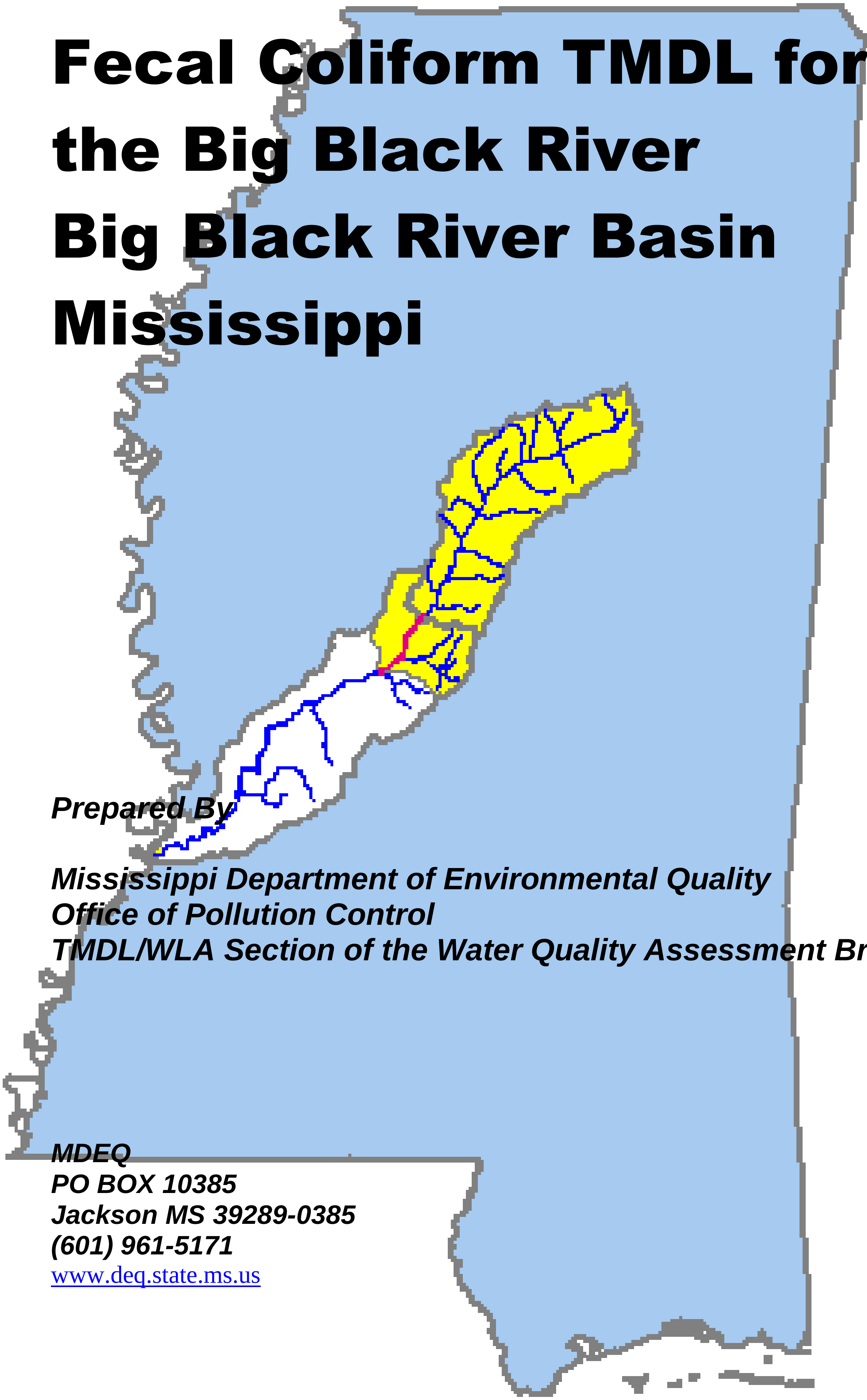
FINAL REPORT
October 2000
ID: 100102401

Fecal Coliform TMDL for the Big Black River Big Black River Basin Mississippi



Prepared By

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FOREWORD

This report has been prepared in accordance with the schedule contained within the federal consent decree dated December 22, 1998. *(Sierra Club v. Hankinson, No. 97-CV-3683 (N.D> Ga.)*) The report contains one or more Total Maximum Daily Loads (TMDLs) for waterbody segments found on Mississippi's 1996 Section 303(d) List of Impaired Waterbodies. Because of the accelerated schedule required by the consent decree, many of these TMDLs have been prepared out of sequence with the State's rotating basin approach. The segments addressed are comprised of monitored segments that have data indicating impairment. The implementation of the TMDLs contained herein will be prioritized within Mississippi's rotating basin approach.

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

Prefixes for fractions and multiples of SI units

Fraction	Prefix	Symbol	Multiple	Prefix	Symbol
10^{-1}	**deci**	**d**	**10**	**deka**	**da**
10^{-2}	**centi**	**c**	**10^{2}**	**hecto**	**h**
10^{-3}	**milli**	**m**	**10^{3}**	**kilo**	**k**
10^{-6}	**micro**	**μ**	**10^{6}**	**mega**	**M**
10^{-9}	**nano**	**n**	**10^{9}**	**giga**	**G**
10^{-12}	**pico**	**p**	**10^{12}**	**tera**	**T**
10^{-15}	**femto**	**f**	**10^{15}**	**peta**	**P**
10^{-18}	**atto**	**a**	**10^{18}**	**exa**	**E**

Conversion Factors

To convert from	To	Multiply by	To Convert from	To	Multiply by
Acres	**Sq. miles**	**0.0015625**	**Days**	**Seconds**	**86400**
Cubic feet	**Cu. Meter**	**0.028316847**	**Feet**	**Meters**	**0.3048**
Cubic feet	**Gallons**	**7.4805195**	**Gallons**	**Cu feet**	**0.133680555**
Cubic feet	**Liters**	**28.316847**	**Hectares**	**Acres**	**2.4710538**
cfs	**Gal/min**	**448.83117**	**Miles**	**Meters**	**1609.344**
cfs	**MGD**	**.6463168**	**Mg/l**	**ppm**	**1**
Cubic meters	**Gallons**	**264.17205**	**μg/l * cfs**	**Gm/day**	**2.45**

CONTENTS

MONITORED SEGMENT IDENTIFICATION

Name:	Lower Big Black River, Segment One
Waterbody ID:	MSLBGBKRM1
Location:	Near Canton: from Highway 51 south of Pickens to confluence with Bear Creek.
Counties:	Madison, Yazoo
USGS HUC Code:	08060202
Model Subwatershed:	08060202011
Length:	23 miles impaired on 303(d) list
Use Impairment:	Fish and Wildlife Support
Cause Noted:	Pathogens (Fecal Coliform)
Priority Rank:	69
Standards Variance:	N/A
Pollutant Standard:	May through October - geometric mean of 200 counts/100 ml, Not more than ten percent of samples exceed 400 counts/100ml. November through April - geometric mean of 2000 counts/100 ml, Not more than ten percent of samples exceed 4000 counts/100 ml.
Waste Load Allocation:	8.84E+12 counts/30 days (Includes all tributary loads), (The TMDL requires all NPDES dischargers to meet water quality standards for disinfection.)
Load Allocation:	107.00E+12 counts/30 days
Margin of Safety:	Implicit: conservative modeling assumptions
Total Maximum Daily loadings Load (TMDL):	116.00E+12 counts/30 days (Combination of point source from permitted facilities and tributaries, direct input from cattle with access to streams and failing septic systems, and loadings from land surface runoff necessary to meet the fecal coliform standard.)

EXECUTIVE SUMMARY

A segment of the Lower Big Black River is included on the Mississippi 1998 Section 303(d) List of Waterbodies for partially supporting the Fish and Wildlife Support designated use. Pathogens are the cause of impairment in this reach. The purpose of the TMDL is to establish water quality objectives required to reduce pollution in order to restore and maintain the quality of water resources.

For this study, the fecal coliform geometric mean standard of 200 counts/100ml during summer months and 2,000 counts/100ml during winter months make up the targeted endpoints for the impaired segment. Because fecal coliform contributions to the Lower Big Black River can be contributed by point and nonpoint sources, the critical condition is represented by a multi-year period of wet and dry weather.

The TMDL evaluation summarized in this report examines all potential sources of fecal coliform in the Big Black River Watershed. This source assessment is used as the basis of developing the model and analyzing the TMDL allocation options. The point sources in the watershed include municipal waste treatment, industrial, and commercial facilities. The nonpoint sources of fecal coliform include failing septic systems, wildlife, land application of hog and cattle manure, grazing animals, land application of poultry litter, cattle contributions directly deposited instream, and urban runoff.

The BASINS model platform and the NPSM model are used to predict the significance of fecal coliform sources and fecal coliform levels in the watershed. To obtain a spatial variation of the concentration of bacteria in the impaired segments of the Lower Big Black River, the watershed is divided into 44 subwatersheds. The weather data used for the model were collected at Jackson and Lexington for the hydrologic period of January 1, 1985 through December 31, 1995.

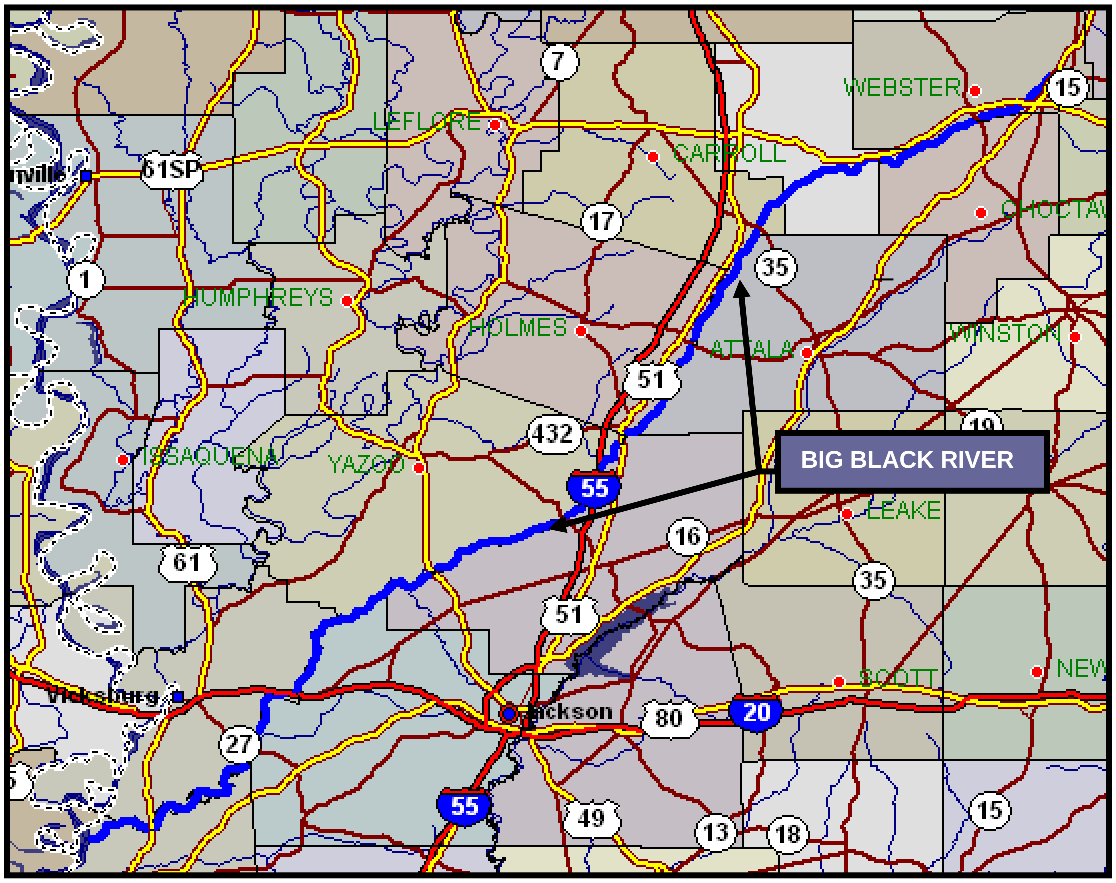
Total maximum daily loads (TMDLs) are composed of the sum of individual waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and a margin of safety (MOS). As part of this TMDL, all facilities will be required to meet water quality standards at the end-of-pipe. All wastewater treatment facilities should take steps to comply with their current NPDES Permits. Reductions are allocated for three point sources: Goodman POTW, Pickens POTW, and West POTW. Nonpoint surface loadings based on land use do not significantly impact the fecal coliform loadings in the Lower Big Black River. These nonpoint sources include wildlife, land application of hog, cattle and chicken waste, cattle and hog grazing, and urban development. Model results indicate that the nonpoint sources of cattle in streams and failing septic systems are significant contributors of fecal coliform bacteria in the Big Black River Watershed. The scenario chosen for these two sources to achieve adequate reduction in fecal loading is a 40 percent reduction in contributions from cattle in the stream and from failing septic systems. A margin of safety is implicitly accounted for in this model by using conservative model assumptions.

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 bacteria. Fecal coliform concentrations are used as indicators of potential pathogen contamination. The purpose of the TMDL is to establish water quality objectives required to reduce pollution from both point and nonpoint sources, and to restore and maintain the quality of water resources.

FIGURE 1.1 AREA MAP



As summarized in Table 1.1, Segment One of the Lower Big Black River, which starts at the Highway 51 Bridge south of Pickens and ends at the confluence with Bear Creek, is included on the 1998 Mississippi Section 303(d) List of Waterbodies for partially supporting its Fish and

Wildlife Support designated use. Pathogens are the cause of impairment for this 23 mile monitored segment.

Table 1.1 303d Listed Waterbody Considered in Lower Big Black River TMDL

Waterbody Name	***State Waterbody ID***	***Assessment type***	***Size***	***County***	***Use Impaired***	***Cause***
Lower Big Black River, Seg 1	MSLBGBKRM1	Monitored	23 mi	Madison, Yazoo	Fish and Wildlife Support	Pathogens
Location – Near Canton: From Highway 51/17 south of Pickens to confluence with Bear Creek						

The entire drainage area of the Big Black River is approximately 3,366 square miles. It is composed of two USGS Hydrologic Unit Code (HUC) boundaries: 08060201 and 08060202. The monitored segment lies within HUC 08060202. The Big Black River Watershed has been divided into 44 subwatersheds for this TMDL study. Eleven of these subwatersheds lie within HUC 08060202:

Table 1.2 Subwatersheds in HUC 08060202

Subwatershed	***ID Number***
Lower Big Black River, reach 11	08060202011
Doaks Creek	08060202012
Doaks Creek	08060202013
Dry Creek	08060202014
Lottville Creek	08060202015
Doaks Creek	08060202016
Doaks Creek	08060202017
Kentuctah Creek	08060202018
Hobucks Creek	08060202019
Lower Big Black River, reach 20	08060202020
Dry Creek	08060202021

The remaining 33 subwatersheds lie within HUC 08060201:

Table 1.3 Subwatersheds in HUC 08060201

Subwatershed	***ID Number***
Big Black River, reach 1	08060201001
Sencasha Creek	08060201002
Big Black River, reach 3	08060201003
Big Black River, reach 4	08060201004
Long Creek	08060201005
Big Black River, reach 6	08060201006
Apooka Creek	08060201007
Big Black River, reach 8	08060201008
Big Black River, reach 9	08060201009
Zilpha Creek	08060201010
Big Black River, reach 11	08060201011
Big Black River, reach 12	08060201012
Big Black River, reach 13	08060201013
Big Black River, reach 14	08060201014
Poplar Creek	08060201015
Big Black River, reach 16	08060201016
Big Black River, reach 17	08060201017
Big Black River, reach 18	08060201018
McCurtain Creek	08060201019
Big Black River, reach 20	08060201020
Big Black River, reach 21	08060201021
Big Black River, reach 22	08060201022
Spring Creek	08060201023
Calabrella Creek	08060201024
Wolf Creek	08060201025
Mulberry Creek	08060201026
Lewis Creek	08060201027
Hays Creek	08060201028
Peachahala Creek	08060201029
Jordan Creek	08060201030
Box Creek	08060201031
Sand Creek	08060201032
Calabrella Creek	08060201033

The watershed contains many small urban areas including Canton, and Winona. Most of the landuse is pasture, forest, and cropland.

Table 1.4 Landuse Distribution in HUC 08060202 (acres)

Watershed	*Urban*	*Forest*	*Wetland*	*Pasture*	*Cropland*	*Barren*	*Total*
8060202011	469	10,847	861	15,333	5,895	0	33,406
8060202012-8060202019, 8060202021	0	50,562	735	56,296	4,160	0	111,753
8060202020	583	28,582	1,714	58,110	14,111	0	103,100
Total	1,052	89,991	3,310	129,739	24,166	0	248,259
Percent	0%	36%	1%	52%	10%	0%	100%

Table 1.5 Landuse Distribution in HUC 08060201 (acres)

Subwatershed	**Urban**	**Forest**	**Wetland**	**Pasture**	**Cropland**	**Barren**	**Total**
8060201001	388	8,105	10,527	6,881	3,674		29,575
8060201002		33,905	31,627	11,348	4,199		81,079
8060201003	61	4,153	3,406	2,554	1,577		11,751
8060201004		4,854	1,206	702	1,264		8,026
8060201005	6	17,017	16,754	10,854	2,693		47,324
8060201006	735	16,975	32,402	6,372	2,074		58,558
8060201007	25	32,521	22,696	12,658	3,088		70,988
8060201008		3,607	7,553	1,087	316		12,563
8060201009	197	10,242	19,235	4,960	2,488		37,122
8060201010		40,675	32,987	10,215	591		84,468
8060201011		415	17,448	891	78		18,832
8060201012	11	2,449	27,509	3,116	51		33,136
8060201013		12,522	8,873	6,335	1,304		29,034
8060201014		4,119	9,410	1,222	262		15,013
8060201015	15	29,451	20,404	10,479	983		61,332
8060201016	83	2,563	1,841	1,634	560		6,681
8060201017		6,822	23,532	3,670	474		34,498
8060201018		14,522	7,339	5,708	242		27,811
8060201019		59,372	26,727	20,380	2,233		108,712
8060201020		162	1,760	32			1,954
8060201021	303	21,583	16,042	15,499	2,358		55,785
8060201022	118	19,724	18,998	10,212	568		49,620
8060201023		10,144	6,383	4,246	191		20,964
8060201024		3,357	6,259	832	10		10,458
8060201025		11,817	10,498	5,767	846		28,928
8060201026	169	11,661	10,086	5,986	2,132		30,034
8060201027	197	7,641	12,661	5,513	1,454		27,466
8060201028	1,396	12,065	17,246	22,775	4,337		57,819
8060201029	291	8,883	28,090	9,568	2,371		49,203
8060201030	179	4,578	12,250	1,948	372		19,327
8060201031	367	5,214	9,678	3,738	612		19,609

8060201032		7,353	10,932	2,711	1,203		22,199
8060201033		6,178	14,016	2,287	449		22,930
Total	**4,541**	**434,649**	**496,375**	**212,180**	**45,054**	**-**	**1,192,799**
Percent	0%	36%	42%	18%	4%	0%	100%

1.2 WATERBODY DESIGNATED USE

The water use classification for the Big Black River, as established by the State of Mississippi in the *Water Quality Criteria for Intrastate, Interstate and Coastal Waters* regulation, is Fish and Wildlife Support. The designated uses for segment MSLBGBKRM1 are Secondary Contact Recreation and Aquatic Life Support. Secondary contact recreation is defined as incidental contact with the water, including wading and occasional swimming.

1.3 APPLICABLE WATER QUALITY STANDARDS

The water quality criteria applicable to the uses of the waterbody and the pollutant of concern is listed in Table 1.6 as defined by the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* regulations.

Table 1.6 State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters

Parameter	***Beneficial use***	***Water Quality Criteria***
Fecal Coliform	Fish and Wildlife Support	*May through October* - Fecal coliform shall not exceed a geometric mean of 200 counts/100 ml, nor shall more than ten percent of the samples examined during any month exceed 400 counts/100 ml. *November through April* - fecal coliform shall not exceed a geometric mean of 2000 counts/100 ml, nor shall more than ten percent of the samples examined during any month exceed 4000 counts/100 ml.

Figure 1.2

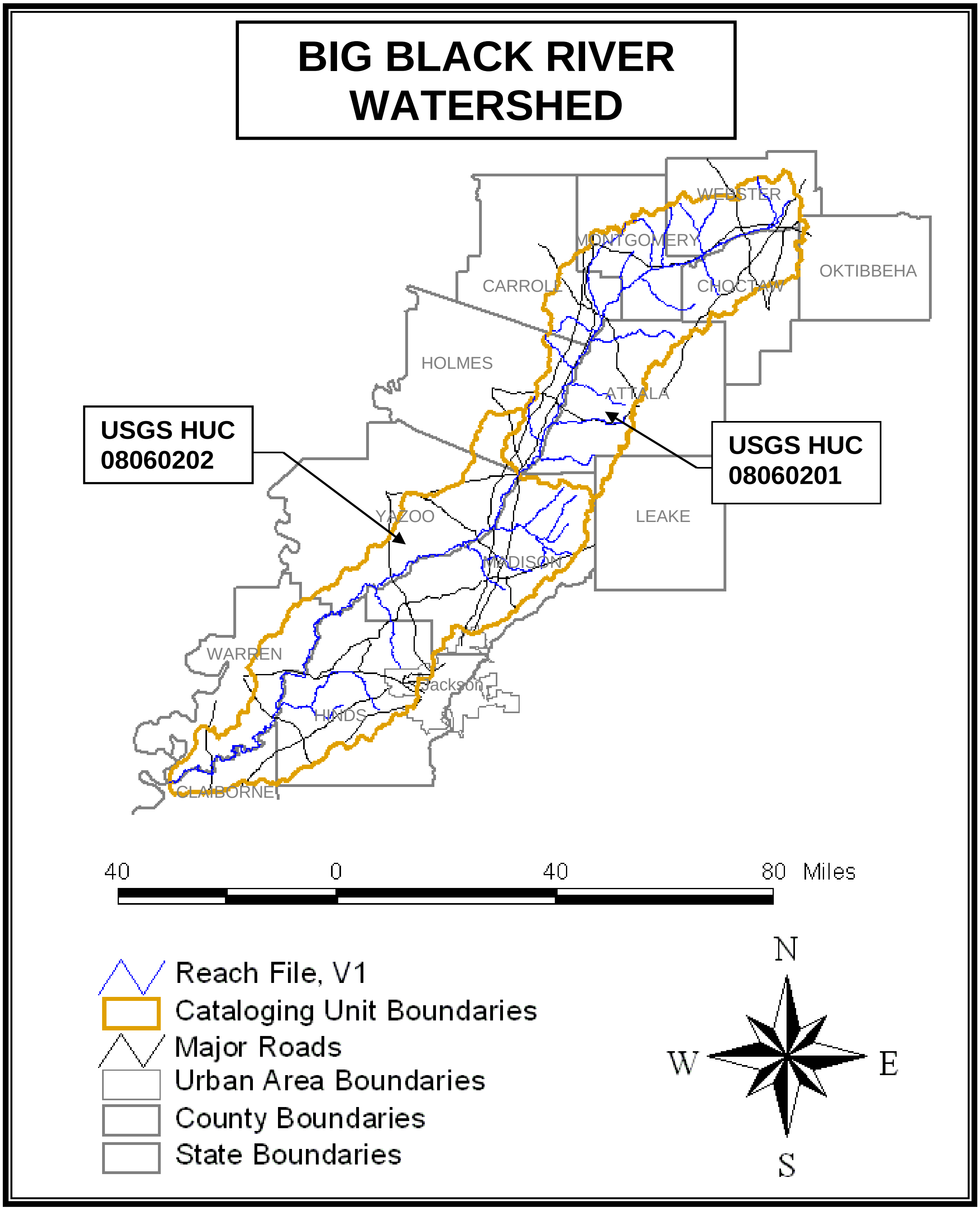
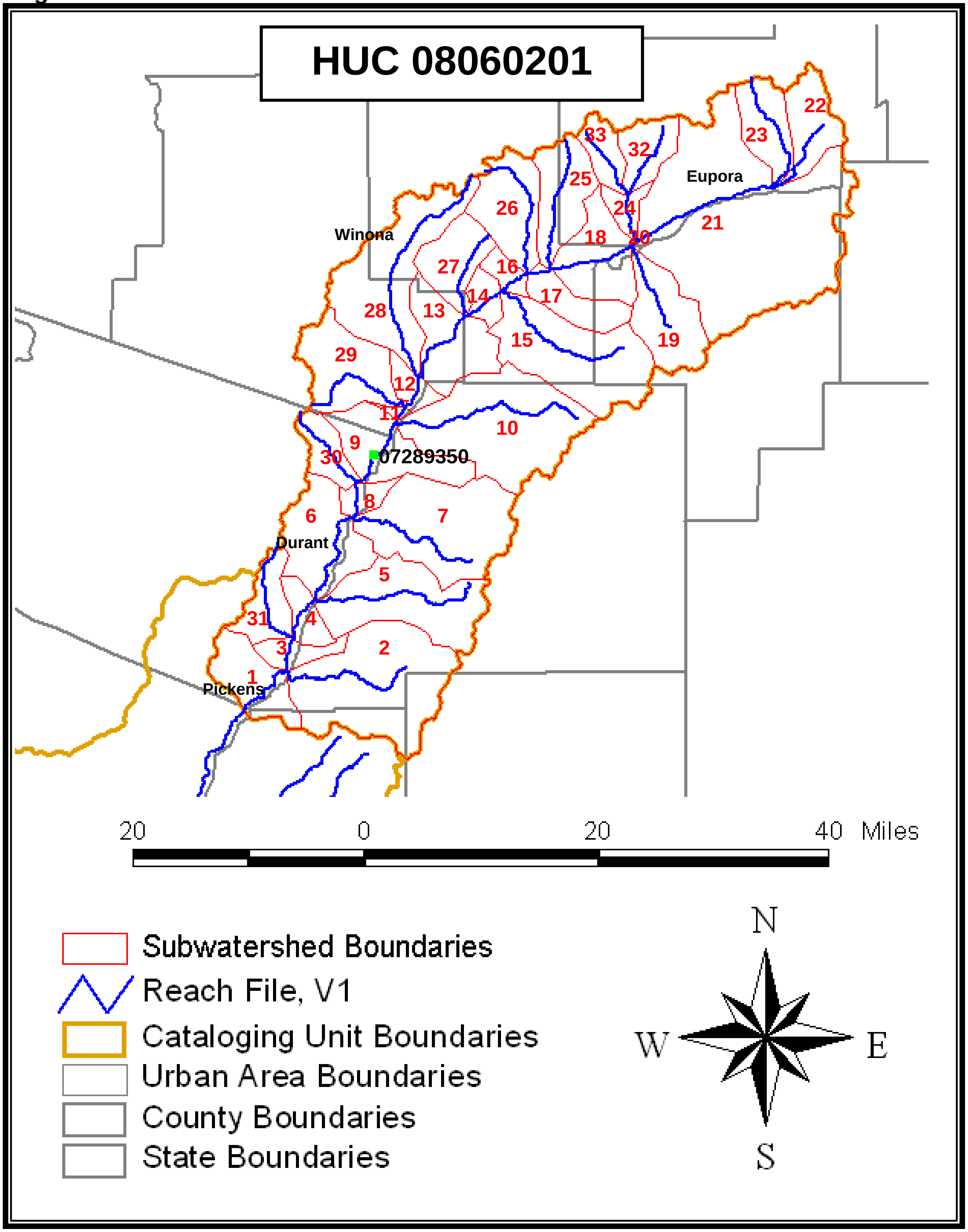

BIG BLACK RIVER
WATERSHED
USGS HUC
08060202
USGS HUC
08060201
WEBSTER
MONTGOMERY
OKTIBBEHA
CARROLL
CHOCTAW
HOLMES
ATTALA
YAZOO
LEAKE
MADISON
WARREN
Jackson
HINDS
CLAIBORNE
40
0
40
80
Miles
Reach File, V1
Cataloging Unit Boundaries
Major Roads
Urban Area Boundaries
County Boundaries
State Boundaries
N
W
E
S

Figure 1.3


HUC 08060201
Winona
Eupora
Durant
Pickens
07289350
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
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33
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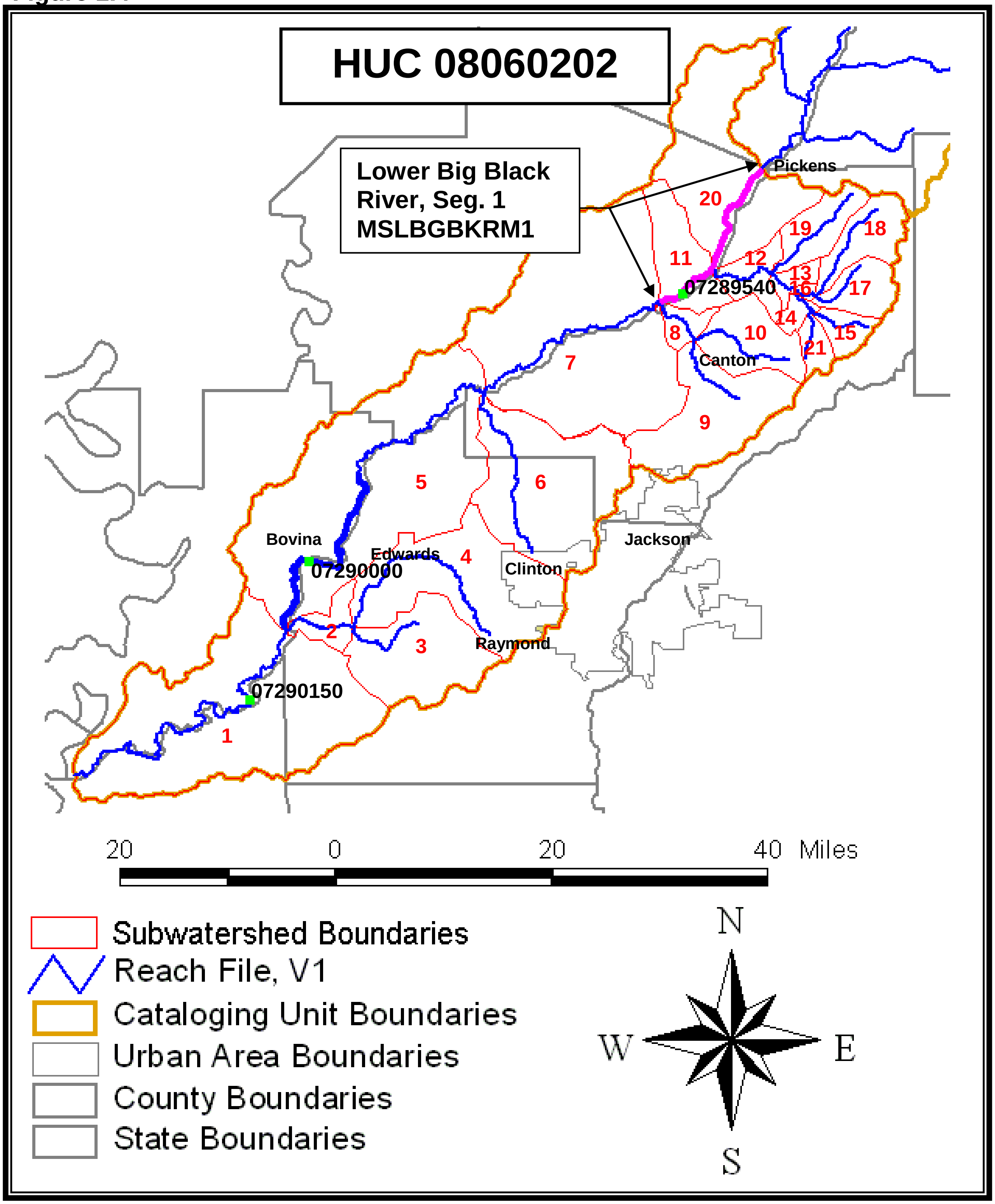
20
40
Miles
Subwatershed Boundaries
Reach File, V1
Cataloging Unit Boundaries
Urban Area Boundaries
County Boundaries
State Boundaries
N
W
E
S

Figure 1.4


HUC 08060202
Lower Big Black River, Seg. 1 MSLBGBKRM1
Pickens
07289540
Canton
Jackson
Clinton
Raymond
Edwards
Bovina
07290000
07290150
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
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0
20
40 Miles
Subwatershed Boundaries
Reach File, V1
Cataloging Unit Boundaries
Urban Area Boundaries
County Boundaries
State Boundaries
N
S
W
E

Figure 1.5

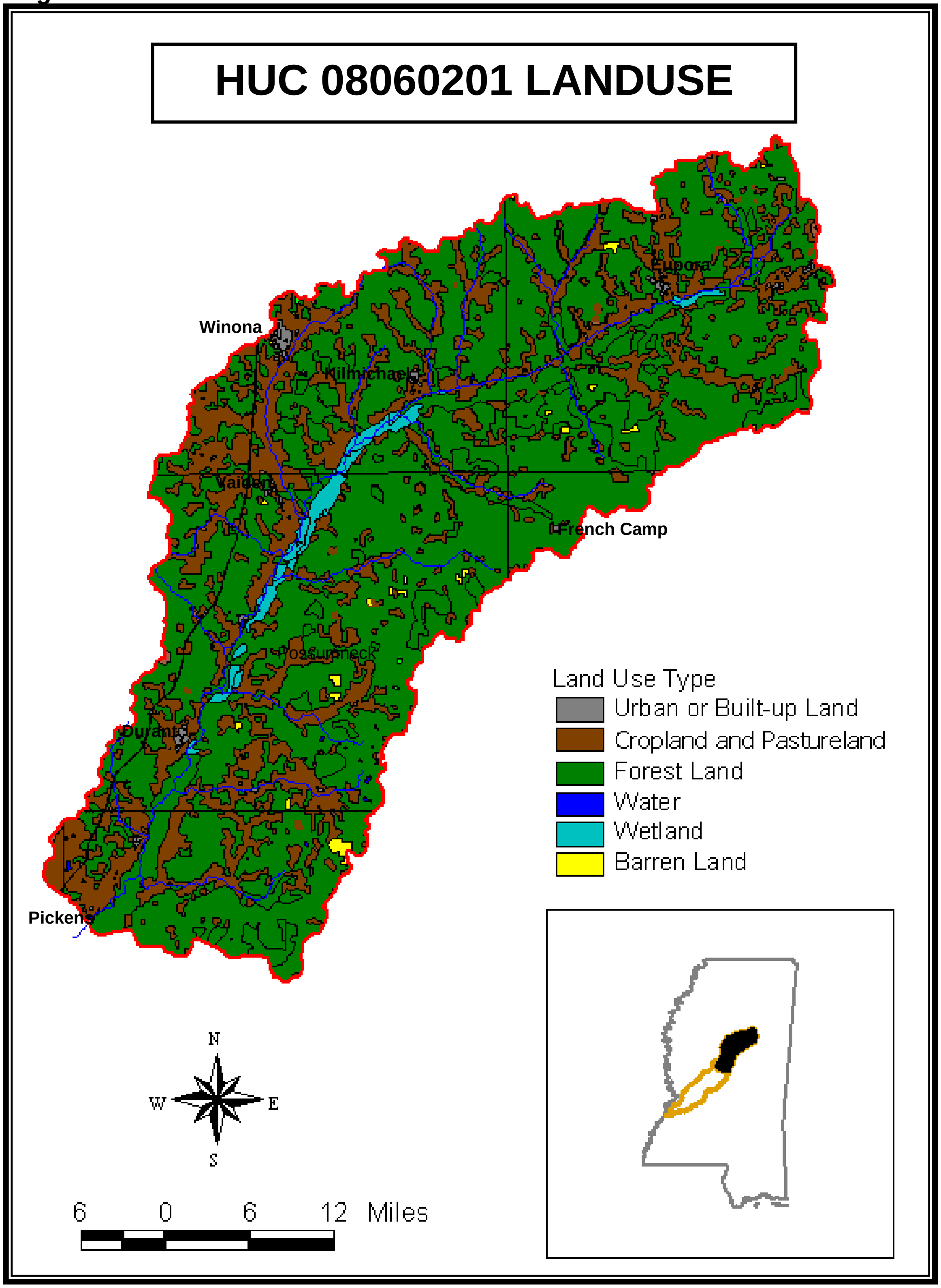
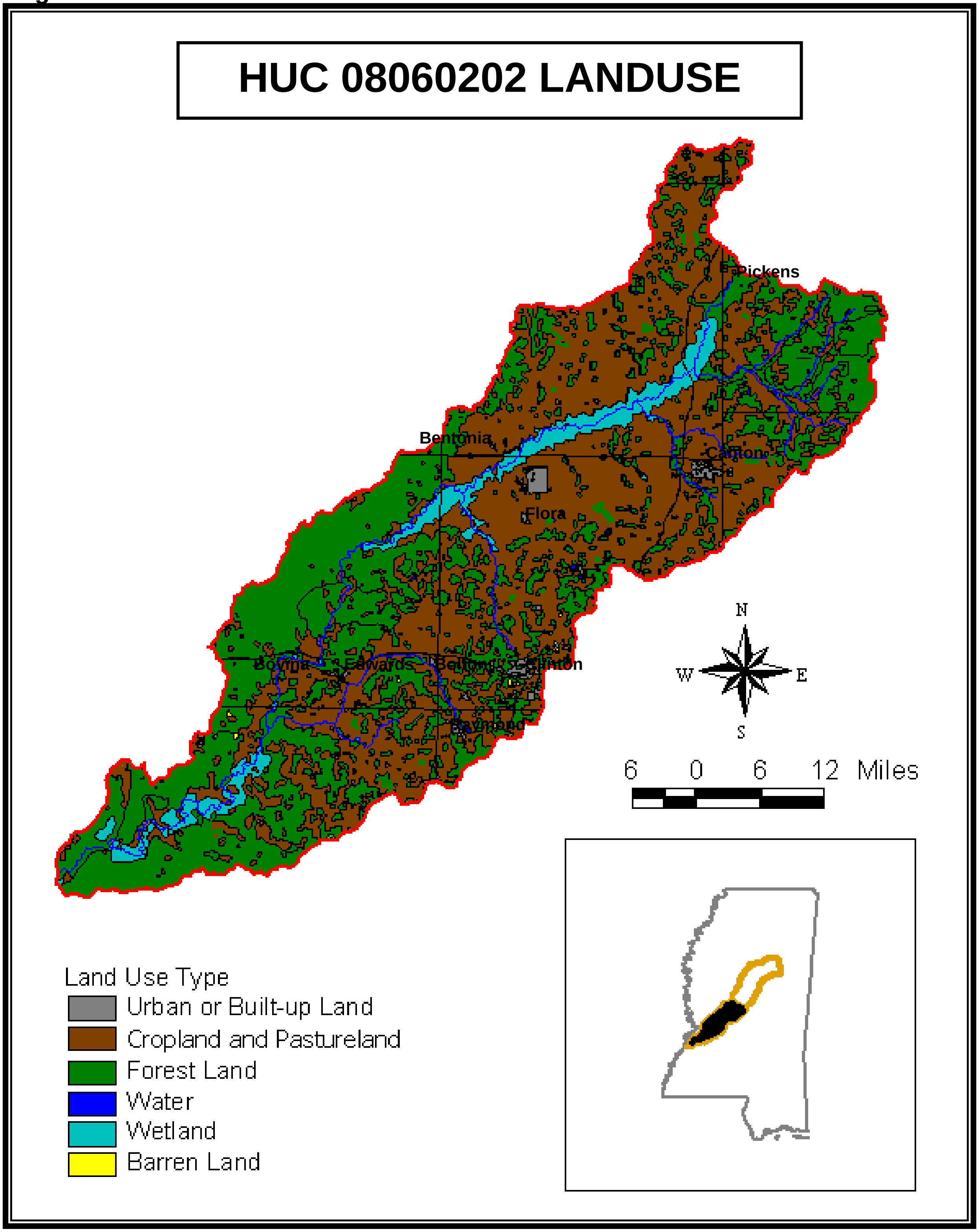

HUC 08060201 LANDUSE
Winona
Kilmichael
Eupora
Vaiden
French Camp
Possumneck
Durant
Pickens
Land Use Type
Urban or Built-up Land
Cropland and Pastureland
Forest Land
Water
Wetland
Barren Land
N
W
E
S
6 0 6 12 Miles

Figure 1.6


HUC 08060202 LANDUSE
Pickens
Bentonia
Canton
Flora
Bovina
Edwards
N
W
E
S
6 0 6 12 Miles
Land Use Type
Urban or Built-up Land
Cropland and Pastureland
Forest Land
Water
Wetland
Barren Land

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 reductions specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. For this TMDL, the fecal coliform geometric mean standard for Fish and Wildlife Support is the targeted endpoint to evaluate impairment and establish the TMDL for the impaired segment.

Because fecal coliform contributions may be attributed to both nonpoint and point sources, the critical condition used for the modeling and evaluation of stream response is 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. However, 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 is selected as representing critical conditions associated with all potential sources of fecal coliform bacteria within the watershed.

2.2 DISCUSSION OF INSTREAM WATER QUALITY

According to the State's 1998 Section 305(b) Water Quality Assessment Report, one segment of the Lower Big Black River is partially supporting the use of Secondary Contact Recreation. This conclusion is based on instantaneous data collected at station 07289540 (Canton). Data collected at this station and at stations 07290000(Bovina), 07289350 (West), and 07290150 (Reganton) are summarized and analyzed in the following sections.

2.2.1 Inventory of Water Quality Monitoring Data

There are two MDEQ stations in the Big Black River where fecal coliform data have been collected.

Table 2.1 Water Quality Station Data Inventory

Station	***Agency***	***Location***	***Frequency***	***Status***	***Sampling Dates***
07289350	MDEQ	West	monthly	active	12/96 – 12/98
07289540	MDEQ	Canton	bimonthly (6/yr)	inactive	1/80 – 9/96

2.2.2 Analysis of Instream Water Quality Monitoring Data

Water quality monitoring data are analyzed to evaluate water quality conditions within the Big Black River Watershed, as well as to identify violations of water quality standards. Statistical summaries of the parameters of concern for the Lower Big Black River and related water quality parameters at selected stations are presented in Table 2.2. The statistical summaries are based on available STORET data from January 1980 to December 1998, listed in Appendix A.

Table 2.2 Water Quality Station Data Analysis

Station	*Param. Code*	*Parameter*	*Samples*	*Min*	*Max*	*Median*
07289350	31616	Fecal Coliform, membrane filter, broth	23	30	32,000	180
07289540	31613	Fecal Coliform, membrane filter, agar, 24hr	59	7	5,900	140
07289540	31615	Fecal Coliform, mpn	31	7	16,000	280

The samples are compared to the instantaneous maximum standard of 400 counts/100ml during summer months and 4000 counts/100ml during winter months because sampling was conducted either monthly or bimonthly (Table 2.1). Appendix A contains tables and charts of actual graphical analyses of the instream water quality data.

3.0 SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examines all known potential sources of fecal coliform in the Big Black River Watershed. The source assessment is used as the basis of development of the model and ultimate analysis of the TMDL allocation options. In evaluation of the sources, loads are characterized by the best available information, literature values, and local management activities. This section documents the available information and interpretation for the analysis. The source assessment chapter is organized into point and nonpoint sections. The representation of the following sources in the model is discussed in Section 4.0, Modeling Procedure: Linking the Sources to the Endpoint.

3.1 ASSESSMENT OF POINT SOURCES

The point sources in the Lower Big Black River model include municipal wastewater treatment, industrial, and commercial facilities. The permitted facilities located in the watershed that have potential for appreciable discharge of fecal coliform bacteria are listed in Table 3.1. The table lists permitted flow and fecal coliform concentrations as compiled from the Permit Compliance System (PCS) database:

Table 3.1 Permitted Facilities in Big Black River Watershed

Facility Name	***NPDES ID***	***Subwatershed***	***Receiving Stream***	***Flow*** *(MGD)*	***Fecal Conc.*** *(#/100ml)*
Velma Jackson School	MS0034045	*8060202012*	Doaks Creek	0.0250	200
Luther Branson Elementary	MS0029378	*8060202012*	Doaks Creek	0.0180	200
Durant POTW	MS0048127	*8060201006*	Big Black River	0.6700	200(s)/2000(w)
Goodman POTW	MS0026921	*8060201003*	Big Black River	0.2880	no limit
Pickens POTW	MS0021130	*8060201001*	Big Black River	0.2500	no limit
Vaiden POTW	MS0021504	*8060201028*	Hurricane Cr.	0.1500	no limit
French Camp POTW	MS0044075	*8060201015*	Poplar Creek	0.0750	200(s)/2000(w)
West POTW	MS0032816	*8060201009*	Big Black River	0.0750	200(s)/no limit(w)
Long Creek Elementary	MS0022918	*8060201001*	Long Creek	0.0300	200
McAdams School	MS0029670	*8060201005*	Long Creek	0.0210	200
Goodman-Pickens School	MS0022578	*8060201003*	Big Black River	0.0160	200
Holmes County State Park	MS0027324	*8060201004*	Box Creek	0.0150	200
Indian Springs Campground	MS0039918	*8060201009*	Baddie Creek	0.0150	200
MDOT I-55 Rest Area	MS0036510	*8060201009*	Poachahala Creek	0.0150	200
MDOT I-55 Rest Area	MS0036641	*8060201009*	Jordan Creek	0.0150	200
Barlow Head Start Center	MS0039951	*8060201009*	Long Creek	0.0010	200

Facility Name	NPDES ID	Subwatershed	Receiving Stream	Flow (MGD)	Fecal Conc. (#/100ml)
Winona POTW	MS0021024	*8060201012*	Hays Creek	1.2000	200(s)/2000(w)
Eupora POTW-HCR	MS0042447	*8060201021*	Little Black Creek Canal	0.5240	no limit
Kilmichael POTW	MS0020001	*8060201016*	Trib. To Big Black River	0.1800	200(s)/2000(w)
Maben POTW	MS0020966	*8060201022*	Pigeon Roost Creek	0.1410	200(s)/2000(w)
Mathiston POTW	MS0023116	*8060201022*	Pigeon Roost Creek	0.1200	200(s)/2000(w)
Sansing Meat Service	MS0037257	*8060201021*	Pigeon Roost Canal	0.0100	200
Anel Industries	MS0048267	*8060201021*	Hays Creek	0.0015	200
Ms. Lignite Mining Co.	MS0054046	*8060201021*	Middle Byway	0.0010	200

The following facilities have no permitted limitation on effluent fecal coliform concentration: Goodman POTW, Pickens POTW, Vaiden POTW-HCR, West POTW (winter), and Eupora POTW-HCR. Two of these POTWs are Hydrograph Controlled Release (HCR) facilities, which only discharge when receiving stream flows are at high levels. The following table lists basic permit data from these facilities.

Table 3.2 HCR Facility Permit Information

Facility	Receiving Stream	Yearly Average Discharge (cfs)	Minimum Stream Flow (cfs)
Eupora POTW	Little Black Creek	0.81	5.0
Vaiden POTW	Hurricane Creek	0.23	10.0

3.2 ASSESSMENT OF NONPOINT SOURCES

The nonpoint sources of fecal coliform pollution include fecal contributors that do not have localized points of release into a stream. In the Big Black River watershed these sources are:

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

The contributions from each of these sources are estimated using the latest information available. MDEQ contacted several agencies to refine the data assumptions made in determining the fecal loading. The Mississippi Department of Wildlife, Fisheries, and Parks estimated the concentration of deer in Mississippi. The Mississippi State Department of Health was contacted regarding the failure rate of septic tank systems in the state. Mississippi State University researchers provided valuable information on manure application practices and loading rates for hog farms and cattle operations. The National Resources Conservation Service (NRCS) gave MDEQ information on manure treatment practices and loading rates for manure.

The location and magnitude of these loads are related to the different land uses in the Big Black River Watershed. The source of land use cover data utilized in this TMDL is the State of Mississippi's Automated Resource Information System (MARIS). This data set is based on Landsat Thematic Mapper digital images taken in 1997. This classification is based on a modified Anderson level one and two system. The MARIS land use categories are condensed into the categories in Tables 1.4 and 1.5. The watershed consists mainly of forest (37%), wetland (30%), and pasture (24%).

3.2.1 Failing Septic Systems

Septic systems provide the potential to deliver fecal coliform bacteria loads to surface waters due to malfunctions, failures, and direct pipe discharges. Properly operating septic systems treat the wastewater and dispose of the water through a series of underground field lines. The water is applied through these field lines into a rock substrate thence into underground absorption. The systems can fail when the field lines are broken, or the underground substrate is clogged or flooded. The septic water reaches the surface and is then available for wash-off into the stream. Another related potential fecal source is the occurrence of direct bypasses to streams. In efforts to keep wastewater from seeping up in a drain field, pipes are sometimes laid from the septic tanks or the field lines to the nearest stream.

Another consideration is the use of individual onsite wastewater treatment plants, which are widely used in Mississippi. They can adequately treat wastewater if properly maintained. However, the systems do not typically receive the attention needed for proper long-term operation. While they require some sort of disinfection to properly operate, homeowners often ignore this step, and the water does not receive adequate disinfection prior to release.

Because of the different modes of failure in both septic systems and individual treatment plants, a portion of the fecal coliform loads from these sources are also considered as point source loads in this TMDL. The number of failing septic systems is estimated from the watershed area normalized count of septic systems in each county (1997 estimates based on 1990 U.S. Census). Of these, it is estimated that 40 percent are currently failing. This failure rate also incorporates estimates for direct bypasses and estimates for failing onsite wastewater treatment systems in the watershed.

3.2.2 Wildlife

Wildlife present in the Big Black River Watershed contribute fecal coliform bacteria onto the land surface where it is available for wash-off during a rain event. In the Big Black River model, all wildlife is accounted for by considering contributions from deer. The deer population is estimated to be 30 to 45 animals per square mile for this area. The upper limit of 45 deer per square mile has been chosen to account for the deer and all of the other wildlife present in the area. It is assumed that the wildlife population remains constant throughout the year, and that wildlife is present on all land classified as forest land, pastureland, cropland, and wetlands. It is also assumed that the wildlife is evenly distributed throughout the aforementioned landuse types.

3.2.3 Land Application of Hog and Cattle Manure

In the Big Black Basin processed manure from confined hog and dairy cattle operations is collected in lagoons and applied to pastureland during certain months of the year. This manure is a potential contributor of bacteria to receiving waterbodies due to runoff produced during a rain event.

Hog farms in the Big Black Basin operate by either keeping the animals confined or allowing them to graze in small pastures or pens. For this model, it is assumed that all of the hog manure produced by either farming method is applied evenly to the available pastureland. Application rates of hog manure to pastureland from confined operations vary monthly according to management practices currently used in the area.

As can be seen from Table 3.5, the cattle operations are almost exclusively beef cattle. There are very few dairy farms operating in the watershed. In those farms, the cows are only confined for a limited period each day, during which time they are being milked and fed. This is estimated to be four hours per day for each cow. The percentage of 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.

Data sources for confined feeding operations include the Census of Agriculture and the Mississippi Agricultural Statistics Service (MASS) which is one of 45 state offices of the U.S. Department of Agriculture's National Agricultural Statistics Service (NASS). 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 percent of the county pastureland within the subwatershed boundaries. This estimate is made with the assumption that the livestock is uniformly distributed throughout the pastureland in the county.

Table 3.3 Estimated Annual Agricultural Animals in Subwatersheds

Subwatershed	Beef Cows	Dairy Cows	Hogs	Broiler Chickens Sold	Layer Chickens	Total Chickens
8060202001	6,038	24	135	0	1	1
8060202002-8060202004	11,083	0	268	0	4	4
8060202005	8,458	14	656	0	1	1
8060202006	6,143	10	105	0	3	3
8060202007	11,265	19	2,574	0	40,679	40,679
8060202008-8060202010	5,824	10	12	0	15,254	15,254
8060202011	1,738	0	637	0	0	0
8060202012-8060202019, 8060202021	3,896	7	8	0	5,086	5,086
8060202020	4,820	8	953	0	3	3
08060201001-08060201033	32,071	543	16,422	1,556,342	22	222,356

3.2.4 Grazing Animals

Cattle, including beef and dairy, spend time grazing on pastureland, depositing manure containing fecal coliform bacteria onto the land surface. During a rain event, a portion of this fecal matter is available for wash-off and delivery to receiving waterbodies. In addition to cattle, hogs in the Big Black River Watershed also spend time on pastureland depositing manure onto the land surface.

In this region of the state, there is no monthly variation in beef and dairy cattle access to the pastures. Therefore, it is assumed that their loading rates are constant throughout the year. Beef cattle spend all of their time in pasture, while dairy cattle are confined for a limited period each day. The percentage of manure deposited during their grazing time is applied to the available pastureland in the watershed.

3.2.5 Land Application of Poultry Litter

Like hog and cattle manure, poultry litter in this region of the state is applied only to pastureland and not to cropland. It is also a potential contributor of pathogens to streams in the watershed when a rain event washes a portion of it to a receiving waterbody. It is assumed that all of the poultry litter from chicken houses is applied evenly to the available pastureland. While there are some alternative uses of poultry litter, such as utilization as cattle feed, almost all of the litter in the state is used as fertilizer.

Predominantly two kinds of chickens are raised on farms in the Big Black Basin, broilers and layers. The growth time of the broiler chickens from when the chicken is born to when it is sold off the farm is approximately 48 days, which is about 1/7 of a year. Conversely, layer chickens remain on farms for ten months or longer. To determine the number of chickens in the watershed on any given day, the number of broiler chickens sold is divided by seven and added to the number of layers.

3.2.6 Cattle Contributions Deposited Directly Instream

Cattle often have direct access to small streams that run through pastureland. 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 Big Black River Watershed, it is assumed that all bank slopes in the watershed are such that cattle are able to access the streams in the pastures. In order to determine the amount of bacteria introduced into streams from cattle, it is assumed that all grazing cattle spend three percent of their time standing in the streams. Thus, the model assumes that three percent of the manure produced by grazing beef and dairy cows is deposited directly in the stream.

3.2.7 Urban Development

Pathogen contributions from urban areas may come from runoff through stormwater sewers (e.g. residential, commercial, industrial, road transportation), illicit discharges of sanitary wastes, and runoff contribution from improper disposal of waste materials. The failure of sewer and septic systems and subsequent migration with stormwater runoff is also a potentially significant source. Urban land use is shown in Tables 1.4 and 1.5 under the “Urban” and “Barren” categories. The Urban areas in the Big Black River Basin are displayed in Figures 1.5 and 1.6.

4.0 MODELING PROCEDURE

Establishing the relationship between the instream water quality target and the source loadings 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. 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 are used to predict the significance of fecal coliform sources and fecal coliform levels in the Big Black River Watershed. BASINS is a multipurpose environmental analysis system for use in performing watershed and water quality-based studies. A geographic information system (GIS) provides the integrating framework for BASINS and allows for the display and analysis of a wide variety of landscape information such as land uses, monitoring stations, point source discharges, and stream descriptions. The NPSM model simulates nonpoint source runoff from the selected watershed, 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 source simulation, as well as its ability to assess instream water quality response.

4.2 MODEL SETUP

The Big Black River Watershed is divided into 44 subwatersheds in an effort to isolate the major stream reaches. The delineation of the watersheds is based primarily on an analysis of the reach file three (RF3) stream network in the basin as well as the topographic analysis of the watershed. The 44 subwatersheds are listed in Tables 1.2 and 1.3 and displayed in Figures 1.3 and 1.4.

4.3 SOURCE REPRESENTATION

Both point and nonpoint sources are represented in the model. Due to die-off rates and overland transportation assumptions, the fecal coliform loadings from point and nonpoint sources must be addressed separately. A fecal coliform spreadsheet has been developed for quantifying point and nonpoint sources of bacteria for the Big Black River model. This spreadsheet calculates the model inputs for fecal coliform loading 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.

Flow and fecal coliform loading rates are derived from the monthly average permit limits, with seasonal variations taken into account. Because the West POTW has no winter permit limits, the DMR average winter fecal coliform concentration of 2,564 counts/100mL (Table 3.3) is used for the model loading rate. The Goodman and Pickens POTWs have no fecal coliform DMR data, so their fecal coliform concentration is estimated to be 20,000 counts/100mL. The five HCR facilities also have no fecal coliform DMR data, but their monthly average fecal coliform concentration is estimated to be 5,000 counts/100mL because of the extended detention times common to these facilities. Loads from these HCR facilities are incorporated into the model only when streamflow levels are high enough to allow it according to permit limitations.

Table 4.1 Model Loadings for Permitted Facilities

Facility Name	*NPDES ID*	*Subwatershed*	*Flow (cfs)*	*Ex. Fecal Conc. (#/100ml)*		*Ex. Fecal Load (#/hr)*	
				summer	*winter*	*summer*	*winter*
Velma Jackson School	MS0034045	8060202012	0.0387	200	200	78.70E+05	78.70E+05
Luther Branson Elementary	MS0029378	8060202012	0.0279	200	200	56.70E+05	56.70E+05
Durant POTW	MS0048127	8060201006	1.0370	200	2000	2110.00E+05	21100.00E+05
Goodman POTW	MS0026921	8060201003	0.4458	20000	20000	90700.00E+05	90700.00E+05
Pickens POTW	MS0021130	8060201001	0.3870	20000	20000	78700.00E+05	78700.00E+05
Vaiden POTW-HCR	MS0021504	8060201028	0.2322	5000	5000	11800.00E+05	11800.00E+05
French Camp POTW	MS0044075	8060201015	0.1161	200	2000	236.00E+05	236.00E+05
West POTW	MS0032816	8060201009	0.1161	200	2564	236.00E+05	236.00E+05
Long Creek Elementary	MS0022918	8060201001	0.0464	200	200	94.40E+05	94.40E+05
McAdams School	MS0029670	8060201005	0.0325	200	200	66.10E+05	66.10E+05
Goodman-Pickens School	MS0022578	8060201003	0.0248	200	200	50.40E+05	50.40E+05
Holmes County State Park	MS0027324	8060201004	0.0232	200	200	47.20E+05	47.20E+05
Indian Springs Campground	MS0039918	8060201009	0.0232	200	200	47.20E+05	47.20E+05
MDOT I-55 Rest Area	MS0036510	8060201009	0.0232	200	200	47.20E+05	47.20E+05
MDOT I-55 Rest Area	MS0036641	8060201009	0.0232	200	200	47.20E+05	47.20E+05
Barlow Head Start Center	MS0039951	8060201009	0.0015	200	200	3.05E+05	3.05E+05
Winona POTW	MS0021024	8060201012	1.8576	200	2000	3780.00E+05	37800.00E+05
Eupora POTW-HCR	MS0042447	8060201021	0.8111	5000	5000	41200.00E+05	41200.00E+05
Kilmichael POTW	MS0020001	8060201016	0.2786	200	2000	567.00E+05	5670.00E+05
Maben POTW	MS0020966	8060201022	0.2183	200	2000	444.00E+05	4440.00E+05
Mathiston POTW	MS0023116	8060201022	0.1858	200	2000	378.00E+05	3780.00E+05
Sansing Meat Service	MS0037257	8060201021	0.0155	200	200	31.50E+05	31.50E+05
Anel Industries	MS0048267	8060201021	0.0023	200	200	4.68E+05	4.68E+05
MS Lignite Mining Company	MS0054046	8060201021	0.0015	200	200	3.05E+05	3.05E+05

The nonpoint sources discussed in Section 3.2 are represented in the model to account for their contributions of fecal coliform either directly to the Big Black River or as applied to the land in the Big Black River Watershed. Due to die off rates and transportation assumptions, the two types of nonpoint fecal loadings must be addressed separately. Fecal coliform accumulation rates (counts/acre/day) are calculated for each land use based on all sources contributing fecal coliform to the surface of the land. For example, the fecal coliform accumulation rate for pastureland is the sum of accumulation rates due to litter application, wildlife, processed manure, and grazing animals. Accumulation rates for pastureland are calculated on a monthly basis to account for seasonal variations in manure and litter application.

4.3.1 Failing Septic Systems

Septic system discharges are quantified based on the following information: The number of septic systems in each subwatershed, the estimated population served by the septic systems, an assumed failure rate of 40 percent, an average daily discharge of 100 gallons/person/day, and a septic effluent fecal coliform concentration of 10^4 cfu/100ml. These loads are represented in the model as direct discharges containing the total load from each subwatershed delivered to each corresponding reach (counts/hour). Fecal coliform loads from failing septic systems are considered not only as nonpoint source loads, but also as point source loads in this TMDL.

4.3.2 Wildlife

Deer are distributed throughout the watershed with a density of 45 deer/mi^2, as discussed in Section 3.2.2. The fecal coliform loading from the deer is evenly distributed in the model to the forest land, pastureland, cropland, and wetlands. The per animal loading rate used in the model is 5.00E+08 counts/day/deer. The per acre loading rate applied to the landuses is calculated to be 3.52E+07 counts/acre/day.

4.3.3 Land Application of Hog and Cattle Manure

The manure produced by hog and dairy cattle operations is collected in lagoons and applied to pastureland in the Big Black River Watershed, as discussed in Section 3.2.3. It is applied typically only during the months of April through October, and the rates of application typically vary during those months. This monthly variation is incorporated into the model.

The fecal loading rates of 1.08E+10 counts/day/hog (ASAE) and 5.40E+09 counts/day/cow (Metcalf & Eddy, 1991) are utilized in the model. The per acre loading rates for cow and hog manure on pasture land are shown in Appendix B.

4.3.4 Grazing Animals

The Big Black River Watershed contains beef and dairy cattle and hogs that contribute fecal coliform directly to the land surface during grazing, as discussed in Section 3.2.4. Because there is no monthly variation in animal access to pasture in this region of the state, the fecal loading rate to pasture land does not vary throughout the year. The per animal fecal loading rates of 1.08E+10 counts/day/hog (ASAE) and 5.40E+09 counts/day/cow (Metcalf & Eddy, 1991) are utilized in this TMDL. The per acre loading rates for grazing animals on pasture land are shown in Appendix B.

4.3.5 Land Application of Poultry Litter

Poultry litter is applied to pastureland in the Big Black River Watershed, as discussed in Section 3.2.5. It is applied typically only during the months of April through October. The fecal loading rate of 6.75E+07 counts/day/chicken (ASAE) is utilized in the model. The counts/acre/day loading rates for poultry litter on pasture land are shown in Appendix B.

4.3.6 Cattle Contributions Deposited Directly Instream

Cattle that have access to streams represent direct contributors of fecal coliform bacteria to the Big Black and its tributaries. The model assumes a cattle-in-stream rate of one percent as discussed in Section 3.2.6. The fecal loading rate of 5.40E+09 counts/day/cow (Metcalf & Eddy, 1991) is utilized in the model. Loads from cattle in streams are represented in the model as direct discharges containing the total load from each subwatershed delivered to its corresponding reach (counts/hour).

4.3.7 Urban Development

Urban land use is represented in Tables 1.4 and 1.5 under the “Urban” and “Barren” categories. Due to a lack of fecal loading data for the urban land in the watershed, literature values are used. A single, weighted urban loading value of 7.18E+6 counts/acre/day is quantified for each subwatershed based on individual built-up landuses present and their corresponding loading rates.

4.4 STREAM CHARACTERISTICS

The stream characteristics given below describe segment MSLBGBKRM1. The channel geometry and length are based on data available within the BASINS modeling system. The mean flow and 7Q10 flow data are based on historical stream flow data from U.S. Geological Survey’s National Water Information System (NWIS) Station 07289370 (Bentonia).

- Length 23 miles
- Average Depth 1.0 ft
- Average Width 114 ft
- Mean Flow 2,122 cfs
- Mean Velocity 19 fps

- 7Q10 Flow 61 cfs
- Slope 0.00027

4.5 SELECTION OF REPRESENTATIVE MODELING PERIOD

The modeling period is from January 1985 to December 1995. The model actually begins running with data from January 1984, but that first year of output data is disregarded to allow for model stabilization. Results from the model are analyzed only for the 11-year time period of January 1985 to December 1995. Because this 11-year time spread is used, a margin of safety is implicitly applied. Also, seasonality is accounted for during the extended time frame.

The critical condition for fecal coliform impairment from nonpoint source contributors is 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 the rainfall. By using the 11-year time period, many of these washloads are represented in the model. Critical conditions for point sources, which occur during low-flow and low dilution conditions, are simulated as well.

4.6 MODEL CALIBRATION PROCESS

Hydraulic calibration has been achieved by comparing predicted flow to historical flow data from USGS Stations 07289370 and 02790000. Some of the factors included in this calibration are groundwater inflow, groundwater storage, evapotranspiration, infiltration capacity of the soil, and length of overland flow. The weather data used for the model were collected at Jackson and Lexington for the hydrologic period of January 1, 1985 through December 31, 1995. A sample of the results of the calibration is included in Appendix C. Modeled output and actual gage data are shown on the same graph for one of the model years.

Insufficient monitoring data are available for meaningful calibration of the fecal coliform concentrations in the model. An extensive effort has been made by MDEQ to confer with researchers and agricultural experts to give as much validity as possible to the assumptions made with the fecal load spreadsheet.

4.7 EXISTING LOADINGS

Appendix C includes a graph of the model results showing the existing fecal coliform 30-day geometric mean concentration over the 1985 – 1995 modeling period in impaired segment MSLBGBKRM1 (08060202011).

5.0 ALLOCATION

Total maximum daily loads (TMDLs) are composed of the sum of individual waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and a margin of safety (MOS). This definition is expressed by the equation:

TMDL = 3WLA + 3LA + MOS

The TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards.

Point source contributions, including permitted facilities and a portion of failing septic systems (50%), enter the stream directly in the appropriate reaches. The nonpoint fecal coliform sources in the model have two different transportation methods. Cattle in the stream and the remaining portion of failing septic systems (50%) are modeled as direct inputs to the stream. The other nonpoint source contributions are applied to land area on a counts per day per acre basis. The fecal coliform bacteria applied to land is subject to a die-off rate and an absorption rate before it enters the stream.

The determination of the TMDL is based on the critical hydrologic flow condition that occurs during the modeled time span. The TMDL includes the sum of the loads from all identified point and nonpoint sources applied or discharged within the portion of the watershed that is proximate to the impaired segment. This includes subwatersheds 08060202011-08060202021, 08060201001-08060201009, 08060201030, and 08060201031.

5.1 WASTELOAD ALLOCATIONS

As discussed in Section 3.1, five facilities currently have no fecal coliform limits in their NPDES permits, including the West POTW which has summer limits, but no winter limits permitted. This TMDL recommends that all facilities meet water quality standards for fecal coliform at the end-of-pipe. The exception of these are the two HCR facilities: Vaiden POTW-HCR, and Eupora POTW-HCR. Because these facilities only discharge during high flow conditions, model results show that they do not impact the fecal coliform concentration in the segment.

Table 5.1 Permitted Facility Loading Allocations

Name	*NPDES ID*	*Season*	*FLOW*	*ESTIMATED EXISTING LOAD*		*ALLOC. LOAD*		*RED.*
				F.C.-Average		*F.C.-Average*		
			cfs	*counts/ 100ml*	*counts/ hr*	*counts/ 100ml*	*counts/ hr*	*%*
Goodman POTW	MS0026921	summer	0.446	20000	907.00E+07	200	9.07E+07	99%
		winter	0.446	20000	907.00E+07	2000	90.70E+07	90%
Pickens POTW	MS0021130	summer	0.387	20000	787.00E+07	200	7.87E+07	99%
		winter	0.387	20000	787.00E+07	2000	78.70E+07	90%
West POTW	MS0032816	summer	0.116	200	2.36E+07	200	2.36E+07	0%
		winter	0.116	2564	30.30E+07	2000	23.60E+07	22%

The recommended allocation for these three point sources is a 200 count/100ml summer concentration limit and a 2000 count/100ml winter concentration limit. The resulting count/hour loading for each point source is listed in Table 5.1. No reduction is recommended for the other point sources in the watershed, so their allocated loads are equivalent to their current permit limits.

Table 5.2 lists the point source contributions on an subwatershed basis, including the existing load, allocated load, and percent reduction. Summer permit limits are used to calculate the NPDES allocated loads because the critical period identified in the modeling analysis falls within the summer months.

Table 5.2 Fecal Coliform Loading Rates for Point Source Contributions from NPDES Facilities

Subwatershed	***Flow (cfs)***	***Existing Load (counts/day)***	***Allocated Load (counts/day)***	***Percent Reduction***
8060202012	0.067	3.25E+08	3.25E+08	0%
8060201001	0.433	1.89E+11	21.20E+08	99%
8060201003	0.471	2.18E+11	23.00E+08	99%
8060201004	0.023	1.13E+08	1.13E+08	0%
8060201005	0.033	1.59E+08	1.59E+08	0%
8060201006	1.037	5.06E+09	50.60E+08	0%
8060201009	0.187	9.14E+08	9.14E+08	0%
Total	2.251	4.14E+11	110.00E+08	97%

5.2 LOAD ALLOCATIONS

Discussion of load allocations to nonpoint sources is divided into categories of surface loadings from land uses and direct discharges from cows in the streams and septic systems. Sensitivity analyses reveal that surface loadings based on land use do not significantly impact the fecal coliform loadings in the Lower Big Black River. These nonpoint sources include wildlife, land application of hog, cattle and chicken waste, cattle and hog grazing, and urban runoff. The percent reduction in fecal loading for these sources is zero. Background conditions are incorporated in the model as loadings from wildlife. Table 5.3 lists the nonpoint source contributions due to the surface loadings previously listed, including existing loads, allocated loads, and percent reductions. The loadings in the table represent the amount of fecal coliform bacteria that enter the stream during the 30-day critical period.

Table 5.3 Fecal Coliform Stream Loading Rates From Nonpoint Surface Loadings

Subwatershed	*Existing Load (counts/day)*	*Allocated Load (counts/day)*	*Percent Reduction*
8060202011	1.34E+11	1.34E+11	0%
8060202012- 8060202019, 8060202021	1.73E+11	1.73E+11	0%
8060202020	3.09E+11	3.09E+11	0%
8060201001- 8060201009, 8060201030, 8060201031	7.6E+11	7.6E+11	0%
Total	13.80E+11	13.80E+11	0%

The nonpoint sources modeled as direct discharges are cattle in streams and failing septic systems. Model analyses reveal these to be significant sources of fecal coliform bacteria to the Lower Big Black River impaired segment MSLBGBKRM1. The scenario chosen for these two sources to achieve adequate reduction in fecal loading is a 40% percent reduction in contributions from cattle in the stream and from failing septic systems in Subwatersheds 08060202011-08060202021. This scenario can be achieved for the cattle in streams loading by supporting BMP projects in pastures. The reduction of fecal coliform loadings from failing septic systems can be attained by extending sewerage systems, and by supporting education projects that encourage homeowners to properly maintain their septic tanks by routinely pumping them out and repairing broken field lines. Stopping direct bypasses and requiring owners of individual onsite treatment plants to disinfect would also contribute to the reduction. Table 5.4 lists the nonpoint source contributions due to cattle access to streams, on a subwatershed basis, along with their existing load, allocated load, and percent reduction. Table 5.5 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 5.4 Fecal Coliform Loading Rates For Cattle Access to Streams

Subwatershed	*Existing Load (counts/day)*	*Allocated Load (counts/day)*	*Percent Reduction*
8060202011	2.82E+11	1.69E+11	40%
8060202012- 8060202019, 8060202021	6.32E+11	3.79E+11	40%
8060202020	7.82E+11	4.69E+11	40%
8060201001- 8060201009, 8060201030, 8060201031	22.10E+11	22.10E+11	0%
Total	39.10E+11	32.30E+11	17%

Table 5.5 Fecal Coliform Loading Rates For Failing Septic Tanks

Subwatershed	*Existing Load (counts/day)*	*Allocated Load (counts/day)*	*Percent Reduction*
8060202011	2.83E+10	1.70E+10	40%
8060202012-8060202019, 8060202021	15.60E+10	9.34E+10	40%
8060202020	8.84E+10	5.31E+10	40%
8060201001-8060201009, 8060201030, 8060201031	40.30E+10	40.30E+10	0%
Total	67.60E+10	56.70E+10	16%

The impact of the load allocations on the instream fecal coliform bacteria concentration in the impaired segment can be seen in the time-series plots presented in Appendix C.

5.3 INCORPORATION OF A MARGIN OF SAFETY

The purpose of a margin of safety is to address modeling uncertainties associated with relating loads to water quality conditions. The two options for MOS development are either 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. Requiring no violations of the water quality standard over the entire 11-year modeling period 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 all of the fecal coliform bacteria discharged from failing septic tanks reach 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 is calculated based on the following equation:

TMDL = WLA + LA + MOS

The TMDL calculated in this report is 1.16E+14 counts/30 days. This 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. 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.

WLA = NPDES Permitted Facilites + ½ of the Septic Tank Failures
= 3.30E+11 counts/30 days + 0.5(170.00E+11) counts/30 days
= 88.40E+11 counts/30 days

LA = Surface Runoff + Cows in the Stream + ½ of the Septic Tank Failures
= 1.38E+12 counts/30 days + 96.90E+12 counts/30 days + 0.5(17.00E+12) counts/30 days
= 107.00E+12 counts/30 days

MOS = implicit

TMDL= 8.84E+12 + 107.00E+12 = 116.00E+12 counts/30 days

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

5.5 SEASONALITY

Seasonal variation is included in the modeling approach for this TMDL. Fecal coliform accumulation rates for animal manure application are determined on a monthly basis for pasture land. Also, seasonality in the permit limits of certain point sources is represented in the model.

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

6.0 CONCLUSION

The fecal coliform reduction scenario used in this TMDL includes requiring NPDES Permitted dischargers of fecal coliform to meet water standards for disinfection, along with reducing the assumed fecal load from the cattle access to streams and the assumed fecal load from 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 Big Black Basin, the Lower Big Black River may receive additional monitoring to identify any improvement in water quality.

6.2 PUBLIC PARTICIPATION

This TMDL was published for a 30-day public notice. During this time, the public was notified by publication in the statewide newspaper and a newspaper in Canton. The public was given an opportunity to review the TMDL and submit comments.

All comments received during the public notice period and at any public hearings become a part of the record of this TMDL. All comments will be considered in the ultimate approval of this TMDL by the Commission on Environmental Quality and for submission of this TMDL to EPA Region IV for final approval.

DEFINITIONS

Ambient stations: 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 amount of contaminant load that can be discharged to a specific stream or river without violating the provisions of the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters and Water Quality* regulations. Assimilative capacity is used to define the ability of a waterbody to naturally absorb and use waste matter and organic materials without impairing water quality or harming aquatic life.

Background: the condition of waters in the absence of 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 waterbody or on historical least impaired data.

Best management practices: methods, measures, or practices that are determined to be reasonable and cost-effective means for a land owner to meet certain, generally nonpoint source, pollution control needs. BMPs include structural and nonstructural controls and operation and maintenance procedures.

Calibration: testing and tuning of a model to a set of field data. Also includes minimization of deviations between measured field conditions and output of a model by selecting appropriate model coefficients.

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: uses specified in water quality standards for each waterbody or segment regardless of actual attainment.

Discharge monitoring report: report of effluent characteristics submitted by a facility that has been granted an NPDES Permit.

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: municipal sewage or industrial or commercial liquid waste (untreated, partially treated, or completely treated).

Fecal coliform bacteria: a group of bacteria that normally reside within the intestines of mammals, including humans. Fecal coliform bacteria are used as indicators of the presence of pathogens 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.

Impairment: the condition in which the applicable state water quality standards are not met for a waterbody and the designated use is impaired.

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.

Margin Of Safety (MOS): a required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant load and the quality of the receiving waterbody.

Nonpoint source pollution: pollution that is 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 watewater, hydrologic modifications, and urban development.

NPDES permit: an individual or general permit issued by the MDEQ Permit Board pursuant to regulations adopted by the Commission under Mississippi Code Annotated (as amended) § 49-17-17 and § 49-17-29 for discharges into State waters.

Point source pollution: 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) : municipal wastewater treatment plant owned and operated by a public governmental entity such as a town or city.

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 (3): 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:

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

STORET: EPA national water quality database for STORage and RETrieval (STORET). The database includes physical, chemical, and biological data measured in waterbodies throughout the United States.

Storm runoff: rainfall that does not evaporate or infiltrate the ground because of impervious land surfaces or a soil infiltration rate lower than rainfall intensity, but instead flows into adjacent land or waterbodies or is routed into a drain or sewer system.

Total Maximum Daily Load (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.

Water quality criteria: water quality criteria comprise numeric and narrative criteria. Numeric criteria are scientifically derived ambient concentrations developed by EPA or states for various pollutants of concern to protect human health and aquatic life. Narrative criteria are statements that describe the desired water quality goal.

Water quality standards: a law or regulation that consists of the beneficial designated use or uses of a waterbody, the numeric and narrative water quality criteria that are necessary to protect the use or uses of that particular waterbody and an antidegradation statement.

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: a part of the land area enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into a receiving water. Also referred to as drainage basin, river basin, or hydrologic unit.

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
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
GIS	Geographic Information System
HCR	Hydrograph Controlled Release Facility
HUC	Hydrologic Unit Code
LA	Load Allocation
MARIS	State of Mississippi Automated Resource Information System
MDEQ	Mississippi Department of Environmental Quality
MOS	Margin of Safety
NRCS	National Resource Conservation Service
NPDES	National Pollution Discharge Elimination System
NPSM	Nonpoint Source Model
PCS	Permit Compliance System
RF3	Reach File Three
USGS	United States Geological Survey
WLA	Waste Load Allocation

REFERENCES

ASAE, 1998. ASAE (American Society of Agricultural Engineers) Standards, 45th Edition, Standards Engineering Practices Data.

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.

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

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

MDEQ. 1998. *State of Mississippi 1998 List of Waterbodies Prepared pursuant to Section 303(d) 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.

APPENDIX A: GRAPHICAL ANALYSIS OF INSTREAM WATER QUALITY DATA

Table A-1 and Figure A-1 represent the fecal coliform monitoring data from MDEQ station 07289350; Table A-2 and Figure A-2, data from MDEQ station 07289540, membrane filter analysis (31613); Table A-3 and Figure A-2, data from MDEQ station 07289540, MPN analysis (31615); Table A-4 and Figure A-4, data from USGS station 07290000; Table A-5 and Figure A-5, data from MDEQ station 07290000; and Table A-6 and Figure A-6, data from MDEQ station 07290150.

Table A-1 **Fecal Coliform, MDEQ Station 07289350**

Date	***Flow***	***Fecal Coliform***
	(cfs)	*(counts/100ml)*
12/17/96	2350	320
01/14/97	4920	600
02/19/97	2840	200
03/18/97	1080	60
04/23/97	296	180
05/15/97	438	150
06/17/97	2960	110
07/15/97	752	500
08/11/97	200	180
09/08/97	116	30
10/08/97		120
11/12/97		90
01/12/98		380
02/11/98		4400
03/16/98		310
04/15/98		30
06/11/98		210
07/13/98		13000
08/12/98		500
09/08/98		80
10/13/98		70
11/09/98		160
12/09/98		32000

Table A-2 **Fecal Coliform, MDEQ Station 07289540 (MF)**

Date	***Flow***	***Fecal Coliform***
	(cfs)	*(counts/100ml)*
01/08/80		1100
02/05/80		800
03/05/80		4000
04/01/80		440
05/06/80		10
05/27/80		1900
07/01/80		147
08/05/80		207
09/03/80		67
09/30/80		10
12/02/80		400
01/06/81		113
03/02/81		5900
03/03/81		5400
04/07/81		40
05/05/81		27
05/26/81		200
06/30/81		40
08/04/81		93
09/01/81		470
10/07/81		105
11/04/81		2900
12/08/81		70
01/05/82		100
02/02/82		2600
03/02/82		170
05/04/82		150
06/29/82		70
08/31/82		10
11/03/82		20
01/05/83		50
03/08/83		4500
05/03/83		66
07/05/83		253
08/30/83		13
10/31/83		93
01/09/84		40
03/05/84		4900
05/07/84		120
07/09/84		140
09/02/84		2200

09/04/84		320
11/06/84		310
01/07/85	268	250
03/04/85	10000	120
07/08/85	300	33
09/03/85	450	310
11/04/85	1750	140
01/07/86	510	27
03/03/86	106	13
05/05/86	240	60
06/30/86	240	10
09/02/86	140	2200
11/03/86	300	7
01/04/88	1180	800
03/07/88	1530	253
05/02/88	165	2400
07/05/88	140	17
11/07/88	680	26

Table A-3 **Fecal Coliform, MDEQ Station 07289540 (MPN)**

Date	Flow (cfs)	Fecal Coliform (counts/100ml)
01/09/89	3120	17
05/01/89	352	1100
01/08/90	7560	260
03/05/90	1930	340
05/01/90	2910	1100
07/09/90	298	20
09/04/90	126	330
11/05/90	140	1300
01/11/93	1590	3500
03/08/93	2200	140
05/03/93	6200	280
07/12/93	375	540
09/13/93	100	50
11/01/93	230	16000
01/10/94	1020	1700
03/07/94	4600	9200
05/02/94	540	70
06/20/94	1050	280
08/23/94	2400	1100
11/07/94	550	2200
01/09/95	2700	1600
03/08/95	8200	280
04/18/95	900	350
07/12/95	500	79
09/11/95	150	33
11/08/95	360	110
01/08/96	6100	26
03/05/96	700	70
05/06/96	950	49
07/10/96	175	13
09/10/96	330	7

Table A-4 **Fecal Coliform, USGS Station 07290000**

Date	***Flow***	***Fecal Coliform***
	(cfs)	*(counts/100ml)*
01/09/80	3000	140
02/07/80	9510	360
04/01/80	48500	610
05/06/80	12200	120
06/30/80	9430	560
10/07/80	352	120
12/03/80	1490	200
01/07/81	601	43
02/04/81	5480	1100
03/03/81	1890	6500
04/01/81	12000	960
06/04/81	953	270
06/29/81	459	940
11/02/81	266	470
03/24/82	7830	1500
07/13/82	443	410
09/15/82	270	2700
10/14/82	988	470
10/21/83	301	400
04/09/84	9010	570
02/25/85	13000	3500
04/02/85	5180	660
08/29/85	360	5700
10/21/85	1020	7200
12/16/85	8510	7500
02/19/86	1340	2900
04/17/86	604	3000
06/12/86	3630	4700
10/22/86	252	1700
12/17/86	2730	1600
02/18/87	9400	8800
04/20/87	2090	1700
06/17/87	11700	420
08/13/87	517	460
11/17/87	15700	12000
01/11/88	1930	1400
02/22/88	8620	3300
04/15/88	2120	7000
06/20/88	147	160
08/30/88	136	940
11/07/88	845	4700

12/20/88	515	1800
02/22/89	8440	8300
04/19/89	2760	2700
06/19/89	9320	700
08/16/89	988	380
11/13/89	6650	470
01/23/90	21800	4300
04/30/90	8870	1600
07/11/90	302	1400
08/08/90	253	6000
10/15/90	103	770
01/22/91	2160	140
02/08/91	5620	2900
04/10/91	11200	220
06/19/91	1200	900
08/26/91	338	420
10/09/91	485	660
12/12/91	11200	740
02/19/92	8110	580
06/17/92	2300	100
08/10/92	327	42
10/07/92	241	80
12/07/92	1720	660
02/10/93	1100	63
06/16/93	438	40
08/10/93	2200	200
10/04/93	234	22
01/10/94	3270	2900
02/11/94	17400	7400
06/22/94	720	190
08/19/94	400	62

Table A-5 **Fecal Coliform, MDEQ Station 07290000**

Date	***Flow***	***Fecal Coliform***
	(cfs)	*(counts/100ml)*
12/11/96	781	20
01/07/97	3080	600
02/11/97	11700	2200
03/11/97		100
04/17/97	1190	90
05/13/97	8730	300
06/05/97	7300	150
07/02/97	1710	180
08/06/97	685	10
09/03/97	466	10
10/09/97		20
11/04/97		400
01/07/98		2400
02/10/98		120
03/05/98		140
04/14/98		20
06/10/98		230
07/09/98		10
08/11/98		50
09/05/98		20
10/12/98		30
11/03/98		60
12/03/98		70

Table A-6 **Fecal Coliform, MDEQ Station 07290150**

Date	***Flow***	***Fecal Coliform***
	(cfs)	*(counts/100ml)*
12/11/96		30
01/07/97		150
02/11/97		2000
02/11/97		100
03/11/97		100
04/17/97		70
05/13/97		350
06/05/97		20
07/02/97		100
08/06/97		10
09/03/97		10
11/04/97		390
01/07/98		5500
01/10/98		120
03/05/98		230
04/14/98		10
06/10/98		10
07/09/98		20
08/11/98		90
09/02/98		270
10/12/98		200
11/03/98		60
12/03/98		60

APPENDIX B: FECAL COLIFORM LOADINGS TO PASTURE LAND

Table B-1 reports the fecal coliform loading rates (counts/acre/day) applied to pastureland in each subwatershed for each month.

APPENDIX C: GRAPHICAL REPRESENTATION OF MODEL OUTPUT

This appendix contains printouts of model run results. Graph C-1 shows the results of the hydraulic calibration comparing modeled flow to the recorded flow at USGS Station 07290000. Graphs C-2 and C-3 display the modeled existing instream fecal coliform concentration and the modeled instream fecal concentration after allocations are applied during the modeling period for segment MSLBGBKRM1.

The TMDL calculated in this report represents the maximum fecal coliform load that can be assimilated by the impaired 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 shows the 30-day geometric mean of instream fecal coliform concentrations representing the allocated loading scenario, 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 impaired waterbody segment included in this report. The numerical values for the wasteload allocation (point sources) and load allocation (nonpoint sources) for each waterbody segment can be found on the waterbody segment identification pages at the beginning of this report.