FINAL REPORT
Approved
October 2002

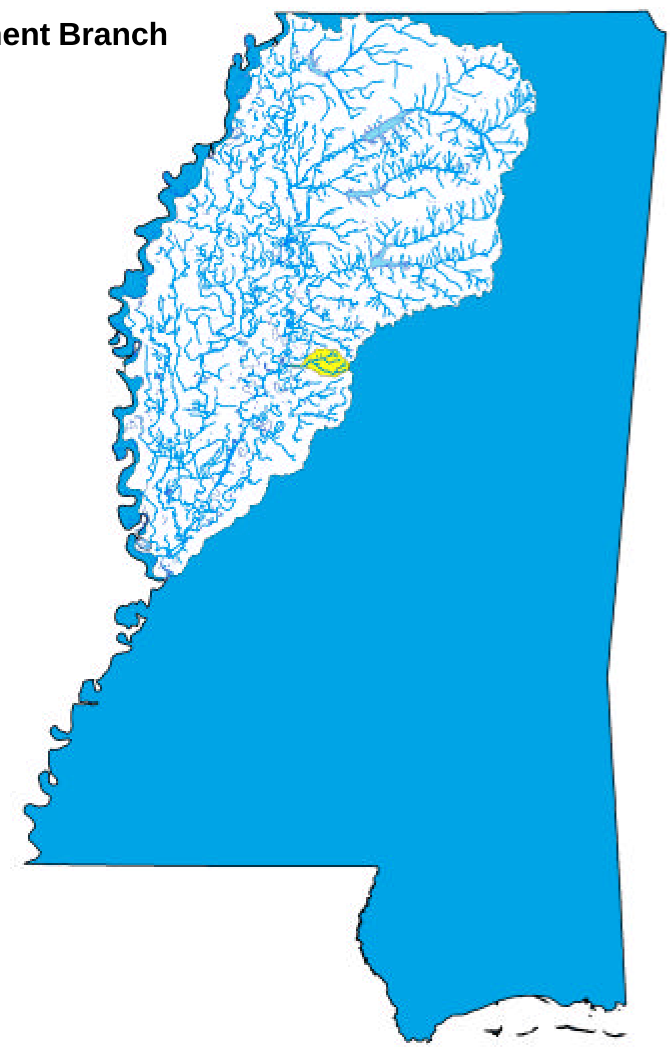
Fecal Coliform TMDL for Abiaca Creek

Yazoo River Basin

Carroll, Holmes, and Leflore Counties, Mississippi

Prepared By

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



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FOREWORD

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

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FIGURES

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TMDL INFORMATION PAGE

Table i. Listing Information

Name	ID	County	HUC	Cause	Mon/Eval
Abiaca Creek segment 1	MS355M1	Carroll Leflore Holmes	08030206	Pathogens	Monitored
At Cruger: From confluence with Coila Creek to the Matthews Brake National Wildlife Refuge					
Abiaca Creek segment 2	MS357M1	Carroll	08030206	Pathogens	Monitored
Near Coila: From headwaters to Sanders Lake					
Abiaca Creek segment 3	MS357M2	Carroll	08030206	Pathogens	Monitored
Near Black Hawk: From Sanders Lake to tributary above Black Hawk					
Abiaca Creek segment 4	MS357M3	Carroll Leflore Holmes	08030206	Pathogens	Monitored
At Black Hawk: From just above Highway 17 to confluence with Coila Creek					
Coila Creek	MS357M4	Carroll	08030206	Pathogens	Monitored
At Seven Pines: From lake dam southeast of Gravel Hill to mouth at Abiaca Creek					

Table ii. Water Quality Standard

Parameter	Beneficial use	Water Quality Criteria
Fecal Coliform	Secondary Contact	**May - October**: Fecal coliform colony counts not to exceed a geometric mean of 200 per 100ml, nor shall more than 10 percent of samples examined during any month exceed a colony count of 400 per 100ml. **November – 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.

Table iii. NPDES Facilities

NPDES ID	Facility Name	Subwatershed	Receiving Water
MS0042315	Cruger POTW	08030206013	Abiaca Creek

Table iv. Total Maximum Daily Load for Abiaca Creek

Type	Number	Unit	MOS Type
WLA	1.68E+11	counts/30 day critical period	
LA	1.80E+15	counts/30 day critical period	
MOS	---	counts/30 day critical period	Implicit
TMDL	1.80E+15	counts/30 day critical period	

Table v. Total Maximum Daily Load for Coila Creek

Type	Number	Unit	MOS Type
WLA	4.66E+10	counts/30 day critical period	
LA	7.02E+14	counts/30 day critical period	
MOS	---	counts/30 day critical period	Implicit
TMDL	7.02E+14	counts/30 day critical period	

EXECUTIVE SUMMARY

Several segments of Abiaca Creek along with a section of Coila Creek, a tributary of Abiaca Creek, have been placed on the Mississippi 1998 Section 303(d) List of Waterbodies as monitored waterbody segments, due to fecal coliform bacteria. The applicable state standard specifies that for the summer months, the maximum allowable level of fecal coliform shall not exceed a geometric mean of 200 colonies per 100 ml, nor shall more than ten percent of the samples examined during any month exceed a colony count of 400 per 100 ml. For the winter months, the maximum allowable level of fecal coliform shall not exceed a geometric mean of 2000 colonies 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.

Photo 1. Abiaca Creek

Abiaca Creek, photo 1, flows in a western direction from its headwaters near Coila, Mississippi into Mosquito Lake within the Mathews Brake National Wildlife Refuge. This TMDL has been developed for four listed sections of Abiaca Creek and one listed section of Coila Creek. The BASINS Nonpoint Source Model (NPSM) was selected as the modeling framework for performing the TMDL allocations for this study. The weather data used for this model were collected at Lexington, MS. The representative hydrologic period used for this TMDL was January 1988, through December 1998.

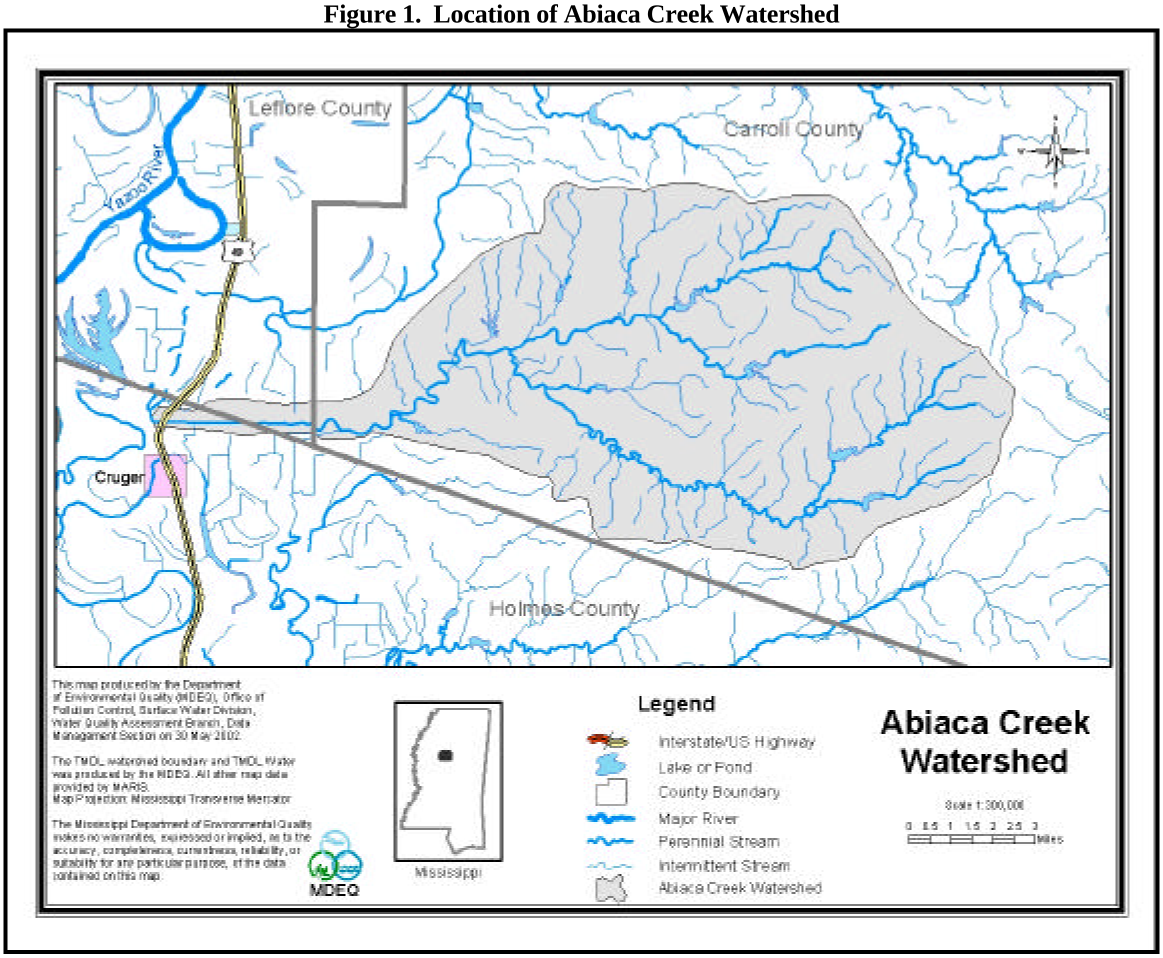
Fecal coliform loadings from nonpoint sources in the watershed were calculated based upon wildlife populations; livestock populations; information on livestock and manure management practices for the Yazoo River Basin; and urban development. The model was then calibrated against the limited fecal coliform data available. 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 other direct inputs to the tributaries of Abiaca Creek. The model assumed an 80 percent failure rate of septic tanks in the drainage area. There is one NPDES permitted facility included as a point source in the model.

Under the existing loading conditions, output from the model indicates violation of the fecal coliform standard in the waterbody. After applying a load reduction scenario with the model, there were no violations of the standard according to the model.

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. The location of the Abiaca Creek watershed is shown below.

Figure 1. Location of Abiaca Creek Watershed



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 nonpoint sources, maintain permit requirements for point sources, and restore and maintain the quality of water resources.

The Abiaca Creek drainage area is in the Yazoo River Basin Hydrologic Unit Code (HUC) 08030206 in northwest Mississippi. The drainage area is based on the major tributaries and topography and is approximately 62,831 acres. It lies within portions of Carroll, Holmes, and Leflore Counties. The watershed is rural. Forest and pasture are the dominant landuses within the watershed. The landuse distribution for the watershed is shown in Table 1 and Figure 6. The location of the 303(d) listed segments is shown in Figure 2.

Table 1. Landuse Distribution for the Abiaca Creek Watershed

	Urban	Forest	Cropland	Pasture	Barren	Wetland	Aquaculture	Water	Total
Area (acres)	0	26,892	2,821	30,936	0	1,757	0	424	62,831
% Area	0%	43%	4%	49%	0%	3%	0%	1%	100%

Figure 2. Abiaca Creek Watershed 303d Listed Segments

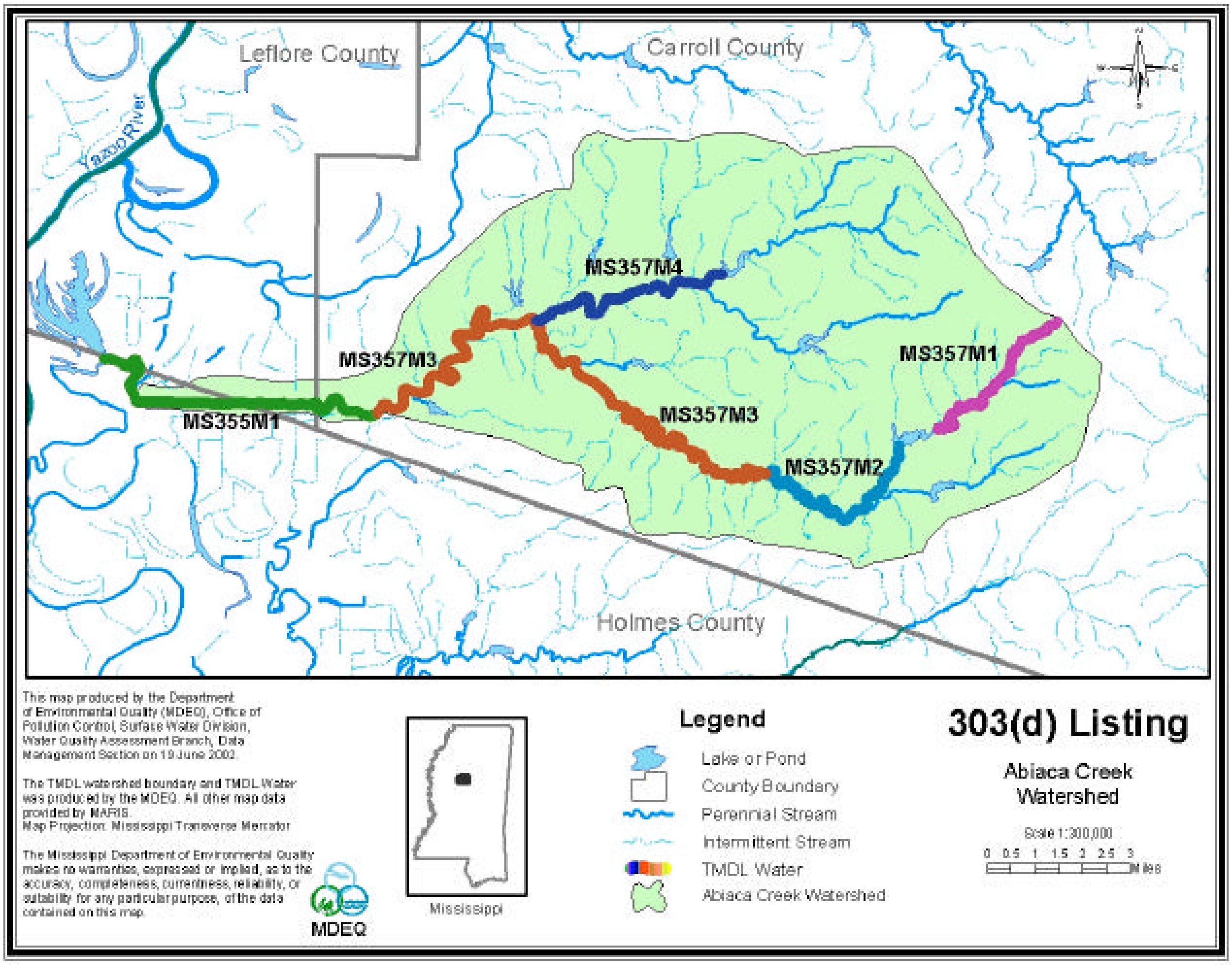
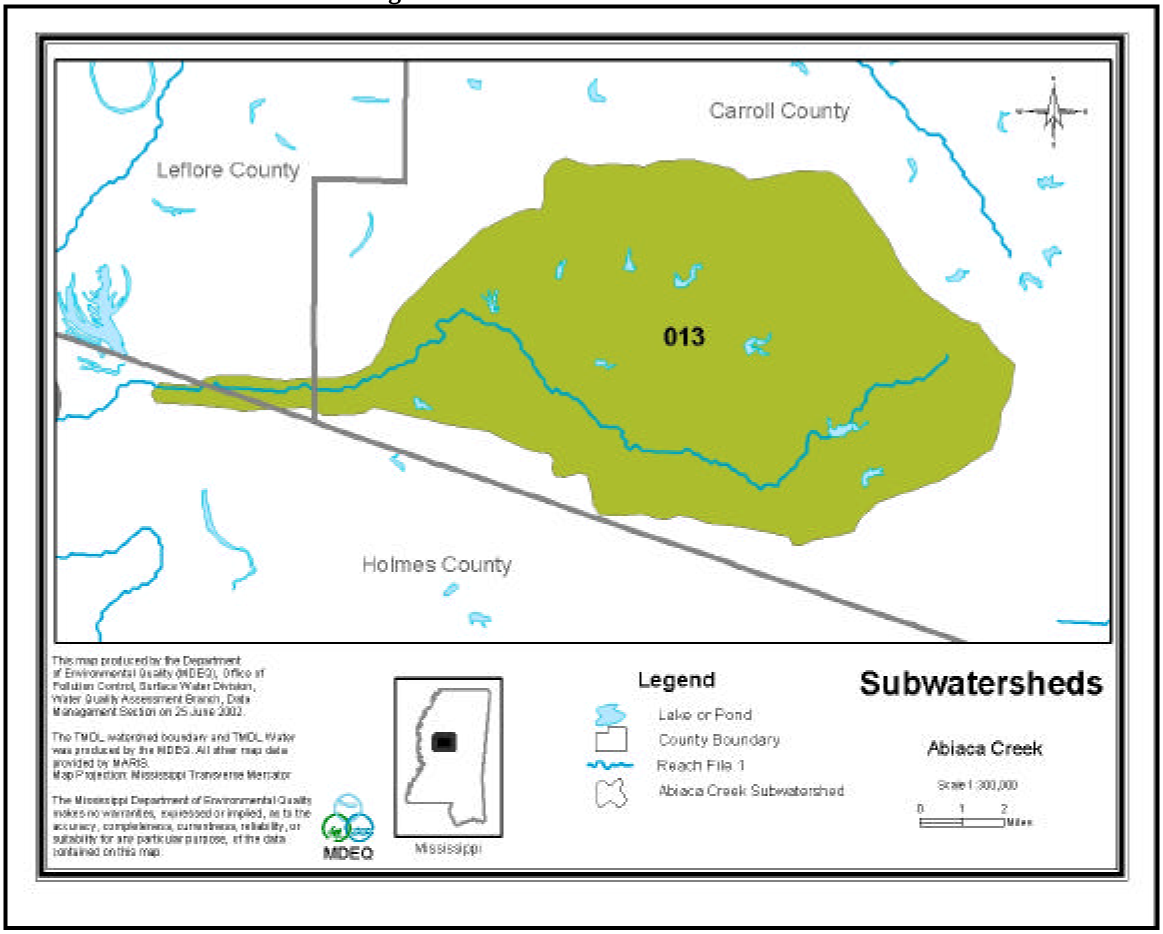


Figure 3. Abiaca Creek Subwatersheds



1.2 Applicable Waterbody Segment Use

The water use classification for the listed segments of Abiaca Creek, 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 beneficial uses for Abiaca Creek are Secondary Contact and Aquatic Life Support.

1.3 Applicable Waterbody Segment Standard

The water quality standard applicable to the use of the waterbody and the pollutant of concern is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. The standard states that for the summer months (May –October) the fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml, nor shall more than ten percent of the samples examined during any month exceed a colony count of 400 per 100 ml. For the winter months (November – April), the fecal coliform colony counts shall not exceed a geometric mean of 2000 colonies 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 the targeted endpoints to evaluated impairment establish this TMDL.

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.

While the endpoint of a TMDL calculation is similar to a standard for a pollutant, the endpoint is not the standard. Currently MDEQ's standard for fecal coliform states that for the summer months the fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml, nor shall more than ten percent of the samples examined during any month exceed a colony count of 400 per 100 ml. For the winter months, the fecal coliform colony counts shall not exceed a geometric mean of 2000 colonies 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. For this TMDL, MDEQ considered the 10 percent portion of the standard when looking at the data for assessment of impairment, however, when setting the target, modeling the waterbody, and calculating the TMDL, MDEQ will use the geometric mean portion of the standard exclusively.

Because fecal coliform may be attributed to both nonpoint and point sources, the critical condition used for the modeling and evaluation of stream response was derived within 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 1988 -1998 period represents both low-flow conditions as well as wet-weather conditions and encompasses a range of wet and dry seasons. Therefore, the 11-year period was used to find the critical conditions associated with all potential sources of fecal coliform bacteria within the watershed.

2.2 Discussion of Instream Water Quality

There are several ambient stations on Abiaca Creek operated by USGS, where fecal coliform monitoring data were collected during the 11-year modeling period. Monitoring for flow and fecal coliform was performed on a routine basis at several stations within each listed segment. Data for segment MS355M1 were collected at station 07287150 at Seven Pines, MS and station 07287160 at Cruger, MS. Segment MS357M1 was monitored by one station, 07287141 near Coila, MS. Segment MS357M2 was monitored at station 07287142 near Black Hawk, MS. Finally, data for segment MS357M3 were collected at station 07287144 at Black Hawk, MS.

MDEQ does not currently collect monthly fecal monitoring data at any of these stations. In order to collect fecal coliform data, MDEQ now goes to monitoring stations six times within a 30-day period. These data can then be used to calculate a geometric mean for the waterbody. Abiaca Creek and Coila Creek were recently included in this type of monitoring. These data were used to confirm impairment in this waterbody.

2.2.1 Inventory of Available Water Quality Monitoring Data

Data collected at the five monitoring stations on Abiaca Creek are included in Table 2 through Table 6. Data collected by MDEQ from the geometric mean study from 2001 are shown below in Table 7 through Table 11.

Table 2. Fecal Coliform Data reported in Abiaca Creek, Station 07028150, April 1992 to August 1995

Date	Time	Flow (cfs)	Fecal Coliform (counts/100ml)
4/20/1992	13:00	615	23000
4/20/1992	19:00	422	6000
4/21/1992	1:00	260	18000
4/21/1992	7:00	205	8600
4/21/1992	13:00	166	5800
4/21/1992	19:00	140	5800
4/22/1992	1:00	128	2500
4/22/1992	7:00	120	2000
4/22/1992	13:00	106	720
8/24/1992	14:00	36	120
8/24/1992	20:00	30	110
8/25/1992	2:00	33	160
8/25/1992	8:00	34	200
8/25/1992	14:00	33	75
8/25/1992	20:00	28	120
8/26/1992	2:00	31	160
8/26/1992	8:00	33	100
8/26/1992	14:00	31	81
12/14/1992	18:00	46	64
12/15/1992		48	140
12/15/1992	6:00	51	330
12/15/1992	12:00	51	84
12/15/1992	18:00	57	6000
12/16/1992		107	4000
12/16/1992	6:00	151	5800
12/16/1992	12:00	134	2800
12/16/1992	18:00	108	3300
8/16/1993	12:30	35	520
8/16/1993	18:30	34	65
8/17/1993	0:30	38	72
8/17/1993	6:30	39	100
8/17/1993	12:30	39	150
8/17/1993	18:30	36	110

Table 2. Continued

Date	Time	Flow (cfs)	Fecal Coliform (counts/100ml)
8/18/1993	0:30	32	62
8/18/1993	6:30	38	100
8/18/1993	12:30	38	85
7/11/1994	18:30	78	560
7/12/1994	0:30	56	2600
7/12/1994	6:30	56	420
7/12/1994	12:30	55	2100
7/12/1994	18:30	51	480
7/13/1994	0:30	51	700
7/13/1994	6:30	58	400
7/13/1994	12:30	112	8400
7/13/1994	18:30	78	5500
8/31/1994	12:15	40	77
7/5/1995	16:15	92	4200
7/5/1995	22:00	459	10000
7/6/1995	4:00	341	4200
7/6/1995	10:00	158	5200
7/6/1995	16:00	103	1100
7/6/1995	22:00	80	760
7/7/1995	4:00	73	550
7/7/1995	10:00	68	620
7/7/1995	13:00	61	280
8/15/1995	12:00	45	140

Table 3. Fecal Coliform Data reported in Abiaca Creek, Station 07028160, April 1992 to August 1995

Date	Time	Flow (cfs)	Fecal Coliform (counts/100ml)
4/20/1992	15:00	538	30000
4/20/1992	19:30	538	19000
4/21/1992	1:30	350	14000
4/21/1992	8:15	242	11000
4/21/1992	13:50	197	5900
4/21/1992	19:30	158	7400
4/22/1992	1:30	141	3400
4/22/1992	7:50	128	2200
4/22/1992	13:50	117	2100
8/24/1992	14:00	37	220
8/24/1992	19:45	36	420
8/25/1992	1:45	28	290
8/25/1992	8:25	31	160
8/25/1992	14:25	34	77
8/25/1992	19:45	32	220
8/26/1992	1:45	28	420
8/26/1992	8:00	32	140
8/26/1992	13:50	34	80
12/14/1992	18:00	55	46
12/15/1992		48	42
12/15/1992	6:00	50	120
12/15/1992	12:00	53	96
12/15/1992	18:00	58	67
12/16/1992		64	6000
12/16/1992	6:00	107	3100
12/16/1992	12:00	144	2700
12/16/1992	18:00	113	2600
8/16/1993	13:00	37	210
8/16/1993	19:00	37	160
8/17/1993	1:00	34	160
8/17/1993	7:00	34	230
8/17/1993	13:00	37	190
8/17/1993	19:00	37	160
8/18/1993	1:00	34	170
8/18/1993	7:00	34	160
8/18/1993	13:00	36	240
7/11/1994	19:00	70	520
7/12/1994	1:00	84	2400
7/12/1994	7:00	88	2000
7/12/1994	13:00	63	280
7/12/1994	19:00	62	240
7/13/1994	1:00	58	560
7/13/1994	7:00	61	480
7/13/1994	13:00	69	2300

Table 3. Continued

Date	Time	Flow (cfs)	Fecal Coliform (counts/100ml)
7/13/1994	19:00	84	6000
8/31/1994	11:30	40	150
7/5/1995	16:00	56	800
7/5/1995	22:00	205	5200
7/6/1995	4:00	323	8200
7/6/1995	10:00	214	5800
7/6/1995	16:00	129	4000
7/6/1995	22:00	108	680
7/7/1995	4:00	88	720
7/7/1995	10:00	79	560
7/7/1995	13:00	79	600
8/15/1995	11:15	43	170

Table 4. Fecal Coliform Data reported in Abiaca Creek, Station 07287141, April 1992 to July 1995

Date	Time	Flow (cfs)	Fecal Coliform (counts/100ml)
04-20-92	13:00	38	13000
04-20-92	19:00	7.8	18000
04-21-92	01:00	5.5	5800
04-21-92	07:00	4.9	3000
04-21-92	13:00	4.1	4100
04-21-92	19:00	3.8	840
04-22-92	01:00	3.7	580
04-22-92	07:00	3.7	540
04-22-92	13:00	3.7	280
08-24-92	12:00	.99	280
08-24-92	18:00	.99	160
08-25-92	00:00	.99	460
08-25-92	06:00	.99	180
08-25-92	12:00	.99	580
08-25-92	18:00	.99	180
08-26-92	00:00	1.0	160
08-26-92	06:00	.99	120
08-26-92	12:00	.99	160
12-14-92	19:15	1.9	10
12-15-92	00:55	1.9	50
12-15-92	07:00	1.9	77
12-15-92	13:00	2.0	31
12-15-92	18:55	8.8	4200
12-16-92	00:40	5.6	830
12-16-92	07:00	4.0	1400
12-16-92	13:00	3.0	1400
12-16-92	19:00	2.9	1200
08-16-93	13:00	1.8	170
08-16-93	19:00	1.7	220
08-17-93	01:00	1.8	230
08-17-93	07:00	1.7	4900
08-17-93	13:00	1.7	260
08-17-93	19:00	1.7	400
08-18-93	01:00	1.8	500
08-18-93	07:00	1.7	260
08-18-93	13:00	1.7	270
07-11-94	18:30	2.0	220
07-12-94	00:30	2.0	220
07-12-94	06:30	1.9	120
07-12-94	12:30	2.0	300
07-12-94	18:30	5.8	6000
07-13-94	00:30	3.0	6000
07-13-94	06:30	3.1	470
07-13-94	12:30	5.9	6000
07-13-94	18:30	4.1	6000

Table 4. Continued

Date	Time	Flow (cfs)	Fecal Coliform (counts/100ml)
07-05-95	15:00	1.8	8200
07-05-95	21:00	4.1	44000
07-06-95	03:00	2.0	12000
07-06-95	09:00	1.9	14000
07-06-95	15:00	1.2	3400
07-06-95	21:00	1.8	1800
07-07-95	03:00	1.5	1500
07-07-95	09:00	1.5	1100
07-07-95	12:00	1.5	800

Table 5. Fecal Coliform Data reported in Abiaca Creek, Station 07287142, April 1992 to August 1995

Date	Time	Flow (cfs)	Fecal Coliform (counts/100ml)
04-20-92	13:20	13	29000
04-20-92	19:20	11	4000
04-21-92	01:20	11	980
04-21-92	07:20	11	1100
04-21-92	13:20	10	840
04-21-92	19:20	10	2700
04-22-92	01:20	9.8	530
04-22-92	07:20	9.5	280
04-22-92	13:20	9.2	160
08-24-92	12:30	2.3	46
08-24-92	18:30	2.3	56
08-25-92	00:30	2.4	60
08-25-92	06:30	2.3	28
08-25-92	12:30	2.3	240
08-25-92	18:30	2.3	32
08-26-92	00:30	2.3	58
08-26-92	06:30	2.3	45
08-26-92	12:30	2.3	31
12-14-92	19:50	7.6	62
12-15-92	01:20	7.6	56
12-15-92	07:20	7.6	28
12-15-92	13:20	7.7	280
12-15-92	19:20	18	2200
12-16-92	01:05	9.8	1000
12-16-92	07:20	8.6	460
12-16-92	13:20	8.6	430
12-16-92	19:20	8.6	150
08-16-93	12:30	1.9	120
08-16-93	18:30	1.9	80
08-17-93	00:30	1.9	40
08-17-93	06:30	1.9	64
08-17-93	12:30	1.9	72
08-17-93	18:30	1.9	76
08-18-93	00:30	1.9	69
08-18-93	06:30	1.9	120
08-18-93	12:30	1.9	210
07-11-94	18:45	1.8	250
07-12-94	00:45	3.0	840
07-12-94	06:45	1.8	220
07-12-94	12:45	.00	260
07-12-94	18:45	.00	6000
07-13-94	00:45	4.0	620
07-13-94	06:45	.00	6000

Table 5. Continued

Date	Time	Flow (cfs)	Fecal Coliform (counts/100ml)
07-13-94	12:45	.00	1000
07-13-94	18:45	5.0	600
07-05-95	15:30	7.4	7200
07-05-95	21:30	6.6	18000
07-06-95	03:30	3.2	1400
07-06-95	09:30	3.6	720
07-06-95	15:30	3.6	360
07-06-95	21:30	2.8	230
07-07-95	03:30	3.0	110
07-07-95	09:30	3.3	130
07-07-95	12:30	3.2	110

Table 6. Fecal Coliform Data reported in Abiaca Creek, Station 07287144, April 1992 to August 1995

Date	Time	Flow (cfs)	Fecal Coliform (counts/100ml)
04-20-92	13:40	112	20000
04-20-92	19:40	66	11000
04-21-92	01:40	50	5700
04-21-92	07:40	40	5400
04-21-92	13:40	35	2900
04-21-92	19:40	34	2800
04-22-92	01:40	33	2500
04-22-92	07:40	25	1000
04-22-92	13:40	24	560
08-24-92	13:00	6.5	270
08-24-92	19:00	6.5	280
08-25-92	01:00	6.5	1100
08-25-92	07:00	6.5	560
08-25-92	13:00	6.5	200
08-25-92	19:00	6.5	460
08-26-92	01:00	6.5	200
08-26-92	07:00	6.4	200
08-26-92	13:00	6.4	96
12-14-92	18:30	13	120
12-15-92	00:30	13	3000
12-15-92	06:45	12	120
12-15-92	12:45	12	5800
12-15-92	18:30	55	5400
12-16-92	00:30	46	4200
12-16-92	06:45	37	16000
12-16-92	12:45	30	1300
12-16-92	18:45	28	1000
08-16-93	12:00	6.5	65
08-16-93	18:00	6.5	220
08-17-93	00:00	6.5	140
08-17-93	06:00	6.5	220
08-17-93	12:00	6.4	260
08-17-93	18:00	6.4	320
08-18-93	00:00	6.5	440
08-18-93	06:00	6.5	560
08-18-93	12:00	6.5	260
07-11-94	18:00	12	2400
07-12-94	00:00	11	3000
07-12-94	06:00	6.7	720
07-12-94	12:00	7.5	210
07-12-94	18:00	12	6000
07-13-94	00:00	16	1300
07-13-94	06:00	9.9	3100
07-13-94	12:00	6.7	6300
07-13-94	18:00	8.4	1400

Table 6. Continued

Date	Time	Flow (cfs)	Fecal Coliform (counts/100ml)
07-05-95	15:30	18	12000
07-05-95	21:30	74	32000
07-06-95	03:30	21	12000
07-06-95	09:30	18	920
07-06-95	15:30	16	1500
07-06-95	21:30	14	1000
07-07-95	03:30	14	720
07-07-95	09:30	14	680
07-07-95	12:30	13	560

2.2.2 Load Duration Curves

Load duration curves have been developed with the monitoring data collected at two of the stations, Station #07287150 near Seven Pines and Station #07287160 near Cruger. These stations were selected for load duration curve development because a continuous record of flow is also available for these locations during the time that the monitoring data were collected. Load duration curves are developed using water quality monitoring data along with long-term flow monitoring data, typically from the station where the sampling data were collected. The flow data are used to create flow duration curves, which display the cumulative frequency distribution of the daily flow data over the period of record. The flow duration curve relates flow values measured at the monitoring station to the percent of time that those values are met or exceeded. Flows are ranked from extremely low flows, which are exceeded nearly 100 percent of the time, to extremely high flows, which are rarely exceeded.

Flow duration curves are then transformed into load duration curves by multiplying the flow values along the curve by applicable water quality criteria values for various monitoring parameters. Water quality monitoring data are plotted on the same graph as the load duration curve. Data points that plot above the load duration curve indicate violation of water quality criteria, while points that plot below indicate attainment. In addition, the plotting position of the calculated loads can be used to determine possible delivery mechanisms of pollutants to the waterbody. Data points that exceed the water quality criteria at low-flow are most likely due to point sources or background pollutant contributions. Those that exceed at high flow are usually attributable to nonpoint sources. Monitoring data that exceed water quality criteria in the mid-range flow indicate that pollutants are most likely due to a combination of these sources.

The load duration curves for both stations are shown below in Figure 4 and Figure 5. The solid lines on the curves represent the water quality standards for the summer (May- October) time period. The upper line represents the instantaneous part of Mississippi's standard, and the lower line represents the geometric mean. The load duration curves show that the majority of the data that exceed the water quality standard were collected during higher flow. This indicates that nonpoint sources are most likely the significant contributors of bacteria at these locations.

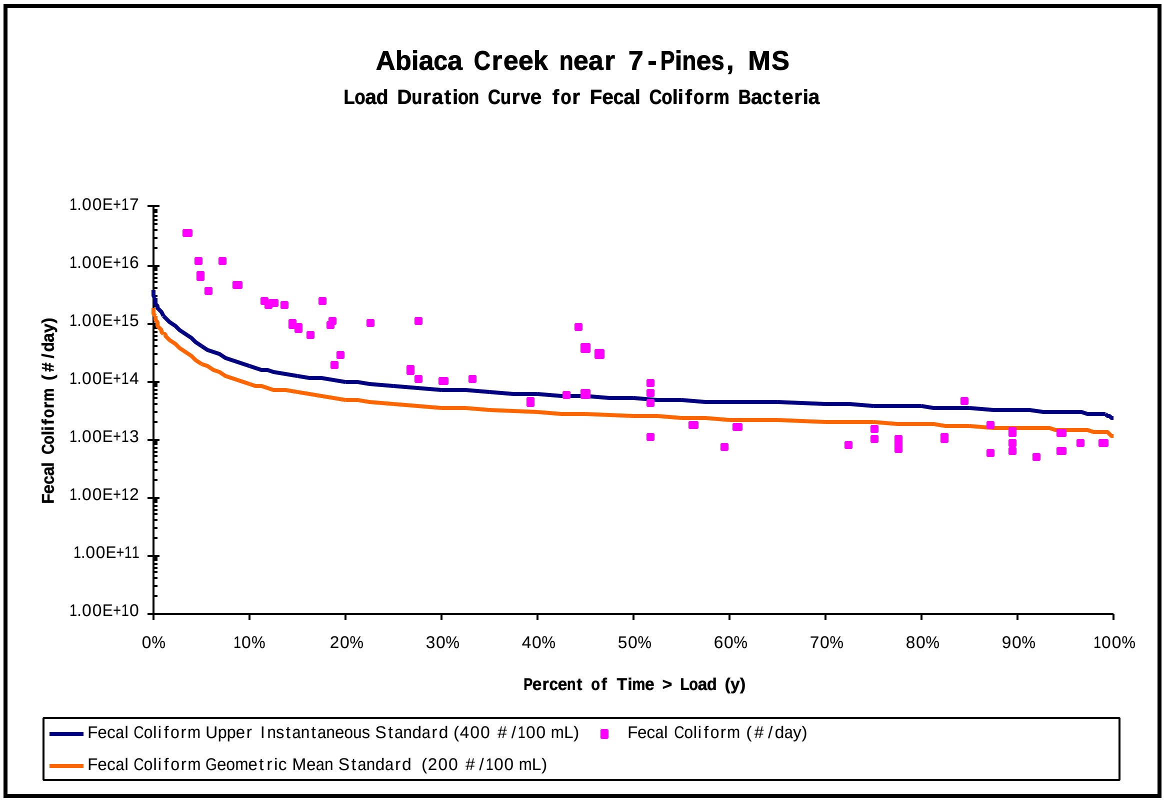


Figure 4. Load Duration Curve for Station #07287150

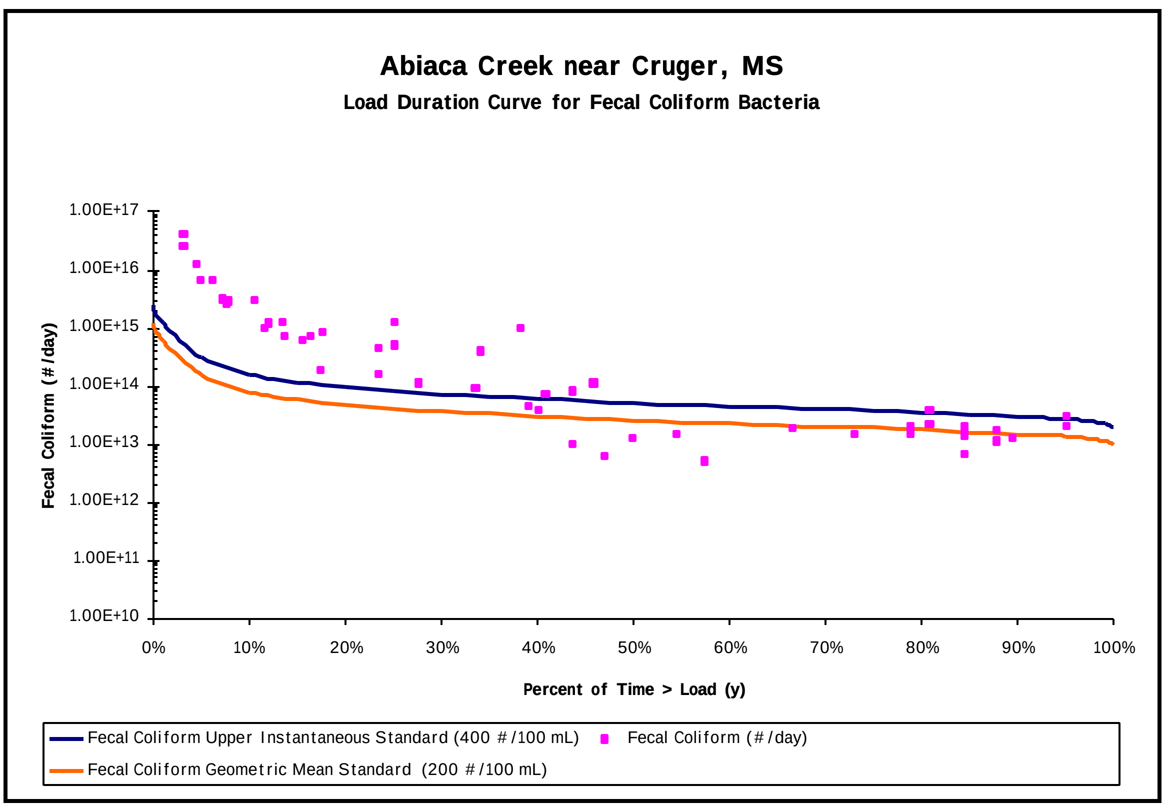


Figure 5. Load Duration Curve for Station #07287160

Table 7. Fecal Coliform Data reported in Abiaca Creek, Station 13, Abiaca Creek at Pine Bluff Road September 2001 to December 2001

Date and Time	Tape Down Measurement	Fecal Coliform (counts/100ml)	Geometric Mean
9/27/2001 11:47	17.68	152	259
10/3/2001 11:10	17.80	54	
10/9/2001 11:01	17.65	196	
10/12/2001 10:17	16.65	6000	
10/17/2001 10:46	19.30	190	
10/23/2001 10:45	17.51	163	
11/14/2001 10:45	17.73	46	403
11/20/2001 11:10	17.75	93	
11/27/2001 11:45	16.40	6000	
11/30/2001 10:47	13.49	3000	
12/5/2001 10:13	17.06	236	
12/11/2001 10:24	17.25	236	

Table 8. Fecal Coliform Data reported in Abiaca Creek, Station 14, Unnamed Road South of Blackhawk Road September 2001 to December 2001

Date and Time	Tape Down Measurement	Fecal Coliform (counts/100ml)	Geometric Mean
9/27/2001 11:15	12.25	276	434
10/3/2001 10:43	11.99	230	
10/9/2001 10:36	12.05	700	
10/12/2001 9:48	11.40	6000	
10/17/2001 10:26	11.90	290	
10/23/2001 10:25	12.07	87	
11/14/2001 10:25	12.25	320	646
11/20/2001 10:33	12.08	510	
11/27/2001 11:24	10.58	4200	
11/30/2001 10:24	9.77	3500	
12/5/2001 9:48	11.67	172	
12/11/2001 10:12	11.70	176	

Table 9. Fecal Coliform Data reported in Abiaca Creek, Station 15, Unnamed Road Upstream of Sanders Lake September 2001 to December 2001

Date and Time	Tape Down Measurement	Fecal Coliform (counts/100ml)	Geometric Mean
9/27/2001 10:00	14.96	160	236
10/3/2001 9:48	14.90	113	
10/9/2001 9:33	14.88	195	
10/12/2001 9:04	14.78	5000	
10/17/2001 9:35	14.95	162	
10/23/2001 9:40	14.85	60	
11/14/2001 9:38	14.85	85	130
11/20/2001 9:46	15.05	16	
11/27/2001 10:31	14.25	6000	
11/30/2001 9:39	14.48	470	
12/5/2001 9:05	14.98	58	
12/11/2001 9:28	14.80	22	

Table 10. Fecal Coliform Data reported in Abiaca Creek, Station 16, Highway 430 September 2001 to December 2001

Date and Time	Tape Down Measurement	Fecal Coliform (counts/100ml)	Geometric Mean
9/27/2001 10:25	21.97	223	321
10/3/2001 10:03	21.70	150	
10/9/2001 9:50	22.28	360	
10/12/2001 9:16	22.10	3700	
10/17/2001 9:52	22.15	118	
10/23/2001 9:55	22.35	209	
11/14/2001 9:58	22.79	94	317
11/20/2001 9:59	21.65	92	
11/27/2001 10:46	21.70	6000	
11/30/2001 9:55	20.67	2200	
12/5/2001 9:19	22.08	32	
12/11/2001 9:44	22.40	280	

Table 11. Fecal Coliform Data reported in Coila Creek, Station 17, Blackhawk Road September 2001 to December 2001

Date and Time	Tape Down Measurement	Fecal Coliform (counts/100ml)	Geometric Mean
9/27/2001 10:50	25.79	296	218
10/3/2001 10:28	25.40	54	
10/9/2001 10:11	25.29	34	
10/12/2001 9:34	24.70	4500	
10/17/2001 10:14	25.10	203	
10/23/2001 10:20	25.40	217	
11/14/2001 10:14	25.50	91	234
11/20/2001 10:21	25.67	229	
11/27/2001 11:05	24.25	6000	
11/30/2001 10:12	27.87	24	
12/5/2001 9:37	25.06	290	
12/11/2001 9:55	25.29	190	

2.2.3 Analysis of Instream Water Quality Monitoring Data

Historically, MDEQ compared all of the samples to no more than 10 percent greater than the instantaneous maximum standard of 400 counts per 100 ml for the summer months and 4000 counts per 100 ml for the winter months. This is not technically in line with the current fecal coliform standard. The new data recently collected have been assessed by calculating the geometric mean of a minimum of five samples within a 30-day period. Also, the data are compared to the instantaneous section where no more than 10 percent can exceed 400 counts per 100 ml for the summer months and 4000 counts per 100 ml for the winter. The recent data indicate the waterbody is impaired as shown in Tables 12 and 13.

Table 12. Summer Statistical Summaries of Water Quality Data

Station Number	Number of Samples	Minimum Value (counts/100ml)	Maximum Value (counts/100ml)	Geometric Mean	Percent Instantaneous Exceedance
13	6	54	6000	259	17%
14	6	87	6000	434	33%
15	6	60	5000	236	17%
16	6	118	3700	321	17%
17	6	34	4500	218	17%

Table 13. Winter Statistical Summaries of Water Quality Data

Station Number	Number of Samples	Minimum Value (counts/100ml)	Maximum Value (counts/100ml)	Geometric Mean	Percent Instantaneous Exceedance
13	6	46	6000	403	17%
14	6	172	4200	646	17%
15	6	16	6000	130	17%
16	6	32	6000	31	17%
17	6	24	6000	234	17%

SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential fecal coliform sources in Abiaca Creek watershed. The source assessment was used as the basis of development for the model and ultimate analysis of the TMDL allocation options. The sources were analyzed according to the separate subwatersheds. The subwatershed delineations were based primarily on an analysis of the Reach File 3 (RF3) stream network and the digital elevation model of the watershed. Abiaca Creek is represented by one subwatershed. 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.

3.1 Assessment of Point Sources

Point sources of fecal coliform bacteria have their greatest potential impact on water quality during periods of low flow. Thus, a careful evaluation of point sources that discharge fecal coliform bacteria was necessary in order to quantify the degree of impairment present during the low-flow, critical condition period. There are two NPDES permitted facilities discharging into the Abiaca Creek watershed. They serve a sand and gravel company and the town of Cruger. Only the Town of Cruger facility contributes fecal coliform bacteria.

Once the permitted dischargers were located, the effluent 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. The DMRs for the NPDES facility within the Abiaca Creek watershed were used to determine the existing load from this source. The facility's permit limits were used as the allocation scenario for this source in the model. However, review of the load duration curves indicates impairment in this stream is nonpoint source based. The NPDES facility for this watershed is shown below in Table 14.

Table 14. Inventory of Point Source Dischargers

Facility Name	Subwatershed	NPDES Permit	Receiving Waterbody
Cruger POTW	08030206013	MS0042315	Abiaca Creek

3.2 Assessment of Nonpoint Sources

There are many potential nonpoint sources of fecal coliform bacteria in the Abiaca Creek watershed, including:

- Failing septic systems
- Wildlife
- Land application of hog and cattle manure
- Grazing animals
- Land application of poultry litter
- Other direct inputs
- Urban development

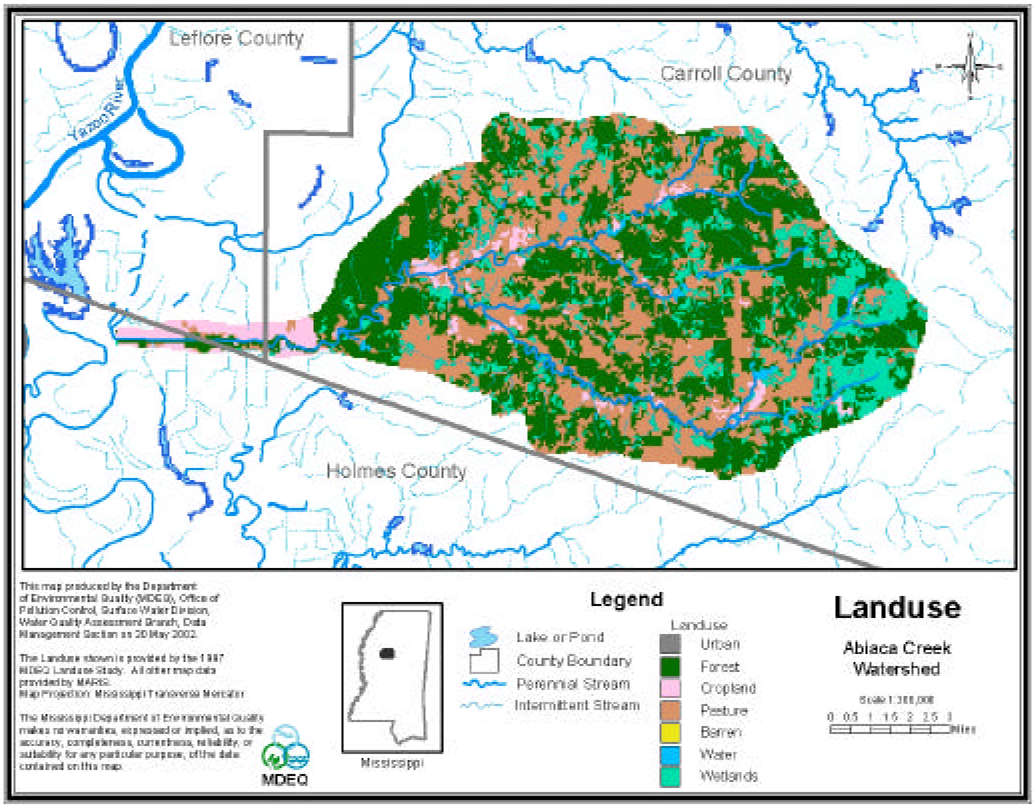
The 62,831-acre drainage area of Abiaca Creek contains many different landuse types, including forest, cropland, pasture, barren, and wetlands as shown in Table 15 and Figure 6. The modeled landuse information for the watershed is based on the State of Mississippi's Automated Resource Information System (MARIS), 1997. This data set is based Landsat Thematic Mapper digital images taken between 1992 and 1993. The MARIS data are classified on a modified Anderson level one and two system with additional level two wetland classifications. For modeling purposes the landuse categories were grouped into the landuses of urban, forest, cropland, pasture, barren, and wetlands.

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, and agriculture census data. MDEQ contacted several agencies to refine the assumptions made in determining the fecal coliform loading. The Mississippi State Department of Health was contacted regarding the failure rate of septic tank systems in this portion of the state. The local Natural Resources Conservation Service office was also contacted regarding the failure rate of septic tank systems in this watershed. Mississippi State University researchers provided information on manure application practices and loading rates for hog farms and cattle operations. The Natural Resources Conservation Service gave MDEQ information on manure treatment practices and land application of manure. Additionally, the USDA ARS Sediment Lab in Oxford has been assisting MDEQ in developing TMDL targets and application figures for best management practices.

Table 15. Landuse Distribution for Each Subwatershed (acres)

Subwatershed	Urban	Forest	Cropland	Pasture	Barren	Wetland	Aquaculture	Water	Total
08030206013	0	26,892	2,821	30,936	0	1,757	0	424	62,831
Percent	0%	43%	4%	49%	0%	3%	0%	1%	100%

Figure 6. Landuse Distribution Map for the Abiaca Creek Watershed



3.2.1 Failing Septic Systems

Septic systems have a potential to deliver fecal coliform bacteria loads to surface waters due to malfunctions, failures, and direct pipe discharges. Properly operating septic systems treat wastewater and dispose of the water through a series of underground field lines. The water is applied through these lines into a rock substrate, thence into underground absorption. The systems can fail when the field lines are broken, or when the underground substrate is clogged or flooded. A failing septic system's discharge can reach the surface, where it becomes available for wash-off into the stream. Another potential problem is a direct bypass from the system to a stream. In an effort to keep the water off the land, pipes are occasionally placed from the septic tank or the field lines directly to the creek. Another consideration is the use of individual onsite wastewater treatment plants. These treatment systems are in wide use in Mississippi. They can adequately treat wastewater when properly maintained. However, these systems may not 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.

Septic systems are a major contributor to the nonpoint source fecal coliform impairment in the Yazoo Basin. The best management practices needed to reduce this pollutant load need to prioritize elimination of septic tank loads from failures and improper use of individual onsite wastewater treatment systems.

3.2.2 Wildlife

Wildlife present in the Abiaca Creek watershed contributes to fecal coliform bacteria on the land surface. In the Abiaca Creek model, all wildlife was accounted for by establishing a constant load of 3.52E+07 counts per acre per day. 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 manure produced by the wildlife was evenly distributed throughout these land types.

3.2.3 Land Application of Hog and Cattle Manure

In the Yazoo River Basin, processed manure from confined hog and dairy operations is collected in lagoons and routinely applied to pastureland during April through October. This manure is a potential contributor of bacteria to receiving waterbodies due to runoff produced during a rain event. Hog farms in the Yazoo River Basin operate by either keeping the animals confined or by 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 Yazoo River Basin confine the animals for a limited time during the day. The model assumes a confinement time of four hours per day, during which time the cattle are milked and fed. 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. There are no dairy cattle operations within the Abiaca Creek watershed.

3.2.4 Grazing Beef and Dairy Cattle

Grazing cattle deposit manure on land where it is available for wash-off and delivery to receiving waterbodies. The dairy farms that are currently operating in the Yazoo River Basin confine the lactating cattle for a limited time during the day. The model assumes a confinement time of four hours per day for one third of the herd. During all other times, and for the dry cattle, dairy cattle are assumed to graze on pasturelands. There are no dairy cattle operations within the Abiaca Creek watershed.

Beef cattle have access to pastureland for grazing all of the time. In addition, according to the local NRCS office some beef cattle within the Abiaca Creek watershed also graze on forested land. Changes were made to the fecal spreadsheets to represent these cattle. Manure produced by grazing beef and dairy cows is directly deposited onto pastureland or forested land and is available for wash off and is subject to a die off rate in the model.

3.2.5 Land Application of Poultry Litter

There are no chickens sold in this area. There are very few layers and no broilers produced in Abiaca Creek watershed. The loading contribution from these few layers was considered insignificant.

3.2.6 Other Direct Inputs

Due to the general topography in the Abiaca Creek watershed, it was assumed that most land slopes in the watershed are such that unconfined animals are generally unable to access the streams in all pastures. Abiaca Creek and its tributaries have incised stream banks up to eight feet in height. In most cases, unconfined animals are unable to enter the streams. Therefore, this source of fecal coliform has been reduced in our estimated loading for this watershed.

The manure that is deposited in the streams by grazing animals is included in the water quality model as a point source having constant flow and concentration. Due to the incised streams, MDEQ reduced our typical loading rate for streams of this size by 75 percent. To estimate the amount of bacteria introduced into streams by all animals, it is assumed that cattle deposit 0.0065 percent of their bacteria load in the stream. This direct input of cattle manure represents all animal access to streams (domestic and wild) and illicit discharges of fecal coliform bacteria.

3.2.7 Urban Development

Fecal coliform contributions from urban areas may come from storm water runoff, runoff from construction sites, and runoff contribution from improper disposal of materials such as litter. Urban areas include land classified as urban and barren. There are no areas classified as urban or barren within the Abiaca Creek watershed.

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

4.2 Model Setup

The Abiaca Creek TMDL model includes the listed sections of Abiaca Creek and Coila Creek. The watershed was represented by one subwatershed. The model allows the relative contribution of point and nonpoint sources to be addressed.

4.3 Source Representation

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

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

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

4.3.1 Failing Septic Systems

The number of failing septic systems used in the model was derived from the watershed area normalized county populations. The percentage of the population on septic systems was determined from 1990 United States Census Data. The total number of septic tanks in the watershed was estimated to be 1055. A failure rate of 80 percent was assumed based on discussions with the local NRCS office. This information was used to calculate the estimated number of failing septic tanks. Therefore, of these 1055 septic tanks it was assumed that 844 were not operating properly. This number of failing septic tanks also incorporates an estimate for the failing individual onsite wastewater treatment systems in the area. In reality, septic tank failures are both point and nonpoint sources. Therefore, the load from failing septic tanks has been considered to contribute equally to the wasteload allocation component and load allocation component of the TMDL calculation

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 70 gallons per person per day, and a septic system effluent fecal coliform concentration of 10^4 counts per 100 ml.

4.3.2 Wildlife

The per-acre loading rate applied to the landuses is 3.52E+07 counts per acre per day. This number is based on an average assumption to the number of wildlife species present in the watershed. The calculation used for the model is an estimate of the wildlife contribution of fecal coliform available for wash off during a rain event. For contributions of fecal coliform directly into the stream, we are using a percentage of the cattle manure available to account for the direct wildlife source as well.

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 USDA Livestock County Estimates. 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 animal 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. Some manure produced by grazing beef cattle in the Abiaca Creek watershed is also applied to forested land. 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 1.06E+11 counts per day per animal (NCSU, 1994). The resulting fecal coliform loads are in the units of counts per acre per day.

4.3.5 Other Direct Inputs

In the water quality model, a point source of constant flow and concentration was added in each subwatershed. This direct input represented animals having direct access to the stream and illicit discharges of fecal coliform bacteria. To estimate the amount of bacteria introduced into streams by all animals, it is assumed that cattle deposit 0.0065 percent of their bacteria load in the stream. The fecal coliform concentration is calculated using this percentage and a bacteria production rate of 1.06E+11 counts per animal per day (NCSU, 1994).

4.4 Stream Characteristics

The stream characteristics given below describe the most downstream reach of the listed drainage area of Abiaca Creek. The channel geometry and lengths for Abiaca Creek are based on data available within the BASINS modeling system. The characteristics of the modeled section of Abiaca Creek are as follows.

- Length 24.86 miles
- Average Depth 1.31 ft
- Average Width 68.95 ft
- Mean Flow 118.7 cubic ft per second near Seven Pines, MS and 104.5 cubic feet per second near Cruger, MS
- Mean Velocity 1.97 ft per second
- 7Q10 Flow 8.7 cubic ft per second at Highway 49, north of Cruger, MS
- Slope 0.00158 ft per ft

4.5 Selection of Representative Modeling Period

The model was run for a 15 year time period, from January 1, 1984, through December 31, 1998. Results from the model were evaluated for the time period from January 1, 1988, until December 31, 1998. Seasonality and critical conditions are accounted for during the extended time frame of the simulation.

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

4.6 Model Calibration Process

For the time period 1984 through 1998, there were two USGS flow monitoring stations on Abiaca Creek. They are 07287150 near Seven Pines, MS and 07287160 on Highway 49 near Cruger. However, hydraulic calibration was performed for the time period 1992-1998. In Appendix A, Graphs A-1, A-2, and A-3 show the modeled flow and the USGS data for 1993, 1995, and 1998.

Water quality was calibrated by comparing the ambient monitoring program data to the output from the model. A computer spreadsheet was developed to compare the daily fecal coliform load calculated in the model with the actual fecal coliform samples taken in monitoring. The monitoring values are instantaneous values of individual samples. The model values and field data values are plotted together with rainfall data to evaluate the relationship between the model and recorded events. This allows the model parameters to be modified as appropriate to calibrate the model. In Appendix A Graphs A-4 through A-8 shows the calibrated model output, ambient fecal coliform data, and the rainfall data.

4.7 Existing Loading

Appendix A (Graph A-9) includes graphs of the model results showing the instream fecal coliform concentrations for reach 08030206013 of Abiaca Creek. The graph shows a 30-day geometric mean of the data. The straight line at 200 counts per 100 ml indicates the water quality target for the TMDL.

ALLOCATION

The allocation for this TMDL involves a wasteload allocation for point sources, a load allocation for nonpoint sources, and a margin of safety. Point source contributions enter the stream directly in the appropriate reach. The nonpoint fecal coliform sources used in the model have two different transportation methods. Failing septic tanks and other direct inputs were modeled as direct inputs to the stream. The other nonpoint source contributions were applied to land area on a count per day per acre basis. The fecal coliform bacteria applied to land are subject to a die-off rate and an absorption rate before entering the stream.

5.1 Wasteload Allocations

The contributions of the point sources were considered on a subwatershed basis for the model. Typically, within each subwatershed, the modeled contribution of each discharger was based on the facility's discharge monitoring data and other records of past performance. The point source contribution, on a subwatershed basis, along with its existing load, allocated load, and percent reduction are shown below. There are two NPDES permitted facilities within the watershed. JJ Ferguson Sand and Gravel Company and Cruger POTW discharge into Abiaca Creek. However, only the Cruger POTW contributes fecal coliform to the stream. Review of available DMR data for this facility indicated that the effluent was not consistently meeting water quality standards. The following table shows the reduction necessary if the facility is to meet end-of-pipe water quality standards. The final wasteload allocation on the summary page also accounts for the load from 50 percent of the failing septic tanks.

Table 16. Wasteload Allocations

Subwatershed	Existing Flow (cfs)	Existing Load (counts/30 days)	Allocated Flow (cfs)	Allocated Load (counts/30 days)	Percent Reduction
08030206013	3.25E-01	1.90E+11	3.25E-01	4.76E+10	75%

5.2 Load Allocations

The TMDL scenario for the load allocation for this TMDL involves two different types of nonpoint sources: septic tanks and other direct inputs. Contributions from both of these sources are input into the model in a manner similar to point source input, with a flow and fecal coliform concentration in counts per hour. The nonpoint source contributions due to other direct inputs, on a subwatershed basis, along with their existing load, allocated load, and percent reduction are shown below. The same parameters for contributions due to septic tank failures are also shown. Septic tank failures in reality are both point and nonpoint contributions and have been calculated as equal contributors to the wasteload allocation component and load allocation component of the TMDL calculation.

Nonpoint fecal coliform loading due to cattle grazing; land application of manure produced by confined dairy cattle and hogs; wildlife; and urban development are also included in the load allocation. Currently, no reduction is required for these contributors in order for Abiaca Creek to achieve water quality standards.

Table 17. Fecal Coliform Loading Rates for Nonpoint Source Contribution of Other Direct Inputs

Subwatershed	Existing Flow (cfs)	Existing Load (counts/30 days)	Allocated Flow (cfs)	Allocated Load (counts/30 days)	Percent Reduction
08030206013	1.80E-06	6.65E+11	2.87E-07	1.06E+11	84%

Table 18. Fecal Coliform Loading Rates for Contribution of Failing Septic Tanks (50% WLA and 50% LA)

Subwatershed	Existing Flow (cfs)	Existing Load (counts/30 days)	Allocated Flow (cfs)	Allocated Load (counts/30 days)	Percent Reduction
08030206013	1.085	7.96E+12	3.26E-2	2.39E+11	97%

The model estimated the fecal coliform bacteria count per 30 days entering Abiaca Creek for each listed segment due to runoff during the 30-day critical period. These values are given in section 5.4.

The scenario used in this analysis for the load allocation in Abiaca Creek watershed assumes a 97 percent reduction in contributions from failing septic tanks and an 84 percent reduction in contributions from other direct inputs is required to meet standards.

5.3 Incorporation of a Margin of Safety (MOS)

The two types of MOS development are to implicitly incorporate the MOS using conservative model assumptions or to explicitly specify a portion of the total TMDL as the MOS. For this study, the MOS is incorporated into the modeling process by utilizing a conservative fecal coliform decay rate, conservative loading and environmental conditions, and running a dynamic simulation for a period of 11 years.

In addition, running the model for an 11 year time period with no violations of the water quality standard provides a component of the implicit MOS. The average 30-day geometric mean value during the 11-year model period after allocations is 60 counts per 100 ml. By setting the reduction needed in the TMDL on the maximum critical instance of 420 counts per 100 ml instead of the average of 175 counts per 100 ml, the implicit MOS can be quantified as a 58 percent conservative assumption. Another conservative assumption contained in the implicit MOS is modeling the flow from septic tanks directly into the stream. While it is likely that some septic tanks reach the stream directly, the majority of failures only discharge a portion of the bacteria load subject to filtration and die off during transport to the stream.

5.4 Calculation of the TMDL

This TMDL is calculated based on the following equation where WLA is the wasteload allocation (the load from the point sources), the LA is the load allocation (the load from nonpoint sources), and MOS is the margin of safety:

$$\textbf{TMDL = WLA + LA + MOS}$$

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

LA = Surface Runoff + Other Direct Inputs + ½ of the Septic Tank Failures

MOS = implicit

The TMDL was calculated based on the 30-day critical period for the Abiaca Creek watershed according to the model. Each of the loading rates has been converted to the 30-day equivalent. The wasteload allocation incorporates the fecal coliform contribution from the identified NPDES Permitted facility and 50 percent of the contribution from failing septic tanks. The load allocation includes the fecal coliform contributions from surface runoff, other direct inputs, and 50 percent of the contribution from failing septic tanks. The margin of safety for this TMDL is derived from the conservative loading assumptions used in setting up the model and is implicit. Table 19 gives the TMDL for the listed segments. The TMDL has been established for the most downstream impaired segment of Abiaca Creek.

Table 19. Summary for Listed Segments (counts/30 days)

MS355M1 (Abiaca Creek)	
NPDES Permits	4.76E+10
½ Failing Septic Tanks	1.20E+11
WLA	**1.68E+11**
Surface Runoff	1.80E+15
Other Direct Inputs	1.06E+11
½ Failing Septic Tanks	1.20E+11
LA	**1.80E+15**
TMDL = WLA + LA	**1.80E+15**
MS357M4 (Coila Creek)	
NPDES Permits	---
½ Failing Septic Tanks	4.66E+10
WLA	**4.66E+10**
Surface Runoff	7.02E+14
Other Direct Inputs	4.13E+10
½ Failing Septic Tanks	4.66E+10
LA	**7.02E+14**
TMDL = WLA + LA	**7.02E+14**

5.5 Seasonality

For many streams in the state, fecal coliform limits vary according to the seasons. This stream is designated for the use of secondary contact. For this use, the pollutant standard is seasonal. 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 1998. 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.

CONCLUSION

The fecal coliform reduction scenario used in this TMDL included requiring all NPDES permitted dischargers of fecal coliform to meet water standards for disinfection, along with reducing the assumed fecal coliform load from 97 percent of the failing septic tanks and the assumed load from 84 percent of the other direct inputs in the watershed. As stated in Section 5.1 the available DMR data for the Cruger POTW indicated that the effluent was not consistently meeting water quality standards. The POTW should disinfect its effluent to meet water quality standards at the end of its pipe. This TMDL recommends modification of the NPDES permit if necessary in order to accomplish this.

The TMDL will not impact existing or future NPDES Permits as long as the effluent is disinfected to meet water quality standards for pathogens. 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 Yazoo River Basin, Abiaca Creek may receive additional monitoring to identify any change in water quality. MDEQ produced guidance for future Section 319 project funding will encourage NPS restoration projects that attempt to address TMDL related issues within Section 303(d)/TMDL watersheds in Mississippi.

6.2 Public Participation

This TMDL will be published for a 30-day public notice. During this time, the public will be notified by publication in the statewide newspaper and a newspaper in the area of the watershed. The public will be given an opportunity to review the TMDL and submit comments. MDEQ also distributes all TMDLs at the beginning of the public notice to those members of the public who have requested to be included on a TMDL mailing list. TMDL mailing list members may request to receive the TMDL reports through either, email or the postal service. Anyone wishing to be included on the TMDL mailing list should contact Linda Burrell at (601) 961-5062 or Linda_Burrell@deq.state.ms.us. 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 meeting.

All written comments received during the public notice period and at any public meeting become a part of the record of this TMDL. All comments will be considered in the ultimate completion of this TMDL for submission of this TMDL to EPA Region 4 for final approval.

DEFINITIONS

Ambient stations: a network of fixed monitoring stations established for systematic water quality sampling at regular intervals, and for uniform parametric coverage over a long-term period.

Assimilative capacity: the capacity of a body of water or soil-plant system to receive wastewater effluents or sludge without violating the provisions of the State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters and Water Quality regulations.

Background: the condition of waters in the absence of man-induced alterations based on the best scientific information available to MDEQ. The establishment of natural background for an altered waterbody may be based upon a similar, unaltered or least impaired, waterbody or on historical pre-alteration data.

Calibrated model: a model in which reaction rates and inputs are significantly based on actual measurements using data from surveys on the receiving waterbody.

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

Daily discharge: the "discharge of a pollutant" measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the "daily average" is calculated as the average.

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

Discharge monitoring report: report of effluent characteristics submitted by a NPDES Permitted facility.

Effluent standards and limitations: all State or Federal effluent standards and limitations on quantities, rates, and concentrations of chemical, physical, biological, and other constituents to which a waste or wastewater discharge may be subject under the Federal Act or the State law. This includes, but is not limited to, effluent limitations, standards of performance, toxic effluent standards and prohibitions, pretreatment standards, and schedules of compliance.

Effluent: treated wastewater flowing out of the treatment facilities.

Fecal coliform bacteria: a group of bacteria that normally live within the intestines of mammals, including humans. Fecal coliform bacteria are used as an indicator of the presence of pathogenic organisms in natural water.

Geometric mean: the nth 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 direct sources and land applied fecal coliform that enter a receiving waterbody. It also contains a portion of the contribution from septic tanks.

Loading: the total amount of pollutants entering a stream from one or multiple sources.

Nonpoint Source: pollution that is in runoff from the land. Rainfall, snowmelt, and other water that does not evaporate become surface runoff and either drains into surface waters or soaks into the soil and finds its way into groundwater. This surface water may contain pollutants that come from land use activities such as agriculture; construction; silviculture; surface mining; disposal of wastewater; hydrologic modifications; and urban development.

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

Point Source: pollution loads discharged at a specific location from pipes, outfalls, and conveyance channels from either wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving stream.

Pollution: contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the State, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance, or leak into any waters of the State, unless in compliance with a valid permit issued by the Permit Board.

Publicly Owned Treatment Works (POTW): a waste treatment facility owned and/or operated by a public body or a privately owned treatment works which accepts discharges which would otherwise be subject to Federal Pretreatment Requirements.

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

Scientific Notation (Exponential Notation): mathematical method in which very large numbers or very small numbers are expressed in a more concise form. The notation is based on powers of ten. Numbers in scientific notation are expressed as the following: *4.16 x 10^(+b)* and *4.16 x 10^(-b) [same as 4.16E4 or4.16E-4]*. In this case, *b* is always a positive, real number. The *10^(+b)* tells us that the decimal point is *b* places to the right of where it is shown. The *10^(-b)* tells us that the decimal point is *b* places to the left of where it is shown.
For example: $2.7X10^4$ = 2.7E+4 =27000 and $2.7X10^{-4}$ = 2.7E-4=0.00027.

Sigma (S): shorthand way to express taking the sum of a series of numbers. For example, the sum or total of three amounts 24, 123, 16, (**d_1**, **d_2**, **d_3**) respectively could be shown as:

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

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

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

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

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

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

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

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

ABBREVIATIONS

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

BASINS.. Better Assessment Science Integrating Point and Nonpoint Sources

BMP ....Best Management Practice

CWA ....Clean Water Act

DMR..Discharge Monitoring Report

EPA .... Environmental Protection Agency

GIS ....Geographic Information System

HUC ....Hydrologic Unit Code

LA... Load Allocation

MARIS .... State of Mississippi Automated Information System

MDEQ .... Mississippi Department of Environmental Quality

MOS.. Margin of Safety

NRCS .... National Resource Conservation Service

NPDES ....National Pollution Discharge Elimination System

NPSM...Nonpoint Source Model

RF3..Reach File 3

USGS...United States Geological Survey

WLA...Waste Load Allocation

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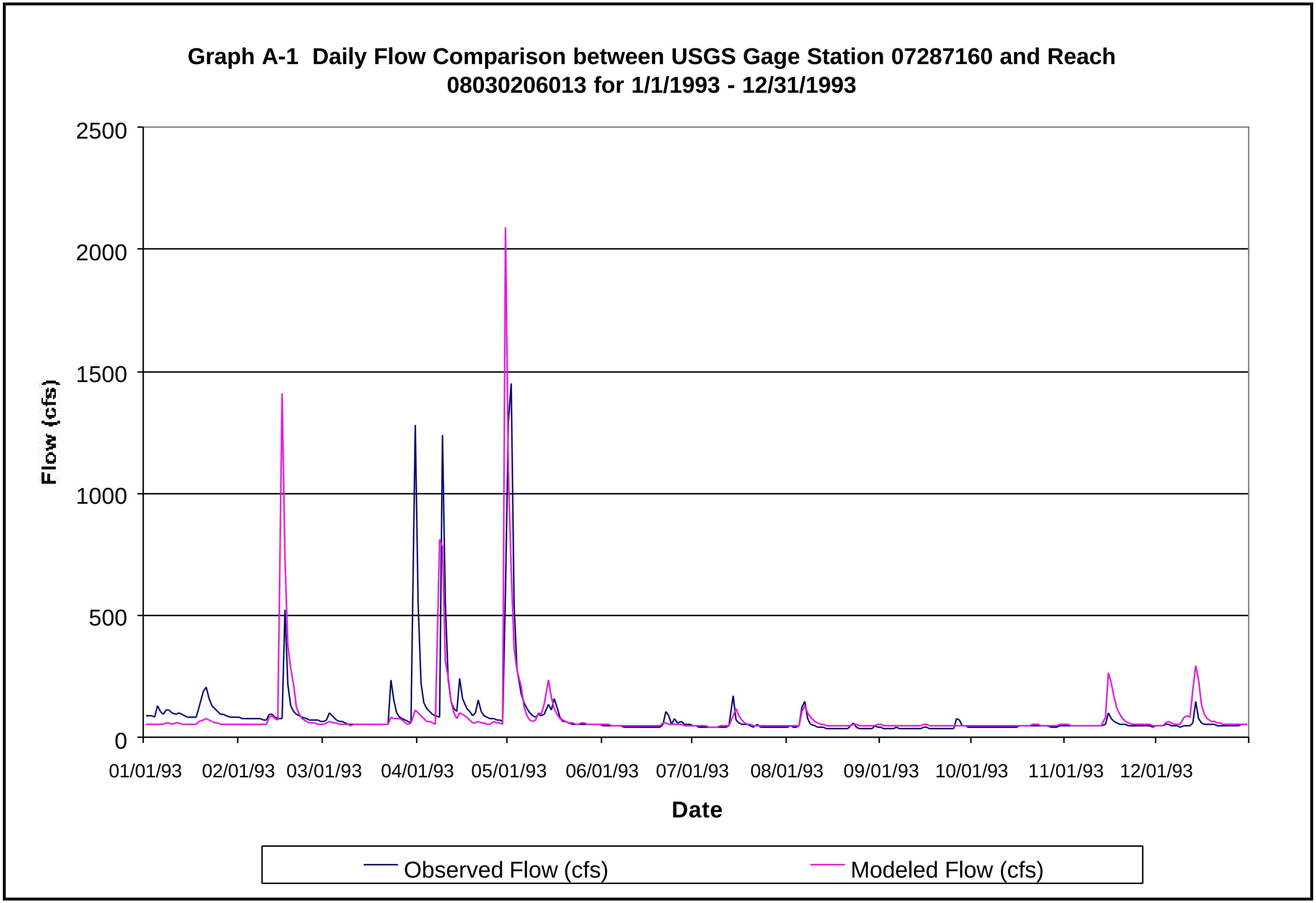
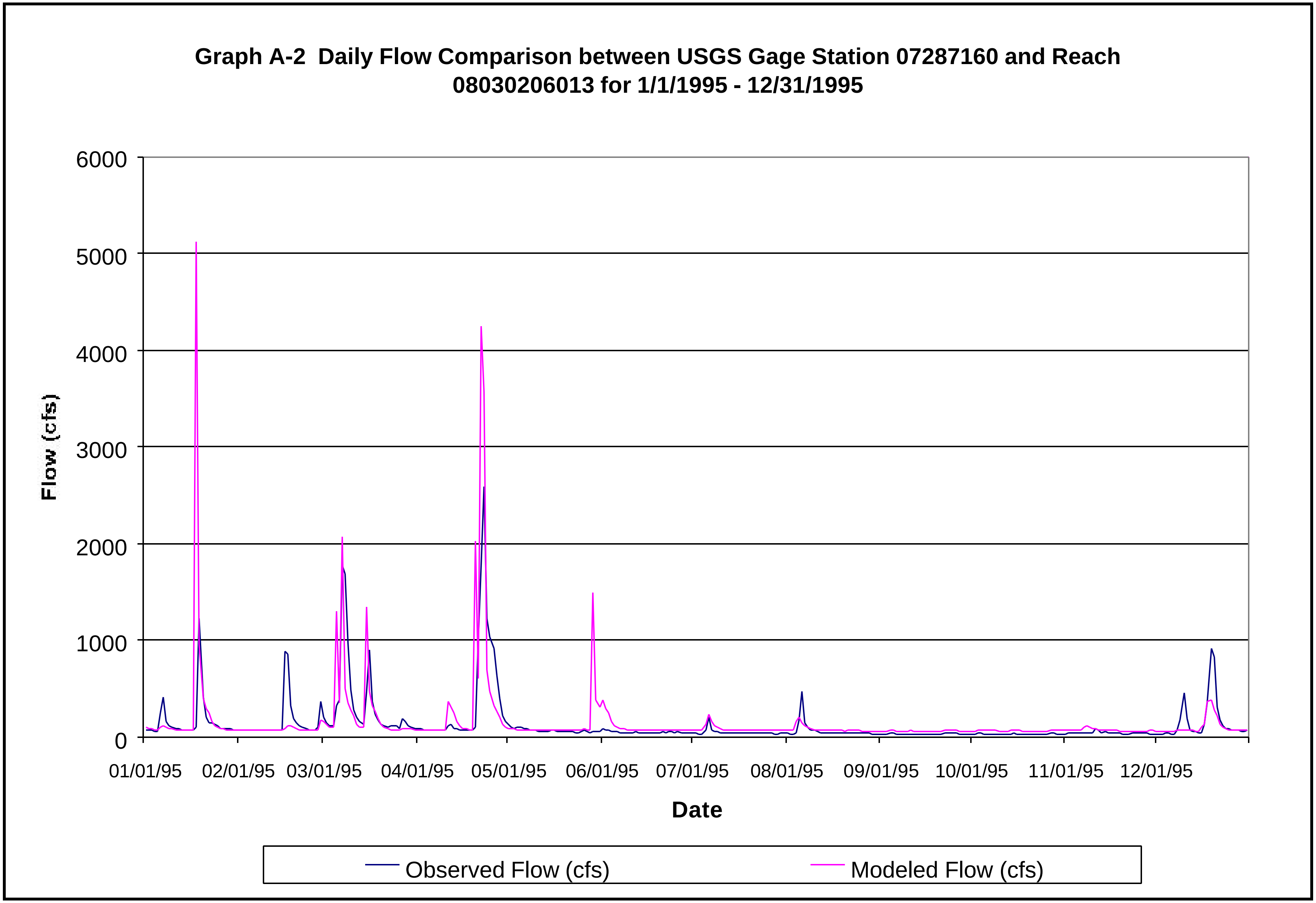
APPENDIX A

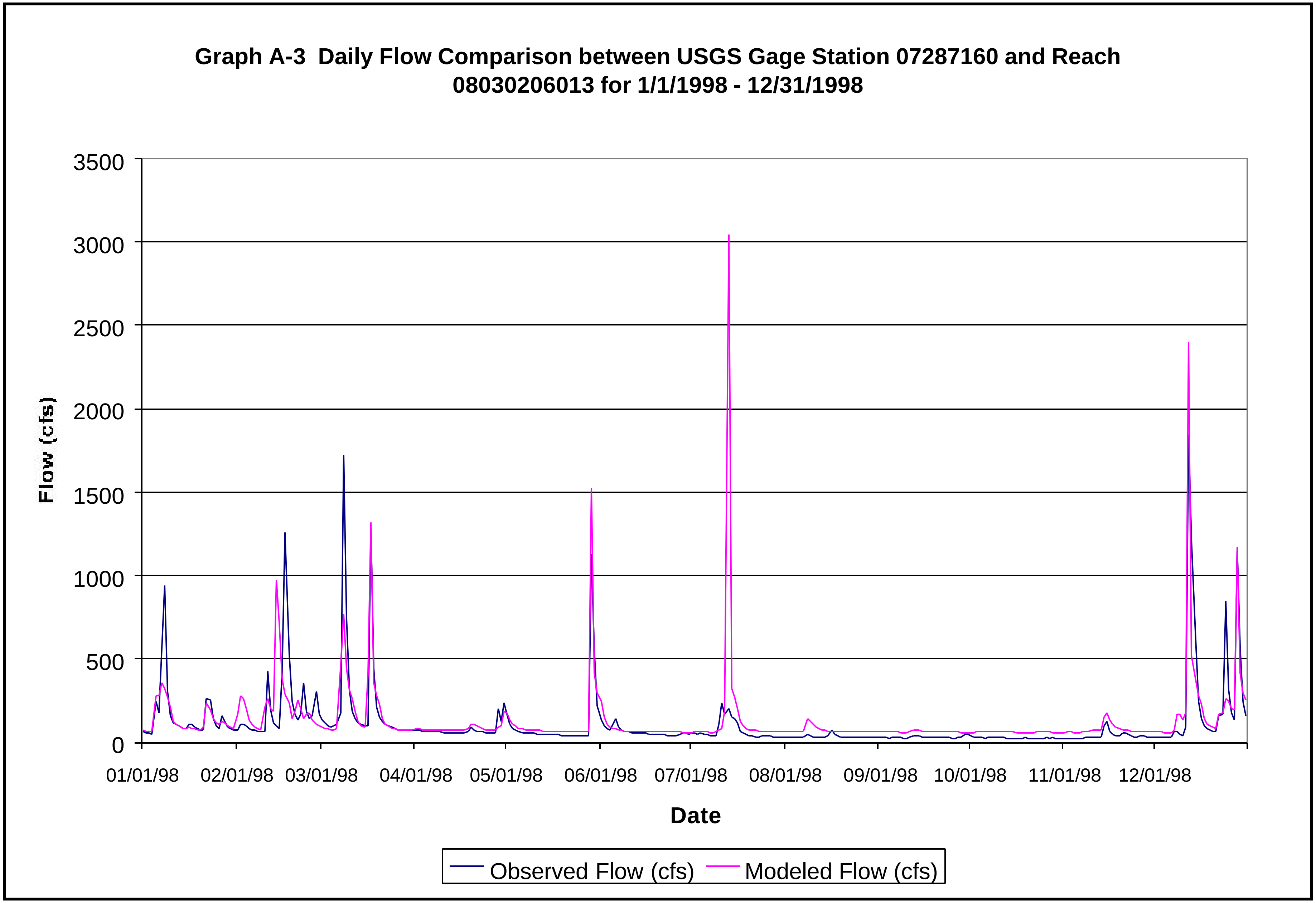
This appendix contains printouts of the various model run results. Graphs A-1, A-2, and A-3 show the modeled flow, in cubic feet per second, through reach 08030206013 compared to the USGS Station 07287160 flow data. Graphs A-4 through A-8 show the calibrated model output, ambient fecal coliform data, and rainfall data. Graphs A-9 and A-10 show the 30-day geometric mean for fecal coliform concentrations in counts per 100 ml in Abiaca Creek. The graphs contain a reference line at 200 counts per 100 ml. Graph A-9 shows the fecal coliform levels in reach 08030206013 during the 11-year modeling period under existing conditions. Graph A-10 shows the modeled fecal coliform levels in reach 08030206013 after the reduction scenario has been applied.

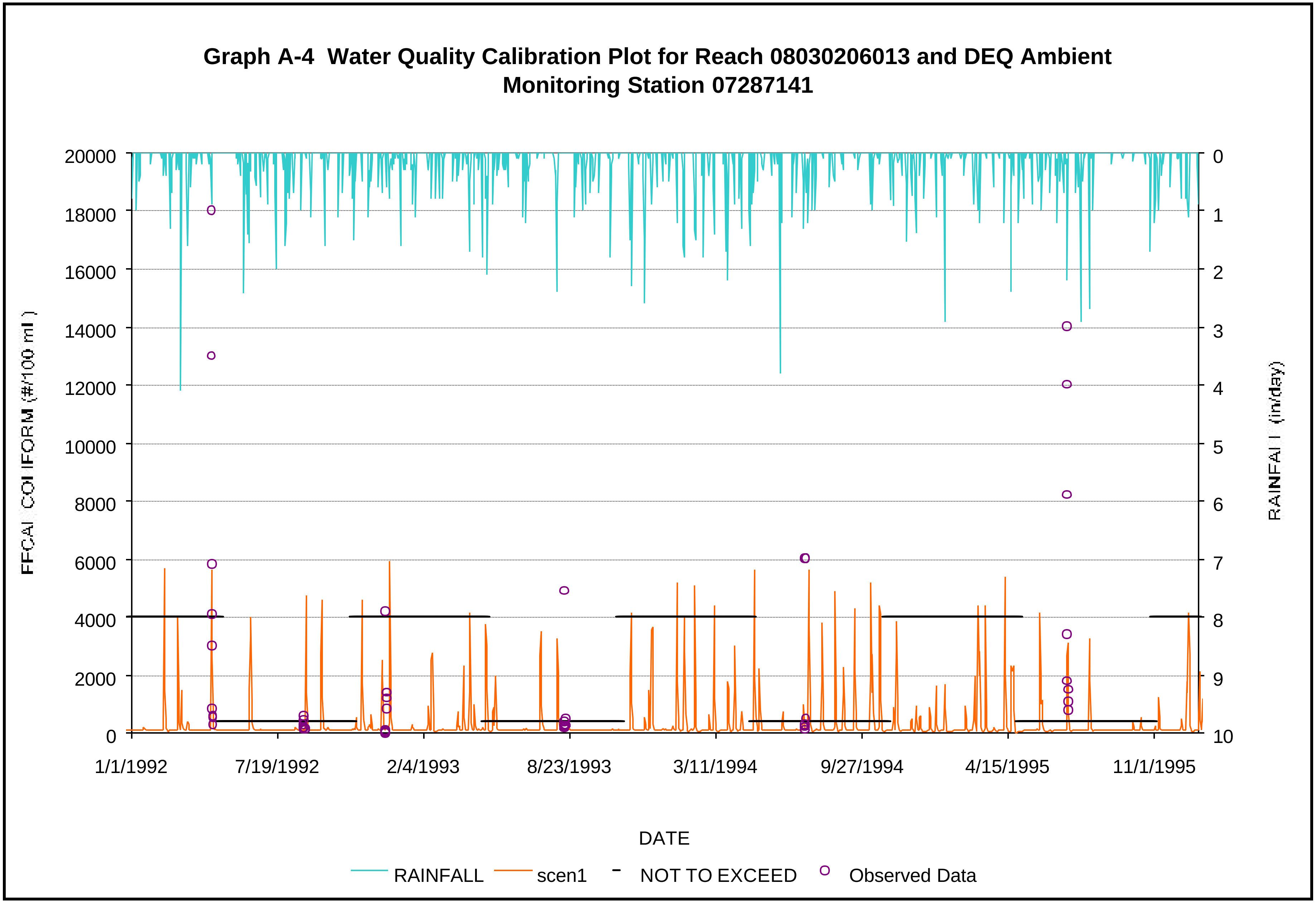
The TMDL calculated in this report represents the fecal coliform load that is estimated in the waterbody segment during the critical 30-day period. The calculation of this TMDL is based on the critical hydrologic flow condition that occurred during the modeled time span. The graph showing the 30-day geometric mean of instream fecal coliform concentrations representing the loading scenario for the most downstream reach 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.



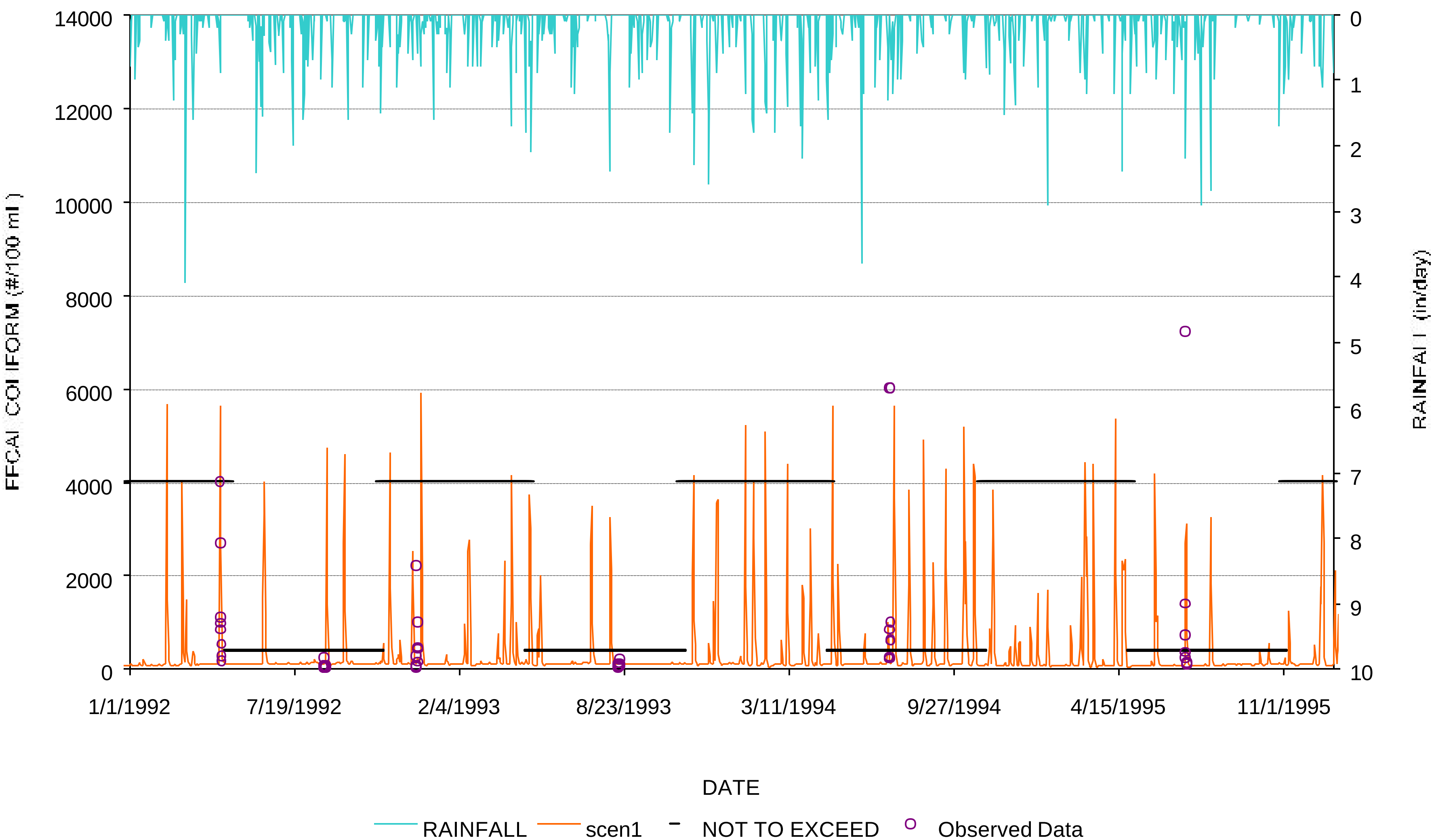
Graph A-1 Daily Flow Comparison between USGS Gage Station 07287160 and Reach 08030206013 for 1/1/1993 - 12/31/1993
Flow (cfs)
2500
2000
1500
1000
500
0
01/01/93
02/01/93
03/01/93
04/01/93
05/01/93
06/01/93
07/01/93
08/01/93
09/01/93
10/01/93
11/01/93
12/01/93
Date
Observed Flow (cfs)
Modeled Flow (cfs)

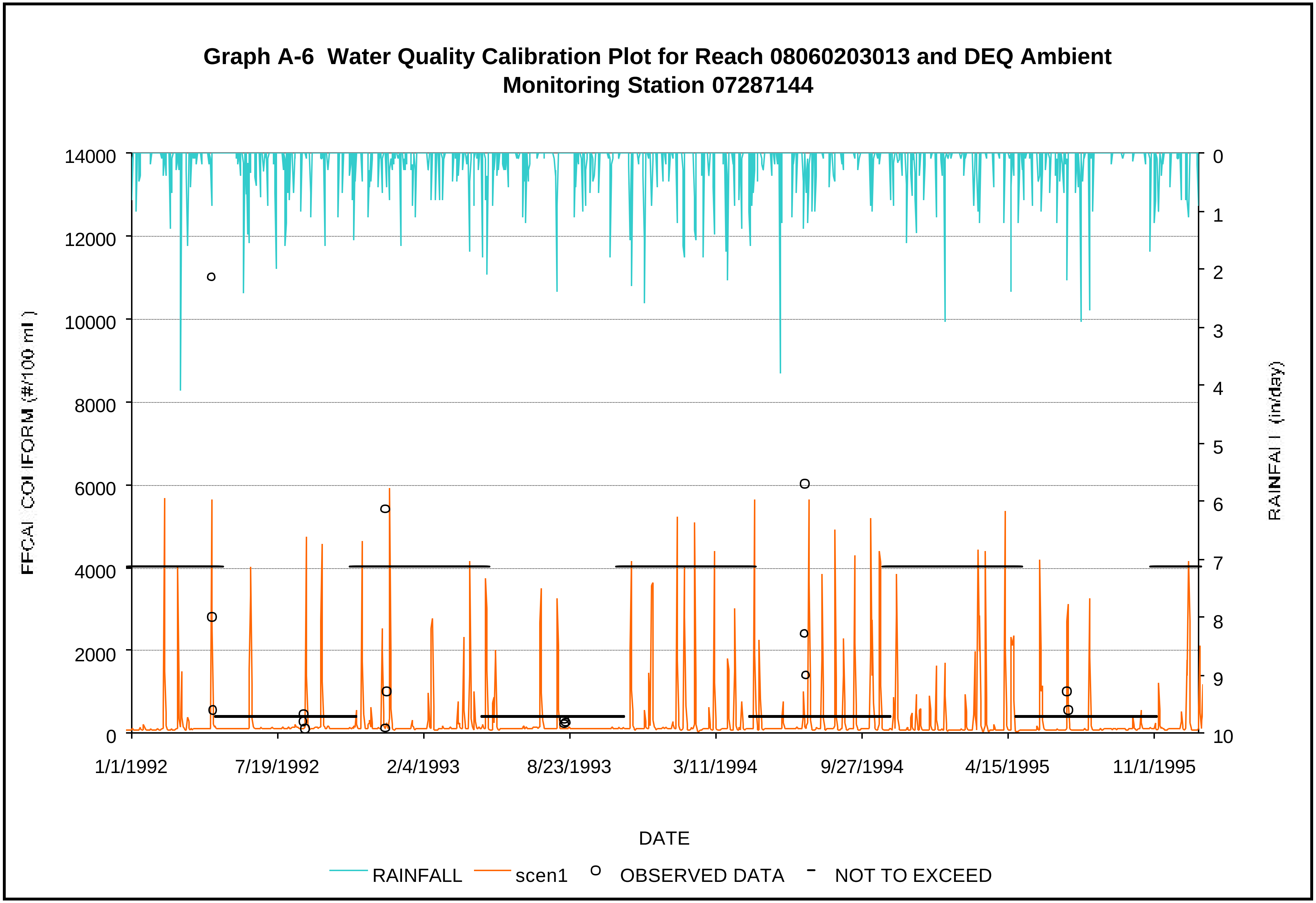

Graph A-2 Daily Flow Comparison between USGS Gage Station 07287160 and Reach 08030206013 for 1/1/1995 - 12/31/1995
6000
5000
4000
3000
2000
1000
0
Flow (cfs)
01/01/95
02/01/95
03/01/95
04/01/95
05/01/95
06/01/95
07/01/95
08/01/95
09/01/95
10/01/95
11/01/95
12/01/95
Date
Observed Flow (cfs)
Modeled Flow (cfs)

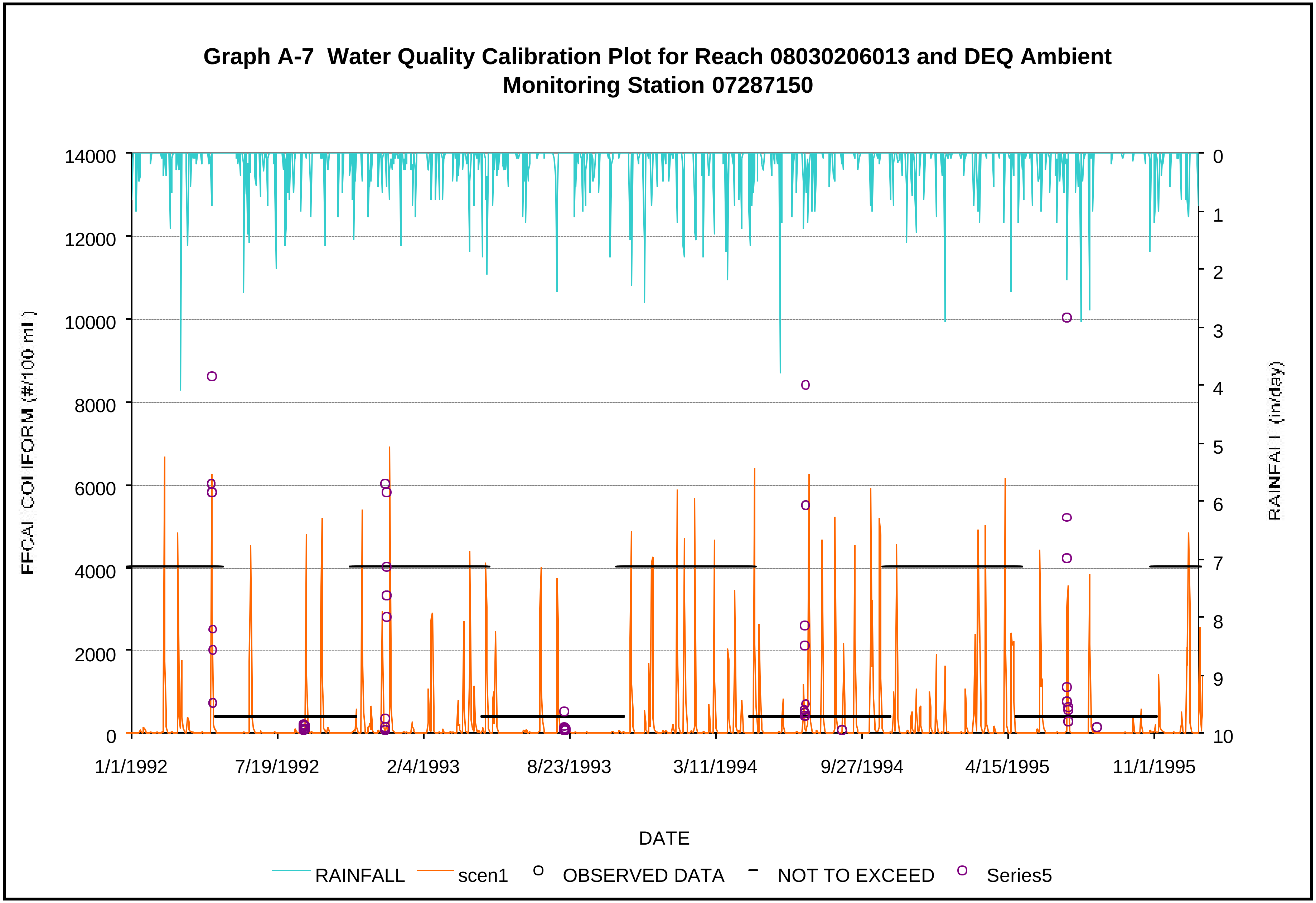

Graph A-3 Daily Flow Comparison between USGS Gage Station 07287160 and Reach 08030206013 for 1/1/1998 - 12/31/1998
Flow (cfs)
3500
3000
2500
2000
1500
1000
500
0
01/01/98
02/01/98
03/01/98
04/01/98
05/01/98
06/01/98
07/01/98
08/01/98
09/01/98
10/01/98
11/01/98
12/01/98
Date
Observed Flow (cfs)
Modeled Flow (cfs)


Graph A-4 Water Quality Calibration Plot for Reach 08030206013 and DEQ Ambient Monitoring Station 07287141
FECAL COLIFORM (#/100 ml)
RAINFALL (in/day)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
1
2
3
4
5
6
7
8
9
10
1/1/1992
7/19/1992
2/4/1993
8/23/1993
3/11/1994
9/27/1994
4/15/1995
11/1/1995
DATE
RAINFALL
scen1
NOT TO EXCEED
Observed Data

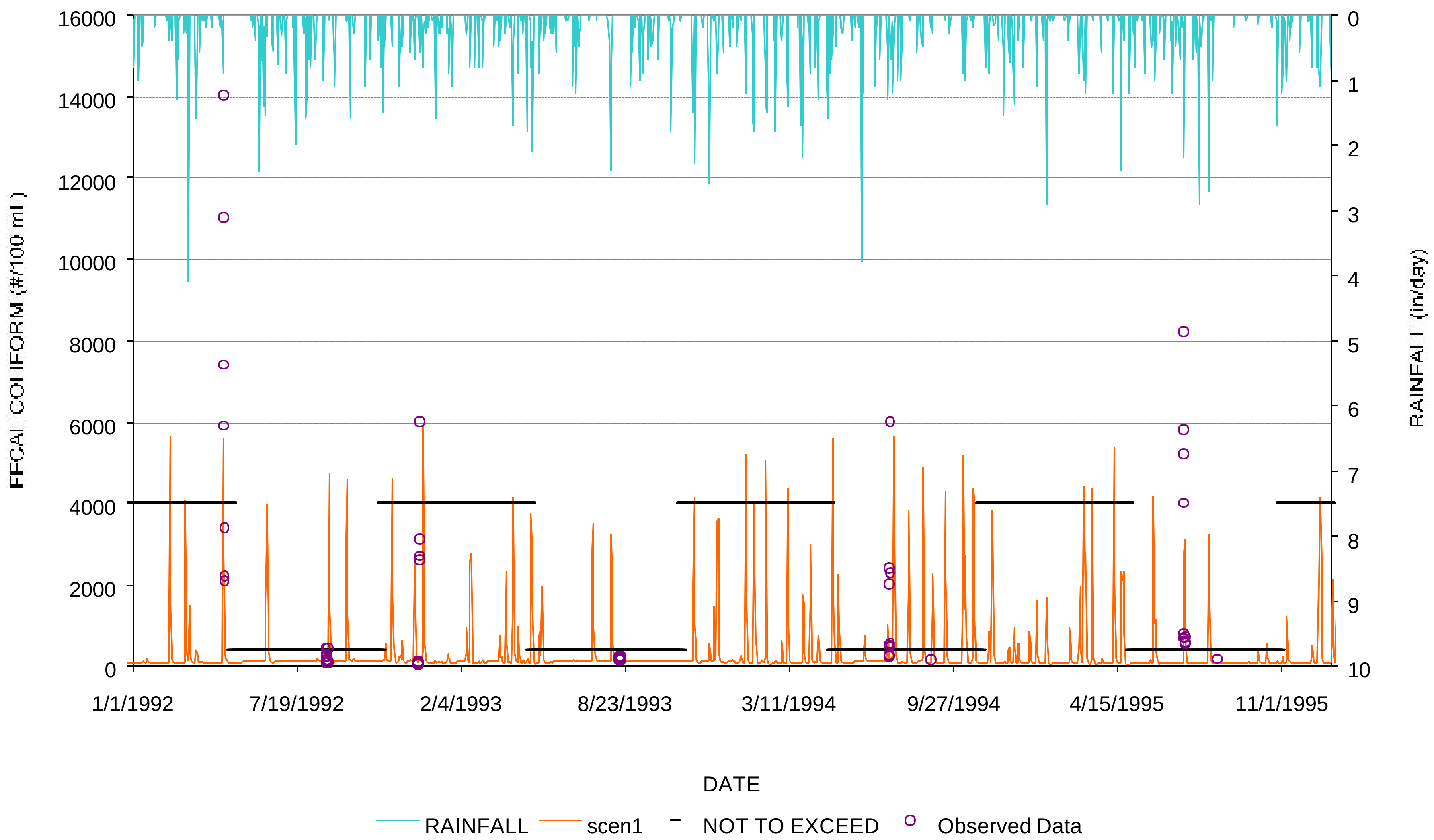
Graph A-5 Water Quality Calibration Plot for Reach 08030206013 and DEQ Ambient Monitoring Station 07287142



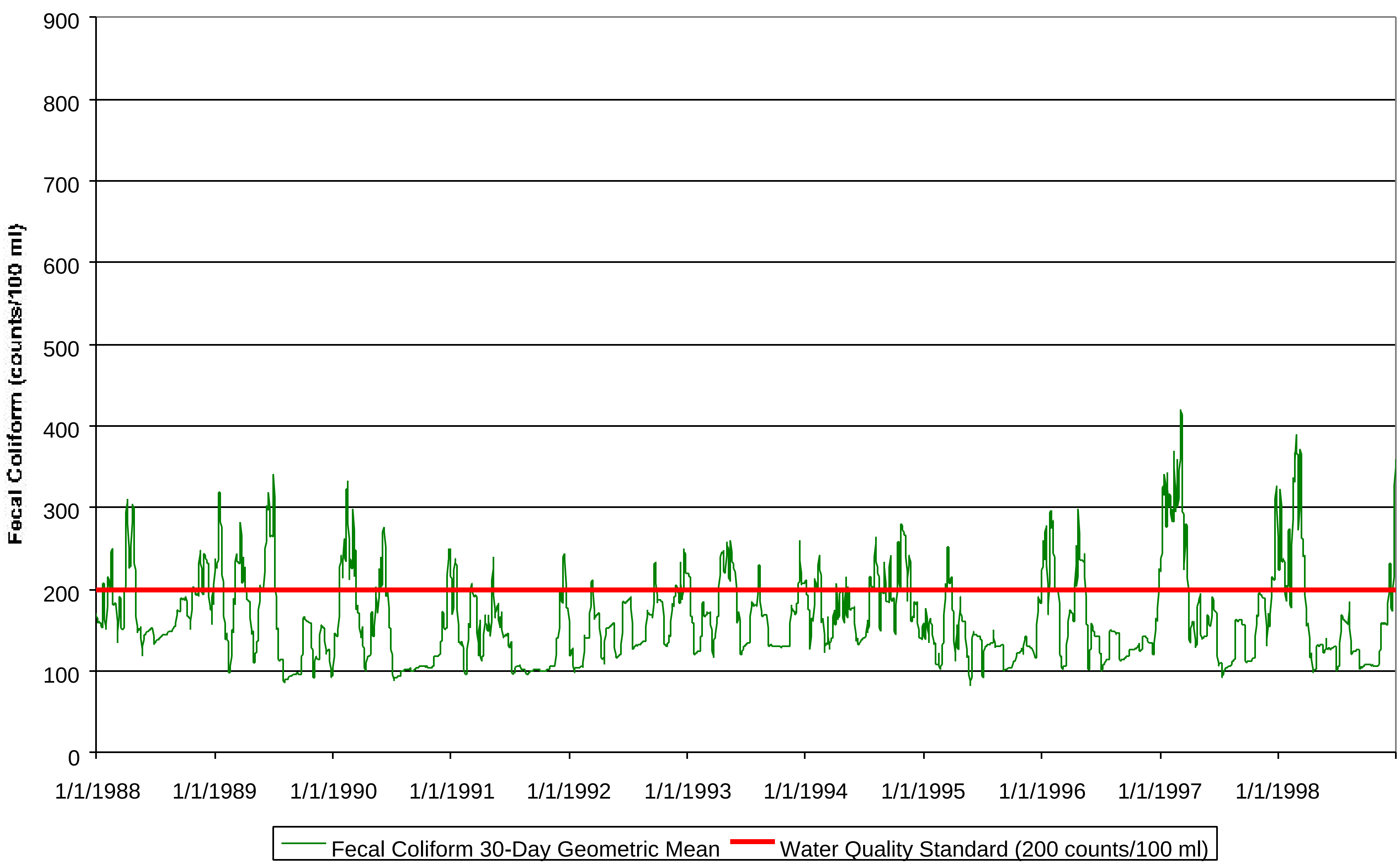

Graph A-6 Water Quality Calibration Plot for Reach 08060203013 and DEQ Ambient Monitoring Station 07287144
14000
12000
10000
8000
6000
4000
2000
0
0
1
2
3
4
5
6
7
8
9
10
FECAL COLIFORM (#/100 ml)
RAINFALL (in/day)
1/1/1992
7/19/1992
2/4/1993
8/23/1993
3/11/1994
9/27/1994
4/15/1995
11/1/1995
DATE
RAINFALL
scen1
OBSERVED DATA
NOT TO EXCEED


Graph A-7 Water Quality Calibration Plot for Reach 08030206013 and DEQ Ambient Monitoring Station 07287150
14000
12000
10000
8000
6000
4000
2000
0
0
1
2
3
4
5
6
7
8
9
10
FECAL COLIFORM (#/100 ml)
RAINFALL (in/day)
1/1/1992
7/19/1992
2/4/1993
8/23/1993
3/11/1994
9/27/1994
4/15/1995
11/1/1995
DATE
RAINFALL
scen1
OBSERVED DATA
NOT TO EXCEED
Series5

Graph A-8 Water Quality Calibration Plot for Reach 08060203013 and DEQ Ambient Monitoring Station 07287160



Graph A-9 Modeled Fecal Coliform Concentrations Under Existing Conditions for Reach 08030206013



Graph A-10 Modeled Fecal Coliform Concentrations After Application of TMDL Scenario for Reach 08030206013