Fecal Coliform TMDL
For
Tuxachanie Creek
Coastal Streams Basin
Harrison County,
Mississippi

Prepared by
Mississippi Department of Environmental Quality
Office of Pollution Control
TMDL/WLA Section of the Water Quality Assessment Branch

February 23, 2000

MDEQ
P.O. Box 10385
Jackson, MS 39289-0385
(601) 961-5171

CONTENTS

Page

MONITORED SEGMENT IDENTIFICATION ... iv
EXECUTIVE SUMMARY ... v

1.0 INTRODUCTION ... 1-1
1.1 Background ... 1-1
1.2 Applicable Waterbody Segment Use ... 1-3
1.3 Applicable Waterbody Segment Standard ... 1-3

2.0 TMDL ENDPOINT AND WATER QUALITY ASSESSMENT ... 2-1
2.1 Selection of a TMDL Endpoint and Critical Condition ... 2-1
2.2 Discussion of Instream Water Quality ... 2-1
2.2.1 Inventory of Available Water Quality Monitoring Data ... 2-1
2.2.2 Analysis of Instream Water Quality Monitoring Data ... 2-3

3.0 SOURCE ASSESSMENT ... 3-1
3.1 Assessment of Point Sources ... 3-1
3.2 Assessment of Nonpoint Sources ... 3-2
3.2.1 Failing Septic Systems ... 3-3
3.2.2 Wildlife ... 3-4
3.2.3 Land Application of Hog and Cattle Manure ... 3-4
3.2.4 Grazing Beef and Dairy Cattle ... 3-4
3.2.5 Cattle Contributions Deposited Directly Instream ... 3-5
3.2.6 Urban Development ... 3-5

4.0 MODELING PROCEDURE: LINKING THE SOURCES TO THE ENDPOINT ... 4-1
4.1 Modeling Framework Selection ... 4-1
4.2 Model Setup ... 4-1
4.3 Source Representation ... 4-1
4.3.1 Failing Septic Systems ... 4-2
4.3.2 Wildlife ... 4-2
4.3.3 Land Application of Hog and Cattle Manure ... 4-3
4.3.4 Grazing Beef and Dairy Cattle ... 4-3
4.3.5 Cattle Contributions Deposited Directly Instream ... 4-3
4.3.6 Urban Development ... 4-3
4.4 Stream Characteristics ... 4-4
4.5 Selection of Representative Modeling Period ... 4-4
4.6 Model Calibration Process ... 4-5
4.7 Existing Loading ... 4-5

5.0 ALLOCATION ... 5-1
5.1 Wasteload Allocations ... 5-1

5.2 Load Allocations....5-1
5.3 Incorporation of a Margin of Safety....5-2
5.4 Calculation of the TMDL....5-3
5.5 Seasonality....5-3

6.0 CONCLUSION....6-1
6.1 Future Monitoring....6-1
6.2 Public Participation....6-1

APPENDIX A....A-1
APPENDIX B....B-1
DEFINITIONS....D-1
ABBREVIATIONS....AB-1
REFERENCES....R-1

MONITORED SEGMENT IDENTIFICATION

Name:	Tuxachanie Creek
Waterbody ID:	MS117M2
Location:	Near Biloxi: From County Road Northwest of White Plains to Mouth at Tchoutacabouffa River
County:	Harrison County, Mississippi
USGS HUC Code:	03170009
NRCS Watershed:	150
Length:	13 miles
Use Impairment:	Contact Recreation
Cause Noted:	Fecal Coliform, an Indicator for the Presence of Pathogenic Bacteria
Priority Rank:	80
NPDES Permits:	There is one NPDES Permit issued for a facility that discharges 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:	0.508E+12 counts/ 30 days (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	1.61E+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):	2.12E+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

A segment of Tuxachanie Creek has been placed on the Mississippi 1998 Section 303(d) List of Waterbodies as an impaired waterbody segment, due to fecal coliform bacteria. The applicable state standard 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. A review of the available monitoring data for the watershed indicates that there is a violation of the standard for the impaired waterbody.

Tuxachanie Creek is a tributary of the Tchoutacabouffa River. It flows in a southeastern direction from its headwaters until it meets the Tchoutacabouffa River. This TMDL, however, has been developed for the section of Tuxachanie Creek found on the 303(d) List. The 13-mile long impaired section of the creek is located in Harrison County near Biloxi from a county road northwest of White Plains to the creek's mouth at the Tchoutacabouffa River. 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 02480500 on Tuxachanie Creek near Biloxi were used to calibrate the hydrologic flow for the watershed. The weather data used for this model were collected at Saucier Experimental Forest Station. The representative hydrologic period used for this TMDL was January 1, 1985, through December 31, 1995.

Fecal coliform loading from nonpoint sources in the watershed were calculated based upon wildlife populations; numbers of cattle and hogs; information on livestock and manure management practices for the Coastal 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 the tributaries of Tuxachanie Creek. There is one NPDES Permitted discharge located in the watershed and included as a point source 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 Tuxachanie Creek Watershed. First, all NPDES facilities will be required to treat their discharge so that the fecal coliform concentrations do not exceed water quality standards. Monitoring of all permitted facilities in the Tuxachanie Creek 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.

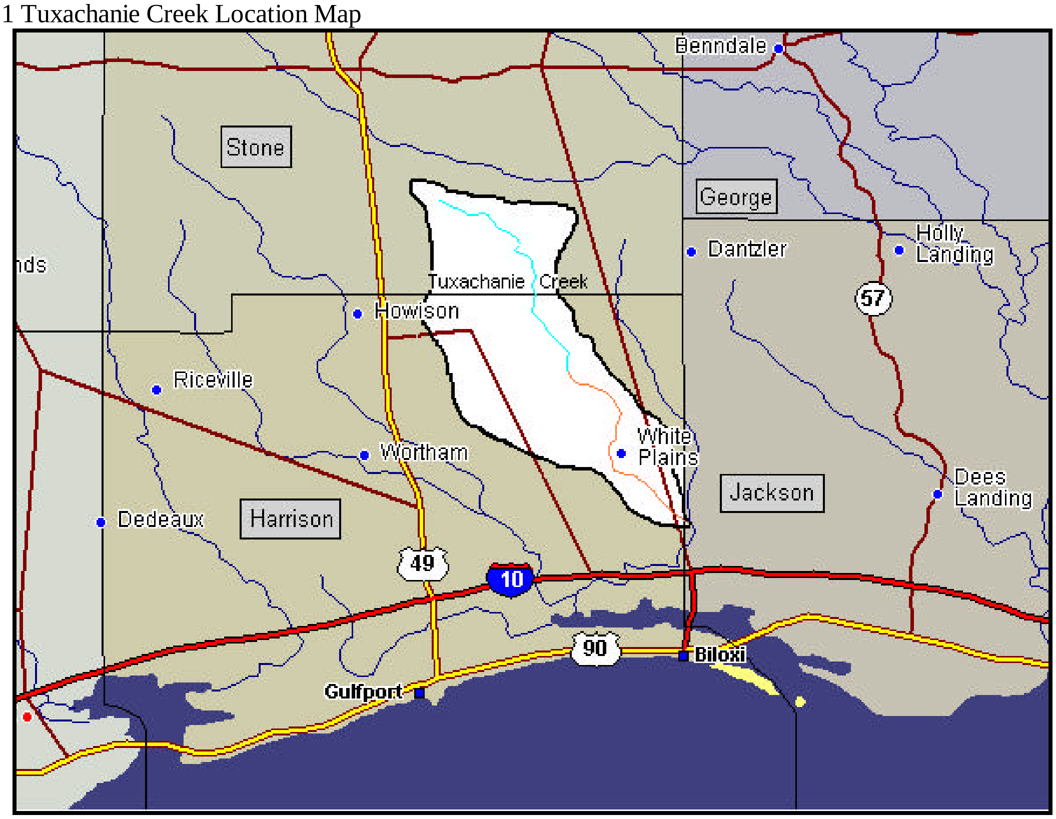
1.0 INTRODUCTION

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 to restore and maintain the quality of water resources.

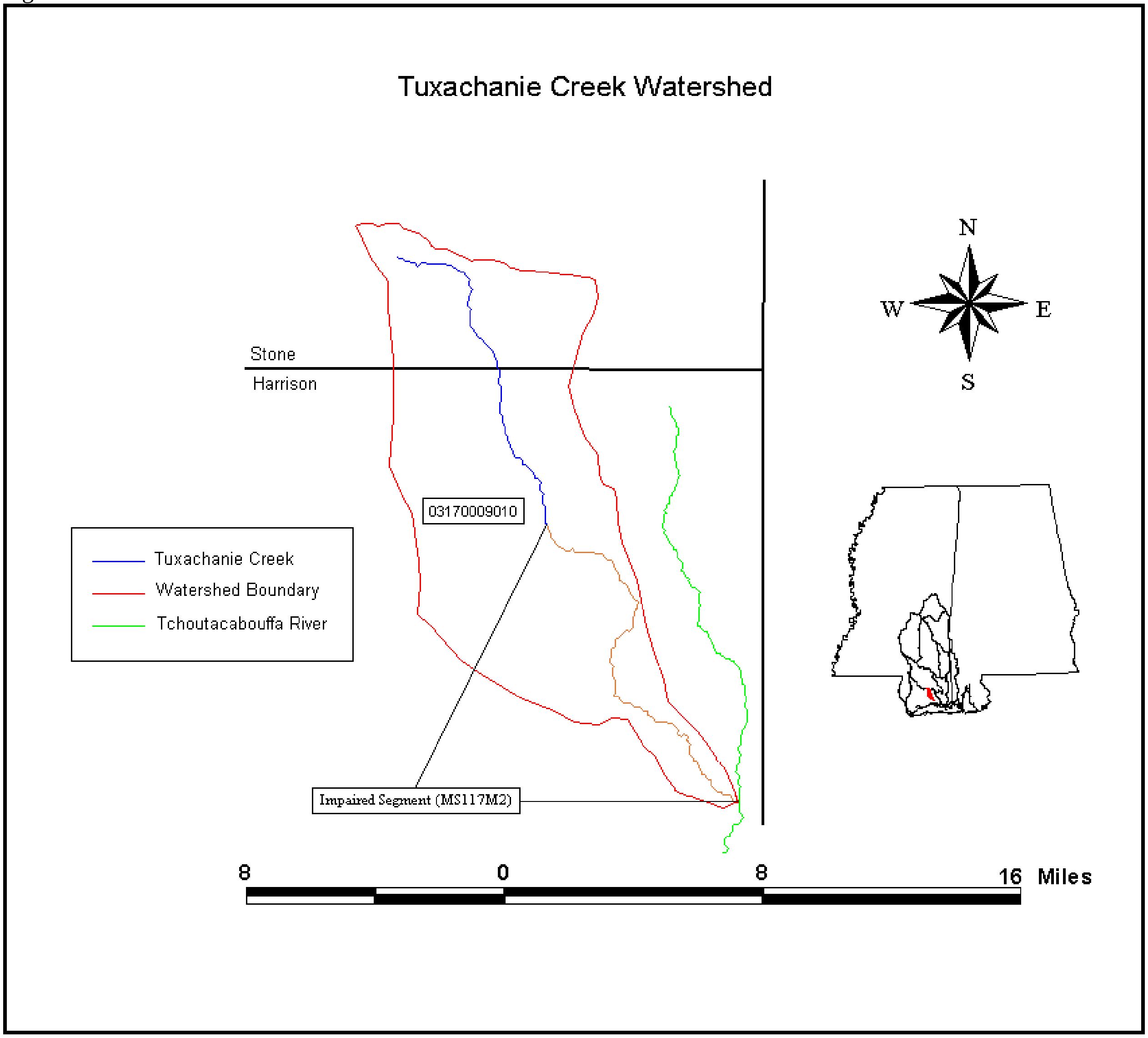
The Mississippi Department of Environmental Quality (MDEQ) has identified a segment of Tuxachanie Creek as being impaired by fecal coliform bacteria for a length of 13 miles as reported in the Mississippi 1998 Section 303(d) List of Waterbodies. This segment is listed as impaired because sufficient monitoring data is available to show that there is an impairment in this segment. The impaired section of the Tuxachanie Creek is in Harrison County near Biloxi from a county road northwest of White Plains to its mouth at the Tchoutacabouffa River. Tuxachanie Creek is highlighted in Figure 1.1.

Figure 1.1 Tuxachanie Creek Location Map



The sources of fecal coliform bacteria in the Tuxachanie Creek Watershed were analyzed by treating the area as a single watershed. The monitored segment is contained entirely within this watershed, 03170009010. Therefore, the load and waste load allocations required in this TMDL are based on water quality in watershed 03170009010. Figure 1.2 shows a map of the drainage area of Tuxachanie Creek. The map also shows an 11-digit identification number for the delineated watershed.

Figure 1.2 Tuxachanie Creek Watershed



This segment of Tuxachanie Creek is in the Coastal River Basin Hydrologic Unit Code (HUC) 03170009 in southeast Mississippi. This segment is located within NRCS Watershed 150. The drainage area of the monitored segment from the headwaters to the end of the impaired section is approximately 57,800 acres; and lies within portions of Harrison and Stone Counties. The watershed is rural in nature and does not include any major cities. The watershed does contain some smaller communities such as White Plains and Success.

Forest is the dominant landuse within this watershed. Figure 3.1 shows the landuse distribution within the monitored drainage area.

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 use for Tuxachanie Creek as defined by the regulations is Contact Recreation. The monitored section of Tuxachanie Creek has the designated use of 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 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. 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 Tuxachanie Creek show that high levels of fecal coliform bacteria frequently impair the stream. There is one ambient station operated by MDEQ that collected fecal coliform monitoring data during the 11-year modeling period. Station 02480500 located on Tuxachanie Creek near Biloxi made measurements of flow and fecal coliform between June 1994 and December 1998. 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, Tuxachanie Creek is partially supporting the use of Contact Recreation. These conclusions were based on instantaneous data collected at station 02480500. Data collected at this station are listed below in Table 2.1.

Table 2.1 Fecal Coliform Data Reported in Tuxachanie Creek, Station #02480500

Date	Fecal Coliform (counts/100 ml)
06/07/94	**500**
08/01/94	130
08/23/94	103
01/31/95	47
04/04/95	20
12/12/96	54
01/14/97	17
02/10/97	25
03/17/97	3
04/08/97	77
05/13/97	**630**
06/12/97	100
07/08/97	210
08/12/97	80
09/02/97	**530**
10/01/97	220
11/13/97	**2070**
12/02/97	120
01/13/98	**1000**
02/10/98	24
03/05/98	10
04/02/98	210
06/11/98	130
07/20/98	17
08/04/98	20
09/03/98	73
10/07/98	**640**
11/02/98	39
12/02/98	49

2.2.2 Analysis of Instream Water Quality Monitoring Data

A statistical summary of the water quality data discussed above is presented in Table 2.2. Samples are compared to the instantaneous maximum standard of 400 counts per 100 ml. 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 Statistical Summary

Station Number	Number of Samples	Minimum Value (counts/100 ml)	Maximum Value (counts/100 ml)	Number of Exceedances	Percent Instantaneous Exceedance
02480500	29	3	2070	6	21%

3.0 SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential fecal coliform sources in the Tuxachanie Creek Watershed. The source assessment was used as the basis of development for the model and the 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.

Tuxachanie Creek was modeled as a single reach from its headwaters to the Tchoutacabouffa River. 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. There is one wastewater treatment plant in the Tuxachanie Creek Watershed that serves a residential subdivision.

A point source assessment was completed for the Tuxachanie Creek drainage area. Table 3.1 lists the fecal coliform discharger in this watershed, along with the NPDES Permit number and the receiving waterbody.

Once the permitted discharger was located, the effluent from the source was characterized based on all available monitoring data including permit limits, discharge monitoring reports, and information on treatment types. The permitted discharge for the Tuxachanie Creek Watershed was characterized by the limits of the NPDES Permit. The permit limits of the facility are given in Table 3.1.

Table 3.1 Identified NPDES Permitted Dischargers

Facility Name	Watershed	NPDES Permit	Fecal Coliform (counts/100ml)	Receiving Waterbody
Destination RV Park	03170009010	MS0039250	200	Tuxachanie Creek

3.2 Assessment of Nonpoint Sources

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

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

The 57,843-acre drainage area of the monitored segment of Tuxachanie Creek 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 of Tuxachanie Creek was considered on a watershed basis. Table 3.2 and Figure 3.1 show the landuse distribution within the watershed in acres.

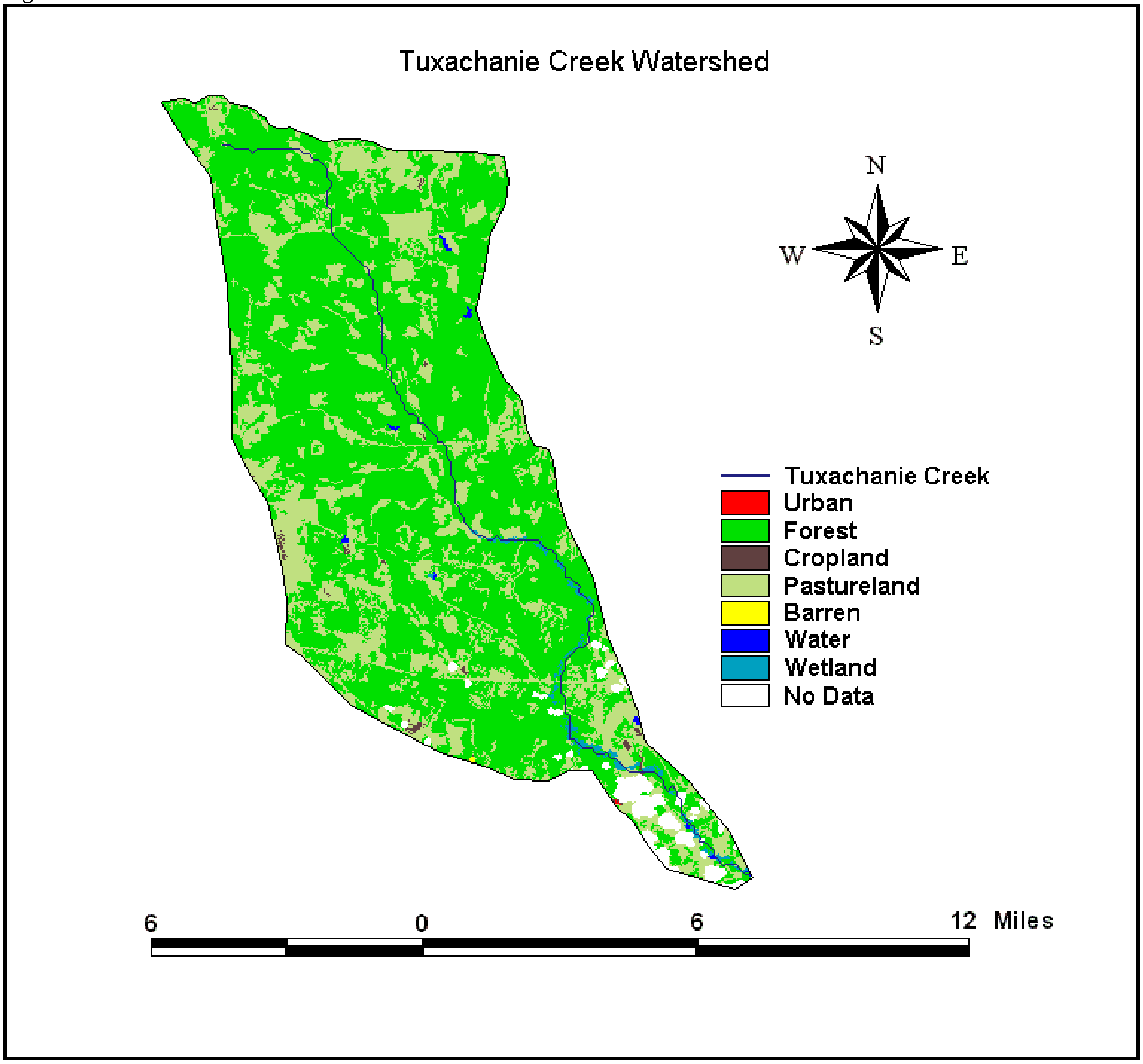
The contribution of fecal coliform due to land application of poultry litter was considered in the Tuxachanie Creek Watershed nonpoint source assessment. Since there are no known chicken houses in the Tuxachanie Creek Watershed, land application of poultry litter is not considered as a source of fecal coliform for this watershed.

Table 3.2 Landuse Distribution in Number of Acres

Watershed	Forest	Croplands	Pasture	Urban	Barren	Wetland	Total
03170009010	41,191	175	16,013	5	8	451	**57,843**

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 Tuxachanie Creek Watershed. The Mississippi State Department of Health was contacted regarding the failure rate of septic tank systems in this portion of the state. Mississippi State University researchers provided information on manure application practices and loading rates for hog farms and cattle operations. The Natural Resources Conservation Service also gave MDEQ information on manure treatment practices and land application of manure.

Figure 3.1 Tuxachanie Creek Landuse Distribution



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 Tuxachanie Creek Watershed contributes to fecal coliform bacteria on the land surface. In the Tuxachanie Creek 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 Coastal 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 Coastal 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 Tuxachanie Creek 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 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 Tuxachanie Creek 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 five percent of their time standing in the streams. Thus, the model assumes that five percent of the manure produced by grazing beef and dairy cows are deposited directly in the stream.

3.2.6 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 Tuxachanie Creek was considered. 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 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 Tuxachanie Creek 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 Tuxachanie Creek TMDL model includes the listed section of the creek as well as all of the drainage area that is upstream of the segment. Thus, all upstream contributors of bacteria are accounted for in the model. A subwatershed delineation of the Tuxachanie Creek Watershed was not necessary due to the small area of the watershed.

4.3 Source Representation

Both point and nonpoint sources were represented in this model. Due to die-off rates and overland transportation assumptions, the fecal coliform loading from point and nonpoint sources must be addressed separately. There is one NPDES Permitted facility in the Tuxachanie Creek Watershed which discharges fecal coliform bacteria. The discharge was added as a direct input into 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 Tuxachanie Creek. Other sources are represented as an application rate to the land in the Tuxachanie Creek Watershed. For these sources, fecal coliform accumulation rates in counts per acre per day were calculated for the watershed 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 contribution of fecal coliform due to land application of poultry litter was considered in the Tuxachanie Creek Watershed nonpoint source assessment. Since there are no known chicken houses in the Tuxachanie Creek Watershed, land application of poultry litter is not considered as a source of fecal coliform for this watershed.

Appendix A contains the Fecal Coliform Spreadsheet developed for quantifying point and nonpoint sources of bacteria for the Tuxachanie Creek model. The model inputs for fecal coliform loading due to point and nonpoint sources are calculated 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 spreadsheet also contains a reference page that lists the literature references used to generate the fecal coliform loading rates.

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 Stone and Harrison 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 80% 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 onsite wastewater treatment systems in the area.

Table 4.1 Percent of Population on Septic Systems, by County

County	Stone	Harrison
Percent on Septic Systems	67%	19%

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. The model inputs for flow and fecal coliform concentration from failing septic tanks are shown in Appendix A.

4.3.2 Wildlife

Based on information provided by the Mississippi Department of Wildlife, Fisheries, and Parks, the deer population throughout the Tuxachanie Creek 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 loading rate for the watershed is available in Appendix A.

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 watershed scale. This is calculated by multiplying the county livestock figures with the area of the county within the watershed 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. The fecal coliform loading rates for land application of hog and liquid dairy manure are shown in Appendix A.

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. The resulting fecal coliform loads are in the units of counts per acre per day. The fecal coliform loading rates due to grazing cattle are shown in the spreadsheet in Appendix A.

4.3.5 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 five percent of the number of grazing cattle in each watershed 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. As shown in Appendix A, 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.

4.3.6 Urban Development

The MARIS landuse data divide urban land into several categories. For the Tuxachanie Creek 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 the watershed. In the model, fecal coliform loading rates on urban land are input as counts per acre per day. These loading rates for the watershed are shown in Appendix A.

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

Watershed	High Density Area (acres)	Low Density Acres (acres)	Transportation Area (acres)	Total
03170009010	2	6	5	**13**

4.4 Stream Characteristics

The stream characteristics given below describe the entire modeled section of Tuxachanie Creek. This section begins at the headwaters and ends at the end of the monitored reach, where it joins Tchoutacabouffa River. The channel geometry and lengths for Tuxachanie Creek 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 Tuxachanie Creek are as follows.

- Length 25 miles
- Average Depth 0.44 ft
- Average Width 30.01 ft
- Mean Flow 198.85 cubic ft per second
- Mean Velocity 1.29 ft per second
- 7Q10 Flow 3.2 cubic ft per second
- Slope 0.00095 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

The model was calibrated for hydrology on various gages in southeast Mississippi. A set of input values was established through the hydrologic calibration. The hydrological model had a continuous USGS gage (02480500) available on Tuxachanie Creek near Biloxi for comparison with the modeled flow. A sample of these results is included in Appendix B, Graph B-1. The modeled output and the most recent actual gage data are shown on the same graph. There is a very good correlation between the two data sets.

MDEQ contacted researchers and agricultural experts to quantify representative pathogen loads entering the stream and give as much validity as possible to the assumptions made within the BASINS model. The weather data used for this model were collected at Saucier Experimental Forest Station. The representative hydrologic period used for the TMDL was January 1, 1985, through December 31, 1995.

4.7 Existing Loading

Appendix B includes two graphs of the model results showing the instream fecal coliform concentrations for Tuxachanie Creek. Graph B-2 shows 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 B-3 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 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 in segment MS117M2. 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 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 B.

5.1 Wasteload Allocations

The contribution of point sources was considered on a watershed basis for the model. Within the watershed, the modeled contribution of each discharger was based on the facility's discharge monitoring data and other records of past performance. 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 contribution to the watershed, along with the existing load, allocated load, and percent reduction. The final wasteload allocation on the summary page also accounts for the load from 50% of the failing septic tanks which are assumed to bypass directly to the stream.

Table 5.1 Wasteload Allocations

Watershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
Tuxachanie Creek	1.90E-03	3.94E+05	1.90E-03	3.94E+05	0%

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 in the watershed, 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.

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

Watershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
Tuxachanie Creek	1.98E-04	7.56E+09	3.96E-05	1.51E+09	80%

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

Watershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
Tuxachanie Creek	5.53E-01	5.63E+09	1.38E-01	1.41E+09	75%

Nonpoint fecal coliform loading due to cattle grazing; land application of manure produced by confined dairy cattle and hogs; wildlife; and urban development are also included in the load allocation. Currently, no reduction is assumed for these contributors in the model for Tuxachanie Creek to achieve water quality standards. The loading rates are constant throughout the year for forest, cropland, and urban land. The loading rates for pastureland vary for each month. These rates are shown in the fecal coliform spreadsheet in Appendix A. Table 5.4 shows the estimated fecal coliform bacteria count per 30 days entering Tuxachanie Creek due to runoff during the 30-day critical period. There is a negligible amount of impervious land within the Tuxachanie Watershed, so no impervious land runoff was calculated.

Table 5.4 Fecal Coliform Counts Per Day Entering Tuxachanie Creek Due to Runoff

Critical Period	Pervious Land Runoff (counts/ 30 days)	Impervious Land Runoff (counts/ 30 days)	Total Runoff (counts/ 30 days)
Total	1.19E+10	0.00	1.19E+10

The scenario used in this analysis for the load allocation in the Tuxachanie Creek Watershed assumes an 80% reduction in contributions from cows in the stream and a 75% 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

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 Tuxachanie Creek 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 margin of safety for this TMDL is derived from the conservative loading assumptions used in setting up the model and are implicit.

WLA = NPDES Permitted Facilites + ½ of the Septic Tank Failures
= 0.284E+09 counts/30 days + 0.50(1.02E+12) counts/30 days
= 0.508E+12 counts/30 days

LA = Surface Runoff + Cows in the Stream + ½ of the Septic Tank Failures
= 11.9E+09 counts/30 days + 1.09E+12 counts/30 days + 0.50(1.02E+12) counts/30 days
= 1.61E+12 counts/30 days

MOS = implicit

TMDL= 0.508E+12 + 1.61E+12 = 2.12E+12 counts/30 days

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

5.5 Seasonality

For many streams in the state, fecal coliform limits vary according to the seasons. This stream, however, is designated for the use of contact recreation. For this use, the pollutant standard is constant throughout the year.

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 80% of the cattle access to streams and the assumed fecal load from 75% 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 Coastal Basin, Tuxachanie Creek 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 Biloxi. 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

The following documents comprise the spreadsheet used to estimate all of the fecal coliform loading used in the model. The spreadsheet consists of several sheets, each dealing with a different aspect of the estimation. The final four sheets bring all of the inputs into one format for model input.

THIS SPREADSHEET QUANTIFIES THE FECAL COLIFORM BACTERIA CONTRIBUTION FROM MULTIPLE SOURCES.

It is based on a modeling study of 9 subwatersheds, composed of four landuses (Cropland, Forest, Built-up, and Pastureland).

BLUE text found throughout the spreadsheet presents valuable information and assumptions.
GREEN text designates values specific to the Coastal Basin.
RED text designates values which should be specified by the user.
BLACK text generally presents information which is calculated by the spreadsheet or that should not be changed.

There are 9 subwatersheds in this study.
The modeled landuses were derived from the original landuses.

Modeled landuses

Areas are listed in acres.

SUBSHED	CROPLAND	FOREST	URBAN	PASTURELAND	TOTAL
3170009010	175	41642	13	16013	57843
TOTAL	175	41642	13	16013	57843

Original landuses

Areas are listed in acres.

Modeled land use category	Original Land use category	3170009010
CROPLAND	CROPLAND	0
FOREST	DECIDUOUS FOREST LAND	0
LAKES	LAKES	0
BUILT-UP	HIGH DENSITY	2
BUILT-UP	NOTHING	0
BUILT-UP	LOW DENSITY	6
BUILT-UP	TRANSPORTATION	5
PASTURELAND	PASTURELAND	0

The total number of animals in the 9 subwatersheds are as follows.

Fecal contributions from these animals are used to derive loading estimates for all landuses except for Built-up.
The number input for Poultry should be "Chickens Sold" from tbl_lstock2.dbf divided by 7.

Agricultural Animals

SUBSHED	BEEF COWS	SWINE (HOGS)	DAIRY COWS	POULTRY	CATTLE	BEEF FOR RATIO	MILK FOR RATIO	Check
3170009010	627	9	54	0	681	371	32	681
TOTAL	627	9	54	0	681	371	32	681

Wildlife

The deer population is the only major wildlife source considered. The same deer density is assumed for all subwatersheds.

Deer/sq mile	45
Deer/acre	0.0703125

This sheet contains information relevant to land application of waste produced by agricultural animals in the study area.
Application of hog manure, cattle manure, and poultry litter are considered.
The information is presented based on monthly variability of waste application.
It is assumed that cattle manure is applied to both Cropland and Pastureland using the same method.

Hog Manure Available for Wash-off

This is the percentage of manure applied by month.

	January	February	March	April	May	June	July	August	September	October	November	December	
% of annual manure applied in month	0.05	0.05	0.05	0.14	0.14	0.08	0.08	0.08	0.12	0.12	0.05	0.04	1

The percent of manure available for runoff is dependent on the method of manure application. The percent available is computed below based on incorporation into soil. These are assumed values.

% available for runoff = (1 - % incorporated) + (% incorporated * 0.5)	0.6	% Applied to Cropland:	0.00	% Applied to Pastureland:	1.00

The following is the resulting manure application based on the monthly percentage applied and incorporation into the soil.

Subwatershed	January	February	March	April	May	June	July	August	September	October	November	December
3170009010	0.03	0.03	0.03	0.084	0.084	0.048	0.048	0.048	0.072	0.072	0.03	0.024

Cattle Manure Available for Wash-off

This is the percentage of manure applied by month.

	January	February	March	April	May	June	July	August	September	October	November	December	
% of annual manure applied in month	0	0	0	0.2	0.2	0.0666	0.0667	0.0667	0.2	0.2	0	0	1

The percent of manure available for runoff is dependent on the method of manure application. The percent available is computed below based on incorporation into soil. These are assumed values.

% available for runoff = (1 - % incorporated) + (% incorporated * 0.5)	0.625	% Applied to Cropland:	0.00	% Applied to Pastureland:	1.00

The following is the resulting manure application based on the monthly percentage applied and incorporation into the soil.

Subwatershed	January	February	March	April	May	June	July	August	September	October	November	December
3170009010	0	0	0	0.125	0.125	0.041625	0.041688	0.041688	0.125	0.125	0	0

Poultry Litter Available for Wash-off

This is the percentage of manure applied by month.

	January	February	March	April	May	June	July	August	September	October	November	December	
% of annual manure applied in month	0	0	0	0.143	0.143	0.143	0.143	0.143	0.143	0.142	0	0	1

The percent of manure available for runoff is dependent on the method of manure application. The percent available is computed below based on incorporation into soil. These are assumed values.

% available for runoff = (1 - % incorporated) + (% incorporated * 0.33)	0.36	% Applied to Cropland:	0.00	% Applied to Pastureland:	1.00

The following is the resulting manure application based on the monthly percentage applied and incorporation into the soil.

Subwatershed	January	February	March	April	May	June	July	August	September	October	November	December
3170009010	0	0	0	0.05148	0.05148	0.05148	0.05148	0.05148	0.05148	0.05112	0	0

This sheet contains information relevant to cattle farming in the study area.

Dairy Cattle

Dairy cattle are assumed to be either kept in feedlots or allowed to graze (depending on the milking/feeding schedule, which is four hours per day). When grazing, a certain percentage are assumed to have direct access to streams.
Dairy cattle waste is therefore either applied as manure to Cropland and Pastureland, contributed directly to Pastureland, or contributed directly to streams (referred to as Cattle in Streams).

Beef Cattle

Beef cattle are assumed to be either kept in feedlots or allowed to graze (depending on the season). When grazing, a certain percentage are assumed to have direct access to streams.
Beef cattle waste is therefore either applied as manure to Cropland and Pastureland, contributed directly to Pastureland, or contributed directly to streams (referred to as Cattle in Streams).

	Beef Cattle Grazing	***Dairy Cattle Grazing***	***Assumed Cattle Access to Streams***
Month	**Percentage of Time not Confined (0.0 or 1.0)**	**Percentage of Time not Confined (0.0 or 1.0)**	**Percentage of Time (0.0 to 1.0)**
January	1.00	0.84	0.05
February	1.00	0.84	0.05
March	1.00	0.84	0.05
April	1.00	0.84	0.05
May	1.00	0.84	0.05
June	1.00	0.84	0.05
July	1.00	0.84	0.05
August	1.00	0.84	0.05
September	1.00	0.84	0.05
October	1.00	0.84	0.05
November	1.00	0.84	0.05
December	1.00	0.84	0.05

These data accessed from the following references are used in the remaining worksheets.

From ASAE

Animal	Total Manure prod (lb/day per 1,000 lb animal)	Typical Animal Mass (lb)	Manure prod per animal (lb/day)	Fecal Coliform (#/day E10 per 1,000 lb animal)	Fecal Coliform (#/day)	Manure prod (lb/yr)	Fecal Coliforr (#/day)
Beef cow	40	794	32	13	1.03E+11	11587	5.71E+10
Dairy cow	86	1411	121	7.2	1.02E+11	44290	1.83E+11
Hog	84	134	11	8	1.08E+10	4123	1.08E+10
Sheep	40	60	2	20	1.19E+10	869	1.19E+10
Chicken	64	4	0	3.4	1.35E+08	93	1.35E+08
Broiler	85	2	0	3.4	6.75E+07	62	6.75E+07
Turkey	47	15	1	0.62	9.29E+07	257	9.29E+07
Duck	110	3	0	81	2.50E+09	124	2.50E+09

From Metcalf & Eddy

Estimated Fecal Coliform Production Rates by Animal

Animal	#/day	Reference	
Cow	5.40E+09	Metcalf & Eddy, 1991	pg. 101
Hog	8.90E+09	Metcalf & Eddy, 1991	
Sheep	1.80E+10	Metcalf & Eddy, 1991	
Chicken	2.40E+08	Metcalf & Eddy, 1991	
Turkey	1.30E+08	Metcalf & Eddy, 1991	
Duck	1.10E+10	Metcalf & Eddy, 1991	
Deer	5.00E+08	BPJ	
Geese	4.90E+10	LIRPB, 1982	

From: Horner, 1992

Fecal Coliform Loading Rates by Landuse

	median #/ha-y	#/acre/day
Road	1.80E+08	2.00E+05
Commercial	5.60E+09	6.21E+06
Single family low density	9.30E+09	1.03E+07
Single family high density	1.50E+10	1.66E+07
Multifamily residential	2.10E+10	2.33E+07

The deer population is the only wildlife considered as a fecal coliform contributor to the Forest.

FOREST LAND

All Months	AREA (AC)	#deer	Wildlife FC prod (#/day)	FC accum (#/acre/day)	TOTAL FC accum (#/acre/day)
3170009010	41642	2927.953	1.46E+12	35156250	3.52E+07

Due to lack of animal counts, etc. for Built-up land, literature values are used.

A single, weighted Built-up loading value is quantified for each subwatershed based on individual built-up landuses present and their corresponding loading rates.

URBAN LAND

All Months	HIGH DENSITY AREA (AC)	FC accum (#/acre/day)	NOTHING AREA (AC)	FC accum (#/acre/day)	LOW DENSITY AREA (AC)	FC accum (#/acre/day)	TRANSPORTATION AREA (AC)	FC accum (#/acre/day)	TOTAL FC accum (#/acre/day)
3170009010	2	1.54E+07	0	0.00E+00	6	1.03E+07	5	2.00E+05	7.18E+06

This sheet contains information related to the contribution of failing septic systems to streams.
The direct contribution of fecal coliform from septics to a stream can be represented as a point source in the model. Required input for point sources in NPSM are loading rate (#/hr) and flow (cfs).

The following assumptions are made for septic contributions.

Assume a failure rate for septics in t	80	%

Assume the average FC concentration reaching the stream (from septic overcharge) is:	1.00E+04	#/100 ml	**(Horsely & Whitten, 1996)**
Assume a typical septic overcharge flow rate of:	100	gal/day/person	**(Horsely & Whitten, 1996)**

SEPTICS AS A POINT SOURCE

Subwatershed	Total # people served by septics	Total # people on failing tanks	Septic flow (gal/day)	Septic flow (mL/hr)	FC rate (#/hr)	Septic flow (cfs)
3170009010	4461	3568.8	356880	56282950	5.63E+09	5.53E-01

POINT SOURCES FOR EACH SUBWATERSHED (Point Sources\Loads)

	Cattle in Streams		Septic Tanks		Dischargers		Fresh Water	Total	
	Flow (cfs)	Fecal (#/hr)	Flow (cfs)	Fecal (#/hr)	Flow (cfs)	Fecal (#/hr)	Flow (cfs)	Flow (cfs)	Fecal (#/hr)
3170009010	3.96E-05	1.51E+09	1.38E-01	1.41E+09	4.60E-03	9.45E+05	1.00E+01	1.0143E+01	2.9208E+09

LANDUSE AREAS (for verification purposes only)

SUBSHED	CROPLAND	FOREST	URBAN	PASTURE	TOTAL
3170009010	175	41642	13	16013	**57843**
0	0	0	0	0	**0**
0	0	0	0	0	**0**
0	0	0	0	0	**0**
0	0	0	0	0	**0**
0	0	0	0	0	**0**
0	0	0	0	0	**0**
0	0	0	0	0	**0**
0	0	0	0	0	**0**
TOTAL	**175**	**41642**	**13**	**16013**	**57843**

SCENARIOS

Source	% Reduced*
Cattle Access	80
Septic Failure	75
Pastureland	0

* Changing the % Reduced will change only the values on this sheet

Dischargers Effluent Concetration Level =
(enter concentration used for current run,
i.e. estimated for modeling period, maximum currently permitted, maximum reccommended permitted, etc…)

PASTURELAND AND CROPLAND - ACCUM (Data Editor\PERLND\PQAL\Monthly Input\MON-ACCUM)

Monthly Input - ACCUM

	3170009010	
	Pastureland	Cropland
January	2.53E+08	3.52E+07
February	2.53E+08	3.52E+07
March	2.53E+08	3.52E+07
April	2.61E+08	3.52E+07
May	2.61E+08	3.52E+07
June	2.56E+08	3.52E+07
July	2.55E+08	3.52E+07
August	2.55E+08	3.52E+07
September	2.60E+08	3.52E+07
October	2.60E+08	3.52E+07
November	2.53E+08	3.52E+07
December	2.52E+08	3.52E+07

PASTURELAND AND CROPLAND - SQOLIM (Data Editor\PERLND\PQAL\Monthly Input\MON-SQOLIM)

Monthly Input - SQOLIM

	3170009010	
	Pastureland	Cropland
January	1.01E+09	1.41E+08
February	1.01E+09	1.41E+08
March	1.01E+09	1.41E+08
April	1.04E+09	1.41E+08
May	1.04E+09	1.41E+08
June	1.02E+09	1.41E+08
July	1.02E+09	1.41E+08
August	1.02E+09	1.41E+08
September	1.04E+09	1.41E+08
October	1.04E+09	1.41E+08
November	1.01E+09	1.41E+08
December	1.01E+09	1.41E+08

URBAN AND FOREST - ACQOP & SQOLIM (Data Editor\PERLND\PQAL\QUAL-INPUT\ACQOP & SQOLIM)

ACQOP for all months

	Urb & Bar	For & Wet
3170009010	7.18E+06	3.52E+07

SQOLIM for all months

	Urb & Bar	For & Wet
3170009010	2.87E+07	1.41E+08

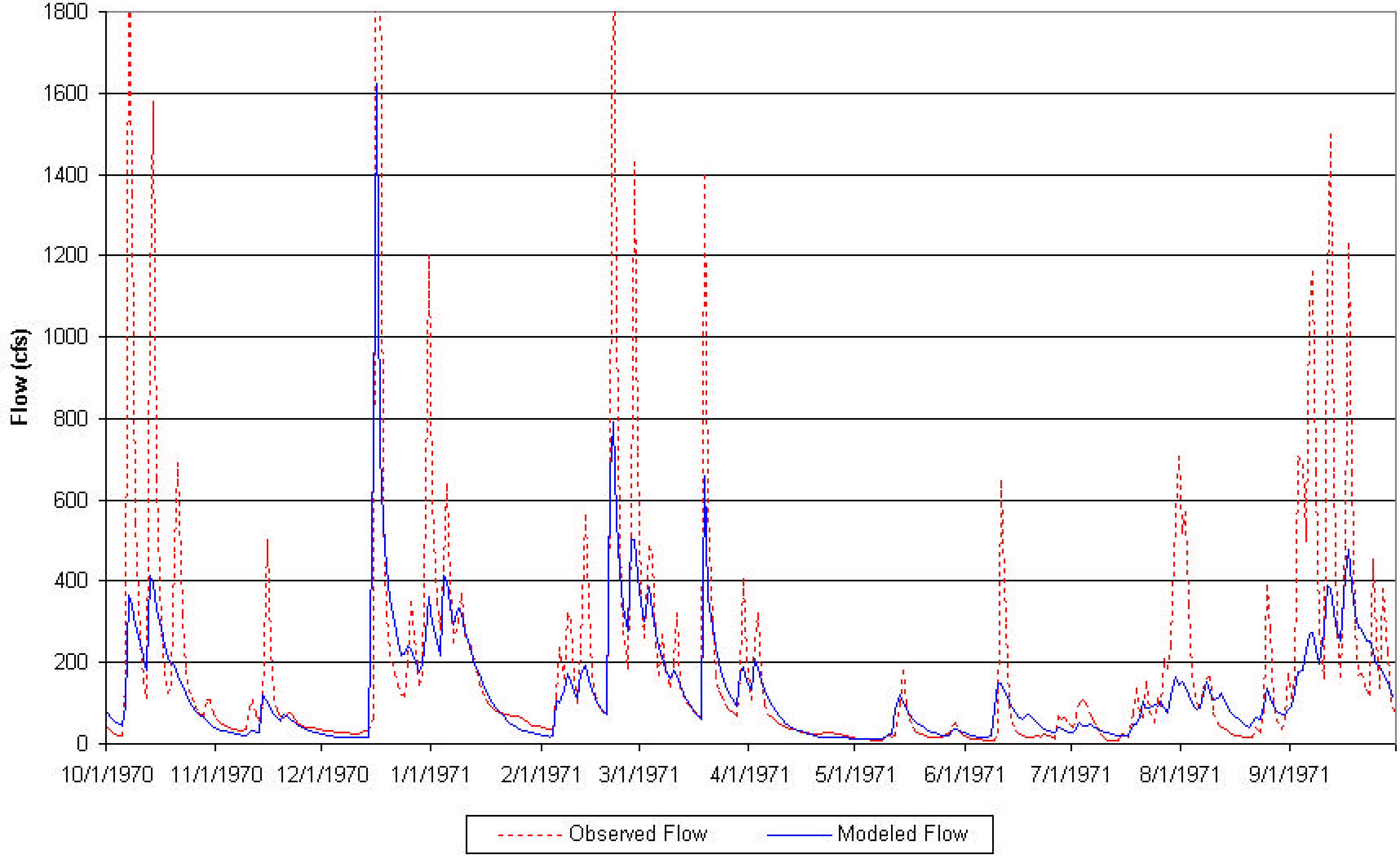
APPENDIX B

This appendix contains printouts of the various model run results. Graph B-1 shows the modeled flow, in cubic feet per second, through Tuxachanie Creek compared to the most recent actual USGS gage readings from Tuxachanie Creek near Biloxi. USGS Gage 02480500 was discontinued in 1971. The remaining graphs represent an 11-year time period, from January 1, 1985, to December 31, 1995. 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 Tuxachanie Creek. The graphs contain a reference line at 200 counts per 100 ml. Graph B-2 represents the existing conditions in Tuxachanie Creek. There are 22 violations of the fecal coliform standard on this graph. Graph B-3 represents the conditions in Tuxachanie Creek after the reduction scenario has been applied. Graph B-3 shows no violations of the standard. Graphs B-2 and B-3 are shown with the same scale for comparison purposes.

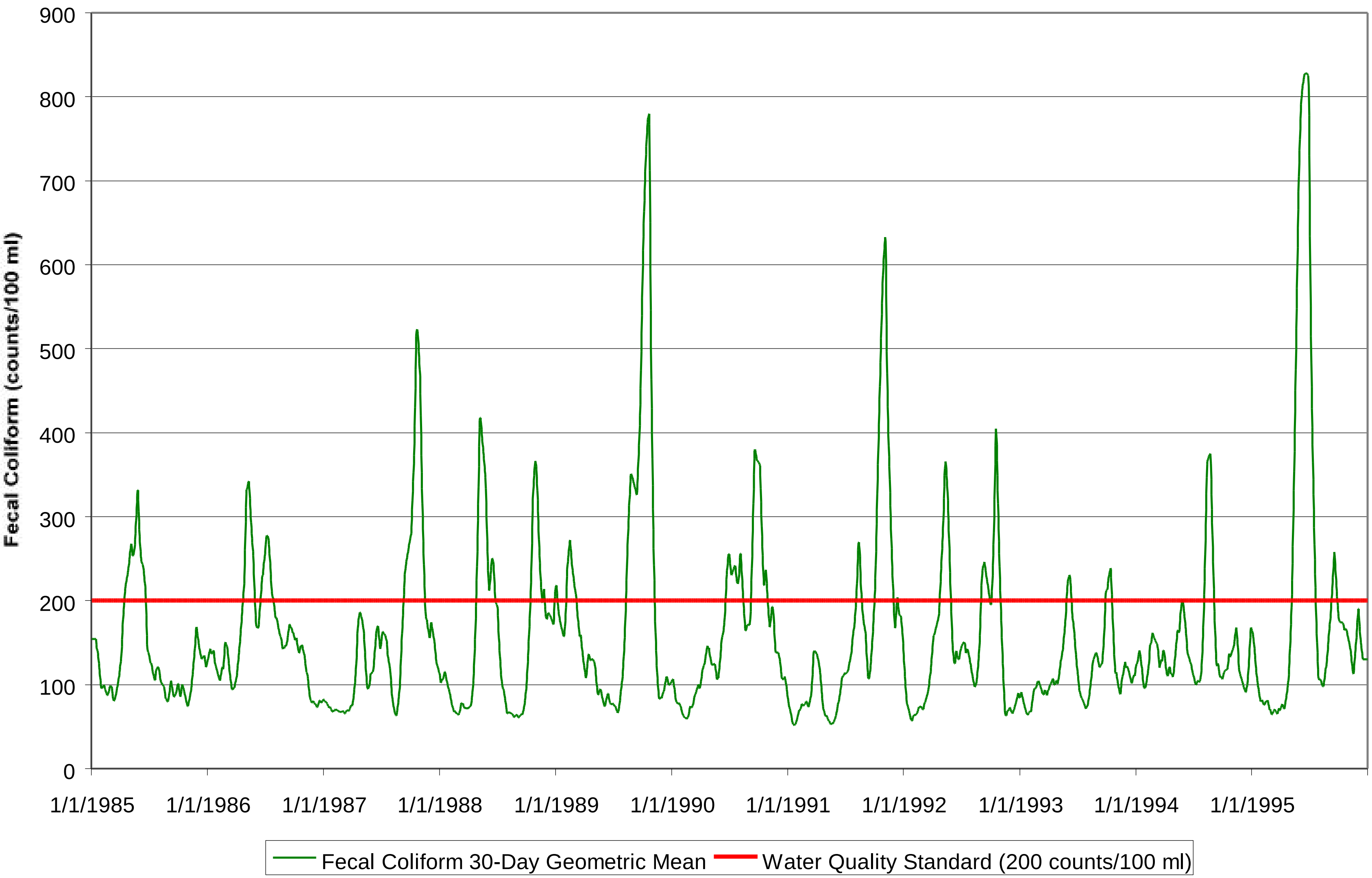
The TMDL calculated in this report represents the maximum fecal coliform load that can be assimilated by the waterbody segment during the critical 30-day period that will maintain water quality standards. The calculation of this TMDL is based on the critical hydrologic flow condition that occurred during the modeled time span. The graph showing the 30-day geometric mean of instream fecal coliform concentrations representing the allocated loading scenario (Graph B-3) 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 and drainage area can be found on the waterbody segment identification pages at the beginning of this report.

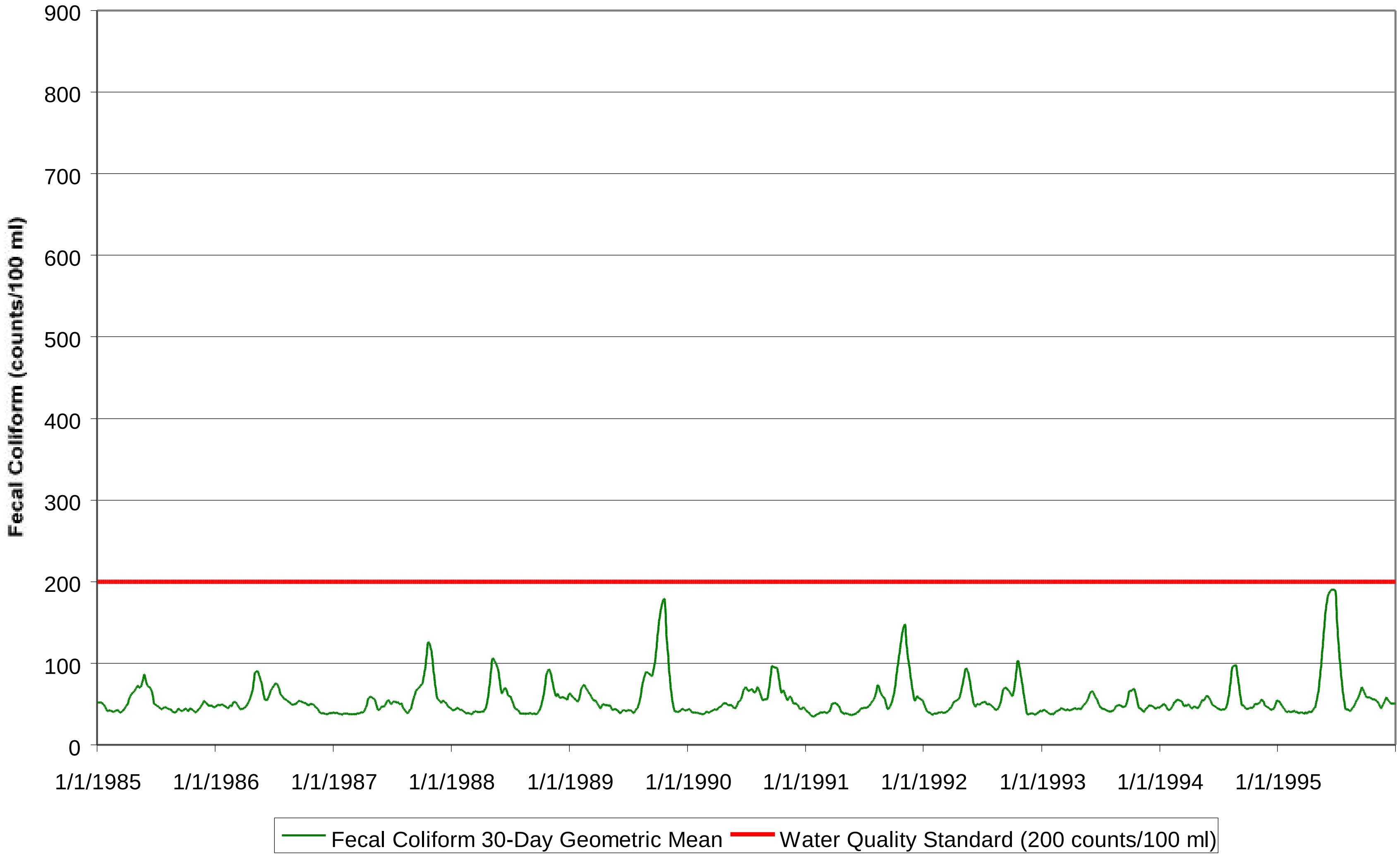
Graph B-1 Daily Flow Comparison between USGS Gage #02480500 and Reach 03170009010 for 10/01/70 - 09/30/71



Graph B-2 Modeled Fecal Coliform Concentrations Under Existing Conditions



Graph B-3 Modeled Fecal Coliform Concentrations After Application of Reduction Scenario



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 30th 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 and $2.7X10^{-4}$ = 2.7E-4=0.00027.

Sigma (ÿ): 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.

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

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

ABBREVIATIONS

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

BASINS................................Better Assessment Science Integrating Point and Nonpoint Sources

BMP ....Best Management Practice

CWA .... Clean Water Act

DMR...Discharge Monitoring Report

EPA ....Environmental Protection Agency

GIS ....Geographic Information System

HUC ....Hydrologic Unit Code

LA ....Load Allocation

MARIS ....State of Mississippi Automated Information System

MDEQ.. Mississippi Department of Environmental Quality

MOS ....Margin of Safety

NRCS ....National Resource Conservation Service

NPDES.. National Pollution Discharge Elimination System

NPSM...Nonpoint Source Model

RF3...Reach File 3

USGS ....United States Geological Survey

WLA..Waste Load Allocation

REFERENCES

Horner, 1992. Water Quality Criteria/Pollutant Loading Estimation/Treatment Effectiveness Estimation. In R.W. Beck and Associates. Covington Master Drainage Plan. King County Surface Water Management Division, Seattle, WA.

Horsley & Whitten, Inc. 1996. Identification and Evaluation of Nutrient Bacterial Loadings to Maquoit Bay, Brunswick, and Freeport, Maine. Casco Bay Estuary Project.

Metccalf and Eddy. 1991. *Wastewater Engineering: Treatment, Disposal, Reuse*. 3rd Edition. McGraw-Hill, Inc., New York.

MDEQ. 1994. *Wastewater Regulations for National Pollutant Discharge Elimination System (NPDES) Permits, Underground Injection Control (UIC) Permits, State Permits, Water Quality Based Effluent Limitations and Water Quality Certification.* Office of Pollution Control.

MDEQ. 1995. *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. Office of Pollution Control.

MDEQ. 1998. *Mississippi List of Waterbodies, Pursuant to Section 303(d) of the Clean Water Act.* Office of Pollution Control.

MDEQ. 1998. *Mississippi 1998 Water Quality Assessment, Pursuant to Section 305(b) of the Clean Water Act*. Office of Pollution Control.

USEPA. 1998. *Better Assessment Science Integrating Point and Nonpoint Sources, BASINS, Version 2.0 User's Manual*. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.