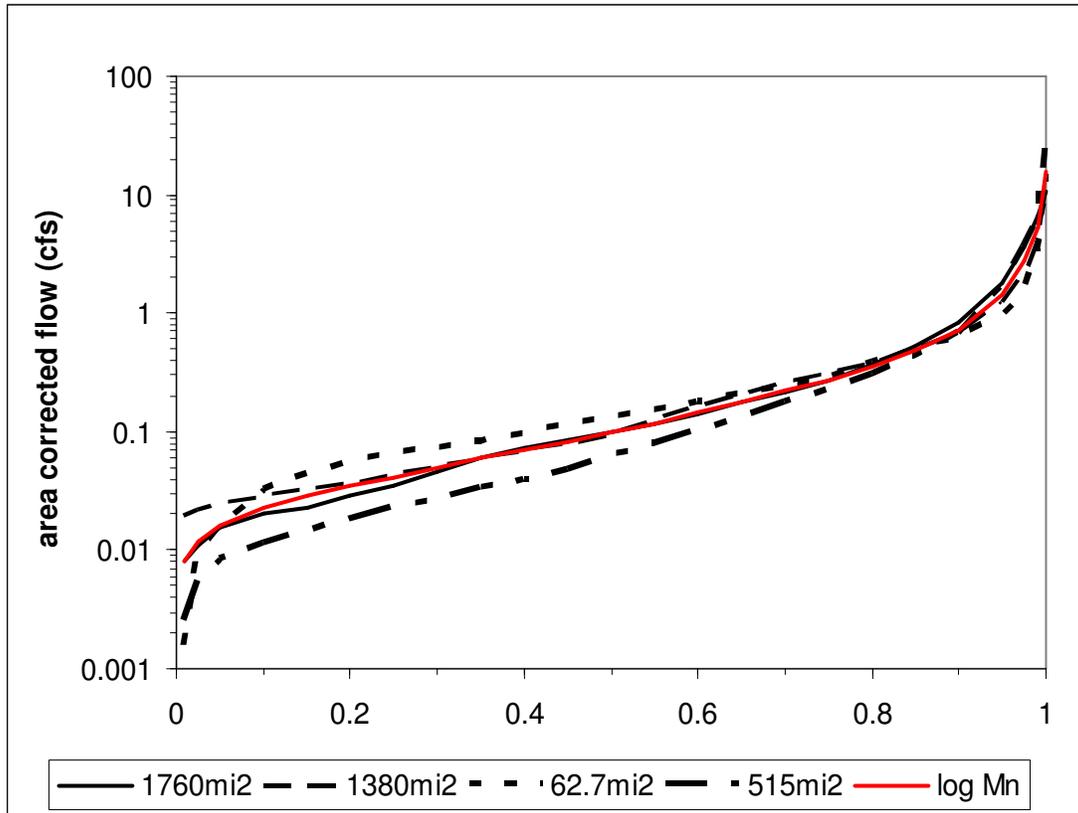
The first step in this procedure is to locate available pollutant data within the EDU of interest. These data along with the instantaneous flow measurement taken at the time of sample collection for the specific date are recorded to create the population from which to develop the load duration. Both the date and pollutant concentration are needed in order to match the measured data to the synthetic EDU flow record.

Secondly, collect average daily flow data for gages with a variety of drainage areas for a period of time to cover the pollutant record. From these flow records normalize the flow to a per square mile basis. Average the log transformations of the average daily discharge for each day in the period of record. For each gage record used to build this synthetic flow record calculate the Nash-Sutcliffe statistic to determine if the relationship is valid for each record. This relationship must be valid in order to use this methodology. This new synthetic record of flow per square

mile is used to develop the load duration for the EDU. The flow record should be of sufficient length to be able to calculate percentiles of flow.

The following examples show the application of the approach to one Missouri EDU.

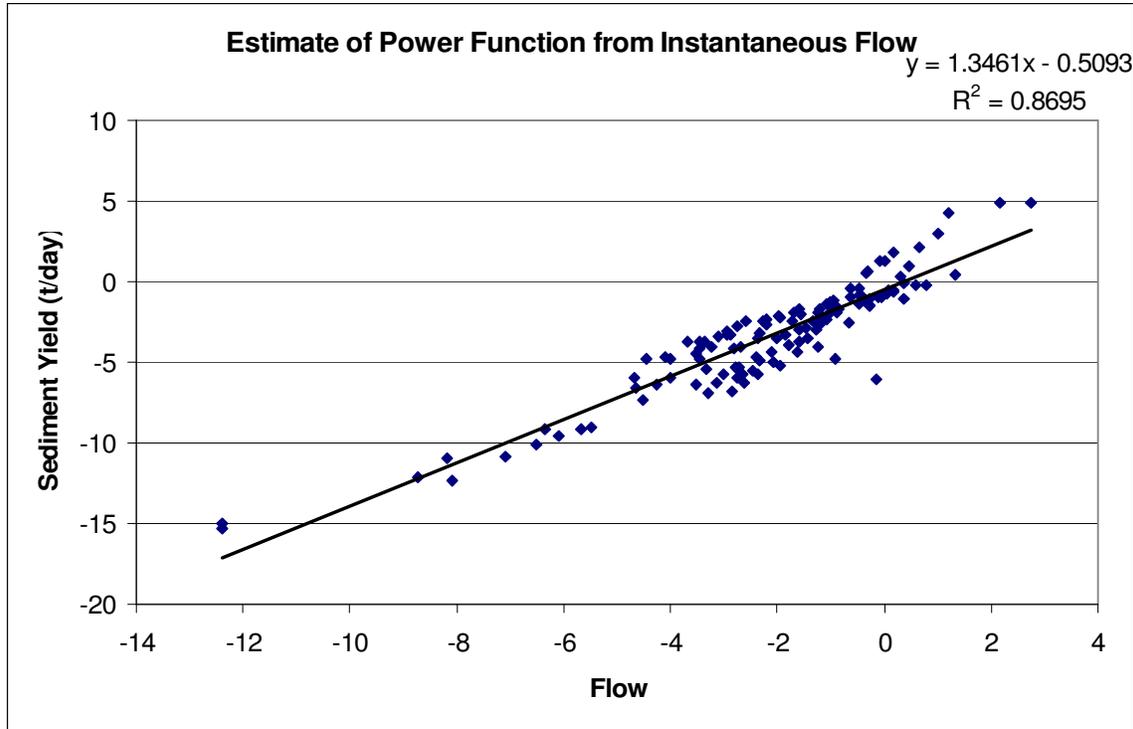
The watershed-size normalized data for the individual gages in the EDU were calculated and compared to a pooled data set including all of the gages. The result of this analysis is displayed in the following figure and table:



Gage	gage	area (mi <sup>2</sup> )	normal Nash-Sutcliffe	lognormal Nash-Sutcliffe
Platte River	06820500	1760	80%	99%
Nodaway River	06817700	1380	90%	96%
Squaw Creek	06815575	62.7	86%	95%
102 River	06819500	515	99%	96%

This demonstrates the pooled data set can confidently be used as a surrogate for the EDU analyses.

The next step is to calculate pollutant-discharge relationships for the EDU, these are log transformed data for the yield (tons/mi<sup>2</sup>/day) and the instantaneous flow (cfs/mi<sup>2</sup>.) The following graph shows the EDU relationship:



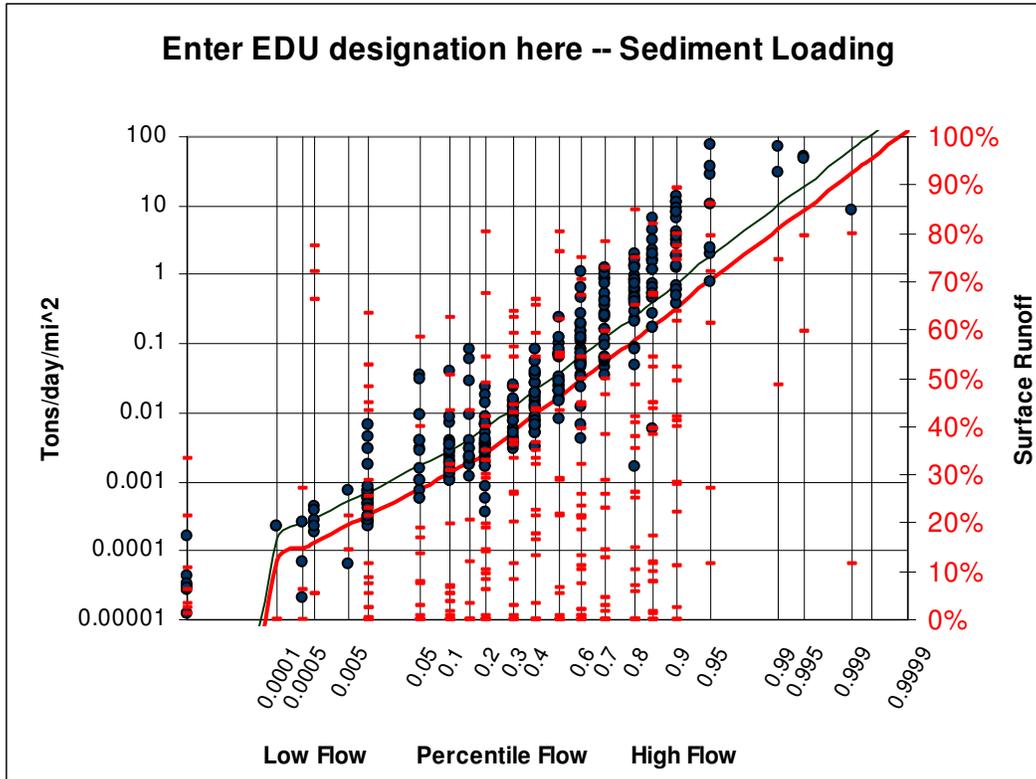
Further statistical analyses on this relationship are included in the following Table:

m	1.34608498	b	-0.509320019
Standard Error (m)	0.04721684	Standard Error (b)	0.152201589
r <sup>2</sup>	0.86948229	Standard Error (y)	1.269553159
F	812.739077	DF	122
SSreg	1309.94458	SSres	196.6353573

The standard error of y was used to estimate the 25%ile level for the TMDL line. This was done by adjusting the intercept (b) by subtracting the product of the one-sided Z<sub>75</sub> statistic times the standard error of (y). The resulting TMDL Equation is the following:

$$\text{Sediment yield (t/day/mi}^2\text{)} = \exp(1.34608498 * \ln(\text{flow}) - 1.36627)$$

A resulting pooled TMDL of all data in the watershed is shown in the following graph:



To apply this process to a specific watershed would entail using the individual watershed data compared to the above TMDL curve that has been multiplied by the watershed area. Data from the impaired segment is then plotted as a load (tons/day) for the y-axis and as the percentile of flow for the EDU on the day the sample was taken for the x-axis.

For more information contact:  
 Environmental Protection Agency, Region 7  
 Water, Wetlands, and Pesticides Division  
 Total Maximum Daily Load Program  
 901 North 5<sup>th</sup> Street  
 Kansas City, Kansas 66101  
 Website: <http://www.epa.gov/region07/water/tmdl.htm>

## Appendix E

### Big Creek Flow Estimate and Source Data for Reference EDU

#### Estimated Flow for Range of Percentiles at the Impaired Segment Outlet

	Percentile of Flow	Discharge (cubic feet per second)
Flow estimate for Big Creek based on drainage area and synthetic ecological drainage unit flow.	10	10.4
	30	35.5
	50	80.1
	70	177
	90	539

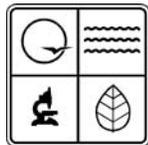
USGS stream gages used to generate synthetic flow:

Big Bull nr Hillsdale KS	06915000
Osage River abv Schell City	06918070
Turnback Creek abv Greenfield	06918460
Cedar Creek nr Pleasant View	06919500
South Grand River at Archie	06921590
South Grand River nr Clinton	06921760

USGS stream sample sites used to generate EDU TMDL:

South Grand River nr Clinton	06921760
Osage River abv Schell City	06918070
Marais des Cygnes R nr KS-MO State Line	06916600
L Osage River at Fulton KS	06917000
Dry Wood Creek nr Deerfield MO	06917680
South Grand River below Freeman MO	06921582
South Grgand River at Urich MO	06921600

## Appendix F



Missouri Department of Natural Resources

# Total Maximum Daily Load Information Sheet

## For Streams with Aquatic Habitat Loss that are Listed for Sediment

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### Waterbody Segment at a Glance:

**Location:** Streams in Northern and West Central Missouri and in the Mississippi Embayment of Southeast Missouri and the Missouri and Mississippi Rivers.

**Impairment:** In 1998 the Department of Natural Resources listed 38 streams with habitat impairment due to agricultural nonpoint source problems. Twelve of them were delisted because new data showed they were higher quality reference streams, not impaired by sediment. One of them was retained on the list for “unknown” pollutants. The other 25 of them appear on the 2002 US EPA 303(d) list for Missouri as being impaired by “sediment”.

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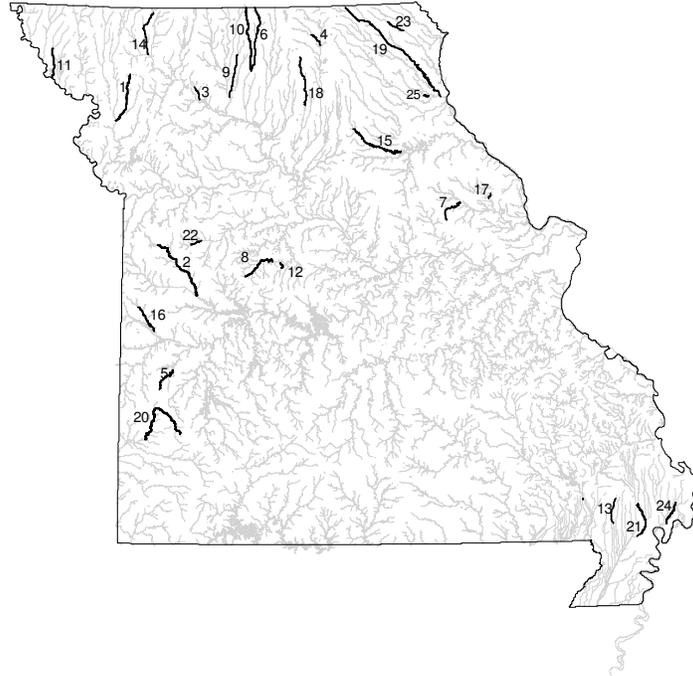
### Description of the Problem

All of these waters, as per Missouri Water Quality Standards, must provide a suitable home for aquatic life. A combination of natural geology and land use in the prairie portions of the state and the Mississippi Embayment is believed to have reduced the amount and impaired the quality of aquatic habitat. The major problems are excessive rates of sediment deposition due to streambank erosion and sheet erosion from agricultural lands, loss of stream length and loss of stream channel heterogeneity due to channelization, and changes in basin hydrology that have increased flood flows and prolonged low flow conditions. Loss of tree cover in riparian zones has caused elevated water temperatures in summer and a reduction in woody debris, a critical aquatic habitat component in prairie streams. The most compelling evidence of loss or impairment of aquatic habitat is the historical change in distribution of fishes in Missouri. Many species of fish no longer appear in portions of the state where they once lived.

The department proposed changing the listing of “sediment” to “habitat loss.” This change was proposed because sediment is often an important, but certainly not the only, pollutant or condition causing degradation of aquatic habitat in these streams. With this proposed change, other problems such as channelization, alteration of streambanks and riparian zones, and alteration of normal flow regimes would be included as conditions contributing to impairment. The US Environmental Protection Agency denied this change because habitat loss is “pollution”, not a specific “pollutant” that can be measured and calculated. This is necessary because a TMDL (Total Maximum Daily Load) is a numeric calculation.

The department is developing a sediment protocol to determine if sediment is actually the pollutant in these streams and a standard way to measure sediment.

## Missouri Streams with Loss of Habitat due to Agricultural Non-Point Source Pollution



#	Waterbody	County (lower section)	Miles affected	#	Waterbody	County (lower section)	Miles affected
1	3 <sup>rd</sup> Fork Platte River	Buchanan	31.5	14	M. Fork Grand River	Gentry	25
2	Big Creek	Henry	49	15	M. Fork Salt River	Monroe	49
3	Big Muddy Creek	Daviess	8	16	Miami Creek	Bates	18
4	Clear Creek	Adair	10.5	17	Mill Creek	Lincoln	4
5	Clear Creek	Vernon	18	18	Mussel Fork	Macon	29
6	E. Fork Medicine Cr.	Grundy	36	19	N. Fabius River	Marion	82
7	Elkhorn Creek	Montgomery	19	20	N. Fork Spring River	Jasper	51.5
8	Flat Creek	Pettis	20	21	Old Channel Little R.	New Madrid	20
9	Honey Creek	Livingston	23	22	S. Fork Blackwater R.	Johnson	5
10	Little Medicine Creek	Grundy	40	23	S. Wyaconda River	Clark	9
11	Little Tarkio Creek	Holt	17.5	24	Spillway Ditch	New Madrid	13.5
12	Lake Creek	Pettis	5	25	Troublesome Creek	Marion	3.5
13	Lateral #2 Main Ditch	Stoddard	11.5				

**For more information call or write:**

Missouri Department of Natural Resources  
 Water Protection Program  
 P.O. Box 176, Jefferson City, MO 65102-0176  
 1-800-361-4827 or (573) 751-1300 office or (573) 751-9396 fax  
 Program Home Page: [www.dnr.state.mo.us/deq/wpcp](http://www.dnr.state.mo.us/deq/wpcp)