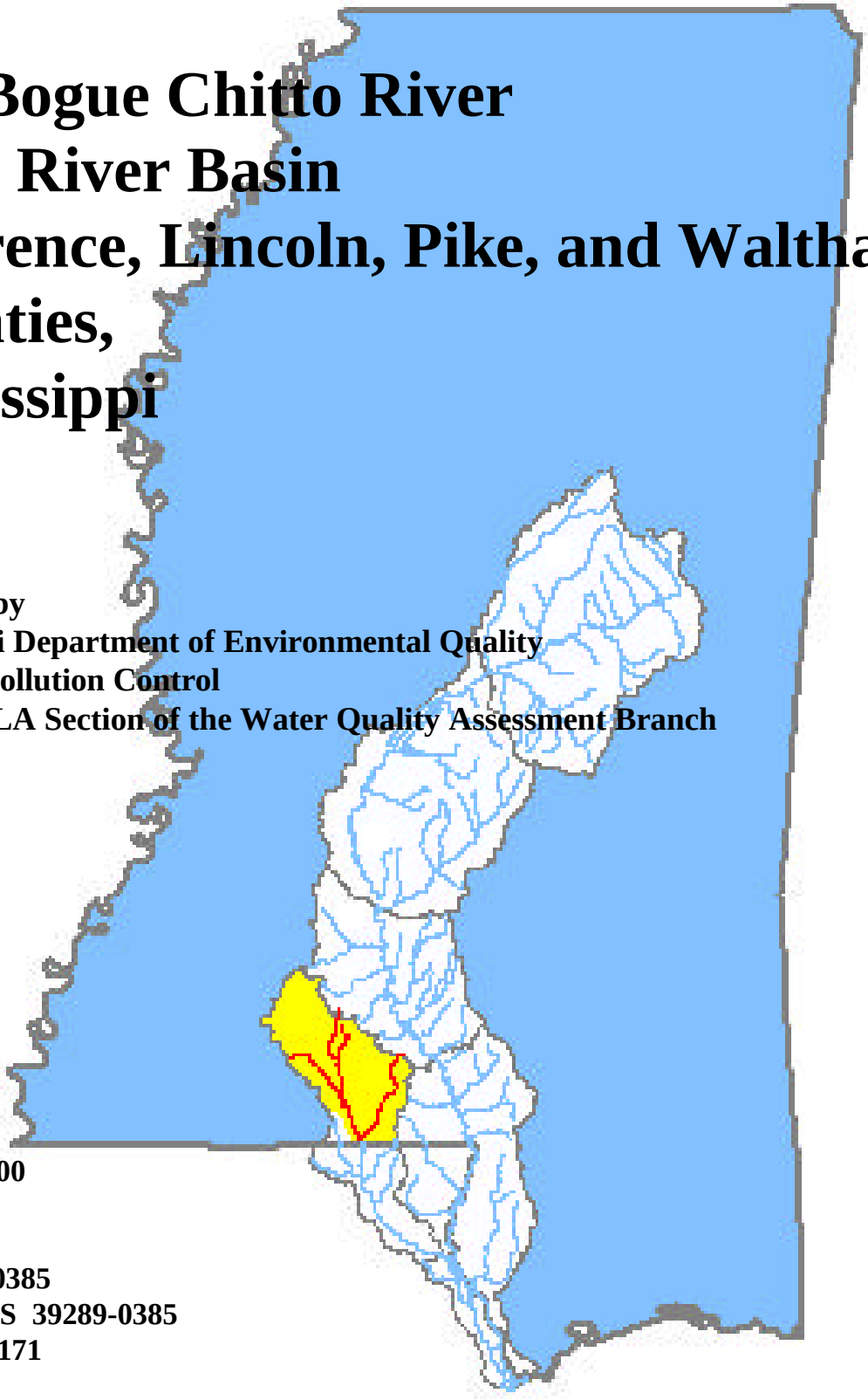
Fecal Coliform TMDL
For
The Bogue Chitto River
Pearl River Basin
Lawrence, Lincoln, Pike, and Walthall Counties,
Mississippi



Prepared by
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May 19, 2000

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FOREWORD

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

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

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MONITORED SEGMENT IDENTIFICATION

Name:	Bogue Chitto River segment 1
Waterbody ID:	MSBGCHTRM1
Location:	Near Enterprise: From Confluence of Halbert Branch and East Bogue Chitto to Confluence of Boone Creek
County:	Lincoln County, Mississippi
USGS HUC Code:	03180005
NRCS Watershed:	010
Length:	7 miles
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Fecal Coliform, an Indicator for the Presence of Pathogenic Bacteria
Priority Rank:	13
NPDES Permits:	There are three NPDES Permits issued for facilities that potentially discharge fecal coliform in the watershed (Table 3.1).
Standards Variance:	None
Pollutant Standard:	May through October - Geometric Mean of 200 per 100 ml, Less Than 10 percent of the Samples may exceed 400 per 100 ml November through April - Geometric mean of 2000 per 100 ml, Less Than 10 percent of the Samples may exceed 4000 per 100 ml.
Waste Load Allocation:	0.78E+12 counts/ 30 days (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	0.72E+12 counts/ 30 days
Margin of Safety:	Implicit modeling assumptions - The model was run for a time span of 11 years.
Total Maximum Daily Load (TMDL):	1.50E+12 counts/ 30 days 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 necessary to meet the fecal coliform standard.

MONITORED SEGMENT IDENTIFICATION

Name:	Bogue Chitto River segment 4
Waterbody ID:	MSBGCHTRM4
Location:	Near Lehr: From Highway 48 to Louisiana State Line
County:	Walthall County, Mississippi
USGS HUC Code:	03180005
Length:	13 miles
Use Impairment:	Contact Recreation
Cause Noted:	Fecal Coliform, an Indicator for the Presence of Pathogenic Bacteria
Priority Rank:	8
NPDES Permits:	There are 21 NPDES Permits issued for facilities that potentially discharge fecal coliform in the watershed (Table 3.1).
Standards Variance:	None
Pollutant Standard:	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.
Waste Load Allocation:	2.23E+12 counts/ 30 days (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	9.15E+12 counts/ 30 days
Margin of Safety:	Implicit modeling assumptions - The model was run for a time span of 11 years.
Total Maximum Daily Load (TMDL):	11.38E+12 counts/ 30 days 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 necessary to meet the fecal coliform standard.

EXECUTIVE SUMMARY

Two segments of the Bogue Chitto River have been placed on the Mississippi 1998 Section 303(d) List of Waterbodies as impaired waterbody segments due to fecal coliform bacteria. For these waterbody segments, the applicable state standard for Contact Recreation specifies that the maximum allowable level of fecal coliform 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. The applicable state standard for Secondary Contact Recreation specifies that from May through October the fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml, nor shall more than 10 percent of the samples examined during any month exceed a colony count of 400 per 100 ml, and that from November through April the fecal coliform colony counts shall not exceed a geometric mean of 2000 per 100 ml, nor shall more than 10 percent of the samples examined during any month exceed a colony count of 4000 per 100 ml. A review of the available monitoring data indicates that there is a violation of these standards within the Bogue Chitto River.

The Bogue Chitto River flows in a southeastern direction from its headwaters to the confluence with Boone Creek in Lincoln County, with Topisaw Creek and Leatherwood Creek in Pike County, and with Magees Creek in Walthall County. This TMDL, however, has been developed for the segments within the Bogue Chitto River Watershed found on the 303(d) List as impaired. The seven-mile long impaired section of the river, MSBGCHTRM1, is in Lincoln County near Enterprise from the confluence of Halbert Branch and East Bogue Chitto to the confluence of Boone Creek. The 13-mile long impaired section of the river, MSBGCHTRM4, is in Walthall County near Lehr from Highway 48 to the Louisiana State Line. The BASINS Nonpoint Source Model (NPSM) was selected as the modeling framework for performing the TMDL allocations for this study. Daily flow values from the USGS gage 02490500 on the Bogue Chitto River near Tylertown, MS were used to calibrate the hydrologic flow for the watershed. The weather data used for this model were collected at Ruth, MS. The representative hydrologic period used for this TMDL was January 1985 through December 1995.

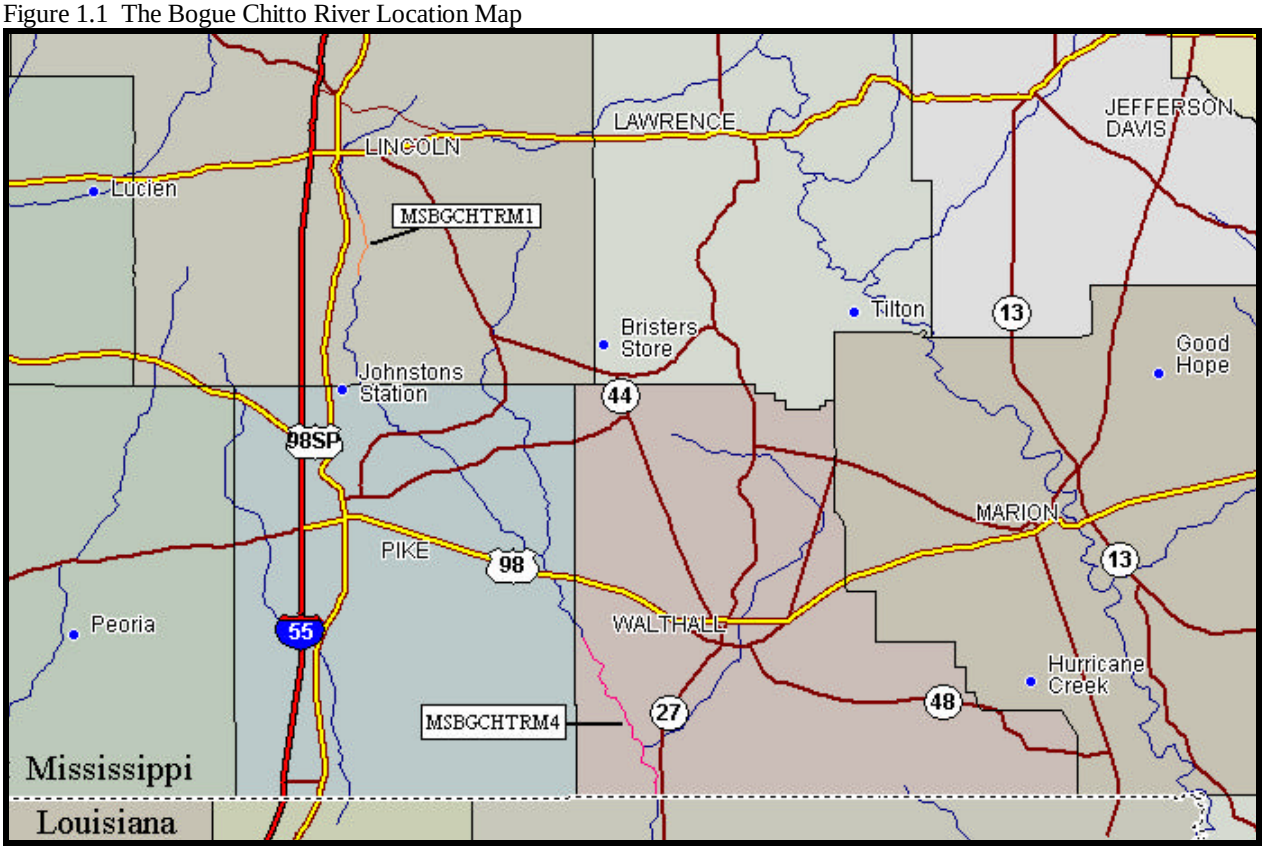
Fecal coliform loading from nonpoint sources in the watershed were calculated based upon wildlife populations; numbers of cattle, hogs, and chickens; information on livestock and manure management practices for the Pearl River Basin; and urban development. The estimated fecal coliform production and 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 Bogue Chitto River. There are 21 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 geometric mean 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 Bogue Chitto River Watershed. First, all NPDES facilities would 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 Bogue Chitto River Watershed should be continued to ensure that compliance with permit limits is consistently attained. Second is the

reduction of 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 reduction in the fecal coliform contribution from failing septic tanks may be required. This TMDL assumed a high failure rate for 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.

Figure 1.1 The Bogue Chitto River Location Map



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 two segments of the Bogue Chitto River as being impaired by fecal coliform bacteria for a length of 7 miles and 13 miles as reported in the Mississippi 1998 Section 303(d) List of Waterbodies. These segments are listed as impaired because sufficient monitoring data is available to show impairment in the segments. The impaired segment, MSBGCHTRM1, begins at the confluence of Halbert Branch and East Bogue Chitto and continues to the confluence of Boone Creek. The impaired segment, MSBGCHTRM4, begins at Highway 48 and continues to the Louisiana State Line. These monitored segments are shown in Figure 1.2.

In order to analyze the sources of fecal coliform bacteria in the Bogue Chitto River Watershed, the entire drainage area was divided into seven separate subwatersheds. The monitored segment MSBGCHTRM1 is contained entirely within watershed 03180005-012. The monitored segment MSBGCHTRM4 is contained within two subwatersheds. The upper portion of the impaired segment is in subwatershed 03180005-008, while the lower portion of the impaired segment in subwatershed 03180005-006. The load and wasteload allocations required for this TMDL are based on water quality in the most downstream subwatershed, 03180005-006.

The entire Bogue Chitto River Watershed is in the Pearl River Basin Hydrologic Unit Code (HUC) 03180005 in south-central Mississippi. The drainage area of the Bogue Chitto River Watershed is approximately 504,600 acres; and lies within portions of Lawrence, Lincoln, Marion, Pike, and Walthall Counties. The watershed is mostly rural in nature but includes the major city of Brookhaven.

As shown in Figure 1.2, the impaired segment (MSBGCHTRM1) is upstream of the other impaired segment (MSBGCHTRM4). MSBGCHTRM1 is located entirely within subwatershed 03180005-012. MSBGCHTRM4 is located within two subwatersheds, 03180005-008 and 03180005-006. The Bogue Chitto River crosses the Mississippi-Louisiana State Line. However, the impaired segment MSBGCHTRM4 ends at the state line. Table 1.1 lists the subwatersheds along with their corresponding stream and acreage. Forest and pastureland are the dominant landuses within this watershed. Figure 3.1 shows the landuse distribution within both the monitored and evaluated drainage areas. The landuse distribution in acres is given in Table 3.2.

Figure 1.2 The Bogue Chitto River Watershed

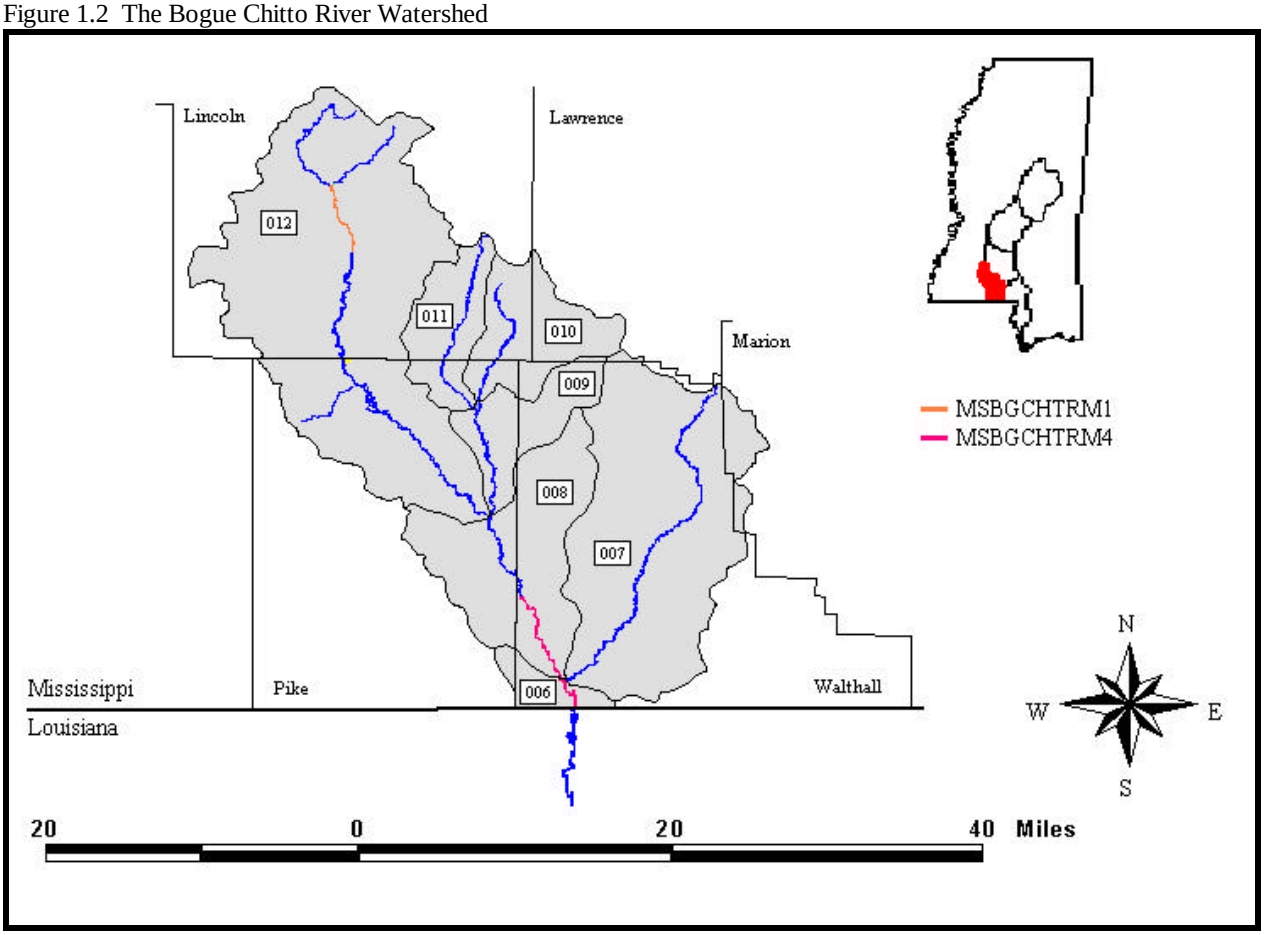


Table 1.1 The Bogue Chitto River Subwatersheds

Subwatershed	Stream Name	Area (acres)
03180005-006	Bogue Chitto River	9,326
03180005-007	Magees Creek	137,512
03180005-008	Bogue Chitto River	70,453
03180005-009	Topisaw Creek	28,190
03180005-010	East Topisaw Creek	37,555
03180005-011	West Topisaw Creek	28,071
03180005-012	Bogue Chitto River	193,481
Total		**504,588**

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 water use classification for impaired segment MSBGCHTRM1 as defined by the regulations is Fish and Wildlife Support. The designated beneficial uses for impaired segment MSBGCHTRM1 are Secondary

Contact Recreation and Fish and Wildlife Support. The water use classifications for impaired segment MSBGCHTRM4 as defined by the regulations are Contact Recreation and Fish and Wildlife Support. The designated beneficial uses for impaired segment MSBGCHTRM4 are Contact Recreation and Fish and Wildlife Support. Secondary Contact Recreation is defined as incidental contact with the water, including wading and occasional swimming.

1.3 Applicable Waterbody Segment Standard

According to the Mississippi 1998 Section 303(d) List of Waterbodies segment MSBGCHTRM1 of the Bogue Chitto River is impaired for the use of Secondary Contact Recreation. The water quality standard applicable to Secondary Contact Recreation 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 from May through October the fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml, nor shall more than 10 percent of the samples examined during any month exceed a colony count of 400 per 100 ml, and that from November through April the fecal coliform colony counts shall not exceed a geometric mean of 2000 per 100 ml, nor shall more than 10 percent of the samples examined during any month exceed a colony count of 4000 per 100 ml. According to the Mississippi 1998 Section 303(d) List of Waterbodies segment MSBGCHTRM4 of the Bogue Chitto River is impaired for the use of Contact Recreation. The water quality standard applicable to Contact Recreation and the pollutant of concern is also defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. The standard states that the fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml, nor shall more than 10 percent of the samples examined during any month exceed a colony count of 400 per 100 ml. These water quality standards 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 Conditions

One of the major components of a TMDL is the establishment of instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints, therefore, represent the water quality goals that are to be achieved by implementing the load and wasteload reductions specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. The 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 derived within 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 used to find the 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 segments of the Bogue Chitto River show that high levels of fecal coliform bacteria impair the stream. There are two ambient stations operated by MDEQ that collected fecal coliform monitoring data during the 11-year modeling period. Monitoring for flow and fecal coliform continued on a bimonthly basis at station 02490270 at Thayer Bridge near Enterprise beginning in January 1990 and ending in November 1993. At station 02490900 near Lehr, MDEQ collected bimonthly fecal coliform samples and flow measurements between January 1984 and 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, Bogue Chitto River impaired segment MSBGCHTRM1 is partially supporting the uses of Secondary Contact Recreation, Fish Consumption, and Aquatic Life Support. According to the report, Bogue Chitto River impaired segment MSBGCHTRM4 is not supporting the use of Contact Recreation, partially supporting the use of Fish Consumption, and threatened for the use of Aquatic Life Support. These conclusions were based on instantaneous data collected at stations 02490270 (MSBGCHTRM1) and 02490900 (MSBGCHTRM4). Data collected at stations 02490270 and 02490900 are listed in Tables 2.1 and 2.2 respectively.

Table 2.1 Fecal Coliform Data Reported in the Bogue Chitto River, Station #02490270

Date	Flow (cfs)	Fecal Coliform (counts/100 ml)
01/08/90	800	70
03/06/90	52	130
05/01/90	6	220
07/09/90	49	**1,300**
09/05/90	9	**9,200**
11/05/90	14	490
01/07/91	44	790
03/04/91	180	260
05/06/91	680	**16,000**
07/08/91	140	**24,000**
09/09/91	23	20
11/04/91	20	1,450
01/06/92	17	2,200
03/02/92	25	20
05/04/92	17	330
07/13/92	9	**920**
09/14/92	12	280
11/02/92	252	2,200
01/11/93	133	940
03/08/93	39	40
05/03/93	530	**920**
07/12/93	77	**920**
11/01/93	15	**24,000**

Table 2.2 Fecal Coliform Data Reported in the Bogue Chitto River, Station #02490900

Date	Flow (cfs)	Fecal Coliform (counts/100 ml)
01/07/91	4,100	**490**
03/04/91	5,100	**490**
05/06/91	10,000	**9,200**
07/08/91	1,750	**3,500**
09/09/91	1,180	2
11/04/91	855	350
01/06/92	567	**490**
03/02/92	1,040	110
05/04/92	660	230
07/13/92	482	220
09/14/92	589	240
11/02/92	796	20
01/11/93	3,560	**16,000**
03/08/93	1,400	40
05/02/93	6,140	350
07/12/93	717	110
09/14/93	584	**3,500**
11/01/93	740	**24,000**
01/10/94	1,150	**16,000**
03/08/94	3,000	**1,100**
05/02/94	800	130
06/20/94	850	**630**
08/24/94	580	**790**
11/07/94	654	**9,200**
01/10/95	650	350
03/06/95	1,200	**1,300**
04/17/95	2,000	110
07/10/95	540	33
09/11/95	430	33
11/06/95	650	130
01/10/96	670	33
03/05/96	640	140
05/06/96	600	33
07/10/96	523	49
09/12/96	500	14

2.2.2 Analysis of Instream Water Quality Monitoring Data

A statistical summary of the water quality data discussed above is presented in Table 2.3. Because the designated use of segment MSBGCHTRM1 is Secondary Contact Recreation, samples from station number 02490270 are compared to the instantaneous maximum standard of 400 counts per 100 ml for the recreation season of May through October and the instantaneous maximum standard

of 4000 counts per 100 ml for November through April. Because the designated use of segment MSBGCHTRM4 is Contact Recreation, samples from station number 02490900 are compared to the instantaneous maximum standard of 400 counts per 100 ml for the entire year. 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 2.3 Statistical Summaries

Station Number	Number of Samples	Minimum Value (counts/100ml)	Maximum Value (counts/100ml)	Number of Exceedances	Percent Instantaneous Exceedance
02490270	23	20	24,000	8	35%
02490900	35	2	24,000	14	40%

3.0 SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential fecal coliform sources in the Bogue Chitto 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.

The Bogue Chitto River was generally divided into a new reach at the confluence of each major tributary. The watershed delineations were based primarily on an analysis of the Reach File 3 (RF3) stream network in the basin as well as a topographic analysis of the watershed.

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 21 wastewater treatment plants in the Bogue Chitto River Watershed serve a variety of activities including residential subdivisions, schools, recreational areas, and other businesses.

A point source assessment was completed for each subwatershed in the Bogue Chitto River drainage area. Figure 1.2 shows a map of the drainage areas of the impaired sections of the Bogue Chitto River and the division of the Bogue Chitto River Watershed into subwatersheds. Table 1.1 shows an 11-digit identification number for each of the subwatersheds along with the stream name associated with that subwatershed. Table 3.1. lists all of the identified fecal coliform dischargers according to subwatershed, along with the NPDES Permit number and the receiving waterbody.

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. If the discharge monitoring data were inadequate, permit limits were used to represent fecal coliform concentrations in the model, unless there was a history of an insufficient or malfunctioning disinfection system. The permit limits of each facility included in the model are given in Table 3.1.

Table 3.1 Inventory of Identified NPDES Permitted Dischargers

Facility Name	Sub Watershed	NPDES Permit	Fecal Coliform (counts/100ml)	Receiving Waterbody
Barne's Meat Plant Incorporated	03180005007	MS0030791	200	Collins Creek
Salem Attendance Center	03180005007	MS0053970	200	Varnell Creek
Tylertown POTW	03180005007	MS0020681	200	Magees Creek
Lexie Headstart Center	03180005007	MS0045560	200	Magees Creek
Little Angels' Day Care	03180005007	MS0055263	200	Tributary of Magees Creek
Transcontinental Gas Pipeline	03180005008	MS0038482	200/2000*	Tributary of Leatherwood Creek
Topeka-Tilton Attendance Center	03180005010	MS0028240	200	East Topisaw Creek
Bogue Chitto Attendance Center	03180005012	MS0034479	200	Big Creek
Enterprise Attendance Center	03180005012	MS0034461	200	Boone Creek
West Lincoln School	03180005012	MS0034452	200	Panther Creek
North Pike Elementary and High School	03180005012	MS0029581	200	Clear Creek
North Pike Junior High	03180005012	MS0031097	200	Bogue Chitto River
The C Store #301	03180005012	MS0053287	200	Clabber Creek
Super 8 Hotel	03180005012	MS0055549	200	West Bogue Chitto River
Brookhaven POTW	03180005012	MS0024147	200/2000*	Halbert Branch
Jones Custom Processing	03180005012	MS0037435	200	Flitterville Creek
Sanderson Farms Incorporated	03180005012	MS0045021	200	Bogue Chitto River
Summit POTW – East	03180005012	MS0021563	No fecal coliform limit	Clear Creek
Summit POTW – North	03180005012	MS0021571	No fecal coliform limit	Clabber Creek
Summit POTW – South	03180005012	MS0021555	No fecal coliform limit	Clear Creek
MS/MS SW Junior College POTW	03180005012	MS0026000	No fecal coliform limit	Clear Creek

*Seasonal Permit Limits

3.2 Assessment of Nonpoint Sources

There are many potential nonpoint sources of fecal coliform bacteria for the Bogue Chitto 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 504,588-acre drainage area of the Bogue Chitto River contains many different landuse types, including urban, forests, cropland, pasture, barren, and wetlands. The landuse information is based on data collected by the State of Mississippi's Automated 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 the Bogue Chitto River was considered on a subwatershed basis. Table 3.2 shows the landuse distribution within each subwatershed in number of acres.

Figure 3.1 The Bogue Chitto River Landuse Distribution

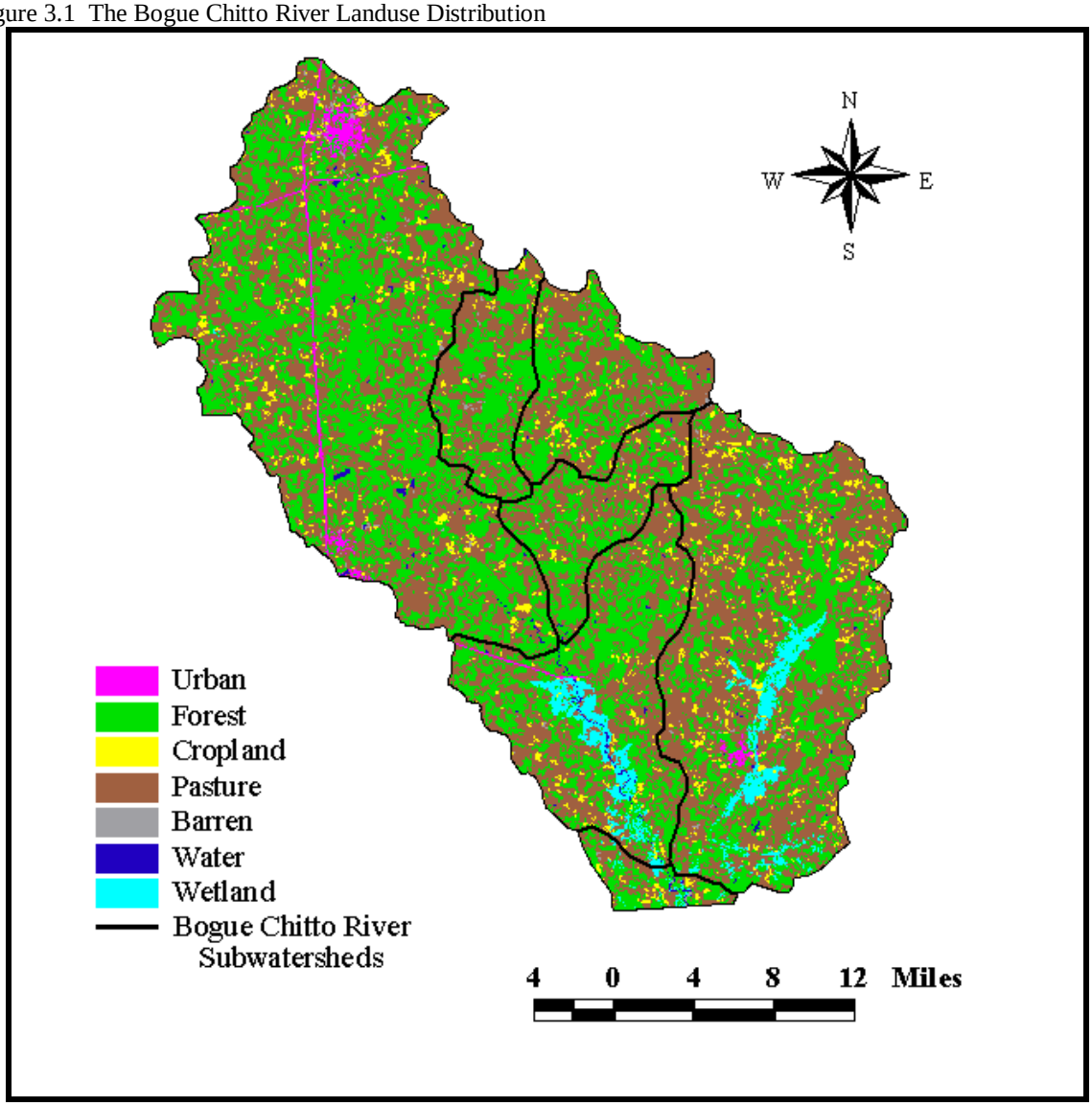


Table 3.2 Landuse Distribution in Number of Acres

Subwatershed	Forest	Croplands	Pasture	Urban	Barren	Wetland	Total
03180005006	4,026	611	4,057	0	99	533	**9,326**
03180005007	45,004	6,856	78,297	464	487	6,404	**137,512**
03180005008	28,316	2,144	34,022	344	89	5,538	**70,453**
03180005009	12,548	766	14,819	0	57	0	**28,190**
03180005010	15,337	1,344	20,725	0	149	0	**37,555**
03180005011	13,335	696	13,862	0	168	10	**28,071**
03180005012	90,924	6,681	90,182	4,685	979	30	**193,481**
Totals	**209,490**	**19,098**	**255,964**	**5,493**	**2,028**	**12,515**	**504,588**
% of Total Area	**41.5%**	**3.8%**	**50.7%**	**1.1%**	**0.4%**	**2.5%**	**100%**

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 Bogue Chitto 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, which can be represented as a point source.

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 Bogue Chitto River Watershed contributes to fecal coliform bacteria on the land surface. In the Bogue Chitto 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 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 March through May and October through November. 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 Bogue Chitto 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 assumed 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 Lawrence, Lincoln, Marion, Pike, and Walthall Counties each year. In these counties, 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 Bogue Chitto 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 0.05% percent of their time standing in the streams. Thus, the model assumes that 0.05% 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 Bogue Chitto River was considered. Municipalities within the Bogue Chitto River Watershed include Brookhaven, Summit, and Tylertown. 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 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 based on sound scientific principles 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 Bogue Chitto 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 Bogue Chitto River TMDL model includes the listed sections of the creek as well as all the drainage areas that are upstream of the segments. Thus, all upstream contributors of bacteria are accounted for in the model. To obtain a spatial variation of the concentration of bacteria along the Bogue Chitto River, the watershed was divided into seven subwatersheds (Figure 1.2) in an effort to isolate the major stream reaches in the Bogue Chitto River Watershed. This 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 this model. A fecal coliform spreadsheet was developed for quantifying point sources and nonpoint sources of bacteria for the Bogue Chitto River model. The 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.

There are 21 NPDES Permitted facilities in the watershed which discharge fecal coliform bacteria. The discharge was added as a direct input into the appropriate reach of the waterbody. 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 Bogue Chitto River. Other sources are represented as an application rate to the land in the Bogue Chitto 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 at the same time, and all forest and wetland contributions were combined for model input. Urban and barren areas were combined and input into the model in the same manner. 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

The number of failing septic systems used in the model was derived from the watershed area normalized population of Lawrence, Lincoln, Marion, Pike, and Walthall Counties. The percentage of the population on septic systems, which was determined from 1990 United States Census Data, is given in Table 4.1. Based on the best available information, a failure rate of 20% was assumed. This information was used to calculate the estimated number of failing septic tanks per watershed. The number of failing septic tanks also incorporates an estimate for the failing individual onsite wastewater treatment systems in the area.

Table 4.1 Percent of Population on Septic Systems, by County

County	Lawrence	Lincoln	Marion	Pike	Walthall
Percent On Septic Systems	78%	59%	67%	48%	85%

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 Bogue Chitto 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.

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 a 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 if applicable 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 0.05% 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 Bogue Chitto 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. The literature values for each urban landuse category are given in Tables 4.2. Table 4.3. shows the urban landuse distribution within each subwatershed. In the model, fecal coliform loading rates on urban land are input as counts per acre per day.

Table 4.2 Urban Loading Rates, by Landuse

High Density Area	Low Density Area	Transportation Area
1.54E+07	1.03E+07	2.00E+05

Table 4.3 Urban Landuse Distribution

Sub Watershed	High Density Area (acres)	Low Density Area (acres)	Transportation Area (acres)	Total
03180005006	16	44	38	**98**
03180005007	152	428	371	**951**
03180005008	69	195	169	**433**
03180005009	9	26	22	**57**
03180005010	24	67	58	**149**
03180005011	27	76	65	**168**
03180005012	906	2,548	2,209	**5,663**

4.4 Stream Characteristics

The stream characteristics given below describe the entire modeled section of the Bogue Chitto River. This section begins at the headwaters and ends at the end of monitored reach MSBGCHTRM4 at the Mississippi – Louisiana State Line. The channel geometry and lengths for the Bogue Chitto 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 Bogue Chitto River are as follows.

- Length 39.50 miles
- Average Depth 1.69 ft
- Average Width 91.64 ft
- Mean Flow 762.78 cubic ft per second
- Mean Velocity 1.82 ft per second
- 7Q10 Flow 192 cubic ft per second
- Slope 0.0009 ft per ft

4.5 Selection of Representative Modeling Period

The model was run for 12 years, from January 1, 1984, through December 31, 1995. The first year of data were used to stabilize the model. 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

Several assumptions were made to determine the fecal coliform loading rates from the nonpoint source contributors. Many of these assumptions were incorporated into the fecal coliform spreadsheet. An effort was made to contact researchers and agricultural experts to give as much validity as possible to the assumptions made within the BASINS model. A data set was applied to various gages in the basin as a means of calibration and validation. The weather data used for this model were collected at Ruth, MS. The representative hydrologic period used for the TMDL was January 1, 1985, through December 31, 1995.

The hydrological model had a continuous USGS gage available on the Bogue Chitto River near Tylertown, MS for comparison with the modeled flow in reach 03180005-008 of the Bogue Chitto River. Samples of these results are included in Appendix A, Graphs A-1 through A-3. Modeled output and actual gage data are shown on the same graph in one-year increments. There is a very good correlation between the two data sets.

4.7 Existing Loading

Appendix A includes two graphs of the model results showing the instream fecal coliform concentrations for reach 03180005-006 of the Bogue Chitto River. Graph A-4 shows the existing conditions of the modeled fecal coliform levels in the stream during the 11-year modeling period. The graph shows a 30-day geometric mean of the data. 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 a 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 both the monitored and evaluated segments 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 in segments MSBGCHTRM1 and MSBGCHTRM4. Point source contributions enter the stream directly in the appropriate reach. Cows in the stream and failing septic tanks were also modeled as direct inputs to the stream. Cows in the stream are nonpoint sources while failing septic tanks are both point and nonpoint sources. The other nonpoint source contributions were applied to land area on a count per day per acre basis. The fecal coliform bacteria applied to land are subject to a die-off rate and an absorption rate before entering the stream.

5.1 Wasteload Allocations

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 some, 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.

Table 5.1 lists the point source contributions, on a subwatershed basis, along with the existing load, allocated load, and percent reduction. Some of the subwatersheds do not contain any permitted point sources, and are not included in the table. The final wasteload allocation on the summary page also accounts for 50% of the failing septic tanks which have direct bypasses to the stream.

Table 5.1 Point Source Contributions on a Subwatershed Basis

Sub Watershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
03180005007	0.69	0.14E+09	0.69	0.14E+09	0%
03180005008	0.04	0.01E+09	0.04	0.01E+09	0%
03180005010	0.03	0.01E+09	0.03	0.01E+09	0%
03180005012	8.22	9.32E+09	8.22	1.67E+09	82%
Total	**8.98**	**9.48E+09**	**8.98**	**1.83E+09**	**81%**

5.2 Load Allocations

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 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 5.3 gives the same parameters for contributions due to septic tank failure. Septic tank failures in reality are both point and nonpoint contributions and have been calculated as equal contributors to the wasteload allocation component and load allocation component of the TMDL calculation.

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 assumed for these contributors in the model for the Bogue Chitto River to achieve water quality standards.

Table 5.2 Fecal Coliform Loading Rates for Nonpoint Source Contribution of Cattle Access to Streams

Sub Watershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
03180005006	0.03E-03	0.10E+10	0.57E-05	0.22E+09	79%
03180005007	0.55E-03	2.09E+10	11.50E-05	4.39E+09	79%
03180005008	0.16E-03	0.60E+10	3.31E-05	1.27E+09	79%
03180005009	0.07E-03	0.26E+10	1.45E-05	0.55E+09	79%
03180005010	0.10E-03	0.37E+10	2.05E-05	0.78E+09	79%
03180005011	0.06E-03	0.21E+10	1.17E-05	0.45E+09	79%
03180005012	0.42E-03	1.61E+10	8.83E-05	3.37E+09	79%
Total	**1.39E-03**	**5.24E+10**	**28.88E-05**	**11.03E+09**	**79%**

Table 5.3 Fecal Coliform Loading Rates for the Contribution from Failing Septic Tanks (50% WLA and 50% LA)

Sub Watershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
03180005006	0.15E-01	0.15E+09	0.44E-02	0.45E+08	70%
03180005007	1.98E-01	2.02E+09	5.95E-02	6.06E+08	70%
03180005008	1.23E-01	1.26E+09	3.70E-02	3.77E+08	70%
03180005009	0.51E-01	0.52E+09	1.53E-02	1.55E+08	70%
03180005010	0.55E-01	0.56E+09	1.64E-02	1.67E+08	70%
03180005011	0.48E-01	0.49E+09	1.44E-02	1.47E+08	70%
03180005012	3.40E-01	3.46E+09	10.20E-02	10.40E+08	70%
Total	**8.30E-01**	**8.46E+09**	**24.90E-02**	**25.37E+08**	**70%**

The model estimated the fecal coliform bacteria count per 30 days entering the Bogue Chitto River for each impaired segment and evaluated drainage area due to runoff during the 30-day critical period. These values are given in Section 5.4 Calculation of the TMDL.

The scenario used in this analysis for the load allocation in the Bogue Chitto River Watershed assumes a 79% reduction in contributions from cows in the stream, and a 70% reduction from failing septic tanks. The scenario also assumes all permitted dischargers meet water quality standards for disinfection. This scenario might 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 individual onsite wastewater treatment plants.

5.3 Incorporation of a Margin of Safety (MOS)

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 Calculation of the TMDL

The TMDL was calculated based on the following equation:

TMDL = WLA + LA + MOS

The TMDL was calculated based on the 30-day critical period for the Bogue Chitto River Watershed according to the model. Each of the loading rates has been converted to the 30-day equivalent. The wasteload allocation incorporates the fecal coliform contribution from identified NPDES Permitted facilities and 50% of the contribution from failing septic tanks. The load allocation includes the fecal coliform contributions from surface runoff, cows in the stream, and 50% of the contribution from failing septic tanks.

The drainage area of impaired segment MSBGCHTRM1 is only a percentage of subwatershed 03180005012. This percentage was used to determine the contributions from each of the components of the LA. Only NPDES Permitted dischargers located within the drainage area of MSBGCHTRM1 were included in the calculation of the WLA.

The margin of safety for this TMDL is derived from the conservative loading assumptions used in setting up the model and is implicit. Table 5.4 and Table 5.5 give the TMDLs for all monitored segments and evaluated drainage areas.

WLA = NPDES Permitted Facilities + ½ of the Septic Tank Failures

LA = Surface Runoff + Cows in the Stream + ½ of the Septic Tank Failures

MOS = implicit

Table 5.4 TMDL Summary for Monitored Segments (counts/30 days)

Monitored Segment	MSBGCHTRM1	MSBGCHTRM4
NPDES Permits	0.68E+12	1.31E+12
1/2 Failing Septic Tanks	0.10E+12	0.92E+12
WLA	**0.78E+12**	**2.23E+12**
Surface Runoff	0.03E+12	0.29E+12
Cows in Stream	0.59E+12	7.94E+12
1/2 Failing Septic Tanks	0.10E+12	0.92E+12
LA	**0.72E+12**	**9.15E+12**
TMDL = WLA + LA	**1.50E+12**	**11.38E+12**

*NOTE: 1.0E+06 = 1 million; 1.0E+09 = 1 billion; 1.0E+12 = 1 trillion

5.5 Seasonality

For one impaired segment of the Bogue Chitto River Watershed, fecal coliform limits vary according to the seasons due to their designation for the use of Secondary Contact Recreation. One segment, however, is designated for the use of Contact Recreation. For this use, the pollutant standard is constant throughout the year. The water quality standard applicable to the use Contact Recreation and the pollutant of concern states that fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml, nor shall more than 10 % of the samples examined during any month exceed a colony count of 400 per 100 ml. The water quality standard applicable to the use Secondary Contact Recreation and the pollutant of concern, for the months May through October, is the same as the standard for Contact Recreation. However, for the months of November through April, the standard states that fecal coliform shall not exceed a geometric mean of 2000 per 100 ml, nor shall more than 10% of the samples examined during any month exceed 4000 per 100 ml.

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 CONCLUSION

The fecal coliform reduction scenario used in this TMDL included requiring all NPDES Permitted dischargers of fecal coliform to meet water standards for disinfection, along with reducing the assumed fecal load from 79% of the cattle access to streams and the assumed fecal load from 70% of the failing septic tanks in the watershed.

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 not approve 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.

6.1 Future Monitoring

MDEQ has adopted the Basin Approach to Water Quality Management, a plan that divides Mississippi's major drainage basins into five groups. During each yearlong cycle, MDEQ resources for water quality monitoring will be focused on one of the basin groups. During the next monitoring phase in the Pearl River Basin, the Bogue Chitto River may receive additional monitoring to identify any change in water quality.

6.2 Public Participation

This TMDL will be published for a 30-day public notice. During this time, the public will be notified by publication in the statewide newspaper and a newspaper in Brookhaven. 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.

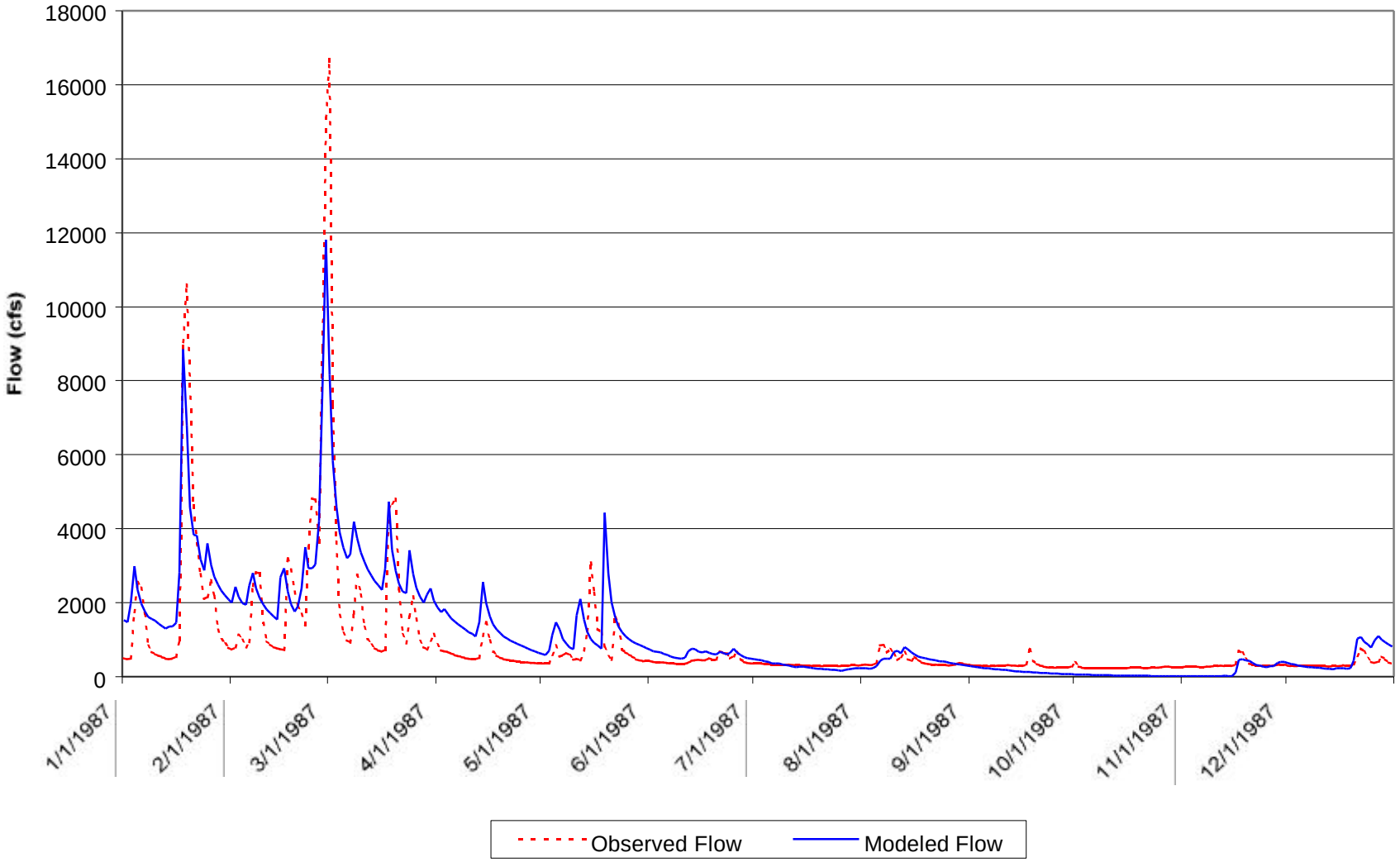
APPENDIX A

This appendix contains printouts of the various model run results. Graphs A-1, A-2, and A-3 show the modeled flow, in cubic feet per second, through reach 03180005008 compared to the actual USGS gage readings from the Bogue Chitto River near Tylertown, MS. The second set of graphs show the 30-day geometric mean for fecal coliform concentrations in counts per 100 ml in the most downstream, impaired section of the Bogue Chitto River, reach 03180005006. The graphs contain a reference line at 200 counts per 100 ml. Graph A-4 represents the existing conditions in the Bogue Chitto River. Graph A-5 represents the conditions in the most downstream, impaired section of the Bogue Chitto River after a reduction scenario has been applied. Graphs A-4 and A-5 are shown with the same scale for comparison purposes.

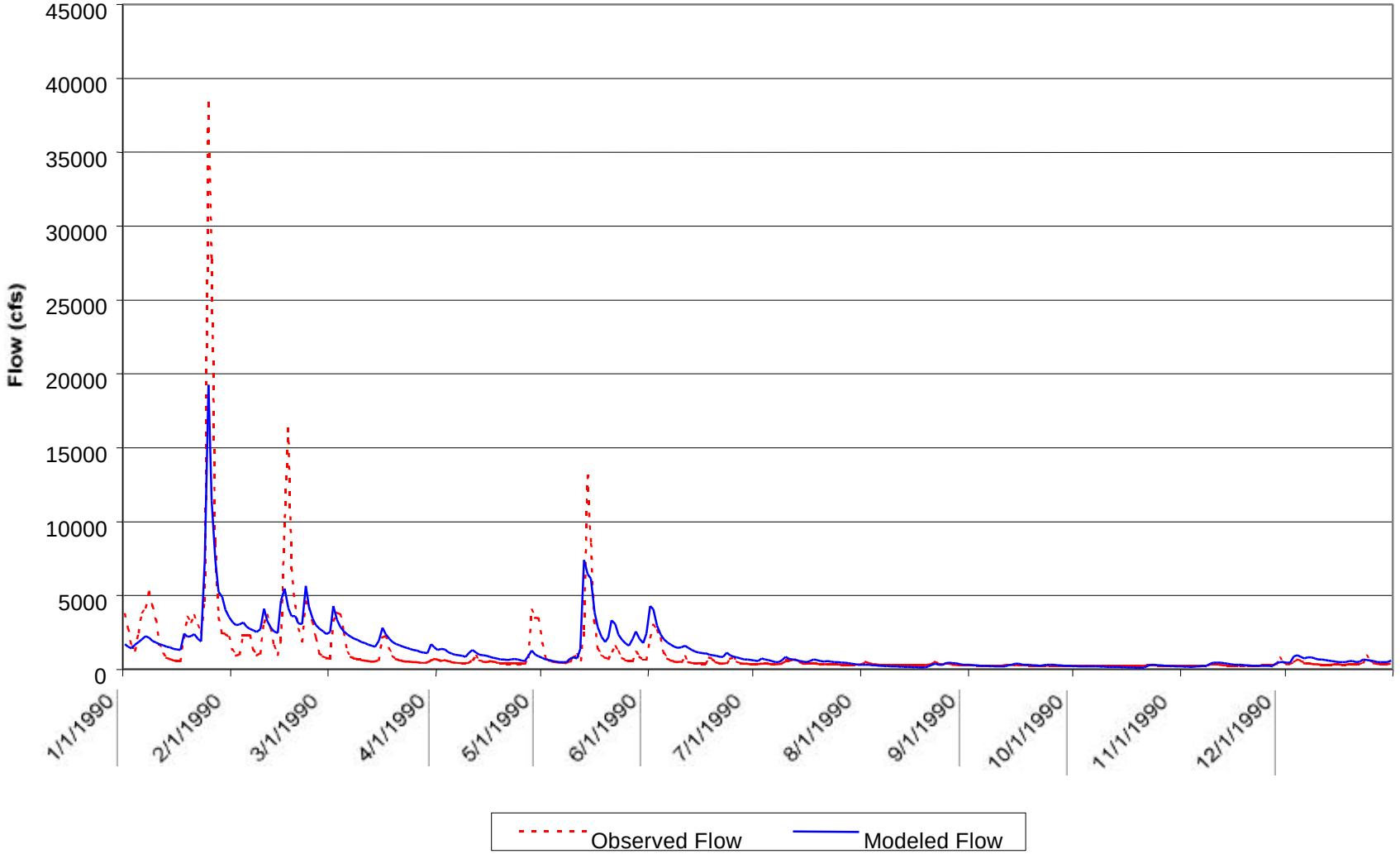
The TMDL calculated in this report represents the maximum fecal coliform load that can be assimilated by the waterbody segment during the critical 30-day period that will maintain water quality standards. The calculation of this TMDL is based on the critical hydrologic flow condition that occurred during 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 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.

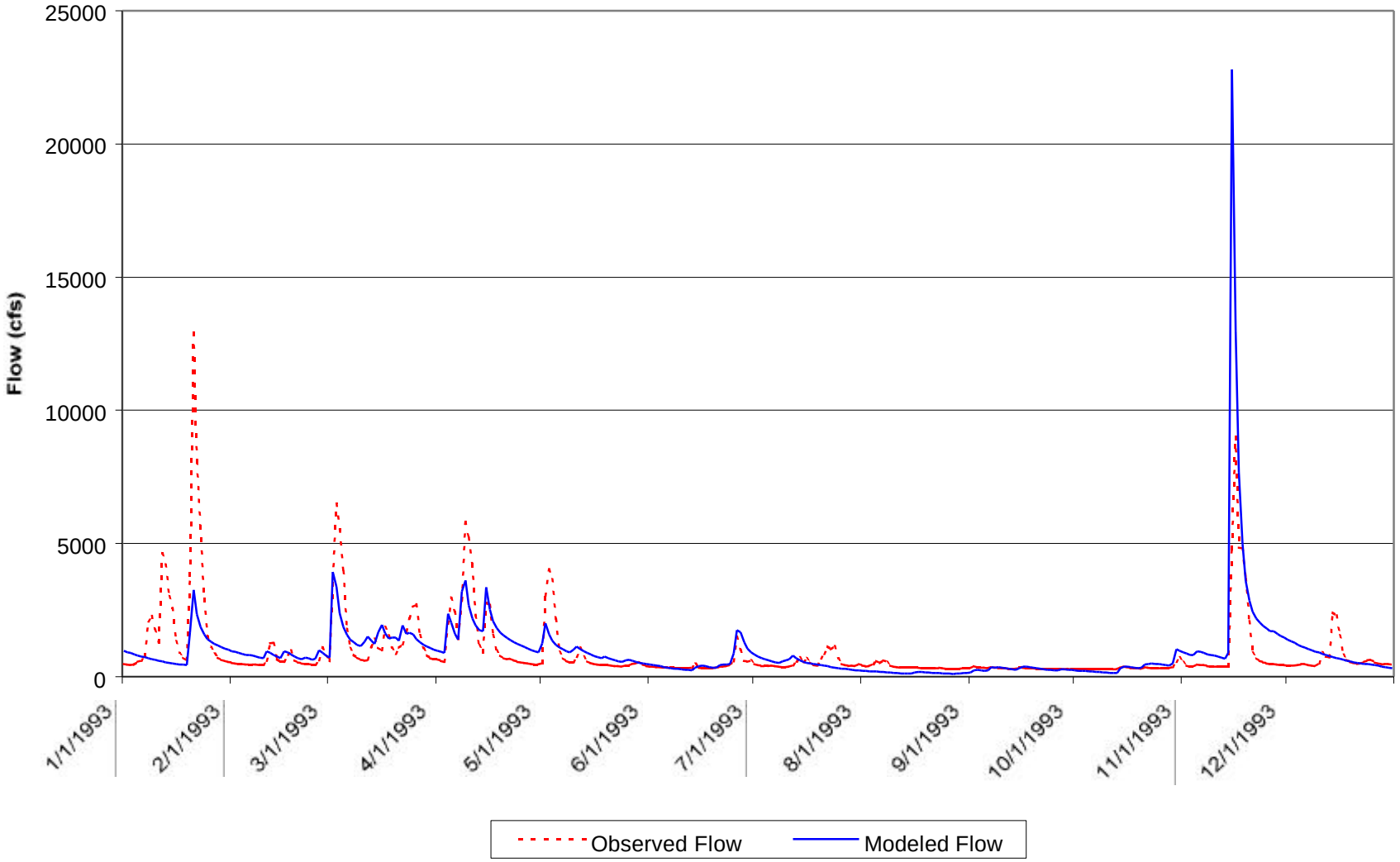
Graph A-1 Daily Flow Comparison between USGS Gage 02490500 and Reach 03180005008 for 01/01/1987 - 12/31/1987



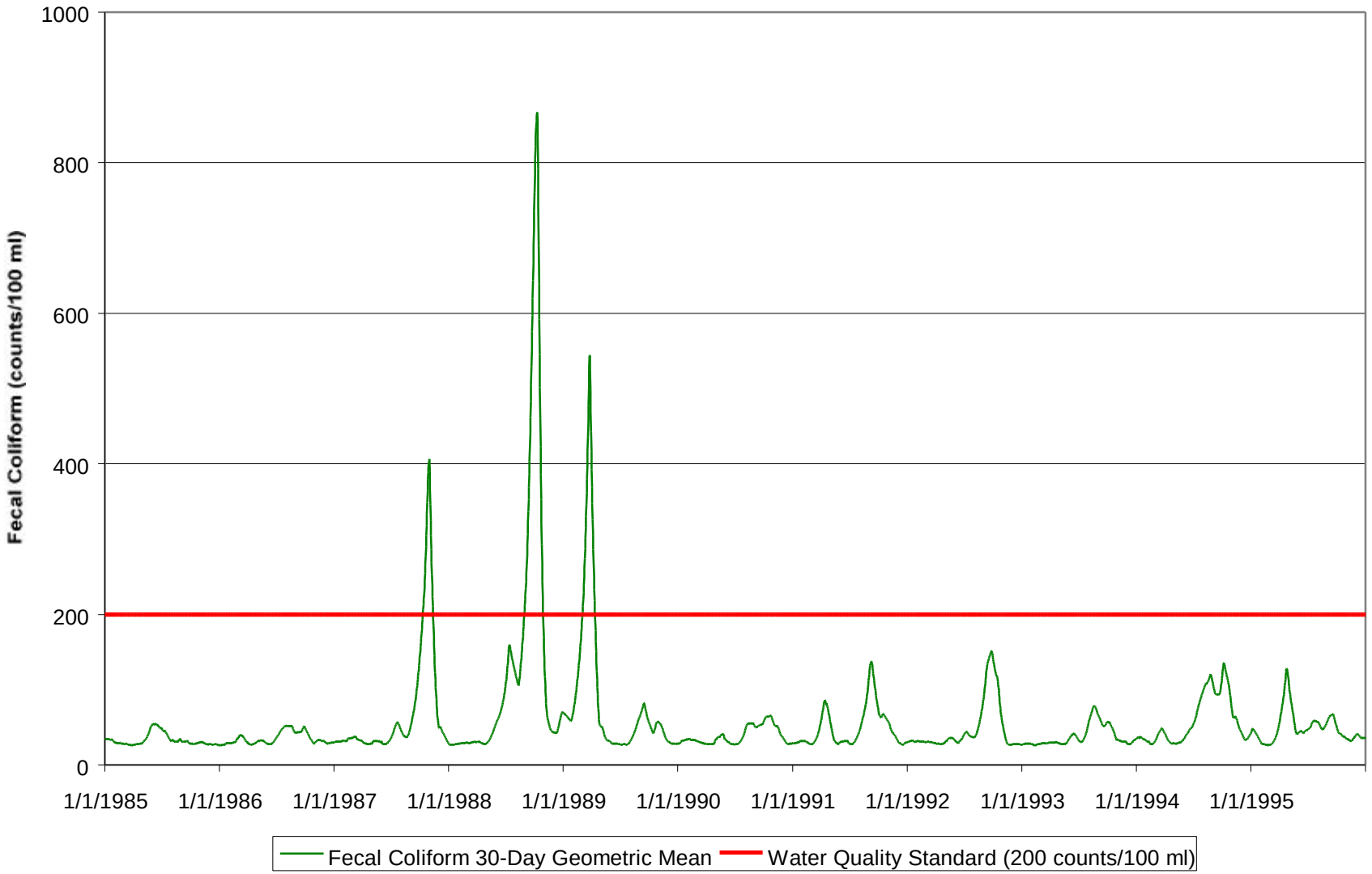
Graph A-2 Daily Flow Comparison between USGS Gage 02490500 and Reach 03180005008 for 01/01/1990 - 12/31/1990



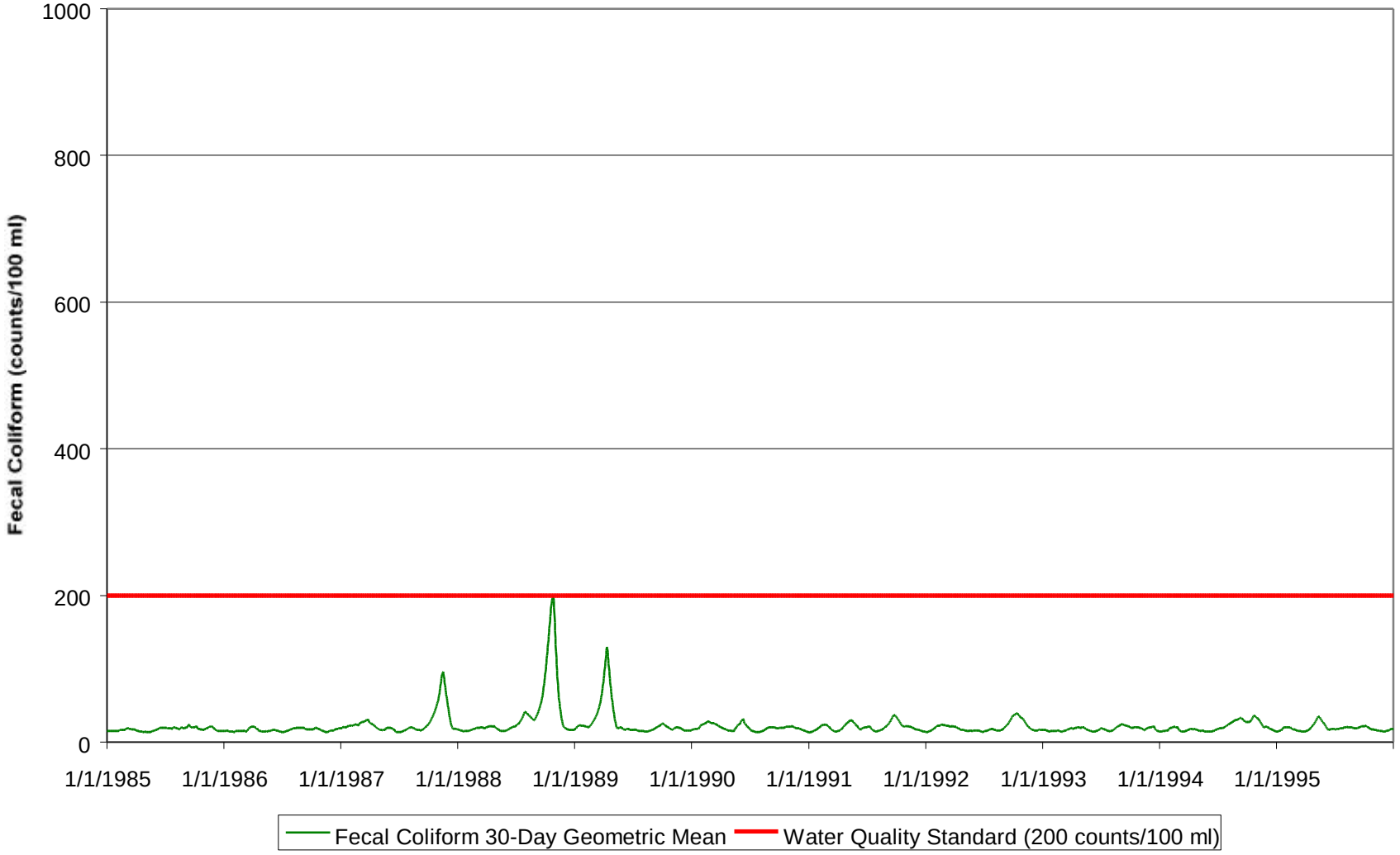
Graph A-3 Daily Flow Comparison between USGS Gage 02490500 and Reach 03180005008 for 01/01/1993 - 12/31/1993



Graph A-4 Modeled Fecal Coliform Concentrations Under Existing Conditions



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



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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.

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

Scientific Notation (Exponential Notation): mathematical method in which very large numbers or very small numbers are expressed in a more concise form. The notation is based on powers of ten. Numbers in scientific notation are expressed as the following: *4.16 x 10^(+b)* and *4.16 x 10^(-b) [same as 4.16E4 or4.16E-4]*. In this case, *b* is always a positive, real number. The *10^(+b)* tells us that the decimal point is *b* places to the right of where it is shown. The *10^(-b)* tells us that the

decimal point is *b* places to the left of where it is shown.

For example: $2.7X10^{4} = 2.7E+4 = 27000$
$2.7X10^{-4} = 2.7E-4 = 0.00027$
One Million = 1.0E+6
One Billion = 1.0E+9
One Trillion = 1.0E+12

Sigma (S**)**: shorthand way to express taking the sum of a series of numbers. For example, the sum or total of three amounts 24, 123, 16, ($\mathbf{d}_1$, $\mathbf{d}_2$, $\mathbf{d}_3$) respectively could be shown as:

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

Total Maximum Daily Load or TMDL: the calculated maximum permissible pollutant loading to a waterbody at which water quality standards can be maintained.

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

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

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

Water quality criteria: elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports the present and future most beneficial uses.

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

Watershed: the area of land draining into a stream at a given location.

ABBREVIATIONS

7Q10 ..... Seven-Day Average Low Stream Flow with a ten-year Occurrence Period

ADEM ..... Alabama Department of Environmental Management

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

FEMA ..... Federal Emergency Management Agency

GIS ..... Geographic Information System

HUC ..... Hydrologic Unit Code

LA ..... Load Allocation

LDEQ ..... Louisiana Department of Environmental Quality

MARIS ..... State of Mississippi Automated Information System

MDEQ ..... Mississippi Department of Environmental Quality

MDH ..... Mississippi Department of Health

MDMR ..... Mississippi Department of Marine Resources

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