

Fecal Coliform TMDL for Chiwapa Creek

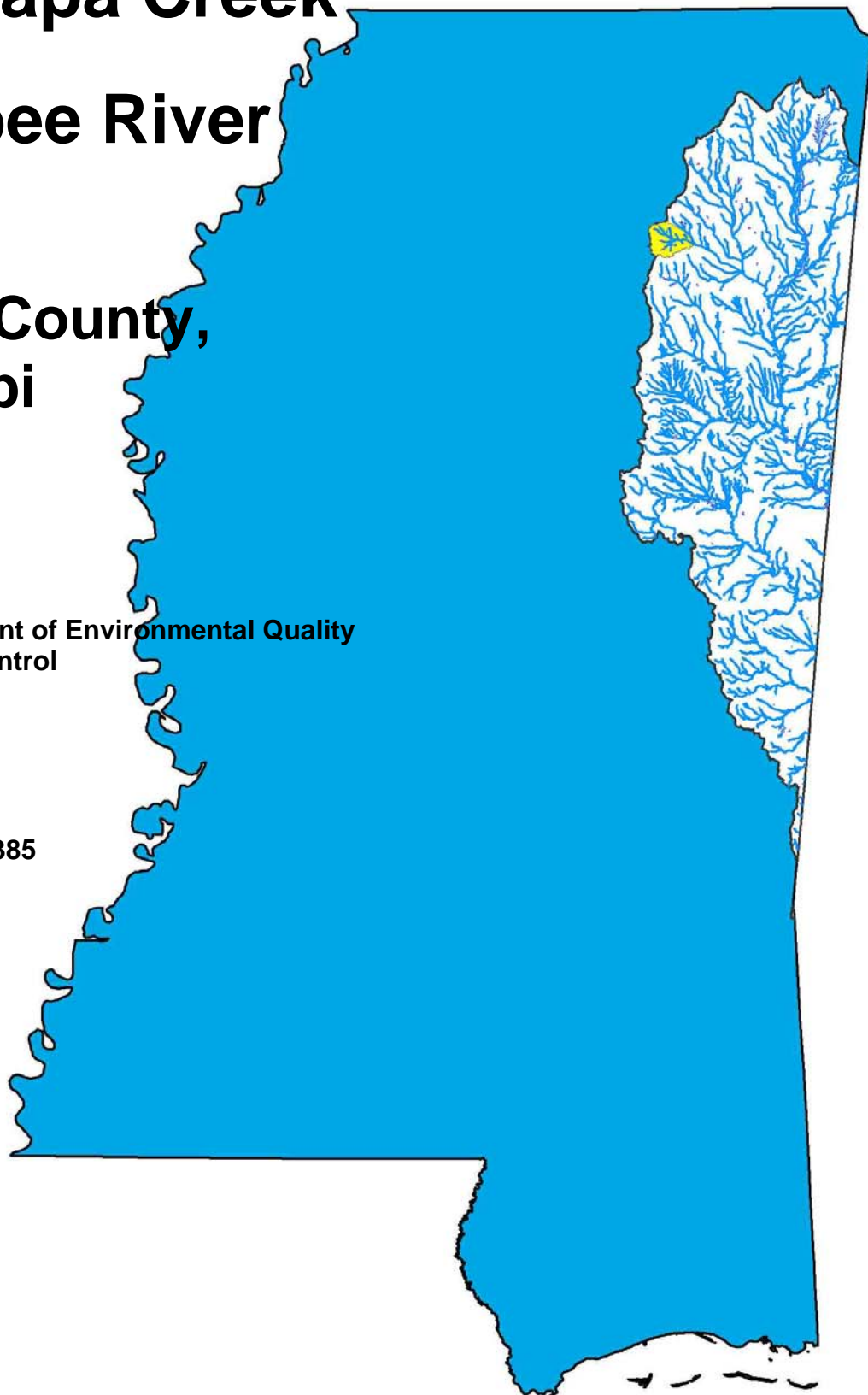
Tombigbee River Basin

Pontotoc County, Mississippi

Prepared By

Mississippi Department of Environmental Quality
Office of Pollution Control
TMDL/WLA Branch

MDEQ
PO Box 10385
Jackson, MS 39289-0385
(601) 961-5171
www.deq.state.ms.us



FOREWORD

This report has been prepared in accordance with the schedule contained within the federal consent decree dated December 22, 1998. The report contains one or more Total Maximum Daily Loads (TMDLs) for water body segments found on Mississippi's 1996 Section 303(d) List of Impaired Waterbodies. Because of the accelerated schedule required by the consent decree, many of these TMDLs have been prepared out of sequence with the State's rotating basin approach. The implementation of the TMDLs contained herein will be prioritized within Mississippi's rotating basin approach.

The amount and quality of the data on which this report is based is limited. As additional information becomes available, the TMDLs may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, or changes in landuse within the watershed. In some cases, additional water quality data may indicate that no impairment exists.

Prefixes for fractions and multiples of SI units

Fraction	Prefix	Symbol	Multiple	Prefix	Symbol
10^{-1}	deci	d	10	deka	Da
10^{-2}	centi	c	10^2	hecto	H
10^{-3}	milli	m	10^3	kilo	K
10^{-6}	micro	μ	10^6	mega	M
10^{-9}	nano	n	10^9	giga	G
10^{-12}	pico	p	10^{12}	tera	T
10^{-15}	femto	f	10^{15}	peta	P
10^{-18}	atto	a	10^{18}	exa	E

Conversion Factors

To convert from	To	Multiply by	To Convert from	To	Multiply by
Acres	Sq. miles	0.00156	Days	Seconds	86400
Cubic feet	Cu. Meter	0.02832	Feet	Meters	0.3048
Cubic feet	Gallons	7.4805	Gallons	Cu feet	0.13368
Cubic feet	Liters	28.316	Hectares	Acres	2.4711
cfs	Gal/min	448.83	Miles	Meters	1609.34
cfs	MGD	0.64632	Mg/l	ppm	1
Cubic meters	Gallons	264.173	$\mu\text{g/l} * \text{cfs}$	Gm/day	2.45

CONTENTS

EXECUTIVE SUMMARY	vi
1.1 Background	1
1.2 Applicable Water Body Segments Use	3
1.3 Applicable Water Body Segments Standard	3
TMDL ENDPOINT AND WATER QUALITY ASSESSMENT	5
2.1 Selection of a TMDL Endpoint and Critical Condition	5
2.1.1 Discussion of the Geometric Mean Test	5
2.1.2 Discussion of the 10% Test	6
2.1.3 Discussion of Combining the Tests	6
2.1.4 Discussion of the Targeted Endpoint	8
2.1.5 Discussion of the Critical Condition for Fecal Coliform	8
2.2 Discussion of Instream Water Quality	8
2.2.1 Inventory of Available Water Quality Monitoring Data	8
2.2.2 Analysis of Instream Water Quality Monitoring Data	10
SOURCE ASSESSMENT	12
3.1 Assessment of Point Sources	12
3.2 Assessment of Nonpoint Sources	13
3.2.1 Failing Septic Systems	14
3.2.2 Confined Animal Feeding Operations	15
3.2.3 Beef and Dairy Cattle	15
3.2.4 Urban Areas	16
3.2.5 Sewer Bypasses	16
3.2.6 Other Direct Inputs	16
MASS BALANCE PROCEDURE	17
4.1 Modeling Framework Selection	17
4.2 Calculation of Allowable Load	17
4.3 Calculation of the Percent Reduction	18
ALLOCATION	19
5.1 Wasteload Allocations	19
5.2 Load Allocations	19
5.3 Incorporation of a Margin of Safety (MOS)	20
5.4 Calculation of the TMDL	20

5.5 Seasonality 21

5.6 Reasonable Assurance..... 22

CONCLUSION..... 23

6.1 Future Monitoring 23

6.2 Public Participation 23

DEFINITIONS..... 25

ABBREVIATIONS 28

REFERENCES 29

FIGURES

Figure 1. Chiwapa Creek at County Road 79 1

Figure 2. Chiwapa Creek 303(d) segment 2

Figure 3. Water Body Segment with Water Quality Station and Flow Gage 3

Figure 4. Theoretical Capacity Curve..... 7

Figure 5. 10% Test Curve for Station 46, Summer 2003..... 11

Figure 6. 10% Test Curve for Station 46, Summer 2004..... 11

Figure 7. Point Source Discharges in Chiwapa Creek Watershed..... 12

Figure 8. Landuse in Chiwapa Creek Watershed..... 14

TABLES

Table 1. Theoretical Capacity Data Set 7

Table 2. Fecal Coliform Data reported in Chiwapa Creek, Station 46, Winter 2001 8

Table 3. Fecal Coliform Data reported in Chiwapa Creek, Station 46, Summer 2002 9

Table 4. Fecal Coliform Data reported in Chiwapa Creek, Station 46, Winter 2003 9

Table 5. Fecal Coliform Data reported in Chiwapa Creek, Station 46, Summer 2003 9

Table 6. Fecal Coliform Data reported in Chiwapa Creek, Station 46, Summer 2004 10

Table 7. Inventory of Point Source Dischargers..... 13

Table 8. Landuse Distribution..... 14

Table 9. Average Flows for Town Creek near Nettleton..... 18

Table 10. Wasteload Allocations for Segment MS014C1E..... 19

Table 11. Load Allocations..... 20

Table 12. Margin of Safety 20

Table 13. Estimated Fecal Coliform Reductions 21

Table 14. TMDL Summary for Chiwapa Creek – MS014C1E (counts per day) 21

TMDL INFORMATION PAGE

Listing Information

Name	ID	County	HUC	Cause	Mon/Eval
Chiwapa Creek ¹	MS014C1E	Pontotoc	03160102	Pathogens	Monitored
Near Pontotoc from headwaters to Mubby Creek					

¹ Listed in 2004 Based on Water Quality Data, Originally listed in 1996 as evaluated

Water Quality Standard

Parameter	Beneficial use	Water Quality Criteria
Pathogens	Secondary Contact	<p>May - October: Fecal coliform colony counts not to exceed a geometric mean of 200 per 100ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples, nor shall the samples examined during a 30-day period exceed 400 per 100ml more than 10% of the time.</p> <p>November – April: Fecal coliform colony counts shall not exceed a geometric mean of 2000 per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples, nor shall the samples examined during a 30-day period exceed 4000 per 100 ml more than 10% of the time.</p>

NPDES Facilities

NPDES ID	Facility Name	Receiving Water	Design Flow (MGD)
MS0021148	Pontotoc POTW Number 1	Mile Branch	0.45
MS0021105	Pontotoc POTW Number 4	Webster Creek	Offline as of 1/1/2005
MS0056049	Children at Play Day Care	Unnamed tributary to Pontotoc Lake	0.0015
MS0058688	Old Trace Rental Properties	Unnamed tributary to Donaldson Creek	0.0028
MS0056171	Hilly Hollow Mobile Home Park	Naugher Creek	0.0015

Chiwapa Creek

Season	WLA (counts per day)	LA (counts per day)	MOS (counts per day)	Total TMDL (counts per day)
Summer	3.45E+9	1.83E+10	2.42E+9	2.42E+10
Winter	3.41E+10	4.83+10	9.16E+9	9.16E+10

EXECUTIVE SUMMARY

A pathogen TMDL has been developed for the water body segment of Chiwapa Creek, MS014C1E. Chiwapa Creek is listed on the Mississippi 2004 Section 303(d) List of Impaired Water Bodies. The segment was originally listed based on anecdotal information. However, impairment has been verified through recent monitoring. Recent monitoring data were assessed based on the 2004 *Consolidated Assessment and Listing Methodology*. MDEQ selected fecal coliform as an indicator organism for pathogenic bacteria.

Chiwapa Creek flows in a southeasterly direction from its headwaters near Pontotoc to its confluence with Town Creek in Monroe County. This TMDL has been developed for Chiwapa Creek from the headwaters to the confluence with the Mubby Creek. Due to data limitations, complex dynamic modeling was inappropriate for performing the TMDL allocations for this study, as were load duration curves. Therefore, a mass balance approach was used to develop the TMDL for the segment MS014C1E.

Although fecal coliform loadings from point and nonpoint sources in the watershed were not explicitly represented with a model, a source assessment was conducted for the watershed. Nonpoint sources of fecal coliform include wildlife, livestock, and urban development. Also considered were the nonpoint sources such as failing septic systems and other direct inputs to Chiwapa Creek. Since all of the point sources within the watershed currently have the most restrictive limits required by the *Wastewater Regulations for National Pollutant Discharge Elimination System (NPDES) Permits, Underground Injection Control (UIC) Permits, State Permits, Water Quality Based Effluent Limitations and Water Quality Certification* no permit modifications are needed.

The seasonal variations in hydrology, climatic conditions, and watershed activities are represented through the use of seasonal average flows and seasonal monitoring. The critical period for Chiwapa creek was determined to be in the summer due to the fact that violations of both portions of the standard occurred in a summer period but no violations occurred in the winter.

The TMDL for Chiwapa Creek was calculated using a mass balance procedure. In order to account for uncertainty in the mass balance procedure an explicit, 10%, margin of safety (MOS) was used. The estimated reduction of fecal coliform is 63%.

Figure 1. Chiwapa Creek at County Road 79



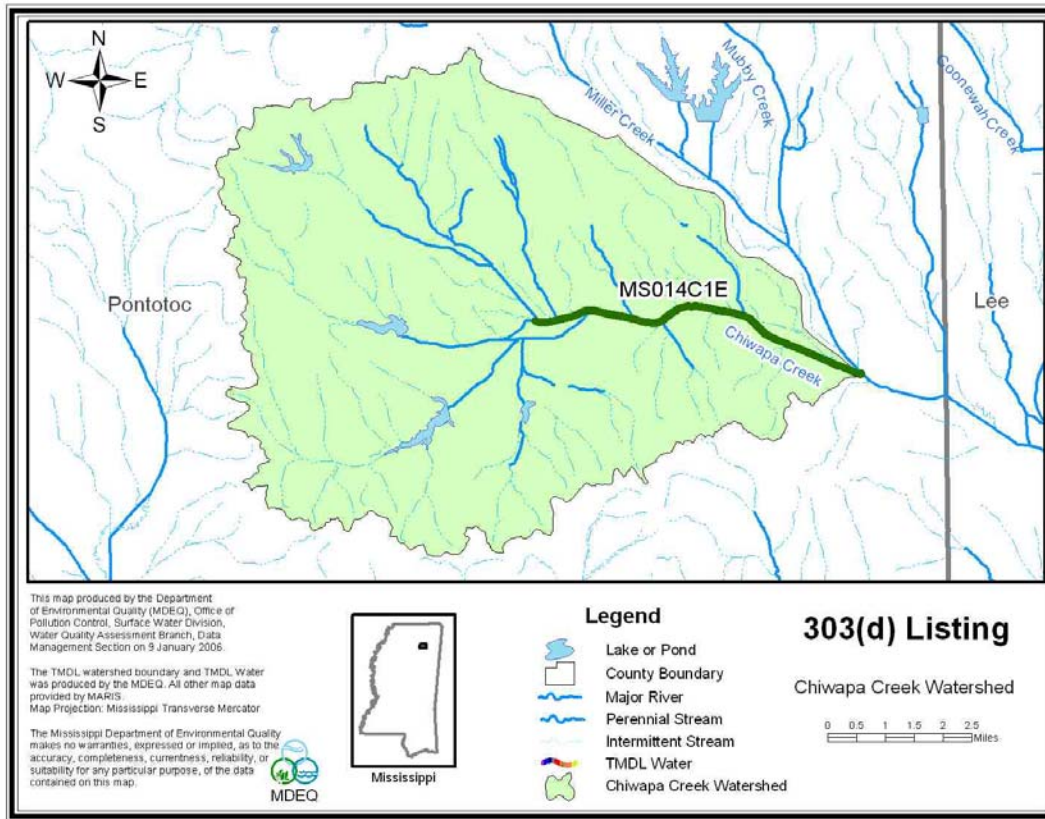
INTRODUCTION

1.1 Background

The identification of water bodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those water bodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR part 130). The TMDL process is designed to restore and maintain the quality of those impaired water bodies through the establishment of pollutant specific allowable loads. The pollutant of concern for this TMDL is pathogens as indicated by fecal coliform. Fecal coliform bacteria are used as indicator organisms because they are readily identifiable and indicate the possible presence of other pathogenic organisms in the water body. The TMDL process can be used to establish water quality based controls to reduce pollution from nonpoint sources, maintain permit requirements for point sources, and restore and maintain the quality of water resources.

Chiwapa Creek, segment MS014C1E, is a 6.12 mile segment that flows in a southeasterly direction from its headwaters near Pontotoc to its confluence with Mubby Creek. The 303(d) listed segment of Chiwapa Creek is shown in Figure 2.

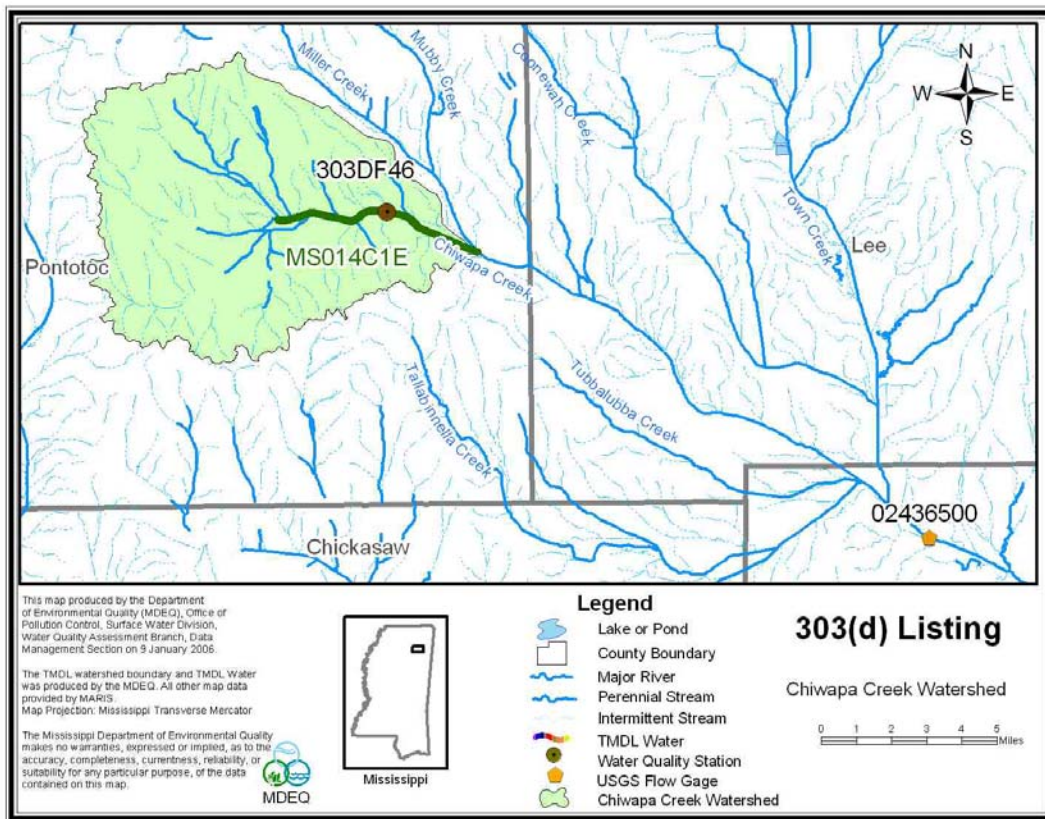
Figure 2. Chiwapa Creek 303(d) segment



Segment MS014C1E was originally listed in 1996 based on anecdotal information and is listed on the evaluated section of the Mississippi 2004 Section 303(d) List of Impaired Water Bodies for pathogen impairment. This segment recently had data collected that confirmed impairment. The data are provided in Section 2.2.

This TMDL was developed using a mass balance method. This method is an applicable method for TMDL development when water quality data are collected in a manner consistent with water quality standards, that is at least 5 samples collected within a 30 day period. The mass balance method requires water quality data and flow data. The water body segment along with the location of the water quality stations and flow gage are shown in Figure 3. The TMDL for Chiwapa Creek was developed using the mass balance method with water quality data from the fecal coliform sampling station. The flow for Chiwapa Creek was determined based on the flow measured at USGS gage 02436500 on Town Creek near Nettleton, MS.

Figure 3. Water Body Segment with Water Quality Station and Flow Gage



Chiwapa Creek is in Hydrologic Unit Code (HUC) 03160102 in northeast Mississippi. The watershed is approximately 6.2 square miles (3,968 acres). The majority of the land area within the watershed is rural.

1.2 Applicable Water Body Segments Use

The water use classification for the water body segment, as established by the State of Mississippi in the 2003 *Water Quality Criteria for Intrastate, Interstate and Coastal Waters*, is Fish and Wildlife Support. The designated beneficial use for the water body segment is Secondary Contact and Aquatic Life Support. Secondary Contact is defined as incidental contact with the water during activities such as wading, fishing, and boating, that are not likely to result in full body immersion.

1.3 Applicable Water Body Segments Standard

The water quality standard applicable to the water body based on the identified use and the pollutant of concern is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (MDEQ, 2003). The standard for fecal coliform is different for

summer and winter for a secondary contact use, where summer is defined as the months of May through October and winter is defined as the months of November through April. For the summer months the fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml, based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples, nor shall the samples examined during a 30-day period exceed 400 per 100 ml more than 10% of the time. For the winter months, the fecal coliform colony counts shall not exceed a geometric mean of 2000 colonies per 100 ml, based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples, nor shall the samples examined during a 30-day period exceed 4000 per 100 ml more than 10% of the time.

TMDL ENDPOINT AND WATER QUALITY ASSESSMENT

2.1 Selection of a TMDL Endpoint and Critical Condition

One of the major components of a TMDL is the establishment of instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints, therefore, represent the water quality goals that are to be achieved by implementing the load and wasteload reductions specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. The fecal coliform standard allows for a statistical review of any fecal coliform data set. There are two tests, the geometric mean test and the 10% test, that the data set must pass to show acceptable water quality.

The geometric mean test states that for the summer season the fecal coliform colony count shall not exceed a geometric mean of 200 per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples and for the winter season the fecal coliform colony count shall not exceed a geometric mean of 2000 per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples. The 10% test states that for the summer the samples examined during a 30-day period shall not exceed a count of 400 per 100 ml more than 10% of the time and for the winter the samples examined during a 30-day period shall not exceed a count of 4000 per 100 ml more than 10% of the time.

2.1.1 Discussion of the Geometric Mean Test

The level of fecal coliform found in a natural water body varies greatly depending on several independent factors such as temperature, flow, or distance from the source. This variability is accentuated by the standard laboratory analysis method used to measure fecal coliform levels in the water. The membrane filtration method uses a direct count of bacteria colonies on a nutrient medium to estimate the fecal level. The fecal coliform colony count per 100 ml is determined using an equation that incorporates the dilution and volume of the sample.

The geometric mean test is used to dampen the impact of the large numbers when there are smaller numbers in the data set. The geometric mean is calculated by multiplying all of the data values together and taking the root of that number based on the number of samples in the data set.

$$G = \sqrt[n]{s_1 * s_2 * s_3 * s_4 * s_5 * sn}$$

The water quality standard requires a minimum of 5 samples be used to determine the geometric mean. MDEQ routinely gathers 6 samples within a 30-day period in case there is a problem with one of the samples. It is conceivable that there would be more samples available in an intensive survey, but typically each data set will contain 6 samples therefore, n would equal 6. For the

data set to indicate no impairment, the result must be less than or equal to 200 in the summer and 2000 in the winter.

2.1.2 Discussion of the 10% Test

The 10% test looks at the data set as representing the 30 days for 100% of the time. The data points are sorted from the lowest to the highest and each value then represents a point on the curve from 0% to 100% or from day 1 to day 30. The lowest value becomes the 1st data point and the highest data point becomes the nth data point. The water quality standard requires that 90% of the time, the counts of fecal coliform in the stream be less than or equal to 400 counts per 100 ml in the summer and 4000 counts per 100 ml in the winter.

By calculating a concentration of fecal coliform for every percentile point based on the data set, it is possible to determine a curve that represents the percentile ranking of the data set. Once the 90th percentile of the data set has been determined, it may be compared to the standard of 400 counts per 100 ml. If the 90th percentile of the data is greater than 400 the stream will be considered impaired. This can be used not only to assess actual water quality data, but also computer generated daily average model results. Actual water quality data will typically have 5 or 6 values in the data set, and computer generated model results would have 30 daily values.

2.1.3 Discussion of Combining the Tests

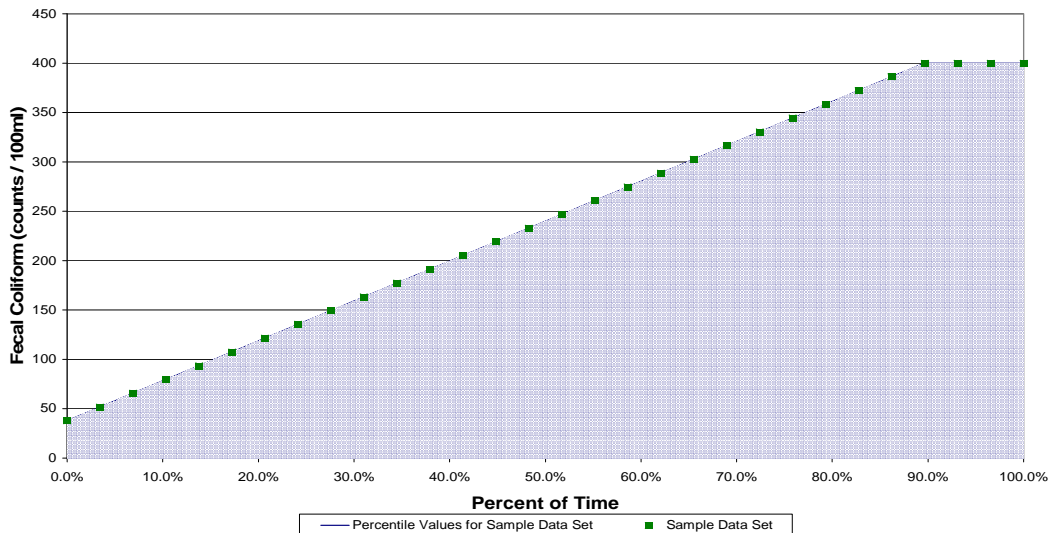
MDEQ determined a theoretical capacity data set that meets both portions of the water quality standard and is indicative of possible water quality conditions. This theoretical capacity data set is shown in Table 1. The theoretical capacity data set was constructed to represent the maximum amount of fecal coliform per day that will still meet both portions of the water quality standard. The theoretical capacity data set was then plotted, generating a theoretical maximum capacity set curve. This curve can be seen in Figure 4. The integral of the theoretical capacity data set curve is used for mass balance TMDL calculations. By multiplying the integral of the theoretical capacity curve by the flow in a given water body, the mass balance TMDL is calculated.

When actual data are collected from a water body, and the data are plotted in a similar way, the resulting curve can be compared to the theoretical capacity curve to determine the percent reduction of fecal coliform necessary for the water body to meet both portions of the water quality standard, the geometric mean test and the 10% test.

Table 1. Theoretical Capacity Data Set

Fecal Coliform (counts/100ml)	Percentile Ranking
37.82	0.0%
51.75	3.4%
65.68	6.9%
79.61	10.3%
93.54	13.8%
107.47	17.2%
121.4	20.7%
135.33	24.1%
149.26	27.6%
163.19	31.0%
177.12	34.5%
191.05	37.9%
204.98	41.4%
218.91	44.8%
232.84	48.3%
246.77	51.7%
260.7	55.2%
274.63	58.6%
288.56	62.1%
302.49	65.5%
316.42	69.0%
330.35	72.4%
344.28	75.9%
358.21	79.3%
372.14	82.8%
386.07	86.2%
400	89.7%
400	93.1%
400	96.6%
400	100.0%

Figure 4. Theoretical Capacity Curve



2.1.4 Discussion of the Targeted Endpoint

While the endpoint of a TMDL calculation is similar to a standard for a pollutant, the endpoint is not the standard. For a mass balance TMDL, the endpoint selected is both portions of the standard, that is the geometric mean test and the 10% test. Meeting the geometric mean test and applying the 10% test to the data sets applies both parts of the standard to an actual data set or when considering a computer generated data set. It is therefore appropriate to select both portions of the standard as the targeted endpoint for the mass balance TMDL.

2.1.5 Discussion of the Critical Condition for Fecal Coliform

Critical conditions for waters impaired by nonpoint sources generally occur during periods of wet-weather and high surface runoff. Critical conditions for point source dominated systems generally occur during periods of low-flow, low-dilution conditions. Violations to water quality standards occurred in the summer season. Based on the available data for segment MS014C1E, Chiwapa Creek, the critical period is the summer.

2.2 Discussion of Instream Water Quality

Monitoring was performed in a manner consistent with the water quality standards. At least 5 samples were collected in each 30-day period, at Station 46 in segment MS014C1E during three summer seasons and two winter seasons between 2001 and 2004. For the summer of 2003, there were 6 samples collected. However, the final sample collected on August 7, 2003 was collected less than 24 hours after a 6.15 inch rain event. This data point is not representative and should not have been collected according to the EPA Publication *Ambient Water Quality Criteria for Bacteria* (EPA440/5-84-002) which states that fecal coliform samples should be collected during dry weather periods to establish steady state conditions. Therefore, this data point has been excluded and was not included in any of the calculations.

2.2.1 Inventory of Available Water Quality Monitoring Data

The data collected at Station 46 on Chiwapa Creek are provided in Tables 2 through 6 below.

Table 2. Fecal Coliform Data reported in Chiwapa Creek, Station 46, Winter 2001

Date	Time	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Violation	90 th Percentile	90 th Percentile Violation
12/04/01	1:45	175	251.5	No	612.0	No
12/06/01	1:15	130				
12/10/01	1:00	270				
12/12/01	12:00	195				
12/18/01	12:30	840				

Table 3. Fecal Coliform Data reported in Chiwapa Creek, Station 46, Summer 2002

Date	Time	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Violation	90 th Percentile	90 th Percentile Violation
5/07/02	1:00	265	97.3	No	220.0	No
5/9/02	10:30	100				
5/14/02	10:30	62				
5/21/02	11:30	190				
5/23/02	1:00	50				
5/28/02	1:30	62				
6/4/02	1:00	85				

Table 4. Fecal Coliform Data reported in Chiwapa Creek, Station 46, Winter 2003

Date	Time	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Violation	90 th Percentile	90 th Percentile Violation
03/13/03	11:30	65	196.3	No	1420.0	No
03/20/03	11:45	1140				
03/24/03	10:30	96				
03/26/03	12:30	1700				
04/01/03	12:30	35				
4/3/2003	11:00	135				

Table 5. Fecal Coliform Data reported in Chiwapa Creek, Station 46, Summer 2003

Date	Time	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Violation	90 th Percentile	90 th Percentile Violation
07/10/03	12:00	700	284.4	Yes, geometric mean is greater than 200	2140.0	Yes, 90 th percentile is greater than 400
07/15/03	9:30	3100				
07/17/03	12:30	190				
07/24/03	12:00	41				
07/28/03	10:30	110				

Table 6. Fecal Coliform Data reported in Chiwapa Creek, Station 46, Summer 2004

Date	Time	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Violation	90th Percentile	90th Percentile Violation
08/23/04	12:30	65	192.6	No	2710.0	Yes, 90 th percentile is greater than 400
08/25/04	11:45	5200				
08/31/04	12:15	220				
09/02/04	12:00	120				
09/08/04	12:00	88				
09/10/04	12:30	65				

2.2.2 Analysis of Instream Water Quality Monitoring Data

For Chiwapa Creek, the data collected at Station 46 indicate a violation of both the geometric mean portion of the standard and the percent of time in exceedence. A graphical representation of the data for Chiwapa Creek can be seen in Figures 5 and 6 below. For the summer periods, a line has been added to the graphs representing 400 counts/100 ml and showing that this occurs less than 90% of the time. Therefore, the counts of fecal coliform in the stream are greater than 400 more than 10% of the time. The critical period for this TMDL was determined to be in the summer, due to the fact that violations of both portions of the standard occurred but no violations occurred in the winter seasons.

Figure 5. 10% Test Curve for Station 46, Summer 2003

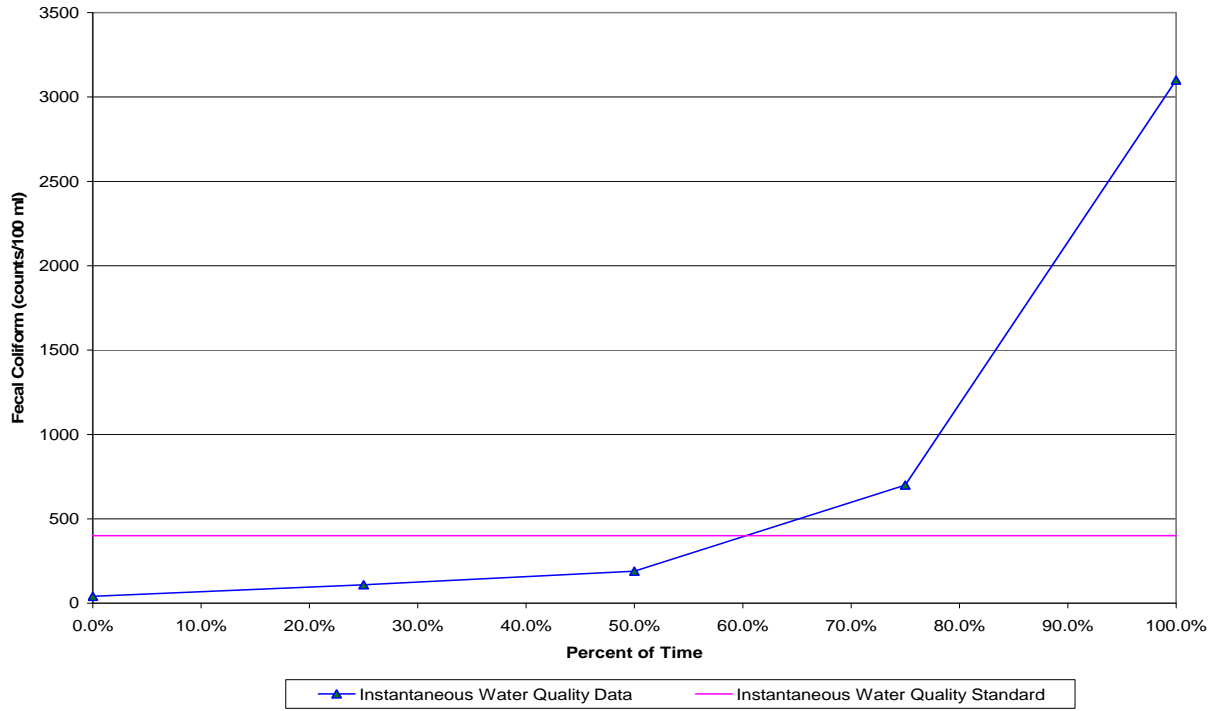
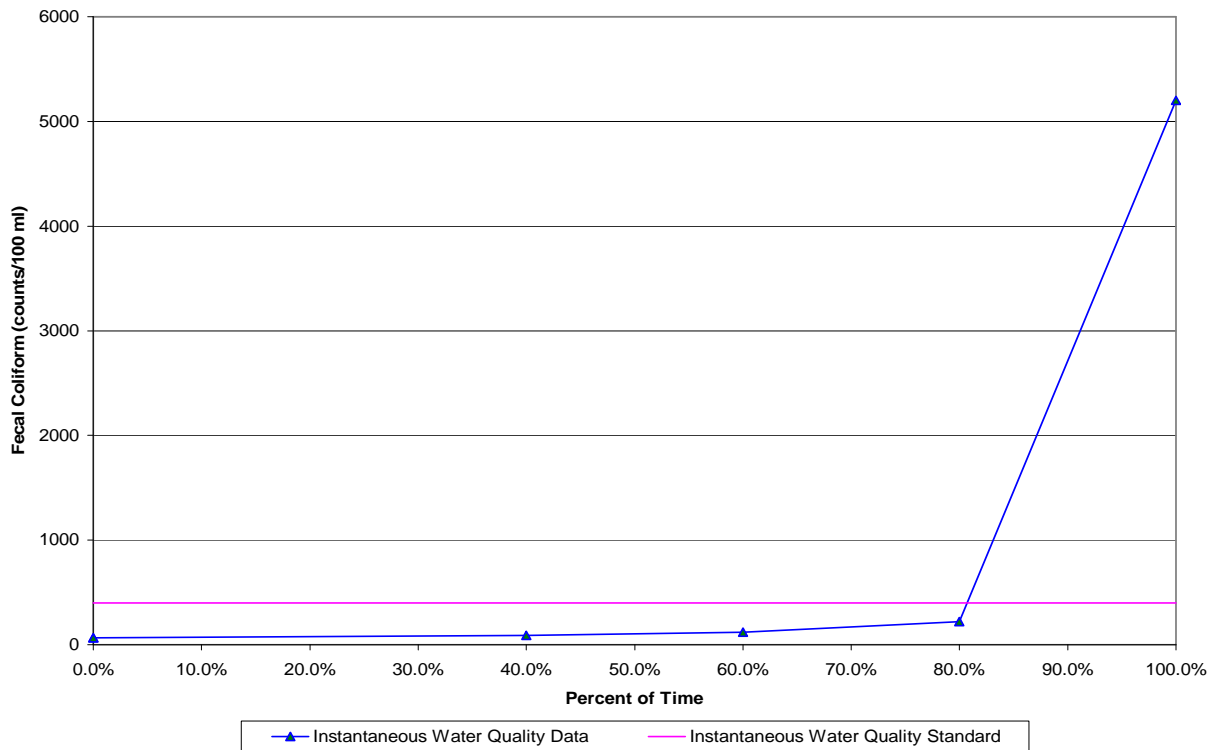


Figure 6. 10% Test Curve for Station 46, Summer 2004



SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential fecal coliform sources in the watershed. In evaluation of the sources, loads were characterized by the best available information, monitoring data, literature values, and local management activities. This section documents the available information and interpretation for the analysis.

3.1 Assessment of Point Sources

Point sources of fecal coliform bacteria have their greatest potential impact on water quality during periods of low flow. Thus, a careful evaluation of point sources that discharge fecal coliform bacteria was necessary in order to quantify the degree of impairment present during the low flow, critical condition period.

The Chiwapa Creek watershed contains five active permitted point sources as shown in Figure 7 below. The effluent from the point sources was characterized based on all available monitoring data including permit limits, discharge monitoring reports, and information on treatment type. The receiving water bodies and the discharge flows are shown in Table 7.

Figure 7. Point Source Discharges in Chiwapa Creek Watershed

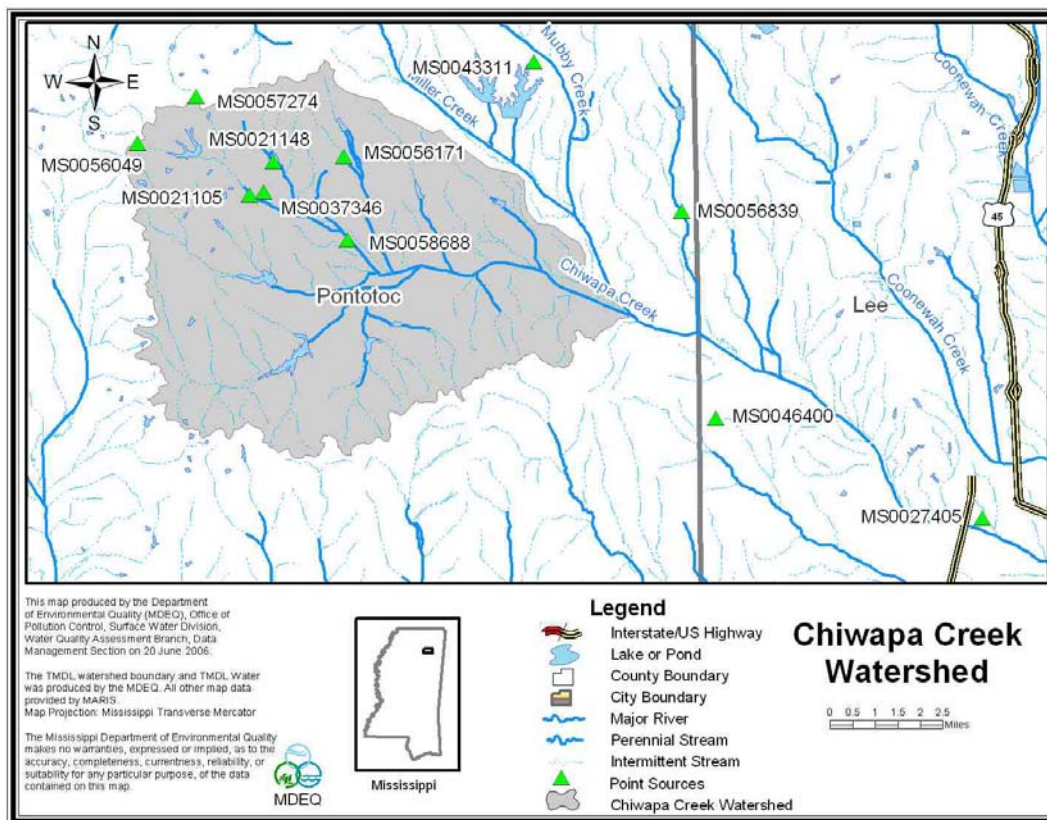


Table 7. Inventory of Point Source Dischargers

NPDES ID	Facility Name	Receiving Water	Design Flow (MGD)
MS0021148	Pontotoc POTW Number 1	Mile Branch thence to Donaldson Creek thence to Chiwapa Creek	0.45
MS0021105	Pontotoc POTW Number 4	Webster Creek thence to Donaldson Creek thence to Chiwapa Creek	Offline as of 1/1/2005
MS0056049	Children at Play Day Care	Unnamed tributary thence to Pontotoc Lake thence Webster Creek thence to Chiwapa Creek	0.0015
MS0058688	Old Trace Rental Properties	Unnamed tributary thence to Donaldson Creek thence to Chiwapa Creek	0.0028
MS0037346	Smokehouse Meats	Unnamed tributary thence to Webster Creek thence to Chiwapa Creek	No Discharge
MS0056171	Hilly Hollow Mobile Home Park	Naugher Creek thence to Chiwapa Creek	0.0015

Pontotoc POTW Number 4 has had a significant history of non-compliance. MDEQ and the City of Pontotoc entered into an agreement that required the city’s wastewater treatment facilities to meet the permitted limits for fecal coliform by November 1, 2002. As a result of this agreement, Pontotoc POTW Number 4 was taken off-line January 1, 2005. This wastewater has been rerouted to POTW Number 1 which has chlorination/de-chlorination equipment and seasonal discharge limits of 200 Counts/100ml during the summer season and 2000 Counts/100ml during the winter season. Pontotoc POTW Number 4 did not have disinfection equipment and no monitoring data for fecal coliform are available. A conservative estimate of the fecal coliform concentration from this lagoon without disinfection is approximately 23,000 counts/100ml. Using the permitted flow for this facility of 0.06 MGD and the conservative estimate Pontotoc POTW Number 4 would have had a load of 5.23E+10 counts. Therefore, elimination of this facility represents a significant step towards the reduction called for in this TMDL.

3.2 Assessment of Nonpoint Sources

There are many potential nonpoint sources of fecal coliform bacteria in the watershed, including:

- ◆ Failing septic systems
- ◆ Confined Animal Feeding Operations
- ◆ Wildlife
- ◆ Grazing animals
- ◆ Urban development
- ◆ Sewer Bypasses
- ◆ Other Direct Inputs

The 6.2 square mile (3,968 acres) drainage area, of Chiwapa Creek contains many different landuse types, including forest, cropland, pasture, scrub/barren, water, and wetlands. The landuse distribution for the watershed is provided in Table 8 and displayed in Figure 8 below. The land

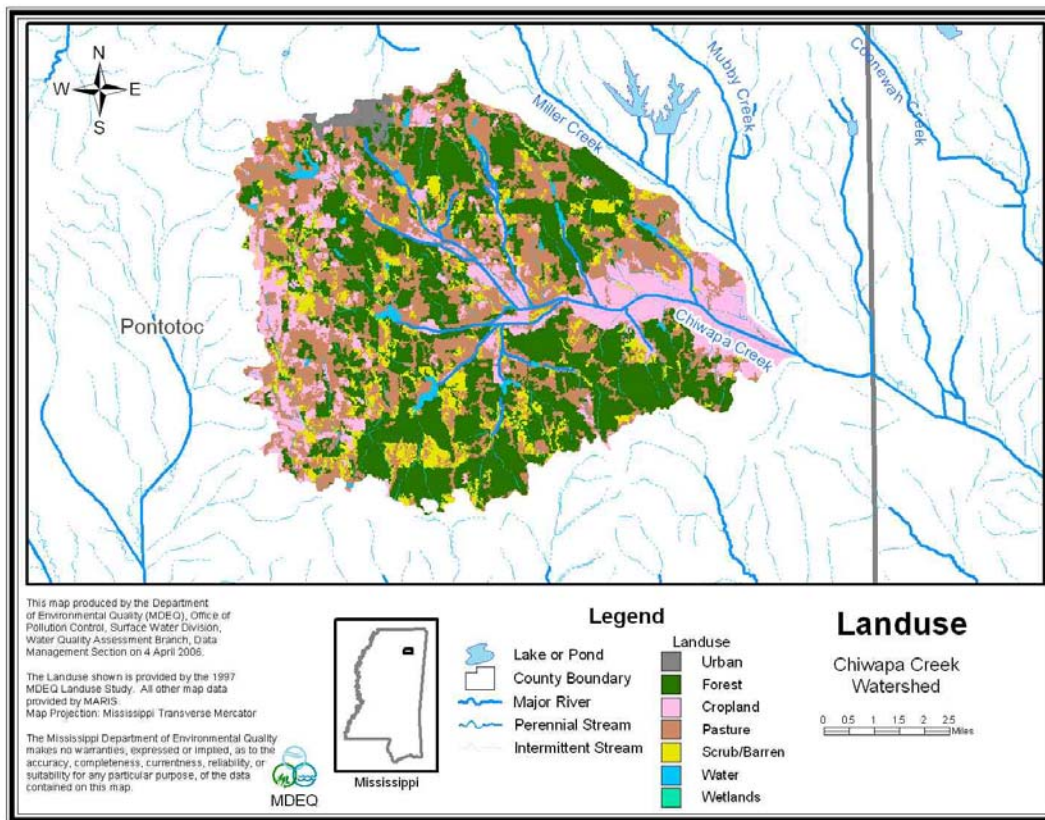
use information for the watershed is based on the State of Mississippi’s Automated Resource Information System (MARIS), 1997. This data set is based Landsat Thematic Mapper digital images taken between 1992 and 1993. The MARIS data are classified on a modified Anderson level one and two system with additional level two wetland classifications. The landuse categories were grouped into the land uses of urban, forest, cropland, pasture, scrub/barren, wetlands, and water.

To refine the information concerning nonpoint sources of fecal coliform bacteria, the 2002 Census of Agriculture produced by the National Agriculture Statistics Service was used to estimate agricultural animal populations in the watershed.

Table 8. Landuse Distribution

	Urban	Forest	Cropland	Pasture	Scrub/Barren	Wetland	Water	Total
Area (acres)	39.7	1,111.0	833.3	1587.2	357.1	0.4	39.4	3,968
% Area	1%	28%	21%	40%	9%	0%	1%	100%

Figure 8. Landuse in Chiwapa Creek Watershed



3.2.1 Failing Septic Systems

Septic systems have a potential to deliver fecal coliform bacteria loads to surface waters due to malfunctions, failures, and direct pipe discharges. Properly operating septic systems treat wastewater and dispose of the water through a series of underground field lines. The water is applied through these lines into a rock substrate, thence into underground absorption. The systems can fail when the field lines are broken, or when the underground substrate is clogged or flooded. A failing septic system's discharge can reach the surface, where it becomes available for wash-off into the stream.

Another potential problem is a direct bypass from the system to a stream. In an effort to keep the water off the land, pipes are occasionally placed from the septic tank or the field lines directly to the creek.

Another consideration is the use of individual onsite wastewater treatment plants. These treatment systems are in wide use in Mississippi. They can adequately treat wastewater when properly maintained. However, these systems may not receive the maintenance needed for proper, long-term operation. These systems require some sort of disinfection to properly operate. When this expense is ignored, the water does not receive adequate disinfection prior to release. The watershed contains several facilities that operate onsite wastewater treatment plants.

All septic systems may have an impact on nonpoint source fecal coliform impairment in the Tombigbee Basin. The best management practices needed to reduce this pollutant load need to prioritize eliminating septic tank failures and improving maintenance and proper use of individual onsite treatment systems.

Some counties in Mississippi manage the problem of onsite treatment systems through the use of a wastewater ordinance. A wastewater ordinance requires that the wastewater treatment and disposal system used be certified as sufficient. It also ensures that electricity, water, or natural gas will not be made available until written approval from the county Health Department or the Mississippi Department of Environmental Quality has been received stating that the system used is sufficient. Currently, Pontotoc County does not have a wastewater ordinance. The lack of a wastewater ordinance could allow some of the rural areas to have only modest wastewater treatment, if any treatment, before discharge.

3.2.2 Confined Animal Feeding Operations

There are no permitted Combined Animal Feeding Operations (CAFOs) within the Chiwapa Creek watershed.

3.2.3 Beef and Dairy Cattle

Grazing cattle deposit manure on pastureland where it is available for wash-off and delivery to receiving water bodies. Beef cattle have access to pastureland for grazing all of the time. For dairy cattle, the dry cattle and heifers have access to pastureland for grazing all of the time. Manure produced by grazing beef and dairy cows is directly deposited onto pastureland and is available for wash-off.

Small dairy farms confine the lactating cattle for a limited time during the day for milking and feeding. The manure collected during confinement is applied to the available pastureland in the watershed. Application rates of dairy cow manure to pastureland vary monthly according to management practices currently used in this area.

Pontotoc County has a small number of cattle farms, in which most of the farms have less than 200 head of cattle. According to the 2002 Census of Agriculture there were only 8 farms with greater than 200 head of cattle and only one operating dairy operation. These cattle are primarily beef cattle, heifers, steers, and bulls.

3.2.4 Urban Areas

There are very small portions of Pontotoc and Algoma within the Chiwapa Creek watershed. But only 39.7 acres are estimated to be urban.

3.2.5 Sewer Bypasses

The only sewer area in the Chiwapa Creek watershed is within the City of Pontotoc. A file review and discussions with MDEQ Compliance officials did not reveal a history of bypass problems. With proper operation and maintenance, sewer bypasses should be kept to a minimum and are not expected to contribute to fecal coliform loading.

3.2.6 Other Direct Inputs

Other direct inputs of fecal coliform bacteria to water bodies in the watershed include illicit discharges, human recreation, and access of both domestic and wild animals to the stream.

MASS BALANCE PROCEDURE

Establishing the relationship between the instream water quality target and the source loading is a critical component of TMDL development. It allows for the evaluation of management options that will achieve the desired source load reductions. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain water body responses to flow and loading conditions. In this section, the selection of the modeling tools, setup, and model application are discussed.

4.1 Modeling Framework Selection

A mass balance approach was used to calculate the TMDL for segment MS014C1E of Chiwapa Creek. This method of analysis was selected because data limitations precluded the use of more complex methods. Therefore, the mass balance approach is suitable for this TMDL.

4.2 Calculation of Allowable Load

The mass balance approach utilizes the conservation of mass principle. Loads can be calculated by multiplying the fecal coliform concentration in the water body for a 30-day period by the flow. The principle of the conservation of mass allows for the addition and subtraction of those loads to determine the appropriate numbers necessary for the TMDL. The loads can be calculated using the following relationship:

$$\begin{aligned} \text{Load (counts per 30 days)} &= \text{Theoretical 30 day Capacity} \left(\frac{\text{day} \cdot \text{counts}}{100 \text{ ml}} \right) \times \text{Flow (cfs)} * \text{Conversion Factor} \\ \text{when Conversion Factor} &= \left(\frac{28316.8 \text{ ml}}{\text{ft}^3} \right) \times \left(\frac{100 \text{ ml}}{100 \text{ ml}} \right) \times \left(\frac{60 \text{ s}}{1 \text{ min}} \right) \times \left(\frac{60 \text{ min}}{1 \text{ hr}} \right) \times \left(\frac{24 \text{ hr}}{1 \text{ day}} \right) \\ &= 2.45\text{E} + 07 \left(\frac{100 \text{ ml} \cdot \text{s}}{\text{ft}^3 \cdot \text{day}} \right) \end{aligned}$$

The theoretical 30 day capacity is calculated by taking the integral of the theoretical capacity curve, Figure 4.

$$\int_0^{26.91} [13.47x + 37.82] dx + \int_{26.91}^{30} 400 dx = \mathbf{7129.4} \text{ (day * counts/100 ml)}$$

The theoretical 30 day capacity is then divided by 30 to get the average daily capacity as shown below:

$$\text{Avg. Daily Capacity} = 7129.4/30 = \mathbf{237.7}(\text{day*counts}/100\text{ml})$$

USGS flow gage 02436500 was used to estimate the flow for Chiwapa Creek. The average summer discharge at the flow gage was calculated by averaging the USGS monthly mean stream flows for the summer period (May through October) for the period of record of the gage. The average winter discharge at the flow gage was calculated accordingly. The average summer flow for Chiwapa Creek was then estimated based on the average summer discharge at this station (02436500) which is on Town Creek near Nettleton, MS and shown in Table 9. To estimate the flow for each water body segment MDEQ utilized a drainage area ratio. The drainage area of the USGS flow gauge is 620 square miles (396,789 acres). The drainage area for segment MS014C1E is 6.20 square miles (3,968 acres). As seen in the equation below, the average summer discharge for Chiwapa Creek was determined to be 4.15 cfs. This method was also used to calculate the average winter discharge. The average winter discharge was determined to be 15.73 cfs as shown below.

Table 9. Average Flows for Town Creek near Nettleton

Season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Summer					1048	504	337	189	226	186			415
Winter	1,686	1,968	2,215	1,545							709	1,407	1,573

$$\text{Avg Seasonal Discharge (cfs)} = \{ [02436500 \text{ Avg Seasonal Discharge (cfs)}] / [02448000 \text{ Drainage Area (sq. miles)}] \} * [\text{Water Body Drainage Area (sq. miles)}]$$

$$\text{MS014C1E Avg Summer Discharge (cfs)} = \{ [415 \text{ (cfs)}] / [620 \text{ (sq. miles)}] \} * [6.20 \text{ (sq. miles)}] = 4.15 \text{ cfs}$$

$$\text{MS014C1E Avg Winter Discharge (cfs)} = \{ [1573 \text{ (cfs)}] / [620 \text{ (sq. miles)}] \} * [6.20 \text{ (sq. miles)}] = 15.73 \text{ cfs}$$

4.3 Calculation of the Percent Reduction

For the calculation of the percent reduction, the area under the 10% Test Curve for each violating season (Section 2.2.2) is computed and then compared to the area under the Theoretical Capacity Curve, Figure 4. The necessary percent reduction based on the observed concentrations for each season is then calculated using the equation below. This method of calculating the percent reduction allows the data set to be compared to both portions of the water quality standard at the same time. Thus, the calculated percent reduction represents the reduction needed in order for the data set to meet both portions of the water quality standard.

$$\text{Percent Reduction} = \left(1 - \frac{\text{Theoretical Capacity Curve Area}}{10\% \text{ Test Curve Area}} \right) * 100$$

ALLOCATION

The allocation for this TMDL includes a wasteload allocation (WLA) for point sources, a load allocation (LA) for nonpoint sources, and a margin of safety (MOS).

5.1 Wasteload Allocations

The wasteload allocation is based on the existing point sources in the watershed. The point sources in Chiwapa Creek and the allocated load are shown in Table 10. Table 10 also provides the permit limits of the sources in the watershed. The first value is the average fecal coliform concentration that the facility may discharge and the second is the maximum fecal coliform concentration that the facility may discharge. While the allocated loads included in the TMDL calculation are based upon the permit limit of the average allowable concentration, the maximum portion of the permit is still allowable. Because the permitted sources currently have the most restrictive coliform limits, no permit modification is necessary. This TMDL was developed using the current limits.

Table 10. Wasteload Allocations for Segment MS014C1E

NPDES ID	Summer Permit Limit Average/Maximum (counts/100ml)	Winter Permit Limit Average/Maximum (counts/100ml)	Average Summer Allocated Load (counts per day)	Average Winter Allocated Load (counts per day)	Permit Modification Necessary
MS0056171	200/400	200/400	1.14E+7	1.14E+7	No
MS0021148	200/400	2000/4000	3.41E+9	3.41E+10	No
MS0056049	200/400	200/400	1.14E+7	1.14E+7	No
MS0058688	200/400	200/400	2.12E+7	2.12E+7	No
Total			3.45E+9	3.41E+10	

5.2 Load Allocations

The load allocation for the Chiwapa Creek is calculated using the water quality criteria and the estimated critical flow. The load allocation is assumed to represent nonpoint sources as described in Section 3.2. In calculating the LA component, the total TMDL for the water body is reduced by a 10% MOS. For this TMDL, the summer load is based on a fecal coliform concentration for 30 days determined by the integral of the theoretical capacity curve and the average summer flow. The resulting winter LA was estimated using the average winter flow and the integral of the theoretical capacity curve. The resulting load allocations are shown below in Table 11 below.

$$LA = 0.9 * 237.7 (\text{day} * \text{counts}/100\text{ml}) * \text{Flow}(\text{cfs}) * 2.45\text{E}+07 [(100\text{ml} * \text{s}) / (\text{ft}^3 * \text{day})] - \text{WLA}$$

Table 11. Load Allocations

Name	ID	Summer LA (counts per day)	Winter LA (counts per day)
Chiwapa Creek	MS014C1E	1.83E+10	4.83E+10

5.3 Incorporation of a Margin of Safety (MOS)

The two types of MOS development are to implicitly incorporate the MOS using conservative assumptions or to explicitly specify a portion of the total TMDL as the MOS. An explicit 10% margin of safety was used for this TMDL. The margin of safety is calculated below for Chiwapa Creek using the average seasonal flows and theoretical capacity data set curve. The results of the calculations are shown in Table 12.

$$\text{MOS} = 0.1 * 237.7(\text{day} * \text{counts}/100\text{ml}) * \text{Flow}(\text{cfs}) * 2.45\text{E}+07[(100\text{ml} * \text{s})/(\text{ft}^3 * \text{day})]$$

Table 12. Margin of Safety

Name	ID	Summer MOS (counts per day)	Winter MOS (counts per day)
Chiwapa Creek	MS014C1E	2.42E+9	9.16+9

5.4 Calculation of the TMDL

The TMDL for Chiwapa Creek is calculated based on the following equation:

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{MOS}$$

where WLA is the Waste Load Allocation, LA is the Load Allocation, and MOS is the Margin of Safety.

WLA = NPDES Permitted Facilities

LA = Surface Runoff + Other Direct Inputs

MOS = 10% explicit

The summer TMDL for segment MS014C1E of Chiwapa Creek was calculated based on the average summer flow of the watershed and a fecal coliform concentration for 30 days determined

by the integral of the theoretical capacity data set curve. The winter TMDL was calculated based on the average winter flow of the watershed and a fecal coliform concentration for 30 days determined by the integral of the theoretical capacity data set curve. The necessary percent reductions are shown below in Table 13.

Table 13. Estimated Fecal Coliform Reductions

Name	ID	Summer % Reduction	Winter % Reduction
Chiwapa Creek	MS014C1E	72%	None Necessary

Summer

$$\text{TMDL} = 237.7(\text{day} \cdot \text{counts}/100\text{ml}) * 4.15(\text{cfs}) * 2.45\text{E}+07[(100\text{ml} \cdot \text{s})/(\text{ft}^3 \cdot \text{day})]$$

$$\text{TMDL} = 2.42\text{E}+10 \text{ (counts per day)}$$

Winter

$$\text{TMDL} = 237.7(\text{day} \cdot \text{counts}/100\text{ml}) * 15.73(\text{cfs}) * 2.45\text{E}+07[(100\text{ml} \cdot \text{s})/(\text{ft}^3 \cdot \text{day})]$$

$$\text{TMDL} = 9.16\text{E}+10 \text{ (counts per day)}$$

Table 14. TMDL Summary for Chiwapa Creek – MS014C1E (counts per day)

	Summer	Winter
WLA	3.45E+9	3.41E+10
LA	1.83E+10	4.83E+10
MOS	2.42E+9	9.16E+9
TMDL = WLA + LA +MOS	2.42E+10	9.16E+10

5.5 Seasonality

For many streams in the state, fecal coliform limits vary according to the seasons. Chiwapa Creek is designated for the use of secondary contact. For this use, the fecal coliform standard is seasonal.

MDEQ used the average summer flow for calculating the summer TMDL and the average winter flow for calculating the winter TMDL. Therefore, the seasonal differences are incorporated in the seasonal average flow values.

5.6 Reasonable Assurance

This component of TMDL development does not apply to this TMDL Report. There is no WLA reduction request based on promised LA components and reductions. This TMDL will recommend that all point sources discharge treated and disinfected effluent to comply with the 200 colony counts per 100ml target at the end of their discharge pipe.

CONCLUSION

The TMDL will not impact future NPDES Permits as long as the effluent is disinfected to meet water quality standards for fecal coliform at the end of the discharge pipe.

Education projects that teach best management practices should be used as a tool for reducing other nonpoint source contributions. These projects may be funded by CWA Section 319 Nonpoint Source (NPS) Grants.

MDEQ will continue to evaluate the point sources through the Environmental Compliance and Enforcement Division. The disinfection of wastewater from Pontotoc POTW Number 4 should conservatively reduce the fecal coliform discharge to Chiwapa Creek by approximately $5.23E+10$ counts per day. This accounts for a significant portion of the 72% reduction recommended in this TMDL.

Additionally, MDEQ will continue its cooperation with state, county and city officials to encourage the adoption of local building standards. These standards should address design and installation of individual on-site wastewater treatment systems to insure proper operation and maintenance.

6.1 Future Monitoring

MDEQ has adopted the Basin Approach to Water Quality Management, a plan that divides Mississippi's major drainage basins into five groups. During each year long cycle, MDEQ resources for water quality monitoring will be focused on one of the basin groups. During the next monitoring phase in the Tombigbee River Basin, Chiwapa Creek may receive additional monitoring to identify any change in water quality. MDEQ produced guidance for future Section 319 project funding will encourage non-point source restoration projects that attempt to address TMDL related issues within Section 303(d)/TMDL watersheds in Mississippi.

6.2 Public Participation

This TMDL will be published for a 30-day public notice. During this time, the public will be notified by publication in the statewide newspaper. The public will be given an opportunity to review the TMDL and submit comments. MDEQ also distributes all TMDLs at the beginning of the public notice to those members of the public who have requested to be included on a TMDL mailing list. TMDL mailing list members may request to receive the TMDL reports through either, email or the postal service. Anyone wishing to become a member of the TMDL mailing list should contact Greg Jackson at (601) 961-5098 or Greg_Jackson@deq.state.ms.us.

All comments should be directed to Greg Jackson at Greg_Jackson@deq.state.ms.us or Greg Jackson, MDEQ, PO Box 10385, Jackson, MS 39289. All comments received during the public notice period and at any public hearings become a part of the record of this TMDL and will be considered in the submission of this TMDL to EPA Region 4 for final approval.

At the end of the 30-day period, MDEQ will determine the level of interest in the TMDL and make a decision on the necessity of holding a public hearing. If a public hearing is deemed appropriate, the public will be given a 30-day notice of the hearing to be held at a location near the watershed. That public hearing would be an official hearing of the Mississippi Commission on Environmental Quality, and would be transcribed.

DEFINITIONS

Ambient stations: a network of fixed monitoring stations established for systematic water quality sampling at regular intervals, and for uniform parametric coverage over a long-term period.

Assimilative capacity: the capacity of a natural body of water to receive wastewaters or toxic materials without deleterious effects and without damage to aquatic life or humans who use the water.

Background: the condition of waters in the absence of man-induced alterations based on the best scientific information available to MDEQ. The establishment of natural background for an altered water body may be based upon a similar, unaltered or least impaired, water body or on historical pre-alteration data.

Calibrated model: a model in which reaction rates and inputs are significantly based on actual measurements using data from surveys on the receiving water body.

Critical Condition: hydrologic and atmospheric conditions in which the pollutants causing impairment of a waterbody have their greatest potential for adverse effects.

Daily discharge: the discharge of a pollutant measured during a 24-hour period that reasonably represents the day for purposes of sampling. For pollutants with limitations expressed in units of mass, the daily discharge is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the daily discharge is calculated as the average measurement of the pollutant over the day.

Designated Uses: (1) those uses specified in the water quality standards for each water body or segments whether or not they are being attained. (2) those water uses identified in state water quality standards which must be achieved and maintained as required under the Clean Water Act. Uses can include public water supply, recreation, etc.

Discharge monitoring report (DMR): the EPA uniform national form, including any subsequent additions, revisions, or modifications for the reporting of self-monitoring results by permittees.

Effluent: wastewater – treated or untreated – that flows out of a treatment plant or industrial outfall. Generally refers to wastes discharged into surface waters.

Effluent limitation: (1) any restriction established by a State or the Administrator on quantities, rates, and concentrations of chemical, physical, biological, and other constituents which are discharged from point sources into navigable waters, the waters of the contiguous zone, or the ocean, including schedules of compliance. (2) restrictions established by a State or EPA on quantities, rates, and concentrations in wastewater discharges.

Effluent standard: any effluent standard or limitation, which may include a prohibition of any discharge, established or proposed to be established for any toxic pollutant under section 307(a) of the Act.

Fecal Coliform Bacteria: (1) those organisms associated with the intestines of warm-blooded animals that are commonly used to indicate the presence of fecal material and the potential presence of organisms capable of causing human disease. (2) bacteria found in the intestinal tracts of mammals. Their presence in water or sludge is an indicator of pollution and possible contamination by pathogens.

Geometric mean: the n th root of the production of n factors. A 30-day geometric mean is the 30th root of the product of 30 numbers.

Impaired Water Body: any water body that does not attain water quality standards due to an individual pollutant, multiple pollutants, pollution, or an unknown cause of impairment.

Land Surface Runoff: water that flows into the receiving stream after application by rainfall or irrigation. It is a transport method for nonpoint source pollution from the land surface to the receiving stream.

Load allocation (LA): the portion of a receiving water's loading capacity that is attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources. Load allocations are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Wherever possible, natural and nonpoint source loads should be distinguished.

Loading: the introduction of waste into a waste management unit but not necessarily to complete capacity.

Mass Balance: a concept based on a fundamental law of physical science (conservation of mass) which says that matter can not be created or destroyed. It is used to calculate all input and output streams of a given substance in a system.

Model: a quantitative or mathematical representation or computer simulation which attempts to describe the characteristics or relationships of physical events.

National pollutant discharge elimination system (NPDES): the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under section 307, 402, 318, and 405 of the Clean Water Act.

Nonpoint Source: the pollution sources which generally are not controlled by establishing effluent limitations under section 301, 302, and 402 of the Clean Water Act. Nonpoint source pollutants are not traceable to a discrete identifiable origin, but generally result from land runoff, precipitation, drainage, or seepage.

Outfall: the point where an effluent is discharges into receiving waters

Point Source: a stationery location or fixed facility from which pollutants are discharges or emitted. Also, any single identifiable source of pollution, e.g., a pipe, ditch, ship, ore pit, factory smokestack.

Pollution: generally, the presence of matter or energy whose nature, location or quantity produces undesired environmental effects. Under the Clean Water Act, for example, the term is defined as the man-made or man-induced alteration of the physical, biological, and radiological integrity of water.

Publicly Owned Treatment Works (POTW): the treatment works treating domestic sewage that is owned by a municipality or State.

Regression: a relationship of y and x in a function of $y = f(x)$, where: y is the expected value of an independent random variable x. The parameters in the function $f(x)$ are determined by the method of least squares. When $f(x)$ is a linear function of x, the term linear regression is used.

Regression Coefficient: a quantity that describes the slope and intercept of a regression line.

Scientific Notation (Exponential Notation): mathematical method in which very large numbers or very small numbers are expressed in a more concise form. The notation is based on powers of ten. Numbers in scientific notation are expressed as the following: $4.16 \times 10^{(+b)}$ and $4.16 \times 10^{(-b)}$ [same as $4.16E4$ or $4.16E-4$]. In this case, b is always a positive, real number. The $10^{(+b)}$ tells us that the decimal point is b places to the right of where it is shown. The $10^{(-b)}$ tells us that the decimal point is b places to the left of where it is shown.

For example: $2.7 \times 10^4 = 2.7E+4 = 27000$ and $2.7 \times 10^{-4} = 2.7E-4 = 0.00027$.

Sigma (Σ): shorthand way to express taking the sum of a series of numbers. For example, the sum or total of three amounts 24, 123, 16, (**d₁**, **d₂**, **d₃**) respectively could be shown as:

$$\sum_{i=1}^3 d_i = d_1 + d_2 + d_3 = 24 + 123 + 16 = 163$$

Total Maximum Daily Load or TMDL: (1) the calculated maximum permissible pollutant loading introduced to a water body such that any additional loading will produce a violation of water quality standards. (2) the sum of the individual waste load allocations and load allocations. A margin of safety is included with the two types of allocations so that any additional loading, regardless of source, would not produce a violation of water quality standards.

Waste: (1) useless, unwanted or discarded material resulting from (agricultural, commercial, community and industrial) activities. Wastes include solids, liquids, and gases. (2) any liquid resulting from industrial, commercial, mining, or agricultural operations, or from community activities that is discarded or is being accumulated, stored, or physically, chemically, or biologically treated prior to being discarded or recycled.

Wasteload allocation (WLA): (1) the portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality based effluent limitation. (2) the portion of a receiving water's total maximum daily load that is allocated to one of its existing or future point source of pollution. (3) the maximum load of pollutants each discharger of waste is allowed to release into a particular waterway. Discharge limits are usually required for each specific water quality criterion being, or expected to be, violated. The portion of a stream's total assimilative capacity assigned to an individual discharge.

Water Quality Standards: State-adopted and EPA-approved regulations mandated by the Clean Water Act and specified in 40 CFR 131 that describe the designated uses of a water body, the numeric and narrative water quality criteria designed to protect those uses, and an antidegradation statement to protect existing levels of water quality. Standards are designed to safeguard the public health and welfare, enhance the quality of water and serve the purposes of the Clean Water Act.

Water quality criteria: numeric water quality values and narrative statements which are derived to protect designated uses. Numeric criteria are scientifically-derived ambient concentrations developed by EPA or States for various pollutants of concern to protect human health and aquatic life. Narrative criteria are statements that describe the desired water quality goal. Ambient waters that meet applicable water quality criteria are considered to support their designated uses.

Waters of the State: all waters within the jurisdiction of this State, including all streams, lakes, ponds, wetlands, impounding reservoirs, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, situated wholly or partly within or bordering upon the State, and such coastal waters as are within the jurisdiction of the State, except lakes, ponds, or other surface waters which are wholly landlocked and privately owned, and which are not regulated under the Federal Clean Water Act (33 U.S.C.1251 et seq.).

Watershed: (1) the land area that drains (contributes runoff) into a stream. (2) the land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common delivery point.

ABBREVIATIONS

BMP	Best Management Practice
CWA	Clean Water Act
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MDEQ	Mississippi Department of Environmental Quality
MGD	Million Gallons per Day
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characterization
NLCD	National Land Cover Data
NRCS	National Resource Conservation Service
NPDES	National Pollution Discharge Elimination System
TMDL	Total Maximum Daily Load
UNT	Unnamed Tributary
USGS	United States Geological Survey
WLA	Waste Load Allocation

REFERENCES

- Horner, 1992. Water Quality Criteria/Pollutant Loading Estimation/Treatment Effectiveness Estimation. In R.W. Beck and Associates. Covington Master Drainage Plan. King County Surface Water Management Division, Seattle, WA.
- Horsley & Whitten, Inc. 1996. Identification and Evaluation of Nutrient Bacterial Loadings to Maquoit Bay, Brunswick, and Freeport, Maine. Casco Bay Estuary Project.
- Lee, C.C.. 1998. *Environmental Engineering Dictionary*. 3rd Edition. Government Institutes, Inc., Rockville, Maryland.
- MDEQ. 2003. *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. Office of Pollution Control.
- MDEQ. 2002. *Mississippi List of Water Bodies, Pursuant to Section 303(d) of the Clean Water Act*. Office of Pollution Control.
- MDEQ. 2001. *Wastewater Regulations for National Pollutant Discharge Elimination System (NPDES) Permits, Underground Injection Control (UIC) Permits, State Permits, Water Quality Based Effluent Limitations and Water Quality Certification*. Office of Pollution Control.
- MDEQ. 2000. *Mississippi 2000 Water Quality Assessment, Pursuant to Section 305(b) of the Clean Water Act. Pascagoula River Supplement*. Office of Pollution Control.
- Metcalf and Eddy. 1991. *Wastewater Engineering: Treatment, Disposal, Reuse*. 3rd Edition. McGraw-Hill, Inc., New York.
- NCSU, 1994. *Livestock Manure Production and Characterization in North Carolina*, North Carolina Cooperative Extension Service, North Carolina State University (NCSU) College of Agriculture and Life Sciences, Raleigh, January 1994.
- Sheely. 2002. *Load Duration Curves: Development and Application to Data Analysis for Streams in the Yazoo River Basin, MS*. Special Project, Summer 2002, Jackson Engineering Graduate Program.
- USDA. 2004. *2002 Census of Agriculture*. U.S. Department of Agriculture, National Agricultural Statistics Service, Washington, D.C.
- USEPA. 1998. *Better Assessment Science Integrating Point and Nonpoint Sources, BASINS, Version 2.0 User's Manual*. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.
- USEPA. 1986. *Ambient Water Quality Criteria for Bacteria - 1986*. EPA440/5-84-002. Office of Water, Washington, DC.