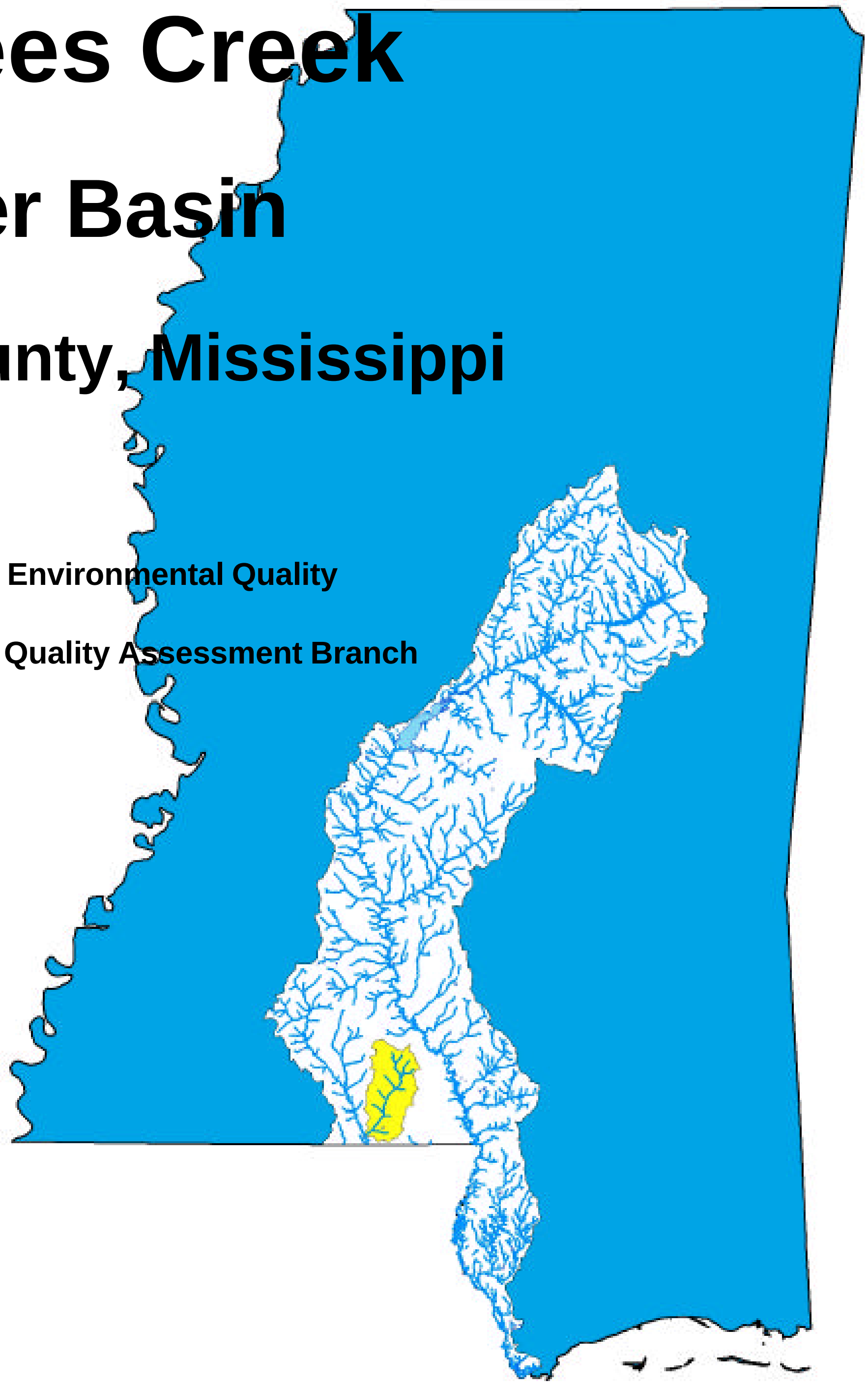
PROPOSED REPORT
April 2003

Phase One
Fecal Coliform TMDL
for Magees Creek

Pearl River Basin

Walthall County, Mississippi



Prepared By

Mississippi Department of Environmental Quality
Office of Pollution Control
TMDL/WLA Section/Water Quality Assessment 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 are 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	0.0015625	Days	Seconds	86400
Cubic feet	Cu. Meter	0.028316847	Feet	Meters	0.3048
Cubic feet	Gallons	7.4805195	Gallons	Cu feet	0.133680555
Cubic feet	Liters	28.316847	Hectares	Acres	2.4710538
cfs	Gal/min	448.83117	Miles	Meters	1609.344
cfs	MGD	.6463168	Mg/l	ppm	1
Cubic meters	Gallons	264.17205	µg/l * cfs	Gm/day	2.45

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Table i. Listing Information

Name	ID	County	HUC	Cause	Mon/Eval
Magees Creek	MS190E	Walthall	03180005	Pathogens	Evaluated
Near Dillon from Headwaters to mouth at Bogue Chitto					

Table ii. Water Quality Standard

Parameter	Beneficial use	Water Quality Criteria
Fecal Coliform	Contact Recreation	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 100 ml more than 10 percent of the time.

Table iii. NPDES Facilities

NPDES ID	Facility Name	Receiving Water
MS0030791	Barnes Meat Plant	Collins Creek
MS0045560	Lexie Headstart Center	Unnamed Tributary of Magees Creek
MS0055263	Little Angel's Day Care	Unnamed Tributary of Magees Creek
MS0053970	Salem Attendance Center	Varnell Creek
MS0020681	Tylertown POTW	Magees Creek

Table iv. MS190E Total Maximum Daily Load

Type	Number	Unit	MOS Type
WLA	1.01E+11	counts/30 day critical period	
LA	1.85E+13	counts/30 day critical period	
MOS	2.07E+12	counts/30 day critical period	Explicit – 10 %
TMDL	2.07E+13	counts/30 day critical period	

EXECUTIVE SUMMARY

One segment of Magees Creek has been placed on the Mississippi 1998 Section 303(d) List of Waterbodies as an evaluated water body segment, due to pathogens. MDEQ selected fecal coliform as an indicator organism for pathogenic bacteria. The applicable state standard specifies that the maximum allowable level of fecal coliform shall not exceed a geometric mean of 200 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 a colony count of 400 per 100 ml more than 10 percent of the time.

Photo 1. Magees Creek

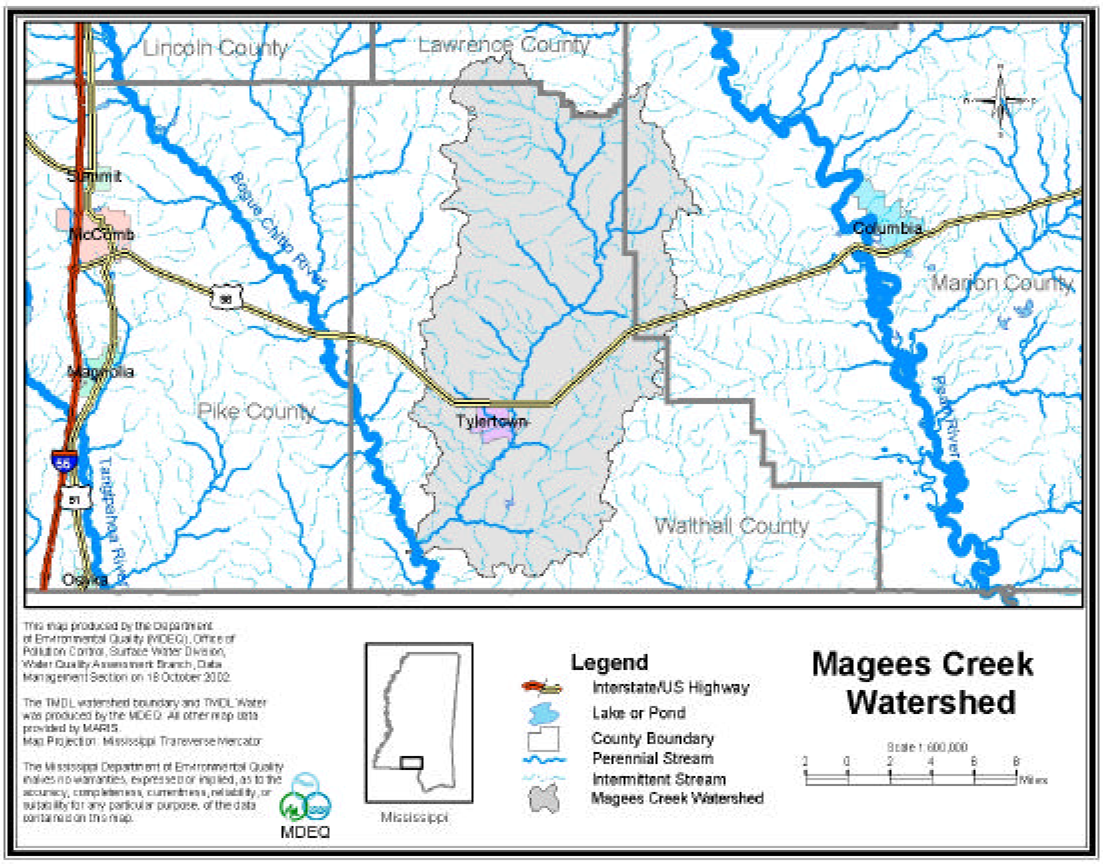
Magees Creek, photo 1, flows in a southwestern direction from its headwaters north of Darbun, Mississippi to the mouth at the Bogue Chitto River. This TMDL has been developed for one listed section of Magees Creek, Figure 2. A mass balance approach was used to calculate this Phase One TMDL. This method of analysis was selected due to the minimal amount of water quality data and the absence of a flow gage on the water body. The TMDL was determined to be 2.07E+13 counts per 30 days.

The limited data available for Magees Creek indicate violation of the percent of time in exceedance portion of the fecal coliform standards. The existing condition load was based on the load for the 30-days during which the critical violation occurred and resulted in an overall 45% reduction in sources of fecal coliform to the water body to meet the TMDL as determined by a thirty sample data set that meets both portions of the standards and is indicative of possible water quality conditions.

Fecal coliform loadings from nonpoint sources in the watershed come from wildlife populations, agricultural animal populations, human sources, and urban development. Also considered were the nonpoint sources such as failing septic systems and other direct inputs to tributaries of Magees Creek.

All NPDES permits currently issued require disinfection so no upgrades are required for the existing five facilities in the watershed. Monitoring of the permitted facilities in the Magees Creek Watershed should continue to ensure that compliance with the NPDES permit limits is consistently attained.

Figure 1. Location of Magees Creek Watershed



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 fecal coliform. Fecal coliform bacteria are used as indicator organisms. 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.

Mississippi Department of Environmental Quality (MDEQ) placed Magees Creek on the Mississippi 1998 Section 303(d) List of Waterbodies as evaluated. The 303(d) listed sections are shown in Figure 2. Magees Creek is in the Pearl River Basin Hydrologic Unit Code (HUC) 03180005 in southwest Mississippi. The Magees Creek watershed is approximately 140,000 acres; and lies within Walthall, Marion, and Lawrence Counties. The watershed is rural. Pasture and forest are the dominant landuses within the watershed. The landuse distribution is shown below in Table 1.

Table 1. Landuse Distribution for the Magees Creek Watershed

	Urban	Forest	Cropland	Pasture	Barren	Wetland	Water	Total
Area (acres)	483	46,461	7,136	82,182	349	6,424	231	143,266
% Area	0%	32%	5%	57%	0%	4%	0%	100%

Figure 2. Magees Creek Watershed Landuse

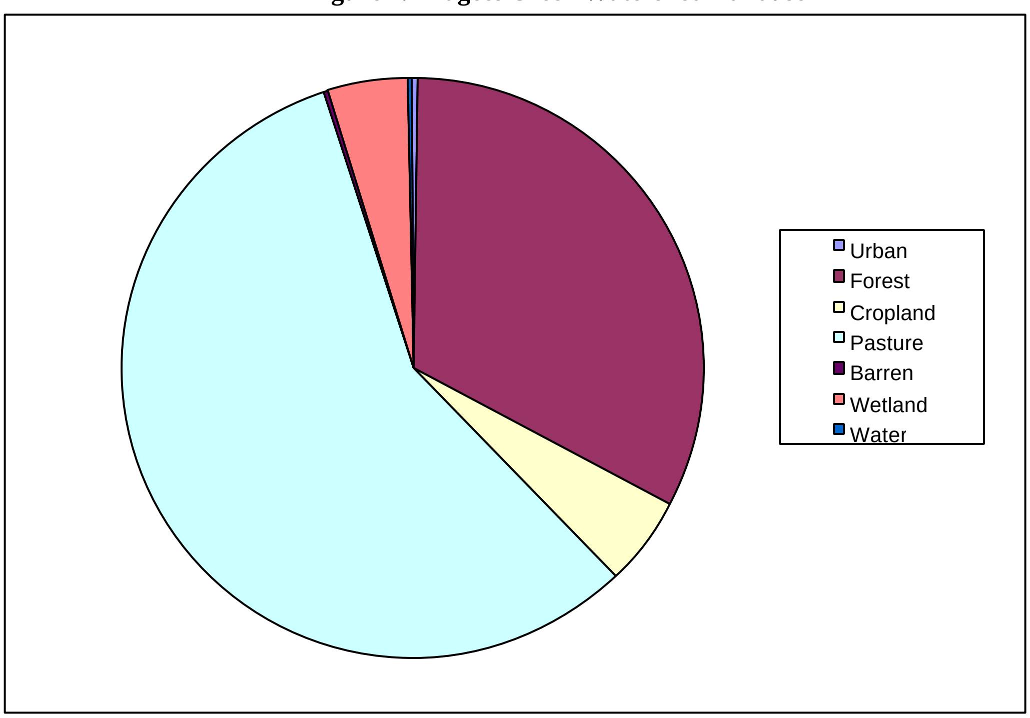
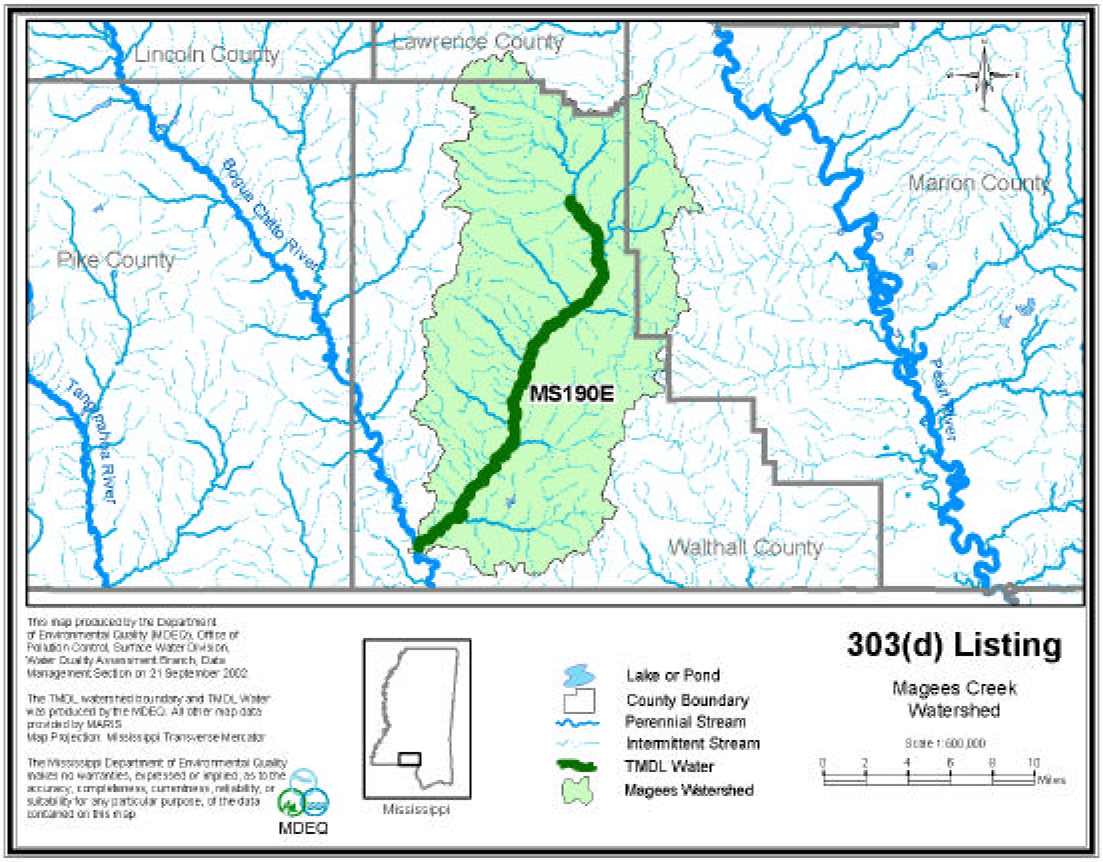


Figure 3. Magees Creek 303(d) Listed Segment



1.2 Applicable Water Body Segment Use

The water use classification for the listed segment of Magees Creek, as established by the State of Mississippi in the *Water Quality Criteria for Intrastate, Interstate and Coastal Waters* (2002) regulation, is Recreation. The designated beneficial uses for Magees Creek are Primary Contact and Aquatic Life Support.

1.3 Applicable Water Body Segment Standard

The water quality standard applicable to the use of the water body and the pollutant of concern is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (2002). The standard states that 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 percent of the time. The water quality standard will be used to assess the data to determine impairment in the water body. The water quality standard will be used as the targeted endpoint to establish this TMDL.

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 waste load reductions specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. Recently, MDEQ established a revision to the fecal coliform standard that allows for a statistical review of any fecal coliform data set. There are two tests that the data set must pass to show non-impairment.

The first test states that 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. The second test states that the samples examined during a 30-day period shall not exceed a count of 400 per 100 ml more than 10 percent 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 test used to measure fecal coliform levels in the water. The membrane filtration or MF 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 filtered.

To account for this variability the dual test standard was established. 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.

$$G = \sqrt[n]{s1 * s2 * s3 * s4 * s5 * sn}$$

The 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.

2.1.2 Discussion of the 10% Test

The other 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 n^{th} data point. The 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.

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 90^{th} percentile of the data set has been determined, it may be compared to the standard of 400 counts per 100 ml. If the 90^{th} percentile of the data is greater than 400 then the stream will be considered impaired. This can be used not only to assess actual water quality data, but also computer generated 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 values.

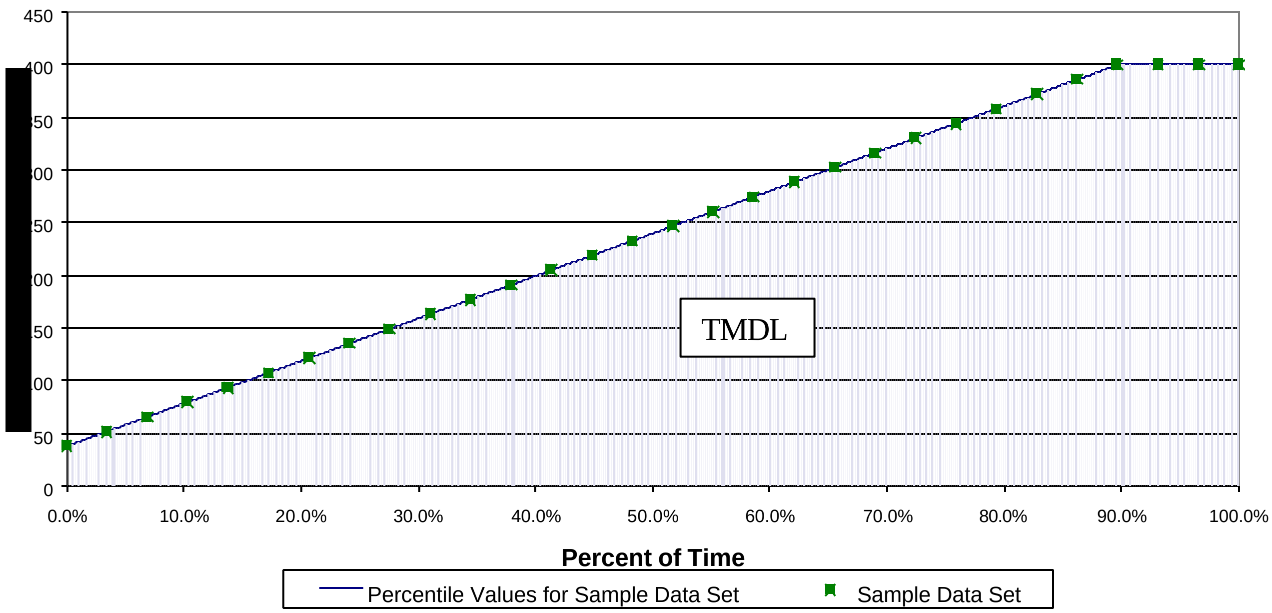
2.1.3 Discussion of Combining the Tests

MDEQ determined a curve that meets both portions of the standard and is indicative of possible water quality conditions. The integral of this curve represents the TMDL. That is, the maximum amount of fecal coliform in the water body either based on actual data sets or on computer generated values. By multiplying the integral of the 30-sample data set curve by the flow in the stream, the TMDL can be calculated.

Table 2. 30 point 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. 30 point data set 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. The endpoint selected for this TMDL is 200 counts per 100 ml for any given sample. If all of the data points are less than or equal to 200 then the water body will automatically pass both tests and not be considered impaired. Meeting the geometric mean test and applying the 10% test to the data sets apply both parts of the standard when applied to an actual data set or when considering a computer generated data set. It is therefore appropriate to select 200 as the targeted endpoint for the 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. But, critical conditions for point source dominated systems generally occur during periods of low-flow, low-dilution conditions. Therefore a careful examination of the data is needed to determine the critical 30-day period to be used for the TMDL.

2.2 Discussion of Instream Water Quality

Data were collected at station MP45, located near Simonds, and at station MP46, located near Darbun. Samples were collected in 30 day groupings in 2000 and 2001. Data collected in this manner can be used to calculate the geometric mean for the water body.

2.2.1 Inventory of Available Water Quality Monitoring Data

Data collected at stations MP45 and MP46 are included in Tables 3, 4, 5, and 6.

Table 3. Fecal Coliform Data reported in Magees Creek, Station MP45
September 2001 to October 2001

Date	Time	Fecal Coliform (counts/100ml)	Flow (cfs)	Geometric Mean	Geometric Mean Violation	90th Percentile	90th Percentile Violation
11/16/2000	11:05	130	150	44	No	126	No
11/21/2000	13:15	120	278				
11/28/2000	12:05	10	175				
12/4/2000	11:40	100	156				
12/11/2000	12:20	10	152				

Table 4. Fecal Coliform Data reported in Magees Creek, Station MP45
September 2001 to October 2001

Date	Time	Fecal Coliform (counts/100ml)	Flow (cfs)	Geometric Mean	Geometric Mean Violation	90th Percentile	90th Percentile Violation
9/26/2001	8:25	170	165	103	No	155	No
9/27/2001	10:00	110	162				
10/2/2001	9:10	140	159				
10/3/2001	12:45	50	159				
10/9/2001	13:00	90	168				
10/10/2001	12:25	100	168				

Table 5. Fecal Coliform Data reported in Magees Creek, Station MP46
November 2000 to December 2000

Date	Time	Fecal Coliform (counts/100ml)	Flow (cfs)	Geometric Mean	Geometric Mean Violation	90th Percentile	90th Percentile Violation
11/20/2000	13:35	**3600**	132	135	No	2232	Yes
11/21/2000	11:25	180	15.5				
11/28/2000	10:20	140	2				
12/4/2000	10:15	50	0.2				
12/11/2000	16:40	10	0.2				

Table 6. Fecal Coliform Data reported in Magees Creek, Station MP46
September 2001 to October 2001

Date	Time	Fecal Coliform (counts/100ml)	Flow (cfs)	Geometric Mean	Geometric Mean Violation	90th Percentile	90th Percentile Violation
9/25/2001	14:10	150	4.2	187	No	275	No
9/27/2001	17:35	160	3.9				
10/1/2001	13:25	170	3.8				
10/3/2001	9:45	140	3.8				
10/9/2001	14:10	270	3.4				
10/10/2001	14:25	280	3.9				

2.2.2 Analysis of Instream Water Quality Monitoring Data

The data collected at station MP46 during November and December of 2000 indicated violation of the percent of time in exceedence portion of the standard. The 90th percentile of the data set is 2232, which is greater than the 400 necessary to meet the standard. A graphical representation can be seen in Figure 7 below. A line has been added to the raph representing 400 counts/100 ml and showing that this occurs less than 90% of the time, meaning that the counts of fecal coliform in the stream is greater than 400 more than 10% of the time. The critical conditions for Magees Creek have been determined to be wet weather events. Figure 5 is a plot of the data set containing the violation from Station MP46 and precipitation data from the weather station at Ruth, MS to attempt to correlate rain events and water quality observations. The spike in the fecal coliform data comes shortly after a 2 inch rainfall, indicating that the critical conditions for Magees Creek are wet weather events.

Figure 5. Statistical Representation of Water Quality Data for Station MP46, November and December 2000

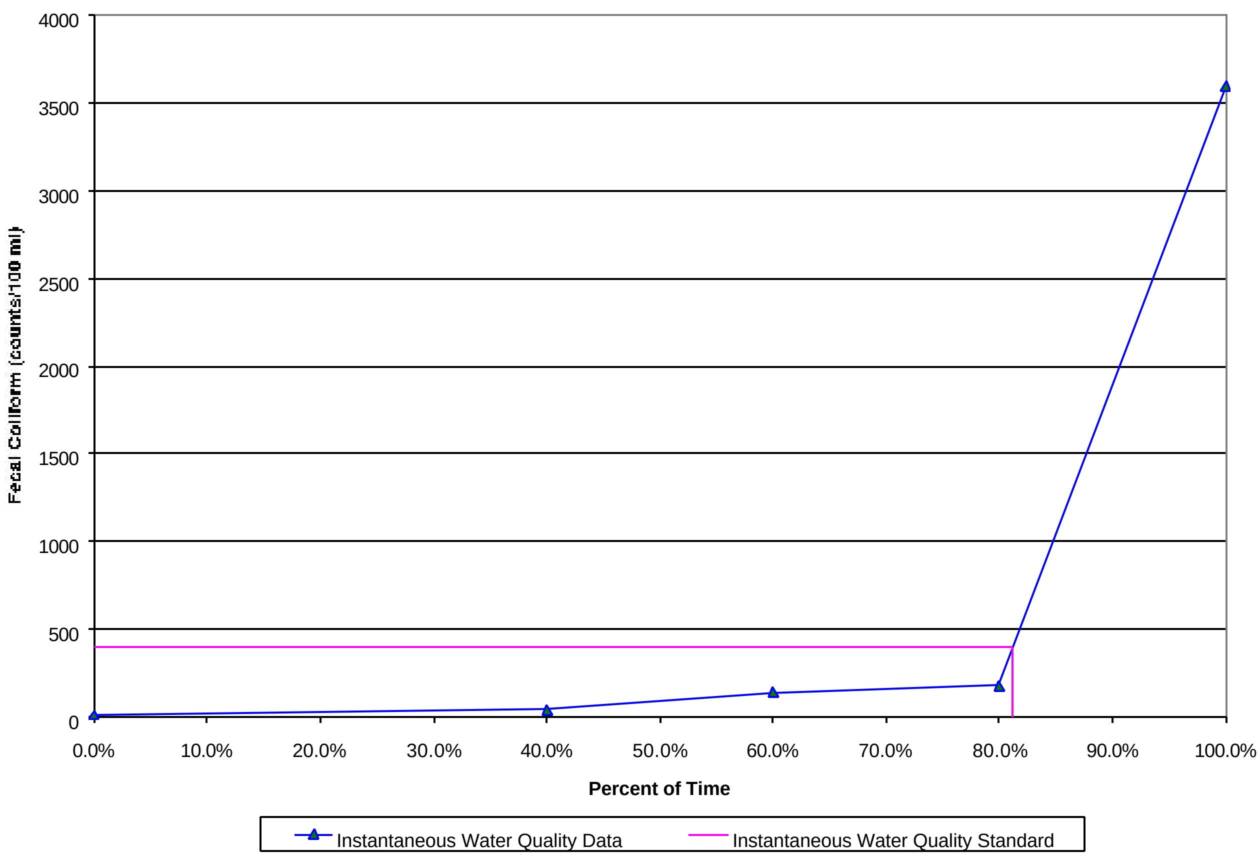
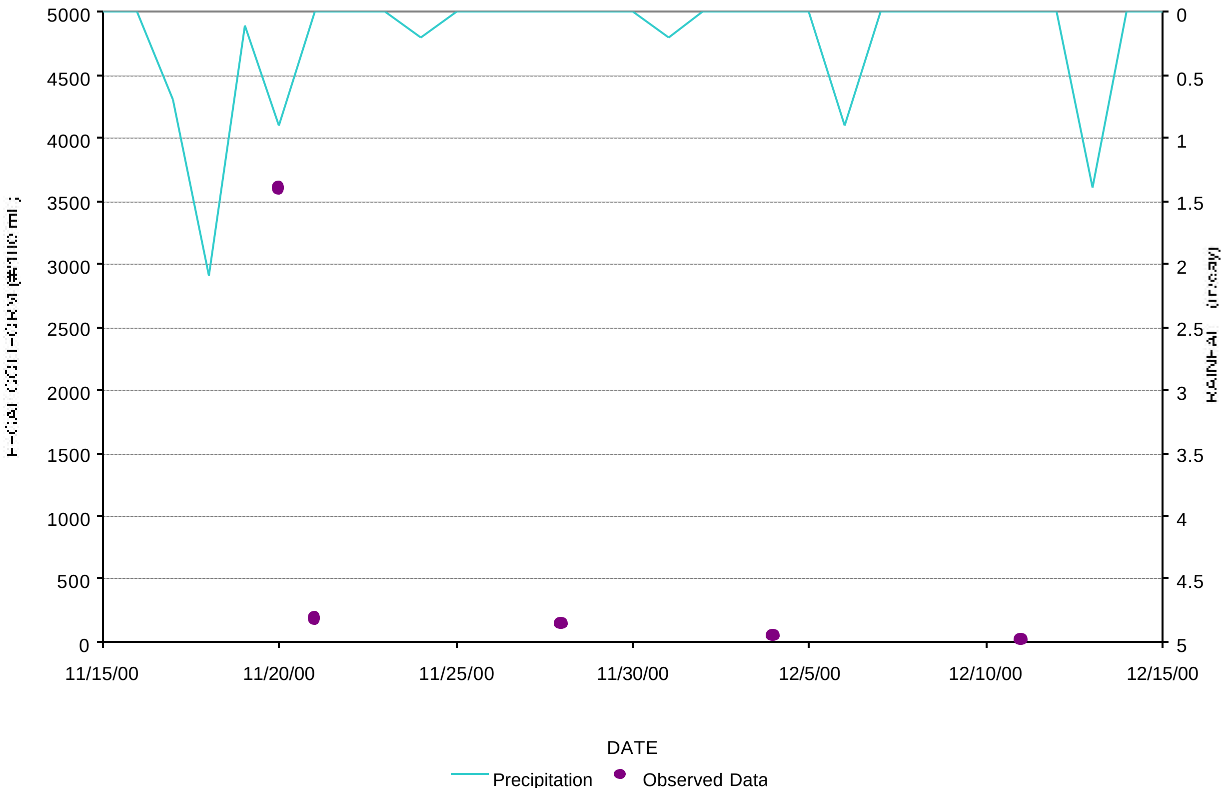


Figure 6. Water Quality Data and Precipitation for Station MP46, November and December 2000



SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential fecal coliform sources in the Magees Creek 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

Once the permitted dischargers were located, the effluent was characterized based on all available monitoring data including permit limits, discharge monitoring reports, and information on treatment types. Discharge monitoring reports (DMRs) were the best data source for characterizing effluents because they report measurements of flow and fecal coliform present in effluent samples. If evidence of insufficient treatment existed or when data were not available, professional judgement was used to estimate a fecal coliform loading rate for the calculations. The facilities are shown in Table 7.

Table 7. Inventory of Point Source Dischargers

NPDES ID	Facility Name	Receiving Water	Design Flow (MGD)
MS0030791	Barnes Meat Plant	Collins Creek	0.005
MS0045560	Lexie Headstart Center	Unnamed Tributary of Magees Creek	0.003
MS0055263	Little Angel's Day Care	Unnamed Tributary of Magees Creek	0.0003
MS0053970	Salem Attendance Center	Varnell Creek	0.015
MS0020681	Tylertown POTW	Magees Creek	0.420

3.2 Assessment of Nonpoint Sources

There are many potential nonpoint sources of fecal coliform bacteria for Magees Creek, including:

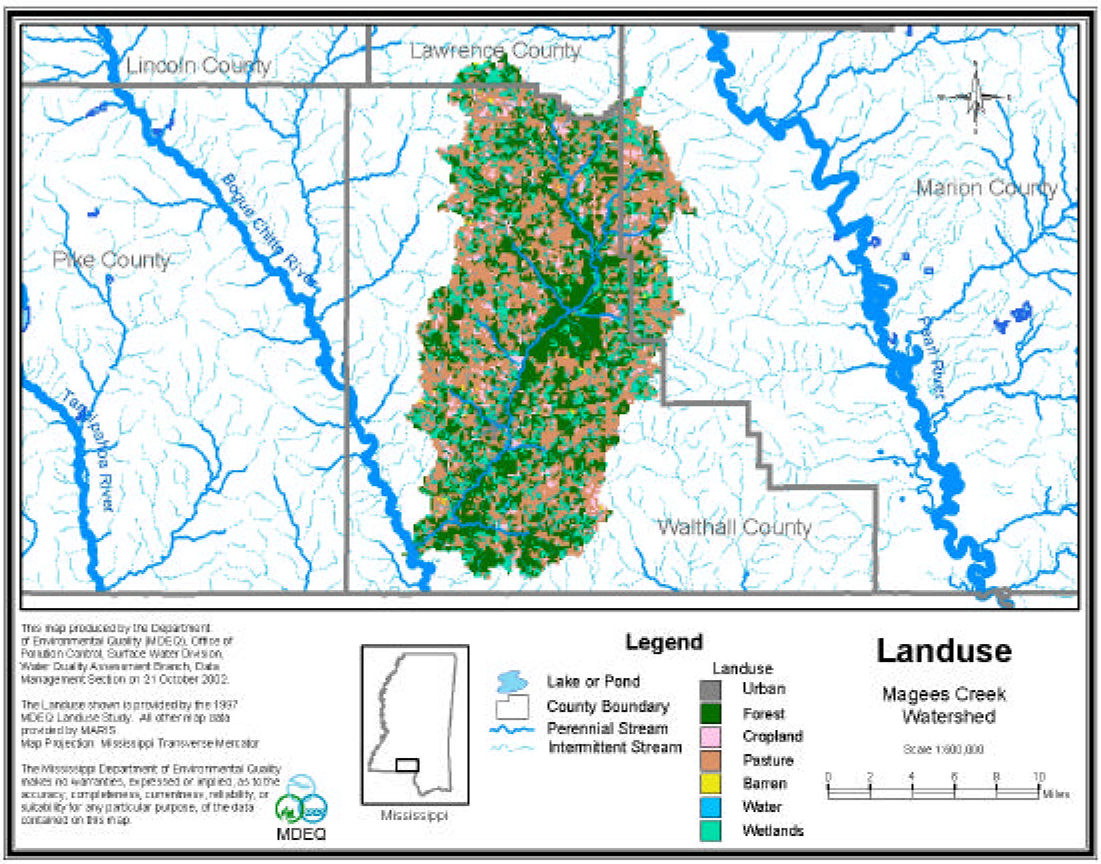
- Failing septic systems
- Wildlife
- Land application of hog and cattle manure
- Grazing animals
- Land application of poultry litter
- Other Direct Inputs
- Urban development

The 140,000 acre drainage area of Magees Creek contains many different landuse types, including urban, forest, cropland, pasture, and wetlands. The landuse distribution for the watershed is provided in Table 8 and displayed in Figure 8. The landuse 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 landuses of urban, forest, cropland, pasture, barren, and wetlands.

Table 8. Landuse Distribution (acres)

	Urban	Forest	Cropland	Pasture	Barren	Wetland	Water	Total
Area (acres)	483	46,461	7,136	82,182	349	6,424	231	143,266
% Area	0%	32%	5%	57%	0%	4%	0%	100%

Figure 7. Landuse Distribution Map for the Magees Creek Watershed



The MARIS landuse data for Mississippi was utilized by the Watershed Characterization System (WCS) to extract landuse sizes, populations, and agriculture census data. MDEQ contacted several agencies to refine the assumptions made in determining the fecal coliform loading. The Mississippi Department of Wildlife, Fisheries, and Parks provided information of wildlife density in the Magees Creek Watershed. The Mississippi State Department of Health was contacted regarding the failure rate of septic tank systems in this portion of the state. Mississippi State University researchers provided information on manure application practices and loading rates for hog farms, poultry farms, and beef and dairy operations. The Natural Resources Conservation Service gave MDEQ information on agricultural manure treatment practices and land application of manure.

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.

Septic systems have an impact on nonpoint source fecal coliform impairment in the Pearl River 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.

3.2.2 Wildlife

Wildlife present in the Magees Creek Watershed contributes to fecal coliform bacteria on the land surface. It was assumed that the wildlife population remained constant throughout the year, and that wildlife were present on all land classified as pastureland, cropland, and forest. It was also assumed that the manure produced by the wildlife was evenly distributed throughout these land types.

3.2.3 Land Application of Hog Manure

In the Pearl River Basin processed manure from confined hog operations is collected in lagoons and routinely applied to pastureland during April through October. This manure is a potential contributor of bacteria to receiving water bodies due to runoff produced during a rain event. Hog farms in the Pearl River Basin operate by keeping the animals confined at all times. The hog waste is collected in a lagoon and periodically sprayed on forage or cropland. The amount of the manure application is determined by the nitrogen uptake of the plant being sprayed. The frequency is determined by rain events so that the waste is not sprayed on saturated ground or just prior to a rain event to minimize runoff. Another factor in the application of the manure is pumping the lagoons often enough to avoid a lagoon overflow. Also, the waste is not land applied during the winter months when there is no forage or crop being grown. It was assumed that all of the hog manure produced was applied evenly to the available pastureland. Application rates of hog manure to pastureland from confined operations varied monthly according to management practices currently used in this area.

Large dairy farms, over 200 head, typically confine the milking herd at all times. Smaller 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. Like the hog farms, application rates of dairy cow manure to pastureland vary monthly according to management practices currently used in this area.

3.2.4 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 are assumed to have access to pastureland for grazing all of the time. For dairy cattle, the dry cattle and heifers are assumed to have access to pastureland for grazing all of the time. The small dairy farms, less than 200 head, in the Pearl River Basin confine the lactating cattle for a limited time during the day. During all other times, the lactating cattle at small dairies are assumed to have access to pastureland for grazing. The milking herd is assumed to make up approximately 80% of the total herd. Manure produced by grazing beef and dairy cows is directly deposited onto pastureland and is available for wash off.

The manure produced by confined dairy cows is collected in lagoons and spray applied to available pastureland in the watershed. Large dairy farms, more than 200 head, typically confine the milking herd at all times. Smaller dairy farms confine the lactating cattle for a limited time during the day for milking and feeding. Like the hog farms, application rates of dairy cow manure to pastureland vary monthly according to management practices currently used in this area.

3.2.5 Land Application of Poultry Litter

There are a considerable number of chickens produced in Lawrence, Marion, and Walthall Counties each year. Predominantly, two kinds of chickens are raised on farms in the Pearl River Basin, broilers and layers.

For the broiler chickens, the amount of growth time from when the chicken is born to when it is sold off the farm is approximately 48 days or 1.6 months. Broiler chickens are confined in poultry houses all of the time. A pine shaving litter material is used to contain broiler chicken waste. This dry waste accumulates and breaks down in the poultry houses. The poultry litter is removed from the houses approximately every two years but may remain as long as seven years. The majority of the litter is used as a fertilizer on hay and row crops and may be used in areas of the state other than the location of the poultry houses. The litter is applied in the spring, summer, and early fall and rates are determined by a phosphorous index. A small amount of the litter may be mixed in with cattle feed and is not land applied.

Layer chickens are confined at all times and remain on farms for ten months or longer. The waste from small scale layer operations is treated in the same way as broiler operations. Large scale layer operations collect the chicken waste in a lagoon and periodically spray apply the waste to corn fields. The application rates vary monthly from the spring through the early fall.

3.2.6 Other Direct Inputs

Due to the general topography in the Magees Creek Watershed, it was assumed that land slopes in the watershed are such that unconfined animals are able to access the intermittent streams in the watershed. This direct input of cattle manure represents all animal access to streams (domestic and wild), illicit discharges of fecal coliform bacteria, human recreation, and leaking sewer collection lines.

3.2.7 Urban Development

Urban areas include land classified as urban and barren. Even though only a small percentage of the watershed is classified as urban, the contribution of the urban areas to fecal coliform loading in Magees Creek was considered. Fecal coliform contributions from urban areas may come from storm water runoff, failing sewer pipes, and runoff contribution from improper disposal of materials such as litter.

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 this Phase One TMDL. This method of analysis was selected due to a lack of water quality data and flow data during the possible modeling time frame. It was not possible to model the time period during which the 2000 data was collected due to a lack of weather data for that time period. Also, there is no continuous gage on the water body, so there was no flow data available. The mass balance approach is suitable for a Phase One TMDL

4.2 Calculation of 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:

Load (counts/30days) = [**Concentration for 30 days** (30 days*counts/ 100 ml)] * [**Flow** (cfs)] * (Conversion Factor)

where (Conversion Factor) = [(28316.8 ml/1 ft^3)*(1 (100 ml)/100 (1 ml))*(60 s/1 min)*
(60 min/1 hour)*(24 hour/1 day)*(30 days/1 (30 days)/30 days]
= 2.45 E+07 ((100 ml * s)/(ft^3 *30 days*30days))

For the calculation of this TMDL, the concentration for 30 days used was the area under a curve that meets both portions of the standard with an assumed 30 sample data set. This value is 7129.425 (30days*counts/100 ml). The geometric mean of the estimated flow for the 30 days prior to the critical violation was used as the estimated critical flow. There is no USGS continuous flow gage located on Magees Creek so the critical flow was estimated based on the method included in MDEQ regulations to be 118.42 cfs based on the discharge of Bogue Chitto Creek at station 02492000 near Bush, Louisianna. (Telis) The USGS gage 02492000 was selected as it is the closest downstream continuous flow gage to the listed segment.

Discharge (cfs)={[**02492000 Discharge** (cfs)]/[**02492000 Drainage Area** (acres)]}
*[**Magees Creek Drainage Area** (acres)]

4.3 Stream Characteristics

The stream characteristics given below describe the reaches that make up the impaired segment of Magees Creek. The channel geometry and lengths for Magees Creek are based on Reach File Version 1 data available within WCS. The characteristics of Magees Creek are as follows.

- Length 30.6 miles
- Average Depth 1.17 ft
- Average Width 48.5 ft
- Average Flow 243.3 cubic ft per second
- Mean Velocity 1.39 ft per second
- Slope 0.00155 ft per ft

ALLOCATION

The allocation for this Phase One TMDL could include a wasteload allocation (WLA) for point sources, a load allocation (LA) for nonpoint sources, and a margin of safety (MOS). This Phase One TMDL is comprised of the WLA, LA and MOS.

5.1 Wasteload Allocations

The contributions of the point sources were considered on a watershed basis. Typically, the contribution of each discharger was based on the facility's discharge monitoring data and other records of past performance. The point source contribution, along with its assumed existing load, allocated load, and percent reduction are shown below. There are 5 point sources within the watershed. A review of these facilities' DMR data showed no problems reaching permit limits. No changes to their permits are required at this time.

Table 9. Wasteload Allocations

	Existing Load (counts/30 days)	Allocated Load (counts/30 days)	Percent Reduction
MS0030791	1.14E+09	1.14E+09	0.0%
MS0045560	6.83E+08	6.83E+08	0.0%
MS0055263	6.83E+07	6.83E+07	0.0%
MS0053970	3.41E+09	3.41E+09	0.0%
MS0020681	9.56E+10	9.56E+10	0.0%
Total	**1.01E+11**	**1.01E+11**	**0.0%**

5.2 Load Allocations

The LA for Magees Creek is calculated using the water quality criterion and the estimated critical flow. In calculating the LA component, the total TMDL for the water body is reduced by a 10 percent MOS. For this Phase One TMDL, the load is based on a fecal coliform concentration for 30 days determined by the area under a curve that meets both portions of the standards for a 30 sample data set and the estimated critical flow of the entire watershed, MS190E, of 118.42 cfs. The resulting load is estimated to be 2.81E+13 counts for 30 days. The WLA is then subtracted from this load to calculate the LA.

LA = 0.9*(7129.425(30 days*counts/100ml)* 118.42(cfs) * 2.45E+07((100ml*s)/(ft^3 *30 days*30 days))) – 1.01E+11(counts for 30 days)

LA = 1.85+13 counts for 30 days

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. For this study, reducing the TMDL by 10 percent explicitly specifies the MOS. The load attributed to the MOS is 3.14E+12 counts for 30 days.

MOS = 0.1*(7129.425(30 days*counts/100ml)* 118.42(cfs) * 2.45E+07((100ml*s)/(ft^3*30 days*30 days)))

MOS = 2.07E+12 counts for 30 days

5.4 Calculation of the TMDL

This TMDL is calculated based on the following equation where WLA is the wasteload allocation (the load from the point sources), the LA is the load allocation (the load from nonpoint sources), and MOS is the margin of safety:

TMDL = WLA + LA + MOS

WLA = NPDES Permitted Facilities

LA = Surface Runoff + Other Direct Inputs

MOS = Explicit

The TMDL was calculated based on the estimated critical flow of the watershed, and a fecal coliform concentration for 30 days determined by the area under a curve that meets both portions of the standards for a 30-sample data set. Table 10 gives the Phase One TMDL for the listed segment Magees Creek.

TMDL = (7129.425(30 days*counts/100ml)* 118.42(cfs) * 2.45E+07((100ml*s)/(ft^3*30 days*30 days)))

TMDL = 2.07E+13 counts for 30 days

Table 10. Summary for Listed Segment (counts/30 days)

	MS190E
WLA	1.01E+11
LA	1.85E+13
MOS	2.07E+12
TMDL = WLA + LA + MOS	2.07E+13

The existing load of fecal coliform bacteria counts per 30 days entering Magees Creek for the listed segment was estimated based on the area under the curve that represented the 30 day period in which the critical violation occurred and the estimated critical flow of 118.42 cfs through the water body. The scenario resulted in an estimated existing load of 3.79E+13 counts for 30 days resulting in a 45% reduction in fecal coliform bacteria to the water body.

5.5 Seasonality

For many streams in the state, fecal coliform limits vary according to the seasons. This stream is designated for the use of contact recreation. For this use, the pollutant standard is constant. Seasonality is addressed by calculating the TMDL based on the estimated flow that occurred during the critical violation.

5.6 Reasonable Assurance

This component of TMDL development does not apply to this TMDL Report. There are no point sources (WLA) requesting a reduction based on promised Load Allocation components and reductions. The point sources are required to discharge effluent treated and disinfected that will be below the 200 colony counts per 100-ml. target at the end of the pipe.

CONCLUSION

The estimated reduction in the existing fecal coliform load is 45%. A reduction in sources of fecal coliform is a priority. Education projects that teach best management practices regarding urban bacteria loads, manure management, and septic tank management should be used as a tool for reducing nonpoint source contributions. These projects may be funded by CWA Section 319 Nonpoint Source (NPS) Grants. The TMDL will not impact existing or future NPDES Permits as long as the effluent is disinfected to meet water quality standards for pathogens. MDEQ will not approve any NPDES Permit application that does not plan to meet water quality standards for disinfection. MDEQ will continue to monitor the stream to check for future compliance with the state bacteria standard.

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 yearlong cycle, MDEQ resources for water quality monitoring will be focused on one of the basin groups. During the next monitoring phase in the Pearl River Basin, Magees Creek may receive additional monitoring to identify any change in water quality. MDEQ produced guidance for future Section 319 project funding will encourage NPS 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 and a newspaper in the area of the watershed. 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 be included on the TMDL mailing list should contact Greg Jackson at (601) 961-5098 or Greg_Jackson@deq.state.ms.us. 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 meeting.

All written comments received during the public notice period and at any public meeting become a part of the record of this TMDL. All comments will be considered in the ultimate completion of this TMDL for submission of this TMDL to EPA Region 4 for final approval.

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 body of water or soil-plant system to receive wastewater effluents or sludge without violating the provisions of the State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters and Water Quality regulations.

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 water body have their greatest potential for adverse effects.

Daily discharge: the "discharge of a pollutant" measured during a calendar day or any 24-hour period that reasonably represents the calendar 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 average" is calculated as the average.

Designated Use: use specified in water quality standards for each water body or segment regardless of actual attainment.

Discharge monitoring report: report of effluent characteristics submitted by a NPDES Permitted facility.

Effluent standards and limitations: all State or Federal effluent standards and limitations on quantities, rates, and concentrations of chemical, physical, biological, and other constituents to which a waste or wastewater discharge may be subject under the Federal Act or the State law. This includes, but is not limited to, effluent limitations, standards of performance, toxic effluent standards and prohibitions, pretreatment standards, and schedules of compliance.

Effluent: treated wastewater flowing out of the treatment facilities.

Fecal coliform bacteria: a group of bacteria that normally live within the intestines of mammals, including humans. Fecal coliform bacteria are used as an indicator of the presence of pathogenic organisms in natural water.

Geometric mean: the *n*th root of the product of *n* numbers. A 30-day geometric mean is the 30^{th} 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 attributed to or assigned to nonpoint sources (NPS) or background sources of a pollutant. The load allocation is the value assigned to the summation of all direct sources and land applied fecal coliform that enter a receiving water body. It also contains a portion of the contribution from septic tanks.

Loading: the total amount of pollutants entering a stream from one or multiple sources.

Nonpoint Source: pollution that is in runoff from the land. Rainfall, snowmelt, and other water that does not evaporate become surface runoff and either drains into surface waters or soaks into the soil and finds its way into groundwater. This surface water may contain pollutants that come from land use activities such as agriculture; construction; silviculture; surface mining; disposal of wastewater; hydrologic modifications; and urban development.

NPDES permit: an individual or general permit issued by the Mississippi Environmental Quality Permit Board pursuant to regulations adopted by the Mississippi Commission on Environmental Quality under Mississippi Code Annotated (as amended) §§ 49-17-17 and 49-17-29 for discharges into State waters.

Point Source: pollution loads discharged at a specific location from pipes, outfalls, and conveyance channels from either wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving stream.

Pollution: contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the State, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance, or leak into any waters of the State, unless in compliance with a valid permit issued by the Permit Board.

Publicly Owned Treatment Works (POTW): a waste treatment facility owned and/or operated by a public body or a privately owned treatment works which accepts discharges which would otherwise be subject to Federal Pretreatment Requirements.

Regression Coefficient: an expression of the functional relationship between two correlated variables that is often empirically determined from data, and is used to predict values of one variable when given values of the other variable.

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 x 10^(+b)* and *4.16 x 10^(-b) [same as 4.16E4 or4.16E-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: $2.7 \mathrm{X} 10^4$ = 2.7E+4 =27000 and $2.7 \mathrm{X} 10^{-4}$ = 2.7E-4=0.00027.

Sigma (S): shorthand way to express taking the sum of a series of numbers. For example, the sum or total of three amounts 24, 123, 16, ($\mathbf{d}_1$, $\mathbf{d}_2$, $\mathbf{d}_3$) 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: the calculated maximum permissible pollutant loading to a water body at which water quality standards can be maintained.

Waste: sewage, industrial wastes, oil field wastes, and all other liquid, gaseous, solid, radioactive, or other substances which may pollute or tend to pollute any waters of the State.

Wasteload allocation (WLA): the portion of a receiving water's loading capacity attributed to or assigned to point sources of a pollutant. It also contains a portion of the contribution from septic tanks.

Water Quality Standards: the criteria and requirements set forth in *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. Water quality standards are standards composed of designated present and future most beneficial uses (classification of waters), the numerical and narrative criteria applied to the specific water uses or classification, and the Mississippi antidegradation policy.

Water quality criteria: elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports the present and future most beneficial 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: the area of land draining into a stream at a given location.

ABBREVIATIONS

7Q10................................Seven-Day Average Low Stream Flow with a Ten-Year Occurrence Period

BASINS.. Better Assessment Science Integrating Point and Nonpoint Sources

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

MARIS .... State of Mississippi Automated Information System

MDEQ .... Mississippi Department of Environmental Quality

MOS.. Margin of Safety

NRCS .... National Resource Conservation Service

NPDES ....National Pollution Discharge Elimination System

NPSM..Nonpoint Source Model

RF3..Reach File 3

USGS..United States Geological Survey

WLA..Waste Load Allocation

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