PROPOSED REPORT
September 2002

Fecal Coliform TMDL for Fannegusha Creek

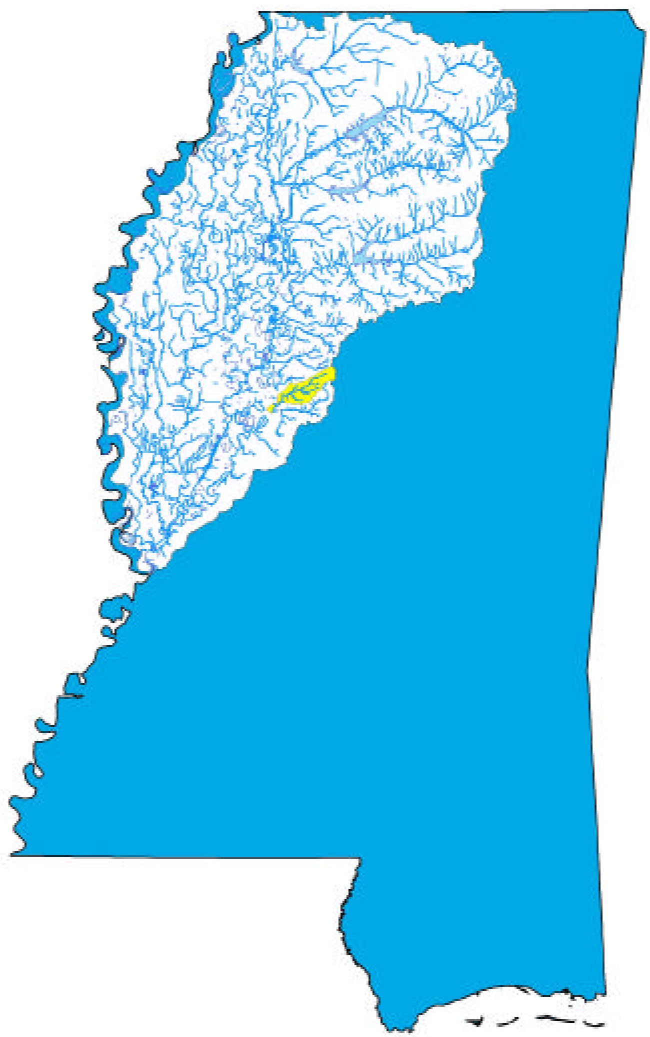
Yazoo River Basin

Holmes County, Mississippi

Prepared By

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

MDEQ
PO Box 10385
Jackson, MS 39289-0385
(601) 961-5171
www.deq.state.ms.us



MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY

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

CONTENTS

FOREWORD.................... ii

CONTENTS.................... iii

TMDL INFORMATION PAGE.................... v

EXECUTIVE SUMMARY.................... vi

INTRODUCTION.................... 1

1.1 Background.................... 1
1.2 Applicable Waterbody Segment Use.................... 1
1.3 Applicable Waterbody Segment Standard.................... 2
TMDL ENDPOINT AND WATER QUALITY ASSESSMENT.................... 3

2.1 Selection of a TMDL Endpoint and Critical Condition.................... 3
2.2 Discussion of Instream Water Quality.................... 3
2.2.1 Inventory of Available Water Quality Monitoring Data.................... 4
2.2.2 Analysis of Instream Water Quality Monitoring Data.................... 4
SOURCE ASSESSMENT.................... 6

3.1 Assessment of Point Sources.................... 6
3.2 Assessment of Nonpoint Sources.................... 6
3.2.1 Failing Septic Systems.................... 7
3.2.2 Wildlife.................... 8
3.2.3 Other Direct Inputs.................... 8
3.2.4 Urban Development.................... 8
LOAD DURATION CURVE PROCEDURE.................... 9

4.1 Development of Flow Duration Curves.................... 9
4.2 Load Duration Curves.................... 10
4.3 Comparison of Monitoring Data and Water Quality Criteria.................... 10
4.4 Source Identification.................... 11
4.5 Stream Characteristics.................... 11
4.6 Selection of Representative Period.................... 11
4.7 Existing Loading.................... 12
ALLOCATION.................... 13

5.1 Wasteload Allocations.................... 13
5.2 Load Allocations.................... 13
5.3 Incorporation of a Margin of Safety (MOS).................... 13
5.4 Calculation of the TMDL.................... 13
5.5 Seasonality.................... 14
5.6 Reasonable Assurance.................... 14
CONCLUSION.................... 15

6.1 Future Monitoring.................... 15
6.2 Public Participation.................... 15

DEFINITIONS 16
ABBREVIATIONS 19
REFERENCES 20
APPENDIX A 21
APPENDIX B 27
APPENDIX C 30

PHOTOS

Photo 1. Fannegusha Creek at Howard Road vi

FIGURES

Figure 1. Location of Fannegusha Creek Watershed -- vii
Figure 2. Fannegusha Creek Watershed 303(d) Listed Segments -- 1
Figure 3. Landuse Distribution Map for the Fannegusha Creek Watershed -- 7
Figure 4. Flow Duration Curve for Fannegusha Creek at Highway 7 Bypass -- 10

TABLES

i. Listing Information v
ii. Water Quality Standard v
iii. NPDES Facilities v
iv. Total Maximum Daily Load v
Table 1. Fecal Coliform Data reported in Fannegusha Creek near Howard, Station 07287355 4
Table 2. Statistical Summaries of Water Quality Data for Station 07287355 5
Table 3. Inventory of Point Source Dischargers 6
Table 4. Landuse Distribution for Each Subwatershed (acres) 7
Table 5. Wasteload Allocations 13
Table 6. TMDL Percent Reduction 14
Table A-1. Fecal Coliform Data reported in the Fannegusha Creek, Station 07278355 21
Table A-2. Fecal Coliform Data reported in Fannegusha Creek, Station 07287330 24

GRAPHS

Graph B-1 28
Graph B-2 29
Graph C-1 31
Graph C-2 32

TMDL INFORMATION PAGE

i. Listing Information

Name	ID	County	HUC	Cause	Mon/Eval
Fannegusha Creek seg 1	MS361M	Yalobusha	08030203	Pathogens	Monitored
Near Howard: From 361 watershed boundary to 362 watershed boundary					
Fannegusha Creek seg 2	MS362M2	Calhoun Lafayette Yalobusha	08030203	Pathogens	Monitored
At Howard: From 362 watershed boundary to Blissdale Swamp					
Fannegusha Creek seg 4	MS359M4	Yalobusha	08030203	Pathogens	Monitored
Near Ituma: From Carroll/Holmes County line to 361 watershed boundary					

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.

iii. NPDES Facilities

NPDES ID	Facility Name	Segment Location	Receiving Water
MS0032620	Tchula Attendance Center	MS362M2	Fannegusha Creek

iv. Total Maximum Daily Load

Segment	WLA (counts/day)	LA (counts/day)	MOS	TMDL Percent Reduction
MS361M	1.51E+08	Varies with Flow	Explicit	50
MS362M2			Explicit	
MS359M4			Explicit	52

EXECUTIVE SUMMARY

Three segments of Fannegusha 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. Fannegusha Creek at Howard Road

Fannegusha Creek, photo 1, flows in a southwestern direction from its headwaters near Emory, Mississippi to Blissdale Swamp. This TMDL has been developed for three listed sections of Fannegusha Creek and one listed section of Town Creek. Load duration curves, which compare the water quality data against a flow-varying allowable load, were used for developing the TMDL for these sections.

Although fecal coliform loadings from point and nonpoint sources in the watershed were not explicitly represented with a model, a source assessment was conducted for the Fannegusha Creek Watershed. There is one NPDES Permitted discharger included in the waste load allocation (WLA). Nonpoint sources considered include wildlife, livestock, and urban development. Also considered were the nonpoint sources such as failing septic systems and other direct inputs to tributaries of Fannegusha Creek. The location of the Fannegusha Creek watershed is shown in Figure 1 below.

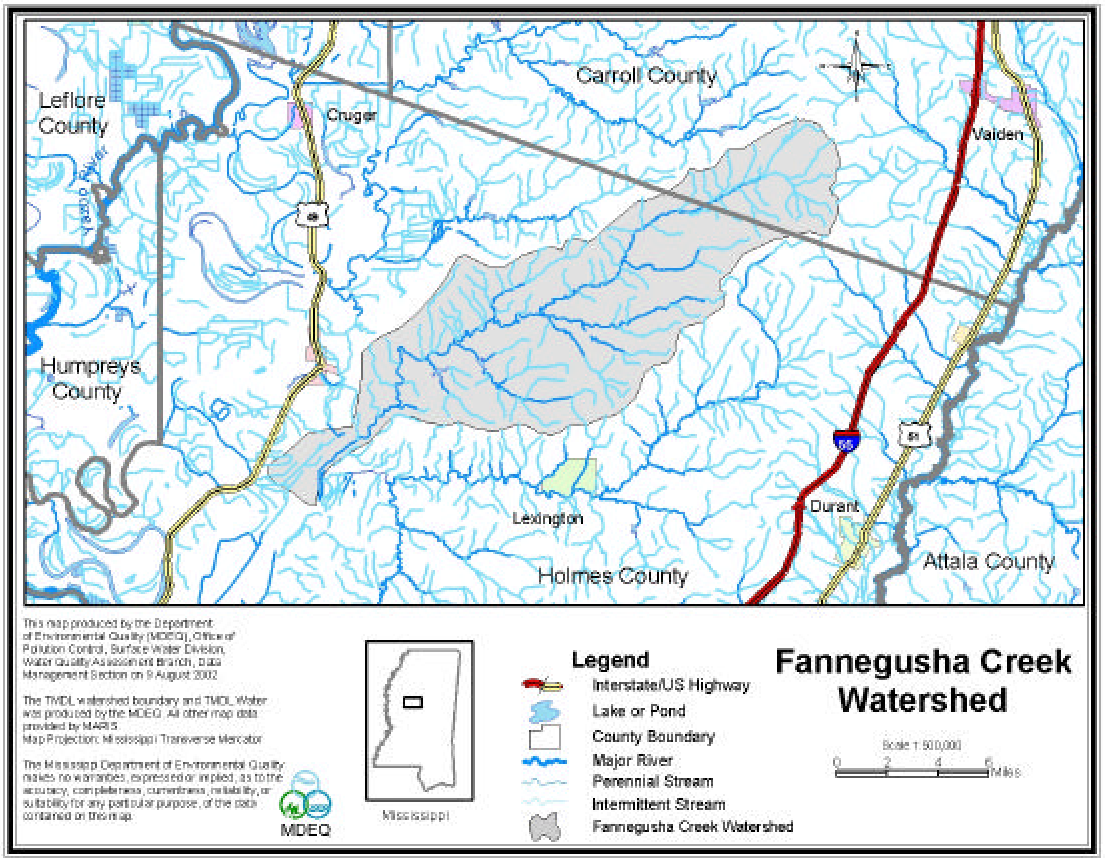


Figure 1. Location of Fannegusha Creek Watershed

The permitted point source facility currently has requirements in its NPDES Permit that requires disinfection to meet water quality standards for pathogens at the end of pipe. Therefore, no changes are required for this existing NPDES permit. Monitoring of the permitted facility in the Fannegusha Creek Watershed should continue to ensure that compliance with permit limits is consistently attained.

The seasonal variations in hydrology, climatic conditions, and watershed activities are represented through the use of a continuous flow gage to develop the acceptable load curve and the use of water quality data collected throughout the year. The critical period was determined to be the summer season of May through October. An explicit 50 percent margin of safety (MOS) was used to account for uncertainty in the load duration curve method. The load duration curves provide a data-based method to estimate the reductions required to meet water quality standards in Fannegusha Creek. Load duration curves and TMDLs were computed at two locations along Fannegusha Creek, according to the location of monitoring stations and corresponding segment locations. The estimated reductions of fecal coliform bacteria required for Fannegusha Creek from downstream to upstream are 50 percent and 52 percent respectively.

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. This TMDL was developed for the 303(d) listed segments shown in Figure 2.

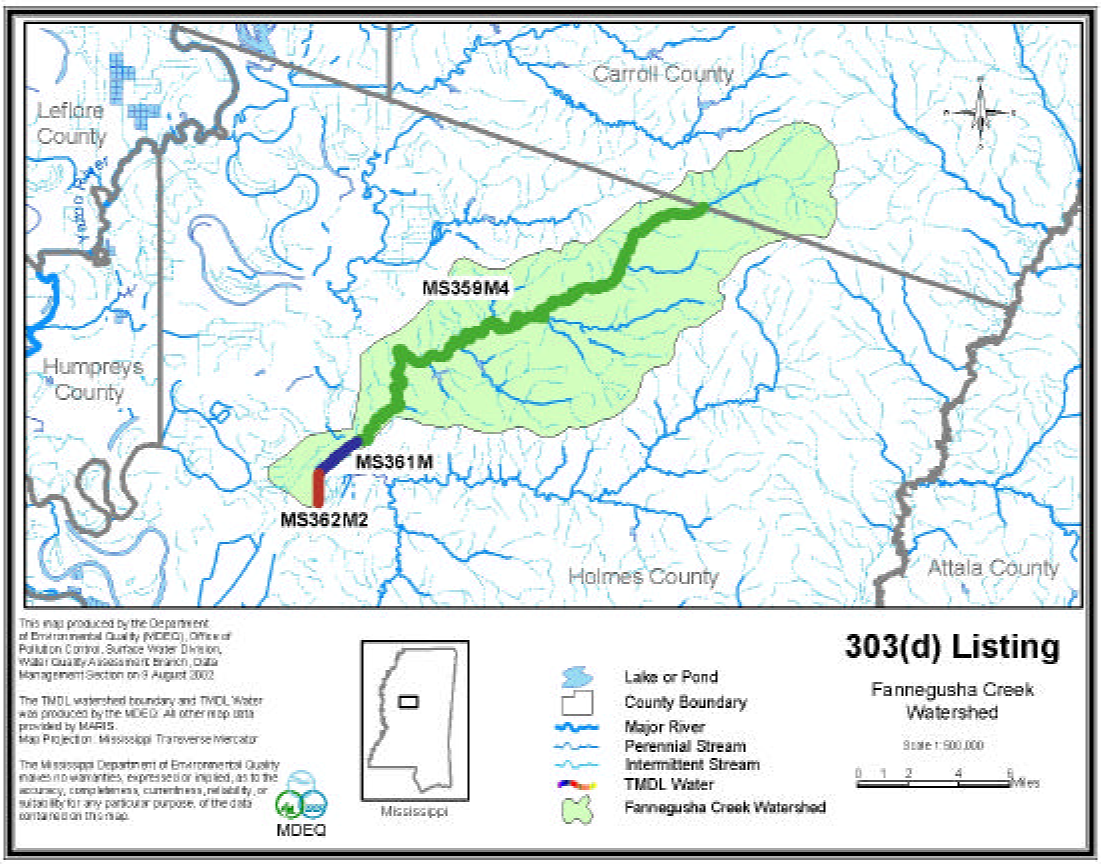


Figure 2. Fannegusha Creek Watershed 303(d) Listed Segments

1.2 Applicable Waterbody Segment Use

The water use classification for the listed segments of the Fannegusha 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 the Fannegusha 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 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 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. The water quality standard was used to assess the data to determine impairment in the waterbody. The instantaneous, summer portion of the water quality standard, 400 counts per 100 ml, was used as the targeted endpoint to establish these TMDLs using the load duration curve method.

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 400 colony counts per 100 ml with an explicit MOS of 50 percent, which reduces the target to 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 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. For these TMDLs, MDEQ considered the instantaneous portion of the standard when looking at the data for assessment of impairment, setting the target, and calculating the TMDL. The geometric mean portion of the standard is not appropriate as a target for use with load duration curves at this time because the data available at stations with the appropriate flow information are instantaneous. Data appropriate for the calculation of geometric means have been recently collected on Fannegusha Creek and are provided in Section 2.2. Additional monitoring of water quality for use in the calculation of geometric means and flow measurement at those stations is ongoing. Assessment of the geometric mean standard will be more fully evaluated upon completion of the monitoring project.

Because fecal coliform bacteria may be attributed to both nonpoint and point sources, the critical condition used for the evaluation of stream response was derived 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 1988-2001 period for which the water quality data exists represents both low-flow conditions as well as wet-weather conditions and encompasses a range of wet and dry seasons. Therefore, the 13-year period was used to find the critical conditions associated with all potential sources of fecal coliform bacteria within the watershed. The summer condition was chosen as the critical condition because the water quality standards are more stringent during this period. The 400 counts per 100 ml standard was applied to all of the data used to develop the load duration curves.

2.2 Discussion of Instream Water Quality

There are two ambient stations on the listed segments operated by USGS that collected fecal coliform monitoring data during the 13-year period. Monitoring for flow and fecal coliform bacteria was performed on a routine basis on Fannegusha Creek at station 07287355 near Howard. This station is located on segments MS362M2 and MS361M of Fannegusha Creek. Monitoring was conducted at one additional station on segment MS359M4 of Fannegusha Creek; station 072787330 on Highway 17 near Ituma. These stations, however, are no longer routinely monitored for fecal coliform bacteria. In order to collect fecal coliform data, MDEQ now goes to monitoring stations multiple times within a 30-day period. These data are used to calculate the geometric mean for the waterbody. One station on Fannegusha Creek was recently included in this type of monitoring. These data confirm impairment in this waterbody for fecal coliform bacteria.

2.2.1 Inventory of Available Water Quality Monitoring Data

Fecal coliform monitoring data collected at the two monitoring stations on Fannegusha Creek are given in Tables A-1 and A-2 in Appendix A. Flow measurements are also given in the tables along with the fecal coliform data. Data collected from the geometric mean study from 2001 are shown below in Table 1.

Table 1. Fecal Coliform Data reported in Fannegusha Creek near Howard, Station 07287355
September 2001 to December 2001

Date	Flow (cfs) (i = instantaneous flow) (m = daily mean flow)	Fecal Coliform (counts/100ml)	Geometric Mean
4/18/2001 8:00	62 (m)	3000	364
4/26/2001 9:30	43 (m)	230	
5/1/2001 9:30	32 (m)	500	
5/9/2001 9:30	27 (m)	230	
5/14/2001 9:30	24 (m)	80	
8/6/2001 9:00	74 (i)	260	220
8/17/2001 9:00	87 (i)	300	
8/27/2001 9:00	79 (i)	170	
8/30/2001 13:30	98 (i)	170	
9/4/2001 9:15	193 (i)	230	

2.2.2 Analysis of Instream Water Quality Monitoring Data

Historically, MDEQ only had data appropriate to compare all of the samples to the instantaneous portion of the standard, which is no more than 10% 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. The geometric mean portion of the current fecal coliform standard was not used in assessment due to lack of appropriate data at that time. MDEQ's new method of collecting data at least 5 times at a site during a 30-day period must be assessed for both parts of the standard. Table 2 shows the statistical summary of the recent monitoring data collected in 2001, which is part of an ongoing project. Both sets of data summarized in Table 2 were assessed according to the summer standard. The data are provisional data and clearly verify impairment indicated by previous assessments.

Table 2. Statistical Summaries of Water Quality Data for Station 07287355

Season	Number of Samples	Geometric Mean	Standard Violation (200 counts/100 ml)	Percent Instantaneous Exceedance	Standard Violation (400 counts/100 ml)
Summer	5	364	Yes	40%	Yes
Summer	5	220	Yes	0%	No

SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential fecal coliform sources in the Fannegusha Creek Watershed. The source assessment is provided as an indication of what sources might be reduced to reach the reduction goals outlined in this report. 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. The only NPDES permitted discharger into the Fannegusha Creek Watershed is the Tchula Attendance Center, an elementary school. Once the permitted discharger was located, Table 3, 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.

Table 3. Inventory of Point Source Dischargers

NPDES ID	Facility Name	Segment Location	Receiving Water
MS0032620	Tchula Attendance Center	MS362M2	Fannegusha Creek

3.2 Assessment of Nonpoint Sources

There are many potential nonpoint sources of fecal coliform bacteria for the Big Sunflower River, including:

- Failing septic systems
- Wildlife
- Other Direct Inputs
- Urban development

The 80,362-acre drainage area of Fannegusha Creek contains many different landuse types, including urban, forest, cropland, pasture, barren, and wetlands. The 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. The landuse distribution is shown in Table 4 and Figure 3.

Table 4. Landuse Distribution for Each Subwatershed (acres)

Subwatershed	Urban	Forest	Cropland	Pasture	Barren	Wetland	Aquaculture	Water	Total
08030203011	1,385	30,824	7,134	39,447	508	52	0	1,011	80,362
Percent	2%	38%	9%	49%	1%	0%	0%	1%	

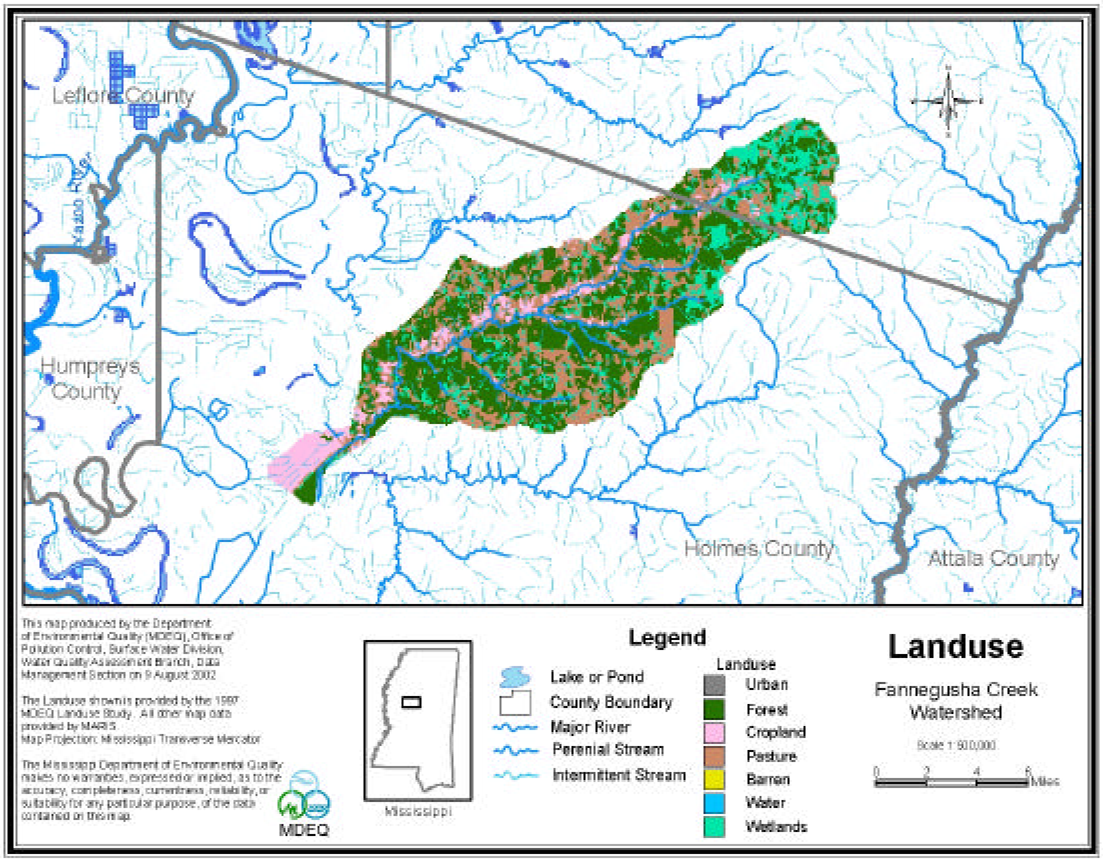


Figure 3. Landuse Distribution Map for the Fannegusha Creek Watershed

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 have the greatest impact on 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 treatment systems.

3.2.2 Wildlife

Wildlife present in the Fannegusha Creek Watershed may contribute to fecal coliform bacteria on the land surface. No attempts were made in this TMDL to quantify the number and location of animals or amount of bacteria washed into Fannegusha Creek due to wildlife contributions.

3.2.3 Other Direct Inputs

Other direct inputs of fecal coliform includes all animal access to streams (domestic and wild), illicit discharges of fecal coliform bacteria, and leaking sewer collection lines.

3.2.4 Urban Development

Urban areas include land classified as urban and barren. Even though only a small percentage of the watershed is classified as urban, the contribution of the urban areas to fecal coliform loading in Fannegusha Creek was considered. Fecal coliform contributions from urban areas may come from storm water runoff, failing sewer pipes, and runoff contribution from improper disposal of materials such as litter.

LOAD DURATION CURVE PROCEDURE

The estimated reductions required for this TMDL were developed using load duration curves. The methodology outlined in a paper completed to explore the use of load duration curves for data analysis applications for streams in the Yazoo River Basin in Mississippi was followed in the development of the load duration curves for this TMDL (Sheely, 2002). Load duration curves were developed as a method in which TMDLs applicable to all hydrological conditions could be calculated. Prior to the introduction of this method, many TMDLs were developed to address a single flow condition such as the 7Q10 (7-day, 10-year low flow) or average flow. This new method allows for the development of TMDLs that addressed more than just a single flow condition. Because these curves include the entire range of flow conditions, pollutant sources of all types can be considered in the TMDLs. The methods used to develop both the flow and load duration curves will be described.

4.1 Development of Flow Duration Curves

The first step in the development of load duration curves is to create flow duration curves using continuous flow or stage data. There is one continuous flow gage in the Fannegusha Creek Watershed maintained by the USGS. Gage 07287355 is located on Fannegusha Creek near Howard, MS. Continuous flow data for the period of March 1987 through September 1999 were available for this station.

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 were developed for two locations on Fannegusha Creek. The first flow duration curve developed was for the water quality monitoring station that was located at the same location as the flow gage. This flow duration curve is shown on a semi-log plot in Figure 4. A flow duration curve for other water quality monitoring station on Fannegusha Creek was developed using a ratio of the drainage areas of the flow gauging station and the monitoring station. The use of this method assumes that the hydrological characteristics of the watersheds are similar. This is a valid assumption because the stations are located within the same waterbody.

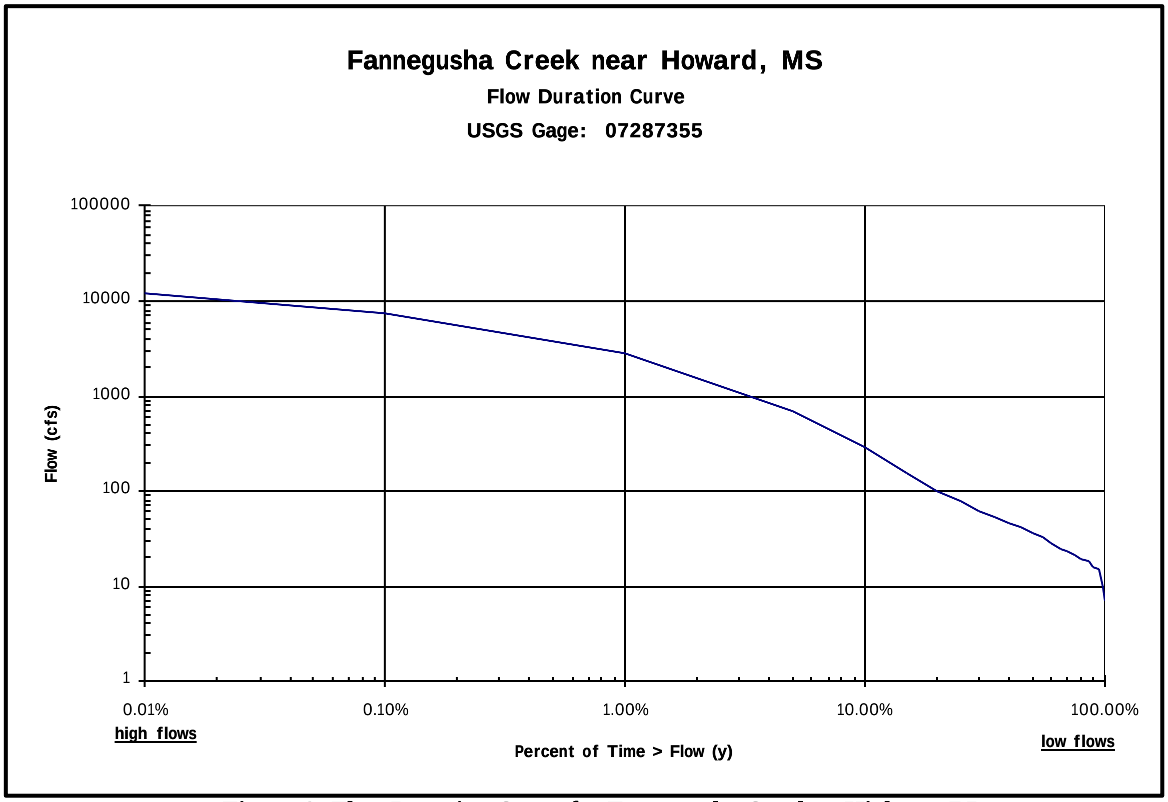


Figure 4. Flow Duration Curve for Fannegusha Creek at Highway 7 Bypass

4.2 Load Duration Curves

Flow duration curves are transformed into load duration curves by multiplying the flow values along the curve by applicable water quality criteria values for pathogens and appropriate conversion factors. The load duration curves are conceptually similar to the flow duration curves, in that the x-axis represents the flow recurrence interval. The y-axis is transformed to represent the allowable load of the water quality parameter. The curve representing the allowable load of fecal coliform bacteria was calculated using the instantaneous, summer water quality criteria of 400 counts per 100 ml and the flow associated with each flow recurrence interval. Load duration curves were developed for the two locations on Fannegusha Creek, where sufficient water quality monitoring data were available. One load duration curve was developed to represent the fecal coliform bacteria load in segments MS362M2 and MS361M of Fannegusha Creek using the data from station 07287355. This monitoring station is located at the boarder between segments MS362M2 and MS361M. Thus, the load duration curve developed with these data was applied to both listed segments. The second load duration curve was developed to represent the fecal coliform bacteria load in segment MS359M4 using data collected at station 07287330. The load duration curves are included in Appendix B.

4.3 Comparison of Monitoring Data and Water Quality Criteria

The final step in the development of load duration curves was to add the monitoring data to the curves. Pollutant loads were estimated from the data as the product of the pollutant concentrations, instantaneous flows measured at the time of sample collection, and appropriate conversion factors. In order to identify the plotting position of each calculated load, the recurrence interval of each instantaneous flow measurement was defined. Water quality monitoring data are plotted on the same graph as the load duration curve. The load duration curves, which are shown in Appendix B, provide a graphical display of the water quality conditions in the waterbody. The monitoring data points that plot above the target line exceed the water quality target, while those that plot below meet the target.

4.4 Source Identification

The position at which the monitoring data exceed the target gives an indication of the potential sources and delivery mechanisms of the pollutants. Violations that occur on the right side of the curve, during low-flow conditions, indicate the presence of continuous pollutant sources, such as NPDES permitted discharges and failing septic tanks. Violations that occur on the left side of the curve, during higher flows, indicate intermittent sources that appear in response to rain events. 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 in Appendix B show that water quality data exceeds the target during all flow conditions at all stations. The interpretation of these curves indicate that both point and nonpoint bacteria sources are present in the Fannegusha Creek Watershed.

Using load duration curves for data analysis is different from the methods typically used in that the frequency of attainment or violation of a particular water quality criteria is stressed rather than the absolute values of the monitoring data. One of the strengths of this method is that it can be used to interpret possible delivery mechanisms of pollutants. Load duration curves have been shown to be influenced by the landuse distribution in their watersheds (Sheely, 2002). Because of this, load duration curves have the potential to be used as a method for targeting pollution reduction efforts in watersheds that are impaired and require TMDL development.

4.5 Stream Characteristics

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

- Length 3.95 miles
- Average Depth 1.06ft
- Average Width 70.45 ft
- Average Flow 914.0 cubic ft per second
- Mean Velocity 1.53 ft per second
- 7Q10 Flow 9.8 cubic ft per second
- Slope 0.0040 ft per ft

4.6 Selection of Representative Period

The period of record for flow data ranged from 1997 to 1999. The period of record for water quality data used to develop the load duration curves ranged from 1988 to 1995. Seasonality and critical conditions are accounted for during the extended time frame of the data represented in the load duration curves.

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 extended time period, many such occurrences should be captured in the data results. Critical conditions for point sources, which occur during low-flow and low-dilution conditions, are considered as well.

4.7 Existing Loading

An additional set of load duration curves showing the target of 200 counts per 100 ml with a 50 percent MOS was developed, Appendix C. Only the monitoring data points that exceed the target of 200 counts per 100 ml are shown on these curves. The curves in Appendix C also include a regression line drawn through the data points that exceed the 200 counts per 100 ml target. The regression line represents the best fit of the existing loading at the two monitoring stations on Fannegusha Creek.

ALLOCATION

In accordance with 40 CFR Section 130.2, which states, "TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure," this TMDL is expressed as a percent reduction of load in order to retain the benefit of utilizing various flow conditions to develop the load duration curve. The use of a single TMDL number would effectively return to the choice of just one flow condition for TMDL development. This method uses the difference between the regression line through the exceeding points (the existing loading) and the load duration target curve to calculate the appropriate percent reduction necessary for the TMDL. The only allocation included in this TMDL is the wasteload allocation for point sources.

5.1 Wasteload Allocations

The wasteload allocation is based on the existing point sources in the Fannegusha Creek Watershed. The WLA is represented on the load duration curves in Appendix C as a horizontal line with a constant load appropriate for each segment. Segment MS359M4 is located upstream of the point source discharger, thus the line representing the WLA is set at zero for this segment. The zero WLA line, however, will not prevent the addition of new point source dischargers within this segment in the future. However, any future discharger within Fannegusha Creek or a tributary of Fannegusha Creek will be required to disinfect their effluent so that the effluent consistently meets water quality standards. The point source and its allocated load are shown in Table 5. No permit modification is necessary for this facility because it currently disinfects its effluent to meet water quality standards.

Table 5. Wasteload Allocations

NPDES ID	Facility Name	Segment Location	Allocated Load (counts/day)	Permit Modification Necessary
MS0032620	Tchula Attendance Center	MS362M2	1.51E+08	No

5.2 Load Allocations

The load allocation for this TMDL varies according to the flow conditions as represented graphically for each segment in graphs C-1 and C-2. In graph C-1 the load allocation is equal to the area of the load duration curve that is above the line representing the WLA and below the curve representing the TMDL. In graph C-2, the load allocation is represented as the entire area under the TMDL curve.

5.3 Incorporation of a Margin of Safety (MOS)

The two types of MOS development are to implicitly incorporate the MOS using conservative assumptions or to explicitly specify a portion of the total TMDL as the MOS. For this TMDL, the MOS is an explicit 50 percent reduction of the criteria of 400 counts per 100 ml to a target of 200 counts per 100 ml.

5.4 Calculation of the TMDL

Because the TMDL is variable depending on the recurrence interval of the appropriate flow, the TMDL is expressed as an average percent reduction of the load. The percent reduction necessary for the TMDL is the average of the differences between the existing load line and the target load curve at each recurrence interval. The regression line through the exceeding points represents the existing load. The target curve represents 200 counts per 100 ml at the various flows. Graphs C-1 and C-2 graphically represent the variable TMDL and LA, WLA, and MOS for each segment. The percent reduction of fecal coliform bacteria recommended for each segment in this TMDL is shown in Table 6. The units of counts per day are appropriate for this TMDL due to the use of the instantaneous standard as opposed to units of counts/per 30 days that are used in conjunction with the use of the geometric mean standard.

Table 6. TMDL Percent Reduction

<table>
<tr><th>Segment</th><th>WLA
(counts/day)</th><th>MOS</th><th>TMDL
Percent Reduction</th></tr>
<tr><td>MS362M2</td><td rowspan="3">1.51E+08</td><td>Explicit</td><td rowspan="2">50.2</td></tr>
<tr><td>MS361M</td><td>Explicit</td></tr>
<tr><td>MS359M4</td><td>Explicit</td><td>52.0</td></tr>
</table>

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. The criteria for the most critical season, which is the summer for Fannegusha Creek, was used as the target for this TMDL. Because data were used throughout the year for several years at each monitoring station, seasonality was addressed. The extended period of record for the stage information allowed for representation of many different flow conditions, which is also relevant to seasonality.

5.6 Reasonable Assurance

This component of TMDL development does not apply to this TMDL Report. There are no point sources (WLA) requesting a reduction based on promised Load Allocation components and reductions. This TMDL will recommend that all point sources discharge treated and disinfected effluent that will be below the 200 colony counts per 100ml target at the end of the pipe.

CONCLUSION

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, Fannegusha 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.

Additional monitoring for fecal coliform bacteria will also continue for one station in the Fannegusha Creek Watershed as part of the geometric mean bacteria sampling project. Bacteria samples will be collected at one station on Fannegusha Creek during two thirty-day periods in fall of 2002 and spring of 2003.

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 *n*th root of the product of *n* numbers. A 30-day geometric mean is the 30^{th} root of the product of 30 numbers.

Impaired Waterbody: any waterbody that does not attain water quality standards due to an individual pollutant, multiple pollutants, pollution, or an unknown cause of impairment.

Land Surface Runoff: water that flows into the receiving stream after application by rainfall or irrigation. It is a transport method for nonpoint source pollution from the land surface to the receiving stream.

Load allocation (LA): the portion of a receiving water's loading capacity attributed to or assigned to nonpoint sources (NPS) or background sources of a pollutant. The load allocation is the value assigned to the summation of all 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, ($\mathbf{d_1}$, $\mathbf{d_2}$, $\mathbf{d_3}$) respectively could be shown as:

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

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

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

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

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

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

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

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

ABBREVIATIONS

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

BASINS.. Better Assessment Science Integrating Point and Nonpoint Sources

BMP ....Best Management Practice

CWA ....Clean Water Act

DMR...Discharge Monitoring Report

EPA .... Environmental Protection Agency

GIS ....Geographic Information System

HUC ....Hydrologic Unit Code

LA.. Load Allocation

MARIS .... State of Mississippi Automated Information System

MDEQ .... Mississippi Department of Environmental Quality

MOS.. Margin of Safety

NRCS .... National Resource Conservation Service

NPDES ....National Pollution Discharge Elimination System

NPSM...Nonpoint Source Model

RF3...Reach File 3

USGS...United States Geological Survey

WLA..Waste Load Allocation

REFERENCES

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

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

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

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

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

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

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

NCSU, 1994. *Livestock Manure Production and Characterization in North Carolina*, North Carolina Cooperative Extension Service, North Carolina State University (NCSU) College of Agriculture and Life Sciences, Raleigh, January 1994.

Sheely, Laura H. 2002. *Load Duration Curves: Development and Application to Data Analysis for Streams in the Yazoo River Basin, MS*. Special Project, Summer 2002, Jackson Engineering Graduate Program.

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

This appendix contains the fecal coliform monitoring data available for the two monitoring stations on Fannegusha Creek; 07287355 near Howard and 07287330 near Ituma. The flow measurements in Fannegusha Creek were recorded from USGS gage 07287355. This flow gage is located at the same location as monitoring station 07287355. The flow data given for both monitoring stations on Fannegusha Creek is based on the data collected at this gage. Flow was estimated for the monitoring stations located near Ituma using a ratio of the drainage area of the monitoring station to the drainage area of the gage.

Table A-1. Fecal Coliform Data reported in the Fannegusha Creek, Station 07278355
March 1988 to August 1995

Date	Time	Flow (cfs)	Fecal Coliform (counts/100ml)
3/24/1988	6:00	37	110
3/24/1988	12:00	33	21
3/24/1988	18:20	32	42
3/25/1988	0:25	40	16
3/25/1988	6:30	40	220
3/25/1988	12:00	50	730
3/25/1988	18:00	155	580
3/26/1988		240	3300
3/26/1988	6:00	178	7500
7/26/1988	6:00	17	1300
7/26/1988	12:00	16	780
7/26/1988	18:00	22	3100
7/27/1988		19	2300
7/27/1988	6:00	17	920
7/27/1988	12:00	16	230
7/27/1988	18:00	14	180
7/28/1988		14	880
7/28/1988	6:00	14	160
1/10/1989	15:15	138	2500
1/10/1989	21:15	160	1000
1/11/1989	4:15	150	860
1/11/1989	10:40	390	5700
1/11/1989	16:00	820	11000
1/11/1989	22:20	1940	4900
1/12/1989	3:45	5530	6600
1/12/1989	12:20	6200	4200
1/12/1989	16:40	4100	4500
8/14/1989	18:00	30	67
8/15/1989		28	60
8/15/1989	6:00	28	73
8/15/1989	12:00	28	80
8/15/1989	18:00	28	7
8/16/1989		28	32
8/16/1989	6:00	28	48
8/16/1989	12:00	28	35

Table A-1 Continued

8/16/1989	18:00	28	15
11/27/1989	18:40	58	240
11/28/1989	0:20	56	240
11/28/1989	6:20	54	160
11/28/1989	12:20	52	85
11/28/1989	18:25	51	230
11/29/1989	0:20	49	240
11/29/1989	6:20	48	46
11/29/1989	12:20	47	42
11/29/1989	18:25	45	76
8/28/1990	18:30	16	12
8/29/1990	0:20	15	72
8/29/1990	6:30	15	31
8/29/1990	12:30	15	24
8/29/1990	18:30	15	40
8/30/1990	0:30	15	55
8/30/1990	6:30	15	60
8/30/1990	12:30	15	14
8/30/1990	18:30	15	28
4/25/1991	12:30	155	76
4/25/1991	18:30	148	100
4/26/1991	0:30	136	77
4/26/1991	6:30	131	120
4/26/1991	12:30	127	68
4/26/1991	18:30	121	120
4/27/1991	0:30	131	700
4/27/1991	6:30	155	840
4/27/1991	12:30	245	2100
4/27/1991	18:30	1250	2300
8/27/1991	13:00	23	180
8/27/1991	19:00	26	520
8/28/1991	1:00	29	160
8/28/1991	7:00	31	24
8/28/1991	13:00	33	12000
8/28/1991	19:00	33	120
8/29/1991	1:00	31	120
8/29/1991	7:00	28	100
8/29/1991	13:00	27	28
1/22/1992	7:00	81	640
1/22/1992	13:00	80	420
1/22/1992	19:00	80	640
1/23/1992	1:00	80	520
1/23/1992	7:00	79	440
1/23/1992	13:00	81	270
1/23/1992	19:00	80	280
1/24/1992	1:00	77	140
1/24/1992	7:00	74	280
8/24/1992	13:00	32	42

Table A-1 Continued

8/24/1992	19:00	26	100

8/25/1992	1:00	23	130
8/25/1992	7:00	21	120
8/25/1992	13:00	18	85
8/25/1992	19:00	17	120
8/26/1992	1:00	16	150
8/26/1992	7:00	15	220
8/26/1992	13:00	14	100
8/16/1993	13:00	20	64
8/16/1993	19:00	20	56
8/17/1993	1:00	19	110
8/17/1993	7:00	19	80
8/17/1993	13:00	20	100
8/17/1993	19:00	20	160
8/18/1993	1:00	19	85
8/18/1993	7:00	19	140
8/18/1993	13:00	20	130
7/11/1994	18:00	70	2100
7/12/1994		64	3200
7/12/1994	6:00	59	240
7/12/1994	12:00	47	290
7/12/1994	18:00	42	680
7/13/1994		38	560
7/13/1994	6:00	45	1800
7/13/1994	12:00	44	4400
7/13/1994	18:00	2200	6000
8/31/1994	10:15	21	77
8/3/1995	16:00	18	72
8/3/1995	22:00	18	130
8/4/1995	4:00	20	170
8/4/1995	10:00	21	300
8/4/1995	16:00	23	480
8/4/1995	22:00	23	300
8/5/1995	4:00	25	210
8/5/1995	10:00	47	240

Table A-2. Fecal Coliform Data reported in Fannegusha Creek, Station 07287330
March 1988 to August 1995

Date	Time	Flow (cfs)	Fecal Coliform (counts/100ml)
3/24/1988	6:45	12	190
3/24/1988	12:35	12	140
3/24/1988	18:35	12	110
3/25/1988	0:40	13	110
3/25/1988	6:35	18	380
3/25/1988	12:35	170	6000
3/25/1988	18:35	152	8800
3/26/1988	0:35	85	7700
3/26/1988	6:35	59	6800
7/26/1988	7:00	8.2	180
7/26/1988	12:40	8.3	510
7/26/1988	18:30	6.7	290
7/27/1988	0:25	6.2	160
7/27/1988	7:00	6.2	330
7/27/1988	12:25	5.9	75
7/27/1988	18:00	5.6	94
7/28/1988	0:25	5.3	44
7/28/1988	6:25	5.3	100
1/10/1989	17:00	60	900
1/10/1989	21:40	53	500
1/11/1989	6:15	79	660
1/11/1989	10:45	400	5300
1/11/1989	16:45	650	3500
1/11/1989	22:45	3200	4700
1/12/1989	6:30	3050	2800
1/12/1989	16:00	1130	2000
8/14/1989	18:45	8.4	20
8/15/1989	0:45	8.2	140
8/15/1989	6:45	7.5	150
8/15/1989	12:35	8.4	38
8/15/1989	18:45	7.5	28
8/16/1989	0:50	6.4	32
8/16/1989	6:45	6.8	160
8/16/1989	12:45	7.5	130
8/16/1989	18:45	7.5	5
11/27/1989	19:00	22	240
11/28/1989	0:45	37	260
11/28/1989	6:45	20	100
11/28/1989	12:30	22	200
11/28/1989	18:45	13	120
11/29/1989	0:40	16	180
11/29/1989	6:40	12	100
11/29/1989	12:35	14	54
11/29/1989	18:40	12	100
8/28/1990	18:40	5.5	40

Table A-2 Continued

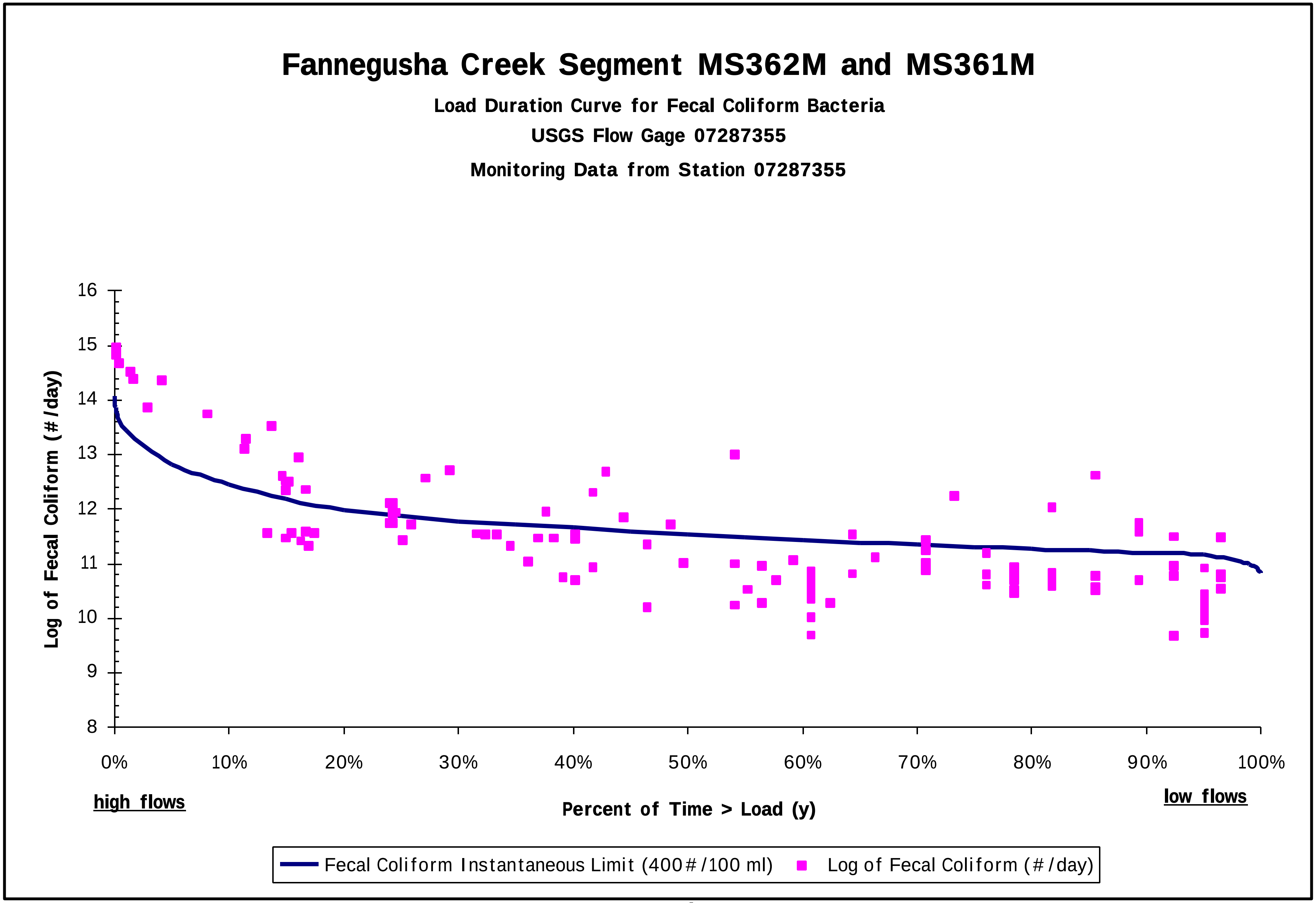
8/29/1990	0:35	5.5	40
8/29/1990	6:35	5.5	43
8/29/1990	12:35	5.5	5
8/29/1990	18:25	5.5	58
8/30/1990	0:35	5.5	55
8/30/1990	6:35	5.5	62
8/30/1990	12:35	5.5	29
8/30/1990	18:35	5.5	88
4/25/1991	12:45	26	160
4/25/1991	18:45	26	140
4/26/1991	0:45	24	64
4/26/1991	6:45	23	60
4/26/1991	12:45	23	92
4/26/1991	18:45	23	88
4/27/1991	0:45	30	2900
4/27/1991	6:45	44	2100
4/27/1991	12:45	198	6000
4/27/1991	18:45	600	19000
8/27/1991	13:00	8.4	77
8/27/1991	19:00	10	3500
8/28/1991	1:00	7.4	180
8/28/1991	7:00	7.4	76
8/28/1991	13:00	7.4	140
8/28/1991	19:00	7.4	390
8/29/1991	1:00	6.9	15
8/29/1991	7:00	6	120
8/29/1991	13:00	7.4	24
1/22/1992	8:40	35	400
1/22/1992	13:40	33	480
1/22/1992	19:00	38	440
1/23/1992	1:00	39	940
1/23/1992	8:00	36	680
1/23/1992	13:20	34	350
1/23/1992	19:00	32	480
1/24/1992	1:00	29	440
1/24/1992	7:40	26	240
8/24/1992	12:00	6.6	310
8/24/1992	18:00	6.6	280
8/25/1992		8	440
8/25/1992	6:00	6.3	380
8/25/1992	12:00	6.3	140
8/25/1992	18:00	6.3	190
8/26/1992		6.2	100
8/26/1992	6:00	6.3	3600
8/26/1992	12:00	6.3	600
8/16/1993	12:30	7.1	230
8/16/1993	18:30	7.2	150
8/17/1993	0:30	7.1	170

Table A-2 Continued

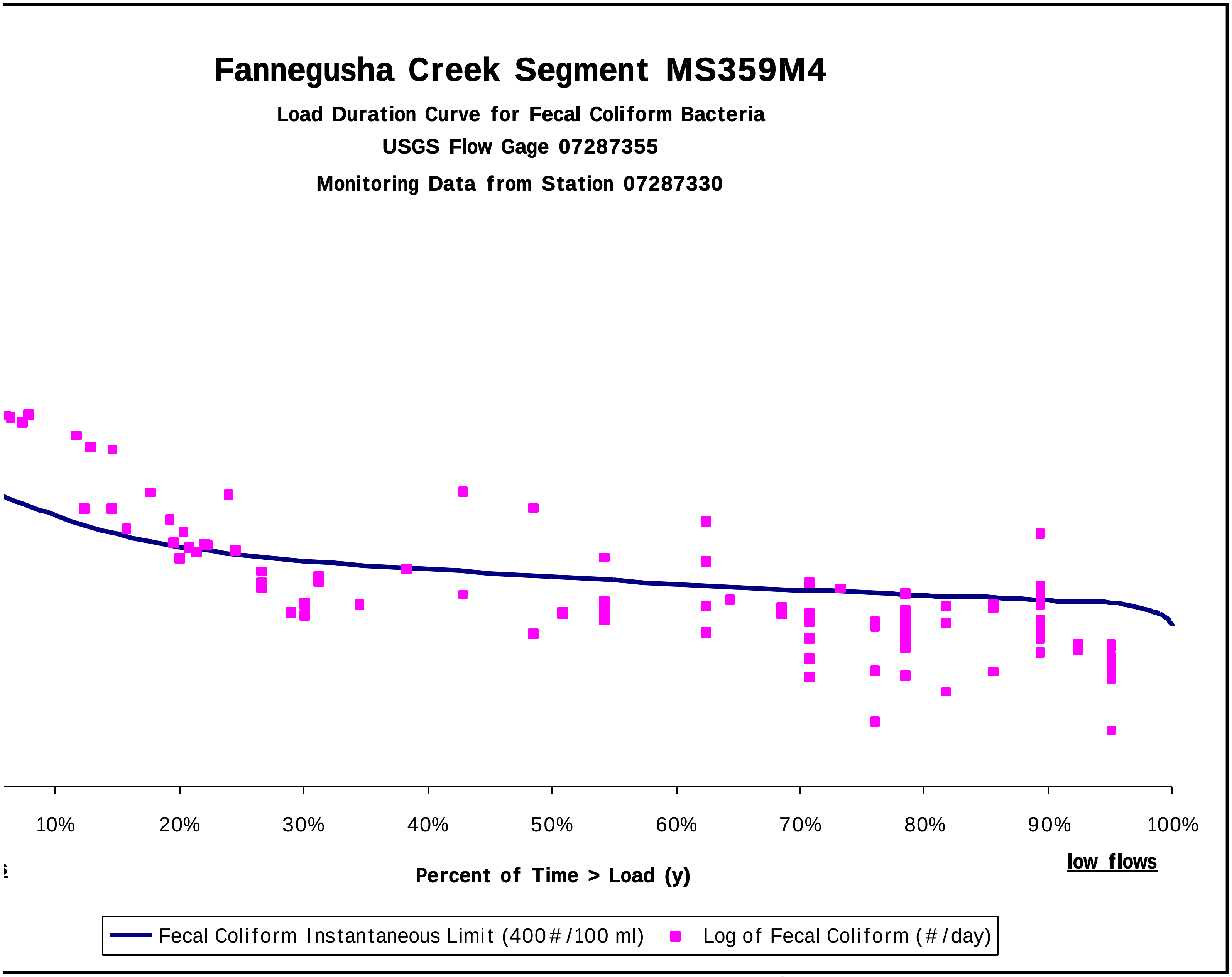
8/17/1993	6:30	7.1	120
8/17/1993	12:30	7.1	65
8/17/1993	18:30	7.1	130
8/18/1993	0:30	7.1	100
8/18/1993	6:30	7.1	140
8/18/1993	12:30	7.1	190
7/11/1994	18:30	74	6000
7/12/1994	0:30	14	3900
7/12/1994	6:30	12	840
7/12/1994	12:30	9.6	250
7/12/1994	18:30	9.7	900
7/13/1994	0:30	9.8	200
7/13/1994	6:30	16	6000
7/13/1994	12:30	1050	6000
7/13/1994	18:30	215	6000
8/3/1995	15:30	6	67
8/4/1995	10:00	6.1	120
8/4/1995	16:00	6	520
8/4/1995	22:00	7.2	200
8/5/1995	4:00	8.8	170
8/5/1995	10:00	9.7	80

APPENDIX B

This appendix contains the load duration curves for the segments included in this TMDL. The load duration curves for all segments are shown on semi-log plots. In order to show the curves and data more clearly, the y-axis of the plots begins at 1.0E+8 fecal coliform (counts/day). Graph B-1 shows the load duration curve for segments MS362M1 and MS361M. The flow data used to develop this load duration curve are from USGS station 07287355, and the water quality data are from station 07287355. Both the flow and water quality monitoring sites are located at the same location. Graph B-2 shows the load duration curve for segment MS359M4. The flow data used to develop this load duration curve were taken from USGS station 07287355, and applied to water quality monitoring station 07287330 using a drainage area ratio.


Fannegusha Creek Segment MS362M and MS361M
Load Duration Curve for Fecal Coliform Bacteria
USGS Flow Gage 07287355
Monitoring Data from Station 07287355
Log of Fecal Coliform (#/day)
16
15
14
13
12
11
10
9
8
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
high flows
Percent of Time > Load (y)
low flows
Fecal Coliform Instantaneous Limit (400#/100 ml)
Log of Fecal Coliform (#/day)

Graph B-1

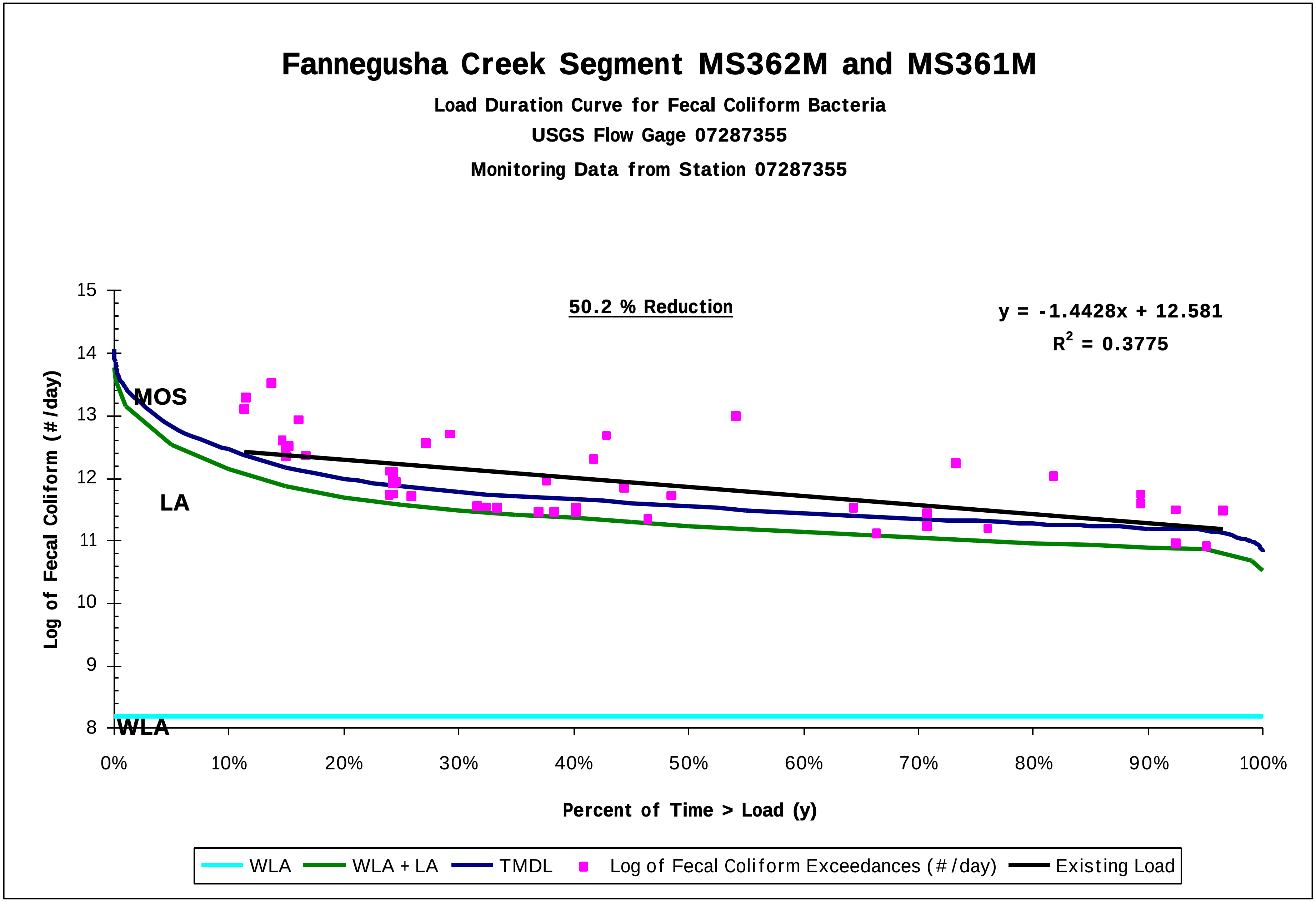

Fannegusha Creek Segment MS359M4
Load Duration Curve for Fecal Coliform Bacteria
USGS Flow Gage 07287355
Monitoring Data from Station 07287330
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
low flows
Percent of Time > Load (y)
Fecal Coliform Instantaneous Limit (400#/100 ml)
Log of Fecal Coliform (#/day)

Graph B-2

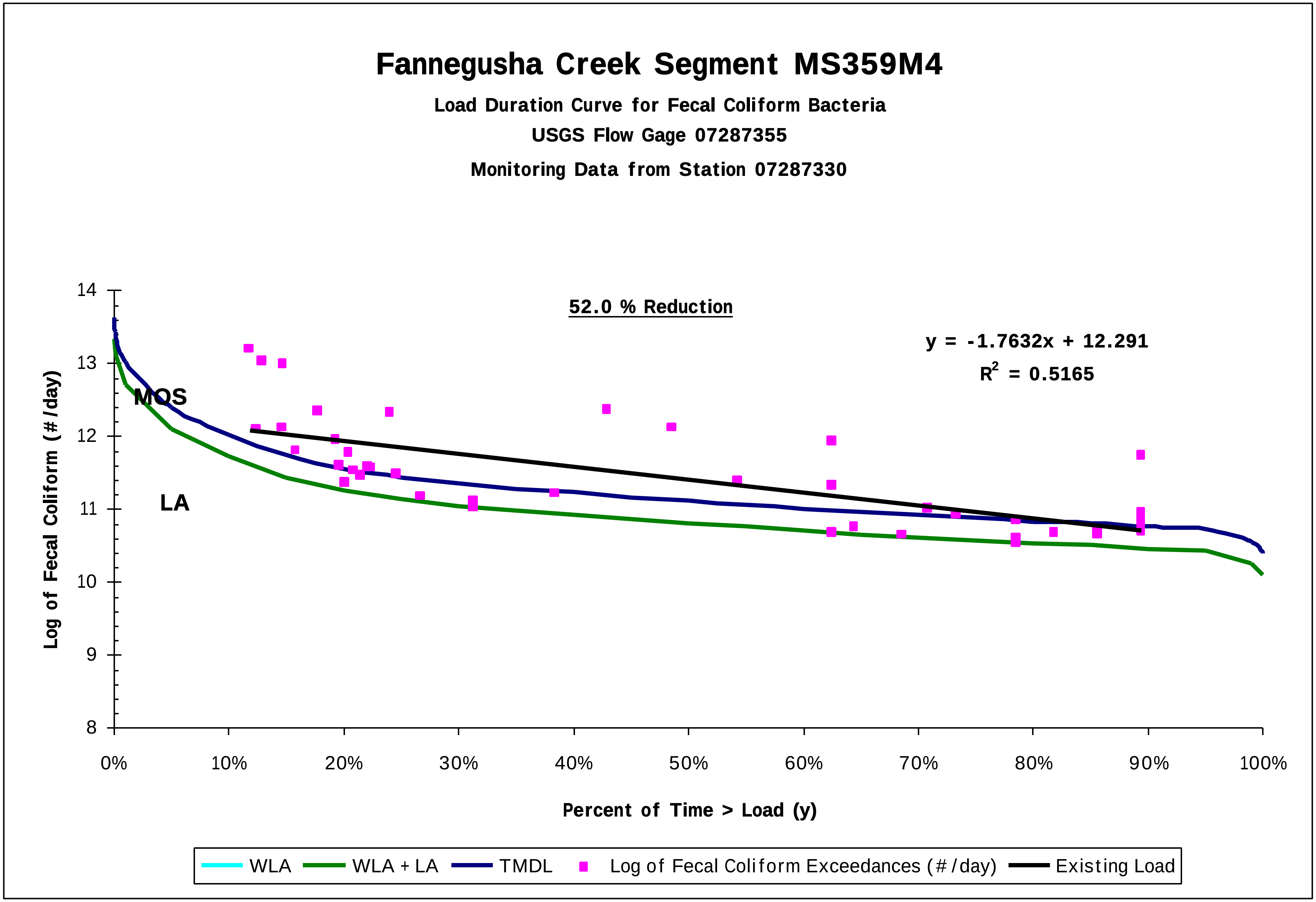
APPENDIX C

This appendix contains the load duration curves used to calculate the percent reductions included in this TMDL. Each graph contains a regression line that represents the existing fecal coliform bacteria load at the monitoring station. The regression lines were developed by applying a best-fit linear regression line to the data points that exceed the water quality standard. The equation displayed on each graph defines the linear regression line. The R-squared (R^2) values, which indicate how closely the regression line corresponds to the actual data, are also shown. R-squared values closer to 1 indicate a better fit of the data. The percent reductions are based on the average difference between the regression line and the curve representing the target load (WLA + LA). The target load curve represents the TMDL target of 200 counts per 100 ml. Finally, the MOS is represented graphically as the difference between the target load curve and the curve representing the 400 counts per 100 ml standard.

In order to show the curves and data more clearly, the y-axis of the plots begins at 1.0E+8 fecal coliform (counts/day) on all of the graphs. Because of this, the line representing the WLA is not visible on the load duration curve in graph C-2. Graph C-1 shows the load duration curve for Fannegusha Creek segments MS362M2 and MS361M. Graph C-2 shows the load duration curve for Fannegusha Creek segment MS359M4.


Fannegusha Creek Segment MS362M and MS361M
Load Duration Curve for Fecal Coliform Bacteria
USGS Flow Gage 07287355
Monitoring Data from Station 07287355
50.2 % Reduction
y = -1.4428x + 12.581
R2 = 0.3775
MOS
LA
WLA
Log of Fecal Coliform (#/day)
15
14
13
12
11
10
9
8
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time > Load (y)
WLA
WLA + LA
TMDL
Log of Fecal Coliform Exceedances (#/day)
Existing Load

Graph C-1



Fannegusha Creek Segment MS359M4
Load Duration Curve for Fecal Coliform Bacteria
USGS Flow Gage 07287355
Monitoring Data from Station 07287330
52.0 % Reduction
y = -1.7632x + 12.291
R^2 = 0.5165
MOS
LA
Log of Fecal Coliform (#/day)
14
13
12
11
10
9
8
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time > Load (y)
WLA
WLA + LA
TMDL
Log of Fecal Coliform Exceedances (#/day)
Existing Load

Graph C-2