United States Environmental Protection Agency
Region 7
Total Maximum Daily Load
For Unknown Pollutants

West Fork Locust Creek (MO_0613)
Sullivan and Putnam Counties, Missouri

Karen A. Flournoy for

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Director
Water, Wetlands and Pesticides Division

9-15-10
Date

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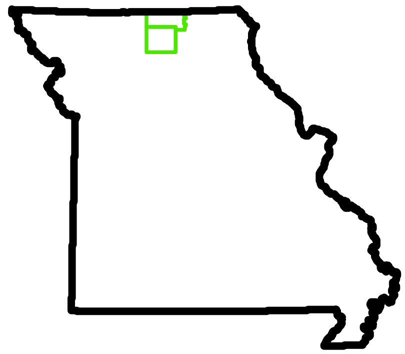
Total Maximum Daily Load (TMDL)
For West Fork Locust Creek
Pollutant: Unknown



Name: West Fork Locust Creek

Location: Sullivan County[1], Putnam County, Missouri

Hydrologic Unit Code (HUC): 10280103-0802 and 10280103-0803

Water Body Identification (WBID): 613

Missouri Stream Class: C[2]

Designated Beneficial Uses:
- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life (CSR, 2009)

Size of Classified Segment: 17.0 miles (all within Sullivan County)

Location of Classified Segments: Hwy 6 to 33, 64N, 21W (CSR, 2009)

Location of Impaired Segment: Hwy 6 to 33, 64N, 21W (CSR, 2009)

Size of Impaired Segment: 17.0 miles[3]

Pollutants: Unknown

Identified Source on 303(d) List: Unknown. The 2008 305(b) Report indicates that the stream is listed due to altered aquatic community and potential sources include rural nonpoint sources.

TMDL Priority Ranking: Medium

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[1] The entire length of the classified segment is located within Sullivan County; the watershed extends into Putnam County.
[2] Class C streams may cease flow in dry periods but maintain disconnected pools which support aquatic life.
[3] The stream length listed corresponds to the EPA approved 303(d) List and Missouri WQS Table H. Due to the increased accuracy of GIS data layers for analysis over previous methods of stream length measurements, the stream length used in the TMDL analysis may not correspond exactly to Table H. The descriptive start and end point of each segment remains the same and this TMDL addresses the impaired segment in its entirety.

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ACRONYMS AND ABBREVIATIONS

Σ	Sum of
AFO	Animal Feeding Operation
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CAFO	Concentrated Animal Feeding Operation
CFR	Code of Federal Regulations
cfs	cubic feet per second
Cl	Chloride
CSR	Code of State Regulations
CWA	Clean Water Act
DO	Dissolved Oxygen
e.g.	For Example
EDU	Ecological Drainage Unit
EPA	United States Environmental Protection Agency
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
lbs/day	Pounds per Day
LC	Loading Capacity
LDC	Load Duration Curve
MDC	Missouri Department of Conservation
mg	Milligrams
MGD	Million Gallons per Day
MO	Missouri
MDNR	Missouri Department of Natural Resources
mg/L	Milligrams per Liter
mi^2	Miles Squared
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
NA	Not Applicable
NASS	National Agricultural Statistics Service
NESC	National Environmental Service Center
NH_3	Ammonia Nitrogen
NO_2	Nitrite Nitrogen
NO_3	Nitrate Nitrogen
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PCS	Permit Compliance System
PSF	Premium Standard Farms
SWPPP	Storm Water Pollution Prevention Plan

ACRONYMS AND ABBREVIATIONS (CONTINUED)

TBELs	Technology Based Effluent Limits
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
URS	URS Group
US	United States
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WBID	Water Body Identification
WLA	Wasteload Allocation
WQBELs	Water Quality Based Effluent Limits
WQS	Water Quality Standards
WWTP	Wastewater Treatment Plant

1 INTRODUCTION

The West Fork Locust Creek 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 (US) Environmental Protection Agency (EPA) approved Missouri 2008 303(d) List and is identified as impaired due to unknown pollutants and sources. Total suspended solids (TSS), total nitrogen (TN) and total phosphorus (TP) measurements in West Fork Locust Creek have shown each parameter to be present at elevated levels and linked to the impaired beneficial use of the water body. This report addresses the West Fork Locust Creek impairment by establishing TSS, TN and TP TMDLs in accordance with Section 303(d) of the CWA. 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 the impairment factors so that states can establish water-quality based controls to reduce pollution 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 causing violations of the water quality standards (WQS). WQS are benchmarks used to assess the quality of rivers and lakes. The TMDL also establishes the pollutant load allocation necessary to meet the Missouri WQS established for each water body based on the relationship between pollutant sources and in-stream water quality conditions. The TMDL consists of a waste load 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 pollutant loads to receiving water impacts. This is often associated with model assumption and data limitations.

The goal of the TMDL program is to restore designated beneficial uses to water bodies. In addition to establishing a TMDL for West Fork Locust Creek, 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, flow data and comparison to a reference stream condition in the same ecoregion and ecological drainage unit (EDU) in which West Fork Locust Creek is located.

Section 2 of this report provides background information on the West Fork Locust Creek watershed and Section 3 describes potential sources of concern. Section 4 presents the applicable WQS and Section 5 describes the modeling that was done to support the TMDL. Sections 6 to 10 present the required TMDL elements (loading capacity (LC), WLA, LA, MOS, seasonal variation) and Sections 11 to 13 summarize the follow-up monitoring plan, reasonable assurances and public participation. A summary of the administrative record is presented in Section 14.

2 BACKGROUND

This section of the report provides information on West Fork Locust Creek and its watershed.

2.1 THE SETTING

West Fork Locust Creek is located in the Eastern Grand River Basin in north central Missouri. West Fork Locust Creek originates in Putnam County. The classified portion of the stream begins in Sullivan County, east of Harris, Missouri and flows south until it joins Locust Creek. Locust Creek ends at its confluence with the Grand River in Chariton County, Missouri. The West Fork Locust Creek impairment spans approximately 17.0 miles, beginning west of Harris, Missouri and ending at Highway 6 with a watershed area of approximately 80.2 square miles. The elevation of the impaired segment ranges from 880 feet above mean sea level to 800 feet above mean sea level with an average stream slope of 0.00086 feet/feet (USDI, 1997).

The stream length listed on page iii corresponds to the EPA approved Missouri WQS Table H. Due to the increased accuracy of Geographic Information System (GIS) data layers for analysis over previous methods of stream length measurements, the stream length used in the TMDL analysis may not correspond exactly to Missouri WQS Table H (CSR, 2009). The descriptive start and end point of each segment remains the same and this TMDL addresses the impaired segment in its entirety.

In 2002, EPA placed West Fork Locust Creek on the Missouri 303(d) List for unknown pollutants, based on the state report, *Monitoring Report on 26 Waters*, published by the Missouri Department of Natural Resources (MDNR). West Fork Locust Creek is a heavily channelized stream that drains the border of Premium Standard Farm's (PSF) Terre Haute Facility. Because of channelization, high turbidity values were often recorded at the sampling sites on this stream. In addition, the appearance of excessive filamentous algae was observed at one sampling site, suggesting that nutrients may be also contributing to the degradation of this stream (MDNR, 2009b).

All waters of the state, as per Missouri WQS, must protect aquatic life. A combination of natural geology and land use in the prairie portions of the state where West Fork Locust Creek is located is believed to have reduced the amount and impaired the quality of habitat for aquatic life. The major water quality problems are excessive nutrients and increased rates of sediment deposition due to stream bank erosion and sheet erosion from agricultural lands, loss of stream length and stream channel heterogeneity due to channelization and changes in basin hydrology that have increased flood flows and prolonged low flow conditions. The number one pollutant entering Missouri's waters is sediment, with about 59 million tons of soil eroding from Missouri's land each year (MSWDC, 2003). Sedimentation occurs when wind or water runoff carries soil particles from an area and transports them to a stream or lake. Excessive sedimentation clouds the water, which reduces the amount of sunlight reaching aquatic plants, covers fish spawning areas and food supplies and clogs the gills of fish. In addition, other pollutants like nitrogen, phosphorus, pathogens and heavy metals are often attached to soil particles and move into streams with the sediment (MDNR, 2009a). TMDLs are not written to address habitat, but are written to correct water quality conditions. To address the unknown pollutant, this TMDL targets nutrients and sediment.

There are many quantitative indicators of sediment, such as TSS, turbidity and bedload sediment, which are appropriate to describe sediment in rivers and streams. TSS was selected as the numeric target for sediment in this TMDL because it enables the use of the highest quality data available, including permit conditions and monitoring data. To address nutrients both TN and TP are selected because both nutrients are generally elevated by both point and nonpoint sources.

2.2 PHYSIOGRAPHIC LOCATION, GEOLOGY AND SOILS

West Fork Locust Creek is located within the Northern Plains; a region within the Dissected Till Plains. The Dissected Till Plains are a physiographic region of the Central Lowlands Province, which are in turn part of the Interior Plains physiographic division of the United States (MDC, 2010). The Dissected Till Plains are characterized by moderately dissected, glaciated, flat-to-rolling terrain that slopes gently toward the Missouri and Mississippi River Valleys. West Fork Locust Creek is a tributary to Locust Creek in the lower Grand River watershed. The West Fork Locust Creek watershed is located in the Late Pennsylvanian Upper Series Missourian State and Middle Pennsylvanian Middle Series-Desmonian Stage. Predominant rock types include shale, sandstone and limestone (Stoeser *et al.*, 2005).

Table 1 and Figure 1 provide a summary of soil types in the impaired West Fork Locust Creek watershed. The dominant soil type, Group C, covers approximately 78 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 downward movement of water. Approximately nine percent of soils in the impaired watershed are categorized as Group D or C/D. Group D soils include clay loam, silty clay loam, sandy clay, silty clay or clay. This hydrologic soil group has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, 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. The remaining seven percent of the watershed area has Group B soils including mainly silt loam or loam soils with a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures (Purdue Research Foundation, 2009). The soils hydrologic group relates to the rate at which surface water enters the soil profile, which in turn affects the amount of water that enters the stream as direct runoff.

Table 1. West Fork Locust Creek Watershed Soils Summary (NRCS, 2009).

Soil Type	Hydrologic Soil Group	Acres	Percent (%)
Landes Loam	B	3,149	6.1
Reger Very Fine Sandy Loam	B	632	1.2
Subtotal	**B**	**3,781**	**7.3**
Adair Loam	C	1,719	3.4
Armstrong Clay Loam	C	10,515	20.5
Gara Clay Loam	C	18,459	36.0
Gara Loam	C	1,225	2.4
Keswick Loam	C	1,617	3.2
Lamoni Clay Loam	C	1,627	3.2
Shelby Clay Loam	C	730	1.4
Shelby Loam	C	1,234	2.4
Vigar-Zook-Nodaway Complex	C	876	1.7
Winnegan Loam	C	2,072	4.0
Subtotal	**C**	**40,074**	**78.2**
Arbela Silt Loam	C/D	563	1.1
Zook Silty Clay Loam	C/D	1,777	3.5
Subtotal	**C/D**	**2,340**	**4.6**
Pershing Silty Clay Loam	D	1,181	2.3
Seymour Silty Clay Loam	D	942	1.8
Subtotal	**D**	**2,123**	**4.1**
Other[4]	B/C/D	2,998	5.8

[4] Other soil types that make up less than one percent of the total watershed area include: Armstrong loam (Hydrologic Soil Group C), Cantril loam (Hydrologic Soil Group C), Chequest silty clay loam (Hydrologic Soil Group C/D), Clarinda silty clay loam (Hydrologic Soil Group D), Edina silt loam (Hydrologic Soil Group D), Gorin silt loam (Hydrologic Soil Group C), Humeston silty clay loam (Hydrologic Soil Group C/D), Keswick clay loam (Hydrologic Soil Group C), Nodaway silt loam (Hydrologic Soil Group B), Olmitz loam (Hydrologic Soil Group B), Reger fine sandy loam (Hydrologic Soil Group B), Rinda silty clay loam (Hydrologic Soil Group D), Tice silt loam (Hydrologic Soil Group C), Vigar loam (Hydrologic Soil Group C), Wabash silty clay (Hydrologic Soil Group D), Winnegan clay loam (Hydrologic Soil Group C) and Water.

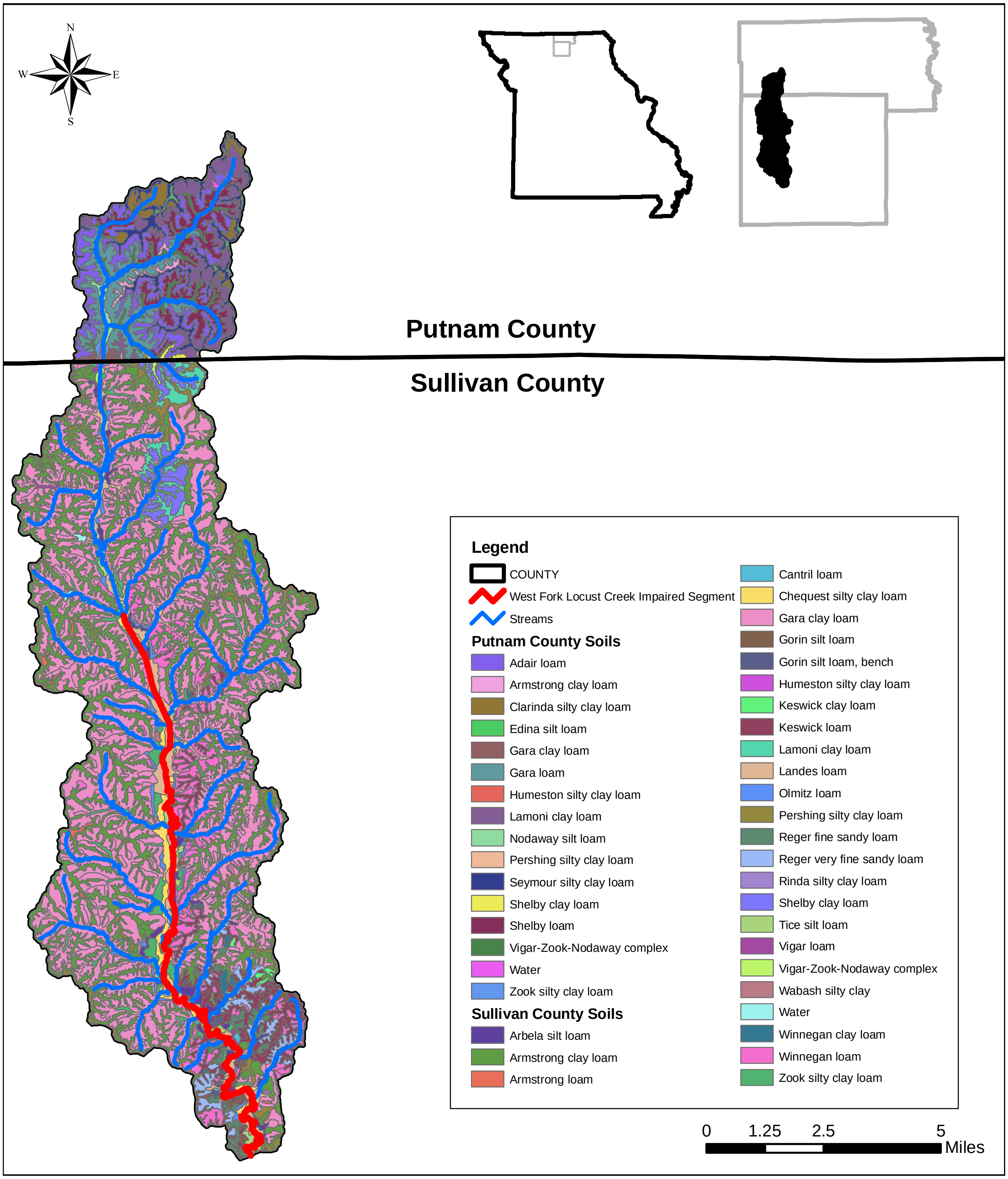

Figure 1. West Fork Locust Creek Soils Map

2.3 RAINFALL AND CLIMATE

The Milan (235578) weather station is located in Sullivan County, within five miles of the West Fork Locust Creek watershed (Figure 2).

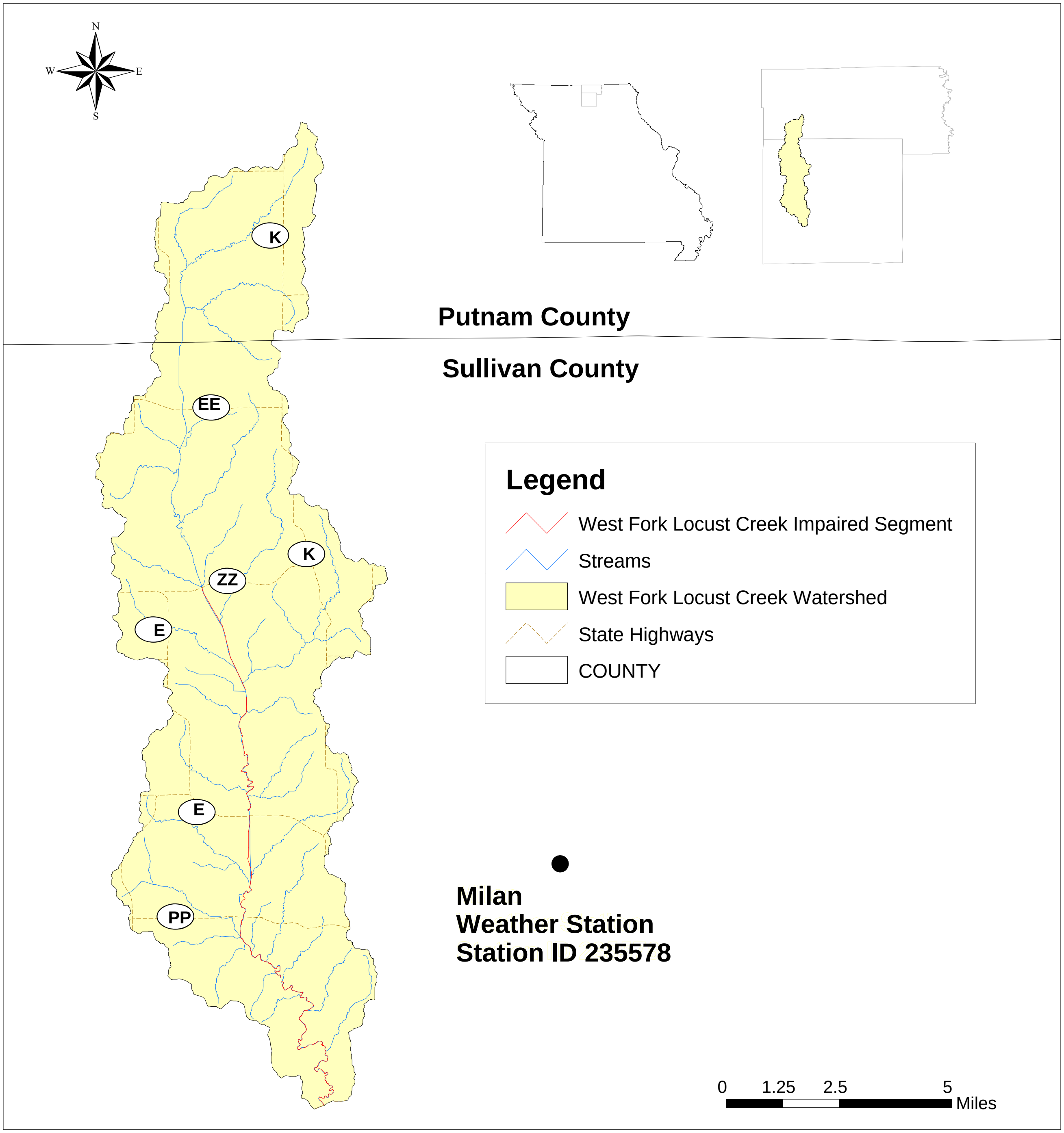

Figure 2. Location of West Fork Locust Creek Watershed with Weather Station

Daily precipitation, maximum and minimum temperature, snowfall and snow depth are recorded at the Milan weather station. Figure 3 provides a summary of rainfall based on 30 years totaled (1971 – 2000) (NOAA, 2009). The annual average precipitation over the 30 year period is 39.1 inches. Weather stations provide useful information for simulating stream hydrology and developing a general understanding of the watershed. There are 6 months (April – September) that have a precipitation value greater than 4 inches. The highest rainfall occurs in May (5.2 inches). Precipitation dictates the hydrology of the stream and has a significant impact on soil erosion and nutrient transport. Based on the precipitation data, soil erosion and high nutrient loading tend to occur between April and September when runoff events are intense. An understanding of annual and monthly precipitation patterns is useful when considering the load duration curve (LDC) approach (see Section 5) to TMDLs.

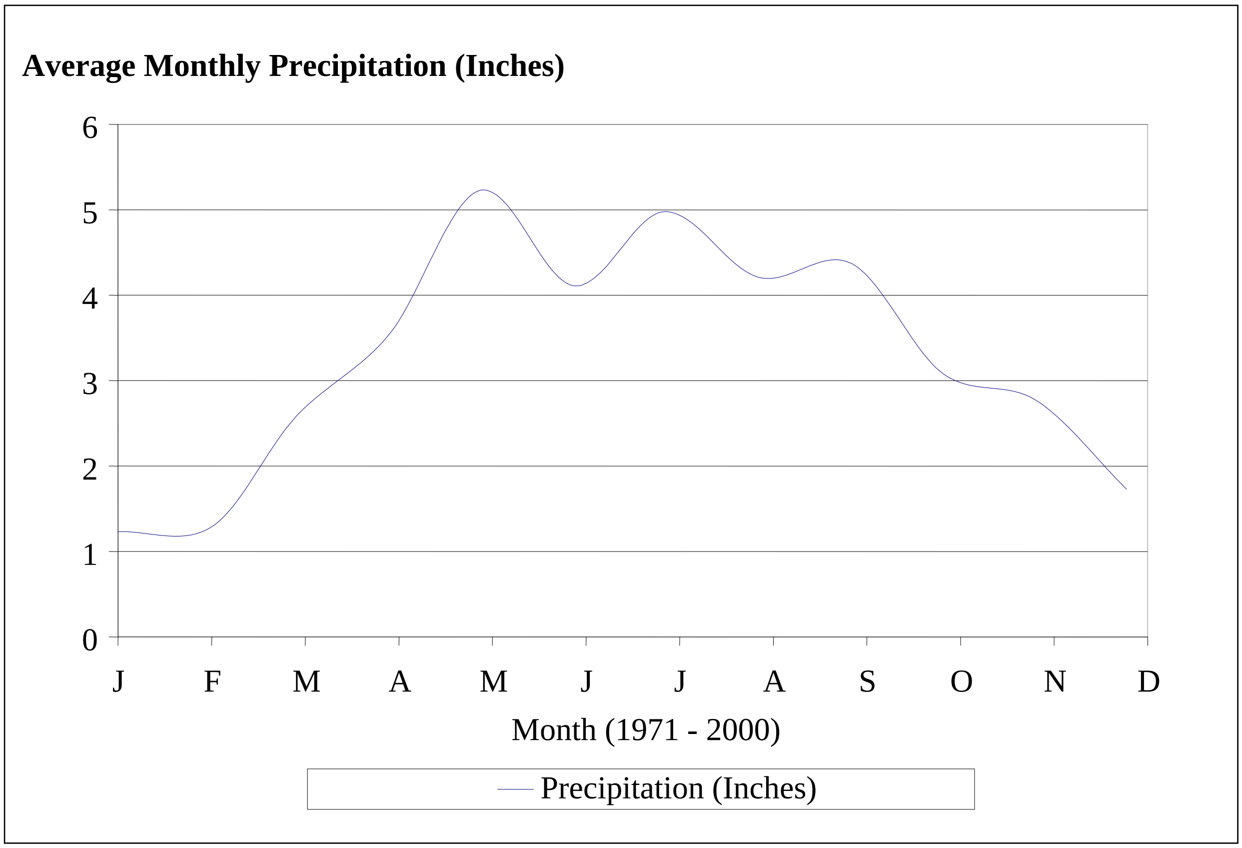

Figure 3. Thirty Year Average Monthly Precipitation for Station 235578 (Milan, MO)

2.4 POPULATION

The population data for the West Fork Locust Creek watershed is not directly available. However, the Census reports that the 2000 population (in Sullivan County and Putnam County) for all urban areas was 2,820 and 2,422, respectively (US Census Bureau, 2000). The rural population of the watershed can be estimated based on the proportion of the watershed compared to Sullivan and Putnam Counties. Sullivan County covers an area of 651.43 square miles and has a population of 7,219 and Putnam County covers an area of 519.66 square miles and has a population of 5,223.

The rural population in Sullivan County is approximately 3,371 people (total county population minus the sum of Green City, Green Castle, Pollock, Millan, Harris, Newtown, Osgood, Humphreys and Browning) and the rural county area is 646.50 square miles (total county area minus county urban area). The portion of the West Fork Locust Creek watershed rural population located in Sullivan County was estimated to be 354 persons; calculated by dividing the rural watershed area in Sullivan County (67.87 square miles) by the Sullivan County rural area (646.50) and multiplying the product by the Sullivan County rural population (3,371).

The rural population in Putnam County is approximately 2,801 people (total county population minus the sum of Powersville, Lucerne, Unionville, Livonia and Worthington) and the rural county area is 516.46 square miles (total county area minus county urban area). The portion of the West Fork Locust Creek watershed rural population located in Putnam County was estimated to be 67 persons; calculated by dividing the rural watershed area in Putnam County (12.31 square miles) by the Putnam County rural area (516.46) and multiplying the product by the Putnam County rural population (2,801).

The total estimated rural population of the West Fork Locust Creek watershed is approximately 421 persons which is the same as the total estimated population (rural and urban) of the West Fork Locust Creek watershed. An overall population density for the West Fork Locust Creek watershed was calculated to be 5 persons per square mile (421 persons divided by 80.2 square miles).

2.5 LAND USE AND LAND COVER

The land use and land cover of the West Fork Locust Creek watershed is shown in Figure 4 and summarized in Table 2 (MoRAP, 2005). The primary land uses/land covers are grassland (64 percent), cropland (14 percent) and forest (11 percent). Herbaceous, wetlands, impervious, barren and water occupy the remaining 10 percent of the watershed area.

Table 2. Land Use/Land Cover in the West Fork Locust Creek Watershed (MoRAP, 2005)

Land Use/Land Cover	**Watershed Area**		**Percent (%)**
	Acres	**Square Miles**	
Impervious[5]	814	1.3	1.6
Barren or Sparsely Vegetated	70	0.1	0.1
Cropland	7,137	11.2	13.9
Grassland	32,687	51.1	63.7
Forest	5,874	9.2	11.5
Herbaceous[5]	1,963	3.1	3.8
Wetland	2,348	3.7	4.6
Open Water	423	0.7	0.8
Total	**51,316**	**80.4**	**100**

[5] Impervious land use includes non-vegetated, impervious surfaces including areas dominated by streets, parking lots and buildings while herbaceous land use includes shrublands, young woodlots and open woodlands (MoRAP, 2005).

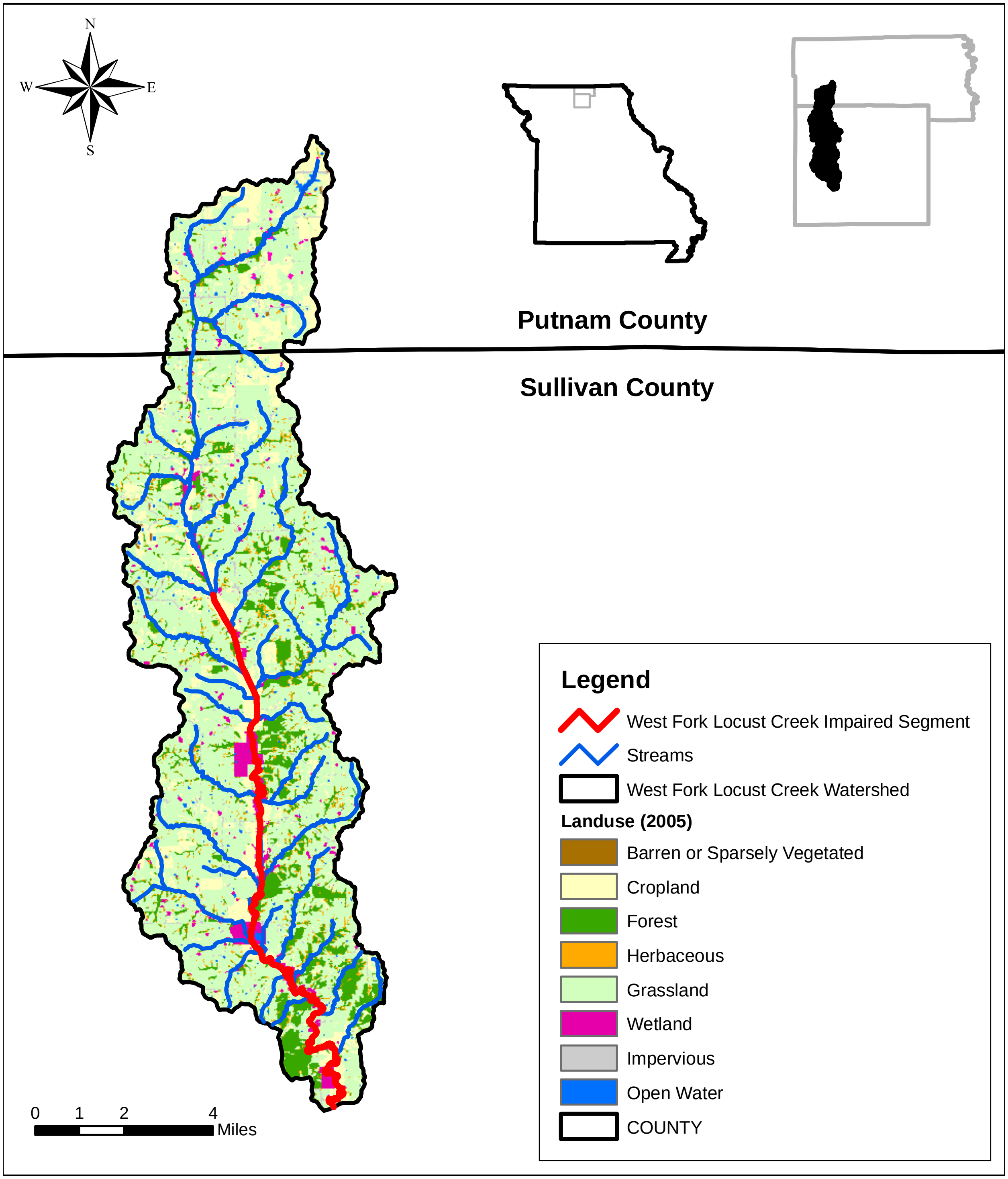

Figure 4. Land Use/Land Cover in the West Fork Locust Creek Watershed (MoRAP, 2005)

3 SOURCE INVENTORY

A source assessment is used to identify and characterize the known and suspected sources contributing to impairment in West Fork Locust Creek. 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. Sediment is considered to be the primary contributor along with nutrients to the impairment of aquatic communities in West Fork Locust Creek. Water quality data used to identify and assess sources in West Fork Locust Creek are presented in Appendix A of this document.

3.1 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 we will use the term "NPDES." The following regulated entities are included in this source category:

- Municipal and industrial wastewater treatment plants (WWTP),
- Concentrated animal feeding operations (CAFOs),
- Storm water runoff from Municipal Separate Storm Sewer Systems (MS4s) and
- General permitted facilities (e.g. including storm water runoff from construction and industrial sites)

General permits (as opposed to site specific permits) are issued to activities that are similar enough to be covered by a single set of requirements. Storm water permits are issued to activities that discharge only in response to precipitation events. Point sources in West Fork Locust Creek were identified by consulting EPA's Permit Compliance System (PCS) website[6] (EPA, 2009a) and MDNR's GIS inventory[7] of NPDES permitted facilities covered under storm water or general permits.

Point sources in the West Fork Locust Creek watershed are listed in Table 3 and shown in Figure 5. Of those listed, two are site specific permits, three are general permits and one is a storm water permit.

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[6] www.epa.gov/enviro/html/pcs/index.html

[7] http://msdis.missouri.edu/datasearch/ThemeList.jsp; GIS layers updated May 2009 and June 2009 (Missouri Spatial Data Information Service [MSDIS], 2009)

There are five permitted CAFOs located in the watershed; two are site specific permits and three are general permits (see Table 3). PSF operates the Terre Haute Farm under the site specific permit MO0118761 and the Locust Ridge Finishing Site under the site specific permit MO0118494. Both facilities are classified as CAFOs. These facilities have a combined design flow of 0.13282 million gallons per day (MGD). At the Terre Haute Farm, there are fourteen anaerobic lagoons with secondary containment structures that capture wastewater, irrigation water, storm water runoff and domestic wastewater. At the Locust Ridge Finishing Site there are eight anaerobic lagoons with secondary containment structures that capture wastewater, irrigation water, storm water runoff and domestic wastewater. Both facilities are no discharge facilities for process waste. Wastewater is stored in the lagoons and land applied based on the available nitrogen approach. Both facilities have a waste management system designed to minimize runoff entering the facility and detain runoff emanating from the operation. In addition, they are designed to retain a 25-year, 24-hour rainfall/runoff event as well as an anticipated two weeks of normal wastewater from their operations. Typically, this rainfall event coincides with stream flow that occurs less than 1 to 5 percent of the time. Though the potential number of animals associated with the CAFO in the watershed is 91,728 head, the actual number of animals at the feedlot operation is typically less than the number allowed by the facility's permit. Since these are no discharge facilities they are unlikely to impact water quality during critical low flow periods.

Countywide data from the National Agriculture Statistics Service (NASS) (USDA, 2002) were combined with the land cover data for the West Fork Locust Creek watershed to estimate approximately 9,322 cattle in the watershed[8]. The cattle are most likely located on the approximate 51 square miles of grassland / pastureland in the watershed. The density of cattle in the West Fork Locust Creek watershed (91 cattle per square mile or 9,322 cattle in the entire watershed) suggests they are a potential source of pollutants. NASS also reports there were 964 sheep and lambs and 364 chickens (layers) in Putnam County in 2007 and 348,167 hogs and pigs, 479 sheep and goats and 260 chickens (layers) in Sullivan County in 2007. Grazing densities within the watershed are estimated at approximately 185 head of cattle per square mile. The high percentage of grassland and pasture in the watershed may serve as ideal seasonal grazing lands for livestock during the winter months, which may account for highly variable livestock populations within the watershed from one year to the next.

Based on these conditions, nutrients within the watershed may be attributed to fertilizer or manure application to the agricultural lands being utilized for pasture, hay, or crop production. Of particular concern are lands near the riparian[9] buffer areas that are subject to livestock grazing or watering and fertilizer applications. The animal wastes from manure applications, for both confined and unconfined feeding sites are considered a major potential source of nutrient, sediment and oxygen consuming substances going into West Fork Locust Creek.

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[8] According to the NASS there are approximately 52,948 head of cattle in Sullivan County and 47,616 head of cattle in Putnam County (USDA, 2007). According to the MoRAP (2005) there are 388 square miles of grasslands in Sullivan County and 286 square miles of grasslands in Putnam County. These values result in a cattle density of approximately 185 cattle per square mile of grasslands in Sullivan County and 167 cattle per square mile of grassland in Putnam County. These densities were multiplied by the number of grassland square miles in each respective county in the West Fork Locust Creek watershed to estimate the number of cattle in the watershed.

[9] A riparian buffer (or corridor) is the linear strip of land running adjacent to a stream bank.

General permits that have sediment as a probable pollutant of concern have permit limits and Best Management Practices (BMPs) required (through the general storm water permit) that should be protective of the impairment. However, facilities will be inspected prior to renewal and if more stringent effluent limitations or monitoring are required, the facility will be required to apply for a site specific permit to ensure compliance with WQS.

Illicit straight pipe discharges of household waste are also potential point sources of suspended sediment and nutrients in rural areas. Illicit discharges drain directly or indirectly to streams and are different than illicitly connected sewers. There is no specific information on the number of illicit straight pipe discharges of household wastes in the West Fork Locust Creek watershed, however illicit straight pipe discharges are not known or expected to be a significant source of suspended sediment and nutrients in West Fork Locust Creek. Critical periods for impacts from illicit straight pipe connections would be low flow periods, not wet weather conditions.

Table 3. Permitted Facilities in the West Fork Locust Creek Watershed

Facility ID	Facility Name	Receiving Stream	Classification/ Description	Reporting Requirements[1]	Design Flow (MGD)[2]	Permit Expiration Date
MOG010705	Ronald Faulkner Farm	Tributary to West Fork Locust Creek	Hogs	NA	General Permit	2011
MOG010624	Brown, David	Tributary to West Fork Locust Creek	Hogs	NA	General Permit	2011
MOG010701	David Brown North Facility	West Fork Locust Creek	Hogs	NA	General Permit	2011
MO0118494	Premium Standard Farms, Locust Ridge	West Fork Locust Creek	Hogs	Flow, DO, NH_3, BOD, pH, Cl, Temperature, TKN, TP, NO_3, NO_2, Solids	0.0961	2009
MO0118761	Premium Standard Farms, Terre Haute Farm	West Fork Locust/Locust/Elm	Hogs	Flow, DO, NH_3, BOD, pH, Cl, Temperature, TKN, TP, NO_3, NO_2, Solids	0.03672	2009
MOR10A194	David Brown Farm	Tributary West Fork Locust Creek	Heavy Construction	NA	Storm Water Permit	2012

[1] Where DO = Dissolved Oxygen, NH_3 = Ammonia Nitrogen, BOD = Biochemical Oxygen Demand, Cl = Chloride, TKN = Total Kjeldahl Nitrogen, TP = Total Phosphorus, NO_3 = Nitrate-Nitrogen, NO_2 = Nitrite-Nitrogen, NA = Not Applicable.

[2] MGD = Million gallons per day.

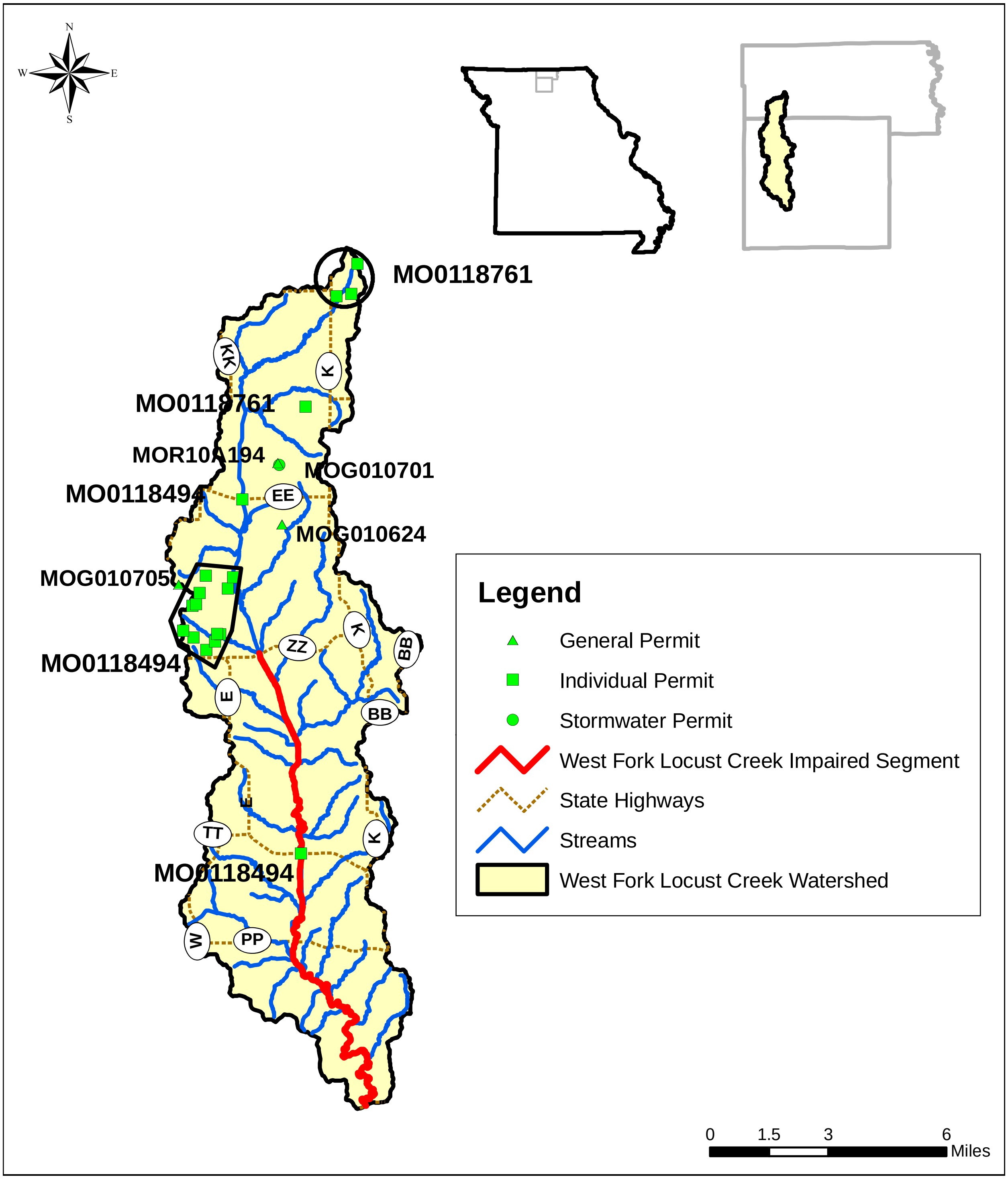

Figure 5. Location of Permitted Facilities in the West Fork Locust Creek Watershed

3.2 NONPOINT SOURCES

Nonpoint sources include all other categories not classified as point sources. Potential nonpoint sources contributing to the impairment in the West Fork Locust Creek include runoff from agricultural areas, runoff from urban areas, onsite wastewater treatment systems (e.g. septic systems) and various sources associated with riparian habitat conditions. Each of these is discussed further in the following sections.

Because of data limitations related to regulated storm water discharges from the facilities present in the watershed and the potential for wide variability of storm water discharges, it is not possible to separate the storm water discharges that are subject to the permitting program (e.g., industrial storm water and storm water from construction activities) from storm water discharges that are not subject to permitting (e.g., agricultural runoff and urban runoff not subject to an MS4 permit). Therefore, all storm water discharges are included in the WLA portion of the TMDL.

In the absence of an NPDES permit, the discharges associated with sources were applied to the LA, as opposed to the WLA **for purposes of this TMDL**. 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 establishing 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 WLAs in this TMDL. WLA in addition to that allocated here is not available.

3.2.1 Runoff from Agricultural Areas

The 2005 land use/land cover data (MoRAP, 2005) indicates there are 7,137 cropland acres in the watershed, which comprises 13.9 percent of the entire watershed (Table 2). Eleven percent of the riparian buffer is classified as cropland (see Table 4 in Section 3.2.4.). Lands used for agricultural purposes can be a source of sediment, nutrients and oxygen consuming substances. Accumulation of nitrogen and phosphorus on cropland occurs from decomposition of residual crop material, fertilization with chemical and manure fertilizers, atmospheric deposition, wildlife excreta and irrigation water. Sediment can be dislodged from the soil matrix by agricultural animals in confined spaces and pastures and stream bank erosion can occur when cattle access streams for drinking water. Runoff from these areas can be potential sources of sediment, nutrients and oxygen consuming substances. 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. Since the watershed is dominated by grassland and pasture the number of smaller animal feeding operations that are not registered is presumably high, particularly during seasonal feeding months in the winter. In addition, when pasture land is not fenced off from the stream, cattle or other livestock may contribute nutrients to the stream while walking in or adjacent to the water body. Additional discussion on CAFOs in the West Fork Locust Creek watershed is provided in Section 3.1 of this report.

Permitted CAFOs identified in this TMDL are part of the assigned WLA. At this time, animal feeding operations (AFOs) and unpermitted CAFOs are considered under the LA because we do not currently have 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 an 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 an 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. However, many large CAFOs (mostly the poultry and swine sectors) contend that they do not discharge nor propose to discharge therefore are not required to obtain an NPDES permit. It is EPA's opinion that many of the "no discharge" CAFOs do not have adequate land application area to ensure the agronomic uptake of land applied waste or are not designed, constructed, operated or maintained so that they do not discharge or propose to discharge. Furthermore, there are many AFOs that meet the definition of a medium CAFO (i.e., discharge via a man-made conveyance) but are unpermitted and have not limited their impact on waters by applying Best Professional Judgment to effluent reductions.

3.2.2 Runoff from Urban Areas

Storm water runoff from urban areas can be a significant source of sediment, bacteria, nutrients and oxygen consuming substances, such as organic material and chemicals (i.e., pesticides and fertilizers). Lawn fertilization can lead to high nutrient loads and pet wastes can contribute both nutrient loads and organic material. For example, phosphorus loads from residential areas can be comparable to or higher than loading rates from agricultural areas (Reckhow et al., 1980; Athayde et al., 1983). Leaking or illicitly connected sewers can also be a significant source of pollutant loads within urban areas. Storm runoff from urban areas such as parking lots and buildings is also warmer than runoff from grassy and woodland areas, which can lead to higher temperatures that lower the dissolved oxygen saturation capacity of the stream. Excessive discharge of suspended solids from urban areas can also lead to streambed siltation problems. Because there are no urban land uses existing in this watershed (see Table 2), runoff from urban areas is not a contributing source of TSS, TN or TP to West Fork Locust Creek.

3.2.3 Onsite Wastewater Treatment Systems

Onsite 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, onsite systems do fail for a variety of reasons. When these septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface waters (Horsley and Witten, 1996). Failing septic systems are sources of nutrients and pathogens that can reach nearby streams through both runoff and groundwater flows.

The exact number of onsite wastewater systems in the West Fork Locust Creek watershed is unknown. However, the National Environmental Service Center (NESC) reports that in 1998 there were 5,704 septic systems with an average population per septic system of 2.1 and a septic failure rate of 0.39 percent in the Lower Grand watershed (HUC 10280103) (EPA, 2009b). As discussed in Section 2.4, the estimated rural population of the West Fork Locust Creek watershed is approximately 421 persons. Based on this population and an average density of 2.1 persons per septic system we can estimate that there are approximately 201 systems in the watershed. Based on a failure rate of 0.39 percent there would potentially be 1 failing septic system within the West Fork Locust Creek watershed (EPA, 2009b). EPA reports that the statewide failure rate of onsite wastewater systems in Missouri is 30 to 50 percent (EPA, 2002). The large difference in failure rates between the studies is likely related to difficulties in identifying failing onsite wastewater systems and different definitions of what constitutes failure. At higher rates of failure onsite wastewater treatment systems could be a potentially significant source of nutrients and pathogens; however, no information was identified that would suggest failing onsite wastewater systems are a significant problem in the West Fork Locust Creek watershed. Based on this information, onsite wastewater treatment systems are considered a potential, albeit not significant, source of nutrients.

3.2.4 Riparian Habitat Conditions

Riparian (streamside) habitat conditions can have a strong influence on in-stream water quality and habitat. Wooded riparian buffers are a vital functional component of stream 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 high pollutant loads than a stream with poor riparian cover. Wooded riparian buffers can also provide shading that reduces stream temperatures and increases the DO saturation capacity of the stream.

As indicated in Table 4, over 20 percent of the land in the West Fork Locust Creek riparian corridor is classified as grassland (which might include pasture areas) and just over 10 percent is cropland (MoRAP, 2005). This analysis defined the riparian area as including a 30-meter area on each side of the creek. Compared to wooded areas, grasslands and cropland have the potential to provide much less shading and higher pollutant loads due to livestock and related agricultural activity. Wetland areas comprise approximately 60 percent of the riparian area (MoRAP, 2005).

Table 4. Percentage Land Use/Land Cover within Riparian Buffer, 30-Meter

Land Use/Land Cover	Percent (%)
Impervious	0.1
Cropland	10.7
Grassland	20.1
Forest	6.3
Herbaceous	3.4
Wetland	59.1
Open Water	0.2
Total	100

4 APPLICABLE WATER QUALITY STANDARDS AND NUMERIC WATER QUALITY TARGETS

Section 303(d) of the CWA and Chapter 40 of the CFR Part 130 require states to develop TMDLs for waters not meeting designated uses. The TMDL process quantitatively assesses the impairment factors so that states can establish water-quality based controls to reduce pollution 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 (US 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 found at 10 CSR 20-7.031, Tables A and B (CSR, 2009)). Missouri's antidegradation policy is outlined at 10 CSR 20-7.031(2) (CSR, 2009).

4.1 DESIGNATED BENEFICIAL USES

The impaired reach includes a 17.0 mile segment of West Fork Locust Creek (WBID 613) with designated beneficial uses classified as:

- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life (CSR, 2009).

The general criteria pertaining to protection of warm water aquatic life is the impaired designated beneficial use.

4.2 CRITERIA

In the 2008 Missouri 303(d) List, West Fork Locust Creek is listed as impaired due to unknown pollutants. Water quality monitoring has not revealed violation of a specific numeric water quality criterion; however, elevated levels of TSS, TN and TP have been identified as potential contributors to impairment. These parameters are being used as surrogate water quality targets that, if met, are protective of the impaired use.

All water bodies in Missouri are protected by the general criteria (standards) contained in Missouri's WQS, 10 CSR 20-7.031(3). These criteria are also called narrative criteria, since they do not contain specific numerical limits. The narrative criteria not being met in West Fork Locust Creek are (3)(A), (C), (D) and (G):

- Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses.
- Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor, or prevent full maintenance of beneficial uses.
- Waters shall be free from substances or conditions in sufficient amounts to result in toxicity to human, animal or aquatic life.
- Waters shall be free from physical, chemical or hydrologic changes that would impair the natural biological community.

In the absence of Missouri numeric standards for nutrients in freshwater streams, ambient water quality criteria recommendations provided by the EPA (2000) are used to quantify TN and TP LCs in Ecoregion 40 and West Fork Locust Creek. Reference conditions for TN and TP in level III Ecoregion 40 streams are as follows: TN = 0.855 milligrams per liter (mg/L) and TP = 0.092 mg/L. For this TMDL, recommended TN and TP criteria are used directly in developing LCs for TN and TP. There are many quantitative indicators of sediment, such as TSS, turbidity and bedload sediment, which are appropriate to describe sediment in rivers and streams (EPA, 2006). A concentration of TSS was selected to represent the numeric target for this TMDL because it enables the use of the highest quality available data and is included in monitoring data. Additional discussion on watershed-specific targets used to develop LCs for TSS, TN and TP is provided in Section 5.1 of this report.

4.3 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 US. Existing in-stream water uses are those uses that were attained on or after November 28, 1975, the date of EPA's first WQS 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 anti-degradation review consisting of: 1) a finding that it is necessary to accommodate important economical 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 BMPs for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable / swimmable" uses and other existing or beneficial 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.

5 MODELING APPROACH

When stream flow gage information is available, a LDC is useful in identifying and differentiating between storm-driven and steady-input sources (Cleland, 2002 and Cleland, 2003). For West Fork Locust Creek, the LDC approach was used to: 1) Provide a visual representation of stream flow conditions under which TSS, TN and TP criteria exceedances have occurred, 2) Assess critical conditions and 3) Quantify the level of reduction necessary to meet the surface water quality targets for TSS, TN and TP in the stream.

A limited amount of flow data is available in the West Fork Locust Creek watershed (Appendix A), which was inadequate for developing a LDC. To develop a synthetic flow record and a flow duration curve for West Fork Locust Creek, information from six United States Geological Survey (USGS) gaging stations (Table 5) in the same region of the state were used to establish a daily flow per square-mile estimate. Average daily flow per square-mile from the six stations was calculated for each day of record and multiplied by the impaired watershed area (80.2 square miles). In West Fork Locust Creek, no permitted continuous or storm water flows are present. This approach was used to estimate average daily flow for each day during the period from July 20, 1978 to December 7, 2009. A detailed discussion of methods used to develop the TSS, TN and TP LDCs is presented in Appendix B and Appendix C.

Table 5. Stream Flow Stations Used to Estimate Flows in West Fork Locust Creek

River/Station Name	Data Source	Station Number	Drainage Area (mi^2)	Discharge Record	Latitude/ Longitude
East Fork Little Chariton River near Macon, MO	USGS	06906200	112	1971–2009	39°45'05.2", 92°31'08.2"
East Fork Little Chariton River near Huntsville, MO	USGS	06906300	220	1962-2009	39°27'17.7", 92°34'06.6"
Thompson River at Trenton, MO	USGS	06899500	1,720	1928–2009	40°04'09.5", 93°38'16.9"

River/Station Name	Data Source	Station Number	Drainage Area (mi^2)	Discharge Record	Latitude/ Longitude
Grand River near Gallatin, MO	USGS	06897500	2,250	1920–2009	39°55'37", 93°56'33"
Mussel Fork near Mussel Fork, MO	USGS	06906000	267	1948–2009	39°31'24.7", 92°56'58.7"
Grand River near Sumner, MO	USGS	06902000	6,880	1924-2009	39°38'24.1", 93°16'25.3"

5.1 CRITERION TO SUPPORT THE TMDL

In West Fork Locust Creek, where narrative standards are targeted for the impaired segment, a reference approach was used to define TMDL targets. The TSS, TN and TP targets were developed as surrogates for the narrative criteria and are protective of the stream's designated beneficial uses. Missouri does not have a numeric criterion for TSS, TN and TP. LDCs are used to establish TMDLs for each of these pollutants. The method used to establish the TSS target differs from the method used to establish the TN and TP targets. Each method is described below.

The TSS target was derived based on a reference approach by targeting the 25th percentile of TSS measurements (USGS, non-filterable residue) in the geographical region in which West Fork Locust Creek is located (see Appendix D for a list of sites and data). In this approach, the target for pollutant loading is the 25th percentile of the current EDU condition calculated from all data available within the EDU in which the water body is located. Therefore, the 25th percentile is targeted as the TMDL LDC. A detailed discussion of the method used to develop the TSS target is provided in Appendix B.

TN and TP TMDL targets and LCs are based on EPA-recommended Ecoregion 40 criteria and water quality observations at locations throughout the ecoregion. For this analysis, the 25th percentile of data for all seasons is used as the target. This value was calculated by taking the median of the four seasonal 25th percentiles of data within an ecoregion (EPA, 2000). TN and TP concentrations from monitoring locations within Missouri and in Ecoregion 40 are plotted with flow to define the relationship between load and flow unique to Missouri streams in this ecoregion. In developing this relationship, individual water quality measurements are "corrected" based on the ecoregion target such that the median of the dataset is equal to the ecoregion target. Allowable pollutant loads are calculated for all flow conditions by multiplying flow by either the EPA-recommended ecoregion target concentration or the concentration established using the Missouri Ecoregion 40 streams; whichever concentration is higher. Reference conditions for TN and TP in level III Ecoregion 40 streams are provided in Table 3e of *Ambient Water Quality Criteria Recommendations, Information Supporting the Development of State and Tribal Nutrient Criteria for Rivers and Streams in Nutrient Ecoregion IX* (EPA, 2000) and in Section 4.2 of this report. A detailed discussion of the method used to develop the TN and TP targets is provided in Appendix C. Criteria used as targets in developing TSS, TN and TP TMDLs are presented in Table 6.

Table 6. Criteria Used to Develop TSS, TN and TP TMDLs[1]

	TSS EDU Target (mg/L)	TN Ecoregion Criteria (mg/L)	TP Ecoregion Criteria (mg/L)
EDU and Ecoregion Targets and Criteria	5.75	0.855	0.092

[1] The TSS target is based on the 25th percentile of the EDU condition calculated from all data available from 1997 to 2009 (see Appendix D) within the Central Plains/Grand/Chariton EDU (12) in which West Fork Locust Creek is located. TN and TP criteria are based on the 25th percentile of data for all seasons in Ecoregion 40. This value is calculated as the median of the four seasonal 25th percentiles of data within an ecoregion (EPA, 2000).

6 CALCULATION OF LOAD 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. Conceptually, this definition is represented by Equation 1.

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

Where:

LC = Loading Capacity

WLA = Waste Load Allocations (point source)

LA = 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 achieved. The CFR (40 CFR § 130.2 (1)) states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures. For West Fork Locust Creek, TSS, TN and TP TMDLs are expressed as pounds per day using a LDC (Figure 6, Figure 7, Figure 8, Table 7, Table 8 and Table 9). The LDC represents the LC as a solid red line over the range of flow conditions present in the creek. Water quality measurements, shown as round (black) points, are loads calculated from TSS, TN and TP concentrations collected in West Fork Locust Creek at Delco Road (Site 612/0.9) and at Highway 6 (Site 613/0.1) during 2009.

As presented in Figure 7, excursions to the TSS threshold occurred under nearly all flow conditions with the exception of low flows occurring between 80 and 100 percent exceedance values. Excursions to the TN and TP thresholds occurred under all flow conditions (Figure 7 and Figure 8).

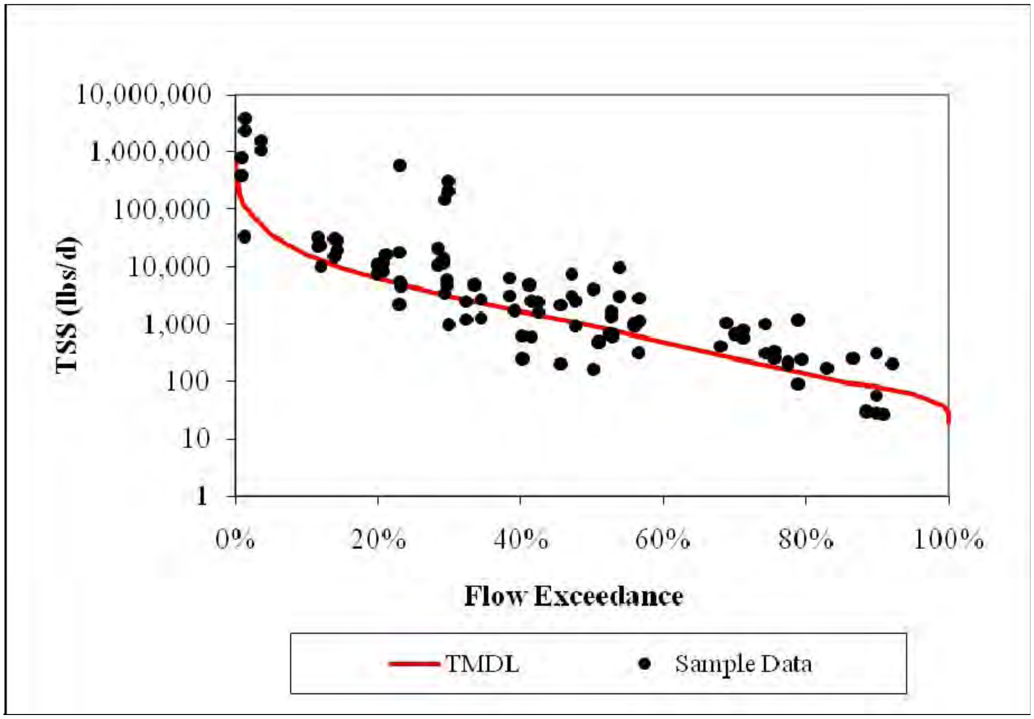

Figure 6. TSS LDC for West Fork Locust Creek Based on 1979-2009 Synthetic Flow and TSS Measurements During 2004-2009

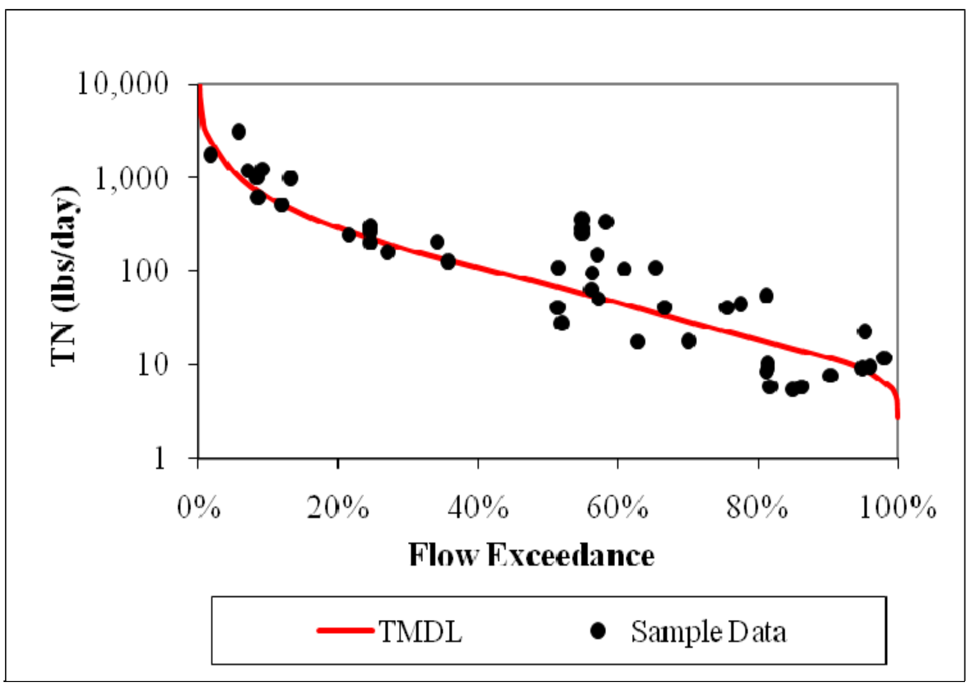

Figure 7. TN LDC for West Fork Locust Creek Based on 1979-2009 Synthetic Flow and TN Measurements During 2000-2009

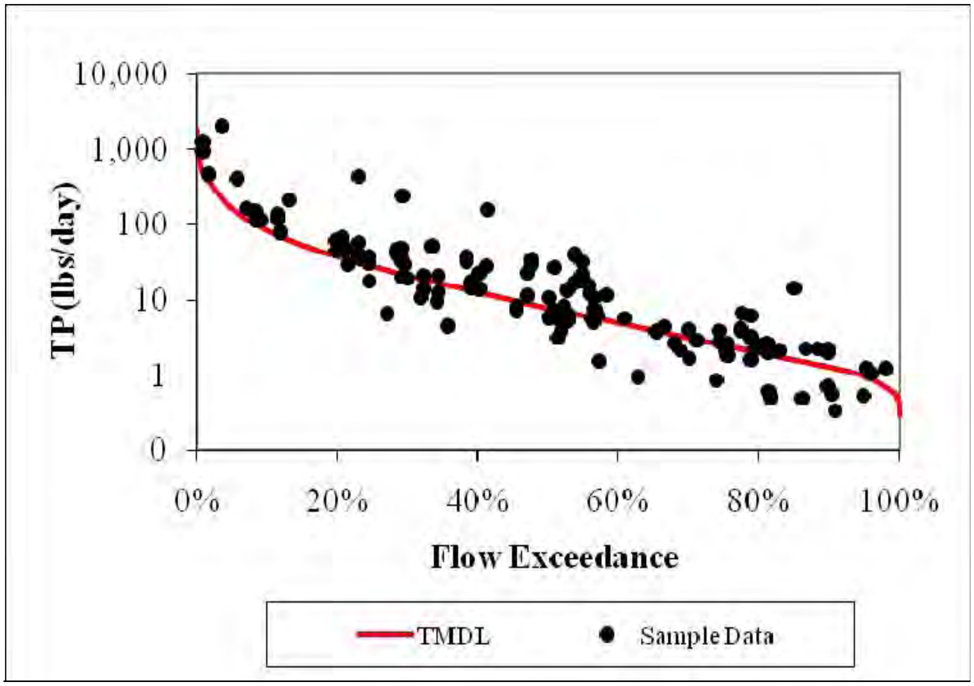

Figure 8. TP LDC for West Fork Locust Creek Based on 1979-2009 Synthetic Flow and TP Measurements During 2000-2009

Table 7. TSS TMDL Under a Range of Flow Conditions in West Fork Locust Creek

Flow Exceedance	Estimated Flow (cfs)	TSS TMDL (lbs/day)	TSS LA (lbs/day)	TSS WLA (lbs/day)
95%	2	60.9	60.9	0
90%	3	80.6	80.6	0
70%	6	252.7	252.7	0
50%	15	919.9	919.9	0
30%	36	3055.1	3055.1	0
10%	115	15983.8	15983.8	0
5%	200	35411.1	35411.1	0

Table 8. TN TMDL Under a Range of Flow Conditions in West Fork Locust Creek

Flow Exceedance	Estimated Flow (cfs)	TN TMDL (lbs/day)	TN LA (lbs/day)	TN WLA (lbs/day)
95%	2	9.1	9.1	0
90%	3	12.0	12.0	0
70%	6	28.9	28.9	0
50%	15	71.5	71.5	0
30%	36	168.0	168.0	0
10%	115	611.0	611.0	0
5%	200	1136.5	1136.5	0

Table 9. TP TMDL Under a Range of Flow Conditions in West Fork Locust Creek

Flow Exceedance	Estimated Flow (cfs)	TP TMDL (lbs/day)	TP LA (lbs/day)	TP WLA (lbs/day)
95%	2	1.0	1.0	0
90%	3	1.3	1.3	0
70%	6	3.1	3.1	0
50%	15	7.7	7.7	0
30%	36	20.8	20.8	0
10%	115	82.7	82.7	0
5%	200	160.3	160.3	0

7 WASTE LOAD ALLOCATION (POINT SOURCE LOADS)

The WLA is the allowable amount of the pollutant that can be assigned to point sources. The WLA is set to the lesser of current permit limits or technology based effluent limits (TBELs). Typically, NPDES permit limits are the most stringent of TBELs or water quality-based effluent limits (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. The permitted CAFO facilities in the watershed are all “no discharge” facilities. Thus, the waste generated on site is not directly discharged to the stream, instead it is land applied. The "no discharge" permits only discharge in the event of a large storm event that exceeds the wastewater storage capacity of the facility. Since these facilities are no discharge and would not cause or contribute to the TSS, TN and TP impairments, the WLA is set to zero.

The single general storm water permit for heavy construction is a potential source of suspended sediment pollution. The WLAs are set at present loads and listings of permit-specific BMPs. Compliance with the NPDES permit will ensure construction sites meet the TMDL area weighted loadings. The permittee will develop a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP ensures the design, implementation and maintenance of BMPs. EPA assumes that construction activities in the watershed will be conducted in compliance with NPDES permit requirements including monitoring and discharge limitations. Compliance with this permit should result in sediment loading from construction sites at or below applicable targets. Given this expectation, the WLA for this permit is set to zero.

Because of data limitations related to regulated storm water discharges from the facilities present in the watershed and the potential for wide variability of storm water discharges, it is not possible to separate the storm water discharges that are subject to the permitting program (e.g., industrial storm water and storm water from construction activities) from storm water discharges that are not subject to permitting (e.g., agricultural runoff and urban runoff not subject to an MS4 permit). Therefore, all storm water discharges are included in the WLA portion of the TMDL. This includes the regulated storm water discharges as well as other sources of storm water not regulated as permitted discharges.

PSF operates the Locust Ridge Finishing Site under permit MO0118494. The facility is classified as a CAFO. There are seven anaerobic lagoons with secondary containment structures that capture wastewater, irrigation water, storm water runoff and domestic wastewater. This is a no discharge facility for process waste. Wastewater is stored in the lagoons and land applied based on the available nitrogen approach. The PSF facilities are "no discharge" permits and would only discharge in the event of a large storm event that exceeds the wastewater storage capacity of the facility. Since this facility is no discharge and would not cause or contribute to the TSS, TN and TP impairments, the WLA is set to zero.

PSF operates the Terre Haute Farm under permit MO0118761. The facility is classified as a CAFO. There are three anaerobic lagoons with secondary containment structures that capture wastewater, irrigation water, storm water runoff and domestic wastewater. This is a no discharge facility for process waste. Wastewater is stored in the lagoons and land applied based on the available nitrogen approach. The PSF facilities are "no discharge" permits and would only discharge in the event of a large storm event that exceeds the wastewater storage capacity of the facility. Since this facility is no discharge and would not cause or contribute to the TSS, TN and TP impairments, the WLA is set to zero.

The three general CAFO facilities are also “no discharge” facilities. They also would only discharge in the event of a large storm event that exceeds the wastewater storage capacity of the facility. Since these facilities are no discharge and would not cause or contribute to the TSS, TN and TP impairments, the WLA is set to zero.

The WLA listed in this TMDL do not preclude the establishment of future point sources of sediment or nutrient loading in the watershed (Table 10). 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.

Table 10. WLAs for Permitted Facilities in the West Fork Locust Creek Watershed

Facility ID	Facility Name[1]	Receiving Stream	WLA (tons per day) d/w/m[2]
MOG010705	Ronald Faulkner Farm	Tributary to West Fork Locust Creek	0.0
MOG010624	Brown, David	Tributary to West Fork Locust Creek	0.0
MOG010701	David Brown North Facility	West Fork Locust Creek	0.0
MO0118494	PSF, Locust Ridge	West Fork Locust Creek	0.0
MO0118761	PSF, Terre Haute Farm	West Locust Creek, West Fork Locust Creek, Elm Creek, East Fork Medicine Creek	0.0
MOR10A194	David Brown Farm	Tributary West Fork Locust Creek	0.0

[1] PSF = “Premium Standard Farms”
[2] Permit limits based on current design loads where d=daily, w=weekly, m=monthly average.

8 LOAD ALLOCATION (NONPOINT SOURCE LOADS)

LA is the allowable amount of the pollutant that can be assigned to nonpoint sources. The TMDL curve is set at an estimate of expected reference conditions over the range of flows. The LA is set at the remainder for the TMDL loading curve after removing allowances for the point source WLA and MOS. Because all point sources in the watershed received a zero WLA and the MOS is implicit, the total LC is allocated to nonpoint sources as LA. TSS, TN and TP LAs are provided in Table 11.

Table 11. TSS, TN and TP LAs in West Fork Locust Creek

Flow Exceedance	Estimated Flow (cfs)	TSS LA (lbs/day)	TN LA (lbs/day)	TP LA (lbs/day)
95%	2	60.9	9.1	1.0
90%	3	80.6	12.0	1.3
70%	6	252.7	28.9	3.1
50%	15	919.9	71.5	7.7
30%	36	3055.1	168.0	20.8
10%	115	15983.8	611.0	82.7
5%	200	35411.1	1136.5	160.3

9 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 critical conditions for the WLA and the LA calculations by making conservative assumptions in the analysis.

An implicit MOS was incorporated into the TMDL based on conservative assumptions used in the development of the LDCs. The use of ecoregion targets in lieu of national or state-wide targets serves to ensure that implementation will result in either pristine or minimally impacted stream systems. The 25th percentile is considered a surrogate for establishing a reference population of the pristine systems (EPA 2000). TN and TP targets are conservative because they are based on the 25th percentile of all TN and TP data gathered from subecoregion 40 of Aggregate Nutrient Ecoregion IX, which these data are not directly influenced by permitted dischargers. In the case of nutrients, the targets are the median calculated from the four seasonal 25th percentile values. As a result, high concentrations seen during the periods of spring runoff and winter flow from snowmelt (or low concentrations seen during low flow conditions in both summer and fall) do not unduly influence the annual reference targets. In the case of sediment, the approach used was to target the 25th percentile of all TSS concentration data available in the EDU in which West Fork Locust Creek is located (See Appendix B and D). The use of these refined and/or EDU specific data ensures that all local geological and landscape conditions are addressed in this TMDL.

10 CRITICAL CONDITIONS AND SEASONAL VARIATION

The TMDL curve represents flow under all seasonal conditions. The LA and TMDL (expressed as concentrations) are applicable at all flow conditions, hence 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. Although there were insufficient water quality data to determine any seasonal pattern that may be occurring in the West Fork Locust Creek watershed, exceedances to the water quality criteria were present under both low and high flow conditions (Figure 6, Figure 7 and Figure 8).

11 MONITORING PLANS

In general, future stream monitoring is scheduled and conducted by MDNR approximately three years after the approval of this TMDL or in a reasonable time frame following the completion of permit compliance schedules and/or the application of new effluent limits. Any volunteer or permittee water quality monitoring that occurs on West Fork Locust Creek will be used for evaluating the present stream condition to see the state's WQS established by the TMDL are being met. MDNR routinely examines 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.

Currently, MDNR is planning to conduct water quality monitoring on this stream at Highway 6 from July 1, 2010 to June 30, 2011. The water quality parameters monitored will include total nitrogen, ammonia nitrogen, nitrite plus nitrate nitrogen, total phosphorus, hardness, calcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, flow, water temperature, dissolved oxygen, pH and conductivity.

12 REASONABLE ASSURANCES

MDNR has the authority to issue and enforce State Operating Permits. Inclusion of effluent limits determined from WLAs established by TMDL modeling into a state permit and monitoring of the effluent and receiving stream reported to MDNR, should provide reasonable assurance that instream WQS will be met. In most cases, "Reasonable Assurance" in reference to TMDLs relates only to point sources. Any assurances that nonpoint source contributors of unknown pollutants will implement measures to reduce their contribution in the future will not be found in this section.

13 PUBLIC PARTICIPATION

EPA regulations require that TMDLs be subject to public review (40 CFR Section 130.7). EPA is providing public notice of this draft TMDL for West Fork Locust Creek on the EPA, Region 7, TMDL Website at http://www.epa.gov/region07/water/tmdl_public_notice.htm. The response to comments and the final TMDL will be available at: http://www.epa.gov/region07/water/apprtmdl.htm#Missouri.

This water quality limited segment of West Fork Locust Creek in Sullivan and Putnam Counties, Missouri, is included on the EPA approved 2008 303(d) List for Missouri. 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 another TMDL for this water at a later 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 or 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.

14 ADMINISTRATIVE RECORD AND SUPPORTING DOCUMENTS

An administrative record on the West Fork Locust Creek TMDL has been assembled and is being kept on file with EPA.

15 APPENDICES

Appendix A – West Fork Locust Creek Water Quality Data
Appendix B – Development of TSS Targets Using Reference LDCs
Appendix C – Development of Nutrient Targets Using Ecoregion Nutrient Criteria with LDCs
Appendix D – Stream Flow and Water Quality Stations Used to Develop TMDLs in West Fork Locust Creek
Appendix E – Supplemental Implementation Plan

REFERENCES

Athayde, D., P. Shelley, E. Driscoll, D. Gaboury and G. Boyd, 1983. *Results of the Nationwide Urban Runoff Program,* Volume I Final Report. PB84-185552, EPA, Washington, D.C.

Cleland, B.R., 2002. TMDL Development From the "Bottom Up" – Part II: Using Load Duration Curves to Connect the Pieces. Proceedings from the WEF National TMDL Science and Policy 2002 Conference, Phoeniz, AZ.

Cleland, B.R., 2003. TMDL Development From the "Bottom Up" – Part III: Duration Curves and Wet-Weather Assessments. America's Clean Water Foundation, Washington, DC.

CSR (Code of State Regulations), 2009. Missouri Secretary of State Web page. Title 10 - Department of Natural Resources. Division 20 – Clean Water Commission. Chapter 7 – Water Quality. 10 CSR 20-7.031 - Water Quality Standards. http://www.sos.mo.gov/adrules/csr/current/10csr/10c20-7.pdf

EPA (United States Environmental Protection Agency), 2000. Ambient Water Quality Criteria Recommendations. Information Supporting the Development of State and Tribal Nutrient Criteria. Rivers and Streams in Nutrient Ecoregion IX. EPA 822-B-00-019. EPA, Washington, D.C.

EPA, 2002. *Onsite Wastewater Treatment System Manual*. EPA/625/R-00/008. Environmental Protection Agency, Office of Water, Washington, DC and Office of Research and Development, Cincinnati, OH. EPA, Washington, D.C.

EPA, 2006. Framework for Developing Suspended and Bedded Sediments (SABS) Water Quality Criteria. EPA-822-R-06-001, EPA, Washington, D.C.

EPA, 2009a. Water Discharge Permits (PCS). Accessed July 17, 2009. www.epa.gov/enviro/html/pcs/index.html.

EPA, 2009b. United States Environmental Protection Agency Region 5 STEPL Online Database Cites NESC (National Environmental Service Center). 2002. Accessed July 28, 2009. http://bering.tetratech-ffx.com/website/stepl/viewer.htm

Horsley & Witten, Inc., 1996. *Identification and Evaluation of Nutrient and Bacterial Loadings to Maquoit Bay, Brunswick and Freeport*, Maine. Casco Bay Estuary Project.

MDC (Missouri Department of Conservation), 2010. *Grand River Watershed – Geology/ Geomorphology*. *Physiographic Region/Geology/Soils.* Accessed February 16, 2010. http://www.mdc.mo.gov/fish/watershed/grand/geology/

MDNR (Missouri Department of Natural Resources), 2008. *Total Maximum Daily Load Information Sheet For Streams with Aquatic Habitat Loss that are Listed for Sediment*. Missouri Department of Natural Resources. Accessed February 16, 2010. http://dnr.mo.gov/env/wpp/tmdl/info/sediment-info.pdf

MDNR, 2009a. Agricultural Nonpoint Source, Special Area Land Treatment Program, NPS Problems, http://www.dnr.mo.gov/env/swcp/service/Salt/nps_problems.htm#improper %20animal%20waste%20management

MDNR, 2009b. *Quality Assurance Project Plan for Low Flow Surveys.* Accessed February 16, 2010. http://oa.mo.gov/purch/bids/b3z09092att7.pdf

MoRAP (Missouri Resource Assessment Partnership), 2005. Land Use/Land Cover Data. Accessed April 26, 2007. http://www.msdis.missouri.edu

MSWDC (Missouri Soil and Water Districts Commission), 2003. Needs Assessment, Plan to Address Identified Needs & A Summary to Date. Accessed February 16, 2010. http://www.dnr.mo.gov/env/swcp/2003%20needs%20assessment.pdf.

MSDIS (Missouri Spatial Data Information Service), 2009. GIS Layers Downloaded May 2009. http://msdis.missouri.edu/datasearch/ThemeList.jsp.

NOAA (National Oceanic and Atmospheric Administration). 2009. *NNDC Climate Data Online*. Accessed July 17, 2009. http://cdo.ncdc.noaa.gov/climatenormals/clim20/mo/234544.pdf.

NRCS (Natural Resources Conservation Service). Accessed July 17, 2009. http://soildatamart.nrcs.usda.gov/Survey.aspx?County=MO001.

Purdue Research Foundation. *Hydrologic Soil Groups*. Accessed July 17, 2009. http://www.ecn.purdue.edu/runoff/documentation/hsg.html, Hydrologic Soil Groups.

Reckhow, K. H., M. N. Beaulac and J. R. Simpson, 1980. *Modeling Phosphorous Loading and Lake Response Under Uncertainty: A Manual and Compilation of Export Coefficients*. EPA-440/5-8-011, EPA, Washington, D.C.

Stoeser, Douglas B., Green, Gregory N., Morath, Laurie C., Heran, William D., Wilson, Anna B., Moore, David W. and Bradley S. Van Gosen, 2005. Preliminary Integrated Geologic Map Databases for the United States Central States: Montana, Wyoming, Colorado, New Mexico, Kansas, Oklahoma, Texas, Missouri, Arkansas and Louisiana, The State of Missouri: US Geological Survey Open-File Report 2005-1351, US Geological Survey, Denver, CO.

United States Census Bureau, 2000. 2000 Population Estimates. Accessed November 6, 2008. http://www.census.gov/

USDA (United States Department of Agriculture). 2002. National Agriculture Statistics Service. Accessed February 19, 2009. http://www.nass.usda.gov/

USDI (US Department of the Interior). US Geological Survey, 1997, Standards for Digital Raster Graphics: Reston, VA.

Appendix A

West Fork Locust Creek Water Quality Data

Site	Site Name	Date	Flow (cfs)	TP (mg/L)	TN (mg/L)	TSS (mg/L)	TSS Method
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	3/22/2000	0.77	0.03			
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	6/21/2000	0.3	0.11	2		
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	9/19/2000		0.12	2.2		
613/17	W. Locust Cr. 2 mi.bl. PSF Locust Ridge Farm	11/8/2000		0.26	4.2		
613/17/1.0	W. Locust Cr. 1 mi.bl. PSF Locust Ridge Farm	11/8/2000		0.47	3.7		
613/17/2.7	W. Locust Cr. @PSF Locust Ridge Farm	11/8/2000		0.32	5.3		
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	12/5/2000	0.2499	0.04	0.5499		
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	3/21/2001		0.42	3.14		
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	6/28/2001	7.1	0.1	0.83		
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	9/11/2001	0.39	0.02499	0.81		
613/4.4	W. Locust Cr. 2 mi.ab. Hwy 6	9/24/2001	0.68	0.09	1		
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	12/11/2001	1.76	0.02499	0.29		
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	3/12/2002	14.8	0.09	1.5		
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	6/6/2002	4.18	0.06			
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	9/12/2002	0	0.07			
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	12/5/2002	0.01	0.11	0.98		
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	3/6/2003		0.05	0.85		
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	6/10/2003	5.15	0.11	1.026		
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	9/11/2003	0	0.16	1.52		
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	12/17/2003	1.6	0.2	5.79		
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	3/1/2004	8.6	0.07	1.39		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	4/27/2004	2.9	0.07		1.99	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	4/27/2004	1.7	0.13		49	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	5/25/2004	100.01	1.53		1154	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	5/25/2004	80.1	1.51		784	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	6/2/2004	17.5	0.17	1.8		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	6/22/2004	40.1	0.17		58	SM 2540D

Site	Site Name	Date	Flow (cfs)	TP (mg/L)	TN (mg/L)	TSS (mg/L)	TSS Method
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	6/22/2004	9.01	0.24		69	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	7/27/2004	2.5	0.12		18	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	7/27/2004	8.4	0.17		45	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	8/24/2004	5.6	0.12		33	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	8/24/2004	1.3	0.24		78	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	8/30/2004		0.23	0.87		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	9/21/2004	1.01	0.11		1.99	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	9/21/2004	1.3	0.18		5	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	10/26/2004	6.3	0.09		18	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	10/26/2004	3.6	0.18		22	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	11/23/2004	14.3	0.08		21	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	11/23/2004	6.7	0.07		1.99	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	1/27/2005	13.4	0.31		29	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	2/21/2005	50.1	0.15		64	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	2/21/2005	22.3	0.15		8	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	3/1/2005	21.5	0.06	1.28		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	3/21/2005	4.5	0.07		9	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	3/21/2005	2.2	0.08		8	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	4/26/2005	56.3	0.15		54	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	4/26/2005	9.393	0.17		54	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	5/24/2005	10.01	0.22		100	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	5/24/2005	4.8	0.2		51	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	6/1/2005	6.65	0.05	0.36		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	6/21/2005	3.6	0.08		8	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	6/21/2005	1.01	0.13		17	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	8/23/2005	0.1	0.27		52	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	8/23/2005	0.1	0.14		4	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	9/21/2005	0	0.83	0.31		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	9/26/2005	0.1	0.14		22	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	9/26/2005	0.1	0.16		4	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	10/24/2005	0.5	0.1		11	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	11/21/2005	0.3	0.02499		1.99	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	12/15/2005	0.56	0.03	0.35		

Site	Site Name	Date	Flow (cfs)	TP (mg/L)	TN (mg/L)	TSS (mg/L)	TSS Method
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	12/28/2005	0.7	0.08		10	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	1/23/2006	0.3	0.05		1.99	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	3/24/2006	0.73	0.07	1.55		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	3/28/2006	2.5	0.09		25	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	3/28/2006	1.1	0.09		18	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	4/26/2006	2.8	0.07		13	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	4/26/2006	0.5	0.1		10	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	5/24/2006	0.9	0.1		11	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	5/24/2006	0.2	0.14		36	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	6/21/2006	0.45	0.02	0.37		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	6/26/2006	0.6	0.08		5	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	7/25/2006	0.3	0.12		16	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	8/22/2006	0.5	0.12		20	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	9/18/2006	0.27	0.05	0.53		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	9/25/2006	0.3	0.11		9	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	10/23/2006	1.3	0.14		16	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	11/20/2006	0.6	0.15		1.99	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	12/12/2006	2.7	0.09	2.57		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	12/22/2006	17.01	0.37		27	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	12/22/2006	8.9	0.32		10	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	1/26/2007	2.4	0.06		29	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	2/21/2007	33.4	1.3		21	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	2/21/2007	25.01	1.3		5	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	3/14/2007	24.8	0.12	1.22		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	3/26/2007	17.5	0.14		34	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	3/26/2007	5.01	0.19		23	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	4/23/2007	4.8	0.11		13	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	4/23/2007	4.2	0.13		14	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	5/24/2007	3.8	0.08		14	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	5/24/2007	1.8	0.12		7	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	6/26/2007		0.04	0.52		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	6/27/2007	0.7	0.33		6	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	6/27/2007	0.8	0.09		6	SM 2540D

Site	Site Name	Date	Flow (cfs)	TP (mg/L)	TN (mg/L)	TSS (mg/L)	TSS Method
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	7/24/2007	0.6	0.07		11	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	8/28/2007	1.2	0.24		23	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	8/28/2007	1.5	0.28		46	SM 2540D
613/17.5	W. Fk. Locust Cr. DS Hwy. ZZ	9/19/2007	0.2499	0.13	0.41		
613/7.9	W. Fk. Locust Cr. Nr. Hwy PP	9/19/2007		0.1	2.64		
613/11.3	W. FK. Locust Cr. DS Hwy. E	9/20/2007		0.03	0.5		
613/15.9	W. Fk. Locust Cr. DS Maple Rd.	9/20/2007	0.2499	0.1	0.45		
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	10/12/2007	1.75	0.28	1.84		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	10/24/2007	7.2	0.19		16	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	10/24/2007	4.2	0.24		14	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	11/21/2007	1.9	0.16		9	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	11/21/2007	1.3	0.17		8	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	12/19/2007		0.1	2.43		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	12/21/2007	50.1	0.24		43	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	12/21/2007	6.7	0.57		135	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	1/30/2008	12.5	0.11		9	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	3/5/2008		0.2	1.37		
613/7.9	W. Fk. Locust Cr. Nr. Hwy PP	3/26/2008	14.4	0.03	0.72		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	3/28/2008	26.01	0.1		17	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	3/28/2008	51.01	1.2		749	SM 2540D
613/11.3	W. FK. Locust Cr. DS Hwy. E	4/1/2008	20.1	0.15	1.04		
613/15.9	W. Fk. Locust Cr. DS Maple Rd.	4/1/2008	16	0.07	0.79		
613/17.5	W. Fk. Locust Cr. DS Hwy. ZZ	4/1/2008	12.6	0.12	1.14		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	4/30/2008	44.5	0.22		59	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	4/30/2008	30.01	0.25		41	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	5/13/2008	33.5	0.16	0.86		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	5/30/2008	417.01	1.6		2112	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	5/30/2008	6.7	0.21		20	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	6/24/2008	20.01	0.18		38	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	6/24/2008	17.01	0.22		27	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	7/31/2008	512.01	0.43		273	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	7/31/2008	200.01	0.33		135	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	8/27/2008	33.4	0.23		41	SM 2540D

Site	Site Name	Date	Flow (cfs)	TP (mg/L)	TN (mg/L)	TSS (mg/L)	TSS Method
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	8/27/2008	17.01	0.23		39	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	9/5/2008		0.45	2.08		
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	9/30/2008	16.7	0.15		30	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	9/30/2008	10.01	0.15		24	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	10/30/2008	7.6	0.1		5	SM 2540D
613/10.7	W. Fk. Locust Cr. @ PSF Locust R Hwy E	11/18/2008	33.4	0.13		18	SM 2540D
613/17.0/4.6	W. Fk. Locust Cr. @ PSF Locust R Hwy EE	11/18/2008	17.01	0.13		17	SM 2540D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	1/14/2009		0.03	0.83		
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	2/18/2009	3.4			14	
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	2/27/2009	4			1580	SM 2540-D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	3/11/2009	8			1020	SM 2540-D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	3/31/2009		0.2	1.43		
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	4/20/2009	12			33	SM 2540-D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	5/6/2009	10			63	SM 2540-D
613/0.1	W. Locust Cr.@Hwy 6, 14 mi.bl. CAFO	5/26/2009		0.15	0.98	19	

Appendix B

Development of TSS Targets Using Reference LDCs

Overview

This procedure is used when a lotic[10] system is placed on the 303(d) List for a pollutant and the designated use being addressed is aquatic life. In cases where pollutant data for the impaired stream is not available a reference approach is used. The target for pollutant loading is the 25th percentile calculated from all data available within the EDU in which the water body is located. Additionally, it is also unlikely that a flow record for the impaired stream is available. If this is the case, a synthetic flow record is needed. In order to develop a synthetic flow record, calculate an average of the log discharge per square mile of USGS gaged rivers for which the drainage area is entirely contained within the EDU. Selection of these gages is based on location, land use/soil/topography similarities to the West Fork Locust Creek watershed and the availability of flow data of sufficient age and duration. From this synthetic record develop the flow duration from which to build a LDC for the pollutant within the EDU.

From this population of load durations follow the reference method used in setting nutrient targets for streams and rivers in Nutrient Ecoregion IX (EPA, 2000). In this methodology the average concentration of either the 75th percentile of reference streams or the 25th percentile of all streams in the region is targeted in the TMDL. For most cases available pollutant data for reference streams is also not likely to be available. Therefore, follow the alternative method and target the 25th percentile of load duration of the available data within the EDU as the TMDL LDC. During periods of low flow the actual pollutant concentration may be more important than load. To account for this during periods of low flow the LDC uses the 25th percentile of EDU concentration at flows where surface runoff is less than 1 percent of the stream flow. This result in an inflection point in the curve below which the TMDL is calculated using load calculated with this reference concentration.

Methodology

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

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

[10] Lotic = pertaining to moving water

relationship must be valid in order to use this methodology. This new synthetic record of flow per square mile is used to develop the load duration for the EDU. The flow record should be of sufficient length to be able to calculate percentiles of flow (typically 20 years or more).

Figure B-1 shows the application of the approach in the West Fork Locust Creek EDU (Central Plains/Grand River/Chariton EDU). Watershed-size normalized data for the individual gages in the EDU were calculated and compared to a pooled data set of all the gages (Figure B-1, Table B-1).

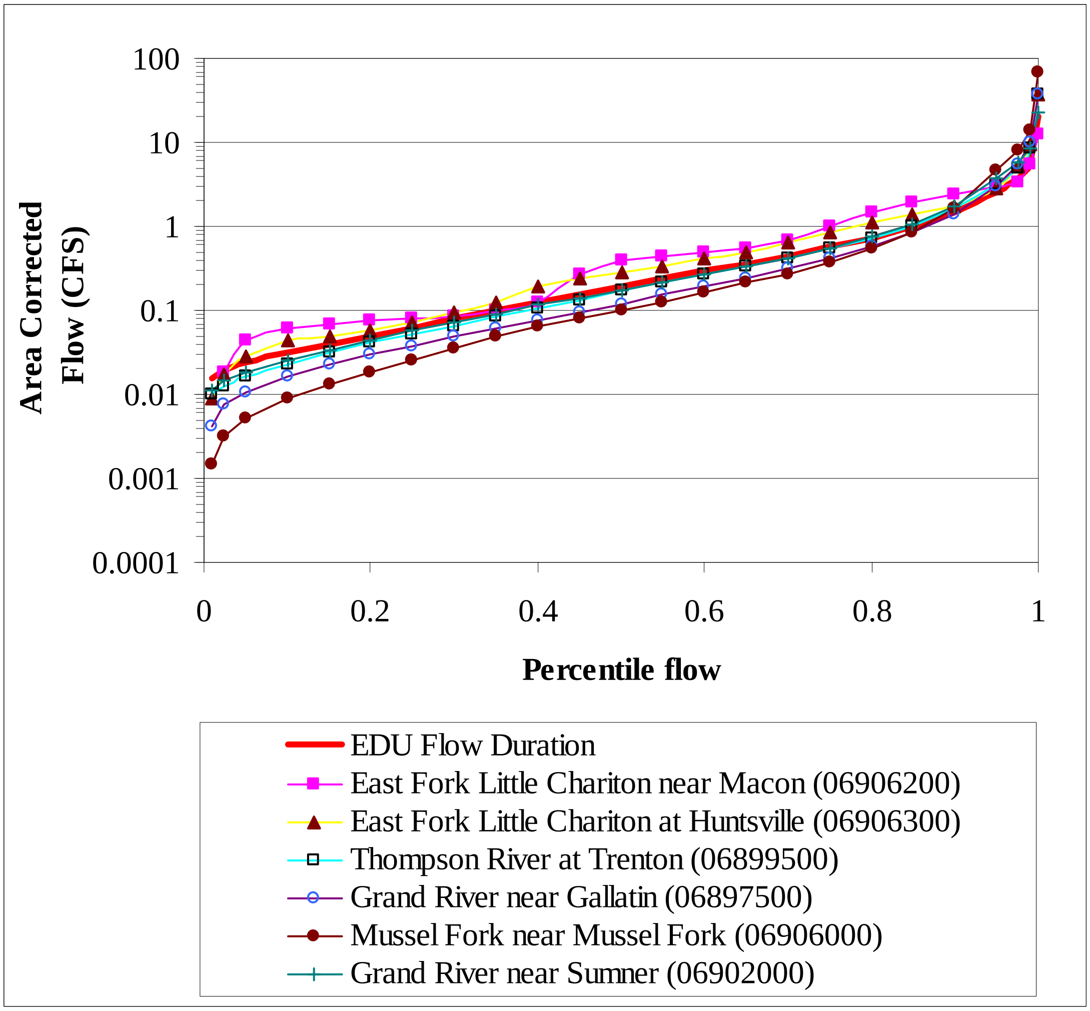

Figure B-1. Synthetic Flow Development in the Central Plains/Grand River/Chariton EDU

Table B-1. Stream Flow Stations Used to Estimate Flows in West Fork Locust Creek

River/Station Name	Data Source	Station Number	Drainage Area (mi^2)	Lognormal Nash-Sutcliffe
East Fork Little Chariton River near Macon, MO	USGS	06906200	112	60%
East Fork Little Chariton River near Huntsville, MO	USGS	06906300	220	78%
Thompson River at Trenton, MO	USGS	06899500	1,720	79%
Grand River near Gallatin, MO	USGS	06897500	2,250	76%
Mussel Fork near Mussel Fork, MO	USGS	06906000	267	47%
Grand River near Sumner, MO	USGS	06902000	6,880	96%

Table B-1 demonstrates the pooled data set can confidently be used as a surrogate for the EDU analyses.

The next step is to calculate sediment-discharge relationship for the EDU. These are log transformed data for the sediment yield (lbs/day) and the instantaneous streamflow (cfs). Figure B-2 shows the EDU sediment-flow relationship. To derive the TMDL curve, the synthetic (or normalized) flow values are multiplied by the watershed area and then applied the sediment-streamflow relationship to calculate the desirable reference stream sediment loads for various flow conditions (see Figure 6).

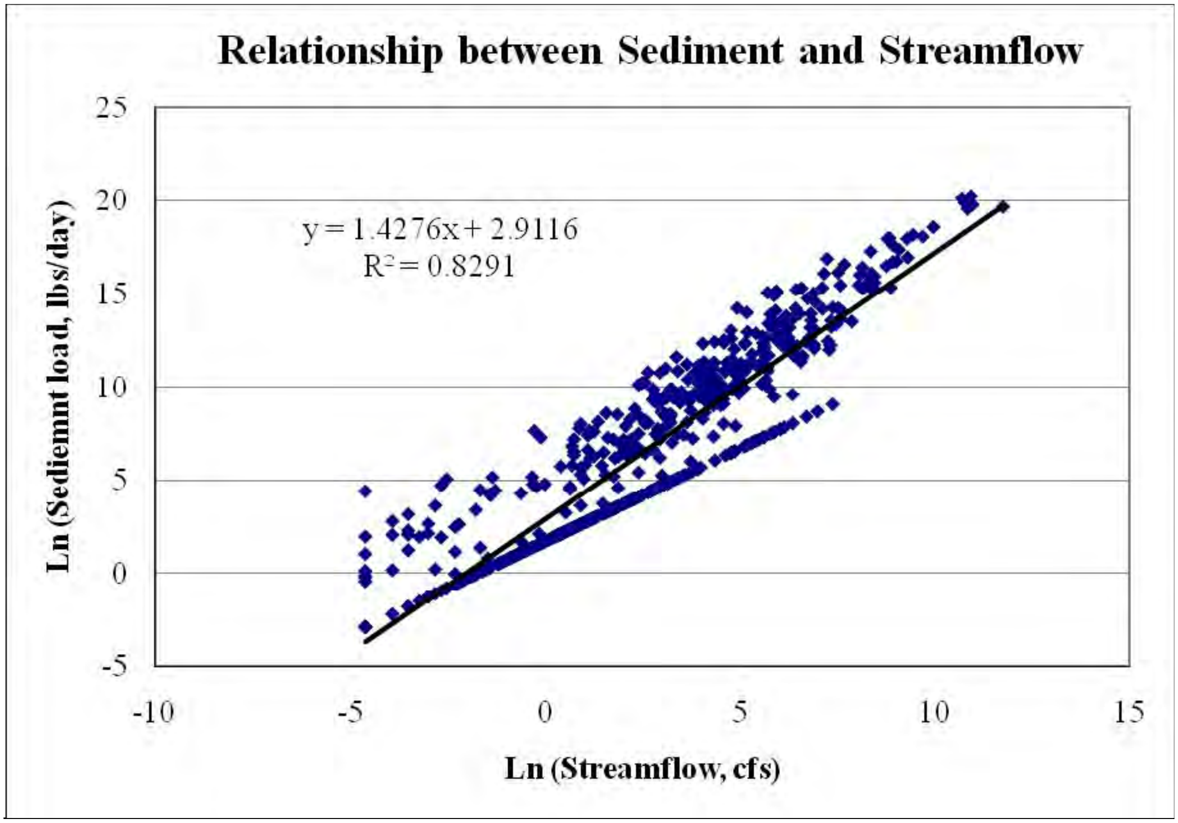

Figure B-2. Estimate of Power Function from Instantaneous Flow in the Central Plains/Grand River/Chariton EDU

For more information contact:

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

Appendix C

Development of Nutrient Targets Using Ecoregion Nutrient Criteria with LDCs

Overview

This procedure is used when a lotic system is placed on the 303(d) impaired water body list for nutrient pollution and the designated use being addressed is aquatic life. In cases where EPA-approved state numeric criteria for the impaired stream is not available a reference approach is used. The target for pollutant loading is the EPA recommended ecoregion nutrient criterion for the specific ecoregion in which the water body is located (EPA, 2000). If a flow record for the impaired stream is not available a synthetic flow record is needed. To develop a synthetic flow record a user should calculate an average of the log discharge per square mile of USGS gaged rivers for which the drainage area is contained within the EDU. Selection of these gages is based on location, land use/soil/topography similarities to the West Fork Locust Creek watershed and the availability of flow data of sufficient age and duration. From this synthetic record develop a flow duration and build a LDC for the pollutant within the EDU.

See EPA (2000) for more detailed information as to how recommended ecoregion nutrient criteria were developed. This appendix describes how the nutrient criteria (TN and TP) are expressed in this TMDL.

Methodology

The first step in this procedure is to gather available nutrient data within the ecoregion of interest. These data along with the instantaneous flow measurement taken at the time of sample collection for the specific date are required to develop the LDC. Both dates and nutrient concentrations are needed in order to match the measured data used with the synthetic EDU flow record.

Secondly, collect average daily flow data from gages with a variety of drainage areas for a period of time to cover the nutrient record. From these flow records normalize the flow to a per square mile basis. Average the log transformations of the average daily discharge for each day in the period of record. For each gage record used to build the synthetic flow record calculate the Nash-Sutcliffe value to determine if the relationship is valid for each record. This relationship must be valid in order to use this methodology. This new synthetic record of flow per square mile is then used to develop the LDC for the EDU. The flow record should be of sufficient length to be able to calculate percentiles of flow (typically 20 years or more).

The following example shows the application of the approach for the Central Plains/Grand River/Chariton EDU. Watershed-size normalized data for the individual gages in the EDU were calculated and compared to a pooled data set of all the gages (Figure C-1, Table C-1). Table C-1 demonstrates the pooled data set can confidently be used as a surrogate for the EDU analyses.

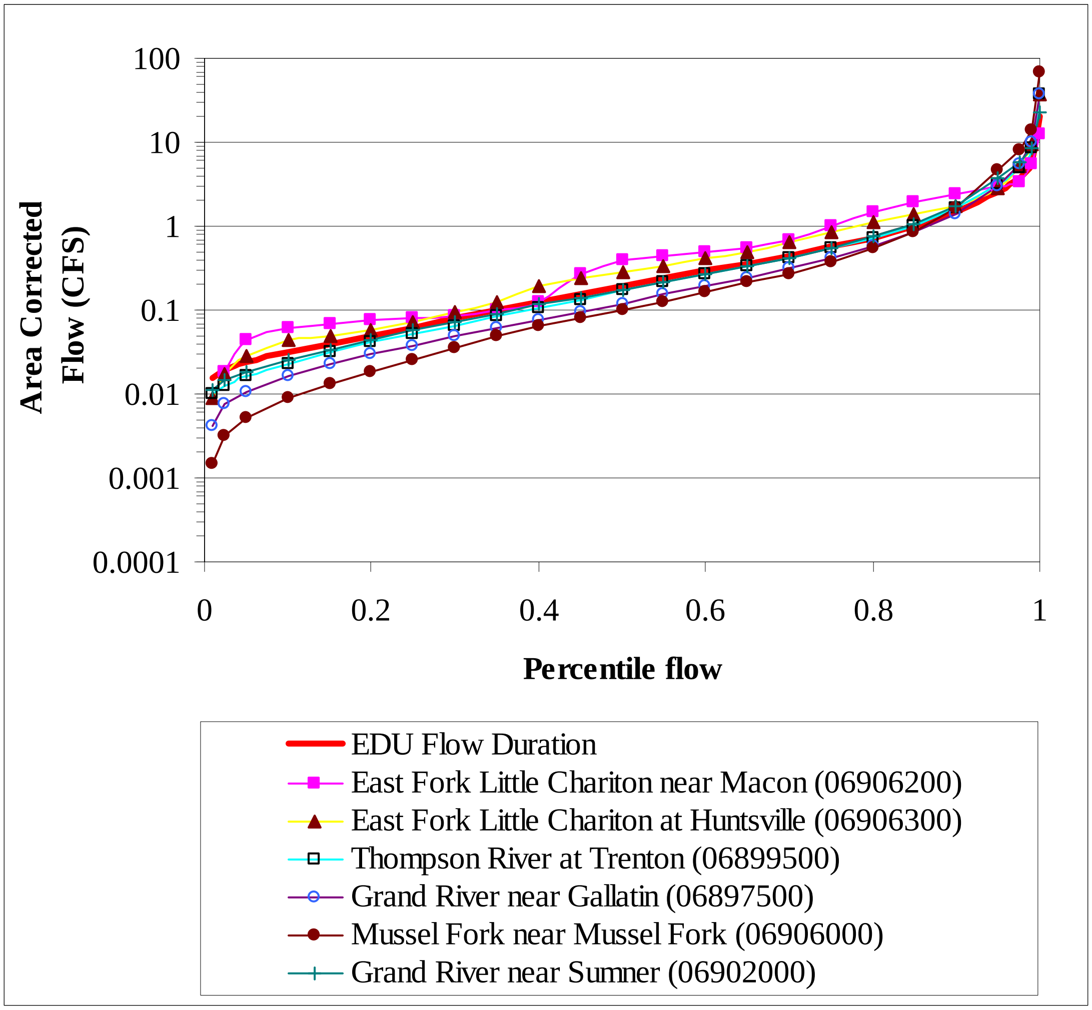

Figure C-1. Synthetic Flow Development in the Central Plains/ Grand River/Chariton EDU

Table C-1. Stream Flow Stations Used to Estimate Flows in West Fork Locust Creek

River/Station Name	Data Source	Station Number	Drainage Area (mi^2)	Lognormal Nash-Sutcliffe
East Fork Little Chariton River near Macon, MO	USGS	06906200	112	60%
East Fork Little Chariton River near Huntsville, MO	USGS	06906300	220	78%
Thompson River at Trenton, MO	USGS	06899500	1,720	79%
Grand River near Gallatin, MO	USGS	06897500	2,250	76%
Mussel Fork near Mussel Fork, MO	USGS	06906000	267	47%
Grand River near Sumner, MO	USGS	06902000	6,880	96%

The next step was to collect previously measured water quality data from within the ecoregion. Measured TN concentrations are adjusted so their median is equal to the EPA recommended ecoregion TN criterion. This is accomplished by subtracting the difference between the EPA recommended ecoregion TN criterion and the median from the measured data. This results in the data retaining most of its natural variability yet having a median which meets the EPA recommended ecoregion TN criterion. Where this adjustment would result in a negative concentration the minimum measured concentration is substituted. Figure C-2 shows an example of this process where the solid line is the measured distribution of the natural log TN concentration with the natural log flow and the dashed line represents a data distribution (the adjusted data) which would comply with the EPA recommended ecoregion TN criterion.

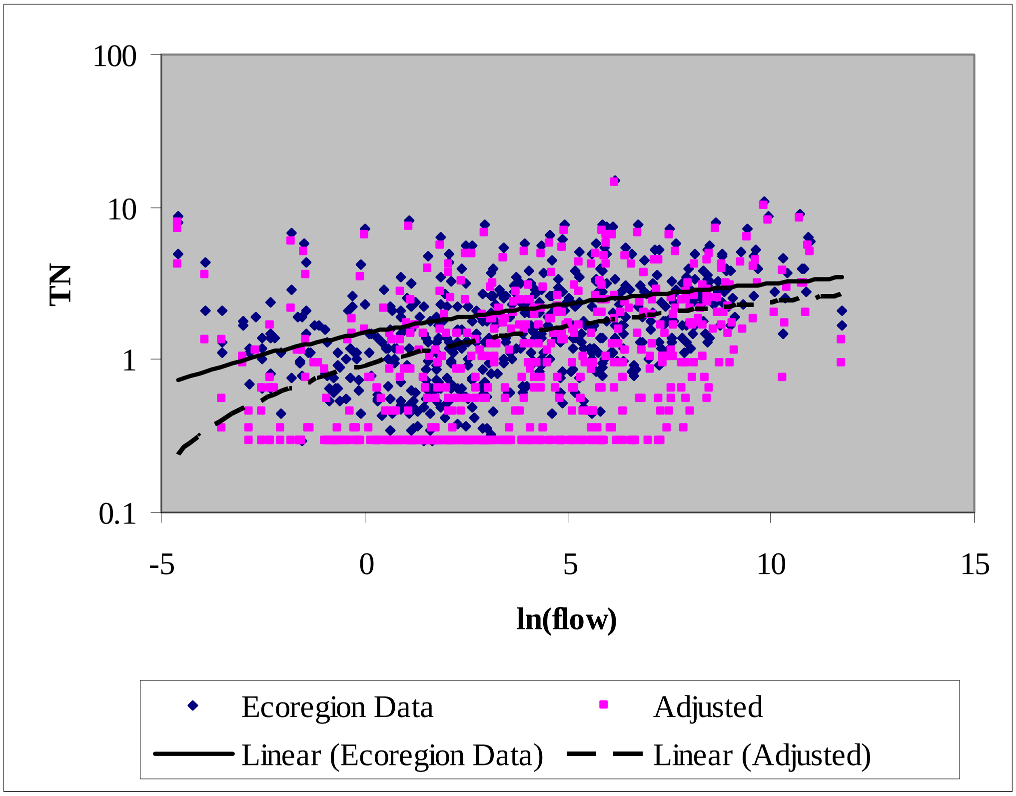

Figure C-2. Graphic Representation of Data Adjustment in Central Plains/ Grand River/Chariton EDU

The next step was to calculate the TN-discharge relationship for the ecoregion using the adjusted data, this is natural log transformed data for the yield (pounds/day) and the instantaneous flow (cfs). Figure C-3 shows this relationship for this TMDL.

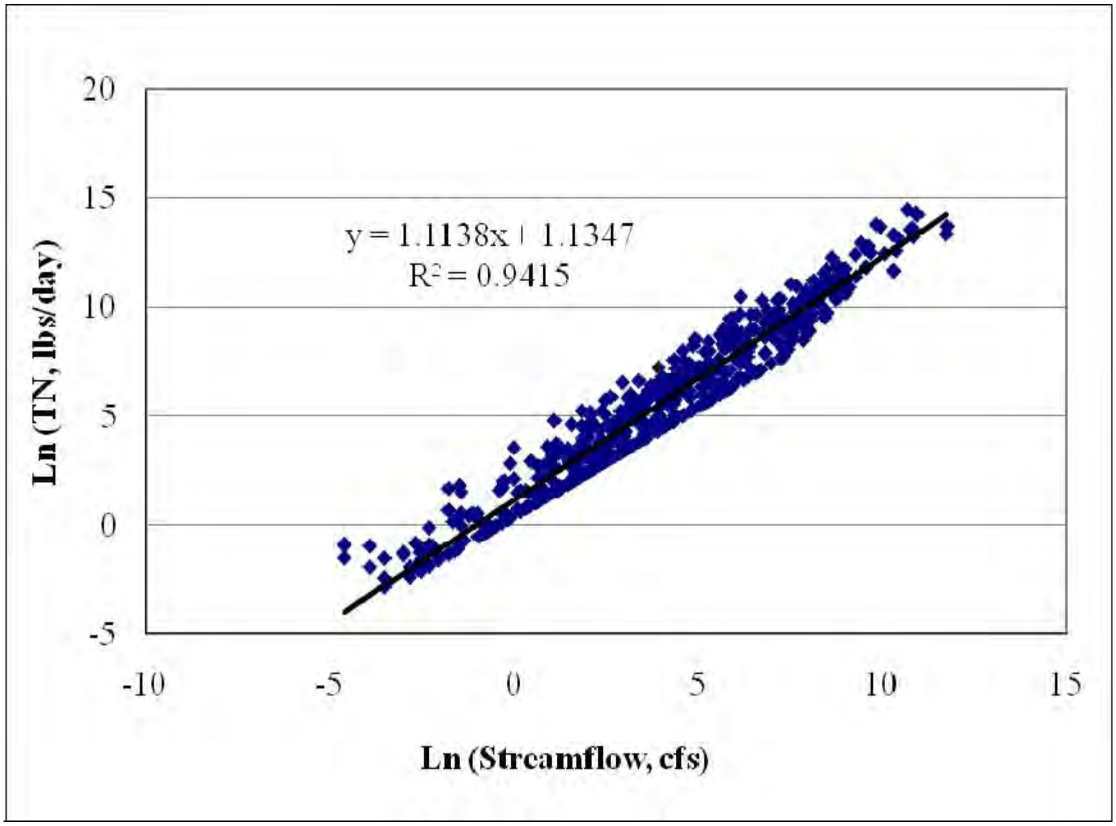

Figure C-3. Load / Flow Relationship Used to Set LDC TMDL

This relationship was used to develop a LDC for which the relationship between flow and nutrient distribution is taken into account. In this LDC the targeted concentration is allowed to change at different percentiles of flow exceedance. However, meeting the LDC will result in a water body in which the median concentration is equal to the EPA recommended ecoregion criterion.

To apply this process to a specific watershed entails using the individual watershed data compared to the TMDL curve that has been multiplied by the watershed area (mi^2). Data from the impaired segment is then plotted as a load (pounds/day) for the y-axis and as the percentile of flow for the EDU on the day the sample was taken for the x-axis. These data points do not have to be collected at the segment outlet. The spreadsheet applies an outlet flow (percentile exceedance) to the concentration based on the synthetic flow estimate for the specific date the sample was taken (Figure C-4).

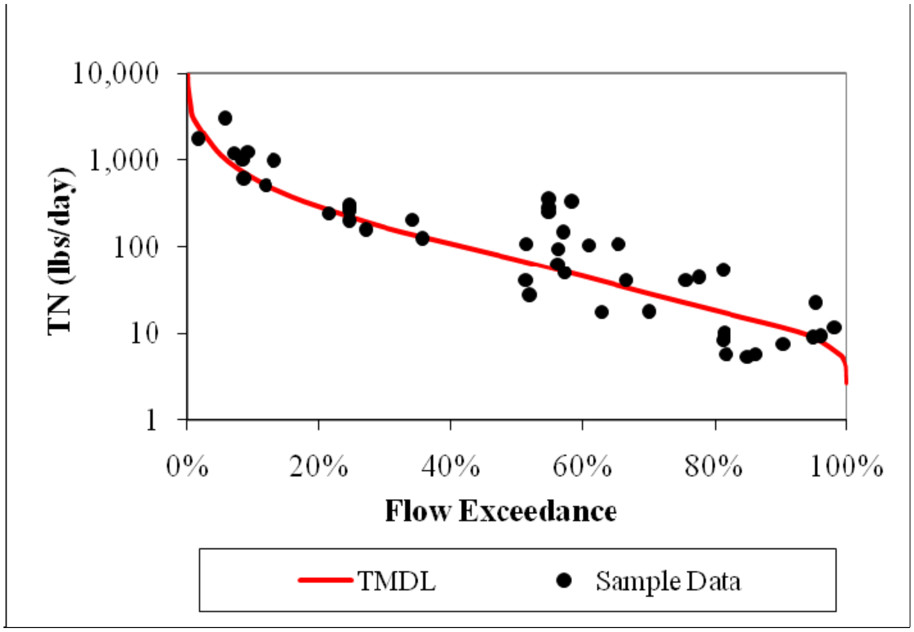

Figure C-4. Example LDC TMDL for TN

The resulting LDC with plotted site specific measured data can now be used to target implementation by identifying flows in which TN concentrations are higher than would be expected in a stream meeting the EPA recommended ecoregion TN criterion.

For more information contact:

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

Appendix D

Stream Flow and Water Quality Stations Used to Develop TMDLs in West Fork Locust Creek

Table D-1. Stream Flow Stations Used to Estimate Flows in West Fork Locust Creek

River/Station Name	Data Source	Station Number	Drainage Area (mi^2)
East Fork Little Chariton River near Macon, MO	USGS	6906200	112
East Fork Little Chariton River near Huntsville, MO	USGS	6906300	220
Thompson River at Trenton, MO	USGS	6899500	1,720
Grand River near Gallatin, MO	USGS	6897500	2,250
Mussel Fork near Mussel Fork, MO	USGS	6906000	267
Grand River near Sumner, MO	USGS	6902000	6,880

Table D-2. Stations Used to Develop Water Quality Data Targets in West Fork Locust Creek

USGS Gage Number	Station Name	Drainage Area (mi^2)
6898100	Thompson River at Mount Moriah, MO	891
6898800	Weldon River near Princeton, MO	452
6899580	NO Creek near Dunlap, MO	34
6899585	NO Creek at Farmersville, MO	67.4
6899950	Medicine Creek near Harris, MO	192
6900100	Little Medicine Creek near Harris, MO	66.5
6901500	Locust Creek near Linneus, MO	550
6902000	Grand River near Sumner, MO	6880
6905725	Mussel Fork near Mystic, MO	24

Table D-3. Water Quality Data Used in TMDL Development

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6898100 - Thompson River at Mount Moriah, MO					
6898100	11/9/1999	22	527		0.86
6898100	1/13/2000	8.6		0.7	E 0.04
6898100	3/23/2000	33			0.26
6898100	5/18/2000	19	27		0.14
6898100	7/13/2000	49			0.2
6898100	9/6/2000	10			0.53
6898100	11/28/2000	15	< 10	0.77	E 0.03
6898100	1/3/2001	7.5		0.75	< 0.06
6898100	3/15/2001	4860		5.6	1.92
6898100	5/2/2001	276	156	1.7	0.26

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6898100	7/13/2001	126			0.16
6898100	9/20/2001	53		E 0.67	0.11
6898100	11/8/2001	41	14		E 0.06
6898100	1/17/2002	14	< 10	0.74	E 0.03
6898100	3/14/2002	91	43	1.9	0.1
6898100	5/9/2002	223	347	1.8	0.39
6898100	8/1/2002	26	30		0.12
6898100	9/3/2002	17	176		0.3
6898100	11/7/2002	18	< 10		0.05
6898100	1/15/2003	15	< 10		E 0.04
6898100	3/28/2003	50	11	0.68	0.07
6898100	5/22/2003	196	107	5.1	0.22
6898100	7/15/2003	76	66	1.4	0.28
6898100	8/29/2003	6.1	< 10		0.08
6898100	9/4/2003	10	146		0.34
6898100	11/4/2003	325	644	4	1.08
6898100	1/23/2004	23	< 10	0.82	E 0.04
6898100	3/25/2004	268	186	5	0.3
6898100	5/20/2004	E 837	593	7.6	1.03
6898100	7/9/2004	118	17	2.8	0.28
6898100	9/10/2004	259	82	1.2	0.26
6898100	11/8/2004	70	132		0.24
6898100	1/21/2005	31	< 10	0.95	E 0.03
6898100	3/3/2005	144	42	2.4	0.09
6898100	5/25/2005	342	292	3.8	0.39
6898100	7/8/2005	96	67		0.19
6898100	9/16/2005	23	< 10	E 0.32	0.05
6898100	11/10/2005	12	< 10		0.04
6898100	1/20/2006	23	< 10		0.04
6898100	3/31/2006	23	< 10		0.04
6898100	5/25/2006	81	100		0.22
6898100	7/27/2006	15	23		0.1
6898100	9/8/2006	44	28		0.13
6898100	11/9/2006	23	< 10		0.05
6898100	1/4/2007	381	333	7.4	0.77
6898100	2/14/2007	24	< 10	3.9	E 0.03
6898100	3/21/2007	291	218	3.4	0.32
6898100	4/6/2007	394	192	3.2	0.3
6898100	5/23/2007	298	63	3.3	0.17
6898100	6/20/2007	133	82	2.1	0.18
6898100	7/25/2007	54	17		0.09
6898100	9/19/2007	132	26	E 0.83	0.1
6898100	11/16/2007	137	48	2.1	0.14
6898100	1/24/2008	200	20	2.4	0.07
6898100	3/12/2008	682	328	2.9	0.55

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6898100	5/29/2008	481	196	3.4	0.29
6898100	7/10/2008	1280	1440	5.2	1.52
6898100	9/17/2008	569	300	1.7	0.43
6898100	10/22/2008	1380	2930	5.2	2.44
6898100	1/14/2009	235	74	1.7	0.09
6898100	3/5/2009	264	254	2.2	0.35
6898100	5/7/2009	614	336	3.1	0.45
6898100	7/16/2009	1220	718	3.2	0.64
6898100	9/3/2009	288	109	1.2	0.25
6898800 - Weldon River near Princeton, MO					
6898800	11/9/1999	5.3		0.29	0.043
6898800	1/11/2000	10		0.38	< 0.05
6898800	3/21/2000	13			E 0.03
6898800	5/16/2000	2.4	< 10		< 0.05
6898800	7/11/2000	9.4			0.09
6898800	9/6/2000	1.8			0.07
6898800	11/30/2000	5.2	< 10	0.6	< 0.060
6898800	1/5/2001	8.1		0.54	< 0.06
6898800	3/15/2001	2840		3.9	1.28
6898800	5/2/2001	152	119	2.5	0.24
6898800	7/11/2001	63			0.13
6898800	9/18/2001	18		E 0.35	< 0.06
6898800	11/6/2001	36	18	0.6	0.1
6898800	1/15/2002	20	< 10	0.57	< 0.06
6898800	3/12/2002	101	114	2.6	0.21
6898800	5/7/2002	527	210	2.3	0.5
6898800	7/30/2002	17	14		0.07
6898800	8/15/2002	8.7	20		0.07
6898800	9/5/2002	3.3	13		E 0.04
6898800	10/24/2002	5	< 10	E 0.34	E 0.03
6898800	11/5/2002	6.5	< 10		< 0.04
6898800	12/10/2002	4.3	< 10	E 0.29	E 0.02
6898800	1/14/2003	1.9	< 10		E 0.02
6898800	3/7/2003	8.6	< 10	0.64	E 0.03
6898800	3/26/2003	7.3	< 10		0.04
6898800	5/20/2003	168	264	1.7	0.33
6898800	7/17/2003	6.1	19		0.08
6898800	9/5/2003	0.73	52		< 0.04
6898800	11/6/2003	99	120	4.5	0.5
6898800	1/21/2004	30	19	2.5	0.13
6898800	3/23/2004	90	39	1.7	0.12
6898800	5/18/2004	473	267	15	1.73
6898800	7/7/2004	44	14		0.08
6898800	9/8/2004	166	85	0.86	0.2
6898800	11/10/2004	20	< 10	E 0.35	E 0.03

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6898800	1/19/2005	11	< 10	0.59	< 0.04
6898800	3/1/2005	80	51	1.1	0.07
6898800	5/23/2005	128	266	2.2	0.34
6898800	7/6/2005	23	< 10		E 0.04
6898800	9/14/2005	6	10		0.05
6898800	11/8/2005	6.5	21		0.04
6898800	1/18/2006	9.4	< 10		< 0.04
6898800	3/31/2006	117	750	3	0.8
6898800	5/23/2006	6.1	12		0.04
6898800	7/25/2006	1.5	60		0.11
6898800	9/6/2006	9.2	42		0.08
6898800	11/7/2006	5.5	< 10		0.06
6898800	1/4/2007	82	44	3.7	0.23
6898800	2/16/2007	7.2	< 10	0.42	E 0.03
6898800	3/23/2007	625	1250	5.5	1.52
6898800	4/6/2007	174	86	1.4	0.15
6898800	5/23/2007	97	28	1	0.09
6898800	6/20/2007	35	31		0.12
6898800	7/25/2007	19	15		0.07
6898800	9/19/2007	42	24		0.07
6898800	11/14/2007	24	13	E 0.46	0.06
6898800	1/24/2008	60	140	1.6	0.26
6898800	3/12/2008	615	472	1.9	0.48
6898800	5/29/2008	166	79	1.2	0.17
6898800	7/10/2008	307	426	2.8	0.6
6898800	9/17/2008	325	364	1.4	0.41
6898800	10/22/2008	6480	1850	4.9	1.93
6898800	1/14/2009	78	< 15	0.92	E 0.04
6898800	3/6/2009	121	112	0.76	0.14
6898800	5/7/2009	260	126	1.2	0.21
6898800	7/16/2009	98	54		0.16
6898800	9/3/2009	274	145	1.1	0.26
6899580 - NO Creek near Dunlap					
6899580	1/22/1998	3.7	1		
6899580	6/2/1998	3.2	51		
6899580	3/30/1999	4.4		0.48	E 0.05
6899580	4/22/1999	14		0.77	0.13
6899580	6/21/1999	0.25	70		0.14
6899580	10/25/1999	0.01		8.6	0.19
6899580	11/29/1999	0.01	73		0.24
6899580	12/20/1999	0.1			0.09
6899580	1/24/2000	0.1	28	1.4	0.12
6899580	2/23/2000	0.06			0.14
6899580	4/20/2000	0.81			0.16
6899580	5/9/2000	0.17	54	6.7	0.3

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6899580	6/14/2000	6.4		6.3	0.46
6899580	6/22/2000	0.4		1.3	0.18
6899580	7/25/2000	0.11	45	1.4	0.15
6899580	10/24/2000	0.37		1.6	0.67
6899580	11/15/2000	0.68	21	2.1	0.14
6899580	12/19/2000	0.08		E 1.4	E 0.06
6899580	1/24/2001	1.6	18	2.9	0.1
6899580	2/15/2001	40		2.8	0.34
6899580	3/27/2001	10		1.6	0.12
6899580	4/24/2001	19		1.3	0.18
6899580	5/22/2001	9.9	41	1.3	0.15
6899580	6/19/2001	2.7		1.6	0.23
6899580	6/25/2001	5.2		1.1	0.18
6899580	7/26/2001	59	290	1.7	0.35
6899580	8/9/2001	0.47		E 0.75	0.12
6899580	9/13/2001	0.1		E 2.4	0.15
6899580	10/23/2001	38	386	2.3	0.72
6899580	11/29/2001	0.28	78		0.19
6899580	12/13/2001	1	20		0.1
6899580	2/28/2002	1.7	22	1.2	0.07
6899580	3/21/2002	2.1	< 10		E 0.03
6899580	4/18/2002	4.3	36	0.75	0.12
6899580	5/23/2002	2.4	< 10	E 0.51	0.07
6899580	6/13/2002	0.53	20	0.64	0.1
6899580	6/28/2002	0.07	40		0.11
6899580	7/23/2002	0.01	< 10	E 8.0	0.17
6899580	8/22/2002	1	44	7.3	0.91
6899580	12/19/2002	0.01	37		0.16
6899580	3/13/2003	0.41	< 10		0.17
6899580	3/20/2003	0.34	12		0.15
6899580	4/25/2003	2.1	82	1.2	0.22
6899580	4/30/2003	0.62	12		0.14
6899580	5/6/2003	6.4	164	3.5	0.38
6899580	6/12/2003	3	68	8.2	0.24
6899580	7/9/2003	0.01	43	4.9	0.27
6899580	9/19/2003	0.26	144	1.1	0.28
6899580	10/23/2003	0.03	70		0.28
6899580	11/18/2003	0.1	23		0.22
6899580	12/11/2003	22	120	3.7	0.43
6899580	1/8/2004	1	17	2.3	0.11
6899580	2/27/2004	5.8	14	1.9	0.11
6899580	3/18/2004	52	117	2	0.25
6899580	4/20/2004	2.7	33		0.1
6899580	5/11/2004	1.3	< 10		0.08
6899580	6/22/2004	9.1	49	1.1	0.17

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6899580	7/16/2004	0.41	23	E 0.78	0.14
6899580	8/23/2004	0.72	67	E 0.77	0.14
6899580	9/14/2004	0.76	520	E 2.6	0.79
6899580	10/26/2004	1	< 10		0.28
6899580	11/16/2004	3.7	< 10	0.46	0.06
6899580	12/14/2004	6.2	18	0.65	0.08
6899580	1/25/2005	0.08	18	1.2	0.14
6899580	2/10/2005	21	138	1.4	0.16
6899580	3/17/2005	2.9	< 10		E 0.04
6899580	4/5/2005	3.6	< 10		0.04
6899580	5/12/2005	2	52		0.14
6899580	6/30/2005	0.86	24	0.73	0.12
6899580	7/13/2005	0.03	< 10		0.06
6899580	8/19/2005	0.02	33		0.09
6899580	9/21/2005	0.05	53		0.12
6899580	10/5/2005	0.08	380		0.49
6899580	11/3/2005	0.01	1510		1.94
6899580	12/14/2005	0.1	44	E 1.5	0.19
6899580	1/25/2006	0.03	43		0.11
6899580	2/14/2006	0.01	22		0.1
6899580	3/9/2006	0.2	< 10		0.07
6899580	4/12/2006	2.1	72	0.95	0.16
6899580	5/9/2006	2.8	44	0.93	0.13
6899580	6/15/2006	0.23	24	5.8	0.13
6899580	7/19/2006	0	152		0.59
6899580	8/10/2006	3.1	147	1.6	0.34
6899580	9/21/2006	0.02	170	E 4.3	0.31
6899580	10/25/2006	0.02	93	E 2.1	0.35
6899580	12/13/2006	0.52	17	0.92	0.12
6899580	1/26/2007	0.84	< 10	1	E 0.04
6899580	2/20/2007	56	162	3.8	0.68
6899580	3/15/2007	8.1	37	1.2	0.09
6899580	4/27/2007	76	225	2.9	0.38
6899580	5/10/2007	18	110	2.7	0.23
6899580	6/28/2007	19	485	7.6	0.64
6899580	7/19/2007	E 0.03	165	E 1.3	0.21
6899580	8/23/2007	0.24	75	1.5	0.21
6899580	9/27/2007	0.19	105		0.25
6899580	10/16/2007	0.06	136	E 1.2	0.36
6899580	11/8/2007	0.01	16		0.28
6899580	12/20/2007	3.1	20	2.2	0.14
6899580	1/10/2008	22	58	2	0.23
6899580	2/26/2008	E 65	86	2.9	0.35
6899580	3/25/2008	8.3	34	0.95	0.1
6899580	4/16/2008	11	102	1.2	0.18

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6899580	5/22/2008	2.1	138	E 1.0	0.22
6899580	6/17/2008	13	74	1.3	0.22
6899580	7/15/2008	0.8	46	1.1	0.14
6899580	8/12/2008	0.55	24	E 0.54	0.1
6899580	9/23/2008	3	< 10	0.44	0.09
6899580	10/28/2008	6.6	< 15	0.65	0.13
6899580	11/18/2008	11	< 15	0.65	0.1
6899580	12/2/2008	5.8	< 15	0.54	0.07
6899580	1/27/2009	1.9	< 15	E 0.34	E 0.04
6899580	2/24/2009	3	16		0.05
6899580	3/12/2009	16	250	2.1	0.34
6899580	4/24/2009	6.5	16	E 0.48	0.08
6899580	5/15/2009	29	730	2.7	0.65
6899580	6/23/2009	20	< 150	1.8	0.27
6899580	8/18/2009	56	266	2	0.38
6899585 - NO Creek at Farmersville, MO					
6899585	11/16/2006	0.13	< 10	0.44	0.26
6899950 - Medicine Creek near Harris, MO					
6899950	10/26/1999	2.3			E 0.045
6899950	11/30/1999	3	6		< 0.05
6899950	12/21/1999	0.1		0.65	< 0.05
6899950	1/25/2000	0.5	3		< 0.05
6899950	2/22/2000	15			E 0.04
6899950	3/27/2000	8.7			E 0.03
6899950	4/18/2000	4			E 0.03
6899950	5/10/2000	10	< 10		0.05
6899950	6/21/2000	6		0.87	0.08
6899950	7/26/2000	6.6	37		0.11
6899950	9/20/2000	3.4		0.54	0.07
6899950	10/26/2000	6.1			0.07
6899950	11/14/2000	5.8	< 10	0.93	0.09
6899950	12/18/2000	3.1		E 0.34	< 0.06
6899950	1/25/2001	12	< 10	3.2	0.11
6899950	2/13/2001	131		2.8	0.3
6899950	3/29/2001	100		2	0.21
6899950	4/26/2001	76		1	0.21
6899950	5/24/2001	52	68	1.3	0.18
6899950	6/19/2001	79		1.5	0.33
6899950	6/26/2001	60		1.1	0.18
6899950	7/25/2001	353	1610	3.2	1.34
6899950	8/8/2001	13		E 0.55	0.09
6899950	9/12/2001	7.4		0.5	0.07
6899950	10/25/2001	33	118	2.6	0.37
6899950	11/28/2001	3.4	12	E 0.35	E 0.03
6899950	12/12/2001	6.2			< 0.06

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6899950	1/3/2002	4.6	< 10	0.55	< 0.06
6899950	1/8/2002	5	< 10	E 0.45	< 0.06
6899950	2/27/2002	9.9	12	1.3	0.07
6899950	3/19/2002	18	< 10		0.06
6899950	4/17/2002	68	130	1.4	0.24
6899950	5/21/2002	38	38	1	0.1
6899950	6/28/2002	5.6	13		E 0.06
6899950	7/24/2002	3.6	< 10		0.08
6899950	8/21/2002	17	41		0.14
6899950	9/10/2002	1.4	< 10		E 0.05
6899950	10/17/2002	1.4	< 10		E 0.03
6899950	11/19/2002	2	< 10		E 0.03
6899950	12/18/2002	2.8	< 10		0.04
6899950	1/30/2003	0.9	< 10		E 0.03
6899950	2/20/2003	3.4	< 10		E 0.03
6899950	3/12/2003	3.9	< 10		0.1
6899950	4/23/2003	14	12		0.25
6899950	5/8/2003	27	104	2.9	0.29
6899950	6/11/2003	51	282	5.8	0.47
6899950	7/10/2003	65	161	1.5	0.3
6899950	8/25/2003	0.61	< 10		0.06
6899950	9/17/2003	4.5	49	1.4	0.36
6899950	10/22/2003	1.3	< 10		0.05
6899950	11/20/2003	3	< 10		0.06
6899950	12/10/2003	368	E 692	5.5	2.81
6899950	1/7/2004	6.2	< 10	1.7	0.06
6899950	2/26/2004	55	66	2.4	0.34
6899950	3/16/2004	71	53	1.7	0.22
6899950	4/22/2004	21	12		0.06
6899950	5/13/2004	11	< 10		0.05
6899950	6/23/2004	42	49	1.2	0.18
6899950	7/14/2004	32	76	1.3	0.24
6899950	8/25/2004	378	1700	4.9	1.77
6899950	9/16/2004	25	15		0.1
6899950	10/27/2004	50	131	1.5	0.31
6899950	11/18/2004	16	< 10		0.04
6899950	12/16/2004	26	< 10	0.82	0.05
6899950	1/27/2005	169	280	2.3	0.53
6899950	2/9/2005	105	165	2.2	0.25
6899950	3/16/2005	28	< 10		0.06
6899950	4/8/2005	77	79		0.21
6899950	5/11/2005	24	15		0.08
6899950	6/29/2005	77	620	5.6	1.27
6899950	7/12/2005	5.7	< 10		0.05
6899950	8/17/2005	6.2	< 10	0.71	0.06

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6899950	9/20/2005	3.6	14	E 0.37	0.05
6899950	10/5/2005	2.8	11		0.04
6899950	11/2/2005	2	< 10		E 0.03
6899950	12/15/2005	4.4	< 10		E 0.02
6899950	1/26/2006	2.6	< 10		E 0.03
6899950	2/17/2006	1.3	< 10		0.04
6899950	3/8/2006	9.8	< 10		0.06
6899950	4/13/2006	12	15		0.08
6899950	5/10/2006	18	20	0.59	0.07
6899950	6/14/2006	2.4	< 10		0.04
6899950	7/18/2006	4.8	16		0.13
6899950	8/9/2006	16	150	1.5	0.38
6899950	9/20/2006	1.4	< 10		< 0.04
6899950	10/24/2006	3	< 10		0.08
6899950	11/15/2006	2.6	< 10		0.09
6899950	12/14/2006	4.4	24	1.5	0.07
6899950	1/25/2007	8	< 10	1.3	0.06
6899950	2/21/2007	460	379	7.4	1.37
6899950	3/14/2007	60	72	2	0.2
6899950	4/27/2007	971	660	4.5	1.19
6899950	5/9/2007	349	424	2.8	0.63
6899950	6/27/2007	10	19	0.65	0.08
6899950	7/18/2007	4.6	10		0.08
6899950	8/21/2007	57	763	3.2	0.93
6899950	9/25/2007	9.8	< 20		0.08
6899950	10/16/2007	46	84	1.2	0.25
6899950	11/6/2007	14	< 10	0.49	0.09
6899950	12/19/2007	57	35	1.7	0.13
6899950	1/9/2008	483	406	2.6	0.56
6899950	2/27/2008	202	140	3.5	0.45
6899950	3/26/2008	64	49	0.97	0.12
6899950	4/16/2008	119	170	1.5	0.27
6899950	5/21/2008	36	19		0.1
6899950	6/18/2008	112	148	1.4	0.28
6899950	7/16/2008	19	35		0.14
6899950	8/13/2008	25	46		0.1
6899950	9/24/2008	98	536	2.6	0.61
6899950	10/29/2008	60	39	0.92	0.17
6899950	11/19/2008	75	42	0.83	0.12
6899950	12/3/2008	49	16	0.61	0.06
6899950	1/28/2009	19	< 15	0.72	0.04
6899950	2/25/2009	34	22	0.61	0.06
6899950	3/11/2009	715	1180	4.9	1.37
6899950	4/22/2009	61	85	0.92	0.17
6899950	5/13/2009	377	1900	6.5	2.37

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6899950	6/24/2009	75	220	2.4	0.42
6899950	7/22/2009	20	24		0.1
6899950	8/20/2009	180	455	2.2	0.54
6900100 - Little Medicine Creek near Harris					
6900100	1/22/1998	8.7	1		
6900100	6/2/1998	11	26		
6900100	1/5/1999	4.8	5	0.67	< 0.05
6900100	3/31/1999	12		0.37	E 0.03
6900100	4/21/1999	35		1.1	0.16
6900100	6/22/1999	4.7	30	0.97	0.11
6900100	8/25/1999	0.62		0.56	E 0.04
6900100	10/26/1999	0.67			E 0.03
6900100	11/30/1999	0.73	1		< 0.05
6900100	12/21/1999	0.1		0.82	0.06
6900100	1/25/2000	0.5	4		< 0.05
6900100	2/22/2000	1.8			E 0.04
6900100	3/27/2000	1.1			< 0.05
6900100	4/18/2000	2			E 0.04
6900100	5/10/2000	1.4	< 10		E 0.03
6900100	6/21/2000	1.2		1.5	0.07
6900100	7/26/2000	1.6	< 10		0.07
6900100	9/20/2000	1.6			0.05
6900100	10/26/2000	1.8			0.08
6900100	11/14/2000	1.8	< 10	1	E 0.06
6900100	12/19/2000	0.91		0.44	E 0.04
6900100	1/25/2001	3.2	< 10	3.2	E 0.04
6900100	2/13/2001	46		3.2	0.42
6900100	3/29/2001	35		1.9	0.14
6900100	4/26/2001	18		0.87	0.15
6900100	5/24/2001	16	31	1.4	0.12
6900100	6/19/2001	17		1.9	0.26
6900100	6/26/2001	13		0.92	0.09
6900100	7/25/2001	11	444	4	0.48
6900100	8/8/2001	1.4		0.59	E 0.05
6900100	9/12/2001	1.2		0.79	0.07
6900100	10/25/2001	7.5	54	2.2	0.2
6900100	11/28/2001	1.5	< 10		< 0.06
6900100	12/12/2001	1.7	< 10		< 0.06
6900100	1/8/2002	0.38	< 10	0.8	< 0.06
6900100	2/27/2002	1.8	< 10	1.2	E 0.03
6900100	3/19/2002	2	< 10		< 0.06
6900100	4/17/2002	13	66	1	0.13
6900100	5/21/2002	9.1	14	0.67	0.07
6900100	6/28/2002	2	< 10	E 0.44	E 0.04
6900100	7/24/2002	0.59	< 10		E 0.04

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6900100	8/21/2002	3.1	< 10	0.62	0.1
6900100	9/10/2002	0.15	< 10		E 0.04
6900100	10/17/2002	0.31	< 10		E 0.03
6900100	11/19/2002	0.41	< 10		0.06
6900100	12/18/2002	0.64	< 10		E 0.02
6900100	1/29/2003	0.11	< 10		0.05
6900100	2/20/2003	0.64	< 10		E 0.03
6900100	3/12/2003	1.4	< 10		< 0.04
6900100	4/23/2003	0.47	< 10	0.61	0.04
6900100	5/8/2003	3.5	127	2.4	0.19
6900100	6/11/2003	30	344	5.4	0.51
6900100	7/10/2003	138	E 2060	7.7	1.76
6900100	8/25/2003	0.08	13	E 0.64	0.1
6900100	9/18/2003	0.48	20	0.65	0.07
6900100	10/22/2003	0.3	< 10		0.07
6900100	11/20/2003	0.52	< 10		0.05
6900100	12/10/2003	98	470	6.5	0.93
6900100	1/7/2004	0.73	16	2.2	E 0.03
6900100	2/26/2004	10	36	2.2	0.11
6900100	3/16/2004	25	56	1.7	0.14
6900100	4/22/2004	4.6	< 10		0.04
6900100	5/13/2004	8.9	102	1.2	0.18
6900100	6/23/2004	12	33	1.3	0.13
6900100	7/14/2004	6	37	1.3	0.15
6900100	8/25/2004	2150	1400	5.8	1.91
6900100	9/16/2004	5.8	64	0.65	0.17
6900100	10/27/2004	16	146	1.3	0.29
6900100	11/18/2004	5.2	< 10		E 0.04
6900100	12/17/2004	4.6	< 10	0.85	E 0.03
6900100	1/27/2005	24	51	2.6	0.37
6900100	2/10/2005	7	48	1.8	0.11
6900100	3/16/2005	7.6	< 10		0.04
6900100	4/8/2005	15	18		0.07
6900100	5/12/2005	8.6	38	E 0.66	0.1
6900100	6/30/2005	6	20	E 0.73	0.1
6900100	7/12/2005	1.4	< 10	E 0.53	0.06
6900100	8/17/2005	0.42	< 10	0.64	0.06
6900100	9/20/2005	0.64	< 10		0.05
6900100	10/5/2005	0.22	< 10	E 0.29	E 0.04
6900100	11/2/2005	0.15	< 10		0.05
6900100	12/15/2005	1.6	< 10		E 0.03
6900100	1/26/2006	0.73	< 10		E 0.03
6900100	2/17/2006	0.37	< 10		E 0.04
6900100	3/8/2006	2.2	< 10		0.04
6900100	4/13/2006	1.5	15		0.07

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6900100	5/10/2006	2.3	19		0.05
6900100	6/14/2006	0.43	< 10	0.53	0.05
6900100	7/19/2006	0.22	< 10	0.79	0.08
6900100	8/9/2006	3	122	1.2	0.25
6900100	9/20/2006	0.16	< 10		E 0.03
6900100	10/24/2006	0.35	< 10		0.06
6900100	11/16/2006	0.45	< 10		0.09
6900100	12/14/2006	1.1	13	1.5	0.06
6900100	1/25/2007	2.2	< 10	1.2	< 0.04
6900100	2/21/2007	E 130	59	6.2	1.16
6900100	3/15/2007	14	64	1.8	0.13
6900100	4/25/2007	1830	1070	7.3	2.42
6900100	5/10/2007	52	184	2.3	0.33
6900100	6/27/2007	1.4	10	0.56	0.06
6900100	7/18/2007	0.53	13		0.06
6900100	8/21/2007	14	663	5.6	0.92
6900100	9/25/2007	1.5	< 20	E 0.43	0.09
6900100	10/17/2007	13	424	2.2	0.81
6900100	11/8/2007	1	< 10		0.1
6900100	12/19/2007	13	31	2.2	0.15
6900100	1/10/2008	68	88	2.7	0.34
6900100	2/27/2008	58	82	3.2	0.37
6900100	3/26/2008	21	43	0.95	0.11
6900100	4/16/2008	33	88	1.4	0.21
6900100	5/21/2008	7.3	< 10		0.08
6900100	6/18/2008	20	74	1.3	0.21
6900100	7/16/2008	3	10	0.51	0.07
6900100	8/13/2008	3.3	13	0.48	0.08
6900100	9/24/2008	300	2200	5.7	1.81
6900100	10/29/2008	18	23	0.65	0.11
6900100	11/19/2008	30	33	1	0.11
6900100	12/3/2008	17	< 15	0.68	0.05
6900100	1/28/2009	4.5	< 15	0.73	E 0.03
6900100	2/25/2009	12	18	0.57	0.05
6900100	3/11/2009	118	490	3.4	0.56
6900100	4/22/2009	15	15	0.41	0.06
6900100	5/13/2009	352	1760	7.8	2.21
6900100	6/24/2009	26	160	2	0.29
6900100	7/22/2009	2.5	< 15	0.47	0.05
6900100	8/20/2009	176	1290	3.8	1.15
6901500 - Locust Creek near Linneus, MO					
6901500	8/26/2003	0.8	<10		0.05
6902000 - Grand River near Sumner, MO					
6902000	11/8/1989	373		1	0.13
6902000	1/18/1990	851		2.2	0.34

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6902000	5/9/1990	5480		2.3	0.42
6902000	7/11/1990	1430		1.3	0.35
6902000	11/7/1990	1310		3.6	0.3
6902000	1/9/1991	452		2	0.24
6902000	5/17/1991	14200		2.6	0.39
6902000	7/16/1991	2510		3.2	0.41
6902000	11/6/1991	470		1.7	0.31
6902000	1/15/1992	2720		1.7	0.34
6902000	7/8/1992	340			0.11
6902000	11/12/1992	7780		2.2	0.22
6902000	12/2/1992	4980		1.4	0.28
6902000	1/6/1993	8980		1.9	0.47
6902000	2/17/1993	2510		1.4	0.25
6902000	3/17/1993	3220		1.5	0.28
6902000	4/8/1993	29800		1.5	0.22
6902000	5/12/1993	33700		3.7	0.2
6902000	6/16/1993	18400		11	1
6902000	7/27/1993	128000		2.1	0.55
6902000	8/25/1993	2820		1.3	
6902000	9/16/1993	23600		2.8	0.34
6902000	10/27/1993	1700		1.1	0.04
6902000	11/16/1993	3300		1.7	0.25
6902000	12/8/1993	1140			0.03
6902000	1/5/1994	755		0.92	0.05
6902000	2/3/1994	1200		2.7	0.18
6902000	3/16/1994	1750		1.8	0.18
6902000	3/30/1994	750		0.78	0.09
6902000	4/27/1994	900			0.12
6902000	5/10/1994	3700		2.6	0.28
6902000	6/14/1994	4500		5.2	1.2
6902000	8/23/1994	250			
6902000	9/14/1994	270			0.11
6902000	10/26/1994	136			0.13
6902000	11/30/1994	1200		2	0.15
6902000	12/14/1994	1140		1.8	0.2
6902000	1/5/1995	350		1.4	0.03
6902000	2/8/1995	2060		2.7	0.27
6902000	3/30/1995	2720		3.5	0.13
6902000	4/18/1995	5660		7.9	0.41
6902000	5/24/1995	51600		2.8	0.4
6902000	6/14/1995	4450		1.5	0.2
6902000	7/12/1995	6100		2.8	0.14
6902000	8/2/1995	2030		1.8	0.39
6902000	9/5/1995	496			0.13
6902000	10/24/1995	235			0.11

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6902000	11/6/1995	595		1.2	0.1
6902000	12/13/1995	216		0.49	0.04
6902000	1/22/1996	430		1.1	0.08
6902000	2/14/1996	3050		2.5	1
6902000	3/26/1996	1480		2.4	0.31
6902000	4/16/1996	520			0.16
6902000	5/20/1996	4660		3.6	0.57
6902000	6/19/1996	14500		4.8	0.83
6902000	7/17/1996	1050			0.16
6902000	8/14/1996	906			0.12
6902000	9/11/1996	1170		1.6	0.14
6902000	10/9/1996	527			0.1
6902000	11/20/1996	4930		3.3	0.18
6902000	1/22/1997	466		1.4	0.07
6902000	2/12/1997	1620		2.2	0.16
6902000	3/17/1997	2510		1.7	0.28
6902000	4/23/1997	29800		4.6	0.28
6902000	5/27/1997	2130		E 2.9	0.44
6902000	6/17/1997	15100		5.2	0.25
6902000	7/29/1997	395			0.12
6902000	8/19/1997	511		0.98	0.18
6902000	9/9/1997	286		1.2	0.15
6902000	11/17/1997	415	6		
6902000	1/15/1998	1590	16		
6902000	6/9/1998	4290	452		
6902000	8/18/1998	587	60		
6902000	11/16/1998	4640	264	1.3	0.15
6902000	12/1/1998	6620		2.4	0.8
6902000	1/25/1999	4150	231	2.4	0.31
6902000	2/23/1999	3040		1.2	0.16
6902000	3/23/1999	2740		3.2	0.25
6902000	4/13/1999	3460		2.5	0.47
6902000	5/19/1999	31900		2.5	0.7
6902000	6/15/1999	6840	1800		
6902000	7/27/1999	429			0.17
6902000	8/10/1999	639	80		0.22
6902000	9/13/1999	365			0.21
6902000	10/26/1999	130			0.1
6902000	11/30/1999	240	10		< 0.05
6902000	12/21/1999	157		0.83	0.06
6902000	1/4/2000	198	16	0.75	0.07
6902000	2/1/2000	123		0.61	0.05
6902000	3/7/2000	565		1.7	0.27
6902000	4/3/2000	301		0.83	0.19
6902000	5/2/2000	308	95		0.22

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6902000	6/12/2000	217			0.22
6902000	7/11/2000	924	180	1.3	0.32
6902000	8/2/2000	465			0.23
6902000	9/12/2000	129			0.22
6902000	10/2/2000	341			0.28
6902000	11/21/2000	220	12	1.2	0.08
6902000	12/5/2000	207		1.3	0.08
6902000	1/3/2001	E 203	< 10	1.5	E 0.03
6902000	2/14/2001	5880		3.3	0.53
6902000	3/6/2001	8040		3.8	0.79
6902000	4/17/2001	7800		3	0.76
6902000	5/1/2001	1740	90		0.22
6902000	6/19/2001	6690		4.7	1.33
6902000	7/10/2001	1830	174	1.2	0.26
6902000	8/13/2001	572			0.17
6902000	9/5/2001	404			0.17
6902000	10/17/2001	3210	555	2.4	0.65
6902000	11/6/2001	416	18		0.1
6902000	12/4/2001	323	16	0.46	0.12
6902000	1/8/2002	179	< 10	0.61	E 0.05
6902000	2/5/2002	347	12	0.95	0.08
6902000	3/6/2002	573	12	0.99	E 0.05
6902000	4/10/2002	4220	1440	3.8	1.16
6902000	5/7/2002	43700	2420	9.1	3.12
6902000	6/10/2002	841			0.2
6902000	7/16/2002	393	145	1.8	0.54
6902000	8/13/2002	175	< 10		0.17
6902000	9/4/2002	145	65		0.18
6902000	10/22/2002	97	39		0.11
6902000	11/27/2002	115	10		0.07
6902000	12/12/2002	102	< 10	0.45	0.05
6902000	2/12/2003	121	< 10	1.3	0.06
6902000	2/25/2003	E 130	< 10	0.52	0.08
6902000	3/21/2003	354	29	0.9	0.09
6902000	4/11/2003	163	46		0.12
6902000	5/2/2003	1940	524	3.3	0.76
6902000	6/20/2003	516	114	2	0.28
6902000	7/29/2003	130	19		0.19
6902000	8/21/2003	66	81		0.23
6902000	9/9/2003	85	58		0.18
6902000	10/21/2003	96	44		0.2
6902000	11/5/2003	75	26		0.09
6902000	12/15/2003	888	89	3.1	0.32
6902000	1/7/2004	E 275	< 10	1.6	0.08
6902000	2/3/2004	E 165	< 10	1.4	0.08

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6902000	3/2/2004	997	112	2.8	0.26
6902000	4/6/2004	2040	136	2.4	0.25
6902000	5/19/2004	21000	1070	8.8	2.37
6902000	6/28/2004	1910	158	1.3	0.28
6902000	7/15/2004	7510	475	3.8	1.22
6902000	8/16/2004	715	49		0.19
6902000	9/2/2004	E 125000	543	1.7	0.57
6902000	10/12/2004	900	132	1.3	0.26
6902000	11/9/2004	1410	56	0.93	0.17
6902000	12/1/2004	813	22	0.86	0.11
6902000	1/24/2005	1530	90	1.8	0.22
6902000	2/14/2005	55000	2160	6.4	1.83
6902000	3/8/2005	1460	43	1.2	0.12
6902000	4/4/2005	992	55		0.11
6902000	5/3/2005	1530	117	1.7	0.21
6902000	6/22/2005	1600	203	1.8	0.34
6902000	7/12/2005	513	135		0.26
6902000	8/22/2005	909	252	1.9	0.41
6902000	9/7/2005	301	55		0.18
6902000	10/12/2005	315	34	1.1	0.12
6902000	11/2/2005	220	< 10	0.54	0.07
6902000	12/19/2005	272	< 10	1	0.04
6902000	1/4/2006	459	14	1.1	0.07
6902000	2/7/2006	357	< 10	0.79	0.07
6902000	3/7/2006	267	12	E 0.44	0.07
6902000	4/10/2006	1010	415	2.7	0.53
6902000	5/3/2006	12500	1180	7.1	1.48
6902000	6/21/2006	386	154		0.3
6902000	7/6/2006	259	41		0.2
6902000	8/2/2006	131	138		0.23
6902000	9/6/2006	432	170		0.34
6902000	10/10/2006	121	51		0.1
6902000	11/6/2006	289	43	1.2	0.15
6902000	12/5/2006	546	76	2.8	0.26
6902000	1/4/2007	3400	767	4.9	1.05
6902000	2/14/2007	272	< 10	1.6	0.05
6902000	3/7/2007	3450	258	3.4	0.48
6902000	4/3/2007	7510	1120	3.9	1.1
6902000	5/2/2007	4620	360	3.4	0.51
6902000	6/6/2007	4600	200	3.1	0.43
6902000	7/10/2007	447	104		0.2
6902000	8/14/2007	1230	242	2	0.37
6902000	9/11/2007	736	52		0.17
6902000	10/23/2007	3100	340	2.9	0.6
6902000	11/6/2007	569	27	1.5	0.12

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6902000	12/4/2007	702	45	0.84	0.14
6902000	1/9/2008	16000	850	3.9	1.11
6902000	2/14/2008	1900	100	1.9	0.22
6902000	3/5/2008	50600	1180	3.9	1.43
6902000	4/16/2008	7050	144	2.8	0.64
6902000	6/2/2008	10700	1120	5.1	1.31
6902000	7/9/2008	4230	384	1.8	0.49
6902000	8/4/2008	8200	452	1.7	0.47
6902000	9/2/2008	803	80		0.16
6902000	10/21/2008	1940	106	1.4	0.27
6902000	11/24/2008	2600	75	1.1	0.15
6902000	12/9/2008	1500	48	0.94	0.11
6902000	2/2/2009	1080	< 15	1	0.06
6902000	3/10/2009	57300	1300	5.9	1.77
6902000	4/1/2009	10900	418	2.3	0.55
6902000	5/5/2009	8690	780	2.5	0.68
6902000	6/2/2009	3960	312	2.9	0.42
6902000	7/28/2009	986	62		0.18
6902000	8/17/2009	46900	1790	3.9	1.52
6902000	9/1/2009	6300	454	1.7	0.53
6905725 - Mussel Fork near Mystic, MO					
6905725	1/23/1998	1.6	12		
6905725	6/3/1998	1.2	22		
6905725	1/6/1999	1.9	4	0.56	< 0.05
6905725	3/31/1999	2.4		0.54	E 0.04
6905725	4/21/1999	8.4		0.98	0.11
6905725	6/23/1999	0.54	47	0.89	0.09
6905725	10/25/1999	0.01			0.07
6905725	11/30/1999	0.01	11		0.05
6905725	12/20/1999	0.1			< 0.05
6905725	1/24/2000	0.1	24		0.05
6905725	4/20/2000	0.16			0.07
6905725	5/11/2000	0.07	< 10		0.07
6905725	6/14/2000	8.3		3.3	0.44
6905725	6/15/2000	7.3		2.7	0.25
6905725	6/20/2000	0.22		1.9	0.11
6905725	7/27/2000	0	10		E 0.04
6905725	10/25/2000	0.03			0.28
6905725	11/15/2000	0.1	< 10		0.08
6905725	12/20/2000	0.02			0.06
6905725	1/24/2001	0.24	10	4.3	0.17
6905725	2/14/2001	59		3.2	0.42
6905725	3/28/2001	4.3		2.2	0.12
6905725	4/25/2001	4.1			0.12
6905725	5/22/2001	1.1		1.1	0.08

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6905725	5/23/2001	0.82	11	1.1	0.08
6905725	6/18/2001	7.6		1.4	0.21
6905725	6/28/2001	2.5			0.11
6905725	7/26/2001	4.8	228	4.7	0.4
6905725	8/9/2001	0.13		E 1.1	0.1
6905725	9/11/2001	0.03		E 1.1	0.1
6905725	10/24/2001	3.5	50	2.4	0.42
6905725	11/29/2001	0.17	< 10		E 0.06
6905725	12/13/2001	0.83	20		E 0.05
6905725	1/9/2002	0.2	10	0.97	E 0.05
6905725	2/28/2002	1.4	18	1.4	0.09
6905725	3/20/2002	0.97	< 10		E 0.04
6905725	4/18/2002	1.6	17		0.07
6905725	5/22/2002	2.2	20		0.12
6905725	6/27/2002	0.06	10	E 0.69	E 0.04
6905725	8/22/2002	0.17	22	E 0.77	0.08
6905725	2/21/2003	0.05	< 10	1.7	0.15
6905725	3/13/2003	2.5	37		0.2
6905725	3/19/2003	0.3	14	E 1.7	0.14
6905725	4/24/2003	0.19	26	1.9	0.1
6905725	4/30/2003	1.9	32	2.2	0.2
6905725	5/7/2003	2.5	44	2.1	0.23
6905725	6/12/2003	0.72	16	E 1.2	0.09
6905725	7/9/2003	E 0.00	11		0.1
6905725	9/17/2003	0.33	15	1.7	0.14
6905725	11/19/2003	E 0.01	38		0.27
6905725	12/11/2003	7.9	84	5	0.41
6905725	1/8/2004	0.24	19	2.1	0.17
6905725	2/20/2004	41	81	3.5	0.52
6905725	3/17/2004	25	60	1.8	0.18
6905725	4/21/2004	1.6	15		0.06
6905725	5/12/2004	0.55	< 10		0.07
6905725	6/24/2004	1.9	31	1.6	0.21
6905725	7/13/2004	11	52	1.6	0.21
6905725	8/24/2004	0.25	21	1.1	0.07
6905725	9/15/2004	0.52	< 10	E 1.1	0.09
6905725	10/28/2004	2	< 10		0.14
6905725	11/17/2004	1.8	< 10	0.67	0.06
6905725	12/17/2004	2.4	< 10	0.71	0.05
6905725	1/26/2005	18	46	1.8	0.22
6905725	2/8/2005	22	65	2.6	0.18
6905725	3/17/2005	2.9	< 10		0.13
6905725	4/7/2005	2.9	< 10		0.06
6905725	5/11/2005	11	10		0.07
6905725	6/29/2005	1.7	21		0.08

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6905725	7/14/2005	0.02	< 10		0.04
6905725	8/18/2005	0.08	22	E 1.8	0.12
6905725	9/21/2005	0.05	74		0.23
6905725	10/4/2005	0.9	316	4.2	0.59
6905725	11/1/2005	0.04	22		0.16
6905725	12/13/2005	0.01	< 10		0.06
6905725	1/27/2006	0.12	< 10		0.05
6905725	2/15/2006	0.17	15	2.9	0.07
6905725	3/9/2006	0.3	< 10		0.04
6905725	4/14/2006	1.3	18		0.08
6905725	5/12/2006	1.1	10		0.07
6905725	6/15/2006	0.11	< 10		0.06
6905725	7/17/2006	0	34	1.5	0.15
6905725	8/8/2006	2.4	203	1.9	0.36
6905725	9/21/2006	0.06	11	1.1	0.06
6905725	10/23/2006	0.03	20	2.1	0.14
6905725	11/15/2006	0.03	82		0.2
6905725	12/15/2006	0.2	< 10	0.95	0.1
6905725	1/24/2007	0.62	11	1	0.1
6905725	2/22/2007	8	< 10	4.4	0.58
6905725	3/13/2007	6.5	25	2.3	0.17
6905725	4/24/2007	1.7	< 50		0.08
6905725	5/8/2007	74	176	2	0.36
6905725	6/28/2007	12	444	5.6	0.6
6905725	7/17/2007	0.06	26		0.08
6905725	8/22/2007	2.5	245	3.5	0.53
6905725	9/26/2007	0.04	54		0.18
6905725	10/17/2007	0.07	312	1.9	0.37
6905725	11/7/2007	0.05	11		0.16
6905725	12/18/2007	2.8	20	2.5	0.2
6905725	1/9/2008	40	68	3.1	0.28
6905725	2/26/2008	39	180	3.1	0.57
6905725	3/25/2008	6.2	21	1.4	0.1
6905725	4/17/2008	5.8	28	1.1	0.11
6905725	5/22/2008	1.2	10		0.07
6905725	6/19/2008	2.5	25	1.5	0.15
6905725	7/18/2008	0.4	16		0.1
6905725	8/14/2008	3.9	182	1.9	0.28
6905725	9/23/2008	2.1	14		0.12
6905725	10/28/2008	1.5	< 15	1.3	0.12
6905725	11/20/2008	4.8	< 15	1.3	0.1
6905725	12/4/2008	3.5	< 15	0.6	0.05
6905725	1/29/2009	0.89	< 15	0.62	0.06
6905725	2/26/2009	4.8	< 15	0.62	0.05
6905725	3/12/2009	25	170	2.3	0.28

USGS Gage Number	Sample Date	Flow (cfs)	TSS/ Non-filterable Residue (mg/L)	TN (mg/L)	TP (mg/L)
6905725	4/23/2009	5.4	< 15	E 0.64	0.07
6905725	5/14/2009	47	214	2.4	0.34
6905725	6/26/2009	5	< 150	1.8	0.16
6905725	7/21/2009	0.32	< 15		0.05
6905725	8/19/2009	2	106	2.1	0.23

Note: Blank cells indicate that there is no data for that parameter on that date.

Appendix E – Supplemental Implementation Plan

This implementation plan is not a requirement of the Federal CWA. However, the contractor included it as part of the TMDL preparation. 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 West Fork Locust Creek TMDL.

The pollutants targeted by the TMDL to address the unknown water quality impairment of West Fork Locust Creek are TSS, total nitrogen and total phosphorus. Potential sources of these pollutants include regulated point sources as well as inputs from agricultural nonpoint sources. Therefore, any practices used to implement this TMDL will focus on these sources.

Point Sources

This part of the TMDL will be implemented through permit action. Effluent limits and monitoring requirements for existing operating permits will be reevaluated to reflect the water quality targets set by the TMDL as the permits approach renewal. This includes effluent limits for TSS and nutrients using the WLAs developed for this TMDL and instream monitoring of TSS or turbidity, nitrogen and phosphorus. Future inspections of the permitted facilities by MDNR will determine the extent and nature of input from these sites. Discharge permits may need to be amended to include additional measures (e.g., a storm water pollution prevention plan) that ensure the facilities do not continue to cause or contribute to the impairment of West Fork Locust Creek. Additionally, permitted facilities identified to contribute to the pollutant loading of the impaired segment shall adopt appropriate best management practices to reduce such loading from their storm water outfalls. BMPs are recommended methods, structures and practices designed to prevent or reduce water pollution. These facilities must also regularly measure instream pollutant concentrations to determine the efficacy of the control measures.

Nonpoint Sources

Nonpoint sources of sediment and nutrients are not regulated in Missouri. However, with cropland and grassland accounting for approximately 78 percent of the land area in the watershed, agricultural runoff is likely a major component of nonpoint source contributions to the impaired segment. Contributions of sediment and nutrients from agricultural areas should be reduced to meet the TMDL targets.

To reduce the loading and effect of sediment on West Fork Locust Creek, efforts should be made to encourage agricultural producers in the watershed to adopt erosion control BMPs. The concept of BMPs is one of a voluntary and site specific approach to water quality problems. In the West Fork Locust Creek watershed, agricultural BMPs should focus on erosion control measures such as grassy swales, contour farming, the expansion or enhancement of riparian zones, off-stream watering of livestock and rotational grazing practices.

To reduce the loading and effect of nutrients on West Fork Locust Creek, efforts should be made to encourage agricultural producers in the watershed to adopt nutrient management practices. Management practices should focus on the proper management of nutrients from manure, previous crops and commercial fertilizers. Soil testing of croplands prior to fertilizer applications should be encouraged and education on cultural techniques such as identifying signs of plant need should be provided. Education on proper manure storage and timing of manure applications may also provide benefits for restoring the impaired water body.

In an effort to most effectively implement voluntary BMPs, MDNR may work with the NRCS, local university extension offices and the local Soil and Water Conservation District to encourage area land owners to implement these practices. An additional approach may be to work with these agencies to form a watershed group comprised of local stakeholders to promote the use of erosion control practices.