FINAL REPORT
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Fecal Coliform TMDL for

Biloxi River, Little Biloxi River, and Saucier Creek

Coastal Streams Basin
Harrison County, Mississippi

Prepared By

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MONITORED SEGMENT IDENTIFICATION

Name:	Biloxi River
Waterbody ID:	MS116M2
Location:	Near Wortham-Woolmarket: from county road southwest of Saucier to mouth at Big Lake
County:	Harrison County, Mississippi
USGS HUC Code:	03170009
NRCS Watershed:	140
Length:	24 miles
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic organisms
Priority Rank:	105
NPDES Permits:	14 fecal coliform dischargers in the entire Biloxi River Watershed (Table 3.1)
Pollutant Standard:	May through October - 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. November through April - 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.
Waste Load Allocation:	3.96E+11 counts/30 days (all dischargers must meet water quality standards for disinfection)
Load Allocation:	26.8E+11 counts/30 days
Margin of Safety:	Implicit in conservative modeling assumptions
Total Maximum Daily Load (TMDL):	30.8E+11 counts/30 days Combination of point and nonpoint sources due to NPDES permits, cows with access to streams, failing septic tanks, and fecal coliform applied to the land available for surface runoff.

MONITORED SEGMENT IDENTIFICATION

Name:	Little Biloxi River
Waterbody ID:	MS116M3
Location:	Near Wortham: from headwaters north of Lizana to approximately 1 mile east of Highway 49
County:	Harrison County, Mississippi
USGS HUC Code:	03170009
NRCS Watershed:	140
Length:	25 miles
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic organisms
Priority Rank:	106
NPDES Permits:	4 of the total 14 fecal coliform dischargers are in the Little Biloxi River Watershed (Table 3.1)
Pollutant Standard:	May through October - 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. November through April - 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.
Waste Load Allocation:	1.33E+11 counts/30 days (all dischargers must meet water quality standards for disinfection)
Load Allocation:	12.0E+11 counts/30 days
Margin of Safety:	Implicit in conservative modeling assumptions
Total Maximum Daily Load (TMDL):	13.3E+11 counts/30 days Combination of point and nonpoint sources due to NPDES permits, cows with access to streams, failing septic tanks, and fecal coliform applied to the land available for surface runoff.

MONITORED SEGMENT IDENTIFICATION

Name:	Saucier Creek
Waterbody ID:	MS116M1
Location:	At Wortham: from headwaters at Stone/Harrison County Line to mouth at Biloxi River
County:	Harrison County, Mississippi
USGS HUC Code:	03170009
NRCS Watershed:	140
Length:	24 miles
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic organisms
Priority Rank:	107
NPDES Permits:	3 of the total 14 fecal coliform dischargers are in the Saucier Creek Watershed (Table 3.1).
Pollutant Standard:	May through October - 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. November through April - Fecal coliform colony counts shall not exceed a geometric mean of 2000 per 100 ml, nor shall more than ten percent of the samples examined during any month exceed a colony count of 4000 per 100 ml.
Waste Load Allocation:	5.47E+10 counts/30 days (all dischargers must meet water quality standards for disinfection)
Load Allocation:	38.9E+10counts/30 days
Margin of Safety:	Implicit in conservative modeling assumptions
Total Maximum Daily Load (TMDL):	44.3E+10 counts/30 days Combination of point and nonpoint sources due to NPDES permits, cows with access to streams, failing septic tanks, and fecal coliform applied to the land available for surface runoff.

EXECUTIVE SUMMARY

Segments of Biloxi River, Little Biloxi River, and Saucier Creek 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 specifies that for the summer months, the maximum allowable level of fecal coliform shall not exceed a geometric mean of 200 counts 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 for the winter months of November through April the maximum allowable level of fecal coliform shall not exceed a geometric mean of 2000 counts 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 for the watershed indicate that there is a violation of the standard for the impaired waterbodies.

The Biloxi River is a major waterbody in the Coastal Streams Basin. The Little Biloxi River and Saucier Creek are tributaries of the Biloxi River. The Biloxi River flows for approximately 36 miles in a southeastern direction from its headwaters to its confluence with Big Lake. The Little Biloxi River is approximately 29 miles in length. It also flows to the southeast from its headwaters to its confluence with the Biloxi River. Saucier Creek flows in a southern direction for approximately 14 miles from its headwaters to its confluence with the Biloxi River.

This TMDL has been developed for the three impaired segments of Biloxi River, Little Biloxi River, and Saucier Creek found on the 303(d) List. 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 02481000 on the Biloxi River at Wortham were used to analyze the hydrologic flow for the watershed. The weather data used for this model were collected at the 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 tributaries of the creeks. There are 14 NPDES permitted discharges that are located in the watershed and included as point sources in the model. Under existing conditions, output from the model indicates that there are frequent violations 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 Biloxi River, Little Biloxi River, and Saucier Creek Watersheds. 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 watersheds should be continued to ensure that compliance with permit limits is consistently attained. Second is the removal of 90 percent of the cattle♣s direct access to tributaries. This could be accomplished by fencing streams in cattle pastures. Education on best management practices is a vital part of achieving this goal. Finally, a 90 percent reduction in the fecal coliform contribution from failing septic tanks is also required. A 40 percent failure rate of septic tanks was modeled in the drainage area. A reduction could be accomplished by education on best management practices for septic tank owners. Additionally, users of individual onsite wastewater treatment plants could be educated on the importance of disinfection of the effluent from their treatment plant.

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

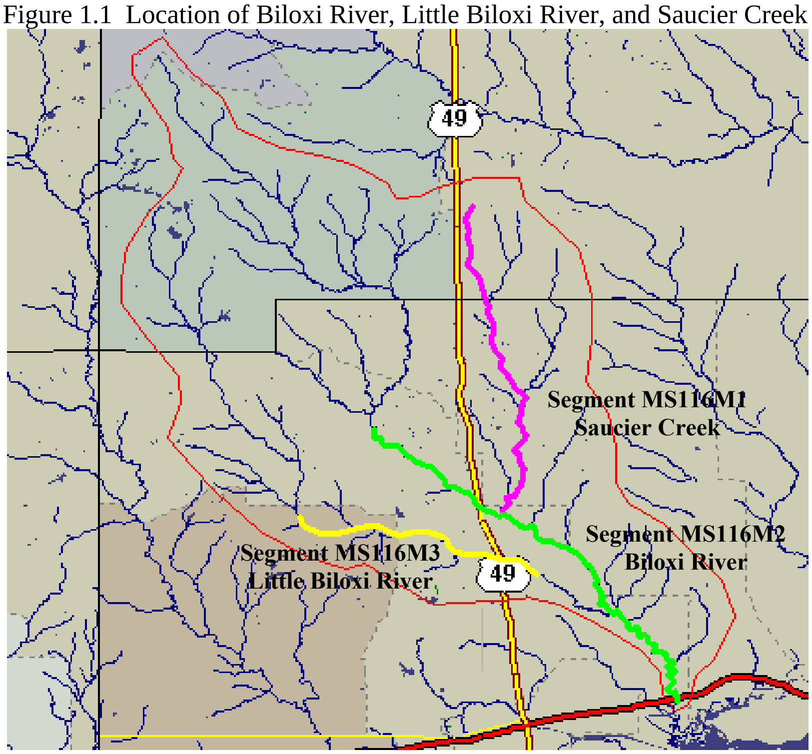
1.0 INTRODUCTION

1.1 Background

The identification of waterbodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those waterbodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR part 130). The TMDL process is designed to restore and maintain the quality of those impaired waterbodies through the establishment of pollutant specific allowable loads. The pollutant of concern for this TMDL is fecal coliform. Fecal coliform bacteria are used as indicator organisms. They are readily identifiable and indicate the possible presence of other pathogenic organisms in the waterbody. The TMDL process can be used to establish water quality based controls to reduce pollution from both point and nonpoint sources, and restore and maintain the quality of water resources.

The Mississippi Department of Environmental Quality (MDEQ) has identified segments of the Biloxi River, the Little Biloxi River, and Saucier Creek as being impaired by fecal coliform bacteria 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 that there are impairments in the segments. The Biloxi River is a 24 mile long section which begins at the county road southwest of Saucier and ends at the mouth at Big Lake. The Little Biloxi River is a 25 mile long section which begins at the Herman Ladner Road and ends approximately one mile east of Highway 49. The 24 mile long impaired section of Saucier Creek begins at the headwaters at the Stone/Harrison County Line and ends at the mouth at the Biloxi River. The locations of the three impaired segments are shown below.

Figure 1.1 Location of Biloxi River, Little Biloxi River, and Saucier Creek



The Biloxi River, Little Biloxi River, and Saucier Creel lie within the Coastal Streams Basin, Hydrologic Unit Code (HUC) 03170009 in southeastern Mississippi. The monitored segments are in NRCS Watershed 140. The watershed of the Biloxi River, from the headwaters to the end of the monitored section, which includes the Little Biloxi River and Saucier Creek, is approximately 164,700 acres. The watershed has been divided into five subwatersheds based on the major tributaries and topography. Figure 1.2 shows the subwatersheds. Table 1.1 provides the corresponding identification number, which is a combination of the eight digit HUC and the three digit Reach File 1 segment identification number, and areas of the subwatersheds. The monitored segment of the Biloxi River, which is shown in green in Figures 1.1 and 1.2, includes reaches 03170009012, 03170009013, and the downstream portion of 03170009015. The monitored segment of the Little Biloxi River, which is shown in yellow in Figures 1.1 and 1.2, is a portion of reach 03170009016. The monitored segment of Saucier Creek, which is shown in magenta in Figures 1.1 and 1.2, is all of reach 03170009014. The Biloxi River Watershed lies within portions of Stone and Harrison Counties, Mississippi. Figure 1.3 shows the general landuse distribution of the Biloxi River Watershed. While forest is the dominant landuse within the Biloxi River Watershed, there are several urban areas with Woolmarket, Saucier, Howison, and McHenry being the largest in the watershed.

Figure 1.2 Biloxi River, Little Biloxi River, and Saucier Creek Subwatersheds

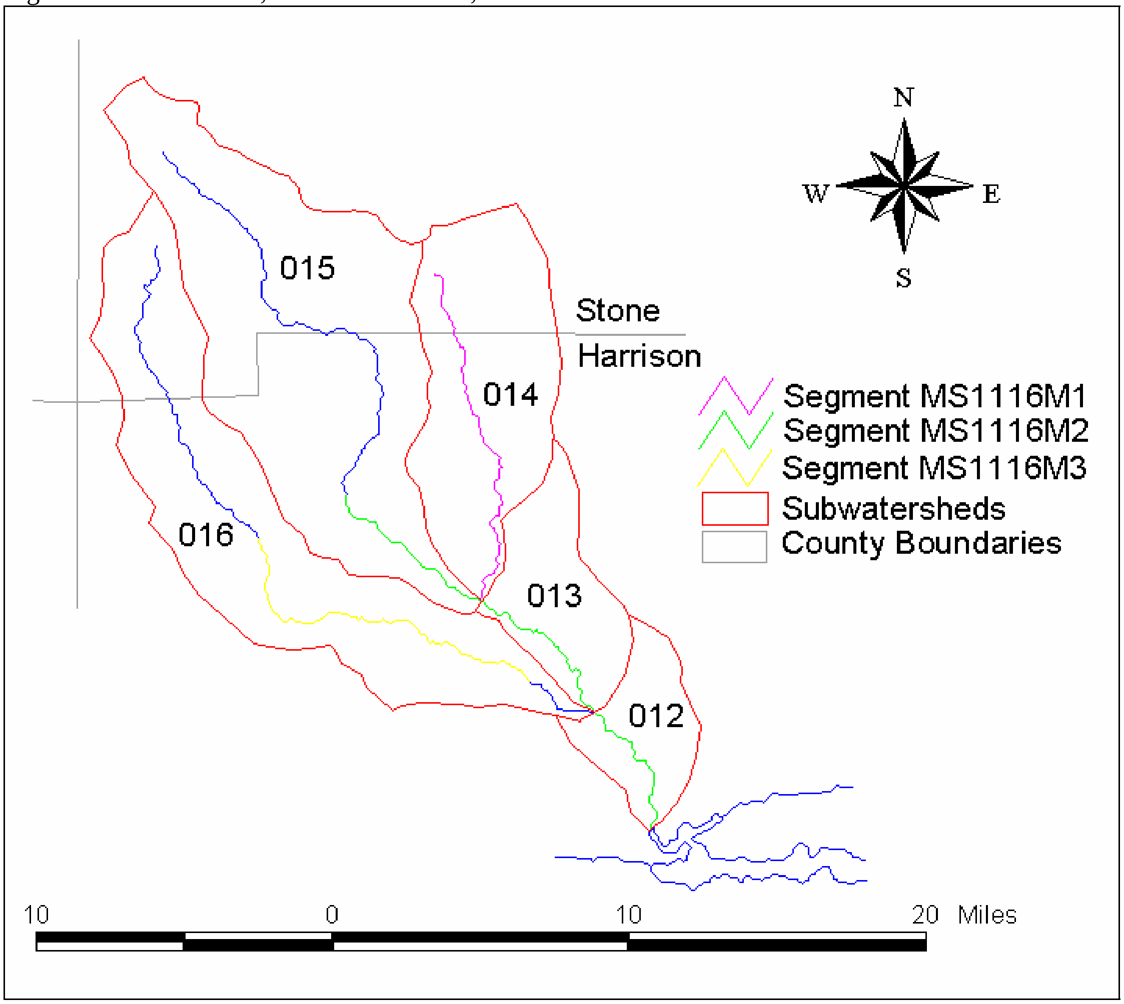
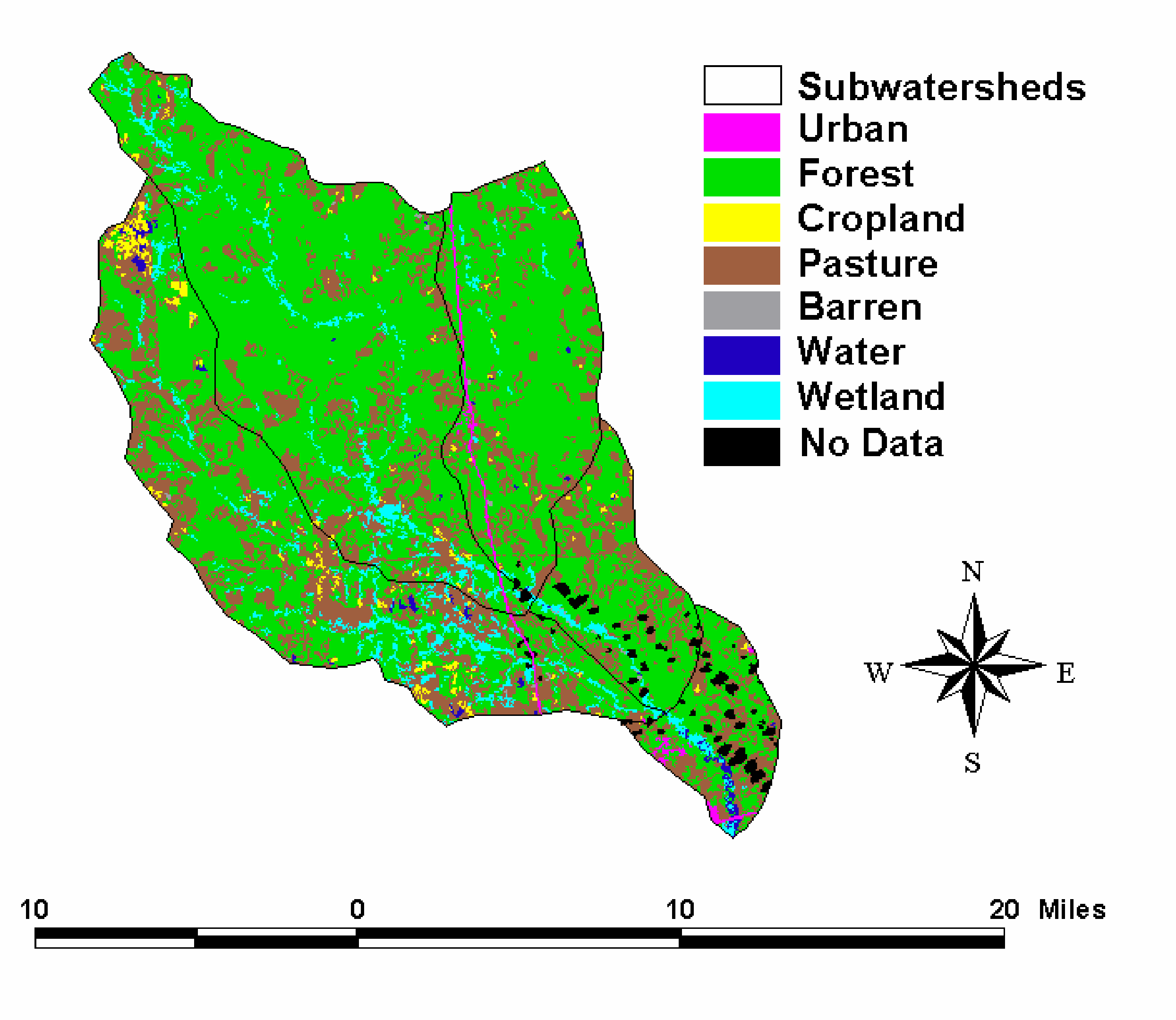


Table 1.1 Biloxi River, Little Biloxi River, and Saucier Creek Subwatersheds

Subwatershed	Major Stream Name	Area (acres)
03170009012	Biloxi River	9,386
03170009013	Biloxi River	14,134
03170009014	Saucier Creek	30,881
03170009015	Biloxi River	61,578
03170009016	Little Biloxi River	48,743
Total		**164,722**

Figure 1.3 Biloxi River, Little Biloxi River, and Saucier Creek Landuse Distribution



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 the Biloxi River, Little Biloxi River, and Saucier Creek as defined by the regulations is Fish and Wildlife. Waters in this classification are intended for fishing and propogation of fish, aquatic life, and wildlife. Waters that meet the Fish and Wildlife Criteria shall also be suitable for secondary contact recreation. Secondary contact recreation is defined as incidental contact with the water, including wading and occasional swimming.

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 from May through October the fecal coliform colony counts shall not exceed a geometric mean of 200 counts per 100 ml, nor shall more than ten percent of the samples examined during any month exceed a colony count of 400 per 100 ml, and that from November through April the fecal coliform colony counts shall not exceed a geometric mean of 2000 per 100 ml, nor shall more than ten percent of the samples examined during any month exceed a colony count of 4000 per 100 ml. This water quality standard will be used as targeted endpoints to evaluate impairments and establish this TMDL.

2.0 TMDL ENDPOINT AND WATER QUALITY ASSESSMENT

2.1 Selection of a TMDL Endpoint and Critical Condition

One of the major components of a TMDL is the establishment of instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints, therefore, represent the water quality goals that are to be achieved by implementing the load and waste load reductions specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. The instream fecal coliform target for this TMDL is a 30-day geometric mean of 200 colony counts per 100 ml during the months of May through October and a 30-day geometric mean of 2000 colony counts per 100 ml during November through April.

Because fecal coliform bacteria 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 eleven-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 segments of the Biloxi River, The Little Biloxi River, and Saucier Creek show that the stream is impaired by fecal coliform bacteria. Data were collected at station 02480990 on the Biloxi River near Wortham, station 02481097 on the Little Biloxi River near Lyman, and station 02481050 on Saucier Creek at Wortham as a part of the fresh water inflow component of the Back Bay of Biloxi Water Quality Monitoring Project during 1993, 1994, and 1995. Station 02480990 on the Biloxi River remains as an ambient station. The data from all three stations 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, all three of the impaired segments included in this report are partially supporting the use of secondary contact recreation. These conclusions were based on instantaneous data collected at the three water quality monitoring stations named in Section 2.2. Data collected at these stations are listed in Table 2.1, Table 2.2 and Table 2.3 for Biloxi River, Little Biloxi River, and Saucier Creek, respectively.

Table 2.1 Data from Station 02480990, Biloxi River

Date	**Flow** (cfs)	**Fecal Coliform** (counts per 100 ml)
6/9/1993	18	20
7/13/1993	401	3000*
8/3/1993	196	2200*
9/14/1993	46	300
10/5/1993	11	78
11/2/1993	204	800
11/30/1993	53	170
1/11/1994	75	500
2/8/1994	257	170
3/8/1994	104	80
4/5/1994	45	130
6/7/1994	135	830*
8/1/1994	35	56
8/23/1994	9	180
1/31/1995	322	80
4/4/1995	223	95
12/11/1996	23	160
1/8/1997		4100*
2/5/1997	686	5200*
3/5/1997	203	73
4/3/1997	74	80
5/6/1997	48	70
6/10/1997	69	70
7/7/1997	243	1600*
8/11/1997	200	2000*
9/4/1997	11	120
10/8/1997		70
11/17/1997		220
12/4/1997		670
1/12/1998		5800*
3/18/1998		660
4/9/1998		80
6/15/1998		130

* Indicates a violation of the Secondary Contact Recreation Standard for Fecal Coliform

Table 2.2 Data from Station 02481097, Little Biloxi River

Date	**Flow** (cfs)	**Fecal Coliform** (counts per 100 ml)
6/9/1993	13	20
7/13/1993	340	800*
8/3/1993	140	5000*
9/14/1993	76	70
10/5/1993	13	1300
11/2/1993	222	1700
11/30/1993	37	230
1/11/1994	57	80
2/8/1994	175	80
3/8/1994	81	40
4/5/1994	28	20
6/7/1994	23	77
2/9/1998		110
7/29/1998		37

* Indicates a violation of the Secondary Contact Recreation Standard for Fecal Coliform

Table 2.3 Data from Station 02481050, Saucier Creek

Date	**Flow** (cfs)	**Fecal Coliform** (counts per 100 ml)
6/9/1993	7	300
7/13/1993	57	1700*
8/3/1993	26	500*
9/14/1993	18	800*
10/5/1993	7	68
11/2/1993	49	300
11/30/1993	24	340
1/11/1994	53	1100
2/8/1994	91	90
3/8/1994	42	140
4/5/1994	23	110
6/7/1994	54	190
8/1/1994	18	20
8/23/1994	8	65
1/31/1995	127	40
4/4/1995	109	80
2/18/1998		60
8/12/1998		40

* Indicates a violation of the Secondary Contact Recreation Standard for Fecal Coliform

2.2.2 Analysis of Instream Water Quality Monitoring Data

Statistical summaries of the water quality data discussed above are presented in Tables 2.4 and 2.5. Samples collected during May through October were compared to the recreational season instantaneous maximum standard of 400 counts per 100 ml in Table 2.4. Table 2.5 shows a comparison of the samples collected during November through April with the non-recreational season instantaneous maximum standard of 4000 counts per 100 ml. The percent exceedance was calculated by dividing the number of exceedances by the total number of samples. Because the samples are instantaneous, the percent exceedance does not represent the amount of time that the water quality is in violation.

Table 2.4 Recreational Season Statistical Summaries

Station Number	Number of Samples	Number of Exceedances	Percent Instantaneous Exceedance
02480990	13	5	39
02481097	6	2	33
02481050	8	3	38

Table 2.5 Non-Recreational Season Statistical Summaries

Station Number	Number of Samples	Number of Exceedances	Percent Instantaneous Exceedance
02480990	20	3	15
02481097	8	0	0
02481050	10	0	0

3.0 SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential fecal coliform sources in the Biloxi River, the Little Biloxi River, and Saucier Creek Watersheds. 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.

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 14 wastewater treatment plants in the modeled watersheds serve a variety of activities including municipalities, residential subdivisions, schools, and other businesses. Table 3.1. lists all of the fecal coliform dischargers according to the subwatershed in which the discharger is located, 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. 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. The permit limits of each facility included in the model are given in Table 3.1.

Table 3.1 Inventory of Point Source Dischargers

Facility Name	Subwatershed	NPDES Permit	Fecal Coliform (counts/100ml)	Receiving Waterbody
Apple Valley Trailer Park	03170009012	MS0040169	200	Mill Creek
Woolmarket School	03170009012	MS0030899	200	Mill Creek
Eagle Point Subdivision	03170009013	MS0034436	200	Biloxi River
Harrison Central High School	03170009013	MS0030911	200	Biloxi River
Hidden Point Subdivision	03170009013	MS0055018	200	Trib to Biloxi River
Jig's Fish Camp	03170009013	MS0052230	200	Biloxi River
Adams Trailer Park #2	03170009014	MS0051845	200	Flat Branch
Philip McLoone Saucier Center	03170009014	MS0040002	200	Flat Branch
Oakland Mobile Home Park	03170009014	MS0049972	200	Hogg Branch
Ponochio's Lyman Trailer Park	03170009014	MS0050431	200	Loya Branch
Saucier Elementary School	03170009014	MS0030945	200	Saucier Creek
Riverline Hills Subdivision	03170009016	MS0027154	200	Little Biloxi River
Robinwood Forest Utilities, Inc.	03170009016	MS0050725	200	Little Biloxi River
City of David Apartments	03170009016	MS0041807	200	Little Biloxi River
Highway 49 Mobile Home Park	03170009016	MS0042200	200	Little Biloxi River

3.2 Assessment of Nonpoint Sources

There are many potential nonpoint sources of fecal coliform bacteria for Biloxi River, Little Biloxi River, and Saucier Creek, including:

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

The 164,722 acre drainage area of the monitored segments of Biloxi River, Little Biloxi River, and Saucier Creek contains many different landuse types, including urban, forests, cropland, pasture, 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 Biloxi River, Little Biloxi River, and Saucier Creek was considered on a subwatershed basis. Table 3.2 shows the landuse distribution within each subwatershed in number of acres.

Table 3.2 Landuse Distribution in Each Subwatershed in Acres

Subwatershed	Forest	Cropland	Pasture	Barren	Urban	Wetland	Total
03170009012	5,285	41	1,376	0	342	2,341	**9,385**
03170009013	9,317	84	1,763	0	66	2,904	**14,134**
03170009014	24,397	133	1,824	0	607	3,920	**30,882**
03170009015	48,894	345	1,788	0	148	10,403	**61,578**
03170009016	29,798	1,520	4,111	0	203	13,112	**48,743**
All	**117,691**	**2,123**	**10,862**	**0**	**1,366**	**32,680**	**164,722**

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 Biloxi River, Little Biloxi River, and Saucier Creek Watersheds. 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.

The use of individual, onsite wastewater treatment plants was also considered. 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 Biloxi River, Little Biloxi River, and Saucier Creek Watersheds contribute to fecal coliform bacteria on the land surface. In the watershed 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. 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 in the months of April 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 Streams 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 Biloxi River, Little Biloxi River, and Saucier Creek Watersheds 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.

3.2.6 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 the larger, impaired 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 Biloxi River, Little Biloxi River, and Saucier Creek Watersheds, 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.

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 Biloxi River, Little Biloxi River, and Saucier Creek was considered. Municipalities within the watersheds include Woolmarket, Wortham, Hovey, Saucier, Howison, and McHenry. 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 Biloxi River, Little Biloxi River, and Saucier Creek. 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 Biloxi River, Little Biloxi River, and Saucier Creek 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 Biloxi River, Little Biloxi River, and Saucier Creek, the watershed was divided into five subwatersheds in an effort to isolate the major stream reaches in the 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. Due to die-off rates and overland transportation assumptions, the fecal coliform loading from point and nonpoint sources must be addressed separately. There are 14 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 Biloxi River, Little Biloxi River, and Saucier Creek. Other sources are represented as an application rate to the land in the 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 fecal coliform accumulations were combined for model input.

A Fecal Coliform Spreadsheet was utilized for quantifying point and nonpoint sources of bacteria for the 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 described 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 Harrison and Stone Counties. The percentage of the population on septic systems was determined from 1990 United States Census Data. In Harrison County it was estimated that 19 percent of the population use septic tanks or individual, onsite wastewater treatment plants. In Stone County the estimate is 67 percent. Based on the best available information, a septic tank failure rate of 40 percent 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.

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 10,000 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 Biloxi River, Little Biloxi River, and Saucier Creek Watersheds was estimated to be greater than 45 deer per square mile. An estimate of 60 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.

4.3.6 Cattle Contributions Deposited Directly Instream

The contribution of fecal coliform bacteria from cattle wading in streams 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 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.

4.3.7 Urban Development

The MARIS landuse data divide urban land into several categories. For the Biloxi River, Little Biloxi River, and Saucier Creek Watersheds, 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 (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. 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 (counts per day)

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

4.4 Stream Characteristics

The stream characteristics given below in Table 4.3 describe the modeled impaired segments of Biloxi River, Little Biloxi River, and Saucier Creek. The channel geometry and lengths for the segments are based on data available within the BASINS modeling system. The 7Q10 flow was determined from USGS data.

Table 4.3 Stream Characteristics

Waterbody	Length (miles)	Average Depth (ft)	Average Width (ft)	Mean Flow (cfs)	Mean Velocity (fps)	7Q10 Flow (cfs)	Slope (ft per ft)
Biloxi River	36.2	0.7	43.5	384.4	1.4	36.5	0.0007
Little Biloxi River	29.1	0.7	28.8	91.8	0.9	16.0	0.0012
Saucier Creek	13.6	0.5	18.6	42.9	0.7	7.5	0.0017

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 eleven-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. Model outputs were also compared to water quality monitoring data from the same time period in order to calibrate the fecal coliform loadings in the model. The loadings were adjusted so that modeled fecal coliform concentrations closely matched the monitoring data.

A set of input values for hydrologic parameters was established for the Coastal Basin. This data set was applied to various gages in the basin as a means of hydrologic calibration and validation. The hydrology calibration was performed by adjusting model parameters representing evapotranspiration, surface runoff, interflow, and groundwater flows. The weather data used for this model were collected at the Saucier Experimental Forest Station. The representative hydrologic period used for the TMDL was January 1, 1985, through December 31, 1995.

The hydrological model had a continuous USGS gage, 02481000, available on the Biloxi River at Wortham for comparison with the modeled flow in reach 03170009015 of the Biloxi River. These results are included in Appendix A. Modeled output and actual gage data are shown on the same graph for representative one year periods, showing a good correlation between the two data sets.

4.7 Existing Loading

Appendix A also includes graphs of the water quality model results. The instream fecal coliform concentrations for each of the impaired segments are shown. Graph A-2a shows the fecal coliform levels in the stream during the 11-year modeling period for the Biloxi River, while Graph A-2b shows the Little Biloxi River, and Graph A-2c shows Saucier Creek. The graphs show 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 during the recreational season.

Graphs B-3a, B-3b, and B-3c for Biloxi River, Little Biloxi River, and Saucier Creek, respectively, show the 30-day geometric mean of the fecal coliform levels after the reduction scenario has been modeled. The scale matches the previous graph for comparison purposes. The graphs indicate that there are no violations of the water quality standard in the impaired segments after the allocations have been modeled.

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 MS116M1, MS116M2, and MS116M3. 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 a nonpoint source, while failing septic tanks are both a point and nonpoint source. 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 entering the stream. The TMDL was calculated based on modeling estimates which are referenced in Appendix A.

5.1 Wasteload Allocations

Point sources within the watershed are subject to some reduction from their current level of fecal coliform contribution. The contribution of point sources was considered on a subwatershed basis for the model. Within each subwatershed, the modeled contribution of each discharger was based on the facility's discharge monitoring data and other records of past performance. In several cases, the fecal coliform contribution from a facility is much greater than the permitted limit. As part of this TMDL, these wastewater treatment facilities will be required to meet water quality standards at the end of their pipe. All wastewater treatment facilities with current NPDES Permits that meet water quality standards should take steps to comply with their current permits. Table 5.1 lists the point source contributions from permitted dischargers, on a subwatershed basis, along with their existing load, allocated load, and percent reduction. A portion of failing septic tanks, which are direct bypasses and a point source of pollution, are also a component of the wasteload allocation (WLA).

Table 5.1 Component of WLA due to permitted dischargers

Subwatershed	Existing Load (counts/hr)	Allocated Load (counts/hr)	Percent Reduction
03170009012	1.57E+07	1.57E+07	0
03170009013	8.76E+07	8.76E+07	0
03170009014	8.82E+06	8.82E+06	0
03170009015	0.0	0.0	0
03170009016	6.72E+07	6.72E+07	0
Total	**1.79E+08**	**1.79E+08**	**0**

5.2 Load Allocations

Nonpoint sources that contribute to fecal coliform accumulation within Biloxi River, Little Biloxi River, and Saucier Creek Watersheds are subject to reduction from their current level of contribution. Reductions in the load allocation for this TMDL involve two different types of nonpoint sources: cattle access to streams and failing septic tanks. Contributions from both of these sources are input into the model in a manner similar to point source input, with a flow in cubic feet per second and fecal coliform concentration in counts per hour. Table 5.2 lists the nonpoint source contributions due to cattle access to streams, while Table 5.3 shows those due to septic tank failure, which are evenly distributed between point and nonpoint sources.

Table 5.2 Fecal Coliform Loading Rates from Cattle Access to Streams

Subwatershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
03170009012	2.93E-05	1.12E+09	2.93E-06	1.12E+08	90
03170009013	2.26E-05	8.65E+08	2.26E-06	8.65E+07	90
03170009014	1.14E-04	4.34E+09	1.14E-05	4.34E+08	90
03170009015	2.74E-04	1.05E+10	2.74E-05	1.05E+09	90
03170009016	3.89E-04	1.49E+10	3.89E-05	1.49E+09	90
Total	**8.29E-04**	**3.17E+10**	**8.29E-5**	**3.17E+09**	**90**

Table 5.3 Fecal Coliform Loading Rates from Failing Septic Tanks (50% WLA, 50% LA)

Subwatershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
03170009012	6.07E-02	6.18E+08	6.07E-03	6.18E+07	90
03170009013	8.26E-02	8.40E+08	8.26E-03	8.40E+07	90
03170009014	1.32E-01	1.34E+09	1.32E-02	1.34E+08	90
03170009015	2.22E-01	2.26E+09	2.22E-02	2.26E+08	90
03170009016	2.32E-01	2.36E+09	2.32E-02	2.36E+08	90
Total	**7.29E-01**	**7.42E+09**	**7.29E-02**	**7.42E+08**	**90**

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 required for these contributors in order for Biloxi River, Little Biloxi River, and Saucier Creek to achieve water quality standards. Daily fecal coliform loading rates for each landuse are given in Table 5.4. The total accumulation for each landuse type was determined by combining the contributions from each subwatershed. For example, the loading rate for forests was determined by combining all of the forest contributions from each of the five subwatersheds. The loading rates are constant throughout the year for forest, cropland, and urban land. The loading rates for pastureland vary for each month, and an average rate is shown. The estimated loads shown in Table 5.4 are those which accumulate on the land and are available for runoff, while the load allocation is the load as it enters the stream due to runoff.

Table 5.4 Daily Fecal Coliform Load Available for Runoff by Subwatershed and Landuse Type in Counts per Day

Subwatershed	Urban & Barren	Forest & Wetland	Cropland	Pastureland Annual Average	Total
03170009012	2.45E+09	2.68E+11	1.44E+09	5.70E+11	8.42E+11
03170009013	4.74E+08	4.30E+11	2.95E+08	4.67E+11	9.00E+11
03170009014	4.36E+09	9.96E+11	4.68E+09	2.09E+12	3.10E+12
03170009015	1.06E+09	2.08E+12	1.21E+10	4.97E+12	7.06E+12
03170009016	1.46E+09	1.51E+12	5.34E+10	7.09E+12	8.65E+12
Total	**9.81E+09**	**5.29E+12**	**7.46E+10**	**1.52E+13**	**2.06E+13**

The scenario chosen for the load allocation in the Biloxi River, Little Biloxi River, and Saucier Creek Watersheds is a 90 percent reduction in contributions from cows in the stream and from failing septic tanks. This scenario could be achieved by supporting BMP projects that promote fencing around streams in pastures, and by supporting education projects that encourage homeowners to properly maintain their septic tanks by routinely pumping them out, repairing broken field lines, and disinfecting the effluent from small individual onsite wastewater treatment plants.

5.3 Incorporation of a Margin of Safety

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

5.4 Seasonality

For the impaired segments included in this TMDL, fecal coliform limits vary according to the seasons due to their designation for the use of secondary contact recreation. The wasteload and load allocations were developed so that the most stringent fecal coliform standard, a geometric mean of 200 counts per 100 ml, was not violated during the recreational season of April through October. The wasteload and load allocations were also developed to prevent exceedances of the non-recreational season limit, a geometric mean of 2000 counts per 100 ml, in November through March. None of the permitted dischargers had seasonal permit limits.

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

6.0 IMPLEMENTATION

6.1 Follow-Up Monitoring

MDEQ has adopted the Basin Approach to Water Quality Management, a plan that divides Mississippi's major drainage basins into five groups. During each one-year 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, Biloxi River, Little Biloxi River, and Saucier Creek may receive follow-up monitoring to identify the improvement in water quality from the implementation of the strategies in this TMDL.

6.2 Reasonable Assurance

The fecal coliform reduction scenario used in this TMDL includes requiring all NPDES permitted dischargers of fecal coliform to meet water standards for disinfection, along with reducing 90 percent of the cattle access to streams and 90 percent of the failing septic tanks in the watershed. Reasonable assurance for the implementation of the TMDL has been considered for both point and nonpoint source contributors.

The TMDL will not impact existing or future NPDES Permits as long as the effluent is disinfected to meet water quality standards for fecal coliform bacteria. MDEQ will reject any NPDES permit application that does not include plans to meet water quality standards for disinfection. Education projects that teach best management practices should be used as a tool for reducing nonpoint source contributions. These projects may be funded by CWA Section 319 Nonpoint Source (NPS) Grants.

6.3 Public Participation

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

7.0 REFERENCES, DEFINITIONS, AND ABBREVIATIONS

7.1 References

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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.

7.2 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 becomes 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 (Σ): shorthand way to express taking the sum of a series of numbers. For example, the sum or total of three amounts 24, 123, 16, ($\mathbf{d}_1$, $\mathbf{d}_2$, $\mathbf{d}_3$) 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.

7.3 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

USGS .... United States Geological Survey

WLA .... Waste Load Allocation

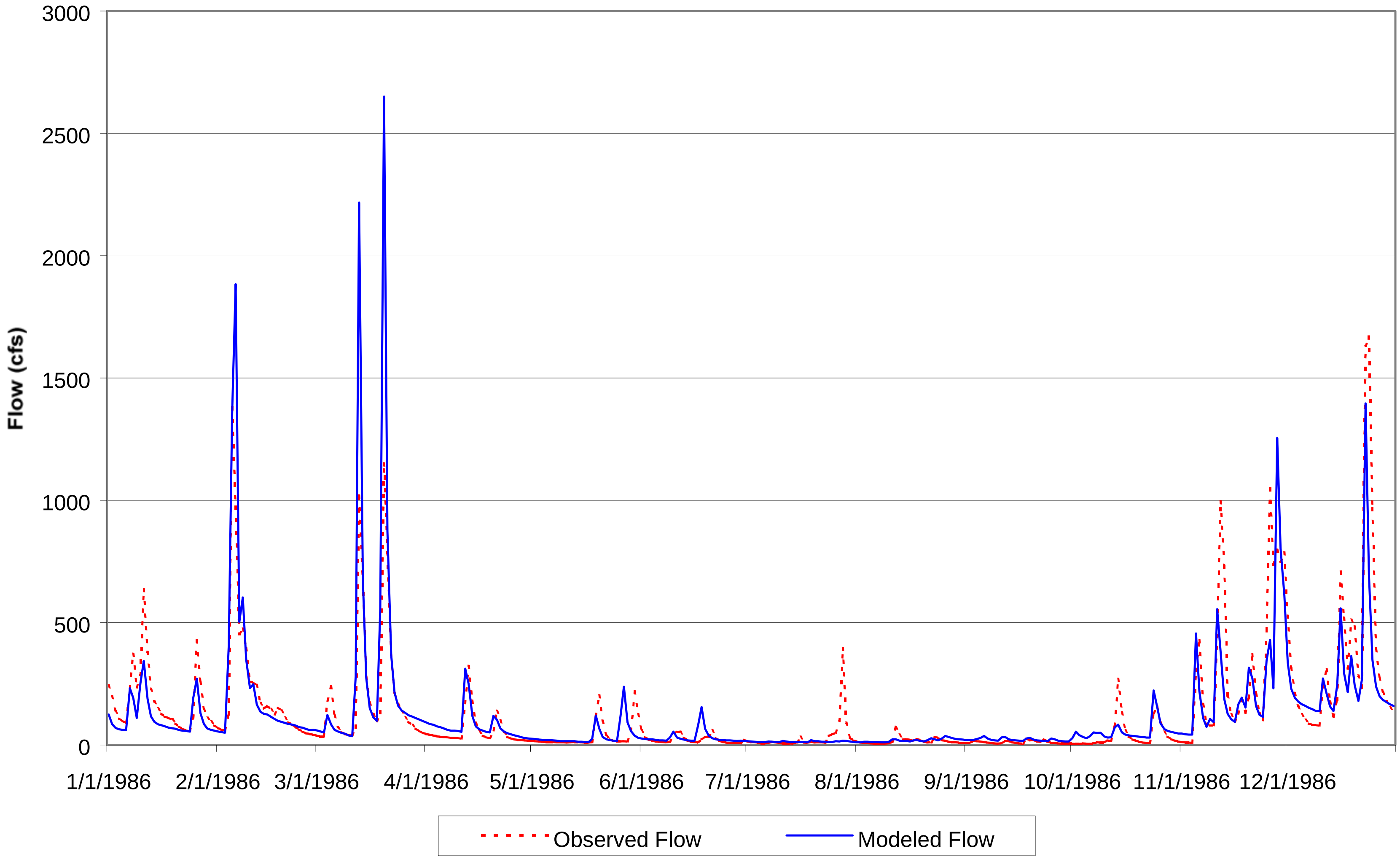
8.0 APPENDIX A

This appendix contains printouts of the various model run results. Graphs A-1a, A-1b, and A-1c show the modeled flow, in cubic feet per second, through reach 03170009015 compared to the actual USGS gage readings from the Biloxi River at Wortham, MS for 1986, 1990, and 1993, respectively. The second set of graphs show the 30-day geometric mean for fecal coliform concentrations in counts per 100 ml in each of the impaired reaches. The graphs contain a reference line at 200 counts per 100 ml, representing the recreational season water quality standard. Graph A-2a represents the existing conditions in the Biloxi River. Graph A-2b represents the existing conditions in the Little Biloxi River. Graph A-2c represents the existing conditions in Saucier Creek. There are frequent violations of the fecal coliform standard on these graphs. Graph A-3a, A-3b, and A3c represent the conditions in the Biloxi River, Little Biloxi River, and Saucier Creek after the reduction scenario has been applied. Graphs A-2 and B-3 for each segment are shown with the same scale for comparison purposes.

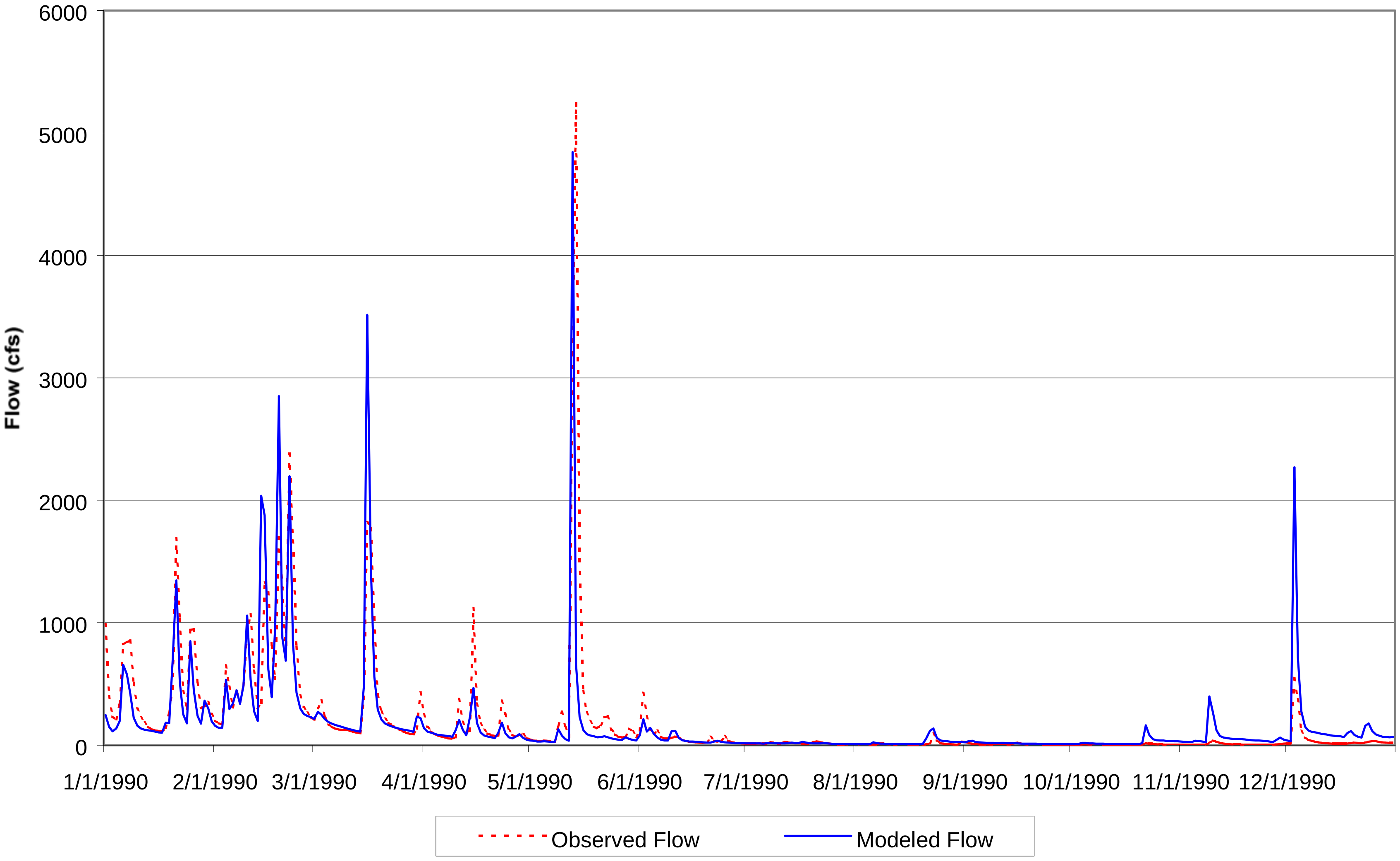
The TMDL calculated in this report represents the maximum fecal coliform load that can be assimilated by the waterbody segment during the critical 30-day period that will maintain water quality standards. The calculation of this TMDL is based on the critical hydrologic flow condition that occurred during the modeled time span. Graphs A-3a, A-3b, and A-3c, which show the 30-day geometric mean of instream fecal coliform concentrations representing the allocated loading scenario, were used to identify the critical condition. The TMDL calculation includes the sum of the loads from all identified point and nonpoint sources applied or discharged within the modeled watershed.

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

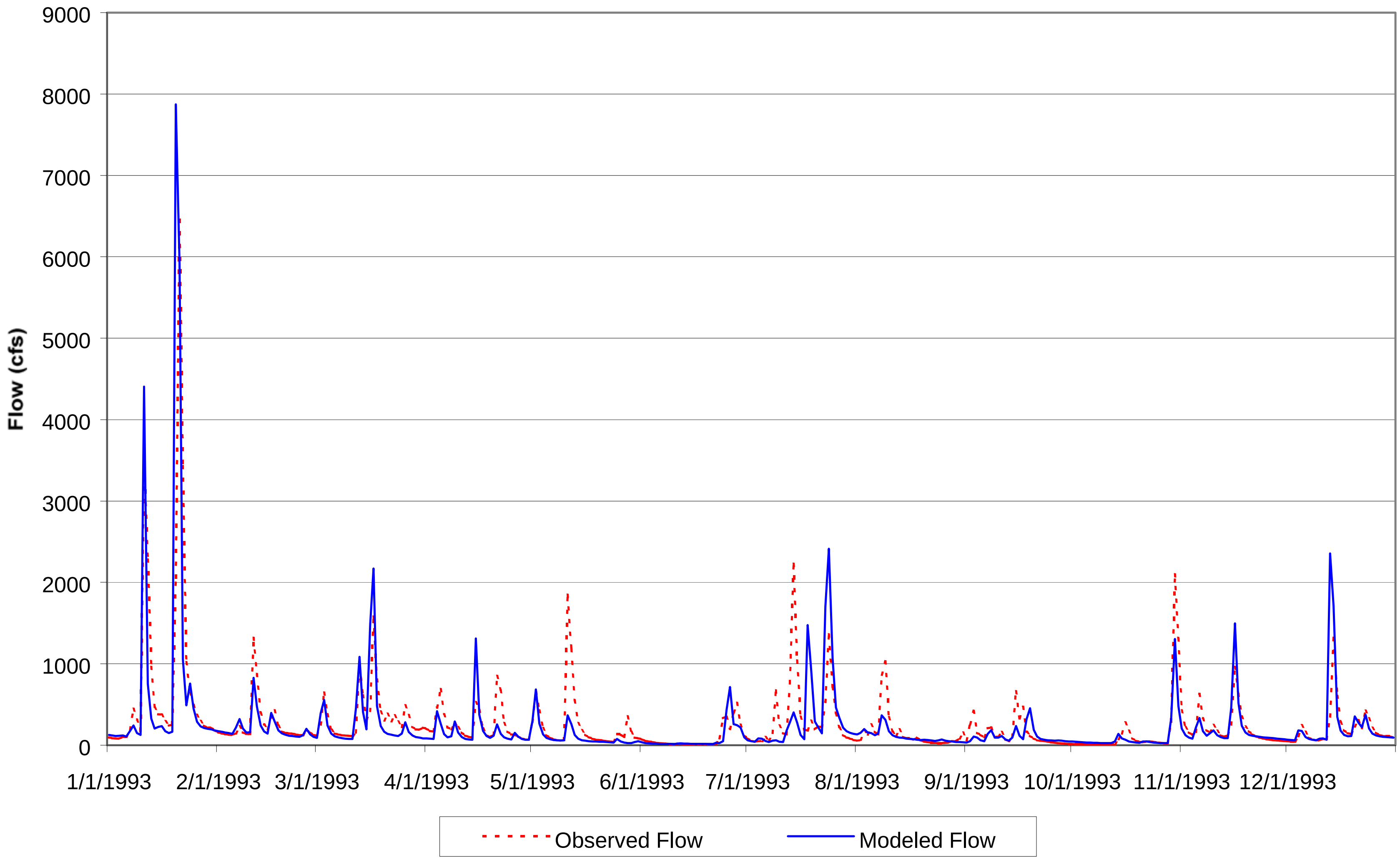
Graph A-1a Daily Flow Comparison between USGS Gage 02481000 and Reach 03170009015 for 1/1/86 - 12/31/86



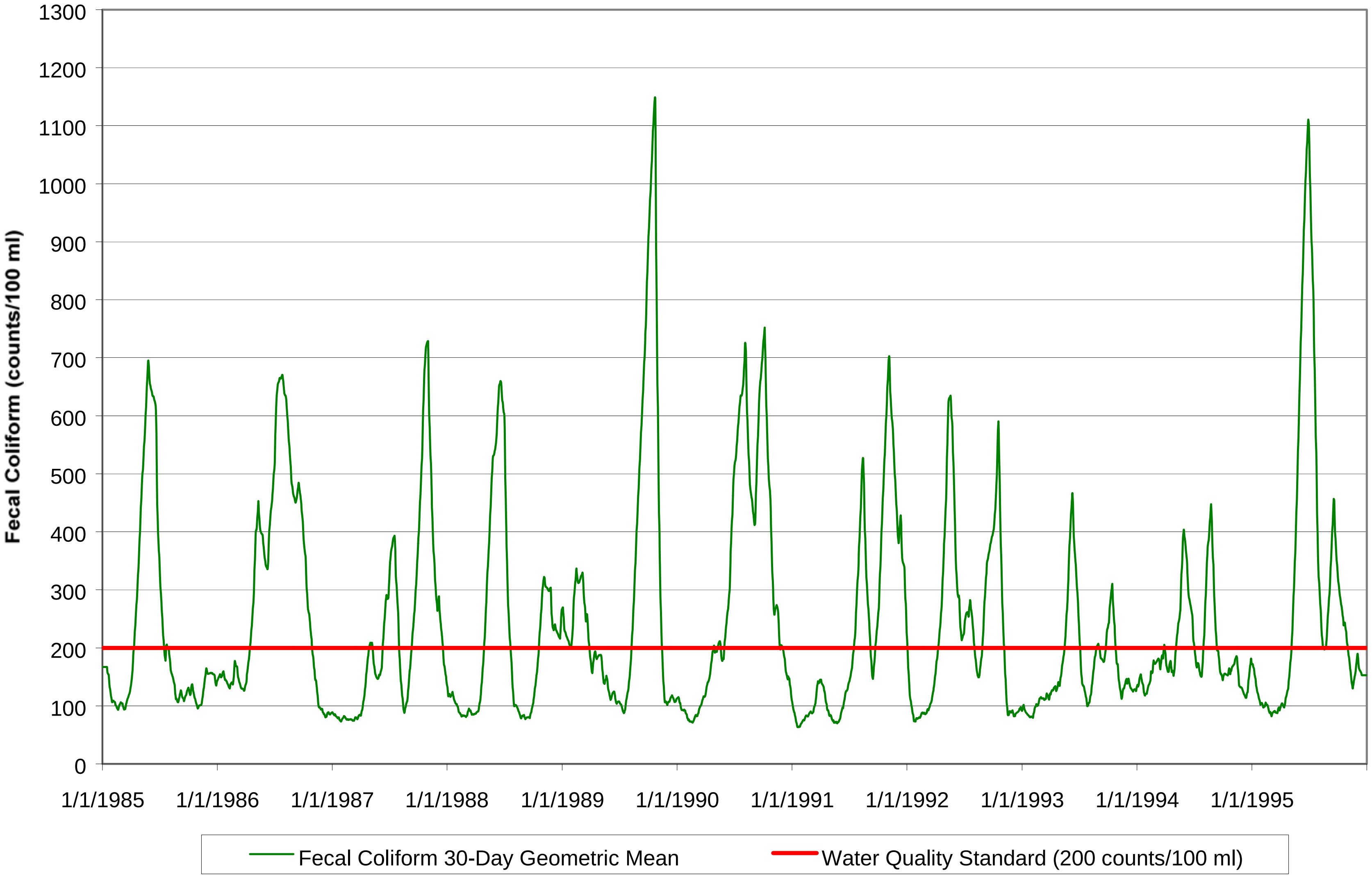
Graph A-1b Daily Flow Comparison between USGS Gage 02481000 and Reach 03170009015 for 1/1/90 - 12/31/90



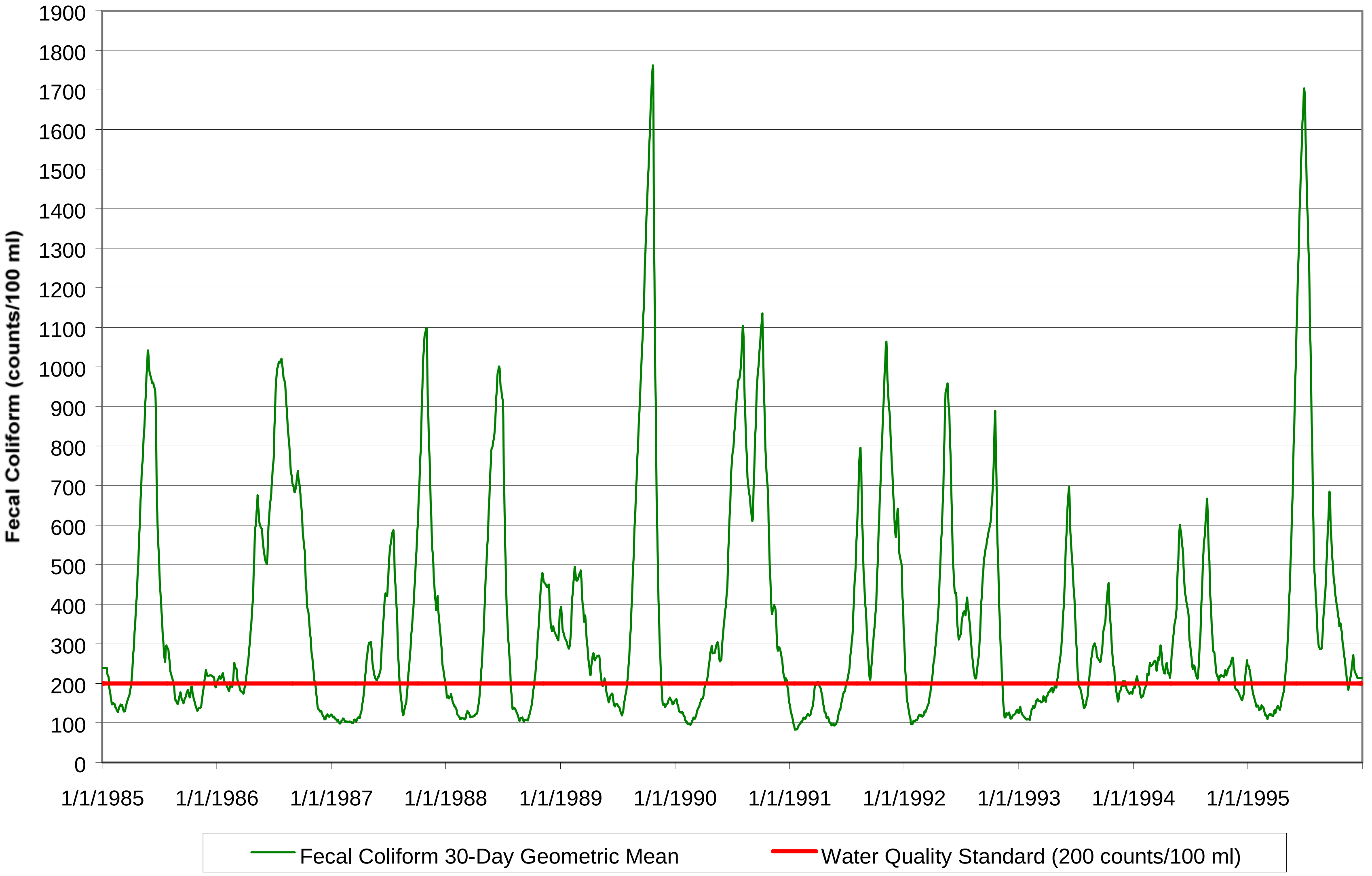
Graph A-1c Daily Flow Comparison between USGS Gage 02481000 and Reach 03170009015 for 1/1/1993 - 12/31/1993



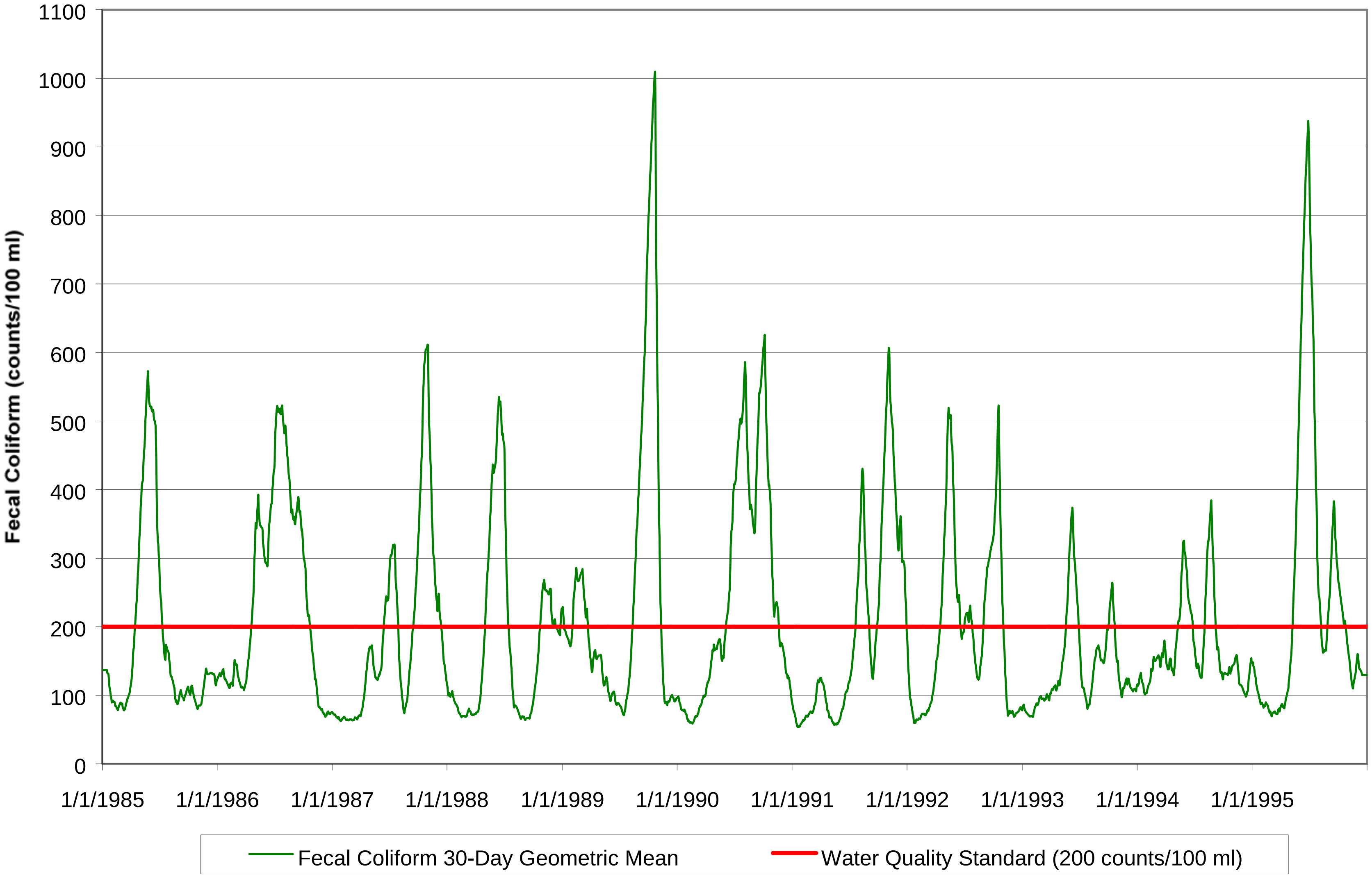
Graph A-2a Modeled Fecal Coliform Concentrations Under Existing Conditions in Biloxi River



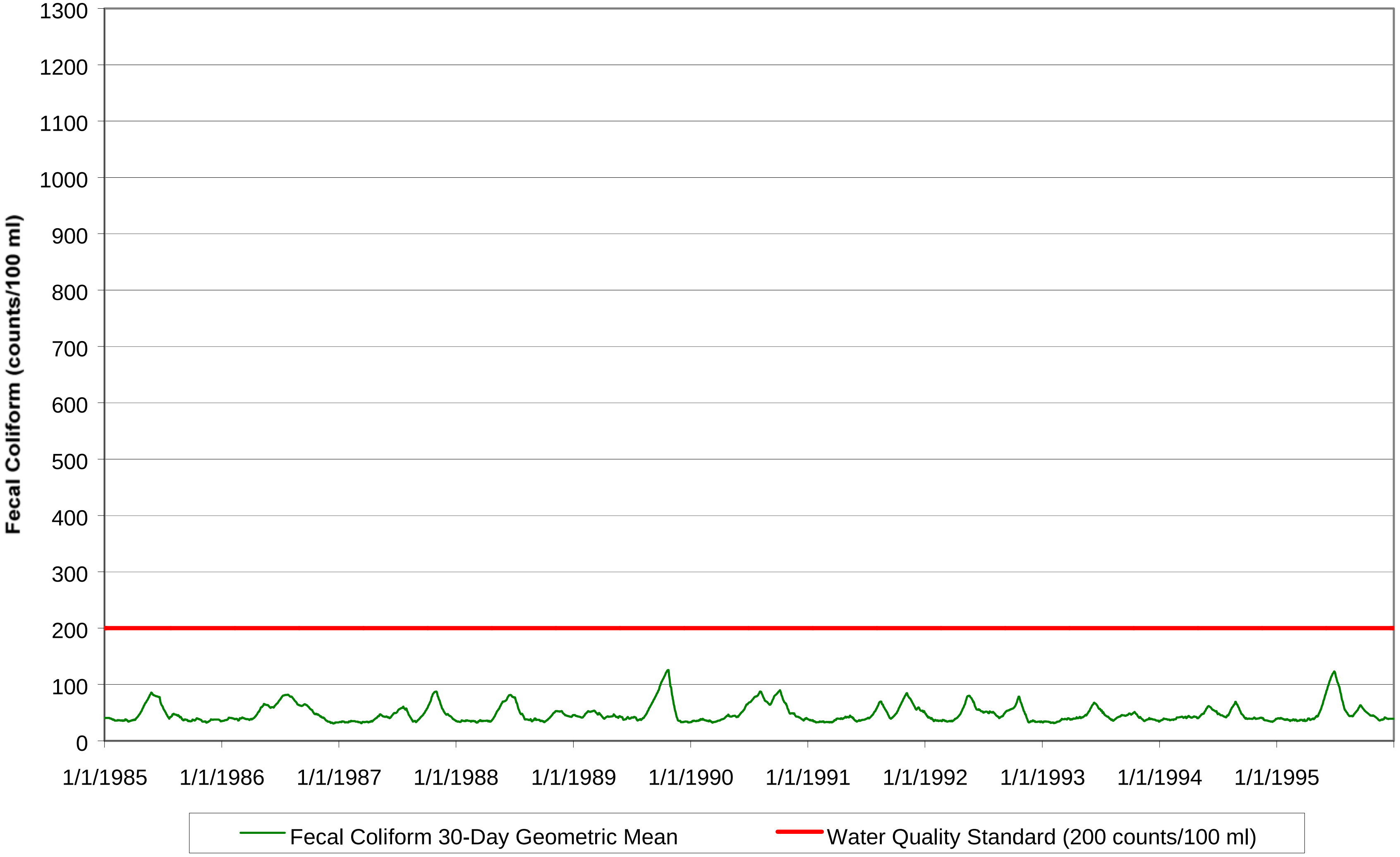
Graph A-2b Modeled Fecal Coliform Concentrations Under Existing Conditions in Little Biloxi River



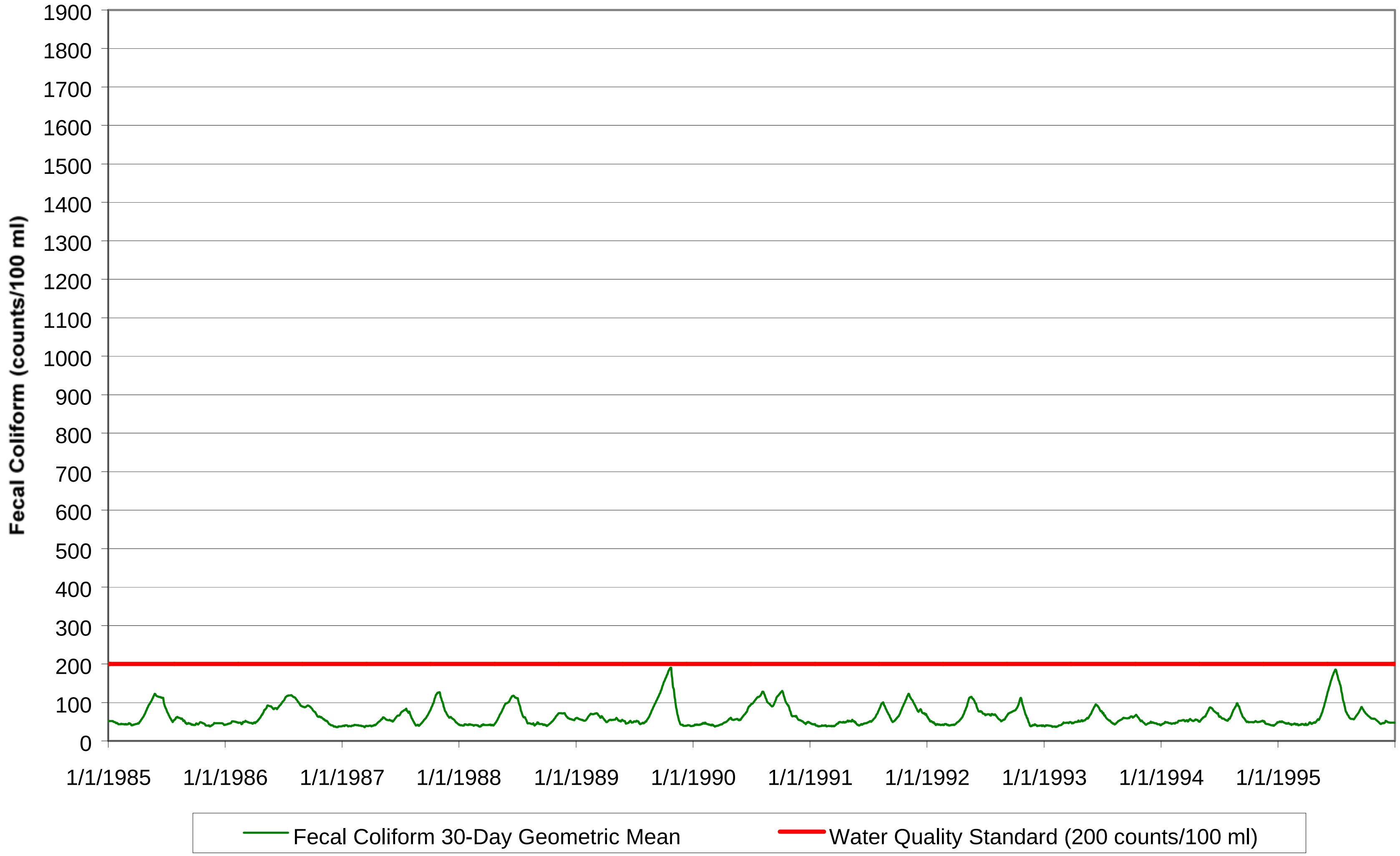
Graph A-2c Modeled Fecal Coliform Concentrations Under Existing Conditions in Saucier Creek



Graph A-3a Modeled Fecal Coliform Concentrations After Application of Reduction Scenario in Biloxi River



Graph A-3b Modeled Fecal Coliform Concentrations After Application of Reduction Scenario in Little Biloxi River



Graph A-3c Modeled Fecal Coliform Concentrations After Application of Reduction Scenario in Saucier Creek