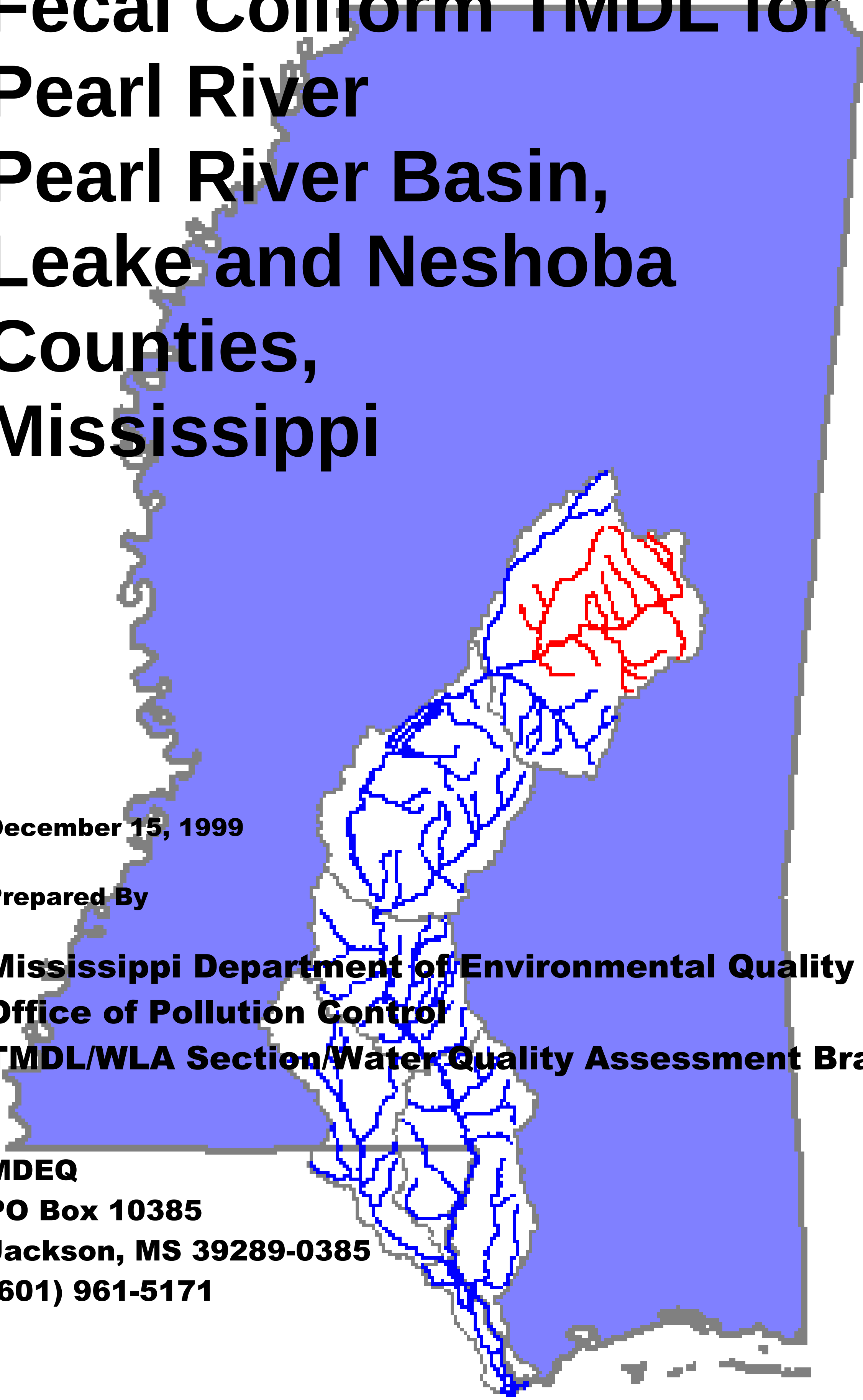
FINAL REPORT
December 1999
ID: 599121501

Fecal Coliform TMDL for Pearl River Pearl River Basin, Leake and Neshoba Counties, Mississippi



December 15, 1999

Prepared By

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CONTENTS

MONITORED SEGMENT IDENTIFICATION

Name:	Pearl River segment 1
Waterbody ID:	MSUPRLRM1
Location:	At Edinburg: from the confluence with Beasha Creek to the confluence with Standing Pine Creek
County:	Leake and Neshoba Counties, Mississippi
USGS HUC Code:	03180001
Length:	18 miles
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic organisms
Priority Rank:	73
NPDES Permits:	There are 9 NPDES Permits issued for facilities that discharge fecal coliform in the watershed (Table 3.1.1).
Standards Variance:	None
Pollutant Standard:	May through October - Geometric mean of 200 per 100 ml, Less than 10% of the samples may exceed 400 per 100 ml. November through April - Geometric mean of 2000 per 100 ml, Less than 10% of the samples may exceed 4000 per 100 ml.
Waste Load Allocation:	2.00E+12 counts per 30 day critical period (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	2.75E+12 counts per 30 day critical period
Margin of Safety:	Implicit modeling assumptions - The model was run for a time span of 11 years.
Total Maximum Daily Load (TMDL):	4.75E+12 counts per 30 day critical period The TMDL is a combination of the direct input of fecal coliform from NPDES Permitted dischargers and nonpoint sources due to cows with access to streams, failing septic tanks, and land surface fecal coliform application rates.

EVALUATED DRAINAGE AREA IDENTIFICATION

Name:	Nanih Waiya Creek - DA
Waterbody ID:	MS120E
Location:	Drainage Area near Handle
County:	Kemper, Neshoba, and Winston Counties, Mississippi
USGS HUC Code:	03180001
NRCS Watershed:	010
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic organisms
Priority Rank:	Low
NPDES Permits:	There is 1 NPDES Permit issued for facilities that discharge fecal coliform in the watershed (Table 3.1.1).
Standards Variance:	None
Pollutant Standard:	May through October - Geometric mean of 200 per 100 ml, Less than 10% of the samples may exceed 400 per 100 ml. November through April - Geometric mean of 2000 per 100 ml, Less than 10% of the samples may exceed 4000 per 100 ml.
Waste Load Allocation:	1.10E+11 counts per 30 day critical period (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	1.44E+12 counts per 30 day critical period
Margin of Safety:	Implicit modeling assumptions - The model was run for a time span of 11 years.
Total Maximum Daily Load (TMDL):	1.55E+12 counts per 30 day critical period The TMDL is a combination of the direct input of fecal coliform from NPDES Permitted dischargers and nonpoint sources due to cows with access to streams, failing septic tanks, and land surface fecal coliform application rates.

EVALUATED DRAINAGE AREA IDENTIFICATION

Name:	Tallahaga Creek - DA
Waterbody ID:	MS122E
Location:	Drainage Area near Claytown
County:	Neshoba and Winston Counties, Mississippi
USGS HUC Code:	03180001
NRCS Watershed:	030
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic organisms
Priority Rank:	Low
NPDES Permits:	There are 3 NPDES Permits issued for facilities that discharge fecal coliform in the watershed (Table 3.1.1).
Pollutant Standard:	May through October - Geometric mean of 200 per 100 ml, Less than 10% of the samples may exceed 400 per 100 ml. November through April - Geometric mean of 2000 per 100 ml, Less than 10% of the samples may exceed 4000 per 100 ml.
Waste Load Allocation:	2.47E+11 counts per 30 day critical period (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	7.93E+11 counts per 30 day critical period
Margin of Safety:	Implicit modeling assumptions - The model was run for a time span of 11 years.
Total Maximum Daily Load (TMDL):	1.04E+12 counts per 30 day critical period The TMDL is a combination of the direct input of fecal coliform from NPDES Permitted dischargers and nonpoint sources due to cows with access to streams, failing septic tanks, and land surface fecal coliform application rates.

EVALUATED DRAINAGE AREA IDENTIFICATION

Name:	Pinishook Creek - DA
Waterbody ID:	MS125PE
Location:	Drainage Area near Burnside
County:	Neshoba and Winston Counties, Mississippi
USGS HUC Code:	03180001
NRCS Watershed:	060
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic organisms
Priority Rank:	Low
NPDES Permits:	There are no NPDES Permits issued for facilities that discharge fecal coliform in the watershed (Table 3.1.1).
Pollutant Standard:	May through October - Geometric mean of 200 per 100 ml, Less than 10% of the samples may exceed 400 per 100 ml. November through April - Geometric mean of 2000 per 100 ml, Less than 10% of the samples may exceed 4000 per 100 ml.
Waste Load Allocation:	4.31E+10 counts per 30 day critical period (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	2.16E+11 counts per 30 day critical period
Margin of Safety:	Implicit modeling assumptions - The model was run for a time span of 11 years.
Total Maximum Daily Load (TMDL):	2.59E+11 counts per 30 day critical period The TMDL is a combination of the direct input of fecal coliform from NPDES Permitted dischargers and nonpoint sources due to cows with access to streams, failing septic tanks, and land surface fecal coliform application rates.

EVALUATED DRAINAGE AREA IDENTIFICATION

Name:	Standing Pine Creek - DA
Waterbody ID:	MS131E
Location:	Drainage Area near Free Trade
County:	Leake and Neshoba Counties, Mississippi
USGS HUC Code:	03180001
NRCS Watershed:	120
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic organisms
Priority Rank:	Low
NPDES Permits:	There are 2 NPDES Permits issued for facilities that discharge fecal coliform in the watershed (Table 3.1.1).
Pollutant Standard:	May through October - Geometric mean of 200 per 100 ml, Less than 10% of the samples may exceed 400 per 100 ml. November through April - Geometric mean of 2000 per 100 ml, Less than 10% of the samples may exceed 4000 per 100 ml.
Waste Load Allocation:	7.23E+10 counts per 30 day critical period (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	6.16E+11 counts per 30 day critical period
Margin of Safety:	Implicit modeling assumptions - The model was run for a time span of 11 years.
Total Maximum Daily Load (TMDL):	6.88E+11 counts per 30 day critical period The TMDL is a combination of the direct input of fecal coliform from NPDES Permitted dischargers and nonpoint sources due to cows with access to streams, failing septic tanks, and land surface fecal coliform application rates

EVALUATED DRAINAGE AREA IDENTIFICATION

Name:	Upper Lobutcha Creek - DA
Waterbody ID:	MS132E
Location:	Drainage Area near Zama
County:	Attala, Choctaw, and Winston Counties, Mississippi
USGS HUC Code:	03180001
NRCS Watershed:	130
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic organisms
Priority Rank:	Low
NPDES Permits:	There are no NPDES Permits issued for facilities that discharge fecal coliform in the watershed (Table 3.1.1).
Pollutant Standard:	May through October - Geometric mean of 200 per 100 ml, Less than 10% of the samples may exceed 400 per 100 ml. November through April - Geometric mean of 2000 per 100 ml, Less than 10% of the samples may exceed 4000 per 100 ml.
Waste Load Allocation:	1.21E+11 counts per 30 day critical period (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	4.11E+11 counts per 30 day critical period
Margin of Safety:	Implicit modeling assumptions - The model was run for a time span of 11 years.
Total Maximum Daily Load (TMDL):	5.32E+11 counts per 30 day critical period The TMDL is a combination of the direct input of fecal coliform from NPDES Permitted dischargers and nonpoint sources due to cows with access to streams, failing septic tanks, and land surface fecal coliform application rates.

EVALUATED DRAINAGE AREA IDENTIFICATION

Name:	Lower Lobutcha Creek - DA
Waterbody ID:	MS133LE
Location:	Drainage Area near Hub
County:	Attala and Leake Counties, Mississippi
USGS HUC Code:	03180001
NRCS Watershed:	140
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic organisms
Priority Rank:	Low
NPDES Permits:	There are no NPDES Permits issued for facilities that discharge fecal coliform in the watershed (Table 3.1.1).
Pollutant Standard:	May through October - Geometric mean of 200 per 100 ml, Less than 10% of the samples may exceed 400 per 100 ml. November through April - Geometric mean of 2000 per 100 ml, Less than 10% of the samples may exceed 4000 per 100 ml.
Waste Load Allocation:	6.37E+09 counts per 30 day critical period (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	2.16E+10 counts per 30 day critical period
Margin of Safety:	Implicit modeling assumptions - The model was run for a time span of 11 years.
Total Maximum Daily Load (TMDL):	2.80E+10 counts per 30 day critical period The TMDL is a combination of the direct input of fecal coliform from NPDES Permitted dischargers and nonpoint sources due to cows with access to streams, failing septic tanks, and land surface fecal coliform application rates.

EXECUTIVE SUMMARY

A segment of the Pearl River has been placed on the Mississippi 1998 Section 303(d) List of Waterbodies as impaired due to fecal coliform bacteria. Six drainage areas within this Pearl River subwatershed have been placed on the list as evaluated, due to fecal coliform bacteria. For these waterbody segments, the applicable state standard specifies that for the summer months, the maximum allowable level of fecal coliform shall not exceed a geometric mean of 200 colonies per 100 ml, nor shall more than ten percent of the samples examined during any month exceed a colony count of 400 per 100 ml. A review of the available monitoring data for the watershed indicates that there is a violation of the standard for the impaired waterbody.

The Pearl River is a major waterbody in Mississippi, flowing in a southerly direction from its headwaters in Winston County to its mouth in the Mississippi Sound. This TMDL has been developed for one impaired section of the Pearl River and six evaluated drainage areas within the Pearl River Watershed. The BASINS Nonpoint Source Model (NPSM) was selected as the modeling framework for performing the TMDL allocations for this study. The weather data used for this model were collected at Jackson, MS. The representative hydrologic period used for this TMDL was January 1, 1985, through December 31, 1995.

Fecal coliform loadings from nonpoint sources in the watershed were calculated based upon wildlife populations; livestock populations; information on livestock and manure management practices for the Pearl River Basin; and urban development. The estimated fecal coliform production and accumulation rates due to nonpoint sources for the watershed were incorporated into the model. Also represented in the model were the nonpoint sources such as failing septic systems and cattle that have direct access to tributaries of the Pearl River. There are 19 NPDES Permitted discharges located in the watershed and included as point sources in the model. Under existing conditions, output from the model indicates violation of the fecal coliform standard in the stream. After applying a load reduction scenario, there were no violations of the standard according to the model.

The scenario used to reduce the fecal coliform load involves a cooperative effort between all fecal coliform contributors in the Pearl River Watershed. First, all NPDES facilities will be required to treat their discharge so that the fecal coliform concentrations do not exceed water quality standards. Careful monitoring of all permitted facilities in the Pearl River Watershed should be continued to ensure that compliance with permit limits is consistently attained. Second is the removal of 95% of the cattle=s direct access to tributaries. This could be accomplished by fencing streams in cattle pastures. Education on best management practices is a vital part of achieving this goal. Finally, a 80% reduction in the fecal coliform contribution from failing septic tanks is required. The model assumed there is a 40% failure rate of septic tanks in the drainage area. A reduction could be accomplished by education on best management practices for septic tank owners. Additionally, users of individual onsite wastewater treatment plants could be educated on the importance of disinfection of the effluent from their treatment plant.

The model accounted for seasonal variations in hydrology, climatic conditions, and watershed activities. The use of the continuous simulation model allowed for consideration of the seasonal aspects of rainfall and temperature patterns within the watershed. Calculation of the fecal coliform accumulation parameters and source contributions on a monthly basis accounted for seasonal variations in watershed activities such as livestock grazing and land application of manure.

1.0 INTRODUCTION

1.1 Background

The identification of waterbodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those waterbodies 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 waterbodies 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 waterbody. The TMDL process can be used to establish water quality based controls to reduce pollution from both point and nonpoint sources, and restore and maintain the quality of water resources.

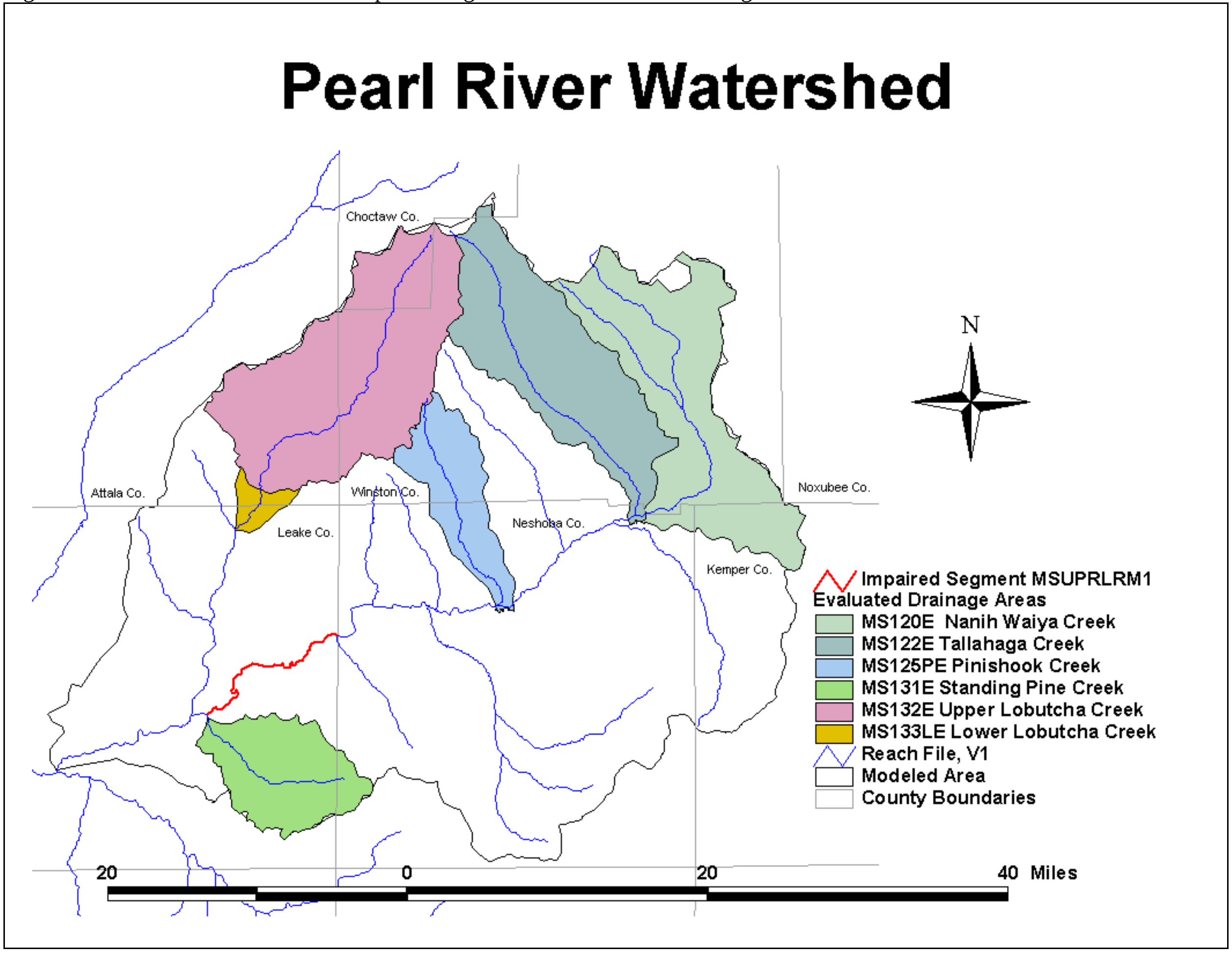
The Mississippi Department of Environmental Quality (MDEQ) has identified a segment of the Pearl River as being impaired by fecal coliform bacteria for a length of 18 miles as reported in the Mississippi 1998 Section 303(d) List of Waterbodies. This segment is listed as impaired because sufficient monitoring data is available to show that there is an impairment in this segment. The impaired segment is at Edinburg, from the confluence with Beasha Creek to the confluence with Standing Pine Creek. There are also six drainage areas within the Pearl River Watershed that are reported as being evaluated for the presence of fecal coliform bacteria. This segment and these drainage areas are listed as evaluated because the data available is insufficient to show a definite impairment caused by fecal coliform bacteria. However, there is anecdotal evidence of a possible water quality problem. Both the monitored and evaluated sections are shown in Figure 1.1.1.

The impaired segment of the Pearl River is in the Pearl River Basin Hydrologic Unit Code (HUC) 03180001 in central Mississippi. The drainage area of the monitored segment and the evaluated drainage areas is approximately 895,000 acres; and lies within portions of Attala, Choctaw, Kemper, Leake, Neshoba, and Winston Counties. The watershed is rural but includes the urban areas of Philadelphia and Louisville. Forest and pasture are the dominant landuses within the watershed. The land distribution is shown in Table 1.1.1.

Table 1.1.1 Land Distribution in Acres for the Pearl River Watershed

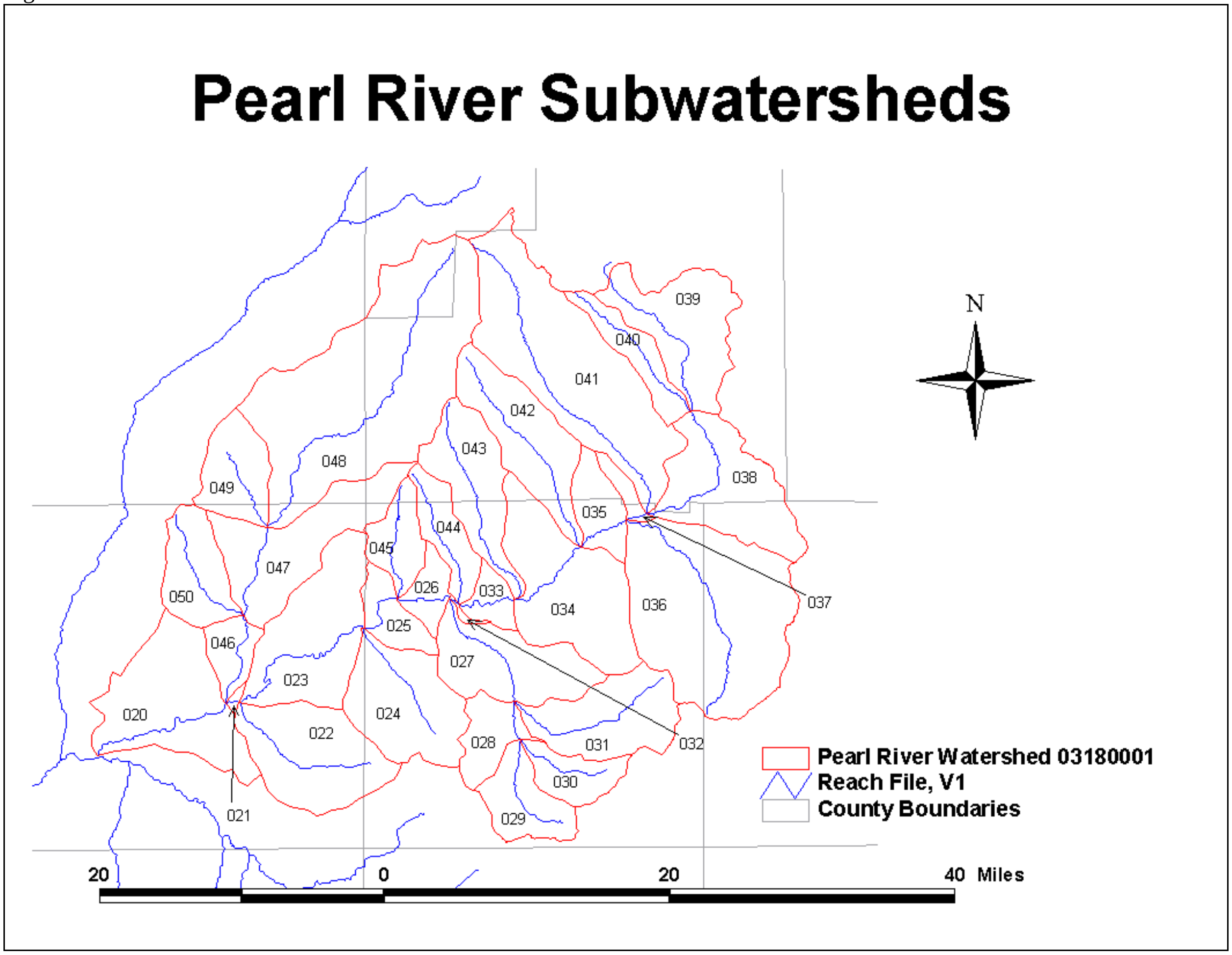
	Urban	Forest	Cropland	Pasture	Barren	Wetland	Total
Area (Acres)	2,468	465,427	9,979	221,710	0	195,785	895,368
% Area	0%	52%	1%	25%	0%	22%	

Figure 1.1.1 Pearl River Watershed Impaired Segments and Evaluated Drainage Areas



The drainage area, or watershed, has been divided into 31 subwatersheds based on the major tributaries and topography. Figure 1.1.2 shows the subwatersheds with a three-digit Reach File 1 segment identification number. Each subwatershed is assigned a corresponding identification number, which is a combination of the eight-digit HUC and the three-digit Reach File 1 segment identification number. The impaired segment is contained in, using HUC and Reach File 1 identification numbers, 03180001023.

Figure 1.1.2 Pearl River Subwatersheds



1.2 Applicable Waterbody Segment Use

Designated beneficial uses and water quality standards are established by the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* regulations. The designated uses for the Pearl River as defined by the regulations are Fish and Wildlife Support. The monitored section of Pearl River has the designated use of Secondary Contact Recreation.

1.3 Applicable Waterbody Segment Standard

The water quality standard applicable to the use of the waterbody and the pollutant of concern is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. The standard states that for the months of May through October the fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml, nor shall more than ten percent of the samples examined during any month exceed a colony count of 400 per 100 ml and that for the months of November through April the fecal coliform colony counts shall not exceed a gerometric mean of 2000 per 100 ml, not shall more than ten percent of the samples examined during any month exceed a colony count of 4000 per 100 ml. This water quality standard will be used as targeted endpoints to evaluate impairments and establish this TMDL.

2.0 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. The instream fecal coliform target for this TMDL is a 30-day geometric mean of 200 colony counts per 100 ml.

Because fecal coliform may be attributed to both nonpoint and point sources, the critical condition used for the modeling and evaluation of stream response was represented by a multi-year period. 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 low flow, low dilution conditions. The 1985-1995 period represents both low flow conditions as well as wet-weather conditions and encompasses a range of wet and dry seasons. Therefore, the 11-year period was selected as representing critical conditions associated with all potential sources of fecal coliform bacteria within the watershed.

2.2 Discussion of Instream Water Quality

Water quality data available for the monitored segment of the Pearl River show that high levels of fecal coliform bacteria frequently impair the stream. There is one ambient station on the impaired segment operated by MDEQ that collected fecal coliform monitoring data during the 11-year modeling period. Data from this station was used to determine the impaired status of the segment. Monitoring for flow and fecal coliform was performed on a bimonthly (six per year) basis at station 02482000 at the Pearl River at Edinburg, beginning in January 1993 and ending in September 1996. The data indicate that high instream fecal coliform concentrations occurred during both periods of high flow and dry, low flow conditions.

2.2.1 Inventory of Available Water Quality Monitoring Data

The State’s 1998 Section 305(b) Water Quality Assessment Report was reviewed to assess water quality conditions and data available for the watershed. According to the report, the Pearl River is not supporting the use of contact recreation and threatened for the use of aquatic life support. These conclusions were based on instantaneous data collected at stations 02482000. Data collected at the station are listed below in Tables 2.2.1.

Table 2.2.1 Fecal Coliform Data reported in the Pearl River, Station 02482000

Date	Flow (cfs)	Fecal Coliform (counts/100ml)
1/11/1993	1825	**16000**
3/8/1993	1540	70
5/3/1993	1762	220
7/12/1993	78	**2400**
9/13/1993	19	80
11/1/1993	150	**24000**
1/10/1994	1290	1400
3/7/1994	2800	790
5/2/1994	234	20
6/20/1994	305	240
8/23/1994	126	**1400**
11/7/1994	134	**5400**
1/9/1995	1680	1600
3/8/1995	4790	540
4/18/1995	471	920
7/11/1995	98	79
9/11/1995	16	350
11/7/1995	284	79
1/8/1996	1840	27
3/5/1996	402	46
5/6/1996	452	49
7/8/1996	19	79
9/10/1996	104	17

2.2.2 Analysis of Instream Water Quality Monitoring Data

Statistical summaries of the water quality data discussed above are presented in Table 2.2.2 and Table 2.2.3. Samples are compared to the instantaneous maximum standard of 400 counts per 100 ml for the summer standard and 4000 counts per 100 ml for the winter standard. The percent exceedance was calculated by dividing the number of exceedances by the total number of samples and does not represent the amount of time that the water quality is in violation.

Table 2.2.2 Summer Statistical Summaries

Station Number	Number of Samples	Minimum Value (counts/100ml)	Maximum Value (counts/100ml)	Number of Exceedances	Percent Instantaneous Exceedance
02482000	11	17	2400	2	18%

Table 2.2.3 Winter Statistical Summaries

Station Number	Number of Samples	Minimum Value (counts/100ml)	Maximum Value (counts/100ml)	Number of Exceedances	Percent Instantaneous Exceedance
02482000	12	27	24000	3	25%

3.0 SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential fecal coliform sources in the Pearl River watershed. The source assessment was used as the basis of development for the model and ultimate analysis of the TMDL allocation options. 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. The representation of the following sources in the model is discussed in Section 4.0, Modeling Procedure: Linking the Sources to the Endpoint.

3.1 Assessment of Point Sources

Point sources of fecal coliform bacteria have their greatest potential impact on water quality during periods of low flow. Thus, a careful evaluation of point sources that discharge fecal coliform bacteria was necessary in order to quantify the degree of impairment present during the low flow, critical condition period. The 19 wastewater treatment plants in the Pearl River Watershed serve a variety of activities including residential subdivisions, schools, recreational areas, and other businesses. The majority of the 19 wastewater treatment plants serve residential subdivisions.

Once the permitted dischargers were located, the effluent from each source 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 effluent because they report measurements of flow and fecal coliform present in effluent samples. Of the facilities for which they were available, the DMRs for the past five years, 1993 through 1998, were analyzed. When data were available, the fecal coliform concentrations used in the model were calculated by taking an average of fecal coliform concentrations reported in the discharge monitoring reports. If evidence of insufficient treatment existed, best professional judgement was used to estimate a fecal coliform loading rate in the model. Every facility included in the model is listed in Table 3.1.1.

Table 3.1.1 Inventory of Point Source Dischargers

Facility Name	Subwatershed	NPDES Permit	Receiving Waterbody
Choctaw Util. Standing Pine Lagoon	03180001022	MS0043494	Standing Pine Creek
Jones Personal Care Home	03180001022	MS0043087	Standing Pine Creek
Edinburg Attendance Center	03180001023	MS0029777	Pearl River
Choctaw Util. Goat Ranch Rd. Lagoon	03180001025	MS0040894	Un. Creek to Jones Creek
Choctaw Util. Standing Pine School	03180001027	MS0040932	Wolf Creek to Kentawka Canal
Philadelphia HCR Site	03180001027	MS0021156	Kentawka Canal
Neshoba County Fairgrounds	03180001028	MS0044920	Coonshuck Creek
Choctaw Util. Tucker Day School	03180001031	MS0040541	Tributary to Cushtusia Canal
Choctaw Util. Tucker Lagoon	03180001031	MS0040924	Un. Branch to Cushtusia Canal
MS Band Choctaw Indians-Pearl	03180001032	MS0053503	Tributary of Wolf Creek
Weyerhaeuser Company	03180001032	MS0001961	Pearl River
Choctaw Util. Bogue Chitto	03180001036	MS0043478	Tributary to Gray Farm Pond
Choctaw Util. Kemper County Lagoon	03180001036	MS0040878	Ditch to Bogue Chitto Creek
Nanih Waiya School	03180001039	MS0038768	Nanih Waiya Creek
Choctaw Util. Crystal Ridge Com.	03180001041	MS0043460	Tallahaga Creek
Louisville POTW - South	03180001041	MS0025836	Hughes Creek
Noxapater POTW - North	03180001041	MS0025241	Tallahaga Creek
Noxapater POTW - South	03180001042	MS0021628	Gum Branch
Choctaw Foods Inc.	03180001050	MS0026140	Pickins Creek

3.2 Assessment of Nonpoint Sources

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

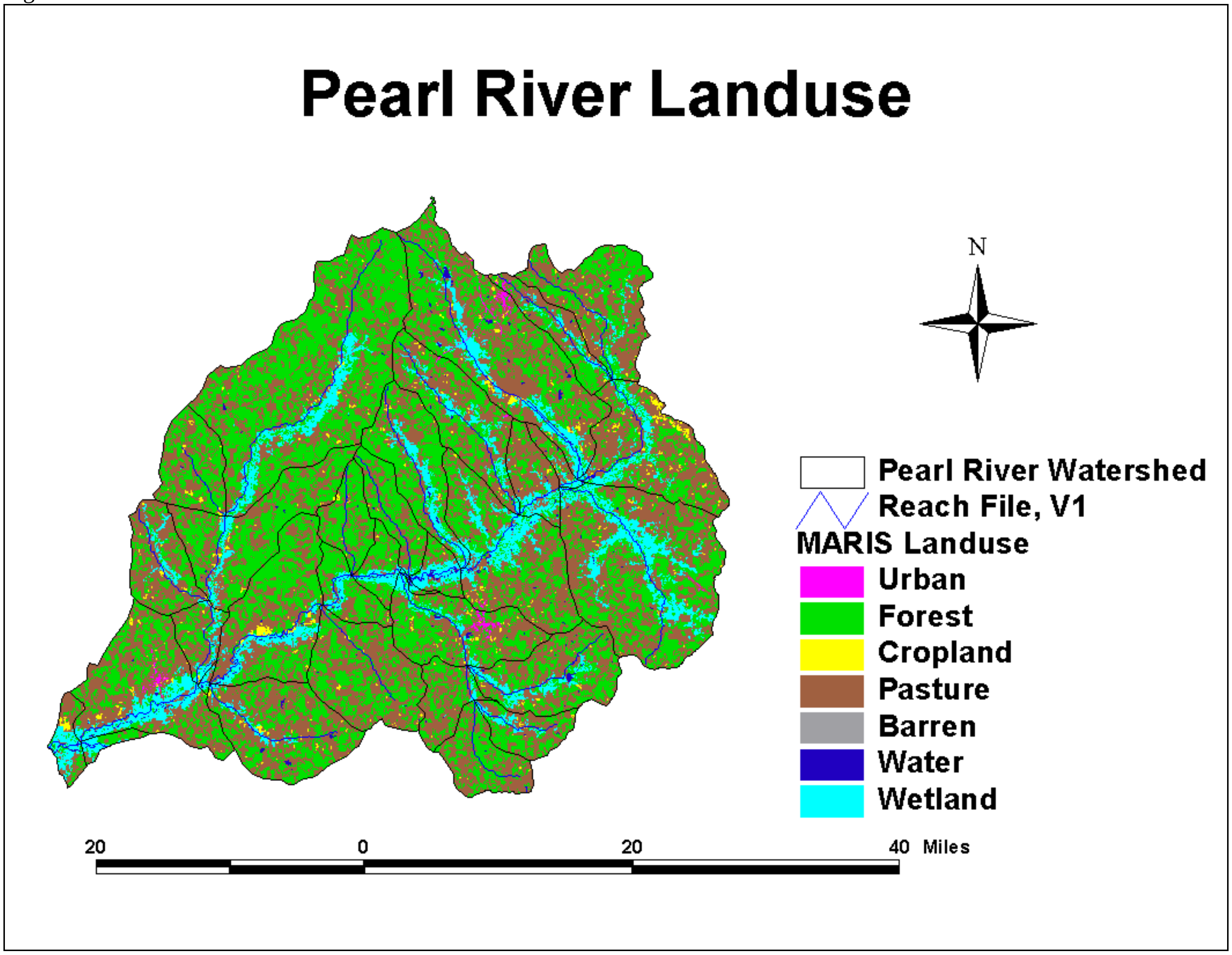
- Failing septic systems
- Wildlife
- Land application of hog and cattle manure
- Grazing animals
- Land application of poultry litter
- Cattle contributions directly deposited instream
- Urban development

The 895,000-acre drainage area of the Pearl River contains many different landuse types. The landuse information is based on data collected by the Mississippi Automated Resources Information System (MARIS), 1997. This data set is based on Landsat Thematic Mapper digital images taken between 1992 and 1993. This classification is based on a modified Anderson level one and two system with additional level two wetland classifications. The contribution of each of these land types to the fecal coliform loading of the Pearl River was considered on a subwatershed basis. Table 3.2.1 and Figure 3.2.1 show the landuse distribution for the watershed.

Table 3.2.1 Landuse Distribution in Number of Acres

Subwatershed	Urban	Forest	Cropland	Pasture	Barren	Wetland	Total
03180001020	494	22,001	600	11,909	0	11,364	46,368
03180001021	0	560	18	134	0	69	780
03180001022	0	16,737	513	12,003	0	9,098	38,351
03180001023	0	23,696	933	8,671	0	10,032	43,333
03180001024	5	16,075	240	11,005	0	8,505	35,830
03180001025	14	7,009	43	1,967	0	2,212	11,245
03180001026	0	5,357	28	1,038	0	1,647	8,069
03180001027	672	16,206	520	8,538	0	5,626	31,562
03180001028	0	5,821	46	3,732	0	3,406	13,005
03180001029	0	8,296	49	4,439	0	4,950	17,734
03180001030	0	6,264	119	3,364	0	2,692	12,439
03180001031	15	16,262	222	8,842	0	6,067	31,409
03180001032	0	343	0	79	0	191	613
03180001033	0	3,326	13	1,235	0	2,078	6,652
03180001034	77	22,804	359	14,300	0	9,919	47,459
03180001035	0	5,053	107	4,755	0	2,957	12,871
03180001036	75	42,713	395	23,626	0	15,518	82,327
03180001037	0	1,603	67	1,357	0	872	3,899
03180001038	0	14,435	1,594	13,662	0	9,232	38,924
03180001039	7	15,948	286	11,871	0	6,821	34,934
03180001040	136	6,625	155	4,539	0	2,403	13,859
03180001041	924	37,220	1,161	19,567	0	16,737	75,608
03180001042	50	16,587	292	8,735	0	6,954	32,619
03180001043	0	18,056	261	5,071	0	4,785	28,174
03180001044	0	8,687	34	2,263	0	3,077	14,060
03180001045	0	8,912	120	1,231	0	2,927	13,190
03180001046	0	4,636	154	2,192	0	2,636	9,617
03180001047	0	23,104	436	7,267	0	8,334	39,141
03180001048	0	72,976	604	14,227	0	23,337	111,143
03180001049	0	10,346	298	3,292	0	5,409	19,345
03180001050	0	7,770	310	6,799	0	5,929	20,807
Total	**2,468**	**465,427**	**9,979**	**221,710**	**0**	**195,785**	**895,368**

Figure 3.2.1 Landuse Distribution



The nonpoint fecal coliform contribution from each landuse was estimated using the latest information available. The MARIS landuse data for Mississippi was utilized by the BASINS model to extract landuse sizes, populations, agriculture census data, and other information. 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 Pearl River 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 valuable information on manure application practices and loading rates for hog farms and cattle operations. The Natural Resources Conservation Service also gave MDEQ information on 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 do not typically 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.

3.2.2 Wildlife

Wildlife present in the Pearl River watershed contributes to fecal coliform bacteria on the land surface. In the Pearl River model, all wildlife was accounted for by considering contributions from deer. Estimates of deer population were designed to account for the deer combined with all of the other wildlife and domestic pets contributing to the area. An upper limit of 45 deer per square mile was used as the estimate. It was assumed that the wildlife population remained constant throughout the year, and that wildlife was present on all land classified as pastureland, cropland, and forest. It was also assumed that the wildlife and the manure produced by the wildlife were evenly distributed throughout these land types.

3.2.3 Land Application of Hog and Cattle Manure

In the Pearl River Basin processed manure from confined hog and dairy cattle operations is collected in lagoons and routinely applied to pastureland during April through October. This manure is a potential contributor of bacteria to receiving waterbodies due to runoff produced during a rain event. Hog farms in the Pearl River Basin operate by either keeping the animals confined by or allowing hogs to graze in a small pasture or pen. For this model, it was assumed that all of the hog manure produced by either farming method 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.

The dairy farms that are currently operating in the Pearl River Watershed only confine the animals for a limited time during the day. The model assumed a confinement time of four hours per day, during which time the cattle are milked and fed. During all other times, dairy cattle are allowed to graze on pasturelands. 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 Grazing Beef and Dairy Cattle

Grazing cattle deposit manure on pastureland where it is available for wash-off and delivery to receiving waterbodies. Beef cattle have access to pastureland for grazing all of the time. However, dairy cattle can spend four hours per day confined in milking barns, and the remainder of their time grazing on pastureland. Manure produced by grazing beef and dairy cows is directly deposited onto pastureland.

3.2.5 Land Application of Poultry Litter

There are a considerable number of chickens produced in the Pearl River Watershed each year. In this area, poultry farming operations use houses in which chickens are confined all of the time. The litter produced by the chickens is collected and is routinely applied as a fertilizer to pastureland in the watershed. Application rates of the litter vary monthly.

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. Layer chickens remain on farms for ten months or longer. More than 93% of the chickens raised in this area are broilers. For the model, a weighted average of growth time was determined to account for both types of chickens. An average growth time of 52 days, or 1/7 of a year, was used. To determine the number of chickens on farms on any given day, the yearly population of chickens sold was divided by seven.

3.2.6 Cattle Contributions Directly Deposited Instream

Cattle often have direct access to flowing and intermittent streams that run through pastureland. These small streams are tributaries of larger streams. Fecal coliform bacteria deposited in these streams by grazing cattle are modeled as a direct input of bacteria to the stream. Due to the general topography in the Pearl River Watershed, it was assumed that all land slopes in the watershed are such that cattle are able to access the intermittent streams in all pastures. In order to determine the amount of bacteria introduced into streams from cattle, it was assumed that all grazing cattle spent two percent of their time standing in the streams. Thus, the model assumes that two percent of the manure produced by grazing beef and dairy cows are deposited directly in the stream.

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 the Pearl River was considered. Municipalities within the Pearl River Watershed include Philadelphia and Louisville. Fecal coliform contributions from urban areas may come from storm water runoff, runoff from construction sites, and runoff contribution from improper disposal of materials such as household toxic materials and litter.

4.0 MODELING PROCEDURE: LINKING THE SOURCES TO THE ENDPOINT

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. The link can be established though a range of techniques, from qualitative assumptions to sophisticated modeling techniques. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain waterbody 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

The BASINS model platform and the NPSM model were used to predict the significance of fecal coliform sources to fecal coliform levels in the Pearl River Watershed. BASINS is a multipurpose environmental analysis system for use in performing watershed and water quality-based studies. A geographic information system (GIS) provides the integrating framework for BASINS and allows for the display and analysis of a wide variety of landscape information such as landuses, monitoring stations, point source discharges, and stream descriptions. The NPSM model simulates nonpoint source runoff from selected watersheds, as well as the transport and flow of the pollutants through stream reaches. A key reason for using BASINS as the modeling framework is its ability to integrate both point and nonpoint sources in the simulation, as well as its ability to assess instream water quality response.

4.2 Model Setup

The Pearl River TMDL model includes the listed section of the creek as well as all the evaluated drainage areas within HUC 03180001. All upstream contributors of bacteria are accounted for in the model. This portion of the watershed was divided into 31 subwatersheds in an effort to isolate the major stream reaches in the Pearl River Watershed. This subdivision allowed the relative contribution of point and nonpoint sources to be addressed within each subwatershed.

4.3 Source Representation

Both point and nonpoint sources were represented in the model. A fecal coliform spreadsheet was developed for quantifying point and nonpoint sources of bacteria for the Pearl River model. This spreadsheet calculates the model inputs for fecal coliform loading due to point and nonpoint sources using assumptions about land management, septic systems, farming practices, and permitted point source contributions. Each of the potential bacteria sources is covered in the fecal coliform spreadsheet.

The discharge from point sources was added as a direct input into the appropriate reach of the waterbody. There are 19 NPDES permitted facilities in the watershed which discharge fecal coliform bacteria. Fecal coliform loading rates for point sources are input to the model as flow in cubic feet per second and fecal coliform contribution in counts per hour.

The nonpoint sources are represented in the model with two different methods. The first of these methods is a direct fecal coliform loading to the Pearl River. Other sources are represented as an application rate to the land in the Pearl River Watershed. For these sources, fecal coliform accumulation rates in counts per acre per day were calculated for each subwatershed on a monthly basis and input to the model for each landuse. Fecal coliform contributions from forests and wetlands were considered to be equal. Urban and barren areas were also considered to produce equal loads. The fecal coliform accumulation rate for pastureland is the sum of accumulation rates due to litter application, wildlife, processed manure, and grazing animals. For cropland, the accumulation rate is only due to wildlife. Accumulation rates for pastureland are calculated on a monthly basis to account for seasonal variations in manure and litter application.

4.3.1 Failing Septic Systems

Discharges from failing septic systems were quantified based on several factors including the estimated population served by the septic systems, an average daily discharge of 100 gallons per person per day, and a septic system effluent fecal coliform concentration of 10^4 counts per 100 ml.

4.3.2 Wildlife

Based on information provided by the Mississippi Department of Wildlife, Fisheries, and Parks, the deer population throughout the Pearl River Watershed was estimated to be 30 to 45 animals per square mile. For the model, the upper limit of 45 deer per square mile was used to account for the deer and all other wildlife contributing to fecal coliform accumulation in the area. The wildlife contribution in counts per acre per day is calculated by multiplying a loading rate by the number of animals. The loading rate used in the model was estimated to be 5.00E+08 counts per day per animal. The per acre loading rate applied to the landuses is 3.52E+07 counts/acre/day.

4.3.3 Land Application of Hog and Cattle Manure

The fecal coliform spreadsheet was used to estimate the amount of waste and the concentration of fecal coliform bacteria contained in hog and dairy cattle manure produced by confined animal feeding operations. The livestock count per county is based upon the 1997 Census of Agriculture data. The county livestock count is used to estimate the number of livestock on a subwatershed scale. This is calculated by multiplying the county livestock figures with the area of the county within the subwatershed boundaries. This estimate is made with the assumption that the livestock are uniformly distributed throughout the county. A fecal coliform production rate in counts per day per animals was multiplied by the number of confined animals to quantify the amount of bacteria produced. The manure produced by these operations is collected in lagoons and applied evenly to all pastureland. Manure application rates to pastureland vary on a monthly basis. This monthly variation is incorporated into the model by using monthly loading rates.

4.3.4 Grazing Beef and Dairy Cattle

The model assumes that the manure produced by grazing beef and dairy cattle is evenly spread on pastureland throughout the year. The fecal coliform content of manure produced by grazing cattle is estimated by multiplying the number of grazing cattle by a fecal coliform production of 5.40E+09 counts per day per animal (Metcalf and Eddy, 1991). The resulting fecal coliform loads are in the units of counts per acre per day.

4.3.5 Land Application of Poultry Litter

The concentration of bacteria, which accumulates in the dry litter where poultry waste is collected, is estimated with the fecal coliform spreadsheet. This is done by multiplying the daily number of chickens on farms by a fecal coliform production rate in counts per day per animal given in Metcalf & Eddy, 1991. The model assumed a watershed area normalized chicken population. The chicken population was determined from the 1997 Census of Agriculture Data for the number of chickens sold from each county per year. Litter application to pastureland varies monthly, and is modeled with a monthly loading rate.

4.3.6 Cattle Contributions Deposited Directly Instream

The contribution of fecal coliform from cattle to a stream is represented as a direct input into the stream by the model. In order to estimate the point source loading produced by grazing beef and dairy cattle with access to streams, it is assumed that two percent of the number of grazing cattle in each subwatershed are standing in a stream at any given time. When cattle are standing in a stream, their fecal coliform production is estimated as flow in cubic feet per second and a concentration in counts per hour. The fecal coliform concentration is calculated using the number of cows in the stream and a bacteria production rate of 5.40E+09 counts per animal per day (Metcalf and Eddy, 1991).

4.3.7 Urban Development

The MARIS landuse data divide urban land into several categories. For the Pearl River Watershed, the urban land is divided into three different categories: high density, low density, and transportation. For the model, fecal coliform buildup rates for each category were determined by using literature values from Horner, 1992. The literature value accounts for all of the potential fecal coliform sources in each urban category. Table 4.3.1 shows the break up of urban land into high density, low density, and transportation on a subwatershed basis. The fecal coliform production rate for each of these subdivisions of urban land is 1.54E+07 for high density, 1.03E+07 for low density, and 2.00E+05 for transportation. In the model, fecal coliform loading rates on urban land are input as counts per acre per day.

Table 4.3.1 Urban Landuse Distribution

Subwatershed	High Density Urban	Low Density Urban	Transportation	Total
03180001020	105	389	0	494
03180001021	0	0	0	0
03180001022	0	0	0	0
03180001023	0	0	0	0
03180001024	0	5	0	5
03180001025	0	14	0	14
03180001026	0	0	0	0
03180001027	151	521	0	672
03180001028	0	0	0	0
03180001029	0	0	0	0
03180001030	0	0	0	0
03180001031	0	15	0	15
03180001032	0	0	0	0
03180001033	0	0	0	0
03180001034	18	59	0	77
03180001035	0	0	0	0
03180001036	0	10	65	75
03180001037	0	0	0	0
03180001038	0	0	0	0
03180001039	0	0	0	0
03180001040	54	82	0	136
03180001041	168	342	414	924
03180001042	8	20	21	50
03180001043	0	0	0	0
03180001044	0	0	0	0
03180001045	0	0	0	0
03180001046	0	0	0	0
03180001047	0	0	0	0
03180001048	0	0	0	0
03180001049	0	0	0	0
03180001050	0	0	0	0
All Watersheds	**505**	**1,457**	**500**	**2,461**

4.4 Stream Characteristics

The stream characteristics given below describe the entire modeled section of the Pearl River. This section begins at the confluence with Beasha Creek and ends at the end of the monitored reach, with the confluence of Standing Pine Creek. The channel geometry and lengths for the Pearl River are based on data available within the BASINS modeling system. The 7Q10 flow was determined from USGS data. The characteristics of the modeled section of the Pearl River are as follows.

- Length 18 miles
- Average Depth 0.79 ft
- Average Width 87.54 ft
- Mean Flow 1347.64 cubic ft per second
- Mean Velocity 1.83 ft per second
- 7Q10 Flow 21.81 cubic ft per second
- Slope 0.00026 ft per ft

4.5 Selection of Representative Modeling Period

The model was run for 11 years, from January 1, 1985, through December 31, 1995. Results from the model were evaluated for the time period from January 1, 1985, until December 31, 1995. Because this 11-year time span is used, a margin of safety is implicitly applied. Seasonality and critical conditions are accounted for during the extended time frame of the simulation.

The critical condition for fecal coliform impairment from nonpoint source contributors occurs after a heavy rainfall that is preceded by several days of dry weather. The dry weather allows a build up of fecal coliform bacteria, which is then washed off the ground by a heavy rainfall. By using the 11-year time period, many such occurrences are captured in the model results. Critical conditions for point sources, which occur during low flow and low dilution conditions, are simulated as well.

4.6 Model Calibration Process

First, the model was calibrated for hydraulics. The data from USGS gage 02482000 was used to calibrate the model hydraulically. The data from this gage was compared to the hydraulic output from the corresponding waterbody segment within the model. A sample of these results is included in Appendix A, Graphs A-1 through A-3.

The water quality data available are such that water quality calibration was difficult. As described in section 2.2 the water quality data available are instantaneous samples collected approximately every two months. The data available are not sufficient for calibration purposes. Instead, MDEQ contacted researchers and agricultural experts to quantify representative pathogen loads entering the stream.

4.7 Existing Loading

Appendix A includes two graphs of the model results showing the instream fecal coliform concentrations for reach 03180001023 of the Pearl River. Graph A-4 shows the fecal coliform levels in the stream during the 11-year modeling period. The graph shows a 30-day geometric mean of the data. There have been 30 standards violations in 11 years according to the model. The straight line at 200 counts per 100 ml indicates the water quality standard for the stream.

Graph A-5 shows the 30-day geometric mean of the fecal coliform levels after the reduction scenario has been modeled. The scale matches the previous graph for comparison purposes. The graph indicates that there are no violations of the water quality standard for the monitored segment after the reduction scenario is applied.

5.0 ALLOCATION

The allocation for this TMDL involves a wasteload allocation for point sources and a load allocation for nonpoint sources necessary for attainment of water quality standards. Point source contributions enter the stream directly in the appropriate reach. The nonpoint fecal coliform sources used in the model have two different transportation methods. Cows in the stream and failing septic tanks were modeled as direct inputs to the stream. The other nonpoint source contributions were applied to land area on a counts per day per acre basis. The fecal coliform bacteria applied to land are subject to a die-off rate and an absorption rate before it enters the stream. The TMDL was calculated based on modeling estimates which are referenced in Appendix A.

5.1 Wasteload Allocations

Point sources within the watershed discharging at their current level are subject to some reduction from their current level of fecal coliform contribution. The contribution of point sources was considered on a subwatershed basis for the model. Within each subwatershed, the modeled contribution of each discharger was based on the facility's discharge monitoring data and other records of past performance. In several cases, the fecal coliform contribution from a facility is much greater than the permitted limit of 200 counts per 100 ml. As part of this TMDL, all wastewater treatment facilities will be required to meet water quality standards at the end of their pipe. All wastewater treatment facilities with current NPDES Permits that meet water quality standards should take steps to comply with their current permits. Table 5.1.1 lists the point source contributions, on a subwatershed basis, along with their existing load, allocated load, and percent reduction.

Table 5.1.1 Wasteload Allocations

Subwatershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
03180001022	0.02	3.90E+07	0.02	5.04E+06	87%
03180001023	0.05	9.45E+06	0.05	9.45E+06	0%
03180001025	0.06	1.16E+08	0.06	1.16E+07	90%
03180001027	2.52	5.13E+09	2.52	5.13E+08	90%
03180001028	0.08	1.57E+08	0.08	1.57E+07	90%
03180001031	0.12	2.36E+08	0.12	2.36E+07	90%
03180001032	0.67	1.37E+09	0.67	1.37E+08	90%
03180001036	0.21	4.31E+07	0.21	4.31E+07	0%
03180001039	0.02	3.15E+06	0.02	3.15E+06	0%
03180001041	1.01	2.60E+09	1.01	2.06E+08	92%
03180001042	0.07	7.08E+08	0.07	1.42E+08	80%
03180001050	3.67	7.46E+09	3.67	7.46E+09	0%

5.2 Load Allocations

Nonpoint sources that contribute to fecal coliform accumulation within the Pearl River Watershed are subject to reduction from their current level of contribution. Reductions in the load allocation for this TMDL involve two different types of nonpoint sources: cattle access to streams and septic tanks. Contributions from both of these sources are input into the model in a manner similar to point source input, with a flow and fecal coliform concentration in counts per hour. Table 5.2.1 lists the nonpoint source contributions due to cattle access to streams, on a subwatershed basis, along with their existing load, allocated load, and percent reduction. Table 5.2.2 gives the same parameters for contributions due to septic tank failure.

Table 5.2.1 Fecal Coliform Loading Rates for Nonpoint Source Contribution of Cattle Access to Streams

Subwatershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
03180001020	1.58E-04	6.02E+09	7.88E-06	3.01E+08	95%
03180001021	9.42E-07	3.60E+07	4.71E-08	1.80E+06	95%
03180001022	3.97E-04	1.52E+10	1.98E-05	7.58E+08	95%
03180001023	2.58E-04	9.87E+09	1.29E-05	4.94E+08	95%
03180001024	3.75E-04	1.43E+10	1.87E-05	7.16E+08	95%
03180001025	3.59E-05	1.37E+09	1.79E-06	6.86E+07	95%
03180001026	1.88E-05	7.17E+08	9.38E-07	3.59E+07	95%
03180001027	1.77E-04	6.75E+09	8.83E-06	3.37E+08	95%
03180001028	1.07E-04	4.08E+09	5.34E-06	2.04E+08	95%
03180001029	1.82E-04	6.94E+09	9.09E-06	3.47E+08	95%
03180001030	1.16E-04	4.42E+09	5.78E-06	2.21E+08	95%
03180001031	3.03E-04	1.16E+10	1.51E-05	5.79E+08	95%
03180001032	1.06E-06	4.05E+07	5.30E-08	2.03E+06	95%
03180001033	3.40E-05	1.30E+09	1.70E-06	6.50E+07	95%
03180001034	3.37E-04	1.29E+10	1.69E-05	6.44E+08	95%
03180001035	1.59E-04	6.07E+09	7.95E-06	3.04E+08	95%
03180001036	9.52E-04	3.64E+10	4.76E-05	1.82E+09	95%
03180001037	4.44E-05	1.70E+09	2.22E-06	8.49E+07	95%
03180001038	5.80E-04	2.21E+10	2.90E-05	1.11E+09	95%
03180001039	2.91E-04	1.11E+10	1.46E-05	5.56E+08	95%
03180001040	9.45E-05	3.61E+09	4.73E-06	1.81E+08	95%
03180001041	5.01E-04	1.92E+10	2.51E-05	9.58E+08	95%
03180001042	1.84E-04	7.02E+09	9.19E-06	3.51E+08	95%
03180001043	1.25E-04	4.77E+09	6.25E-06	2.39E+08	95%
03180001044	6.66E-05	2.54E+09	3.33E-06	1.27E+08	95%
03180001045	2.62E-05	1.00E+09	1.31E-06	5.01E+07	95%
03180001046	6.57E-05	2.51E+09	3.28E-06	1.25E+08	95%
03180001047	2.00E-04	7.64E+09	9.99E-06	3.82E+08	95%
03180001048	2.19E-04	8.38E+09	1.10E-05	4.19E+08	95%
03180001049	6.33E-05	2.42E+09	3.16E-06	1.21E+08	95%
03180001050	2.38E-04	9.09E+09	1.19E-05	4.54E+08	95%
Total	**6.31E-03**	**2.41E+11**	**3.15E-04**	**1.21E+10**	**95%**

Table 5.2.2 Fecal Coliform Loading Rates for Failing Septic Tanks (50% WLA and 50% LA)

Subwatershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
03180001020	1.12E-01	1.14E+09	2.23E-02	2.27E+08	80%
03180001021	1.97E-03	2.01E+07	3.95E-04	4.01E+06	80%
03180001022	9.37E-02	9.54E+08	1.87E-02	1.91E+08	80%
03180001023	1.05E-01	1.06E+09	2.09E-02	2.13E+08	80%
03180001024	9.57E-02	9.74E+08	1.91E-02	1.95E+08	80%
03180001025	3.05E-02	3.11E+08	6.11E-03	6.22E+07	80%
03180001026	2.21E-02	2.25E+08	4.42E-03	4.50E+07	80%
03180001027	8.57E-02	8.72E+08	1.71E-02	1.74E+08	80%
03180001028	3.52E-02	3.58E+08	7.04E-03	7.16E+07	80%
03180001029	4.80E-02	4.88E+08	9.59E-03	9.76E+07	80%
03180001030	3.37E-02	3.43E+08	6.74E-03	6.86E+07	80%
03180001031	8.56E-02	8.71E+08	1.71E-02	1.74E+08	80%
03180001032	1.94E-03	1.97E+07	3.88E-04	3.95E+06	80%
03180001033	1.90E-02	1.93E+08	3.80E-03	3.86E+07	80%
03180001034	1.27E-01	1.29E+09	2.54E-02	2.59E+08	80%
03180001035	3.03E-02	3.08E+08	6.06E-03	6.16E+07	80%
03180001036	1.49E-01	1.51E+09	2.98E-02	3.03E+08	80%
03180001037	8.04E-03	8.18E+07	1.61E-03	1.64E+07	80%
03180001038	6.18E-02	6.28E+08	1.24E-02	1.26E+08	80%
03180001039	6.15E-02	6.26E+08	1.23E-02	1.25E+08	80%
03180001040	2.45E-02	2.49E+08	4.89E-03	4.98E+07	80%
03180001041	1.35E-01	1.37E+09	2.70E-02	2.75E+08	80%
03180001042	6.03E-02	6.14E+08	1.21E-02	1.23E+08	80%
03180001043	5.89E-02	5.99E+08	1.18E-02	1.20E+08	80%
03180001044	3.50E-02	3.56E+08	7.00E-03	7.12E+07	80%
03180001045	3.43E-02	3.49E+08	6.86E-03	6.98E+07	80%
03180001046	2.31E-02	2.35E+08	4.62E-03	4.71E+07	80%
03180001047	8.88E-02	9.04E+08	1.78E-02	1.81E+08	80%
03180001048	1.74E-01	1.77E+09	3.48E-02	3.54E+08	80%
03180001049	2.92E-02	2.97E+08	5.84E-03	5.94E+07	80%
03180001050	4.98E-02	5.07E+08	9.97E-03	1.01E+08	80%
Total	**1.92E+00**	**1.95E+10**	**3.84E-01**	**3.91E+09**	**80%**

Nonpoint fecal coliform loading due to cattle grazing; land application of manure produced by confined dairy cattle, hogs, and poultry; wildlife; and urban development are also included in the load allocation. Currently, no reduction is required for these contributors in order for the Pearl River to achieve water quality standards. Daily fecal coliform loading rates for each landuse are given in Table 5.2.3. The total accumulation for each landuse type was determined by combining the contributions from each subwatershed. For example, the loading rate for forests was determined by combining all of the forest contributions from each of the five subwatersheds. The loading rates are constant throughout the year for forest, cropland, and urban land. The loading rates for pastureland vary for each month. However, in the table, the given pastureland rate is based on an average of the monthly accumulation rates.

Table 5.2.3Number of Bacteria Applied to Land, Available for Surface Runoff, in Counts per Day

Subwatershed	Urban & Barren	Forest & Wetland	Cropland	Pastureland	Total
03180001020	5.63E+09	1.17E+12	2.11E+10	1.60E+13	1.72E+13
03180001021	0.00E+00	2.21E+10	6.25E+08	9.61E+10	1.19E+11
03180001022	0.00E+00	9.08E+11	1.80E+10	3.94E+13	4.03E+13
03180001023	0.00E+00	1.19E+12	3.28E+10	2.58E+13	2.70E+13
03180001024	5.27E+07	8.64E+11	8.42E+09	3.53E+13	3.62E+13
03180001025	1.40E+08	3.24E+11	1.52E+09	3.40E+12	3.73E+12
03180001026	0.00E+00	2.46E+11	9.77E+08	1.78E+12	2.03E+12
03180001027	7.69E+09	7.68E+11	1.83E+10	1.67E+13	1.75E+13
03180001028	0.00E+00	3.24E+11	1.63E+09	1.01E+13	1.04E+13
03180001029	0.00E+00	4.66E+11	1.72E+09	1.71E+13	1.75E+13
03180001030	0.00E+00	3.15E+11	4.18E+09	1.09E+13	1.12E+13
03180001031	1.58E+08	7.85E+11	7.81E+09	2.85E+13	2.93E+13
03180001032	0.00E+00	1.88E+10	0.00E+00	9.99E+10	1.19E+11
03180001033	0.00E+00	1.90E+11	4.53E+08	3.20E+12	3.39E+12
03180001034	8.82E+08	1.15E+12	1.26E+10	3.15E+13	3.27E+13
03180001035	0.00E+00	2.82E+11	3.76E+09	1.16E+13	1.19E+13
03180001036	1.14E+08	2.05E+12	1.39E+10	6.26E+13	6.46E+13
03180001037	0.00E+00	8.70E+10	2.37E+09	2.38E+12	2.47E+12
03180001038	0.00E+00	8.32E+11	5.61E+10	2.75E+13	2.84E+13
03180001039	7.81E+07	8.00E+11	1.01E+10	1.39E+13	1.47E+13
03180001040	1.67E+09	3.17E+11	5.46E+09	4.55E+12	4.87E+12
03180001041	6.19E+09	1.90E+12	4.08E+10	2.47E+13	2.66E+13
03180001042	3.43E+08	8.28E+11	1.03E+10	9.54E+12	1.04E+13
03180001043	0.00E+00	8.03E+11	9.19E+09	7.45E+12	8.26E+12
03180001044	0.00E+00	4.14E+11	1.18E+09	5.85E+12	6.26E+12
03180001045	0.00E+00	4.16E+11	4.23E+09	2.44E+12	2.86E+12
03180001046	0.00E+00	2.56E+11	5.41E+09	6.56E+12	6.82E+12
03180001047	0.00E+00	1.11E+12	1.53E+10	1.91E+13	2.02E+13
03180001048	0.00E+00	3.39E+12	2.12E+10	2.05E+13	2.39E+13
03180001049	0.00E+00	5.54E+11	1.05E+10	3.86E+12	4.42E+12
03180001050	0.00E+00	4.82E+11	1.09E+10	2.37E+13	2.42E+13
Total	**2.30E+10**	**2.32E+13**	**3.51E+11**	**4.86E+14**	**5.10E+14**

The scenario chosen for the load allocation in the Pearl River Watershed is a 95% reduction in contributions from cows in the stream, and a 80% reduction from failing septic tanks. The scenario also requires all permitted dischargers to meet water quality standards for disinfection. This scenario could be achieved by supporting BMP projects that promote fencing around streams in pastures, and by supporting education projects that encourage homeowners to properly maintain their septic tanks by routinely pumping them out, repairing broken field lines, and disinfecting the effluent from small individual onsite wastewater treatment plants.

5.3 Incorporation of a Margin of Safety

The two types of MOS development are to implicitly incorporate the MOS using conservative model assumptions or to explicitly specify a portion of the total TMDL as the MOS. The MOS selected for this model is implicit. Running the model for 11 years with no violations of the water quality standard provides the primary component of the MOS. Ensuring compliance with the standard throughout all of the critical condition periods represented during the 11 years is a conservative practice. Another component of the MOS is the conservative assumption that in the model all of the fecal coliform bacteria discharged from failing septic tanks reaches the stream, while it is likely that only a portion of the bacteria will reach the stream due to filtration and die off during transport.

5.4 Seasonality

For many streams in the state, fecal coliform limits vary according to the seasons. This stream is designated for the use of secondary contact recreation. For this use, the pollutant standard changes seasonally.

Because the model was established for an 11-year time span, it took into account all of the seasons within the calendar years from 1985 to 1995. The extended time period allowed the simulation of many different atmospheric conditions such as rainy and dry periods and high and low temperatures. It also allowed seasonal critical conditions to be simulated.

6.0 IMPLEMENTATION

6.1 Follow-Up 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, the Pearl River may receive follow-up monitoring to identify the improvement in water quality from the implementation of the strategies in this TMDL.

6.2 Reasonable Assurance

The fecal coliform reduction scenario used by this TMDL includes requiring all NPDES Permitted dischargers of fecal coliform to meet water quality standards for disinfection, along with reducing 95% of the cattle access to streams and 80% of the failing septic tanks in the watershed. Reasonable assurance for the implementation of the TMDL has been considered for both point and nonpoint source contributors.

The TMDL will not impact existing or future NPDES Permits as long as the effluent is disinfected to meet water quality standards for fecal coliform bacteria. MDEQ will reject any NPDES Permit application that does not plan to meet water quality standards for disinfection. 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.

6.3 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. At the end of the 30-day period, MDEQ will determine the level of interest in the TMDL and make a decision on the necessity of holding a public hearing.

If a public hearing is deemed appropriate, the public will be given a 30-day notice of the hearing to be held at a location near the watershed. That public hearing would be an official hearing of the Mississippi Commission on Environmental Quality, and would be transcribed.

All comments received during the public notice period and at any public hearings become a part of the record of this TMDL. All comments will be considered in the ultimate approval of this TMDL by the Commission on Environmental Quality and for submission of this TMDL to EPA Region IV 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 waterbody may be based upon a similar, unaltered or least impaired, waterbody 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 waterbody.

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

Daily discharge: the "discharge of a pollutant" measured during a 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 waterbody 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 Waterbody: any waterbody 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 cattle and land applied fecal coliform that enter a receiving waterbody. 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.

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: the calculated maximum permissible pollutant loading to a waterbody at which water quality standards can be maintained.

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.

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 Resources 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

USGS .... United States Geological Survey

WLA ....Waste Load Allocation

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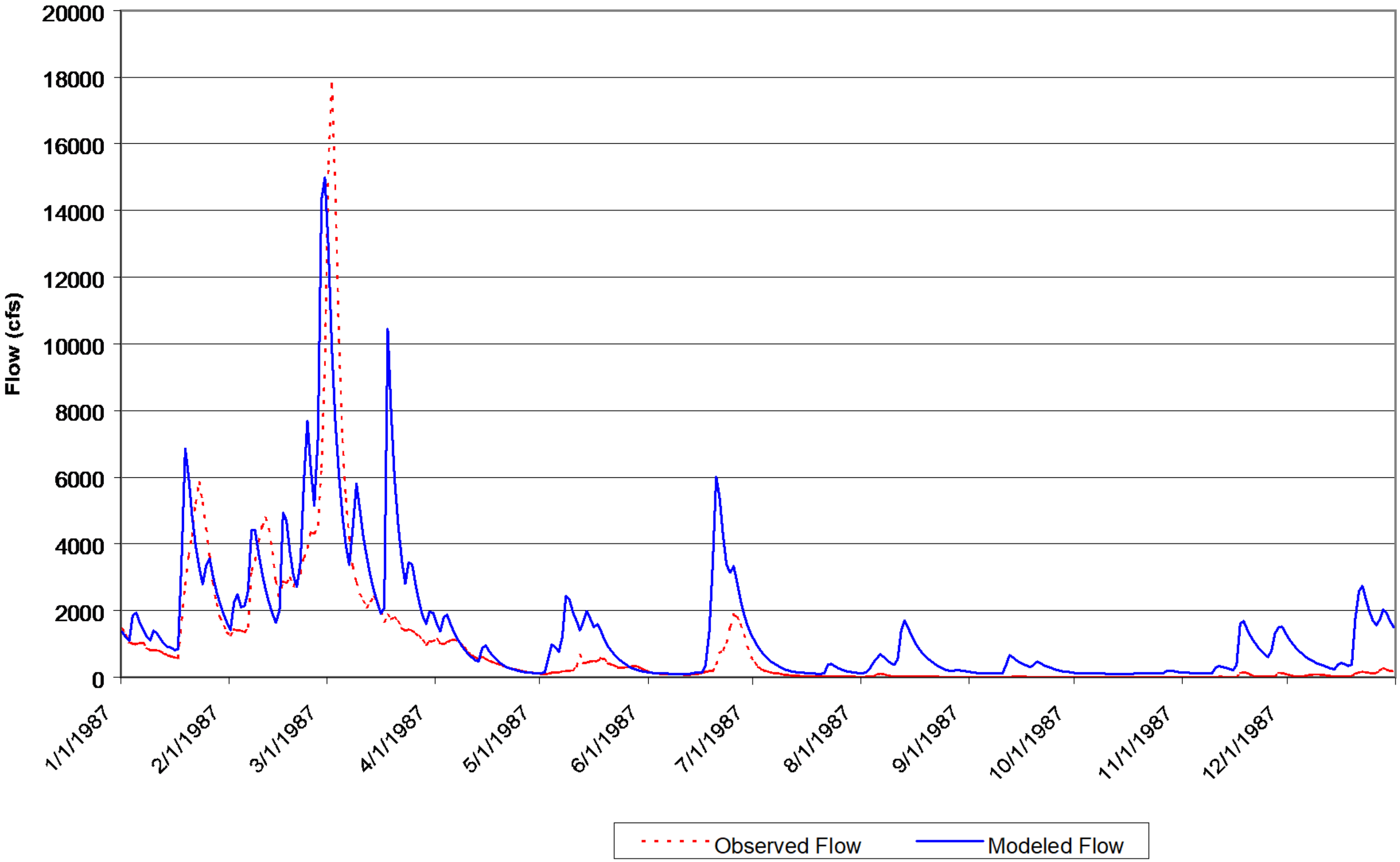
APPENDIX A

This appendix contains printouts of the various model run results. All graphs represent an 11-year time period, from January 1, 1985, to December 31, 1995. Graphs A-1 through A-3 show the modeled flow, in cubic feet per second, through reach 03180001023 compared to the actual USGS gage readings from the Pearl River at Edinburg. The second set of graphs show the 30-day geometric mean for fecal coliform concentrations in counts per 100 ml in the impaired section of the Pearl River, reach 03180001023. The graphs contain a reference line at 200 counts per 100 ml. Graph A-4 represents the existing conditions in the Pearl River. There are 30 violations of the fecal coliform standard on this graph. Graph A-5 represents the conditions in the Pearl River after the reduction scenario has been applied. Graphs A-4 and A-5 are shown with the same scale for comparison purposes.

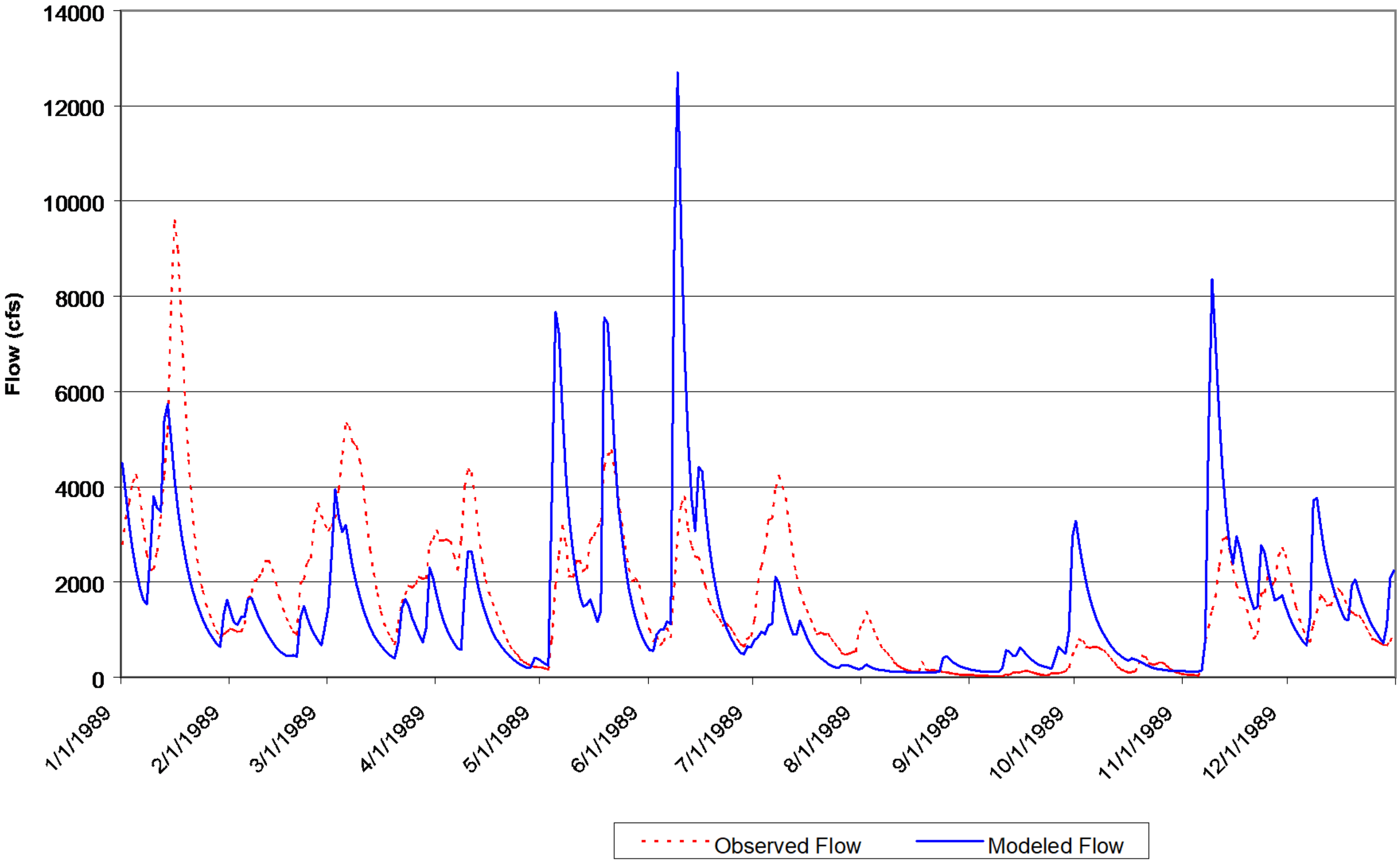
The TMDL calculated in this report represents the maximum fecal coliform load that can be assimilated by the waterbody segment during the critical 30-day period that will maintain water quality standards. The calculation of this TMDL is based on the critical hydrologic flow condition that occurred during the modeled time span. The graph showing the 30-day geometric mean of instream fecal coliform concentrations representing the allocated loading scenario (Graph A-5) was used to identify the critical condition. The TMDL calculation includes the sum of the loads from all identified point and nonpoint sources applied or discharged within the modeled watershed.

An individual TMDL calculation was prepared for each waterbody segment and drainage area included in this report. The numerical values for the wasteload allocation (point sources) and load allocation (nonpoint sources) for each waterbody segment or drainage area can be found on the waterbody segment identification pages at the beginning of this report.

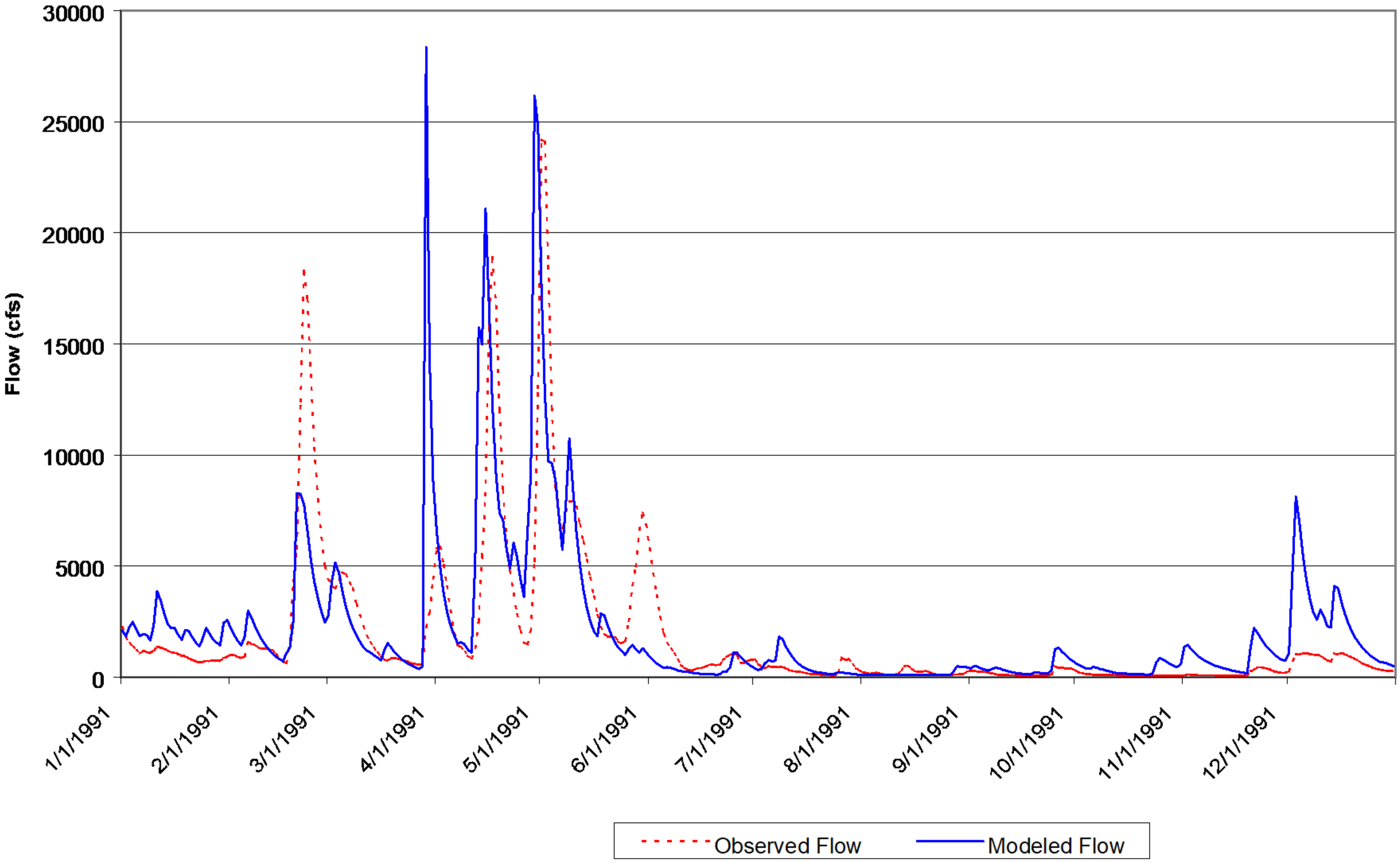
Graph A-1 Daily Flow Comparison between USGS Gage 02482000 and Reach 03180001023 for 1/1/1987 - 12/31/1987



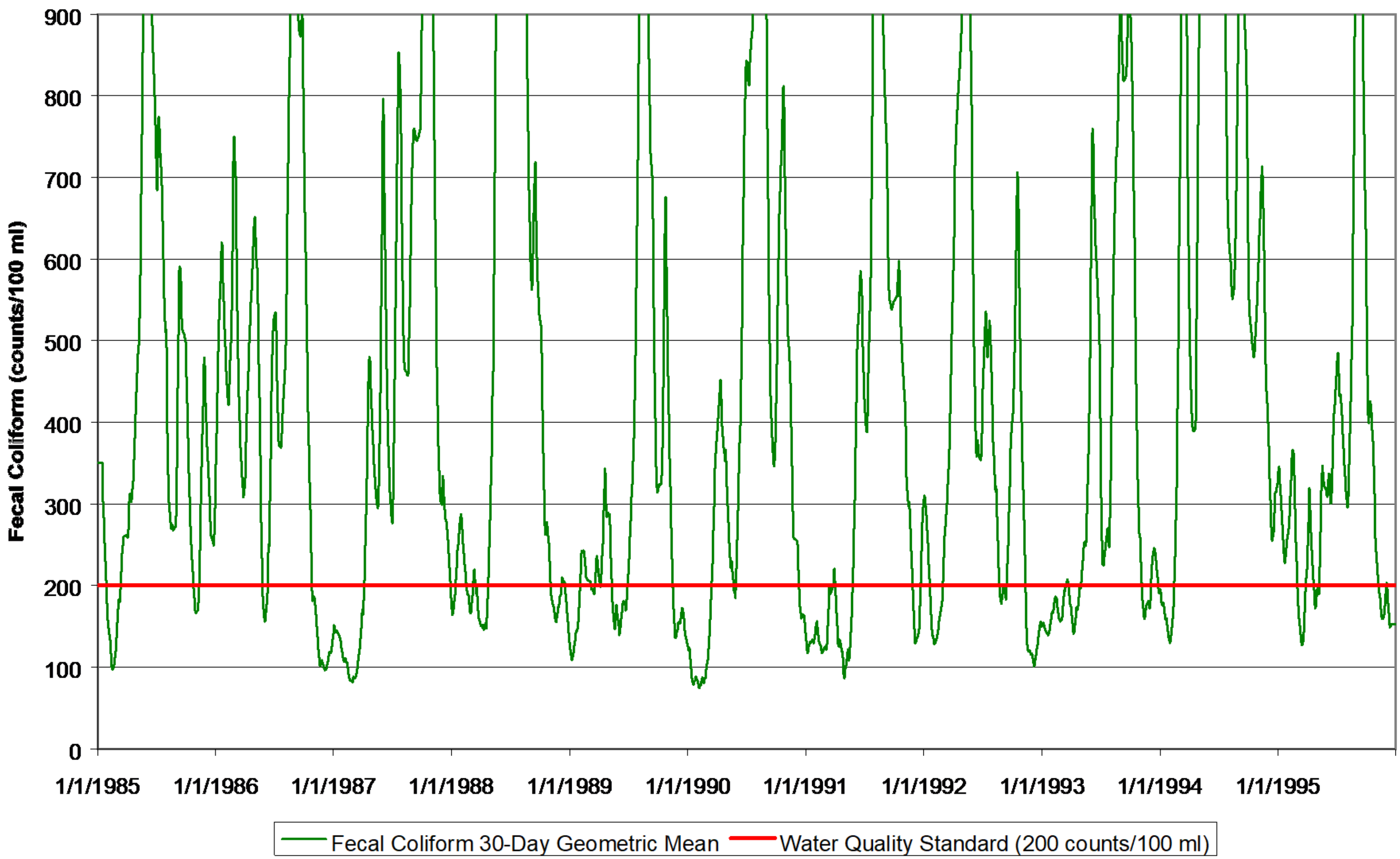
Graph A-2 Daily Flow Comparison between USGS Gage 02482000 and Reach 03180001023 for 1/1/1989 - 12/31/1989



Graph A-3 Daily Flow Comparison between USGS Gage 02482000 and Reach 03180001023 for 1/1/1991 - 12/31/1991



Graph A-4 Modeled Fecal Coliform Concentrations Under Existing Conditions for Reach 03180001023



Graph A-5 Modeled Fecal Coliform Concentrations After Application of Reduction Scenario for Reach 03180001023