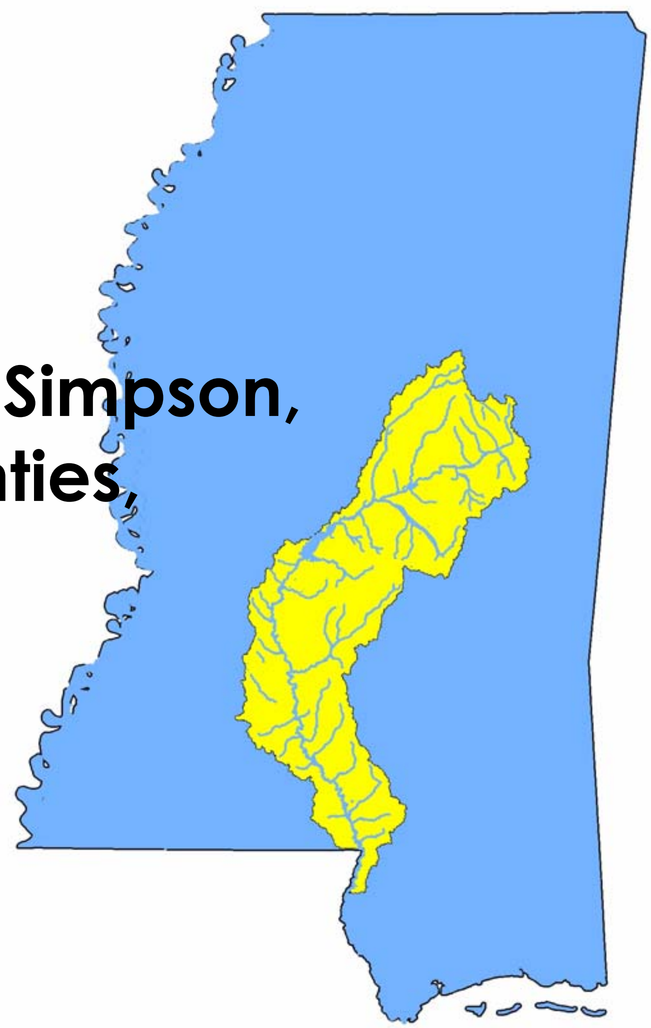
FINAL
January 2012

Fecal Coliform TMDL for Segments of the Pearl River, the Strong River, Halls Creek, and Pretty Branch



Pearl River Basin

Copiah, Pearl River, Simpson, and Lawrence Counties, Mississippi

Prepared By

Mississippi Department
of Environmental Quality

FOREWORD

The report contains one or more Total Maximum Daily Loads (TMDLs) for water body segments found on Mississippi's current Section 303(d) List of Impaired Water Bodies. The implementation of the TMDLs contained herein will be prioritized within Mississippi's rotating basin approach.

As additional information becomes available, the TMDLs may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, modifications to the water quality standards or criteria, 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	µg/l * cfs	Gm/day	2.45

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Listing Information

Name	ID	County	HUC	Cause
Pearl River	510711	Copiah	3180002	Pathogens
From MWS Boundary 5106 to confluence with Weeks Mill Creek				
Pearl River	518211	Pearl River	3180004	Pathogens
From confluence with Big Creek to MWS Boundary 5184 below Hwy 26				
Strong River	MSSTRONGE1	Simpson	3180002	Pathogens
From Cambell Creek to the Pearl River				
Pretty Branch	514811	Lawrence	3180003	Pathogens
Near Ferguson from headwaters to the Pearl River				
Halls Creek	515011	Lawrence	3180003	Pathogens
Near Monticello from headwaters to the mouth at the Pearl River				

Water Quality Standard

Parameter	Beneficial use	Water Quality Criteria
Fecal Coliform	Secondary Contact	**May - October**: Fecal coliform colony counts are not to exceed a geometric mean of 200 per 100ml based on a minimum of 5 samples taken over a 30-day period with a minimum of 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. **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.

Total Maximum Daily Load for the Pearl River (510711)

WLA (counts per day)	LA (counts per day)	MOS (counts per day)	Total TMDL (counts per day)	TMDL Percent Reduction
4.28E+11	2.39E+13	2.70E+12	2.70E+13	75%

Total Maximum Daily Load for the Pearl River (518211)

WLA (counts per day)	LA (counts per day)	MOS (counts per day)	Total TMDL (counts per day)	TMDL Percent Reduction
1.21E+12	4.14E+13	4.73E+12	4.73E+13	70%

Total Maximum Daily Load for Pretty Branch (514811)

WLA (counts per day)	LA (counts per day)	MOS (counts per day)	Total TMDL (counts per day)	TMDL Percent Reduction
9.13E+10	6.59E+10	1.75E+10	1.75E+11	63%

Total Maximum Daily Load for the Strong River (MSSTRONGE1)

WLA (counts per day)	LA (counts per day)	MOS (counts per day)	Total TMDL (counts per day)	TMDL Percent Reduction
2.80E+10	4.59E+12	5.13E+11	5.13E+12	68%

Total Maximum Daily Load for Halls Creek (515011)

WLA (counts per day)	LA (counts per day)	MOS (counts per day)	Total TMDL (counts per day)	TMDL Percent Reduction
2.80E+10	2.70E+11	3.31E+10	3.31E+11	70%

EXECUTIVE SUMMARY

A pathogen TMDL was developed for water body segments located in the Pearl River Basin that are listed on the Mississippi 2010 Section 303(d) List of Impaired Water Bodies. The water bodies are segments 510711 and 518211 of the Pearl River, MSSTRONGE1 of the Strong River, 514811 of Pretty Branch, and 515011 of Halls Creek. The recent monitoring data collected for these segments were assessed based on the 2007 *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. MDEQ selected fecal coliform as an indicator organism for pathogenic bacteria.

The impaired segments are located in several locations throughout the Pearl River Basin. Segment 510711 of the Pearl River flows in a south-easterly direction from MWS Boundary 5106 to the confluence of Weeks Mill Creek. Segment 518211 of the Pearl River flows in a south-westerly direction from the confluence with Big Creek to MWS Boundary 5184 below Highway 26. Segment MSSTRONGE1 flows in a south-westerly direction from its headwaters at Cambell Creek to its mouth at the Pearl River. Segment 514811 flows from its headwaters near Ferguson to its mouth at the Pearl River. Segment 515011 flows in a north-easterly direction and flows from its headwaters near Monticello to its mouth at the Pearl River. 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 TMDLs for all of the segments. All locations are shown Figure 1.

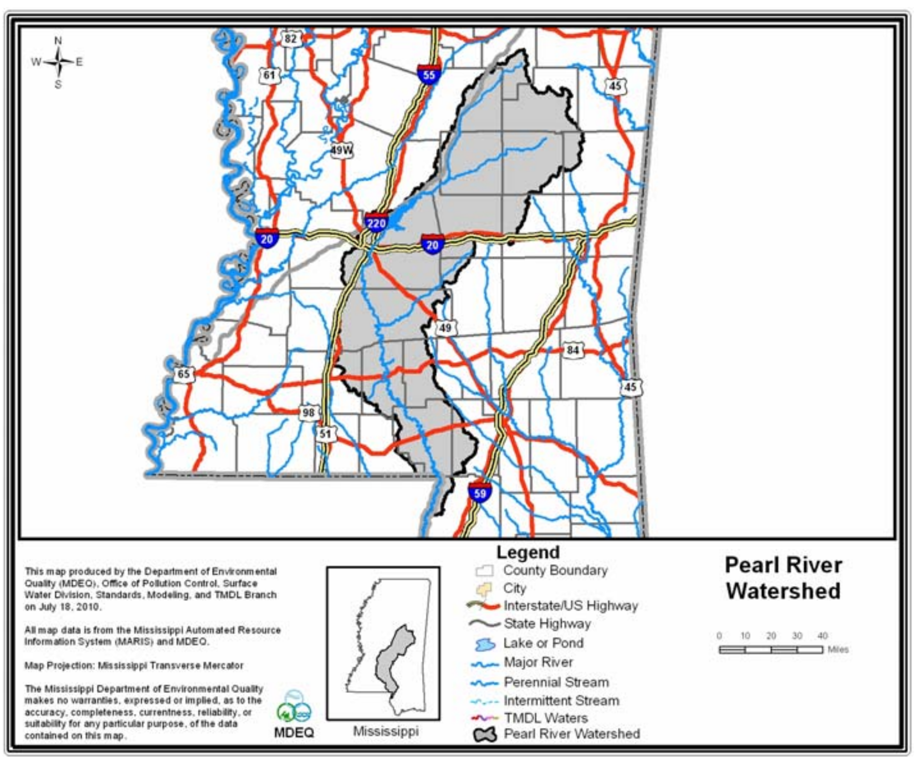


Figure 1. Location of the Pearl River Watershed

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 Pearl River Watershed. Nonpoint sources of fecal coliform may include wildlife, livestock, and urban/ developed areas. Also, considered were the nonpoint sources such as failing septic systems and other direct inputs into the Pearl River. There are 42 point sources in the wasteload allocation (WLA) for segment 510711 of the Pearl River, and there are 84 point sources in the WLA for segment 518211 including all point sources from segment 510711 of the Pearl River. There are also 8 point sources in the WLA segment for MSSTRONGE1, one point source in the WLA segment for 518411, and one point source for segment 515011.

The seasonal variations in hydrology, climatic conditions, and watershed activities are represented through the use of a seasonal TMDL based on average flows and seasonal monitoring. Although, violations occurred during both seasons for the impaired segments, the critical period was selected based upon the season that required a greater percent reduction to meet water quality standards. The critical period for segments 510711 and 518211 was the winter season since a greater reduction was needed to meet the water quality standard. The percent reductions needed for the segments, respectively were 75% and 70%. The critical period for segments MSSTRONGE1, 518411, and 515011 was determined to be the summer season since a greater reduction was needed to meet the water quality standard. The percent reductions needed for the segments, respectively were 68%, 63%, and 70%. An explicit 10% margin of safety (MOS) was used in the mass balance method to account for uncertainty.

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 is 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.

A TMDL has been developed for segments 510711 and 518211 of the Pearl River, segment MSSTRONGE1 of the Strong River, 514811 of Pretty Branch, and 515011 of Halls Creek. All segments, shown in Figure 2, are listed on the Draft Mississippi 2010 Section 303(d) List of Impaired Water Bodies for pathogens. The fecal coliform data that were recently collected for these segments are listed in Section 2.2.

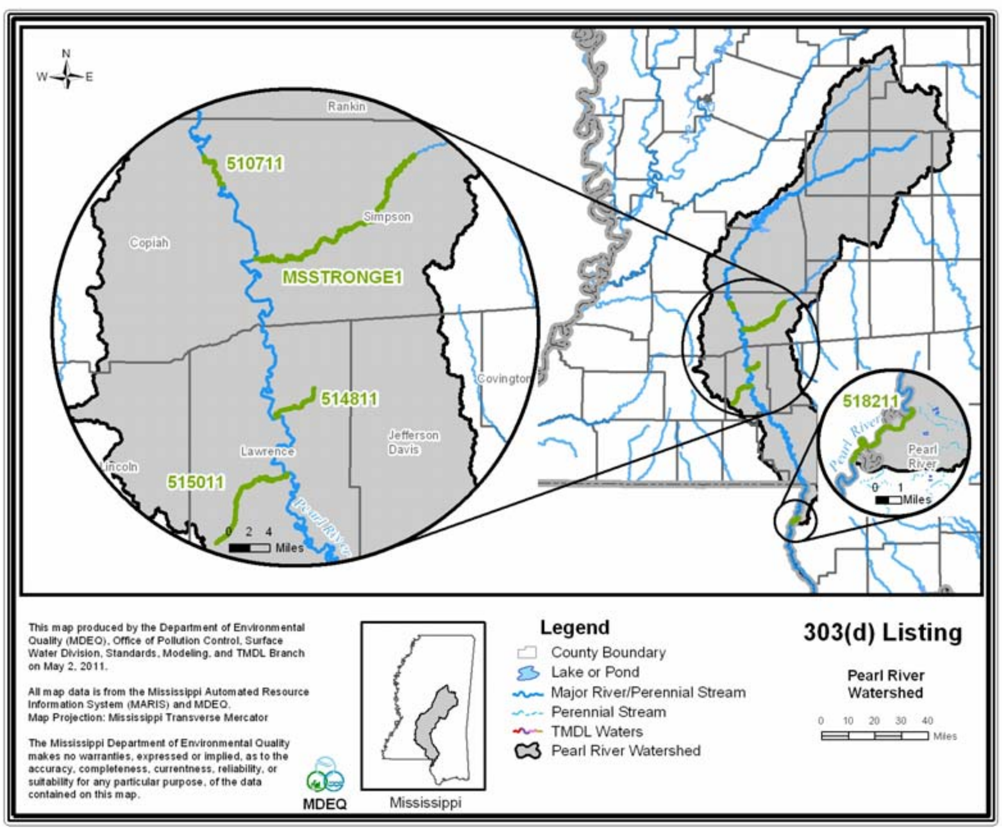


Figure 2. Pearl River Watershed Segments

The mass balance method is an applicable method for TMDL development when the water quality data are collected in a manner consistent with the water quality standards (5 samples collected within a 30 day period). The mass balance method requires water quality data and flow data. The water body segments are shown in Figure 3. The TMDLs for the segments were developed using the mass balance method with water quality data from the stations shown in Table 1.

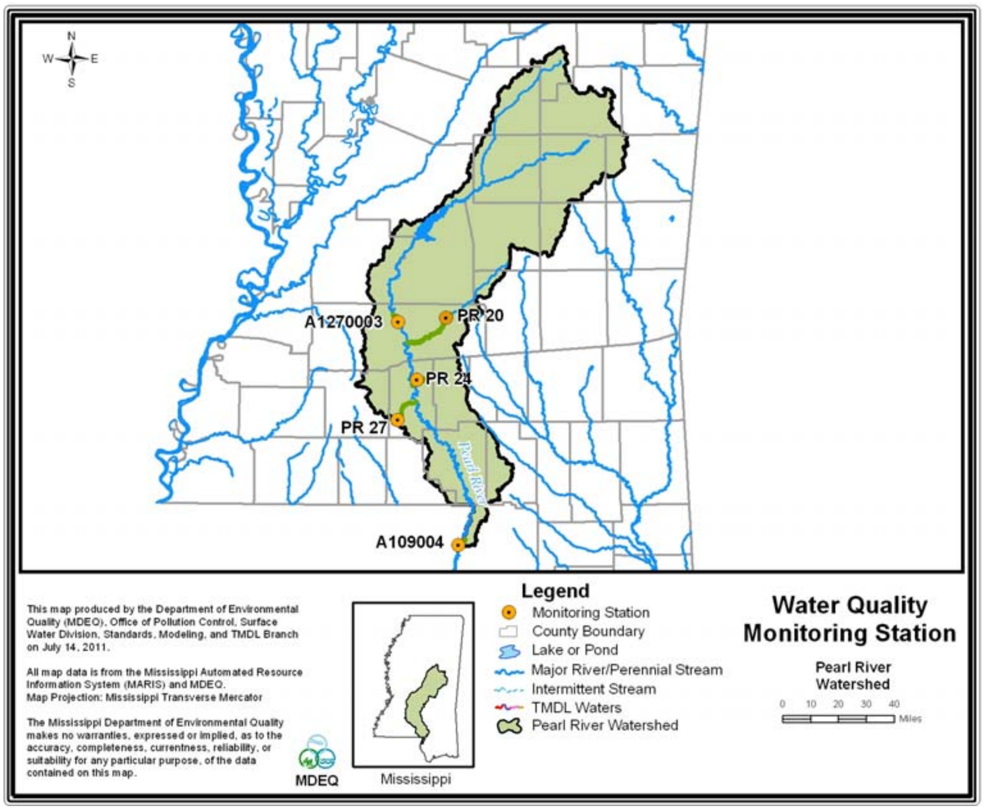


Figure 3. Pearl River Watershed with Water Quality Gages

Table 1. Annual Average Flows for Impaired Segments

Station ID	Water body Name	Water body ID	Average Annual Flows (cfs)
A1270003	Pearl River	510711	4,650
A1090004	Pearl River	518211	8,132
PR-24	Pretty Branch	514811	30
PR-20	Strong River	MSSTRONGE1	882
PR-27	Halls Creek	515011	57

The entire watershed is approximately 4,034,489 (6303.9 square miles) and is primarily forest.

1.2 Applicable Water Body Segment Use

The water use classification as established by the State of Mississippi in the *Water Quality Criteria for Intrastate, Interstate and Coastal Waters (WPC-2) regulation* for the 2 listed segments of the Pearl River and the Strong River is recreation. The water use classification for Pretty Branch and Halls Creek is Fish and Wildlife 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 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 WPC-2* (MDEQ, 2007). The standard for fecal coliform can be categorized as primary contact recreation or secondary contact recreation.

For primary contact recreation, the fecal coliform standard is the same year round. 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.

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 maximum allowable level of fecal coliform 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. This water quality standard was used to assess the data to determine impairment in the water body.

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. MDEQ's 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 indicate acceptable water quality.

The geometric mean test states that for primary contact recreation, the annual 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 10% test states that for the annual fecal coliform colony, 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.

The geometric mean test states that for secondary contact recreation, the summer 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 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 (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 to the sample filtered.

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 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 counts per 100 ml annually for primary contact recreation and less than or equal to 200 counts per 100 ml in the summer and 2000 counts per 100 ml in winter for secondary contact recreation.

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 1^{st} data point and the highest data point becomes the n^{th} 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 annually for primary contact recreation and 400 counts per 100 ml in summer and 4000 counts per 100 ml in winter for secondary contact recreation.

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 data violates the criteria and 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 2. 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 capacity curve. This curve can be seen in Figure 4. The integral of the theoretical capacity 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 can be calculated.

When actual data violate both portions of the standard, 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 2. Theoretical Capacity Data Set

Fecal Coliform (counts/100ml)	Percentile Ranking
37.82	0.0%
52.75	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	52.7%
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%

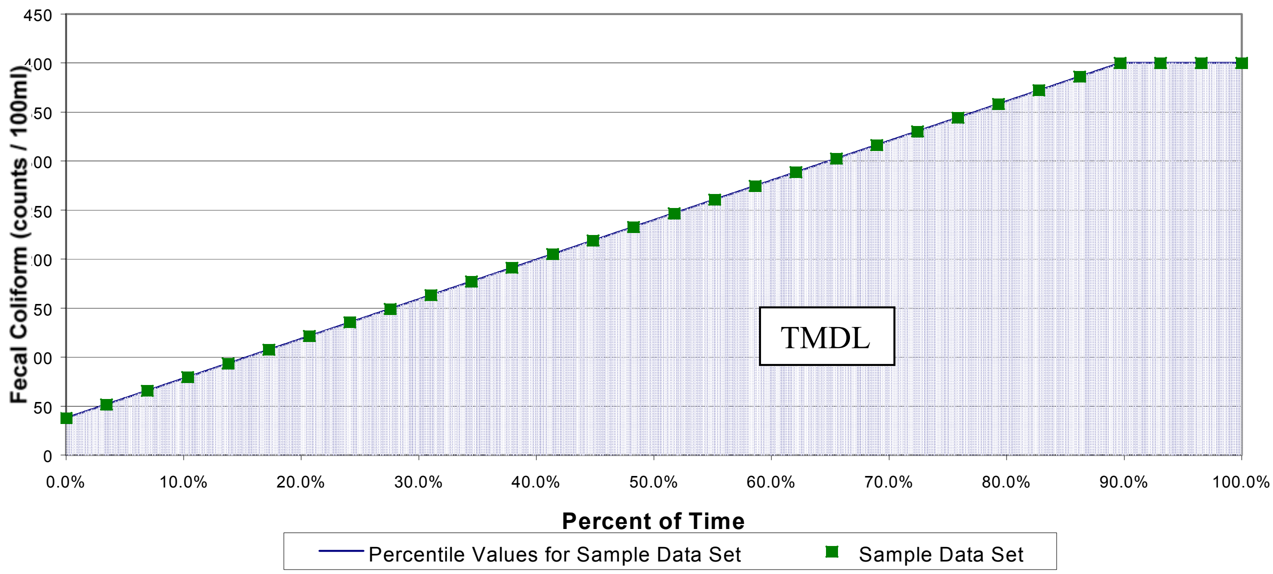


Figure 4. Theoretical Capacity Curve

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 to a considered 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. However, critical conditions for point source dominated systems generally occur during periods of low flow, low dilution conditions. Therefore, an 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

Monitoring was performed in a manner consistent with the water quality standards. At least 5 samples were collected in a 30-day period, at all of the water quality monitoring stations. The collection dates range from 2001 through 2008.

2.2.1 Inventory of Available Water Quality Monitoring Data

The data collected at Stations A1270003 and A1090004 (Pearl River), PR-24 (Pretty Branch), PR-20 (Strong River), and PR-27 (Halls Creek) are provided in Tables 3 through 17.

Table 3. Fecal Coliform Data reported in the Pearl River, Station A1270003 Winter 2008

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Test Violation	90th Percentile	10% Test Violation
1/14/08	420	340.6	Yes, geometric mean is >200	1600	Yes, 90th percentile is >400
1/28/08	900				
2/11/08	73				
2/20/08	590				
2/25/08	460				
2/27/08	230				
3/3/08	110				
3/5/08	4400				

Table 4. Fecal Coliform Data reported in the Pearl River, Station A1270003 Summer 2007

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Test Violation	90th Percentile	10% Test Violation
6/13/07	14	138	No, geometric mean is <200	833	Yes, 90th percentile is >400
6/18/07	60				
6/27/07	23				
7/2/07	23				
7/9/07	600				
7/19/07	1233				
7/23/07	590				
7/25/07	197				
7/27/07	833				
7/30/07	42				
8/1/07	260				

Table 5. Fecal Coliform Data reported in the Pearl River, Station A1270003 Summer 2008

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Test Violation	90th Percentile	10% Test Violation
7/1/08	87	25	No, geometric mean is <200	63	No, 90th percentile is <400
7/15/08	16				
7/17/08	14				
7/22/08	17				
7/24/08	20				
7/29/08	39				

Table 6. Fecal Coliform Data reported in the Pearl River, Station A1090004
Winter 2008

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Test Violation	90th Percentile	10% Test Violation
1/22/08	1667	369	Yes, geometric mean is >200	1333	Yes, 90th percentile is >400
1/29/08	833				
1/31/08	400				
2/7/08	183				
2/14/08	67				

Table 7. Fecal Coliform Data reported in the Pearl River, Station A1090004
Summer 2007

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Test Violation	90th Percentile	10% Test Violation
8/22/07	26	35	No, geometric mean is <200	79	No, 90th percentile is <400
8/30/07	37				
9/4/07	67				
9/6/07	47				
9/11/07	7				
9/13/07	90				

Table 8. Fecal Coliform Data reported in the Pearl River, Station A1090004
Summer 2008

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Test Violation	90th Percentile	10% Test Violation
8/28/08	7	27	No, geometric mean is <200	216	No, 90th percentile is <400
9/9/08	33				
9/16/08	12				
9/18/08	12				
9/23/08	400				
9/26/08	33				

Table 9. Fecal Coliform Data reported in Pretty Branch, Station PR-24
Summer 2001

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Test Violation	90th Percentile	10% Test Violation
09/25/01	150	58	No, geometric mean is <200	160	No, 90th percentile is <400
09/26/01	19				
10/01/01	31				
10/03/01	170				
10/08/01	27				
10/11/01	100				

Table 10. Fecal Coliform Data reported in Pretty Branch, Station PR-24 Winter 2003

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Test Violation	90th Percentile	10% Test Violation
3/25/2003	62	81	No, geometric mean is <2000	120	No, 90th percentile is <4000
3/27/2003	96				
3/31/2003	83				
4/2/2003	46				
4/4/2003	92				
4/14/2003	143				

Table 11. Fecal Coliform Data reported in Pretty Branch, Station PR-24 Summer 2003

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Test Violation	90th Percentile	10% Test Violation
7/9/2003	1367	395	Yes, geometric mean is >200	1100	Yes, 90th percentile is >400
7/11/2003	170				
7/14/2003	370				
7/16/2003	160				
7/18/2003	700				

Table 12. Fecal Coliform Data reported in the Strong River, Station PR-20 Summer 2001

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Test Violation	90th Percentile	10% Test Violation
09/21/01	150	79	No, geometric mean is <200	129	No, 90th percentile is <400
09/24/01	92				
09/26/01	108				
10/01/01	96				
10/02/01	42				
10/08/01	42				

Table 13. Fecal Coliform Data reported in the Strong River, Station PR-20 Winter 2003

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Test Violation	90th Percentile	10% Test Violation
3/24/2003	65	89	No, geometric mean is <200	130	No, 90th percentile is <400
3/26/2003	83				
3/28/2003	117				
4/1/2003	67				
4/3/2003	84				
4/14/2003	143				

Table 14. Fecal Coliform Data reported in the Strong River, Station PR-20
Summer 2003

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Test Violation	90th Percentile	10% Test Violation
7/16/2003	80	222	Yes, geometric mean is >200	1265	Yes, 90th percentile is >400
7/21/2003	173				
7/29/2003	58				
7/31/2003	530				
8/8/2003	2000				
8/12/2003	140				

Table 15. Fecal Coliform Data reported in Halls Creek, Station PR-27
Summer 2001

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Test Violation	90th Percentile	10% Test Violation
09/25/01	70	151	No, geometric mean is <200	598	Yes, 90th percentile is >400
09/26/01	35				
10/01/01	120				
10/03/01	120				
10/08/01	720				
10/11/01	475				

Table 16. Fecal Coliform Data reported in Halls Creek, Station PR-27
Winter 2003

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Test Violation	90th Percentile	10% Test Violation
3/25/2003	100	95	No, geometric mean is <2000	156	No, 90th percentile is <4000
3/27/2003	145				
3/31/2003	54				
4/2/2003	77				
4/4/2003	73				
4/15/2003	167				

Table 17. Fecal Coliform Data reported in Halls Creek, Station PR-27
Summer 2003

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Test Violation	90th Percentile	10% Test Violation
7/9/2003	1933	424	Yes, geometric mean is >200	1364	Yes, 90th percentile is >400
7/11/2003	210				
7/14/2003	510				
7/16/2003	133				
7/18/2003	500				

2.2.2 Analysis of Instream Water Quality Monitoring Data

The data collected shows violations of the standard for all stations. Each season that violated the standard was given a percent reduction. At stations A1270003 and A1090004, the winter of 2008 data sets presented the greatest reduction for segments 510711 and 518211 of the Pearl River, respectively. At stations PR-24, PR-20, PR-27, the summer of 2003 data sets presented the greatest percent reductions for segments 514811, MSSTRONGE1, and 515011, respectively. The graphs for each station are shown in Figures 5-9.

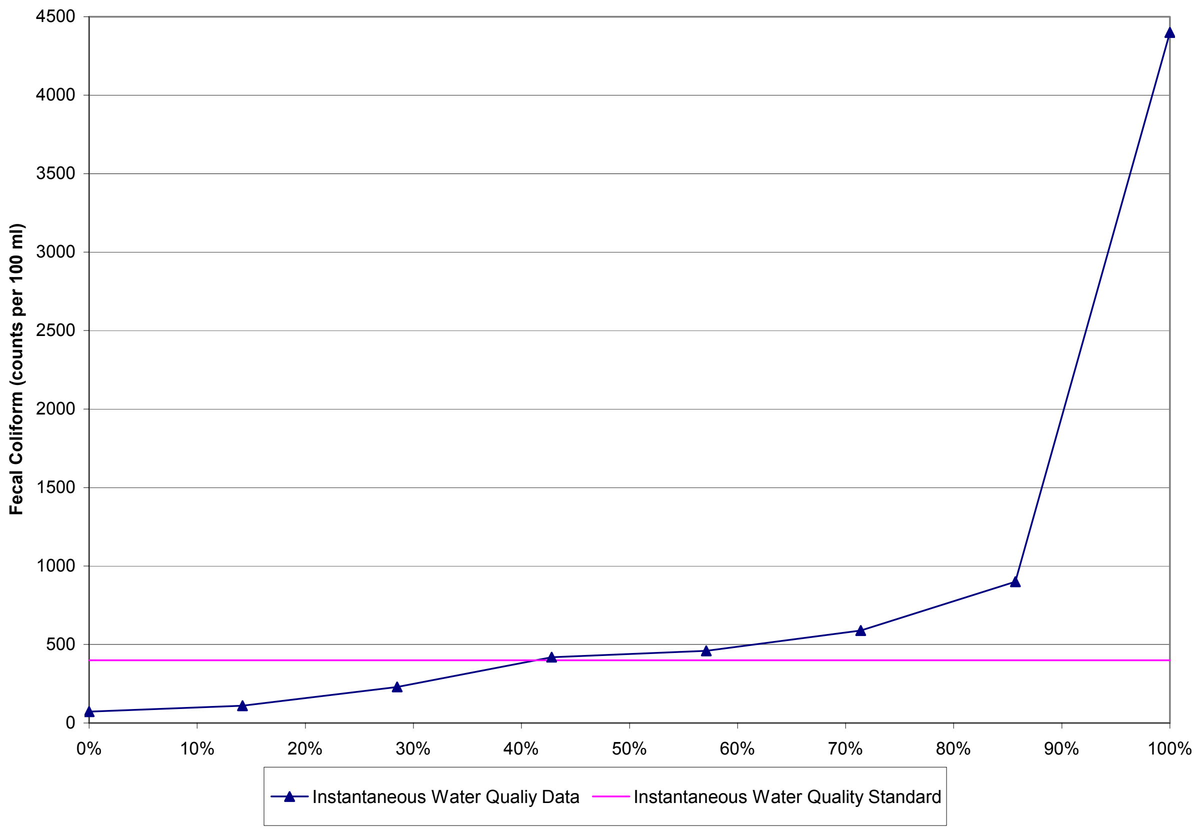


Figure 5. 10% Test Curve for Station A1270003, Winter 2008

Figure 6. 10% Test Curve for Station A1090004, Winter 2008

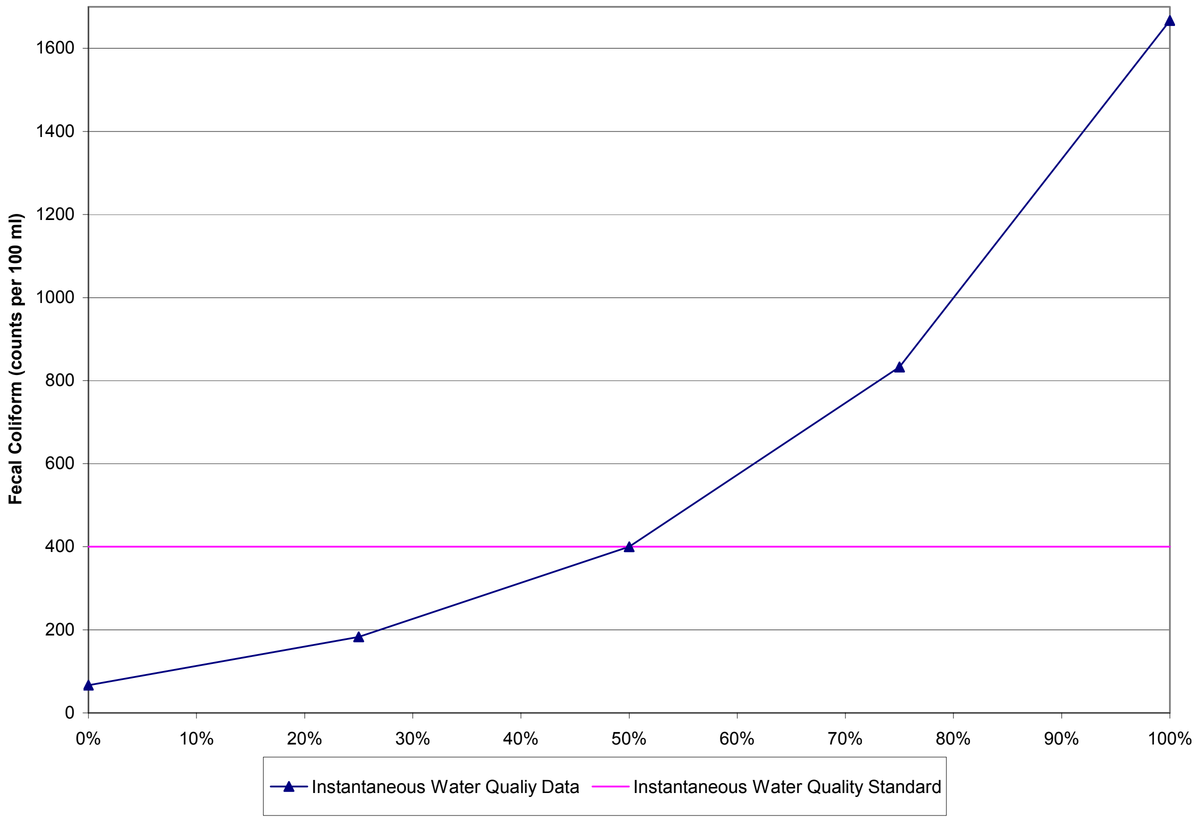


Figure 7. 10% Test Curve for Station PR-24, Summer 2003

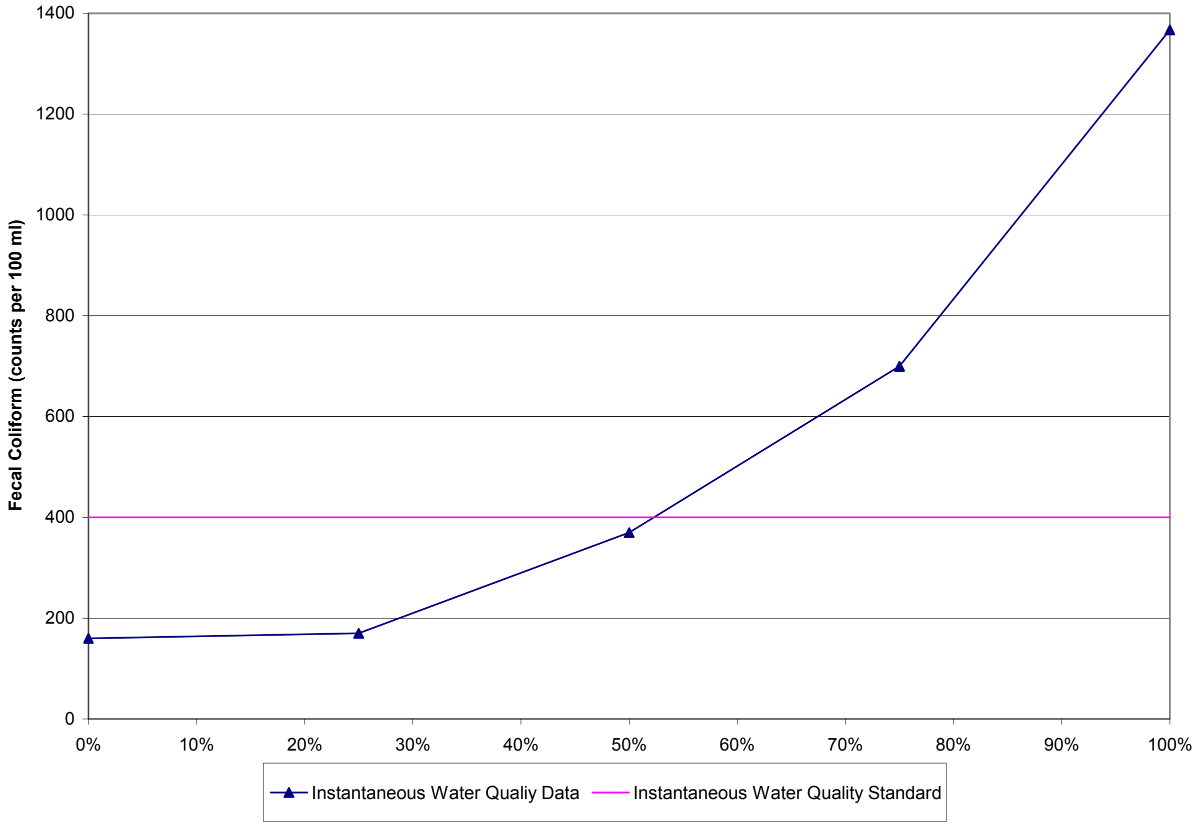


Figure 8. 10% Test Curve for Station PR-27, Summer 2003

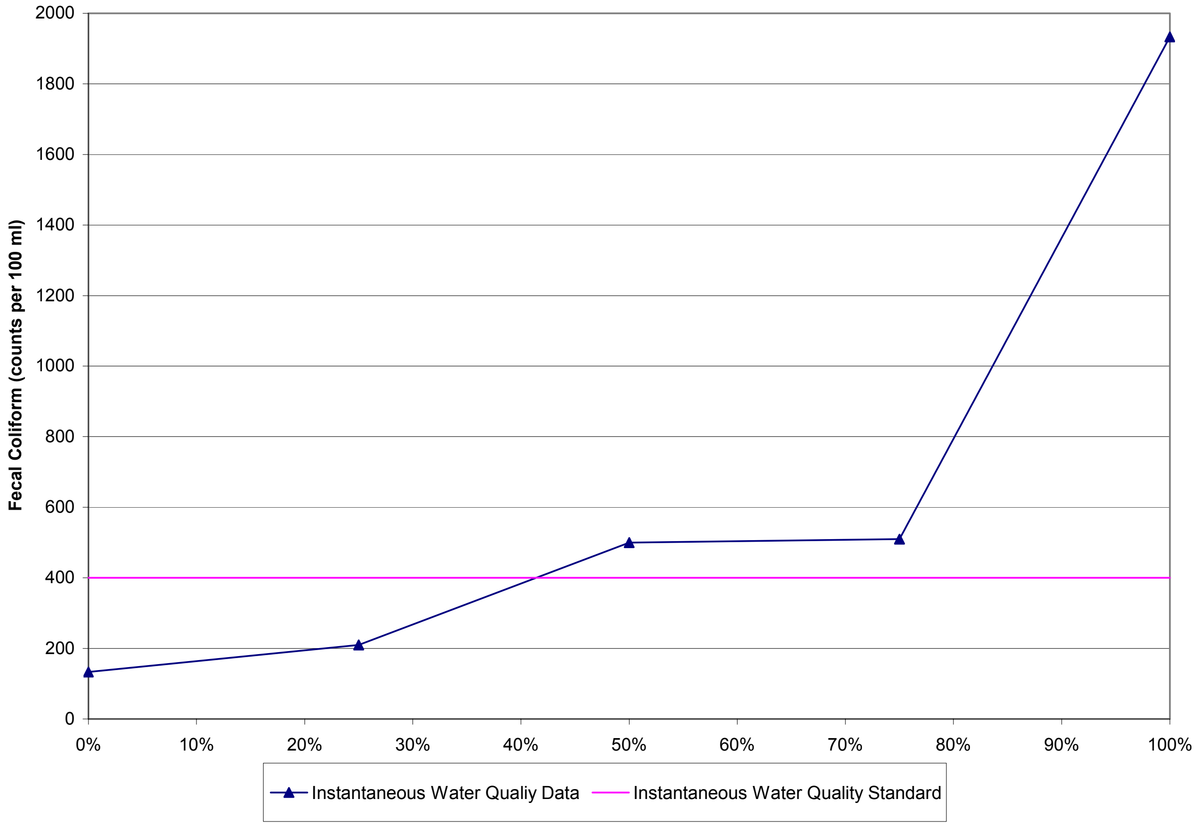
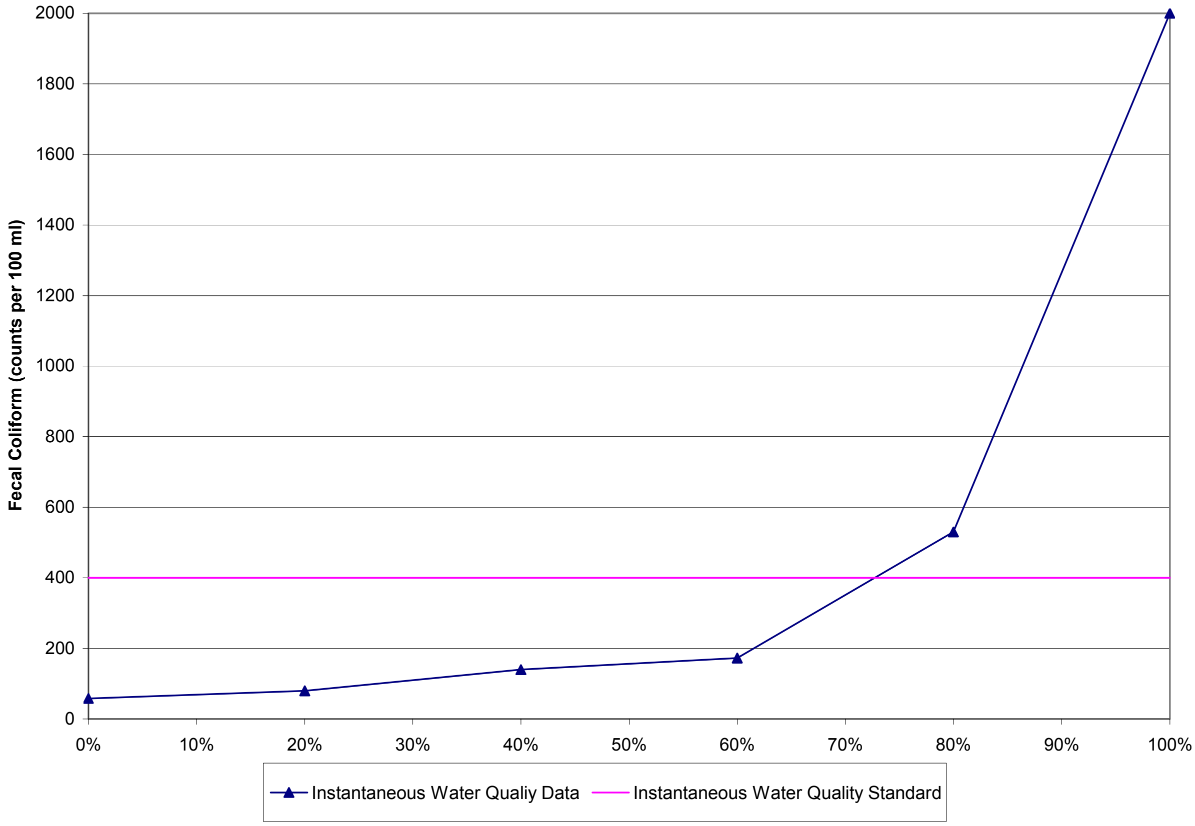


Figure 9. 10% Test Curve for Station PR-20, Summer 2003



SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential fecal coliform sources in the Pearl River 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, an evaluation of point sources that discharge fecal coliform bacteria was necessary in order to quantify the degree of impairment present during low flow periods. There are 128 permitted point sources in the watershed. However, only 83 of them will be utilized to calculate the fecal loads for the impaired segments. All of the point sources above the reservoir were considered negligible based upon data collected by the Mississippi Department of Health and will not be used for any calculations in this TMDL report for the Pearl River Watershed. The data are being summarized in a report by FTN Associates, Ltd that is for the Ross Barnett Reservoir Monitoring Plan Initiative. All of the point sources are shown in Figure 10 and are denoted in different colors to indicate if they are located above or below the reservoir. A full list of the point sources is given in Tables 18-22.

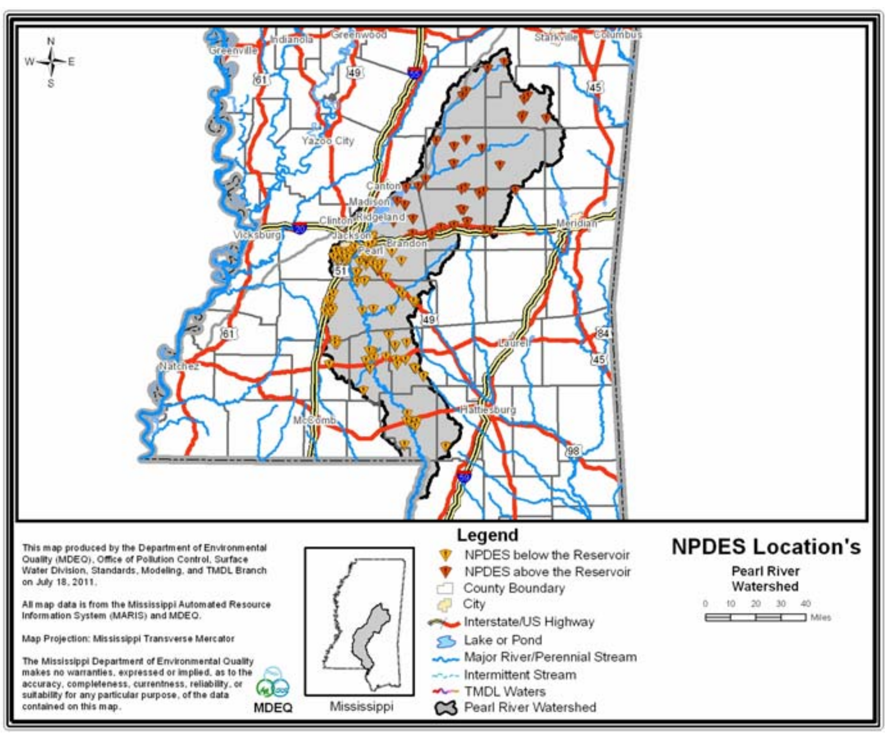


Figure 10. Pearl River Watershed NPDES Permitted Facilities

Table 18. Point Sources Above Reservoir (Not included in TMDL calculations)

NPDES	Permit Number
Ackerman POTW	MS0020575
Attala County Schools, Greenlee Elementary School	MS0032158
Carthage POTW	MS0020061
Ethel POTW	MS0024791
Forest POTW	MS0020362
Lady Forest Farms Inc, Forest Hatchery	MS0056103
Lake POTW	MS0025194
Leake County Board of Education, Edinburg Attendance Center	MS0029777
Leake County Board of Education, Thomastown Attendance Center	MS0030066
Lees Steakhouse	MS0048194
Louisville Municipal School District, Nanih Waiya School	MS0038768
Louisville POTW, East	MS0025640
MDOT, Interstate 20 West, Rest Area, Scott	MS0028347
Mississippi Department of Wildlife Fisheries and Parks, Roose	MS0028398
Mississippi Poultry Corporation	MS0037486
Mississippi Poultry Corporation	MS0060275
Natchez Trace Parkway, River Bend Comfort Station	MS0040622
Neshoba County Fair Association, Neshoba County Fairgrounds	MS0044920
Noxapater POTW, North	MS0025241
Noxapater POTW, South	MS0021628
One Hundred Travel Center	MS0049034
Pearl River Valley Water Supply District, Lake Harbor	MS0025003
Pearl River Water Supply District, Coal Bluff Water Park	MS0054925
Pearl River Water Supply District, Leake County Water Park	MS0044113
Pearl River Water Supply District, Leake County Water Park	MS0044113
Pearl River Water Supply District, Leake County Water Park	MS0044113
Peco Foods Inc	MS0002615
Pelahatchie POTW, West	MS0021008
Rankin County School District, Pisgah High School	MS0034185
Renfroe Country Store	MS0061107
Reservoir East Subdivision	MS0035327
Scott County Schools, Scott Central Attendance Center	MS0038393
Sebastopol Water Association	MS0026727
Tyson Foods Inc, Carthage Processing Plant	MS0026140
Tyson Foods Inc, River Valley Animal Foods, Forest	MS0046931
Walnut Grove POTW	MS0020982
Weir POTW	MS0020435

Table 19. Point Sources Discharging Below Reservoir into Segment 510711 of Pearl River

NPDES	Permit Number
AAAG Mississippi LLC, dba Rea Brothers Mid South Auction	MS0059846
ABF Freight Systems Inc	MS0029122
Airgas Carbonic Inc, Star Plant	MS0060542
Autumn Light Personal Care Home	MS0023493
B and G Utilities Inc, Brookwood Subdivision	MS0031194
Briar Hill Rest Home LLC	MS0029726
Child Care Management Group, The Child Development Center	MS0045161
Cleary Heights POTW	MS0036307
Corporate Child Care Services Inc, Child Development Center	MS0045837
Craig Estates Mobile Home Park	MS0059927
David K May Office Building	MS0057819
Eddie Williams Mobile Home Park	MS0043621
First Presbyterian Church, Twin Lakes Conference Center	MS0056600
Florence POTW	MS0025275
Friends of Children of Mississippi Inc, New Hope Headstart Ce	MS0044547
G and J Enterprises LLC	MS0053821
Gulf South Pipeline Company, LP Jackson Compressor Station	MS0001724
Haney Commercial Building	MS0051063
High Place, The	MS0038971
Hinds County School District, Gary Road Elementary	MS0042099
Jackson POTW, Savanna Street	MS0024295
Jackson POTW, Trahon and Big Creek	MS0044059
King Rental Properties Inc	MS0058220
Ks Kids Learning Center Inc	MS0048488
M and S Trailer Park	MS0045527
McInnis Electric Company	MS0057711
MSBR Star LLC, West Quick Stop	MS0059340
Oakview Utility Company Inc, Rowan Oak Subdivision	MS0057835
Pine Ridge Mobile Home Park	MS0050482
Poole Subdivision	MS0039845
Rankin County School District, McLaurin Attendance Center	MS0038466
Raworth and Harvel LLC, Country View Estates Mobile Home Park	MS0047856
Red River Utility Company, Ridge Park, Wakeland Hills and Wil	MS0044792
Restoration Community Fellowship Church	MS0042579
Rolling Hills Wastewater Inc, Rolling Hills Subdivision	MS0040134
Sanctuary Golf Club	MS0033006
Siwell Utility Company Inc, Owens Road Subdivision	MS0051781
Siwell Utility Company Inc, Siwell Utility Company Treatment	MS0043541
Star View Mobile Home Park	MS0059382
Terry POTW	MS0025224
Total Environmental Solutions Inc, Woodland Acres Subdivision	MS0030252
W G Yates and Sons Construction Company, Heavy Division Offic	MS0059323

Table 20. Point Sources Discharging Below Reservoir and below Segment 510711 of Pearl River

NPDES	Permit Number
Bassfield POTW	MS0024848
Columbia POTW, North	MS0020222
Columbia POTW, South	MS0044164
Copiah County Industrial Park	MS0032921
Copiah Educational Foundation Inc, Copiah Academy	MS0022462
Crystal Springs POTW	MS0041874
D Lo POTW	MS0024821
Family Fish House	MS0050971
First Federal Service Corporation, Golden Age Estates	MS0053139
Five County Child Development Program Inc, Monticello Head St	MS0048143-001
Five County Child Development Program Inc, Monticello Head St	MS0048143-002
Five County Child Development Program Inc, Pinola Head Start	MS0053848
Forbes Meat Processing	MS0037192
Foxworth POTW	MS0043656
Georgetown POTW	MS0020605
Georgia Pacific Monticello LLC	MS0002941-001A
Georgia Pacific Monticello LLC	MS0002941-001B
Hazlehurst POTW, Activated Sludge	MS0023922
Howard Industries Inc	MS0056731
Lamar County School District, Baxterville Attendance Center	MS0038423
Lampton Sewer District POTW	MS0061379
Lawrence County School District, Topeka Tilton Attendance Cen	MS0028240
Lily Rose Water Association Inc, Stamps Subdivision	MS0038989
Marion County School District, East Marion High School	MS0033774
Mendenhall POTW	MS0021539
Mississippi Department of Wildlife Fisheries and Parks, Lake	MS0036871
Mississippi Regional Housing, Dan Stepney Homes	MS0042145
Monticello POTW	MS0024643
Morton POTW	MS0036234
New Hebron POTW	MS0020729
Piney Woods Country Life School	MS0037541
Polks Meat Products Inc, Prentiss Plant	MS0037109
Prentiss POTW	MS0029033
Rock Hill Baptist Church	MS0052744
Sanderson Farms Inc, Hazlehurst Processing Division	MS0044725
Sanderson Farms Inc, Monticello	MS0055492
Silver Creek POTW	MS0025453
Simpson County School District, Simpson Central School	MS0033626
Sophia Sutton Mission Assembly	MS0047031
Southwest Mississippi Mental Health Foundation Inc, New Haven	MS0058508
Speights Trailer Park	MS0036579
Timberlanes Camp and Dude Ranch	MS0034894

Table 21. Point Sources Discharging to MSSTRONGE1 (Strong River)

NPDES	Permit Number
Simpson County School District, Simpson Central School	MS0033626
Piney Woods Country Life School	MS0037541
D Lo POTW	MS0024821
Rock Hill Baptist Church	MS0052744
Mendenhall POTW	MS0021539
Howard Industries Inc	MS0056731
Five County Child Development Program Inc, Pinola Head Start	MS0053848
Morton POTW	MS0036234

Table 22. Point Sources Discharging to 514811 (Pretty Branch)

NPDES	Permit Number
Georgia Pacific Monticello LLC	MS0002941-001B

Table 23. Point Sources Discharging to 515011 (Halls Creek)

NPDES	Permit Number
Monticello POTW	MS0024643

3.2 Assessment of Nonpoint Sources

There are many potential nonpoint sources of fecal coliform bacteria for the Pearl River including:

- Beef and dairy cattle
- Failing septic systems
- Urban/ developed areas
- Wildlife
- Other direct inputs

The approximately 4,034,489 acre drainage area of the Pearl River watershed contains many different land use types, including urban, forest, cropland, pasture, scrub/barren, water, and wetlands. The predominant landuse in the watershed is forest. The land use distribution for the watershed is provided in Table 24 and displayed in Figure 11. The land use for the Pearl River Watershed is gathered from the National Land Cover Database (NLCD). The land use categories were grouped into the following uses: urban, forest, cropland, pasture, scrub/ barren, water, and wetlands.

Table 24. Land Use Distribution (acres)

	Water	Urban	Forest	Scrub/Barren	Pasture	Cropland	Wetland
Area (acres)	56,715	277,799	1,923,448	474,473	626,133	91,605	584,316
% Area	1.4%	6.9%	47.7%	11.8%	15.5%	2.3%	14.5%

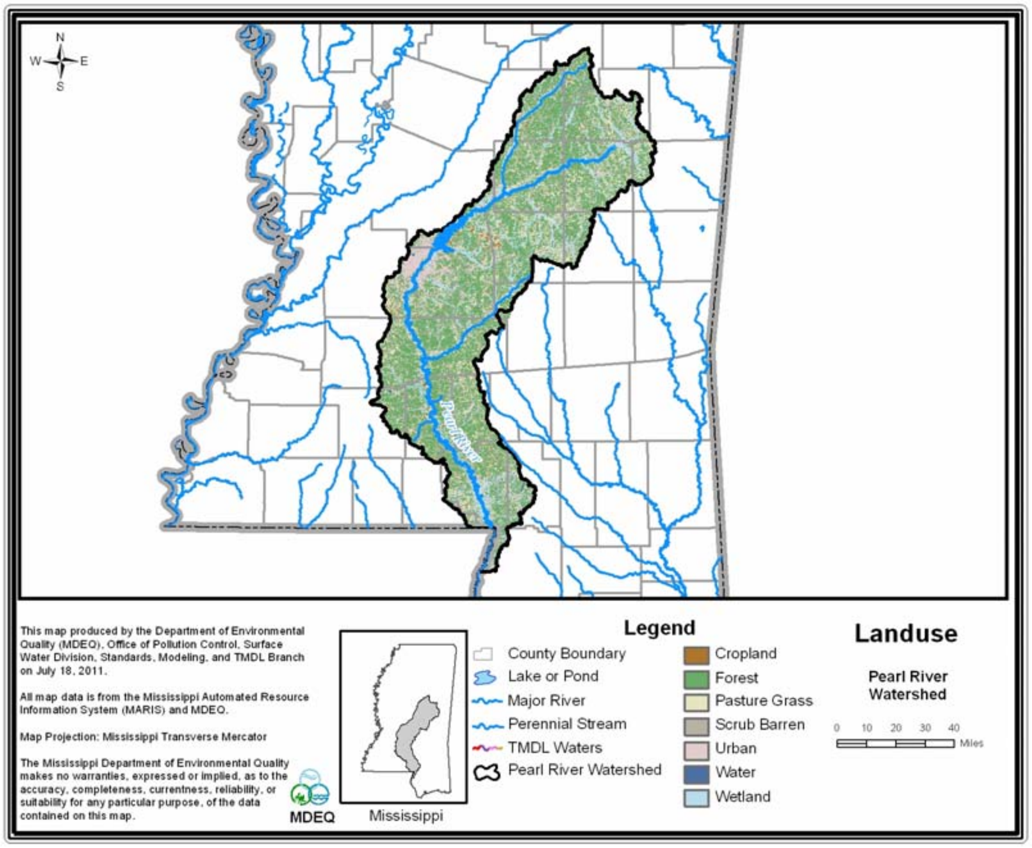


Figure 11. Land Use Distribution Map for the Pearl River Watershed

3.2.1 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.

Large dairy farms, over 200 head, typically confine the milking herd at all times. 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.

The *2007 Census of Agriculture* (USDA, 2009) produced by the National Agriculture Statistics Service (NASS) was used to estimate the number of cattle in the watershed. The cattle are primarily beef cattle, heifers, steers, and bulls. The impaired Pearl River segments are located in Copiah and Pearl River Counties. The impaired segment of the Strong River is in Simpson County and the impaired segments of Pretty Branch and Halls Creek are in Lawrence County. In Copiah County, there are 299 farms with a total of 13,561 head of cattle. Most of the farms have less than 500 head of cattle. There is only one farm that has greater than 500 head of cattle. In Pearl River County, there are 480 farms with a total of 27,175 head of cattle. Most of the farms have less than 500 head of cattle. There are only four farms that have greater than 500 head of cattle. In Simpson County, there are 345 farms with a total of 22,639 head of cattle. Most of the farms have less than 500 head of cattle. There are only three farms that have greater than 500 head of cattle. In Lawrence County, there are 232 farms with a total of 11,895 head of cattle. Most of the farms have less than 500 head of cattle. There is only one farm that has greater than 500 head of cattle.

3.2.2 Land Application of Hog Manure

Processed manure from confined hog operations is usually collected in lagoons and routinely applied to pastureland according to the management practices used in the area. 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. This manure is a potential contributor of bacteria to receiving water bodies due to runoff produced during a rain event.

Data from the *2007 Census of Agriculture* (USDA, 2009) produced by the NASS indicate there are 10 hog farms in Copiah County one of which has over 1,000 hogs. In Pearl River County, there are 29 hog farms. Twenty-seven of them have between 1 and 24 hogs. The remaining hog farms in Pearl River County have less than 50 hogs each. In Simpson County, there are 4 hog farms one of which has between 500-999 hogs. The remaining hog farms in Simpson County have less than 50 hogs each. In Lawrence County, there are 12 hog farms. Eleven of them have between 1 and 24 hogs.

3.2.3 Land Application of Poultry Litter

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. Typically, the dry waste accumulated in the poultry houses is "de-caked" between flocks unless a disease situation warrants clean-out before the change of flocks. During "de-caking", approximately the top two inches of litter is removed. Every year or two, the middle third of the poultry house is removed and the remaining litter is spread evenly in the house. 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.

Layer chickens are confined at all times and remain on farms for ten months or longer. Large scale layer operations collect the chicken waste in a lagoon and periodically apply the waste to corn fields. The application rates vary monthly from the spring through the early fall. There are 51 poultry farms in Copiah County. These farms raise layers, pullets and broilers. Twenty-three of the farms have less than 50 layers. The other farms have less than 50 broilers or pullets each. In Pearl River County, there are 98 poultry farms that raise layers, pullets and broilers. Eighty-two farms have less than 50 layers, and two have less than 100 layers. The remaining farms have less than 200 birds each. In Simpson County, there are 145 poultry farms that raise layers, pullets and broilers. Forty-three farms have layers. Five of these farms have between 50,000 and 99,999 layers. Ten farms have between 20,000 and 49,999 layers. The remaining farms have a combined total of nearly 11.5 million birds. In Lawrence County, there are 64 poultry farms that raise layers, pullets and broilers. Thirty-two of the farms have layers. Three of these farms have between 20,000 and 49,999 layers. Twenty-nine of the farms have less than 20,000 layers. The remaining farms have a combined total of over 5 million birds.

3.2.4 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 and dispose of wastewater 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.

3.2.5 Urban / Developed Areas

Land classified as urban in the Pearl River Watershed is primarily representative of transportation corridors and does not represent land use activities associated with urban / developed areas that would contribute fecal coliform.

3.2.6 Wildlife

Wildlife present in the Pearl River Watershed contributes to fecal coliform bacteria on the land surface which is then available for wash-off and delivery to receiving water bodies. Some form of wildlife may be present on all land uses within the watershed. Also, wildlife is present throughout the year.

3.2.7 Other Direct Inputs

Other direct inputs of fecal coliform bacteria to water bodies in the Pearl River Watershed could include illicit discharges, human recreation, leaking sewer collection lines, 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 the impaired segment in the watershed. This method of analysis was selected because data limitations precluded the use of more complex methods. The mass balance approach is suitable for this TMDL.

4.2 Calculation of the 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 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:

$$\text{Load}\,(\textit{counts per day}) = \text{AverageDailyCapacity}\left(\frac{\text{day}\cdot\text{counts}}{100\,\text{ml}}\right)\times \text{Flow (cfs)} * \text{ConversionFactor}$$

$$\text{when Conversion Factor} = \left(\frac{28316.8\text{ml}}{\text{ft}^3}\right)\times\left(\frac{100\text{ml}}{100\text{ml}}\right)\times\left(\frac{60\text{s}}{1\text{min}}\right)\times\left(\frac{60\text{min}}{1\text{hr}}\right)\times\left(\frac{24\text{hr}}{1\text{day}}\right)$$

$$= 2.45E+07\left(\frac{100\,\text{ml}\cdot\text{s}}{\text{ft}^3\cdot\text{day}}\right)$$

The first step in calculating the average daily capacity is to calculate the theoretical 30 day capacity, as shown in the equation below, by taking the integral of the theoretical capacity curve shown in Figure 4.

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

The average daily capacity is then computed by dividing the theoretical 30 day capacity by 30.

$$\text{Average Daily Capacity} = \left(\frac{\mathbf{7129.4}\ (\text{day} * \text{counts}/100\ \text{ml})}{30} \right) = 237.65\ (\text{day} * \text{counts}/100\ \text{ml})$$

4.3 Calculation of the Percent Reduction

For the calculation of the percent reduction, the area under the 10% Test Curve for each season that violates both portions of the standard (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 data 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.

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

For a season which only violates one portion of the standard, the percent reduction will only be based on the violating portion. The percent reduction calculation for a data set that violates the geometric mean portion of the standard follows.

$$\text{Percent Reduction} = \left(1 - \frac{\text{Geometric Mean of 200 mg/L}}{\text{Actual Greometric Mean of Violating Data Set}} \right) * 100$$

The same could be done for a data set that only violates the 10% of the time portion of the standard.

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

There are 82 NPDES point sources included in this report for the Pearl River Watershed which includes the Pearl River, Pretty Branch, the Strong River, and Halls Creek. Future permits will be considered in accordance with Mississippi's *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*.

5.2 Load Allocations

The load allocations for the impaired segments are calculated using the water quality criteria and the average annual 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 and the WLA component.

For the TMDL for segment 510711, the load is based on the average daily capacity and the average annual flow of 4650 cfs. The resulting LA is estimated to be 2.39E+13 counts per day.

LA = 0.9*237.65(day*counts/100ml)* 4650 (cfs) * 2.45E+07[(100ml*s)/(ft^3 *day)] – 4.28E+11 WLA

LA = 2.39E+13 (counts per day)

For the TMDL for segment 518211, the load is based on the average daily capacity and the average annual flow of 8132 cfs. The resulting LA is estimated to be 4.14E+13 counts per day.

LA = 0.9*237.65(day*counts/100ml)* 8132 (cfs) * 2.45E+07[(100ml*s)/(ft^3 *day)] – 1.21E+12 WLA

LA = 4.14E+13 (counts per day)

For the TMDL for segment 514811, the load is based on the average daily capacity and the average annual flow of 30 cfs. The resulting LA is estimated to be 6.59E+10 counts per day.

LA = 0.9*237.65(day*counts/100ml)* 30 (cfs) * 2.45E+07[(100ml*s)/(ft^3*day)] – 9.13E+10 WLA

LA = 6.59E+10 (counts per day)

For the TMDL for segment MSSTRONGE1, the load is based on the average daily capacity and the average annual flow of 882 (cfs). The resulting LA is estimated to be 4.59E+12 counts per day.

LA = 0.9*237.65(day*counts/100ml)* 882 (cfs) * 2.45E+07[(100ml*s)/(ft^3*day)] – 2.80E+10 WLA

LA = 4.59E+12 (counts per day)

For the TMDL for segment 515011, the load is based on the average daily capacity and the average annual flow of 57 cfs. The resulting LA is estimated to be 2.71E+11 counts per day.

LA = 0.9*237.65(day*counts/100ml)* 57 (cfs) * 2.45E+07[(100ml*s)/(ft^3*day)] – 2.80E+10 WLA

LA = 2.71E+11 (counts per day)

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 the impaired segments, reducing the TMDL by 10% explicitly specifies the MOS.

For segment 510711, assuming the average flow, the resulting load attributed to the MOS is 2.70E+12 counts per day.

MOS = 0.1*237.65(day*counts/100ml)* 4650 (cfs) * 2.45E+07[(100ml*s)/(ft^3*day)]

MOS = 2.70E+12 (counts per day)

For segment 518211, assuming the average flow, the resulting load attributed to the MOS is 4.73E+12 counts per day.

MOS = 0.1*237.65(day*counts/100ml)* 8132 (cfs) * 2.45E+07[(100ml*s)/(ft^3*day)]

MOS = 4.73E+12 (counts per day)

For segment 514811, assuming the average flow, the resulting load attributed to the MOS is 1.75E+10 counts per day.

MOS = 0.1*237.65(day*counts/100ml)* 30 (cfs) * 2.45E+07[(100ml*s)/(ft^3*day)]

MOS = 1.75E+10 (counts per day)

For segment MSSTRONGE1, assuming the average flow, the resulting load attributed to the MOS is 5.13E+11 counts per day.

MOS = 0.1*237.65(day*counts/100ml)* 882 (cfs) * 2.45E+07[(100ml*s)/(ft^3*day)]

MOS = 5.13E+11 (counts per day)

For segment 515011, assuming the average flow, the resulting load attributed to the MOS is 3.31E+10 counts per day.

MOS = 0.1*237.65(day*counts/100ml)* 57 (cfs) * 2.45E+07[(100ml*s)/(ft^3*day)]

MOS = 3.31E+10 (counts per day)

5.4 Calculation of the TMDL

The TMDL for the impaired segments is calculated based on the following equation:

TMDL = WLA + LA + MOS

where WLA is the Wasteload 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 TMDLs for the impaired segments were calculated based on the average flow of the water body, and the average daily capacity. They are shown in Table 25. The necessary percent reduction of fecal coliform to segments is shown in Table 26 . These are based on the most critical data set for each segment.

For Segment 510711:

TMDL = 237.65(day*counts/100ml)* 4650 (cfs) * 2.45E+07[(100ml*s)/(ft^3*day)]

TMDL = 2.70E+13 (counts per day)

For Segment 518211:

TMDL = 237.65(day*counts/100ml)* 8132 (cfs) * 2.45E+07[(100ml*s)/(ft^3*day)]

TMDL = 4.73E+14 (counts per day)

For Segment 514811:

TMDL = 237.65(day*counts/100ml)* 30 (cfs) * 2.45E+07[(100ml*s)/(ft^3*day)]

TMDL = 1.75E+11 (counts per day)

For Segment MSSTRONGE1:

TMDL = 237.65(day*counts/100ml)* 882 (cfs) * 2.45E+07[(100ml*s)/(ft^3*day)]

TMDL = 5.13E+12 (counts per day)

For Segment 515011:

TMDL = 237.65(day*counts/100ml)* 57 (cfs) * 2.45E+07[(100ml*s)/(ft^3*day)]

TMDL = 3.31E+11 (counts per day)

Table 25. TMDL Summary for Segments 510711, 518211, 514811, MSSTRONGE1, and 515011 (counts per day)

	510711	518211	514811	MSSTRONGE1	515011
WLA	4.28E+11	1.21E+12	9.13E+10	2.80E+10	2.80E+10
LA	2.39E+13	4.14E+13	6.59E+10	4.59E+12	2.71E+11
MOS	2.70E+12	4.73E+12	1.75E+10	5.13E+11	3.31E+10
TMDL = WLA + LA +MOS	2.70E+13	4.73E+13	1.75E+11	5.13E+12	3.31E+11

Table 26. Percent Reductions for Impaired Segments

	510711	518211	514811	MSSTRONGE1	515011
% reduction	75%	70%	63%	68%	70%

5.5 Seasonality

For water bodies in the state, fecal coliform limits can vary according to designated use as well as the seasons. All of the streams were sampled during a summer and winter season to determine when or if violations occurred. The criterion for the most critical season for each impaired segment was used as the target for the TMDLs.

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.

CONCLUSION

The TMDL will not impact future NPDES Permits as long as the effluent is disinfected to meet water quality standards for fecal coliform. All permits that currently do not disinfect will be required to do so by their next permitting cycle. MDEQ will not approve any NPDES Permit application that does not plan to meet water quality standards for fecal coliform. Education projects that teach best management practices should be used as a tool for reducing nonpoint source contributions. These projects may be funded by CWA Section 319 Nonpoint Source (NPS) Grants.

6.1 Future Monitoring

MDEQ has adopted the Basin Approach to Water Quality Management, a plan that divides Mississippi's major drainage basins into four 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 Pearl River Basin, the Pearl River, the Strong River, Pretty Branch, and Halls 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. The public will be given an opportunity to review the TMDLs 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. Anyone wishing to become a member of the TMDL mailing list should contact Greg Jackson at gjackson@deq.state.ms.us.

All comments should be directed to Greg Jackson at gjackson@deq.state.ms.us or Greg Jackson, MDEQ, PO Box 2261, Jackson, MS 39225. 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.

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 water body 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 segment 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 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 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 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: $2.7X10^{4}$ = 2.7E+4 =27000 and $2.7X10^{-4}$ = 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, ($\mathbf{d_l}$, $\mathbf{d_2}$, $\mathbf{d_3}$) 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: (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 wasteload 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 form (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 antidegredation 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.1252 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

CAFO .... Concentrated Animal Feeding Operation

CWA .... Clean Water Act

DMR.. Discharge Monitoring Report

EPA .... Environmental Protection Agency

GIS .... Geographic Information System

HCR .... Hydrograph Controlled Release

HUC .... Hydrologic Unit Code

LA.. Load Allocation

MARIS .... Mississippi Automated Resource Information System

MDEQ.. Mississippi Department of Environmental Quality

MOS .... Margin of Safety

NRCS .... National Resource Conservation Service

NPDES .... National Pollution Discharge Elimination System

UNT .... Unnamed Tributary

USGS.. United States Geological Survey

WLA .... Wasteload Allocation

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