United States Environmental Protection Agency
Region 7
Total Maximum Daily Load
For Bacteria (*Escherichia coli* or *E. coli*)

Chariton River (MO_0640)
Putnam and Chariton Counties, Missouri

for Karen A. Flournoy
William A. Spratlin
Director
Water, Wetlands and Pesticides Division

12-21-10
Date

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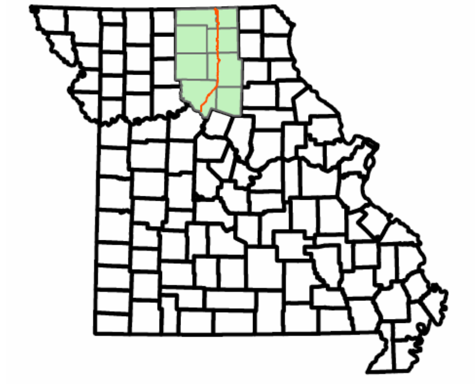
Total Maximum Daily Load (TMDL)
For Chariton River, Missouri
Pollutant: Bacteria



Name: Chariton River

Location: Putnam and Chariton Counties, near
Kirksville and Novinger Missouri

Hydrologic Unit Codes (HUCs): 10280201 and 10280202

Water Body Identification (WBID): 0640

Missouri Stream Classification: Streams that maintain permanent flow during drought conditions (P) [1]

Designated Beneficial Uses:
- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life
- Human Health Protection (Fish Consumption)
- Whole Body Contact Recreation – Category A (Swimming)
- Secondary Contact Recreation (Fishing and Boating)
- Irrigation (CSR, 2009)
- Outstanding State Resource Water (9.8 miles in Rebels Cove Conservation Area only)

Impaired Beneficial Uses: Whole Body Contact Recreation–Category A (Swimming)

Location of Impaired Classified Segment: Located in Putnam, Schuyler, Adair, Macon and Chariton counties. Segment begins at the mouth of the river at its confluence with the Missouri River and ends at the state line shared with Iowa.

Impaired Classified Segment Size:[2] 110 miles

Pollutant: Bacteria (*Escherichia coli* or *E. coli*)

Identified Source on 303(d) List: Rural Nonpoint Source

TMDL Priority Ranking: Medium

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[1] See Missouri WQS 10 CSR 20-7.031 (1)(F).
[2] Classified Segment Size reflects the classified segment length according to Missouri's water quality standards (WQS) at 10 CSR 20-7.031 Tables G and H. Listed as impaired on the 2008 Missouri 303(d) List for the full classified water body length of 110 miles. Length of water body segment is revised in 10 CSR 20·7.031 Table H to 111 miles, October 2009. This revision reflects a more accurate measurement of length. The location and the starting and ending points of this segment have not changed. Revisions to 10 CSR 20·7 .031 have not been approved by EPA at this time.

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List of Acronyms and Abbreviations

°F	Degrees Fahrenheit
AFO	Animal Feeding Operation
BMP	Best Management Practice
CAFO	Concentrated Animal Feeding Operation
CFR	*Code of Federal Regulations*
cfs	Cubic Feet per Second
CSR	Code of State Regulations
CWA	Clean Water Act
DOI	U.S. Department of Interior
E. coli	*Escherichia coli*
EDU	Ecological Drainage Unit
EPA	U.S. Environmental Protection Agency
GIS	Geographic Information System
HSG	Hydrologic Soil Group
HUC	Hydrologic Unit Code
IDNR	Iowa Department of Natural Resources
LA	Load Allocation
LC	Loading Capacity
LDC	Load Duration Curve
mi^2	Square Miles
MDC	Missouri Department of Conservation
MGD	Million Gallons per Day
MDNR	Missouri Department of Natural Resources
mL	Milliliters
MoRAP	Missouri Resource Assessment Partnership
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
MSDIS	Missouri Spatial Data Information Service
MSOPS	Missouri State Operating Permit System
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
P	Streams that maintain permanent flow during drought conditions
PCS	Permit Compliance System
PSF	Premium Standard Farms, LLC
STEPL	Spreadsheet Tool for Estimating Pollutant Load
SWPPP	Storm Water Pollution Prevention Plan
TBELs	Technology-based Effluent Limits
TMDL	Total Maximum Daily Load
URS	URS Group
USDA	U.S. Department of Agriculture

List of Acronyms and Abbreviations

USGS	U.S. Geological Survey
WBID	Water body Identification
WLA	Wasteload Allocation
WQBELs	Water Quality–based Effluent Limitations
WQS	Water Quality Standards
WTP	Water Treatment Plant
WWTF	Wastewater Treatment Facility
WWTP	Wastewater Treatment Plant

1.0 Introduction

The Chariton River Total Maximum Daily Load (TMDL) is being established in accordance with Section 303(d) of the Clean Water Act (CWA). The water quality limited segment is included on the United States Environmental Protection Agency (EPA) approved 2008 Missouri 303(d) List and is identified as impaired due to bacteria from rural nonpoint sources. Data analyses and field investigations conducted to support the listing and TMDL development have identified fecal bacteria (*Escherichia coli* [*E. coli*]) as a contributor to the impairment. *E. coli* has been shown to be present at concentrations that result in exceedances of Missouri's Water Quality Standards (WQS). This report addresses the Chariton River impairment by establishing a TMDL for *E. coli* in accordance with Section 303(d) of the CWA and with the assumption that Missouri WQS are being met at the Iowa/Missouri state line. EPA is establishing this TMDL 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.

Section 303(d) of the CWA and Federal Chapter 40 of the Code of Federal Regulations (CFR) Part 130, requires states to develop TMDLs for waters not meeting designated beneficial uses. The TMDL process quantitatively assesses impairment factors so that states can establish water-quality based controls to reduce pollutants and restore and protect the quality of their water resources. The purpose of a TMDL is to determine the maximum amount of a pollutant (the load) that a water body can assimilate without exceeding the WQS for that pollutant. WQS are benchmarks used to assess the quality of rivers and lakes. The TMDL also establishes the pollutant loading capacity (LC) necessary to meet the Missouri WQS established for each water body based on the relationship between pollutant sources and instream water quality conditions. The TMDL consists of a wasteload allocation (WLA), a load allocation (LA) and a margin of safety (MOS). The WLA is the portion of the allowable load that is allocated to point sources. The LA is the portion of the allowable load that is allocated to nonpoint sources. The MOS accounts for the uncertainty associated with linking the pollutant load to the water quality impairment. This is often associated with model assumptions and data limitations.

The goal of the TMDL program is to restore impaired designated beneficial uses to water bodies. In addition to establishing a TMDL for Chariton River in Missouri, this report provides a summary of information, results and recommendations related to the impairment based on a broad analysis of watershed information and detailed analysis of water quality. The sections of this report are organized as follows:

- Section 2 provides background information on the Chariton River watershed;
- Section 3 describes potential sources of concern;
- Section 4 presents the applicable WQS;
- Section 5 describes the modeling that was conducted to support the TMDL;
- Sections 6 through 10 present the required TMDL elements (e.g., LC, WLA, LA, MOS, seasonal variation);
- Sections 11 through 13 summarize the follow-up monitoring plan, reasonable assurances and public participation; and

- Section 14 summarizes the administrative record.

In addition, Chariton River water quality data are included in Appendix A. Appendix B provides a list of soil types present in the watershed, Appendix C lists permitted facilities in the Chariton River watershed and Appendix D describes the modeling approach.

2.0 Background

This section of the report provides background information on the Chariton River and its watershed.

2.1 The Setting

The Chariton River is a permanently flowing stream located in the Grand and Chariton Rivers' Ecological Drainage Unit (EDU) of the Plains Subregion (NRCS, 2003). The Chariton River originates in Iowa and enters into Putnam County, Missouri, and flows south to its confluence with the Missouri River in Chariton County. The Chariton River watershed covers an area of approximately 2,370 square miles (mi^2) in Iowa and Missouri, with a river distance of 110 miles in Missouri. The topographic relief along the impaired segment, in Missouri, is generally 33 to 66 feet along the broad and uniform valley bottom and adjoining flat uplands. The elevation of the impaired segment ranges from approximately 853 feet (upstream) to 623 feet (downstream) (MSDIS, 2010). The watershed was delineated using the eight-digit watershed hydrologic unit codes (HUCs) labeled 10280201 and 10280202. The following 10-digit watershed HUCs are located within the Chariton River watershed: Wolf Creek–Chariton River, South Fork Chariton River, Copper Creek–Chariton River, Shoal Creek, Blackbird Creek, Elm Creek–Chariton River, Bee Branch–Chariton River, Mussel Fork, Walnut Creek–Chariton River, Spring Creek and Shuteye Creek–Chariton River. The Chariton River watershed was further defined using contours based on U.S. Geological Survey (USGS) topographic maps and national hydrography streams data.

The Chariton River was placed on the 2008 Missouri 303(d) List due to elevated levels of *E. coli*. The basis for this listing was supported by data from the Iowa Department of Natural Resources (IDNR) and from USGS. These data were collected in the upper portion of the river (a few miles north of the Missouri state line) during 2002–2008 and were used to determine bacteria conditions in the upper part of the Chariton River in Missouri. These data showed that the Missouri water quality criterion (for Whole-Body Contact Recreation – Category A [WBC-A]) for *E. coli* of 126 counts per 100 milliliters of water (126 *E. coli* counts/100 mL), based on a geometric mean of samples collected during the recreation season (April 1 through October 31), was exceeded in 2000, 2003, 2004, 2006 and 2008 in Iowa. USGS data from 1998–2008 collected at Prairie Hill in Chariton County, Missouri, were used to evaluate the more downstream portions of the Chariton River. Recreation season data at this location during 1997, 1998, 2002–2004 and 2006–2008 exceeded the *E. coli* WQS.

As per Missouri WQS, this water body must provide a suitable environment to support whole-body contact recreation. Rural nonpoint sources of bacteria are believed to have reduced the Chariton River's ability to support safe whole-body contact recreation, including swimming. Elevated levels of bacteria are thought to be predominately due to runoff from agricultural land.

Excessive amounts of fecal bacteria in surface water used for recreation are an indication of an increased risk of pathogen-induced illness to humans. Infections due to pathogen-contaminated waters include gastrointestinal, respiratory, eye, ear, nose, throat and skin diseases. *E. coli* are bacteria found in the intestines of warm-blooded animals and used as indicators of the risk of waterborne disease from pathogenic (i.e., disease-causing) bacteria or viruses (Hudault et al., 2001; Reid et al., 2001). Most *E. coli* strains are harmless, but some can cause serious illness in humans and are occasionally responsible for product recalls. The harmless strains are part of the normal flora of the intestines and can benefit their hosts by preventing the establishment of pathogenic bacteria within the intestine (Hudault et al., 2001; Reid et al., 2001). Missouri's bacteria criteria are based on specific levels of risk of acute gastrointestinal illness. The levels of risk correlating to these criteria for the WBC – A designated use are no more than eight illnesses per 1,000 swimmers in fresh water (MDNR, 2010a). To address these water quality deficiencies, this TMDL targets instream bacteria levels using *E. coli* as the primary measurement parameter. There are other quantitative indicators of fecal bacteria and coliform; however, *E. coli* was selected as the numeric target for bacteria in this TMDL because it enables the use of the most common and accepted sampling methods and techniques and allows the use of the highest-quality data available, including WQS and monitoring data.

2.2 Physiographic Location, Geology and Soils

The Chariton River watershed is located within the Glaciated Plains region of Missouri and Iowa, also known as the Dissected Till Plains (USACE, 1963). The watershed is predominately composed of the Marmaton and Cherokee geologic groups of the Middle Pennsylvanian Middle Series–Desmonian Stage. The predominant rock types include shale, limestone and sandstone (DOI, 2005). Only a small portion of the watershed, near the confluence of the Chariton and Missouri rivers, is composed of the Holocene Series geologic group of the Quaternary–Holocene Series State, whose predominant rock types are clay, mud or silt (DOI, 2005). The geological origins of the Chariton River basin start at the bottom of a stratum that exists 350 to 600 feet below ground surface. Up to 250 feet of limestone were deposited during the Mississippian Period and above the limestone are deposits of Pennsylvanian-age sedimentary rock in layers up to 170-feet thick. These layers were formed under rapidly changing conditions that caused sediments to be deposited in alternating sequences (Unklesbay and Vineyard, 1992). The river basin contains coal deposits of the Pennsylvanian age, but not all have commercial value. Of the five minable coal fields in Missouri, two lie partially within the boundaries of the Chariton River basin (Unklesbay and Vineyard, 1992). The plains in this area are the deposits that were left on top of the Pennsylvanian strata by glaciers—a level expanse of till or drift up to 200-feet deep that is composed of mostly clay with rock fragments and sand lenses (MDC, 2010).

Table 1 provides a summary of hydrologic soil groups in the impaired Chariton River watershed. A soil's hydrologic soil group relates to the rate at which water enters the soil profile, which in turn affects the amount of water entering the stream as direct runoff. The dominant soil group in the Chariton River watershed is Group C, which covers approximately 67.0 percent of the watershed. Group C includes sandy clay loam soils that have a moderately fine to fine structure. These soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes the downward movement of water. Approximately

16.5 percent of soils in the impaired watershed are categorized as Group D soils, which include clay loam, silty clay loam, sandy clay, silty clay or clay. Group D soils have the highest runoff potential because they have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material (Purdue Research Foundation, 2010). The relatively low permeability of the soil and till in the Chariton River watershed, coupled with the presence of shale and coal greatly inhibits the percolation of surface water to groundwater sources. Consequently, most water movement occurs through the stream network (MDC, 2010). A complete listing of individual soil types in the Chariton River watershed, including detailed soil names and coverage area, is presented in Appendix B. According to the U.S. Department of Agriculture (USDA), approximately 57 to 71 percent of the mappable soil units in Putnam, Adair and Macon counties in Missouri were classified as eroded or severely eroded (USDA, 2002). The streams of the Chariton River basin have served as depositories for these eroded soils. The bed of the Chariton River itself is comprised almost exclusively of unconsolidated sand.

Table 1. Chariton River Watershed Soils Summary (NRCS, 2010)

Hydrologic Soil Group (HSG)	Impaired Watershed Area			Missouri Portion of the Impaired Watershed		
	Total Watershed Area			Watershed Area in Missouri		
	Acres	Square Miles	Percent (%)	Acres	Square Miles	Percent (%)
A	1,112.35	1.74	0.07	948.03	1.48	0.1
B	115,555.76	180.56	7.62	44,550.50	69.61	4.8
B/D	25,610.57	40.02	1.69	22,007.75	34.39	2.4
C	1,015,274.40	1,586.37	66.94	672,362.47	1,050.57	72.1
C/D	84,824.88	132.54	5.59	57,298.34	89.53	6.1
D	250,070.12	390.73	16.49	128,968.06	201.51	13.8
Other*	24,345.38	38.08	1.61	6,438.21	10.10	0.7
Total	**1,516,793.5**	**2,370.0**	**100.0**	**932,573.4**	**1,457.2**	**100**

* Other includes areas without hydrologic group ratings, such as water, lagoons, built wetland, marsh, orthents, pits and strip mines.

2.3 Rainfall and Climate

Weather stations provide useful information for developing a general understanding of climatic conditions in the watershed. The Centerville Weather Station and the Brookfield Weather Station are the closest sources to the Chariton River watershed with recent and available weather and climate data. The Centerville station data are representative of weather conditions in the upper portions of the watershed, whereas the Brookfield station provides data representative of weather conditions in the lower portions of the watershed. The Centerville station is located within the Chariton River watershed in Appanoose County, Iowa, approximately 12 miles northwest of the where the river crosses the Iowa–Missouri border (Figure 1). The Brookfield station is located outside of the Chariton River watershed in Linn County, Missouri, approximately 19 miles west of the Chariton River. Both stations record daily precipitation, maximum and minimum temperatures, snowfall and snow depth. Figure 2 provides a summary of precipitation and climate data for the Centerville and Brookfield stations based on 30-year totals (1971–2000) (NOAA, 2010). The annual average precipitation and minimum and maximum temperatures over the 30-year period are 36.72 inches and 39.7/60.8 degrees Fahrenheit (°F) for the Centerville station and 39.73 inches and 40.8/62.1°F for the Brookfield station. Precipitation is one important factor related to stream flow and runoff events that influences storm water runoff and pollutant sources. Other factors include temperature, rates of evapotranspiration and antecedent soil moisture.

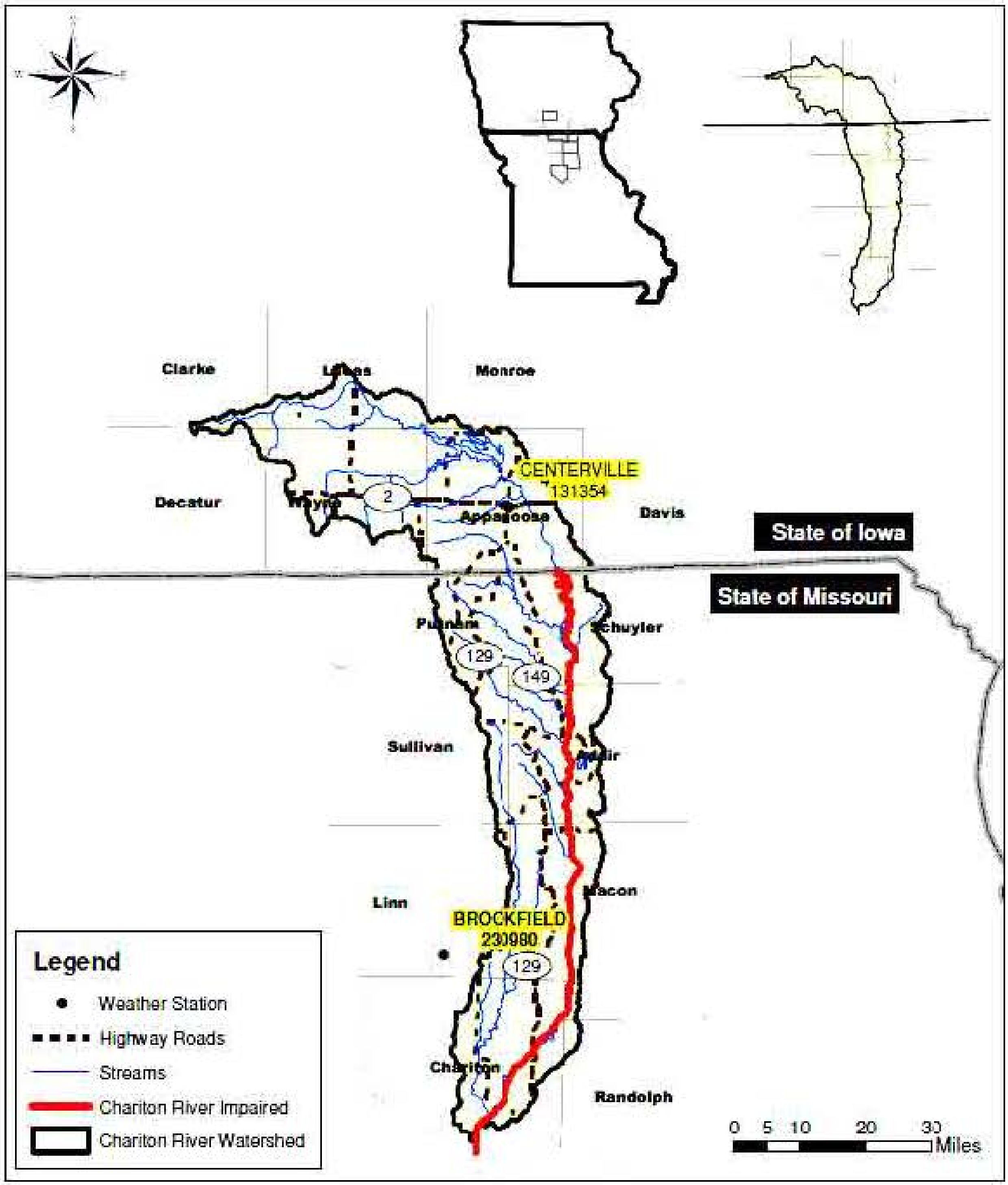

Figure 1. Location of Chariton River Watershed and Weather Stations

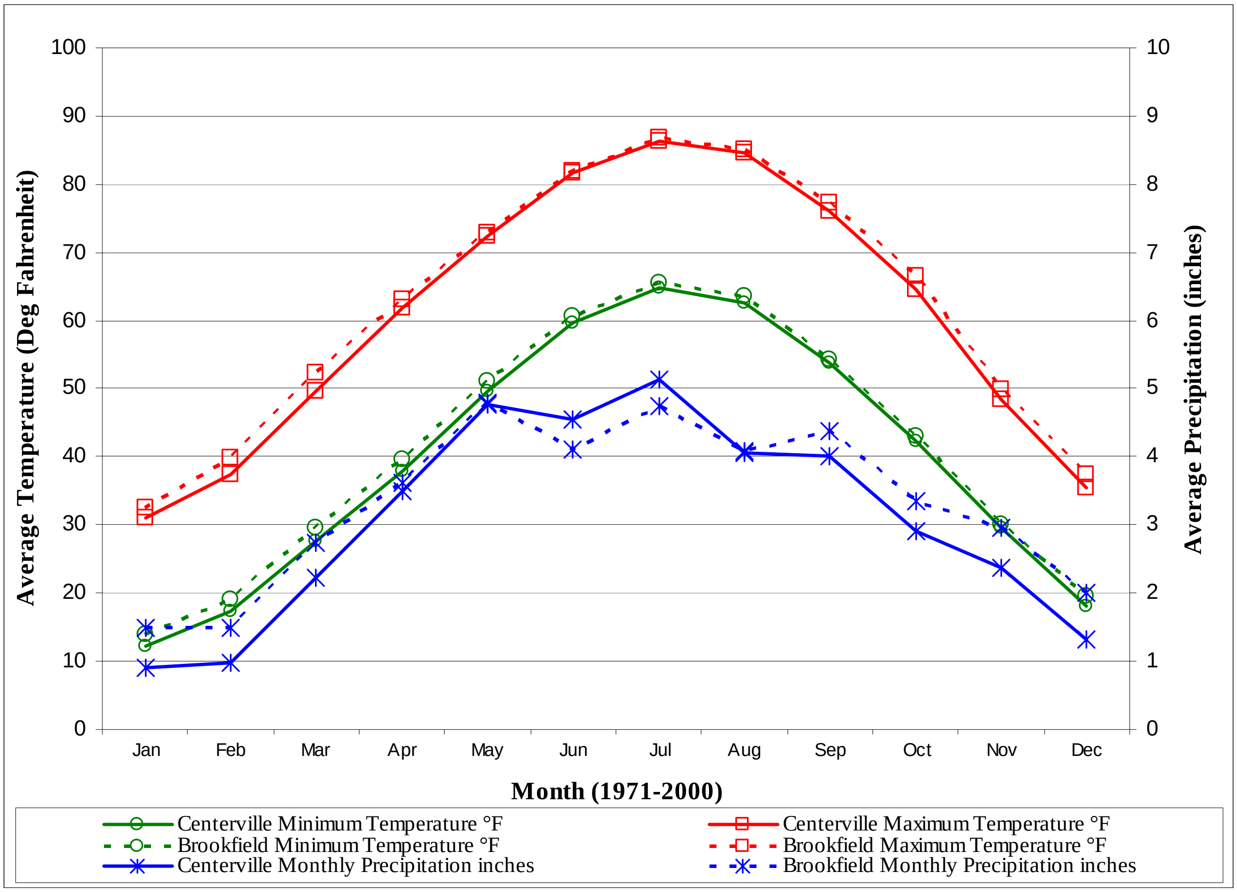

Figure 2. Thirty-year Monthly Temperature and Precipitation Averages for Centerville and Brookfield Weather Stations

2.4 Population

According to the U.S. Census Bureau, the population for all county areas in Iowa (i.e., Clarke, Lucas, Monroe, Davis, Decatur, Wayne and Appanoose) and Missouri (i.e., Schuyler, Putnam, Sullivan, Adair, Macon, Linn, Chariton and Randolph) located within the Chariton River watershed in 2000 was 168,458 (U.S. Census Bureau, 2000). The population of the Chariton River watershed is not directly available; however, the watershed's population can be estimated based on the total number of people per census block points located within the watershed. The points represent the centroids of census blocks—the smallest entity for which the census provides population data. For use in this TMDL's LA calculation, the Chariton River watershed population was estimated to be 39,352 persons. This estimate was calculated using geographic information systems (GIS) by selecting the census block points located within the Chariton River watershed (2,370 mi^2). Based on the calculation, an estimated overall population density for the Chariton River watershed was calculated to be approximately 17 persons per square mile (39,352 persons divided by 2,370 mi^2).

2.5 Land Use and Land Cover

The land use and land cover of the Chariton River watershed is shown in Figure 3 and is summarized in Table 2 (MoRAP, 2005; IDNR, 2002). The primary land uses/land covers of the entire watershed are grassland (44.8 percent), cropland (25.1 percent) and forest (23.0 percent). Wetlands, impervious, high-intensity urban, low-intensity urban, barren, open water and unmapped or unknown lands occupy the remaining 7.1 percent of the watershed area. The Missouri portion of the watershed has similar land use/land cover composition to the total watershed. The primary land uses/land covers of the entire watershed are grassland (43.3 percent), cropland (20.0 percent) and forest (29.2 percent). Wetlands, impervious, high-intensity urban, low-intensity urban, barren, open water and unmapped or unknown lands occupy the remaining 7.5 percent of the watershed area.

Table 2. Land Use/Land Cover in the Chariton River Watershed[1]

Land Use/Land Cover[2]	Impaired Watershed Area			Missouri Portion of the Impaired Watershed		
	Total Watershed Area		Percent (%)	Watershed Area in Missouri		Percent (%)
	Acres	Square Miles		Acres	Square Miles	
Impervious[3]	26,647.72	41.64	1.76	13,212.92	20.65	1.42
High-Intensity Urban	1,859.02	2.90	0.12	121.65	0.19	0.02
Low-Intensity Urban	6,288.88	9.83	0.41	3,563.37	5.57	0.38
Barren or Sparsely Vegetated	1,147.86	1.79	0.08	483.03	0.76	0.05
Cropland	380,207.75	594.07	25.1	186,904.64	292.04	20.0
Grassland	678,861.20	1,060.72	44.8	404,027.31	631.29	43.3
Forest	349,437.96	546.00	23.0	271,840.32	424.75	29.2
Wetland	35,813.53	55.96	2.36	30,220.89	47.22	3.24
Open Water	26,866.50	41.98	1.77	12,501.31	19.53	1.34
Unmapped/Unknown[4]	9,699.89	15.16	0.64	9,697.67	15.15	1.04
Total	**1,516,830.30**	**2,370.10**	**100**	**932,573.10**	**1,457.20**	**100**

[1] MoRAP, 2005; IDNR, 2002

[2] Due to difference in land-use/land-cover categories, Iowa's data were assimilated into Missouri's format by integrating the Residential and Commercial/Industrial categories of Iowa into the Low-Intensity Urban and High-Intensity Urban categories of Missouri, respectively.

[3] Impervious land use includes non-vegetated, impervious surfaces such as areas dominated by streets, parking lots and buildings (MoRAP, 2005).

[4] The Unmapped/Unknown category is due to clouds or shadows in the satellite imagery that could not be rectified.

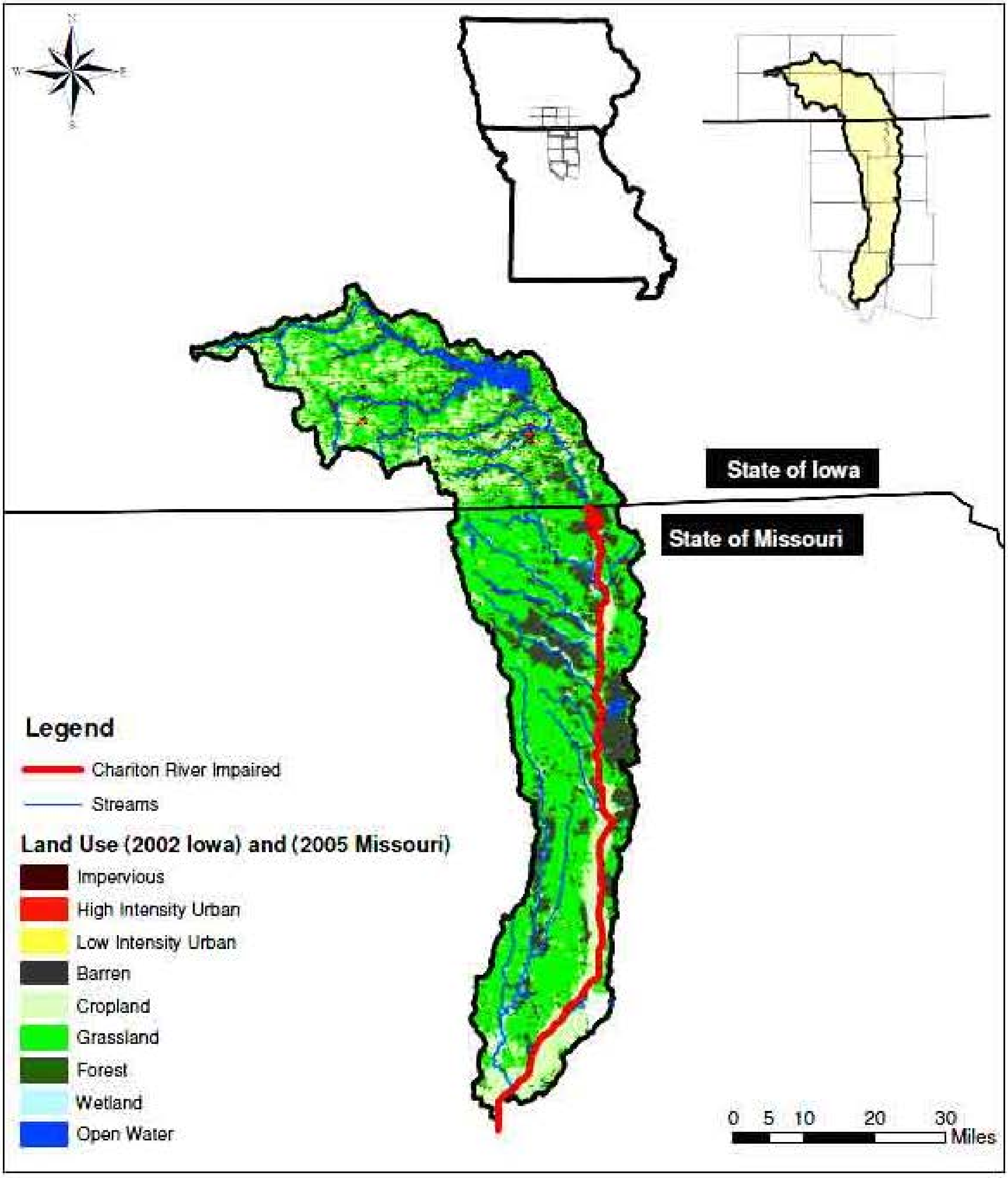

Figure 3. Land Use and Land Cover in the Chariton River Watershed (MoRAP, 2005; IDNR, 2002)

3.0 Defining the Problem

The Chariton River is identified as impaired due to elevated levels of bacteria from rural nonpoint sources. Water quality monitoring has revealed exceedances of WQS due to high levels of *E. coli* in the upper and lower Chariton River. Water quality data collected by IDNR downstream of the Rathbun Dam near Centerville, Iowa, were used to determine conditions in the upper portion of the Chariton River. Monthly samples were collected and tested for *E. coli* from October 1999 to November 2009 to provide a data set representative of the upper section of the Chariton River. These data showed that the *E. coli* water quality criterion was likely exceeded in the upper Chariton River during the recreation seasons in 2000, 2003, 2004, 2006 and 2008. When monthly geometric means are calculated to examine the possibility of seasonal trends, June and July are shown to be in likely exceedance of the numeric criterion. Based on this information, *E. coli* levels in the upper portion of the river appear to be highest during the summer months. Tables 3 and 4 and Figures 4 and 5 summarize water quality data collected in the Chariton River downstream of the Rathbun Dam near Centerville, Iowa, by IDNR.

The U.S. Department of Interior's (DOI)/USGS data from 1998–2008 collected at Prairie Hill in Chariton County, Missouri (USGS-06905500), were used to evaluate the more downstream portions of the Chariton River. Recreation season data collected during 1997, 1998, 2002–2004 and 2006–2008 resulted in geometric mean values that exceeded the criterion. Similar to the upstream sampling data, the Prairie Hill location also showed seasonal trends with elevated *E. coli* levels during the summer months. Geometric means of *E. coli* data collected during April, May, June, July and October were higher than the bacteria criterion. Tables 5 and 6 and Figures 6 and 7 summarize water quality data collected in the Chariton River by the USGS. To illustrate existing bacteria loads in the lower Chariton River watershed, Table 8 presents the recreation season load duration curve (LDC) and existing daily average bacteria loads.

Table 3. Upper Chariton River (Centerville, Iowa) Annual *E. coli* Data 1999–2009[1] (IDNR, 2010)

Year	Number of Samples	Recreation Season[2] Geometric Mean	Critierion[3]	Exceedance
2000	7	224.4	126	Yes
2001	7	79.9	126	No
2002	7	70.0	126	No
2003	7	146.0	126	Yes
2004	7	127.8	126	Yes
2005	7	53.8	126	No
2006	7	200.9	126	Yes
2007	7	37.5	126	No
2008	6	153.4	126	Yes
2009	7	49.4	126	No

[1] The units for all values are *E. coli* counts/100 mL of water.

[2] The recreation season includes April, May, June, July, August, September and October.

[3] The water quality criterion for *E. coli* is a geometric mean of 126 *E. coli* counts/100 mL of water during the recreation season.

Table 4. Upper Chariton River (Centerville, Iowa) Seasonal *E. coli* Data 1999–2009[1] (IDNR, 2010)

Month[2]	Sampling Events	Geometric Mean	Minimum	Maximum	Lower Quartile	Upper Quartile	Criterion[3]	Exceedance
January	9	37.3	5	1,100	10	63	126	No
February	9	23.8	0	590	7.5	155	126	No
March	9	13.4	0	190	2.5	20	126	No
April	10	24.5	0	450	8.7	102.5	126	No
May	10	123.3	18	4,500	25.3	705	126	No
June	10	163.1	10	4,900	53	897.5	126	Yes
July	10	137.0	20	6,700	35	262.5	126	Yes
August	10	98.8	20	1,200	34.5	200	126	No
September	10	116.9	30	280	60	215	126	No
October	10	100.7	20	940	30	317.5	126	No
November	10	121.9	20	700	45	370	126	No
December	9	22.4	0	370	2.5	339	126	No

[1] The units for all values are *E. coli* counts/100 mL of water.

[2] The recreation season includes April, May, June, July, August, September and October.

[3] The water quality criterion for *E. coli* is a geometric mean of 126 *E. coli* counts/100 mL of water during the recreation season.

Table 5. Lower Chariton River (Prairie Hill, Missouri) Annual *E. coli* Data 1997–2008[1] (DOI, 2008)

Year	Number of Samples	Recreation Season[2] Geometric Mean	Critierion[3]	Exceedance
1998	7	160.5	126	Yes
1999	6	131.2	126	Yes
2000	3	60.3	126	No
2001	3	63.8	126	No
2002	3	445.0	126	Yes
2003	3	403.1	126	Yes
2004	3	1554.1	126	Yes
2005	3	82.9	126	No
2006	3	160.5	126	Yes
2007	5	315.4	126	Yes
2008	3	900.4	126	Yes

[1] The units for all values are *E. coli* counts/100 mL of water.

[2] The recreation season includes April, May, June, July, August, September and October.

[3] The water quality criterion for *E. coli* is a geometric mean of 126 *E. coli* counts/100 mL of water during the recreation season.

Table 6. Lower Chariton River (Prairie Hill, Missouri) Seasonal *E. coli* Data 1997–2008[1] (DOI, 2008)

Month[2]	Sampling Events	Geometric Mean	Minimum	Maximum	Lower Quartile	Upper Quartile	Criterion[3]	Exceedance
January	10	51.6	0.5	3,700	5.8	845	126	No
February	3	64.0	25	350	25	350	126	No
March	10	29.9	0.5	1,400	3.5	412.5	126	No
April	3	335.4	205	460	205	460	126	Yes
May	11	416.9	15	13,000	50	4,700	126	Yes
June	3	363.8	200	860	200	860	126	Yes
July	111	239.5	36	8,550	80	800	126	Yes
August	2	49.3	38	64	N/A	N/A	126	No
September	11	97.4	11	690	38	280	126	No
October	2	152.3	80	290	N/A	N/A	126	Yes
November	11	24.2	1	840	8	50	126	No
December	2	624.5	75	5,200	N/A	N/A	126	No

[1] The units for all values are *E. coli* counts/100 mL of water.

[2] The recreation season includes April, May, June, July, August, September and October.

[3] The water quality criterion for *E. coli* is a geometric mean of 126 *E. coli* counts/100 mL of water during the recreation season.

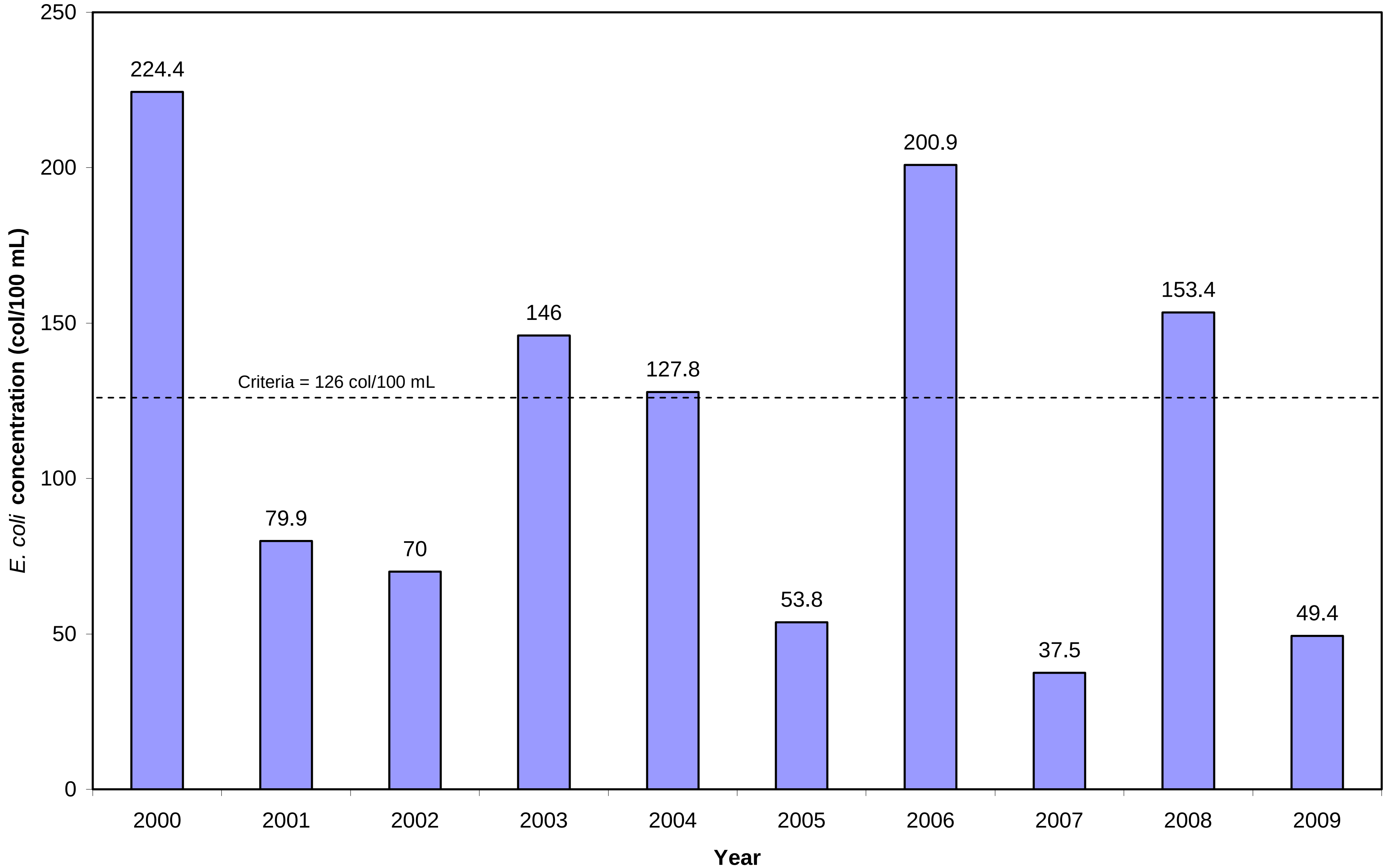

Figure 4. Upper Chariton River (Centerville, Iowa) Annual Recreation Season Geometric Mean *E. coli* Data (IDNR, 2010)

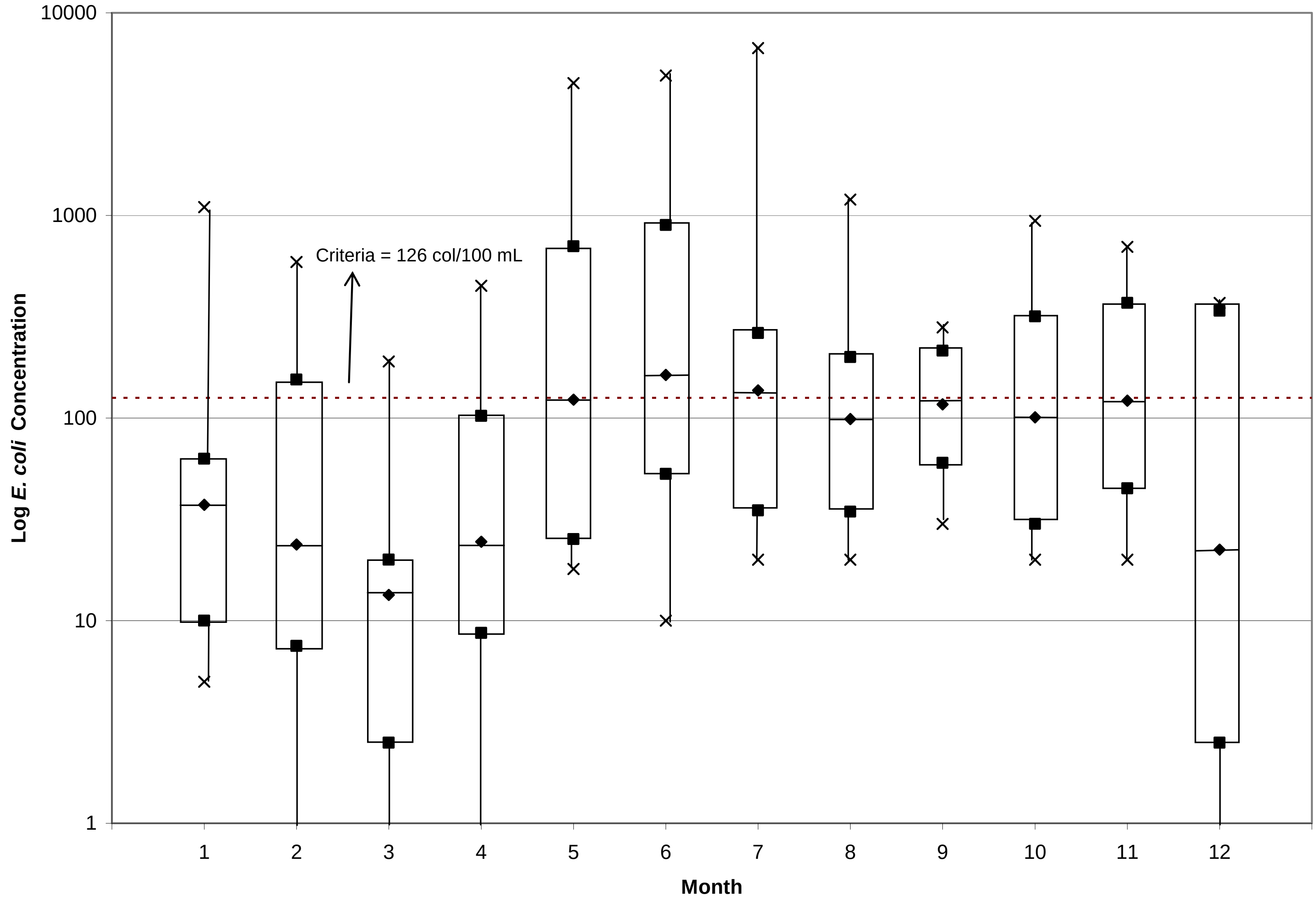

Figure 5. Upper Chariton River (Centerville, Iowa) Seasonal *E. coli* Data (IDNR, 2010)

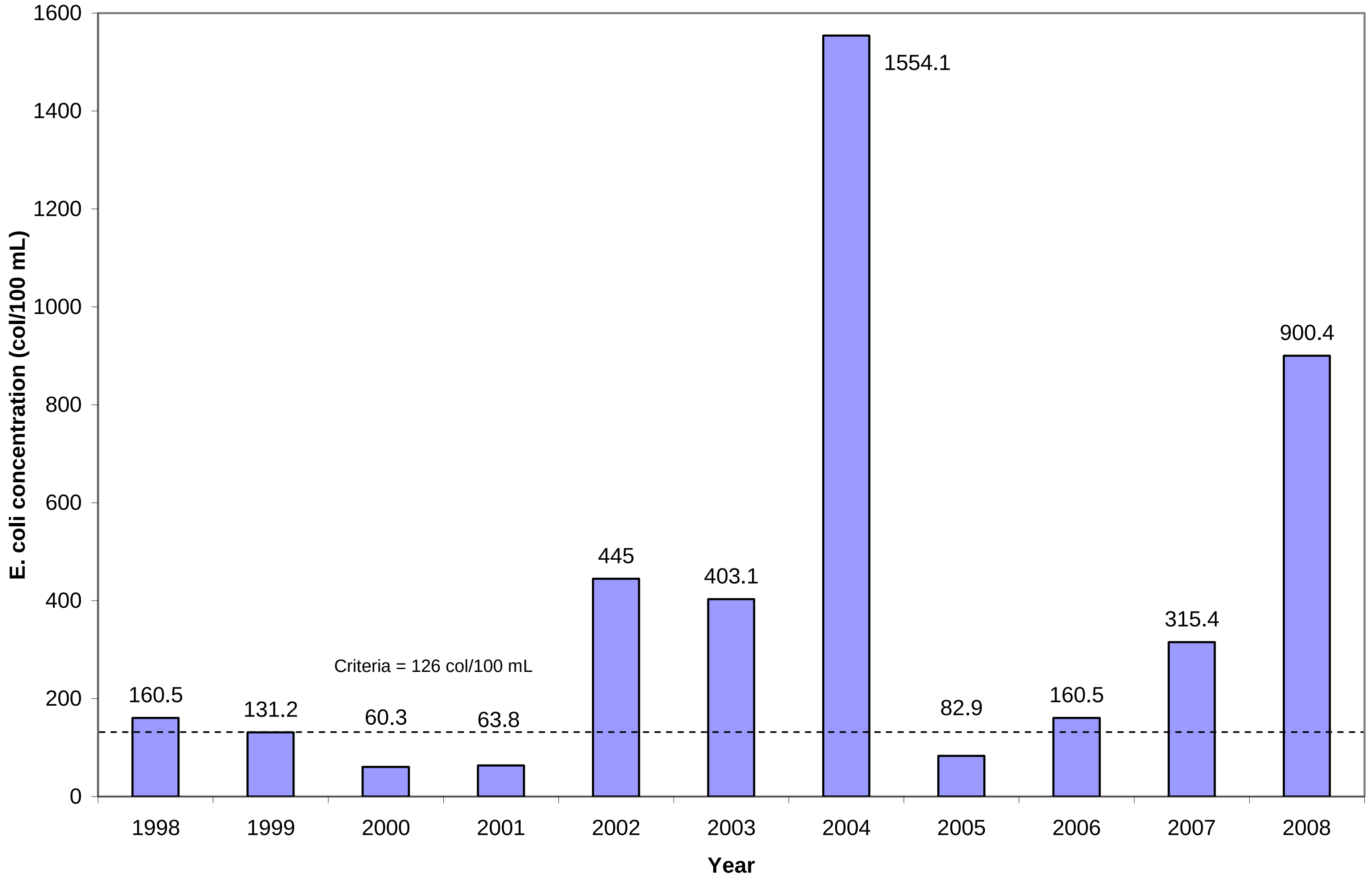

Figure 6. Lower Chariton River (Prairie Hill, Missouri) Annual Recreation Season Geometric Mean *E. coli* Data (DOI, 2008)

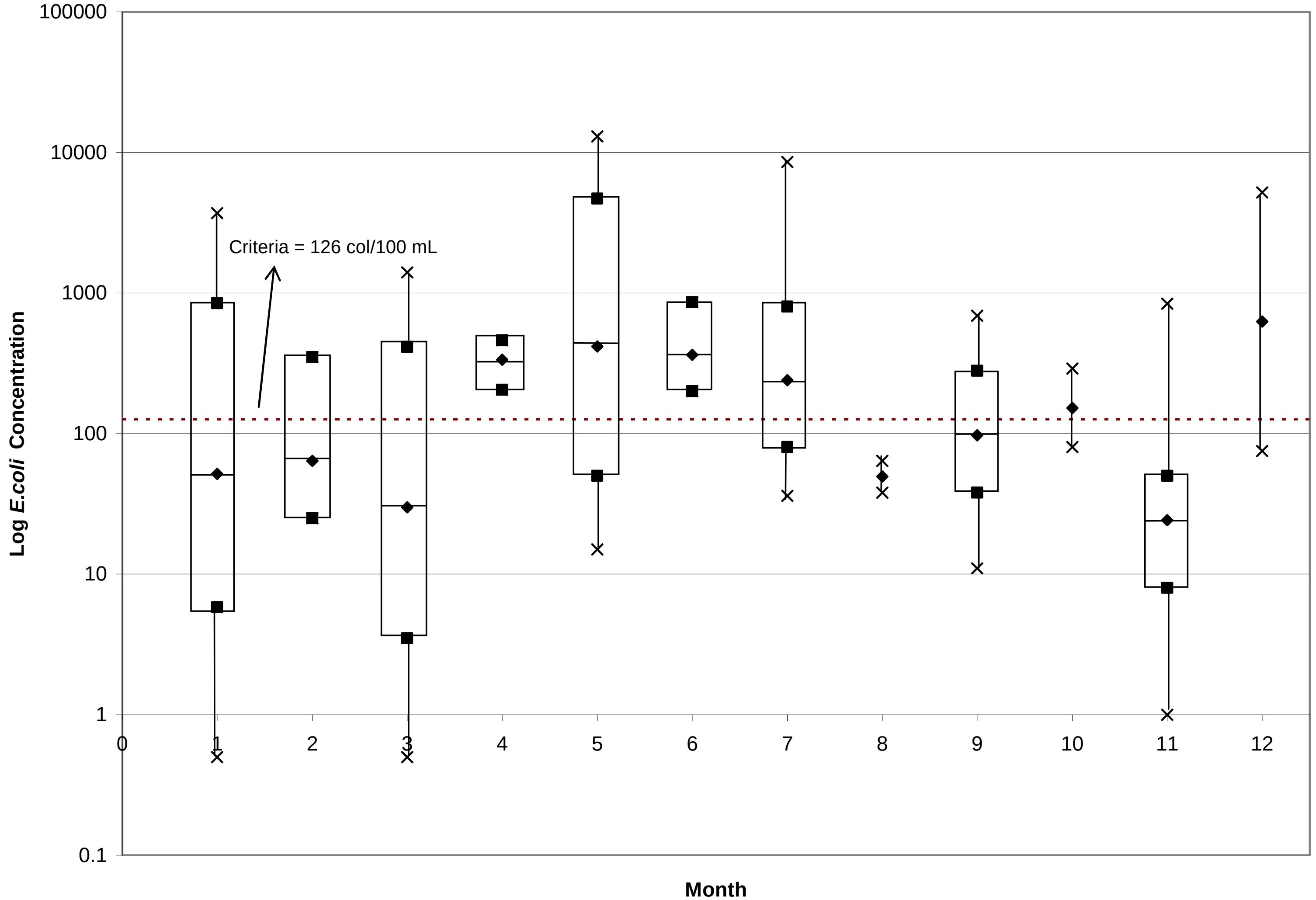

Figure 7. Lower Chariton River (Prairie Hill, Missouri) Seasonal *E. coli* Data (DOI, 2008)

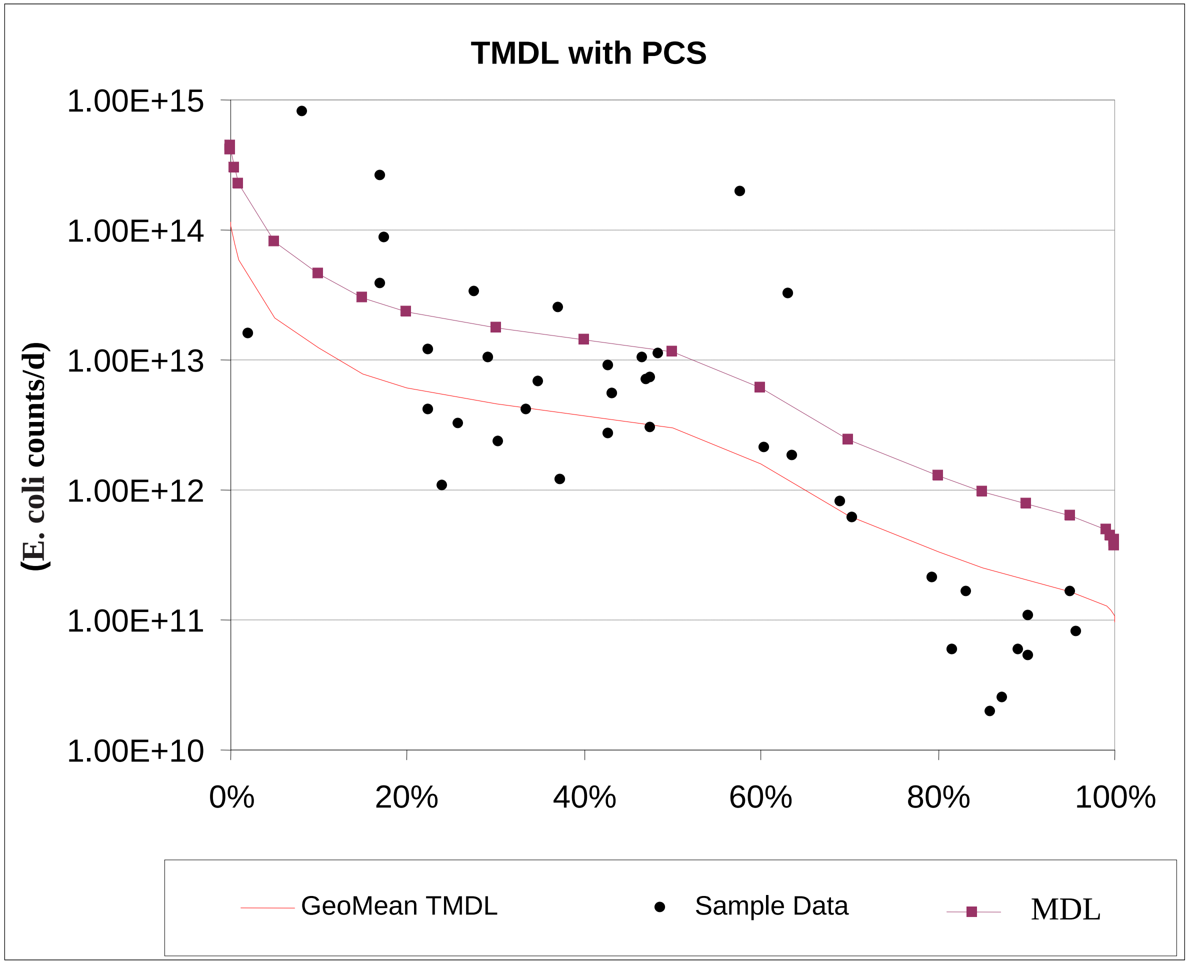

Figure 8. Recreation Season Load Duration Curve at Prairie Hill Comparing Geometric Mean Recreational Target to Daily Average Bacteria Measurements

4.0 Source Inventory

A source assessment is used to identify and characterize the known and suspected pollutant sources contributing to impairment in the Chariton River. For the purpose of this report, sources have been divided into two broad categories: point sources and nonpoint sources. Point sources can be defined as sources, either constant or time transient, which occur at a fixed location in a watershed. Nonpoint sources are generally accepted to be diffuse sources not entering a water body at a specific location.

4.1 Point Sources

The term "point source" refers to any discernible, confined and discrete conveyance, such as a pipe, ditch, channel, tunnel or conduit, by which pollutants are transported to a water body. For the purposes of TMDL development, point sources are defined as sources regulated through the National Pollutant Discharge Elimination System (NPDES) program. Missouri has its own program for administering the NPDES program, referred to as the Missouri State Operating Permit System (MSOPS). The NPDES and MSOPS programs are the same and for the purposes of this document, the term NPDES is used. The following regulated entities are included in this source category:

- Municipal and industrial wastewater treatment plants (WWTPs),
- Concentrated animal feeding operations (CAFOs),
- Storm water runoff from Municipal Separate Storm Sewer System (MS4) and
- General permitted facilities (storm water runoff from construction and industrial sites).

General permits (as opposed to site specific permits) are issued for activities that are similar enough to be covered by a single set of requirements. Storm water permits are issued for activities that discharge only in response to precipitation events. Point sources in the Chariton River were identified by consulting EPA's Permit Compliance System (PCS) Website (EPA, 2010a) and Missouri Department of Natural Resources' (MDNR's) GIS inventory[3] of NPDES–permitted facilities covered under storm water or general permits.

Point sources in the Chariton River watershed are listed in Appendix C and shown in Figure 9. A majority of the listed NPDES permits are associated with WWTPs or CAFOs. Both of these types of facilities have the potential to be significant sources of *E. coli* and fecal bacteria.

A CAFO can be covered by the general NPDES wastewater permit if it has a design capacity of less than 7,000 animal units (i.e., based on a standard of 7,000 beef animals, where the thresholds for other livestock types are 17,500 swine, 4,900 dairy or 210,000 laying hens). Requirements of the general permit include no point-source discharge except for storm events that exceed the system design capacity, required monitoring of flow estimates during any discharges to waters of the state and operational monitoring of land application systems (MDNR, 2010b). Larger CAFOs are usually covered under a site specific NPDES wastewater permit

[3] http://msdis.missouri.edu. GIS layers were updated on May 2010 (MSDIS, 2010).

(e.g., Premium Standard Farms, LLC [PSF], Whitetail Finishing Site [PSF Whitetail]). PSF Whitetail (MO0117421) is a hog finishing facility and is designed for finishing 79,488 hogs per year. Wastewater is stored in the lagoons and is land applied based on the available nitrogen approach to nutrient management. The facility has a waste management system designed to minimize runoff entering the facility and detain runoff emanating from the operation. In addition, PSF Whitetail is designed to retain a 25-year, 24-hour rainfall/runoff event, as well as an anticipated 2 weeks of normal wastewater from its operations. This facility has a “no discharge” permit (i.e., effluent is land applied), specifying that it would only discharge due to an extreme storm event. However, this one facility has 19 registered outfalls.[4] Another PSF facility, Valley View Finishing, has 25 registered outfalls[5]. Because these CAFOs are listed as no-discharge facilities, they will likely not impact water quality during critical low-flow periods or typical storm events. However, because the watershed has a significant amount of grassland and pasture, the number of smaller animal feeding operations (AFOs) that are not permitted is presumably high.

Other potential point sources of *E. coli* and bacteria to the Chariton River are domestic and municipal WWTPs. There are approximately 28 NPDES wastewater permits associated with WWTPs that discharge approximately 4.9 MGD of treated water to the Chariton River and its tributaries. Of these, 17 WWTPs discharging approximately 1 MGD of wastewater are located in Missouri. Point sources in the Chariton River watershed are listed in Appendix C and shown in Figure 9.

[4] Not all of the 19 outfalls are discharging from storage lagoons; 10 have the potential to discharge, 3 are terminated, and the rest are stream monitoring or storm water outfalls. See permit for details.
[5] Not all of the 25 outfalls are discharging from storage lagoons. See permit for details.

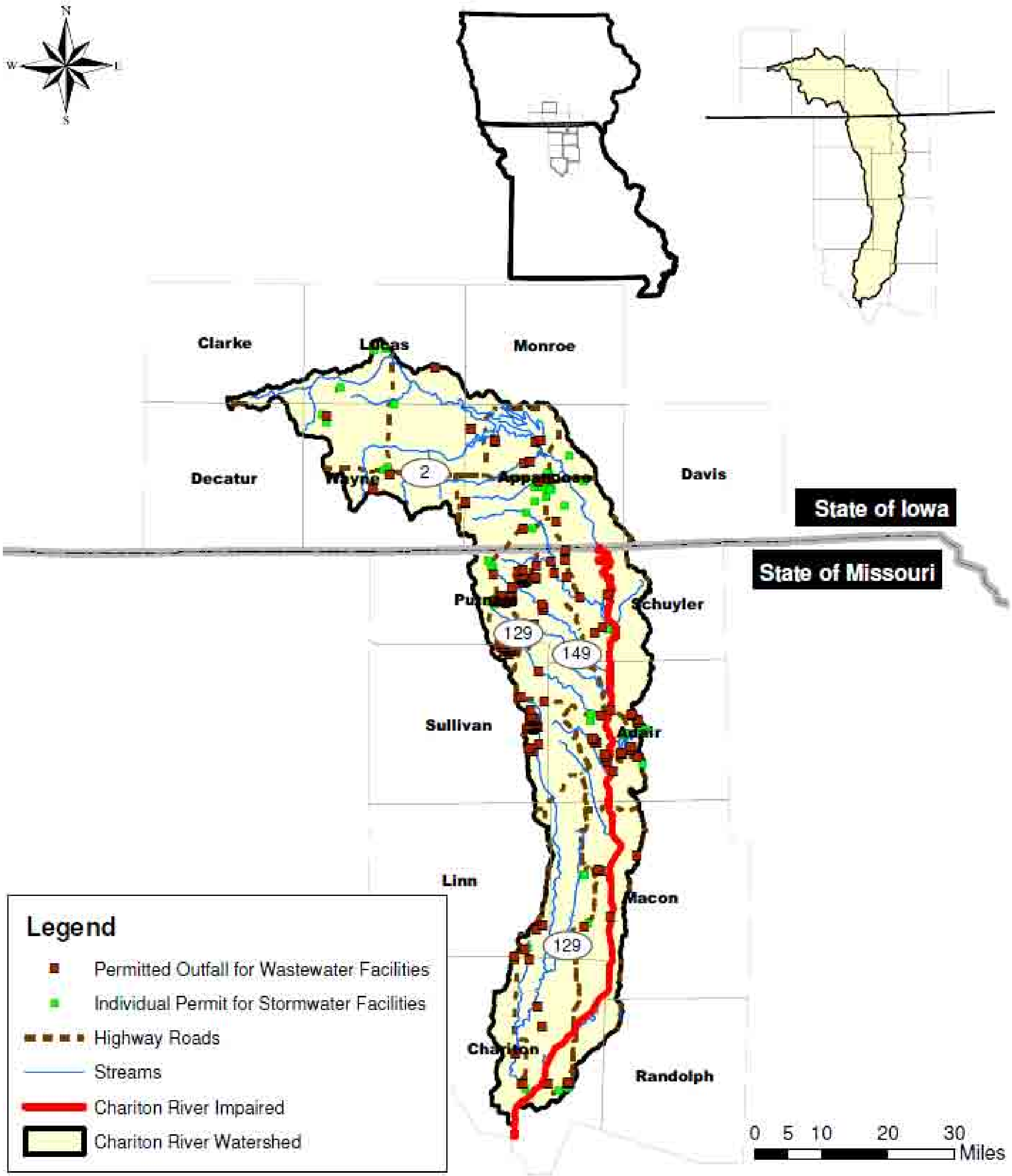

Figure 9. Location of Permitted Facilities in the Chariton River Watershed

4.2 Nonpoint Sources

Nonpoint sources include all other categories of pollutant sources not classified as point sources. Potential nonpoint sources contributing to the impairment in the Chariton River include runoff from agricultural areas, such as cropland and pasture; non-regulated animal feeding areas;

runoff from urban areas; on-site wastewater treatment systems; and riparian habitat conditions. Each of these sources is discussed further in the following sections.

Based on the information before us, the decision to apply discharges associated with unpermitted sources to the LA, as opposed to the WLA for purposes of this TMDL, is acceptable. The decision to allocate these sources to the LA does not reflect any determination by EPA as to whether these discharges are, in fact, unpermitted point source discharges within this watershed. In addition, by approving these TMDLs with some sources treated as LAs, EPA is not determining that these discharges are exempt from NPDES permitting requirements. If sources of the allocated pollutant in this TMDL are found to be or become, NPDES-regulated discharges, their loads must be considered as part of the calculated sum of the WLA in this TMDL. WLA in addition to that allocated here is not available.

4.2.1 Runoff from Agriculture Areas

The 2005 land-use/land-cover data (MoRAP, 2005; IDNR, 2002) indicate that there are approximately 380,208 cropland acres in the watershed (comprising 25.1 percent of the entire watershed) and approximately 678,861 acres (44.8 percent) grassland acres in the watershed (Table 2). Additionally, cropland comprises approximately 35.8 percent of the riparian buffer and 26.1 percent is classified as grassland (Table 7). Lands used for agricultural purposes can be a source of nutrients and bacteria. Activities associated with these land uses include fertilization with manure fertilizers and livestock/wildlife excreta. Runoff from these areas and activities can be potential sources of *E. coli* and other bacteria. Animals grazing in pasture areas deposit manure directly upon the land surface and even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event. In addition, when pasture land is not fenced off from the stream, cattle or other livestock may contribute fecal matter and bacteria into the stream while walking in or adjacent to the water body. According to watershed-level data from USDA, the grasslands and pastures of the Chariton River watershed support approximately 89,106 cows, 5,536 sheep and 3,298 horses (USDA, 2002). Additionally, 18 registered CAFOs in the watershed, primarily associated with hog farming, are regulated under NPDES wastewater permits. The density of cattle and other livestock in the watershed suggests that agricultural runoff is a potential source of bacteria.

Permitted CAFOs identified in this TMDL are part of the assigned WLA. At this time, AFOs and unpermitted CAFOs are considered under the LA because there is currently not enough detailed information to know whether these facilities are required to obtain NPDES permits. This TMDL does not reflect a determination by EPA that such facility does not meet the definition of a CAFO nor that the facility does not need to obtain a permit. To the contrary, a CAFO that discharges or proposes to discharge has a duty to obtain a permit. If it is determined that any such operation is an AFO or CAFO that discharges, any future WLA assigned to the facility must not result in an exceedance of the sum of the WLAs in this TMDL as approved.

Any CAFO that does not obtain a NPDES permit must operate as a no discharge operation. Any discharge from an unpermitted CAFO is a violation of Section 301. It is EPA’s position that all CAFOs should obtain a NPDES permit because it provides clarity of compliance requirements, authorization to discharge when the discharges are the result of large precipitation events (e.g., in excess of 25-year and 24-hour frequency/duration) or are from a man-made conveyance.

4.2.2 Runoff from Non-MS4 Urban Areas

Only a small portion of the Chariton River watershed is classified as Low-Intensity Urban (0.4 percent) or High-Intensity Urban (0.1 percent) and only 1.8 percent of the watershed is identified as impervious. It is unlikely that runoff from urban areas is a significant source of pollutants in the watershed. However, storm water runoff from impervious and urban areas can contribute pollutants during precipitation events. A general description of potential impacts from urban runoff is provided below.

Storm water runoff from urban areas can be a significant source of bacteria due to runoff contaminated by pollutants, such as pet wastes. Leaking or illicitly connected sewers can also be a significant source of bacteria within urban areas. However, storm water runoff from urban areas such as parking lots and buildings is unlikely to be a significant contributor of bacteria to the Chariton River due to the lack of urban areas in the watershed.

4.2.3 On-site Wastewater Treatment Systems

On-site wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, on-site wastewater treatment systems do fail for a variety of reasons. When these systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration), there can be adverse effects to surface waters (Horsley & Witten, 1996). Failing on-site wastewater treatment systems are sources of nutrients and bacteria that can reach nearby streams through both runoff and subsurface flows.

The EPA's Spreadsheet Tool for Estimating Pollutant Load (STEPL)[6] indicates that there are approximately 9,332 septic systems in the Chariton River watershed (EPA, 2010b). The Upper Chariton watershed (HUC 10280201) has approximately 4,747 septic systems, with an average population per septic system of 2.23. The Lower Chariton watershed (HUC 10280202) has 4,585 septic systems, with an average population per septic system of 2.49 people (EPA, 2010b). An EPA study reports that the estimated failure rate of on-site wastewater treatment systems in Missouri is 30 percent to 50 percent (EPA, 2010b). At this failure rate, there would be approximately 2,800 to 4,666 failing systems in the watershed. Although there are no data that suggest that failing on-site wastewater treatment systems are a significant problem in the Chariton River watershed, these failing systems could be a potential contributor to the elevated *E. coli* levels.

4.2.4 Riparian Habitat Conditions

Riparian[7] (streamside) habitat conditions can have a strong influence on instream water quality and habitat. Wooded riparian buffers are a vital functional component of stream

[6] Available at http://bering.tetratech-ffx.com/website/stepl/viewer.htm
[7] A riparian corridor (or zone or area) is the linear strip of land running adjacent to a stream bank.

ecosystems and are instrumental in the detention, removal and assimilation of pollutants from runoff. Therefore, a stream with good riparian habitat is better able to moderate the impacts of runoff with high levels of bacteria than a stream with poor riparian cover.

As indicated in Table 7, 35.8 percent of the land in the Chariton River riparian corridor (defined as a 30-meter buffer on either side of the Chariton River) is classified as cropland, 26.1 percent is classified as grassland and 28.2 percent is classified as wetlands (MoRAP, 2005; IDNR, 2002). Compared to wooded areas or wetlands, grasslands (which may include pasture areas) and croplands generally provide less shading and higher pollutant loads due to livestock and related agricultural activity. Because approximately 61.9 percent of the riparian areas around the Chariton River are grassland or cropland habitat, it is likely that riparian habitat conditions are a contributor to the degraded water quality in the Chariton River.

Table 7. Percentage of Land Use/Land Cover within Riparian Buffer (30 Meters) of Impaired Reach

Land Use/Land Cover[1]	Acres	Square Miles	Percent (%)
Cropland	1155.0	1.80	35.8
Forest	273.3	0.4	8.5
Grassland	841.6	1.3	26.1
Wetlands	909.1	1.4	28.2
Barren or Sparsely Vegetated	15.0	0.02	0.5
Impervious[2]	29.1	0.05	0.9
Unmapped/Unknown	2.8	0.004	0.1
Total	**3,225.9**	**5.0**	**100**

[1] Missouri Resource Assessment Partnership (MoRAP), 2005; IDNR, 2002

[2] Impervious land uses include non-vegetated, impervious surfaces, such as areas dominated by streets, parking lots and buildings (MoRAP, 2005).

5.0 Applicable Water Quality Standards and Numeric Water Quality Targets

Section 303(d) of the CWA and Chapter 40 of CFR Part 130 require states to develop TMDLs for waters not meeting WQS. The TMDL process quantitatively assesses the impairment factors so that states can establish water-quality based controls to reduce pollutants from both point and nonpoint sources and to restore and protect the quality of their water resources.

Under the CWA, every state must adopt WQS to protect, maintain and improve the quality of the nation's surface waters (U.S. Code Title 33, Chapter 26, Subchapter III [US Code, 2009]). These standards represent a level of water quality that will support the CWA's goal of "fishable/swimmable" waters. Missouri's Surface WQS (10 Code of State Regulation [CSR, 2009] 20-7.031) consist of three components: designated uses, criteria (general and numeric) and an antidegradation policy.

Beneficial or designated uses for Missouri streams are found in the WQS at 10 CSR 20-7.031(1)(C), (1)(F) and Table H (CSR, 2009). Criteria for designated uses are presented in 10 CSR 20-7.031, Tables A and B (CSR, 2009). Missouri's antidegradation policy is outlined in 10 CSR 20-7.031(2) (CSR, 2009).

5.1 Designated Beneficial Uses

The impaired Chariton River segment (WBID 0640) is 110 miles in length and is classified as a stream that maintains permanent flow during drought conditions (P). Designated beneficial uses are:

- Whole Body Contact Recreation—Category A (Swimming);
- Livestock and Wildlife Watering;
- Protection of Warm Water Aquatic Life;
- Protection of Human Health (Fish Consumption);
- Irrigation; and
- Secondary Contact Recreation (Fishing and Boating).[8]
- Outstanding State Resource Water (9.8 miles in Rebels Cove Conservation Area only)

The impaired use is "Whole-Body Contact Recreation – Category A." The designated beneficial uses and stream classifications for Missouri may be found in the WQS at 10 CSR 20-7.031(1)(C), (1)(F) and Table H available from the Missouri Secretary of State (CSR, 2009).

5.2 Criteria

In the 2008 Missouri 303(d) List, the Chariton River was listed as impaired due to bacteria. Water quality monitoring has revealed specific exceedances of the *E. coli* bacteria water quality criterion in the Chariton River. *E. coli* concentrations were routinely above the numeric criterion for Whole Body Contact—Category A (Swimming). The specific numeric criterion is a geometric mean of 126 *E. coli* counts/100 mL of water for the recreation season (April 1 through October 31).

5.3 Antidegradation Policy

Missouri's WQS include EPA's "three-tiered" approach to antidegradation, which may be found at 10 CSR 20-7.031(2) (CSR, 2009).

- Tier 1—Protects existing uses and a level of water quality necessary to maintain and protect those uses. Tier 1 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 28, 1975, the date of EPA's first Water Quality Regulation.
- Tier 2—Protects and maintains the existing level of water quality where it is better than applicable water quality criteria. 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

[8] According to the 2008 Missouri 303(d) List

accommodate important economic and social development in the area where the waters are 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 best management practices (BMP) 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 or designated uses.

- Tier 3—Protects the quality of outstanding national and state resource waters, 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.

6.0 Modeling Approach

When stream flow gage information is available, a LDC can be a useful method of identifying and differentiating between storm-driven and steady-input sources of pollutants (Cleland, 2002 and 2003). For the Chariton River, the LDC approach was used to: 1) provide a visual representation of stream-flow conditions under which bacteria criteria exceedances have occurred, 2) assess critical conditions and 3) quantify the level of reduction necessary to meet the surface water quality targets for bacteria in the stream.

A sufficient amount of flow data (31 years) is available for the Chariton River at the water quality monitoring site and at a gage near the Missouri – Iowa border (Table 8). The difference between these two gages was used to calculate the flow duration curve of the Missouri direct drainage area to the Chariton River. The average daily flow at the Prairie Hill and Livonia gage for each day during the period from August 2, 1979 to May 10, 2010, was collected for the TMDL analysis. The difference between these gages flow duration curve was used to estimate the flow duration curve for the direct drainage area. The percent exceedance values for the difference between the gages were multiplied by the recreation season geometric mean water quality target of 126 *E. coli* counts/100 mL to calculate a daily LDC. A detailed discussion of methods used to develop the bacteria LDC is presented in Appendix D.

Table 8. Stream-Flow Stations Used to Estimate Flows in Chariton River near Prairie Hill

River/Station Name	Data Source	Station Number	Drainage Area (mi^2)	Discharge Record	Latitude/ Longitude
Chariton River near Prairie Hill, MO	USGS	06905500	1,870	1979–2010	39°32'23.8"/ 92°47'26.7"
Chariton River at Livonia, MO[9]	USGS	06904050	864	1974-2010	40°29'02.5" / 92°41'09.3"

7.0 Calculation of Loading Capacity

LC is defined as the greatest amount of a pollutant that a water body can assimilate without violating WQS. The TMDL quantifies and allocates the LC to known point and nonpoint sources in the form of WLAs, LAs, a MOS and natural background conditions. The MOS accounts for uncertainty in the relationship between pollutant loads and the quality of the receiving water body. If the MOS is implicit, no numeric allowance is necessary. Conceptually, this definition is represented by Equation 1.

$$LC = \Sigma \text{ WLAs} + \Sigma \text{ LAs} + \text{MOS}$$ **Equation 1**

Where:

LC = Loading capacity

WLAs = Wasteload allocations (point source)

LAs = Load allocations (nonpoint source)

MOS = Margin of safety (may be implicit and factored into a conservative WLA or LA or explicit)

The objective of the TMDL is to estimate allowable pollutant loads and to allocate these loads to known pollutant sources within the watershed so appropriate control measures can be implemented and the WQS can be achieved. According to 40 CFR 130.2 (1), TMDLs can be expressed in terms of mass per time, toxicity or other appropriate measures. For Chariton River, bacteria TMDLs are expressed as *E. coli* counts per day using a LDC (Figure 8). The LDC represents the geometric mean LC as a solid red line and maximum daily limit (MDL) as a solid maroon line over the range of flows.[10] Water quality measurements, shown as round (black)

[9] The Livonia USGS gage is influenced by the regulated releases from the Rathbun Reservoir.

[10] The MDL concentration is 481 *E. coli* counts/100 mL of water. A detailed discussion of methods used to develop the bacteria LDC is presented in Appendix D. The MDL does not establish criterion for Missouri and is not part of Missouri's WQS 10 CSR 20-7.031. The MDL is used as a translation from the geometric mean LC to a daily load (40 CFR Part 130.2(i) and Anacostia Ruling, Friends of the Earth, Inc., et al. v. EPA, No. 05-5015, April 25, 2006). Should Missouri promulgate bacteria criterion in the future, Missouri may revise or modify this TMDL at any time.

points are loads calculated from bacteria concentrations collected in Chariton River near Prairie Hill, Missouri.

As presented in Figure 8, excursions to the bacteria geometric mean criterion occurred during 21 samplings. The geometric mean criteria is 126 *E. coli* counts/100 mL of water, based on a geometric mean of samples collected during the recreation season (April 1 through October 31). Based on the geometric mean of 126 *E. coli* counts /100 mL of water, the 30-year LDC was compared to bacteria data collected during the recreation season and analyzed for exceedances.

8.0 Wasteload Allocation (Point Source Loads)

The WLA is the allowable amount of the pollutant that can be allocated to existing and or future point sources of pollutants. Typically, NPDES permit limits are the most stringent of technology-based effluent limits (TBELs) or water quality–based effluent limitations (WQBELs) for a given pollutant. TBELs are based upon the expected capability of a treatment method to reduce the pollutant to a certain concentration. WQBELs represent the most stringent concentration of a pollutant that a receiving stream can assimilate without exceeding applicable WQS or criteria at a specific location.

There are 28 WWTPs or wastewater treatment facilities (WWTFs) in the Chariton River watershed that discharge 4.9 MGD of treated effluent. The WWTPs or WWTFs have different levels of treatment. Those facilities disinfecting their effluent could reduce bacteria concentrations to very low numbers if operated properly (see Appendix C). WLAs for individual dischargers are the bacteria target multiplied by their design flow.

In the more rural areas of the watershed, there are 10 CAFOs. CAFOs typically use containment structures that capture wastewater, irrigation water, storm water runoff and domestic wastewater. These facilities are no discharge facilities for process wastewater. Wastewater is stored in lagoons and is land applied based on the available nitrogen approach to nutrient management. CAFOs are issued “no discharge” permits and would only discharge due to an extreme storm event. Because CAFOs are listed as no discharge facilities, they would not cause or contribute to the bacteria impairments; therefore, WLAs for these facilities are set to zero.

EPA assumes that other permitted or land-disturbance activities, including monitoring and discharge limitations in the watershed, will be conducted in compliance with Missouri’s Storm Water Permit program. As required under the permit, Storm Water Pollution Prevention Plans (SWPPPs) ensure the design, implementation and maintenance of BMPs. Compliance with the SWPPPs should result in bacteria loading from construction sites at or below applicable targets.

The WLAs listed in this TMDL do not preclude the establishment of future point sources of bacteria 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.

9.0 Load Allocation (Nonpoint Source Loads)

The LA is the allowable amount of the pollutant that can be assigned to nonpoint sources and includes all existing and future nonpoint sources and natural background contributions (40 CFR § 130.2(g)). The TMDL curve is set at the bacteria geometric mean over the range of flows expected in the Chariton River watershed. The LA is set at the remainder of the TMDL loading curve after removing allowances for the point source WLA and MOS. The bacteria TMDLs for the E. coli geometric mean during the recreation season is provided in Figure 10. Table 9 reports the TMDL, WLA, LA and MOS for bacteria at several flows.

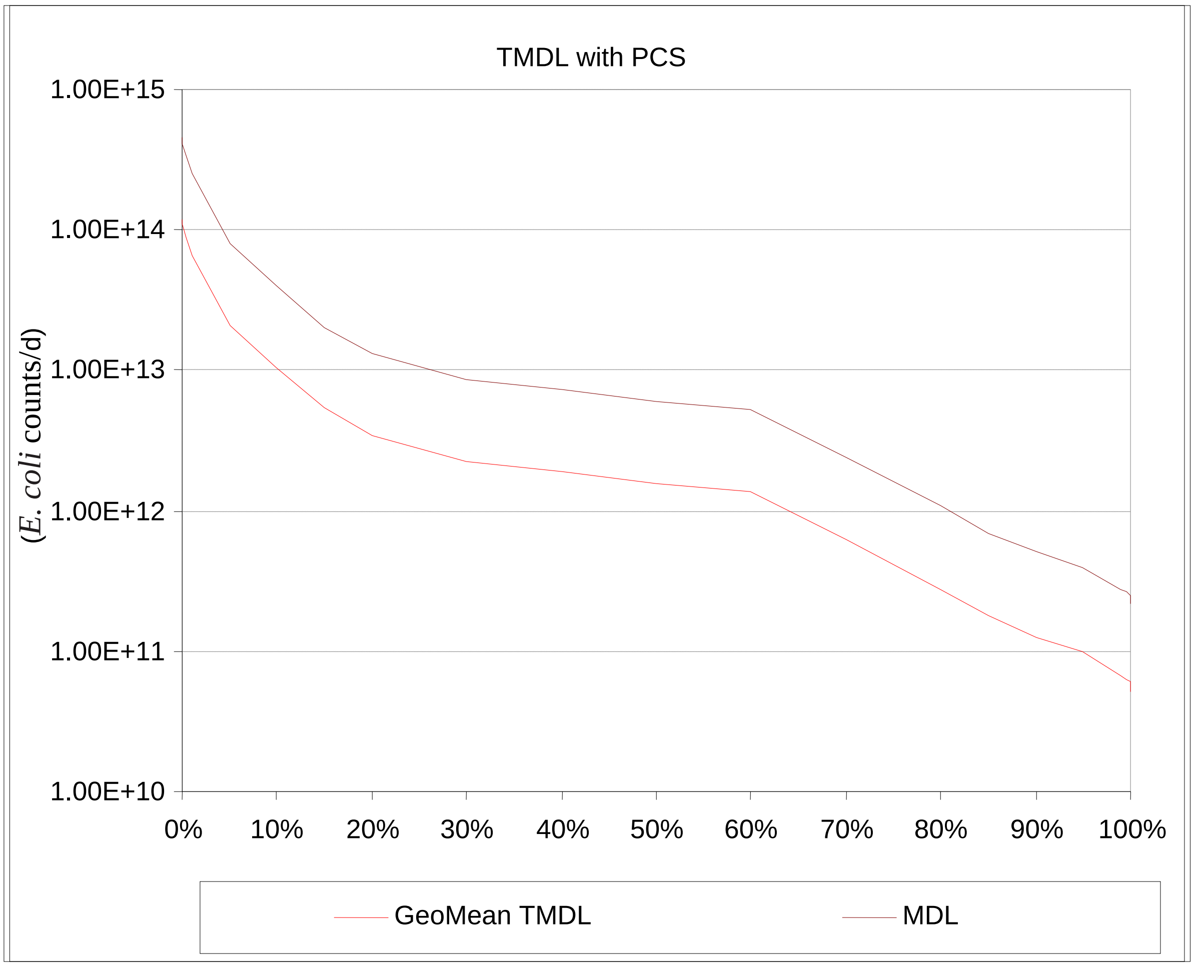

Figure 10. Bacteria LDC for Chariton River Missouri

Table 9. Bacteria TMDL Under a Range of Flow Conditions in Chariton River

Percentile flow Exceedance	Flow (cfs)[1]	Targets Based on Geometric Mean			
		TMDL (counts /day)[2]	WLA (counts /day)	LA (counts /day)	MOS (counts /day)
95	31.9	9.82E+10	5.12E+09	8.33E+10	9.82E+09
90	41.1	1.27E+11	5.12E+09	1.09E+11	1.27E+10
70	202.3	6.24E+11	5.12E+09	5.56E+11	6.24E+10
50	508.7	1.57E+12	5.12E+09	1.41E+12	1.57E+11
30	722.3	2.23E+12	5.12E+09	2.00E+12	2.23E+11
10	3387.5	1.04E+13	5.12E+09	9.39E+12	1.04E+12
5	6804.1	2.10E+13	5.12E+09	1.89E+13	2.10E+12

[1]cfs = cubic feet per second
[2]*E. coli* counts/day

10.0 Margin of Safety

A MOS is required in the TMDL calculation to account for uncertainties in scientific and technical understanding of water quality in natural systems. 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 LC as a separate term in the TMDL.
2. Implicit–Incorporate the MOS as part of the design conditions for the WLA and LA calculations by making conservative assumptions in the analysis.

The MOS for *E. coli* is an explicit 10 percent of the LC at each percentile flow exceedance as shown in Table 9. An implicit MOS was also incorporated into the TMDL based on the conservative assumptions listed below:

- Decay and/or die off of *E. coli* were not accounted for in either the source assessment or in establishment of the load reduction. That is, the entire concentration/load from the source was assumed to be present within the water body and the reductions should focus on the load.

- The TMDL assumed the effluent discharge *E. coli* density allowed by the WLA of 126 *E. coli* counts/100 mL. The WWTF disinfection systems are often designed and operated to achieve 100 percent reduction in the indicator bacteria or 0 *E. coli* counts/100mL. The actual NPDES permitted point source contribution is likely less than expected by the TMDL.

11 Critical Conditions and Seasonal Variation

Chariton River is designated for whole body contact recreation during the period from April 1 to October 31. During this recreation season, the potential for human activities in and around the stream intensify. The TMDL addresses seasonal variation by associating a daily load to every flow during this season. Within this season, the critical season extends from June to October because this is when the flow is generally at its lowest and the stream use is at its peak. If the WQS are met within this critical period, they are sure to be met throughout the recreation season.

The TMDL LDC represents flow under all conditions. Because the WLA, LA and TMDL are applicable at all flow conditions, they are also applicable and protective over all seasons. The advantage of the LDC approach is that all flow conditions are considered and the constraints associated with using a single-flow critical condition are avoided.

12.0 Monitoring Plans

In general, future stream monitoring is scheduled and conducted by MDNR approximately three years after the approval of a TMDL or in a reasonable time frame following the completion of permit compliance schedules and/or the application of new effluent limits. MDNR will routinely examine stream habitat, water quality, invertebrate and fish community data collected by the Resource Assessment and Monitoring Program of the Missouri Department of Conservation. This program randomly samples streams across Missouri on a five- to six- year rotating schedule.

13.0 Reasonable Assurances

MDNR has the authority to issue and enforce Missouri State Operating Permits. Inclusion of effluent limits in a state operating permit and requiring that effluent and instream monitoring be reported to MDNR should provide reasonable assurance that instream WQS will be met. Section 301(b)(1)(C) requires that point source permits have effluent limits as stringent as necessary to meet WQS. However, for WLAs to serve that purpose, they must themselves be stringent enough so that (in conjunction with the water body's other loadings) they meet WQS. This generally occurs when the TMDL's combined nonpoint source LAs and point source WLAs do not exceed the WQS-based LC and there is reasonable assurance that the TMDL's allocations can be achieved. Any discussion of reduction efforts relating to nonpoint sources would be found in the implementation section of the TMDL.

14.0 Public Participation

EPA regulations require that TMDLs be subject to public review (40 CFR 130.7). EPA is providing public notice of this draft TMDL for the Chariton River on the EPA, Region 7, TMDL website: 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 the Chariton River in Schuyler, Putnam, Sullivan, Adair, Macon, Linn, Chariton and Randolph Counties, Missouri, is included on the EPA-approved 2008 Missouri 303(d) List. This TMDL is being established 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 meet the *American Canoe* consent decree milestones. Missouri may submit and EPA may approve, a revised or modified TMDL for this water at any time.

Before finalizing EPA established TMDLs (such as this TMDL), the public is notified that a comment period is open on the EPA Region 7 website for at least 30 days. EPA's public notices to comment on draft TMDLs are also distributed via mail and electronic mail to major stakeholders in the watershed and other potentially impacted parties. After the comment period closes, EPA reviews all comments, edits the TMDL as is appropriate, writes a Summary of Response to Comments and establishes the TMDL. For Missouri TMDLs, groups receiving the public notice announcement include a distribution list provided by MDNR, the Missouri Clean Water Commission, the Missouri Water Quality Coordinating Committee, stream team volunteers, state legislators, County Commissioners, the County Soil and Water Conservation District and potentially impacted cities, towns and facilities. EPA followed this public notice process for this TMDL. Links to active public notices for draft TMDLs, final (approved and established) TMDLs and Summary of Response to Comments are posted on the EPA website: http://www.epa.gov/region07/water/tmdl.htm.

15.0 Administrative Record and Supporting Documentation

An administrative record on the Chariton River TMDL has been assembled and is being kept on file with EPA.

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APPENDIX A – CHARITON RIVER *E. COLI* DATA

ID	Org	Site	Site Name	Year	Month	Day	Time	Flow	*E. coli*
212	USGS	640/19.7	Chariton R. nr. Prairie Hill	1997	10	21	1545	110	80
213	USGS	640/19.7	Chariton R. nr. Prairie Hill	1997	11	17	1620	99	25
214	USGS	640/19.7	Chariton R. nr. Prairie Hill	1997	12	16	1700	1,400	75
215	USGS	640/19.7	Chariton R. nr. Prairie Hill	1998	1	12	1000	1,180	100
216	USGS	640/19.7	Chariton R. nr. Prairie Hill	1998	2	20	915	2,000	350
217	USGS	640/19.7	Chariton R. nr. Prairie Hill	1998	3	11	1000	3,670	1,400
218	USGS	640/19.7	Chariton R. nr. Prairie Hill	1998	4	22	1200	1,330	205
219	USGS	640/19.7	Chariton R. nr. Prairie Hill	1998	5	19	1220	1,120	330
220	USGS	640/19.7	Chariton R. nr. Prairie Hill	1998	6	8	1315	1,070	200
221	USGS	640/19.7	Chariton R. nr. Prairie Hill	1998	7	21	1215	1,820	91
222	USGS	640/19.7	Chariton R. nr. Prairie Hill	1998	8	18	1115	1,470	64
223	USGS	640/19.7	Chariton R. nr. Prairie Hill	1998	9	3	1515	894	120
224	USGS	640/19.7	Chariton R. nr. Prairie Hill	1998	10	27	1215	1,020	290
225	USGS	640/19.7	Chariton R. nr. Prairie Hill	1998	11	16	915	1,290	840
226	USGS	640/19.7	Chariton R. nr. Prairie Hill	1998	12	1	1415	1,480	5,200
227	USGS	640/19.7	Chariton R. nr. Prairie Hill	1999	1	25	1115	2,830	3,700
228	USGS	640/19.7	Chariton R. nr. Prairie Hill	1999	2	23	1230	764	25
229	USGS	640/19.7	Chariton R. nr. Prairie Hill	1999	3	22	1315	1,700	77
230	USGS	640/19.7	Chariton R. nr. Prairie Hill	1999	4	12	1215	932	460
231	USGS	640/19.7	Chariton R. nr. Prairie Hill	1999	5	18	1330	13,100	50
232	USGS	640/19.7	Chariton R. nr. Prairie Hill	1999	6	14	1430	1,230	280
233	USGS	640/19.7	Chariton R. nr. Prairie Hill	1999	7	26	1330	1,280	800
234	USGS	640/19.7	Chariton R. nr. Prairie Hill	1999	8	9	1330	1,260	38
235	USGS	640/19.7	Chariton R. nr. Prairie Hill	1999	9	14	815	92	26
470	USGS	640/19.7	Chariton R. nr. Prairie Hill	1999	11	29	1515	75	8
472	USGS	640/19.7	Chariton R. nr. Prairie Hill	2000	3	6	1230	191	0.499
473	USGS	640/19.7	Chariton R. nr. Prairie Hill	2000	5	1	1400	55	15
474	USGS	640/19.7	Chariton R. nr. Prairie Hill	2000	7	10	1430	344	200
475	USGS	640/19.7	Chariton R. nr. Prairie Hill	2000	9	13	850	33	73
609	USGS	640/19.7	Chariton R. nr. Prairie Hill	2000	11	20	1430	65	1
610	USGS	640/19.7	Chariton R. nr. Prairie Hill	2001	1	2	1550	66	2
611	USGS	640/19.7	Chariton R. nr. Prairie Hill	2001	3	5	1500	2,970	83
612	USGS	640/19.7	Chariton R. nr. Prairie Hill	2001	5	1	1345	1,770	25
613	USGS	640/19.7	Chariton R. nr. Prairie Hill	2001	7	10	940	1,650	80
614	USGS	640/19.7	Chariton R. nr. Prairie Hill	2001	9	4	1345	188	130
629	USGS	640/19.7	Chariton R. nr. Prairie Hill	2001	11	5	1345	481	34
630	USGS	640/19.7	Chariton R. nr. Prairie Hill	2002	1	7	1525	60	0.499
631	USGS	640/19.7	Chariton R. nr. Prairie Hill	2002	3	5	1420	120	2
632	USGS	640/19.7	Chariton R. nr. Prairie Hill	2002	5	6	1610	5,920	6,800
633	USGS	640/19.7	Chariton R. nr. Prairie Hill	2002	7	15	1350	965	180
700	USGS	640/19.7	Chariton R. nr. Prairie Hill	2002	9	4	1050	61	72
713	USGS	640/19.7	Chariton R. nr. Prairie Hill	2002	11	26	1220	58	5
714	USGS	640/19.7	Chariton R. nr. Prairie Hill	2003	1	10	1300	55	7

ID	Org	Site	Site Name	Year	Month	Day	Time	Flow	*E. coli*
716	USGS	640/19.7	Chariton R. nr. Prairie Hill	2003	5	1	1215	530	13,000
717	USGS	640/19.7	Chariton R. nr. Prairie Hill	2003	7	30	1350	58	36
718	USGS	640/19.7	Chariton R. nr. Prairie Hill	2003	9	11	900	46	140
739	USGS	640/19.7	Chariton R. nr. Prairie Hill	2003	11	5	850	61	27
740	USGS	640/19.7	Chariton R. nr. Prairie Hill	2004	1	7	840	80	20
741	USGS	640/19.7	Chariton R. nr. Prairie Hill	2004	3	1	1550	444	10
742	USGS	640/19.7	Chariton R. nr. Prairie Hill	2004	5	19	1100	136	3,400
743	USGS	640/19.7	Chariton R. nr. Prairie Hill	2004	7	14	1440	1,970	1,600
744	USGS	640/19.7	Chariton R. nr. Prairie Hill	2004	9	1	1335	2,100	690
757	USGS	640/19.7	Chariton R. nr. Prairie Hill	2004	11	8	1340	646	66
758	USGS	640/19.7	Chariton R. nr. Prairie Hill	2005	1	25	845	518	90
759	USGS	640/19.7	Chariton R. nr. Prairie Hill	2005	3	7	1405	535	8
760	USGS	640/19.7	Chariton R. nr. Prairie Hill	2005	5	3	1200	1,110	100
761	USGS	640/19.7	Chariton R. nr. Prairie Hill	2005	7	11	1330	219	150
762	USGS	640/19.7	Chariton R. nr. Prairie Hill	2005	9	6	1330	63	38
779	USGS	640/19.7	Chariton R. nr. Prairie Hill	2005	11	2	950	56	27
780	USGS	640/19.7	Chariton R. nr. Prairie Hill	2006	1	5	830	108	31
781	USGS	640/19.7	Chariton R. nr. Prairie Hill	2006	3	6	1545	82	4
782	USGS	640/19.7	Chariton R. nr. Prairie Hill	2006	5	3	1200	2,640	4,700
783	USGS	640/19.7	Chariton R. nr. Prairie Hill	2006	7	5	1415	84	80
784	USGS	640/19.7	Chariton R. nr. Prairie Hill	2006	9	5	1430	74	11
803	USGS	640/19.7	Chariton R. nr. Prairie Hill	2006	11	7	850	52	24
804	USGS	640/19.7	Chariton R. nr. Prairie Hill	2007	1	4	930	535	460
805	USGS	640/19.7	Chariton R. nr. Prairie Hill	2007	2	13	1330	51	30
806	USGS	640/19.7	Chariton R. nr. Prairie Hill	2007	3	6	1435	680	370
807	USGS	640/19.7	Chariton R. nr. Prairie Hill	2007	4	3	930	861	400
808	USGS	640/19.7	Chariton R. nr. Prairie Hill	2007	5	2	1000	1,840	270
809	USGS	640/19.7	Chariton R. nr. Prairie Hill	2007	6	5	1407	1,480	860
810	USGS	640/19.7	Chariton R. nr. Prairie Hill	2007	7	10	935	1,400	120
811	USGS	640/19.7	Chariton R. nr. Prairie Hill	2007	9	11	925	1,030	280
352	IDNR	640/IOWAb	Chariton R. nr. Centerville	1999	10	25		13	27
353	IDNR	640/IOWAb	Chariton R. nr. Centerville	1999	11	29		13	300
354	IDNR	640/IOWAb	Chariton R. nr. Centerville	1999	12	13		12	45
355	IDNR	640/IOWAb	Chariton R. nr. Centerville	2000	1	5		13	10
356	IDNR	640/IOWAb	Chariton R. nr. Centerville	2000	2	14		12	10
357	IDNR	640/IOWAb	Chariton R. nr. Centerville	2000	3	6		12	10
358	IDNR	640/IOWAb	Chariton R. nr. Centerville	2000	4	3		12	27
359	IDNR	640/IOWAb	Chariton R. nr. Centerville	2000	5	2		12	140
360	IDNR	640/IOWAb	Chariton R. nr. Centerville	2000	6	20		11	530
361	IDNR	640/IOWAb	Chariton R. nr. Centerville	2000	7	24		17	170
362	IDNR	640/IOWAb	Chariton R. nr. Centerville	2000	8	28		16	320
363	IDNR	640/IOWAb	Chariton R. nr. Centerville	2000	9	12		17	280
364	IDNR	640/IOWAb	Chariton R. nr. Centerville	2000	10	5		7	940
365	IDNR	640/IOWAb	Chariton R. nr. Centerville	2000	11	9		9	330
366	IDNR	640/IOWAb	Chariton R. nr. Centerville	2000	12	7		11	0

ID	Org	Site	Site Name	Year	Month	Day	Time	Flow	*E. coli*
367	IDNR	640/IOWAb	Chariton R. nr. Centerville	2001	1	3		8	63
368	IDNR	640/IOWAb	Chariton R. nr. Centerville	2001	2	8		10	280
582	IDNR	640/IOWAb	Chariton R. nr. Centerville	2001	3	8	1120	1,200	10
583	IDNR	640/IOWAb	Chariton R. nr. Centerville	2001	4	3	1115	1,500	4.99
584	IDNR	640/IOWAb	Chariton R. nr. Centerville	2001	5	1	1120	800	18
585	IDNR	640/IOWAb	Chariton R. nr. Centerville	2001	6	6	1130	800	4,900
586	IDNR	640/IOWAb	Chariton R. nr. Centerville	2001	7	3	1200	1,500	20
587	IDNR	640/IOWAb	Chariton R. nr. Centerville	2001	8	1	1100	800	30
588	IDNR	640/IOWAb	Chariton R. nr. Centerville	2001	9	4	1145	12	140
589	IDNR	640/IOWAb	Chariton R. nr. Centerville	2001	10	2	1115	21	280
590	IDNR	640/IOWAb	Chariton R. nr. Centerville	2001	11	5	1230	13	120
591	IDNR	640/IOWAb	Chariton R. nr. Centerville	2001	12	3	1245	11	10
592	IDNR	640/IOWAb	Chariton R. nr. Centerville	2002	1	2	1130		4.99
593	IDNR	640/IOWAb	Chariton R. nr. Centerville	2002	2	4	1100	13	10
594	IDNR	640/IOWAb	Chariton R. nr. Centerville	2002	3	4	110		4.99
595	IDNR	640/IOWAb	Chariton R. nr. Centerville	2002	4	1	1145	8	10
596	IDNR	640/IOWAb	Chariton R. nr. Centerville	2002	5	1	1215	13	240
597	IDNR	640/IOWAb	Chariton R. nr. Centerville	2002	6	3	1145	1,500	10
598	IDNR	640/IOWAb	Chariton R. nr. Centerville	2002	7	1	1120	160	140
599	IDNR	640/IOWAb	Chariton R. nr. Centerville	2002	8	5	1230	9	160
600	IDNR	640/IOWAb	Chariton R. nr. Centerville	2002	9	4	1045	11	110
601	IDNR	640/IOWAb	Chariton R. nr. Centerville	2002	10	1	1115	11	140
602	IDNR	640/IOWAb	Chariton R. nr. Centerville	2002	11	5		10	54
603	IDNR	640/IOWAb	Chariton R. nr. Centerville	2002	12	2	1115	8	4.99
604	IDNR	640/IOWAb	Chariton R. nr. Centerville	2003	1	6	1115	9	54
605	IDNR	640/IOWAb	Chariton R. nr. Centerville	2003	2	3	1045		4.99
606	IDNR	640/IOWAb	Chariton R. nr. Centerville	2003	3	3	1115	9	4.99
607	IDNR	640/IOWAb	Chariton R. nr. Centerville	2003	4	1	1100	10	10
608	IDNR	640/IOWAb	Chariton R. nr. Centerville	2003	5	5	1125	9	4,500
609	IDNR	640/IOWAb	Chariton R. nr. Centerville	2003	6	4	1130	11	54
610	IDNR	640/IOWAb	Chariton R. nr. Centerville	2003	7	2	1145	19	300
611	IDNR	640/IOWAb	Chariton R. nr. Centerville	2003	8	4	1145	14	120
612	IDNR	640/IOWAb	Chariton R. nr. Centerville	2003	9	1	1030	14	200
613	IDNR	640/IOWAb	Chariton R. nr. Centerville	2003	10	1	1300	22	81
689	IDNR	640/IOWAb	Chariton R. nr. Centerville	2003	11	3		16	490
690	IDNR	640/IOWAb	Chariton R. nr. Centerville	2003	12	1		24	27
691	IDNR	640/IOWAb	Chariton R. nr. Centerville	2004	1	7			10
692	IDNR	640/IOWAb	Chariton R. nr. Centerville	2004	2	3			10
693	IDNR	640/IOWAb	Chariton R. nr. Centerville	2004	3	1		7	10
694	IDNR	640/IOWAb	Chariton R. nr. Centerville	2004	4	5		200	0
695	IDNR	640/IOWAb	Chariton R. nr. Centerville	2004	5	3		8	110
696	IDNR	640/IOWAb	Chariton R. nr. Centerville	2004	6	1		7	2,000
697	IDNR	640/IOWAb	Chariton R. nr. Centerville	2004	7	1		810	81
698	IDNR	640/IOWAb	Chariton R. nr. Centerville	2004	8	2		10	1,200
699	IDNR	640/IOWAb	Chariton R. nr. Centerville	2004	9	1		800	260

ID	Org	Site	Site Name	Year	Month	Day	Time	Flow	*E. coli*
700	IDNR	640/IOWAb	Chariton R. nr. Centerville	2004	10	4		98	100
701	IDNR	640/IOWAb	Chariton R. nr. Centerville	2004	11	1		4	700
702	IDNR	640/IOWAb	Chariton R. nr. Centerville	2004	12	1		3	63
703	IDNR	640/IOWAb	Chariton R. nr. Centerville	2005	1	4			63
704	IDNR	640/IOWAb	Chariton R. nr. Centerville	2005	2	1		20	590
705	IDNR	640/IOWAb	Chariton R. nr. Centerville	2005	3	1			0
706	IDNR	640/IOWAb	Chariton R. nr. Centerville	2005	4	4		7	10
707	IDNR	640/IOWAb	Chariton R. nr. Centerville	2005	5	2		800	20
708	IDNR	640/IOWAb	Chariton R. nr. Centerville	2005	6	1		5	90
709	IDNR	640/IOWAb	Chariton R. nr. Centerville	2005	7	6		400	40
710	IDNR	640/IOWAb	Chariton R. nr. Centerville	2005	8	1		14	140
711	IDNR	640/IOWAb	Chariton R. nr. Centerville	2005	9	6		12	30
712	IDNR	640/IOWAb	Chariton R. nr. Centerville	2005	10	3		15	430
713	IDNR	640/IOWAb	Chariton R. nr. Centerville	2005	11	1		10	50
714	IDNR	640/IOWAb	Chariton R. nr. Centerville	2005	12	7			0
715	IDNR	640/IOWAb	Chariton R. nr. Centerville	2006	1	4		8	20
716	IDNR	640/IOWAb	Chariton R. nr. Centerville	2006	2	1		13	10
717	IDNR	640/IOWAb	Chariton R. nr. Centerville	2006	3	1		9	0
718	IDNR	640/IOWAb	Chariton R. nr. Centerville	2006	4	4		9	140
719	IDNR	640/IOWAb	Chariton R. nr. Centerville	2006	5	2		9	2,100
720	IDNR	640/IOWAb	Chariton R. nr. Centerville	2006	6	1		7	180
721	IDNR	640/IOWAb	Chariton R. nr. Centerville	2006	7	3		8	250
722	IDNR	640/IOWAb	Chariton R. nr. Centerville	2006	8	1		10	100
723	IDNR	640/IOWAb	Chariton R. nr. Centerville	2006	9	6		4	200
724	IDNR	640/IOWAb	Chariton R. nr. Centerville	2006	10	2		12	50
725	IDNR	640/IOWAb	Chariton R. nr. Centerville	2006	11	1		11	20
726	IDNR	640/IOWAb	Chariton R. nr. Centerville	2006	12	4		10	370
727	IDNR	640/IOWAb	Chariton R. nr. Centerville	2007	1	4		11	60
728	IDNR	640/IOWAb	Chariton R. nr. Centerville	2007	2	6			0
754	IDNR	640/IOWAb	Chariton R. nr. Centerville	2007	3	5	1130	10	30
755	IDNR	640/IOWAb	Chariton R. nr. Centerville	2007	4	2	1110	43	90
756	IDNR	640/IOWAb	Chariton R. nr. Centerville	2007	5	1	1100	790	27
757	IDNR	640/IOWAb	Chariton R. nr. Centerville	2007	6	4	1050	800	50
758	IDNR	640/IOWAb	Chariton R. nr. Centerville	2007	7	5	1145	1,200	20
759	IDNR	640/IOWAb	Chariton R. nr. Centerville	2007	8	1	1220	400	36
760	IDNR	640/IOWAb	Chariton R. nr. Centerville	2007	9	5	1210	400	60
761	IDNR	640/IOWAb	Chariton R. nr. Centerville	2007	10	1	1130	800	20
762	IDNR	640/IOWAb	Chariton R. nr. Centerville	2007	11	5	1030	800	30
763	IDNR	640/IOWAb	Chariton R. nr. Centerville	2007	12	3	1050	800	10
764	IDNR	640/IOWAb	Chariton R. nr. Centerville	2008	1	7	1130	200	1,100
765	IDNR	640/IOWAb	Chariton R. nr. Centerville	2008	2	5	1030	790	30
766	IDNR	640/IOWAb	Chariton R. nr. Centerville	2008	3	4	1120		190
767	IDNR	640/IOWAb	Chariton R. nr. Centerville	2008	4	1	1140	1,200	450
768	IDNR	640/IOWAb	Chariton R. nr. Centerville	2008	5	5	1140	790	30
769	IDNR	640/IOWAb	Chariton R. nr. Centerville	2008	6	2	1110	790	60

ID	Org	Site	Site Name	Year	Month	Day	Time	Flow	*E. coli*
770	IDNR	640/IOWAb	Chariton R. nr. Centerville	2008	7	9	1305	12	6,700
771	IDNR	640/IOWAb	Chariton R. nr. Centerville	2008	8	6	1145	1,500	40
772	IDNR	640/IOWAb	Chariton R. nr. Centerville	2008	9	4	1040	1,500	60

Note: Blank cells in the "Time" column indicate that the specific time of sample collection was not provided in the Missouri water quality database. Blank cells in flow column indicate flow was not collected during the sampling event.
R = River in Site Name
nr. = near in Site Name

APPENDIX B – CHARITON RIVER SOIL DATA

Soil Name	Hydrologic Group	Area (mi²)	Area (acre)
Ackmore silt loam	B	1.099	703.46
Adair clay loam	C	13.180	8,435.02
Adair loam	C	26.028	16,658.05
Adair soils	C	1.300	831.72
Adair-Shelby complex	C	10.269	6,572.27
Adco silt loam	D	5.755	3,683.40
Alvin loamy sand	B	0.220	140.84
Amana silt loam	B	3.630	2,323.00
Amana silty clay loam	B	5.244	3,356.02
Animal waste lagoon	NR	0.005	3.32
Appanoose silt loam	D	2.559	1,637.82
Arbela and Humeston soils	C/D	1.541	986.45
Arbela silt loam	C/D	1.551	992.64
Arbela silty clay loam	C/D	1.078	689.97
Arents	D	0.022	13.83
Arispe silty clay loam	C	29.628	18,961.70
Armstrong clay loam	C	88.088	56,376.62
Armstrong loam	C	178.364	114,153.20
Armstrong soils	C	2.167	1,386.72
Armstrong-Gara complex	C	3.619	2,316.01
Armstrong-Gara loams	C	12.338	7,896.22
Ashgrove silt loam	D	0.289	184.81
Beckwith silt loam	D	0.087	55.66
Belinda silt loam	D	3.786	2,422.72
Bevier silt loam	C	0.921	589.17
Bevier silty clay loam	C	26.675	17,071.88
Blackoar silt loam	D	5.341	3,418.33
Booker silty clay	D	1.265	809.72
Bremer loam	D	2.041	1,306.50
Bremer silt loam	C/D	4.261	2,727.30

Soil Name	Hydrologic Group	Area (mi^2)	Area (acre)
Bucknell silty clay loam	D	1.737	1,111.62
Bucknell-Gara complex	D	0.154	98.84
Built wetland	NR	0.006	3.99
Caleb loam	B	4.385	2,806.59
Caleb soils	B	3.828	2,449.98
Caleb-Mystic complex	B	0.399	255.61
Cantril loam	C	0.766	489.94
Carlow silty clay	D	34.131	21,843.91
Chariton silt loam	D	1.832	1,172.29
Chequest silt loam	C	0.046	29.55
Chequest silty clay loam	C/D	19.177	12,273.19
Clarinda silty clay	D	0.159	101.71
Clarinda silty clay loam	D	102.524	65,615.56
Clarinda soils	D	3.891	2,490.43
Colo silt loam	B/D	11.277	7,217.23
Colo silty clay loam	B/D	8.514	5,448.82
Colo-Ely silty clay loams	B/D	0.018	11.82
Colo-Zook silt loams	B/D	0.395	252.69
Coppock silt loam	B	2.712	1,735.94
Cotter silt loam	B	2.191	1,402.21
Crestmeade silt loam	D	0.504	322.42
Darwin silty clay	D	17.298	11,070.61
Dockery and Tice silt loams	C	20.251	12,960.33
Dockery silt loam	C	36.072	23,086.09
Edina silt loam	D	71.911	46,022.77
Excello silt loam	B/D	1.964	1,257.04
Fatima silt loam	B	2.106	1,347.67
Floris loam	B	11.014	7,048.77
Floris silt loam	B	3.885	2,486.56
Gara clay loam	C	34.517	22,091.09
Gara fine sandy loam	C	35.647	22,814.38
Gara loam	C	77.488	49,592.54
Gara soils	C	5.598	3,582.56

Soil Name	Hydrologic Group	Area (mi^2)	Area (acre)
Gara-Armstrong clay loams	C	0.111	70.87
Gara-Armstrong complex	C	1.944	1,244.44
Gara-Armstrong loams	C	0.132	84.75
Gifford silt loam	D	7.545	4,829.10
Gifford silty clay loam	D	4.452	2,849.59
Gorin silt loam	C	21.355	13,667.40
Gorin silty clay loam	C	2.414	1,544.87
Gorin-Winnegan complex	C	31.262	20,007.84
Gosport loam	D	0.471	301.22
Gosport silty clay loam	D	12.502	8,001.49
Gosport-Clanton silt loams	C	2.656	1,700.06
Grundy silt loam	C	11.529	7,378.32
Grundy silty clay loam	C	46.959	30,053.68
Haig silt loam	C/D	12.252	7,841.03
Haig silty clay loam	C/D	6.969	4,460.05
Haynie-Waldron complex	B	0.031	19.85
Higginsville silt loam	C	6.619	4,235.94
Humeston silt loam	C/D	1.372	878.05
Humeston silty clay loam	C/D	3.894	2,492.05
Intermittent Water	A	0.257	164.32
Kennebec and Fatima soils	B	2.645	1,693.10
Kennebec silt loam	B	0.060	38.65
Kennebec-Amana silt loams	B	8.217	5,258.71
Keswick clay loam	C	19.084	12,213.86
Keswick loam	C	54.326	34,768.80
Keswick silt loam	C	3.798	2,430.74
Keswick soils	C	0.825	527.85
Kilwinning silt loam	D	2.207	1,412.37
Kniffin silt loam	C	29.193	18,683.35
Knox silty clay loam	B	2.649	1,695.41
Lagonda silt loam	C	10.610	6,790.38
Lagonda silty clay loam	C	14.531	9,299.96
Lamoni clay loam	C	7.725	4,943.90

Soil Name	Hydrologic Group	Area (mi^2)	Area (acre)
Lamoni loam	C	1.421	909.31
Lamoni silty clay loam	C	26.484	16,949.57
Lamoni soils	C	3.361	2,150.91
Lamoni-Shelby complex	C	3.149	2,015.34
Landes fine sandy loam	B	0.229	146.71
Landes loam	B	8.409	5,381.47
Lawson silt loam	B	0.134	85.47
Lawson-Nodaway complex	B	6.603	4,225.70
Lenzburg clay loam	D	0.042	27.16
Lenzburg silty clay loam	D	0.201	128.82
Leonard silt loam	D	1.761	1,127.28
Leonard silty clay loam	D	1.697	1,086.00
Lindley loam	C	21.308	13,637.05
Lindley soils	C	2.236	1,431.03
Lineville silt loam	C	7.394	4,732.34
Marion silt loam	D	2.062	1,319.64
Marsh	NR	0.545	349.05
Menfro silt loam	B	2.236	1,430.99
Miscellaneous water	NR	0.057	36.71
Modale silt loam	C	0.020	13.06
Moniteau silt loam	C/D	1.288	824.54
Mystic clay loam	C	2.283	1,460.97
Mystic silt loam	C	8.388	5,368.64
Mystic soils	C	3.976	2,544.70
Mystic variant silty clay loam	D	0.128	81.67
Mystic-Caleb complex	C	5.140	3,289.73
Newcomer loam	C	0.342	218.59
Nodaway silt loam	B	16.962	10,855.82
Nodaway-Alluvial land complex	B	0.963	616.44
Nodaway-Lawson complex	B	7.861	5,031.21
Nodaway-Lawson silt loams	B	0.061	39.23
Norborne loam	B	0.901	576.93
Olmitz loam	B	5.004	3,202.29

Soil Name	Hydrologic Group	Area (mi^2)	Area (acre)
Olmitz-Colo-Vesser complex	B	0.763	488.18
Olmitz-Vesser-Colo complex	B	57.365	36,713.84
Olmitz-Vesser-Zook complex	B	0.128	81.88
Olmitz-Zook-Colo complex	B	0.967	618.99
Olmitz-Zook-Vesser complex	B	0.809	517.51
Orthents	NR	0.100	63.98
Parkville silty clay loam	C	0.112	71.90
Pershing silt loam	C	13.439	8,601.15
Pershing silty clay loam	D	21.114	13,512.99
Piopolis silty clay loam	D	1.330	851.39
Pits	NR	2.005	1282.89
Plainfield loamy sand	A	0.899	575.41
Portage silty clay	D	0.374	239.05
Purdin clay loam	C	32.698	20,926.44
Purdin loam	C	38.028	24,337.77
Putco clay loam	B	0.295	189.08
Putco silty clay loam	B	1.434	917.60
Putnam silt loam	D	0.240	153.85
Radford silt loam	B	0.795	509.00
Rathbun silt loam	D	10.957	7,012.39
Reger fine sandy loam	B	0.481	307.73
Reger very fine sandy loam	B	2.806	1,795.71
Rinda silty clay loam	D	3.703	2,369.62
Riverwash	A	0.582	372.62
Schuline clay loam	C	6.402	4,097.06
Sewage lagoon	NR	0.066	42.07
Seymour silt loam	C	56.788	36,344.57
Seymour silty clay loam	C	42.427	27,153.57
Shannondale silt loam	C	3.878	2,481.87
Sharpsburg silty clay loam	B	0.027	17.56
Shelby clay loam	C	10.689	6,840.91
Shelby loam	C	39.290	25,145.87
Shelby soils	C	7.103	4,545.66

Soil Name	Hydrologic Group	Area (mi^2)	Area (acre)
Shelby-Adair clay loams	C	1.388	888.52
Shelby-Adair complex	C	2.366	1,514.40
Shelby-Adair loams	C	0.018	11.30
Sogn-Gosport-Clanton complex	D	1.790	1,145.46
Speed silt loam	C	9.105	5,827.09
Strip mines		0.258	165.40
Tice silt loam	C	17.223	11,022.56
Tice silty clay loam	C	4.610	2,950.29
Tina silt loam	C	8.623	5,518.65
Triplett silt loam	D	10.737	6,871.62
Tuskeego silt loam	C/D	1.897	1,214.11
Tuskeego silty clay loam	C/D	0.692	442.78
Udorthents	NR	0.437	279.75
Vanmeter loam	D	6.637	4,247.48
Vanmeter silty clay loam	D	27.748	17,758.52
Vesser silt loam	C/D	26.668	17,067.35
Vigar loam	C	9.871	6,317.49
Vigar silt loam	C	2.283	1,460.93
Vigar-Zook-Excello complex	B/D	5.649	3,615.55
Vigar-Zook-Nodaway complex	B	10.893	6,971.75
Wabash silty clay	D	6.735	4,310.13
Wabash silty clay loam	D	2.572	1,646.03
Wakenda silt loam	B	4.751	3,040.34
Water	NR	34.560	22,118.22
Weller silt loam	C	5.013	3,208.05
Weller silty clay loam	C	0.074	47.49
Wilbur silt loam	B	5.594	3,580.24
Winnegan clay loam	C	6.707	4,292.44
Winnegan loam	C	307.786	19,6983.36
Wiota silt loam	B	0.610	390.27
Zook and Excello soils	B/D	0.886	566.84
Zook silt loam	C/D	0.567	363.16
Zook silty clay loam	C/D	53.527	34,257.24

Soil Name	Hydrologic Group	Area (mi^2)	Area (acre)
Zook-Colo silty clay loams	C/D	0.991	633.95
Zook-Olmitz-Vesser complex	C/D	10.639	6,809.19
	Total	2369.990	1,516,793.51

Mi^2 = square miles

NR = Not reported

Note: See Section 2.2 Physiographic Location, Geology and Soils for a description of the soil groups

APPENDIX C – PERMITTED FACILITIES IN THE CHARITON RIVER WATERSHED

WASTEWATER TREATMENT PLANTS								
State ID	**Name**	**Number of Outfalls**	**Flow Rate (MGD)**	**Classified Receiving Water body**	**Facility Type**	**Permit Issue Date**	**Permit Expiration**	**Disinfection Status[1]**
IA0410001	City of Cincinnati STP	1	0.0610	UNNAMED TRIBUTARY TO SHOAL CREEK	Municipal	N/A	N/A	
IA0426001	City of Exline STP	1	0.0206	PIGEON CREEK	Municipal	07/08/2005	07/07/2010	
IA9368001	City of Seymour STP	2	0.1100	UNNAMED TRIBUTARY TO COOPER CREEK	Municipal	04/18/2006	04/17/2011	
IA9303003	City of Allerton STP (North)	1	0.0200	WEST JACKSON CREEK TO JACKSON CREEK	Municipal	05/21/2008	05/20/2013	
IA0407004	City of Centerville STP (West)	2	0.4100	MANSON BRANCH CREEI TO COOPER CREEK	Municipal	N/A	N/A	
IA0407003	City of Centerville STP (East)	2	1.5000	CATHEDRAL CREEK TO COOPER CREEK	Municipal	N/A	N/A	
IA9334004	City of Corydon STP	1	0.9360	UNNAMED TRIBUTARY TO WEST JACKSON CREEK	Municipal	N/A	N/A	
IA0477001	City of Mystic STP	1	0.0710	UNNAMED TRIBUTARY TO WALNUT CREEK	Municipal	04/11/2005	04/10/2010	
IA0400918	Rathbun Regional Water Association	1	0.0380	CHARITON RIVER	Municipal	12/17/2008	12/16/2013	
IA9348001	City of Humeston WWTP	1	0.3250	UNNAMED TRIBUTARY TO CHARITON RIVER	Municipal	N/A	N/A	
IA5939001	City of Russell STP	1	0.1070	HONEY CREEK TO CHARITON RIVER	Municipal	N/A	N/A	
MO0026646	Unionville South WWTF	4	0.3500	TRIB S BLACKBIRD CREEK	Municipal	07/13/2007	07/12/2012	None
MO0048640	Keytesville WWTF	1	0.0500	MUSSEL FORK	Municipal	12/08/2006	12/07/2011	Planned
MO0054569	Unionville North WWTF	4	0.2000	TRIB N BLACKBIRD CREEK	Municipal	07/13/2007	07/12/2012	None
MO0056634	Salisbury WWTF	1	0.0280	PUZZLE CREEK	Municipal	12/22/2006	12/21/2011	None
MO0056987	Novinger WWTF	1	0.0710	SPRING CREEK	Municipal	12/22/2006	12/21/2011	Planned
MO0057215	Wildflower Com Assoc WWTF	1	0.0855	NORTH BLACKBIRD CREEK	Non-municipal	07/13/2007	07/12/2012	None
MO0085928	Bucklin East WWTF	1	0.0654	TRIB VAN DORSAN CREEK	Municipal	02/13/2009	02/12/2014	None

WASTEWATER TREATMENT PLANTS								
State ID	**Name**	**Number of Outfalls**	**Flow Rate (MGD)**	**Classified Receiving Water body**	**Facility Type**	**Permit Issue Date**	**Permit Expiration**	**Disinfection Status[1]**
MO0088510	Lake Nehai Tonkayea WWTF	1	0.0090	TRIB MUSSEL FORK CREEK	Non-municipal	11/03/2006	11/02/2011	Planned
MO0094706	New Cambria WWTF	1	0.0390	UN TRIB PUZZLE CREEK	Municipal	01/09/2009	01/08/2014	None
MO0103322	Green Castle Lagoon System	1	0.0265	TRIB MUSSEL FORK	Municipal	11/03/2006	11/02/2011	None
MO0112135	Green City WWTF	1	0.1000	TRIB MUSSEL FORK CREEK	Municipal	06/01/2007	05/31/2012	None
MO0121916	Livonia WWTF	1	0.0155	OLD CHANNEL CHARITON	Municipal	03/23/2007	03/22/2012	Planned
MO0129267	Spring Lake Sewer Co WWTP	1	0.0300	TRIB ELM CREEK	Non-municipal	03/24/2006	03/23/2011	Yes
MOG640038	Kirksville WTP	1	0.0000	TRIB TO FOREST LK	Non-municipal	12/12/2008	10/23/2013	n/a
MOG640165	Salisbury WTP	1	0.0000	TRIB PUZZLE CREEK	Non-municipal	12/19/2008	10/23/2013	n/a
MOG640189	Unionville WTP	1	0.0000	TRIB S BLACKBIRD CREEK	Non-municipal	12/19/2008	10/23/2013	n/a
MOG640210	Keytesville Water Treatment	1	0.0000	TRIB MUSSEL FORK CREEK	Non-municipal	12/24/2008	10/23/2013	n/a

QUARRIES							
State ID	**Name**	**Number of Outfalls**	**Flow Rate (MGD)**	**Classified Receiving Water body**	**Facility Type**	**Permit Issue Date**	**Permit Expiration**
IA0400103	L&W Quarries, Inc. (Quarry #8)	1	0.0000	WALNUT CREEK TO CHARITON RIVER	Non-municipal	N/A	N/A
IA0400102	L&W Quarries, Inc. (Quarry #5)	1	0.0000	SOUTH FORK CHARITON RIVER TO CHARITON RIVER	Non-municipal	N/A	N/A
IA0400101	L&W Quarries, Inc. (Quarry #3)	1	0.0000	SOUTH FORK CHARITON RIVER TO CHARITON RIVER	Non-municipal	N/A	N/A
MOG490422	Chariton County Concrete	1	0.0000	TRIB PUZZLE CREEK	Non-municipal	12/22/2006	10/05/2011
MOG500057	W.L. Miller Company Sand	1	0.0000	CHARITON RIVER	Non-municipal	02/18/2005	02/03/2010
MOG490824	Glasgow Quarries, Inc.	1	0.0000	TRIB CLARKS CREEK	Non-municipal	01/05/2007	10/05/2011

[1] Applies to the Missouri site specific permits only
n/a = not applicable
Yes = does disinfect
None = does not disinfect and do not have a schedule of compliance (SOC) to meet disinfection requirements
Planned = these permits are under a SOC to meet disinfection requirements

CONCENTRATED ANIMAL FEEDING OPERATIONS							
State ID	**Name**	**Number of Outfalls**	**Flow Rate (MGD)**	**Classified Receiving Water body**	**Facility Type**	**Permit Issue Date**	**Permit Expiration**
MO0117421	PSF, Whitetail Finishing	19	0.0000	SHOAL/SANDY/N BLKBRD	AFO–CAFO	04/16/2004	04/15/2009
MO0118478	PSF, Valley View Finishing	25	0.0000	EAST YELLOW CR/MUSSEL CR	AFO–CAFO	04/16/2004	04/15/2009
MO0118486	PSF, Green Hills Finishing	17	0.0000	SPRING CR	AFO–CAFO	04/16/2004	04/15/2009
MOG010170	Joe E. Jones Farms, Inc.	1	0.0000	MUSSEL FK CK	AFO–CAFO	09/21/2007	02/23/2011
MOG010206	Ricketts Farm Service	1	0.0000	TRIB CHARITON R.	AFO–CAFO	07/21/2006	02/23/2011
MOG010415	Cooper Pork Farm	1	0.0000	SWEEZER CR	AFO–CAFO	01/25/2002	02/22/2006
MOG010425	Vasey, Lawrence	3	0.0000	TRIB MUSSEL FK CREEK	AFO–CAFO	09/21/2007	02/23/2011
MOG010426	Ronald Blankenship	2	0.0000	TRIB TO SANDY CREEK	AFO–CAFO	04/06/2007	02/23/2011
MOG010450	Pearson Farms	2	0.0000	WILLIAMS BRNCH	AFO–CAFO	03/30/2007	02/23/2011
MOG010464	Fowler Farms–Chad Fowler	1	0.0000	N. BLACKBIRD CREEK	AFO–CAFO	03/30/2007	02/23/2011
MOG010491	Putnam CountyH&H Farms	1	0.0000	TRIB TO SHOAL CREEK	AFO–CAFO	07/13/2007	02/23/2011
MOG010496	King Farms	1	0.0000	TRIB TO MUSSEL FORK	AFO–CAFO	08/01/2008	02/23/2011
MOG010604	Overton Farm	1	0.0000	TRIB CHARITON RIVER	AFO–CAFO	03/16/2007	02/23/2011
MOG010648	Davis Farm	1	0.0000	TRIB OLD CH CHARITON	AFO–CAFO	09/22/2006	02/23/2011
MOG010657	L&D Farms	1	0.0000	TRIB MUSSEL FORK CK	AFO–CAFO	04/27/2007	02/23/2011
MOG010685	J.D. Wright Farms	1	0.0000	TRIB COTTONWOOD CK	AFO–CAFO	11/30/2007	02/23/2011
MOG010695	Bruce Baughman	1	0.0000	TRIB SHOAL CK	AFO–CAFO	08/01/2008	02/23/2011
MOG010711	Polson Family Hog Farm	1	0.0000	TRIB TURKEY CK	AFO–CAFO	02/09/2009	02/23/2011

OTHER FACILITIES							
State ID	**Name**	**Number of Outfalls**	**Flow Rate (MGD)**	**Classified Receiving Water body**	**Facility Type**	**Permit Issue Date**	**Permit Expiration**
IA0400913	DNR Rathbun Fish Hatchery	1	0.0000	CHARITON RIVER	Non-municipal	03/12/2007	03/11/2012
MO0045501	Lake Road Village Park	1	0.0035	TRIB FOREST LAKE	Non-municipal	09/29/2006	09/28/2011
MO0112526	Amoco, Chariton R Oil Spill	2	0.0000	LITTLE TURKEY CREEK	Non-municipal	06/22/2007	06/21/2012
MO0119741	Rye Creek Landfill	3	0.0000	RYE CREEK	Non-municipal	02/22/2002	02/21/2007
MO0128309	Hutchison Salt–BNSF Raily	2	0.0000	TRIB. LONG BRANCH	Non-municipal	04/25/2008	04/24/2013

OTHER FACILITIES							
State ID	Name	Number of Outfalls	Flow Rate (MGD)	Classified Receiving Water body	Facility Type	Permit Issue Date	Permit Expiration
MOG350065	MFA Bulk Plant, Bucklin	1	0.0000	BR VAN DORSEN CREEK	Non-municipal	07/27/2007	06/14/2012
MOG350078	MFA Bulk Plant, Unionville	1	0.0000	TRIB S BLACKBIRD CREEK	Non-municipal	07/27/2007	06/14/2012
MO0094315	Missouri Mining, So Mines	3	0.0000	KINNEY CREEK	Non-municipal	03/05/1993	03/04/1998
MO0094323	Missouri Mining, No Mines	3	0.0000	L. SANDY & SHOAL CREEKS	Non-municipal	03/05/1993	03/04/1998
MOG500009	Missouri Contractors, LLC	1	0.0000	CHARITON RIVER	Non-municipal	02/18/2005	02/03/2010
MOG821073	D&R Pumping Service Inc.	27	0.0000	TRIB HOG CREEK/CHARITON RIVER/TRIB CHARITON RIVER/TRIB GILL BRANCH/TRIB SUGAR CREEK	Non-municipal	10/26/2007	10/04/2012
MOG821138	R.S. Portable Johns	5	0.0000	UN TR N BLACKBIRD CREEK	Non-municipal	10/19/2007	10/04/2012
MOG822140	King Processing & Catering	1	0.0000	LOCUST BRANCH	Non-municipal	07/28/2006	06/08/2011
MOG822178	Yoder Slaughter Facility	1	0.0000	CHARITON RIVER	Non-municipal	01/29/2010	06/08/2011
MOG670217	Key Station	3	0.0000	CHARITON RIVER	Non-municipal	11/30/2007	10/04/2012
MOG822179	D and R Pumping Service	6	0.0000	SPRING CREEK	Non-municipal	10/23/2009	06/08/2011
MOG491155	Twin States Limestone LLC	1	0.0000	SHOAL CREEK	Non-municipal	04/23/2010	10/05/2011

STORM WATER							
Facility ID	Facility Name	City	State	Status	Permit Type	Permit Issue Date	Permit Expiration
310910404	Longs Recycler	Centerville	IA	Active	General–Industrial Activity	N/A	N/A
310892114	Northside Auto Recyclers	Centerville	IA	Active	General–Industrial Activity	12/01/2003	12/01/2010
310899904	Ideal Ready Mix Company, Inc.	Humeston	IA	Discontinued	General–Industrial Activity	10/01/1992	Discontinued
310887208	IDOT Chariton Maintenance Garage	Chariton	IA	Discontinued	General–Industrial Activity	10/23/2001	Discontinued
311306524	Coates Mfg. Co.	Corydon	IA	Active	General–Industrial Activity	10/01/1992	10/01/2010
310898207	Barker Specialty Products LLC, Centerville	Centerville	IA	Discontinued	General–Industrial Activity	03/30/2001	12/01/2010
310909103	Appanoose County Sanitary Landfill	Centerville	IA	Active	General–Industrial Activity	10/01/1992	Discontinued

STORM WATER							
Facility ID	**Facility Name**	**City**	**State**	**Status**	**Permit Type**	**Permit Issue Date**	**Permit Expiration**
311309045	East Penn Manufacturing Company	Corydon	IA	Active	General–Industrial Activity	10/01/1992	10/01/2012
310998475	Teater's Auto & Salvage	Moulton	IA	Inactive	General–Industrial Activity	11/23/1994	11/23/2007
311010107	Gwinn Automotive	Humeston	IA	Discontinued	General–Industrial Activity	03/13/1997	Discontinued
311305058	Barker Company	Centerville	IA	Active	General–Industrial Activity	09/26/2007	9/26/2011
311042056	McCoy Auto Repair & Salvage	Centerville	IA	Active	General–Industrial Activity	11/30/1994	12/02/2010
310984237	Young Radiator Company, Inc.	Centerville	IA	Discontinued	General–Industrial Activity	10/01/1992	Discontinued
311006627	Chariton Municipal Airport	Chariton	IA	Active	General–Industrial Activity	10/01/1992	9/30/2011
310984853	Grimm's Salvage	Centerville	IA	Discontinued	General–Industrial Activity	05/26/1999	Discontinued
310994971	McClure Auto	Cincinnati	IA	Active	General–Industrial Activity	11/28/1994	11/30/2010
311027019	L&W Quarries, Inc. (Quarry #5)	Centerville	IA	Discontinued	General–Industrial Activity	10/01/1992	Discontinued
311043064	Curwood, Inc.	Centerville	IA	Active	General–Industrial Activity	10/01/1992	10/01/2012
310940828	John B. Danner	Derby	IA	Inactive	General–Industrial Activity	09/15/2003	9/30/2008
310946073	Ed Rust Junkyard	Centerville	IA	Active	General–Industrial Activity	05/27/1995	5/29/2010
310956515	Jef-Scot Metal Industries, Inc.	Centerville	IA	Inactive	General–Industrial Activity	10/01/1992	10/01/1993
310944379	Iowa Steel & Wire Co., Inc.	Centerville	IA	Active	General–Industrial Activity	10/01/1992	10/01/2012
311040598	East WWTP	Centerville	IA	Active	General–Industrial Activity	05/16/2003	3/10/2011
310932266	Iowa Department of Transportation Centerville Maintenance Garage	Centerville	IA	Discontinued	General–Industrial Activity	10/23/2001	Discontinued
310961356	L&W Quarries, Inc. (Quarry #8)	Centerville	IA	Discontinued	General–Industrial Activity	10/01/1992	Discontinued
310924864	Johnson Machine Works	Chariton	IA	Active	General–Industrial Activity	11/15/2002	11/15/2012
310931169	Fluoro-Seal International, LP	Centerville	IA	Discontinued	General–Industrial Activity	10/01/1992	Discontinued
310945641	Centerville Municipal Airport	Centerville	IA	Active	General–Industrial Activity	10/01/1992	10/01/2010
310969958	Centerville Iron & Metal, Inc.	Centerville	IA	Active	General–Industrial Activity	10/01/1992	9/30/2013
MOR10C448	Sinclair Transportation C	Ethel	MO	Active	SLAND	01/30/2009	02/07/2012
MOR109Q11	L&D Farms	Green City	MO	Active	SLAND	03/30/2007	03/07/2012
MOR10B665	Green Hills and System[11]	Green City	MO	Active	SLAND	03/14/2008	02/07/2012

[11] This permit has been terminated by MDNR.

STORM WATER							
Facility ID	**Facility Name**	**City**	**State**	**Status**	**Permit Type**	**Permit Issue Date**	**Permit Expiration**
MOR10A171	J.D. Wright Farms	Keytesville	MO	Active	SLAND	02/09/2007	02/07/2012
MOR240507	Young's Agri-Service Inc.	Keytesville	MO	Active	AGCEM	03/20/2009	02/19/2014
MOR040078	City of Kirksville	Kirksville	MO	Active	MS4	07/11/2008	06/12/2013
MOR108126	Osteopathy St. Improvement	Kirksville	MO	Active	SLAND	02/23/2007	02/07/2012
MOR109BU4	Thousand Hills State Park	Kirksville	MO	Active	SLAND	02/01/2008	03/07/2012
MOR10A726	City of Kirksville[12]	Kirksville	MO	Active	SLAND	06/01/2007	02/07/2012
MOR10C397	Recycle-It	Kirksville	MO	Active	SLAND	12/19/2008	02/07/2012
MOR60A185	Sutton Auto Sales	Kirksville	MO	Active	SALV	07/03/2008	05/29/2013
MOR80C119	Rogers Trucking, Inc.	Kirksville	MO	Active	TRU M	09/26/2008	10/04/2012
MOR80E044	MDNR, Thousand Hills State Park	Kirksville	MO	Inactive	PARKS	05/02/2003	03/09/2005
MOR80H111	Recycle-It	Kirksville	MO	Inactive	TRANS	12/19/2008	02/05/2009
MOR10B123	Polson Family Hog Farm	Livonia	MO	Active	SLAND	09/21/2007	02/07/2012
MOR10B819	Blue Borrow Area	Livonia	MO	Active	SLAND	04/28/2008	02/07/2012
MOR109DM7	Marceline, MO, Old Reserve	Marceline	MO	Active	SLAND	02/07/2012	02/07/2012
MOR10C168	Sinclair Transportation	Marceline	MO	Active	SLAND	02/07/2012	02/07/2012
MOR240068	MFA Agri Services Inc., New Cambria	New Cambria	MO	Active	AGCEM	03/20/2009	02/19/2014
MOR10B438	Billy Creek Land Reclamation	Novinger	MO	Active	SLAND	12/14/2007	02/07/2012
MOR10B439	Blacksmith Land Reclamation	Novinger	MO	Active	SLAND	12/14/2007	02/07/2012
MOR10B826	Chariton Park Health Care	Salisbury	MO	Active	SLAND	05/02/2008	02/07/2012
MOR203309	Semco, Inc.	Salisbury	MO	Inactive	METAL	03/26/2004	03/04/2009
MOR240066	MFA Agri Services Inc., Salisbury	Salisbury	MO	Active	AGCEM	03/20/2009	02/19/2014
MOR240297	Ricketts Farm Service, Inc.	Salisbury	MO	Active	AGCEM	03/13/2009	02/19/2014
MOR109BA5	Lake Thunderhead North Bay	Unionville	MO	Active	SLAND	09/14/2007	03/07/2012
MOR109S21	Lake Thunderhead N Lagoon	Unionville	MO	Active	SLAND	04/20/2007	03/07/2012
MOR10B184	Bruce Baughman	Unionville	MO	Active	SLAND	09/28/2007	02/07/2012
MOR10B279	Putnam County Memorial Hospital	Unionville	MO	Active	SLAND	10/18/2007	02/07/2012

[12] This permit has been terminated by MDNR.

STORM WATER							
Facility ID	**Facility Name**	**City**	**State**	**Status**	**Permit Type**	**Permit Issue Date**	**Permit Expiration**
MOR240065	MFA Retail Bulk Plant	Unionville	MO	Active	AGCEM	03/13/2009	02/19/2014
MOR240523	Fowler Elevator, Inc., Unionville	Unionville	MO	Active	AGCEM	03/20/2009	02/19/2014
MOR240332	Worthington Ag Service Inc.	Worthington	MO	Active	AGCEM	03/13/2009	02/19/2014
MOR10C575	Putnam Lo Bridge	Unionville	MO	Active	Land Disturbance	04/17/2009	02/07/2012
MOR10C681	Dollar General-Salsibury	Salisbury	MO	Active	Land Disturbance	05/22/2009	02/07/2012
MOR10D086	Sperry 69 KVTAP	Kirksville	MO	Active	Land Disturbance	01/15/2010	02/07/2012
MOR10D329	Salisbury R IV School Dist	Salisbury	MO	Active	Land Disturbance	05/21/2010	02/07/2012
MOR10D501	Chad Fowler Farms	Unionville	MO	Active	Land Disturbance	08/13/2010	02/07/2012
MOR203437	Hurtt Fabricating	Marceline	MO	Active	Land Disturbance	07/16/2010	06/14/2014
MOR80H125	S and S Auto Sales	Marceline	MO	Active	General Storm Water Industrial	05/21/2010	07/23/2014

Notes: WTP = Water Treatment Plants, MGD = millions of gallons per day
States: IA = Iowa, MO = Missouri

APPENDIX D – DEVELOPMENT OF BACTERIA LOAD DURATION CURVE

D.1 Overview

A load duration curve (LDC) approach was used to develop the Total Maximum Daily Load (TMDL) for the direct drainage area of Missouri that flows into the Chariton River. The flow duration curve for this area was developed using the difference between the Chariton River near Prairie Hill and Chariton River at Livonia gage. The LDC method allows for characterizing water quality concentrations (or water quality data) at different flow regimes and estimating load allocation (LA) and wasteload allocation (WLA) for an impaired segment. This method provides a visual display of the relationship between stream flow and loading capacity. Using the duration curve framework, allowable loadings are easily presented.

D.2 Methodology

Using a LDC method requires a long time series of flow data, numeric water quality targets and paired flow and bacteria data from the impaired stream. The first step in this method is to gather available bacteria data within the impaired reach. These data, along with the instantaneous flow measurement taken at the time of sample collection for the specific date, are plotted along with the LDC to assess when the water quality target is exceeded.

The second step in this method is to collect a long record of average daily flow data from a gage or multiple gages that are representative of the impaired reach. These flow records are used to develop the LDC for the impaired reach; therefore, the flow record should be of sufficient length to be able to calculate percentiles of flow (typically 20 years or more). The Chariton gage (06905500) near Prairie Hill, Missouri and Chariton at Livonia (06904050) were used to develop the LDC for this TMDL. The difference between these two gages was used to calculate the flow duration curve of the Missouri direct drainage area to the Chariton River. The Livonia gage is influenced by the regulated releases from the Rathbun Reservoir. The average daily flow at the Prairie Hill and Livonia gage for each day during the period from August 2, 1979 to May 10, 2010, was collected for the TMDL analysis. The difference between these gages flow duration curve was used to estimate the flow duration curve for the direct drainage area. The flow duration curve calculated from the difference between the two gages was converted to the flow at the end of the impaired reach by converting daily average flow to flow per square mile by dividing by the gage's drainage area. The resulting flow per square mile time series was multiplied by the drainage area of the impaired reach to generate an average daily flow time series at the downstream end of the impaired reach. Figures D.1 and D.2 report the daily average flow at the U. S. Geological Survey (USGS) gages near Prairie Hill and Livonia, Missouri. Figure D.3 reports the flow duration curve of the Prairie Hill and Livonia gages and Figure D.4 reports the difference between the gages. The flow duration curve difference represents the direct drainage area to the impaired Chariton River segment. The flow duration curve was estimated in this manner in order to isolate the direct drainage flow for the impaired segment while also accounting for impacts from regulated reservoir releases that influence the flow regime upstream of the impaired segment. Some uncertainty in the daily flow estimates exist due to the instream storage and routing of the stream between gages.

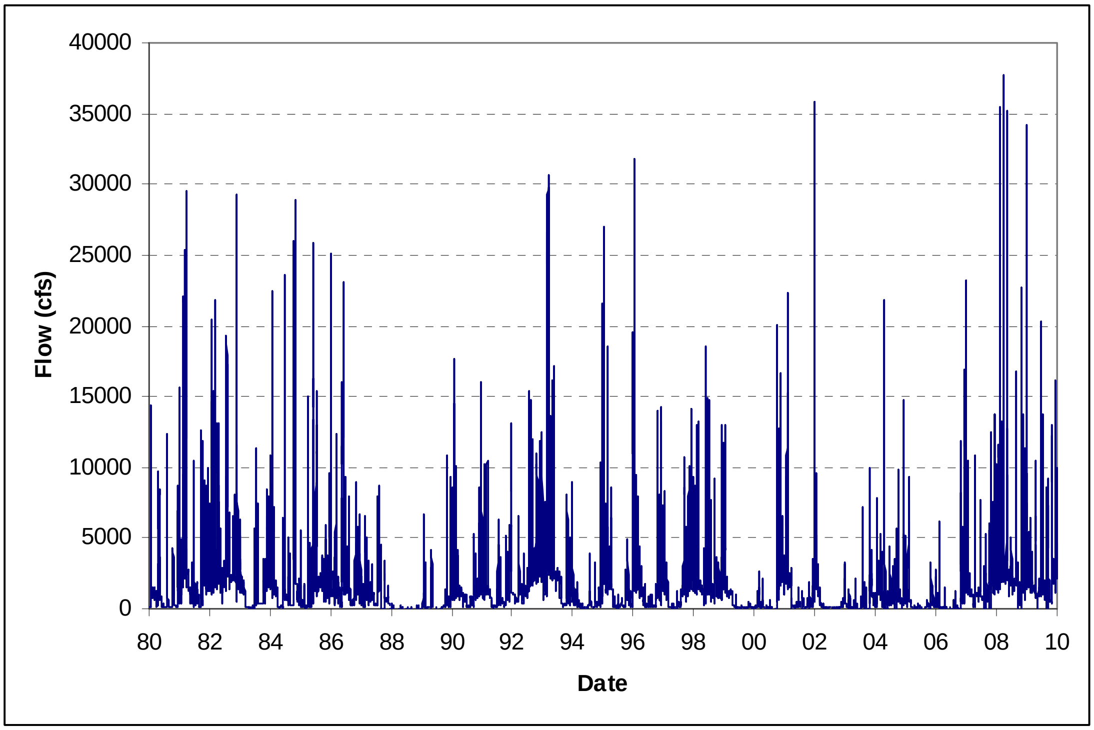

Figure D.1. Daily Average Flow at USGS Gage 06905500
Chariton River near Prairie Hill, Missouri

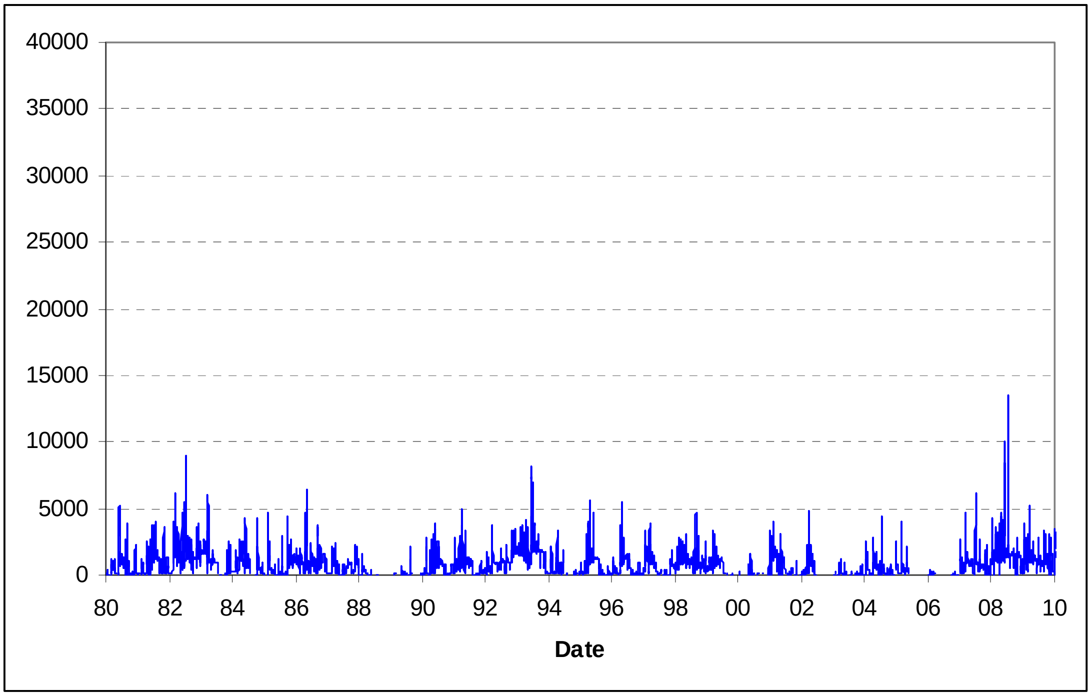

Figure D.2. Daily Average Flow at USGS Gage 06904050
Chariton River at Livonia, Missouri

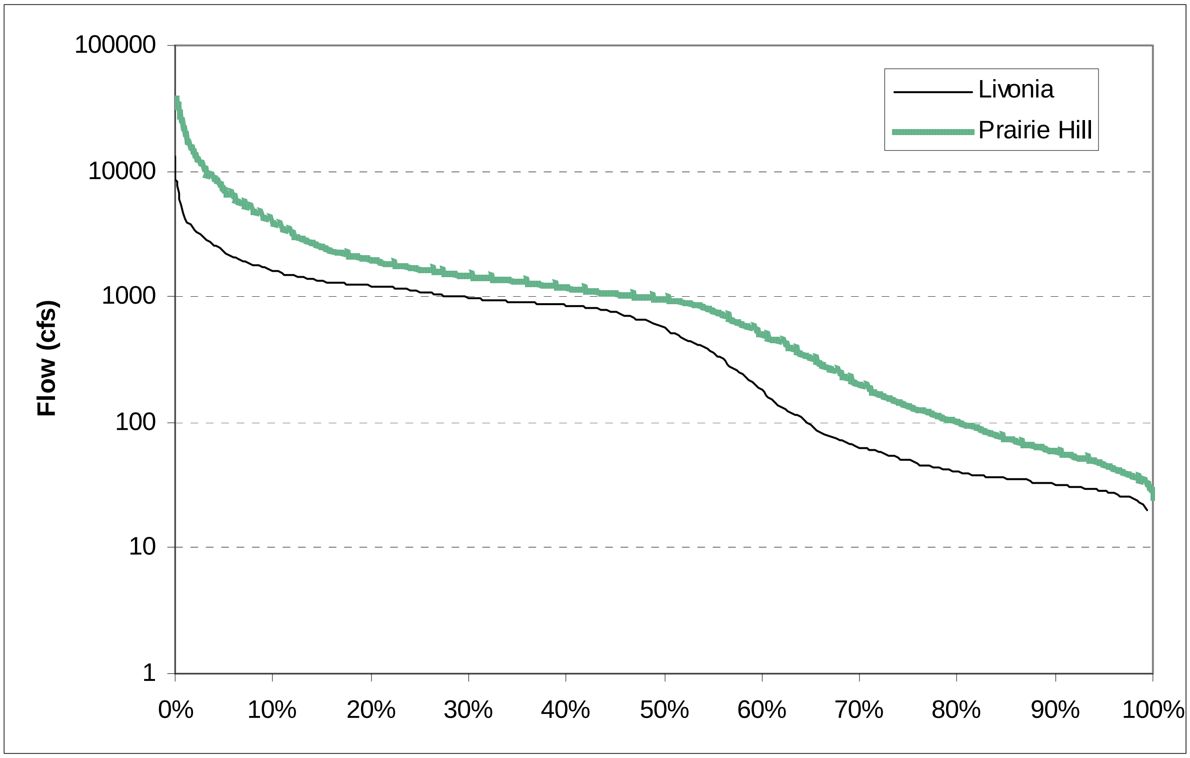

Figure D.3. Flow duration curve for Chariton River at Prairie Hill and near Livonia

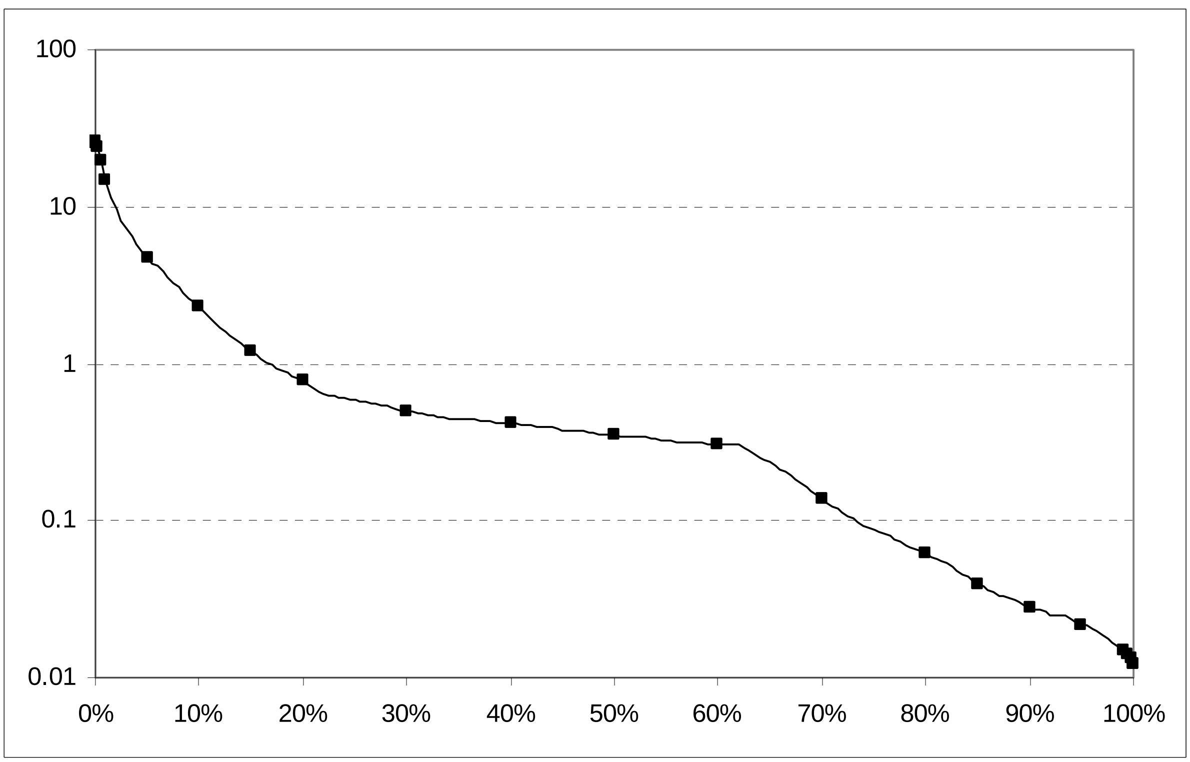

Figure D.4. Flow duration curve for difference between the direct drainage area to the impaired Chariton River segment. This is the difference between the Prairie Hill and Livonia gages

The selected watershed targets are multiplied by the flow to generate the allowable load at different flows. With this LDC, the targeted concentration is constant at all flow percentiles to reflect that static nature of the WQS. The targets used for this LDC were the recreation season geometric mean applied as a daily target and a Maximum Daily Limit (MDL) derived from the geometric mean.

The MDL was calculated using the approach described in the *TSD for Water Quality-based Toxics Control* (EPA, 1991). Because the water quality criteria does not include a daily "not to exceed" value, the recreation season geometric mean criteria can be used to identify an appropriate target. The MDL was derived using the geometric mean target and coefficient of variation of bacteria data in the Chariton River; the averaging period is sufficiently protective to attain and maintain the applicable water quality criteria.

The linkage between the recreation season geometric mean and the MDL target is defined by the statistical relationship between these values. Attaining the MDL will also result in attaining the recreation season geometric mean criteria. The linkage method is based on the statistical relationship between the recreation season geometric mean and the inherent variability that occurs with bacteria concentrations in the water column. The MDL can be calculated using the permit limit calculations, as shown in Table 5-2 and Appendix E of the *TSD for Water Quality-based Toxics Control* (EPA, 1991), a 95th percentile occurrence probability and the coefficient of variation of bacteria data (2.787). For the Chariton River, the statistics from the Prairie Hill monitoring station were used. Table D.1 reports the statistics used to calculate the MDL. The equations used follow the data table.

Table D.1. Statistics of bacteria data collected at Prairie Hill, Missouri, monitoring station and used to calculate the MDL.

Statistic	**Value for untransformed data**
Long term average (LTA)	126 *E. coli* counts/100 ml
Coefficient of Variation	***2.787***

Using the above data and the equation below the long term average can be translated into a MDL. The result of this calculation for lognormally distributed bacteria data is 481 *E. coli* counts/100 mL. The equation used is as follows:

$$MDL = LTA * \exp(Z_p \sigma_y - 0.5\sigma_y^2)$$

Where:

Z_p = pth percentage poin of the standard normal distribution (for this application we are using the 95th percentile which is 1.645)

LTA is the desired long term average of 126 *E. coli* counts/100 mL

σ is the standard deviation of the of the daily loads calculated as $\sigma = \sqrt{\ln(CV^2 + 1)}$

CV is the coefficient of variation of the untransformed data

The resulting LDCs with plotted site specific measured data can now be used to target implementation by identifying flows in which bacteria concentrations are higher than would be expected in a stream meeting the state water quality criterion.

For more information, please contact the following:

Environmental Protection Agency, Region 7
Water, Wetlands and Pesticides Division
Total Maximum Daily Load Program
901 North 5th Street
Kansas City, KS 66101
Web site: http://www.epa.gov/region07/water/tmdl.htm

References

EPA (U. S. Environmental Protection Agency). 1991. *Technical Support Document For Water Quality Based Toxics Control*. EPA 505/2-90-001. March 1991.

Appendix E – Supplemental Implementation Plan

States are not required under Section 303(d) of the Clean Water Act to develop TMDL implementation plans and EPA does not approve or disapprove them. However, the Missouri Department of Natural Resources (MDNR) included an implementation plan in this TMDL to provide information regarding how point and nonpoint sources can or should be controlled to ensure implementation efforts achieve the loading reductions identified in this TMDL. EPA recognizes that technical guidance and support are critical to determining the feasibility of and achieving the goals outlined in this TMDL. Therefore, this informational plan is included to be used by local professionals, watershed managers and citizens for decision-making support and planning purposes. It should not be considered to be a part of the established Chariton River TMDL.

Point Source

Domestic and Non-Domestic Wastewater Permits

Domestic wastewater permitted dischargers are potential sources for bacteria, while non-domestic wastewater permitted dischargers are generally not anticipated to cause or contribute to the impairment of the Chariton River. Both types of wastewater are well-characterized and permit terms and conditions should be protective of instream water quality. During implementation of this TMDL, an analysis of facility compliance history, sampling results, permit effluent limitations and monitoring requirements will be conducted during reissuance of site specific wastewater permits. If MDNR determines a permitted wastewater facility may be causing or contributing to the impairment of the Chariton River, then additional monitoring requirements (e.g., effluent or instream) will be included in the reissued permit. Should MDNR determine more protective effluent limitations or permit conditions are necessary, these requirements will be included in the facility permit upon renewal. It is also possible for the permit to be reopened between renewal periods and adjustments made.

Nonpoint Source

Onsite Wastewater Treatment Systems (Septic Systems)

Education of homeowners regarding recommended septic maintenance should be conducted. Increasing knowledge of proper septic system care and maintenance may help to reduce potential impacts from these sources. Education may be completed by MDNR or through local watershed groups. Additionally, counties or municipalities present in the Chariton River watershed may want to consider ordinances pertaining to the construction of new onsite sewage treatment facilities and the remodeling or repairing of older systems. Additionally, these local governments may wish to consider connection of homes serviced by onsite septic systems to the nearest municipal wastewater treatment plant.

Voluntary Best Management Practices (BMPs) and Public Outreach
Since nonpoint sources are not regulated in Missouri, most implementation of the TMDL from these sources will be dependent upon the voluntary implementation of BMPs and will require education of such practices to those who might use them. BMPs to reduce bacteria inputs from livestock include rotational grazing systems, and riparian corridor exclusion. Likewise, inputs from crop agriculture can be reduced through implementation of nutrient management plans for fields where manure is utilized as a fertilizer and through erosion control practices to reduce the movement of such fertilizer during a storm events. Bacterial inputs from urban inputs can be implemented through pet waste management plans, storm water detention and reduction of impervious surfaces. Education and promotion of such practices and uses may be completed by various parties including MDNR, local governments or local watershed groups.