Alabama Department of Environmental Management

Final

Total Maximum Daily Load (TMDL)
for
Goose Creek

Assessment Unit ID # AL06030002-0404-200

Pathogens (E. coli)

Alabama Department of Environmental Management
Water Quality Branch
Water Division
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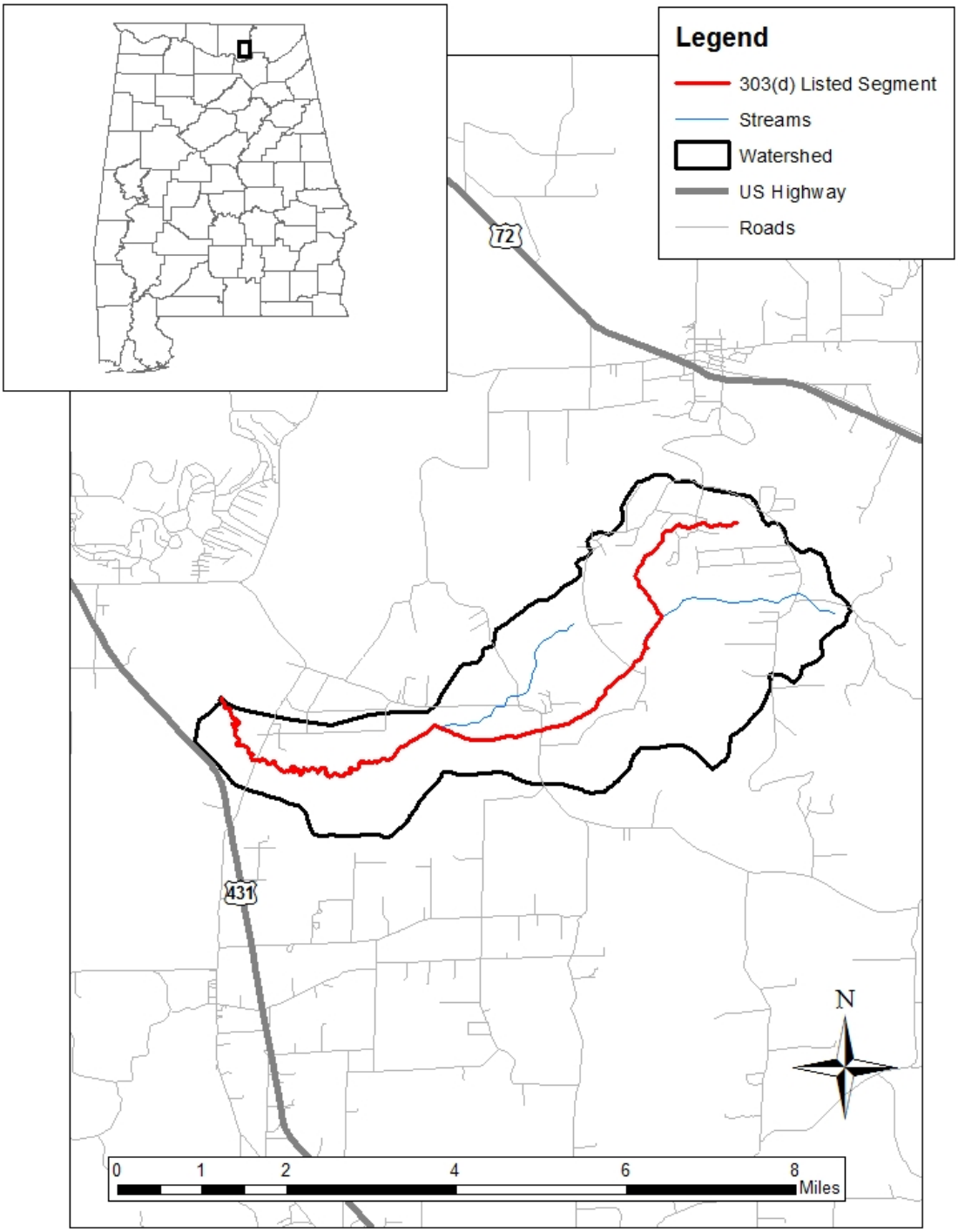
Figure I: Goose Creek Watershed



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1.0 Executive Summary

Section §303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to identify waterbodies which are not meeting their designated uses and to determine the Total Maximum Daily Load (TMDL) for pollutants causing the use impairment. A TMDL is the sum of individual wasteload allocations for point sources (WLAs), load allocations (LAs) for nonpoint sources including natural background levels, and a margin of safety (MOS).

Goose Creek is on the §303(d) list for pathogens from its source to the Flint River. Goose Creek forms in Madison County east of the Hampton Cove, in the Tennessee River Basin. It flows west through Madison County and into the Flint River. The total length of Goose Creek is 8.89 miles, of which 8.89 miles are on the §303(d) list. The total drainage area of the Goose Creek watershed is 13.90 square miles, of which 13.90 square miles drains to the impaired segment. Goose Creek has a use classification of Fish & Wildlife (F&W).

Goose Creek was first listed for unknown toxicity on the §303(d) list in 1998 based on a very poor macroinvertebrate/EPT from 1994 through 1995 by the Tennessee Valley Authority (TVA). Goose Creek has subsequently been listed on the 2000, 2002, 2004, 2006, 2008 and 2010 §303(d) lists of impaired waterbodies. On the Draft 2012 §303(d) list the listing has been changed from unknown toxicity to pathogens based on 2010 water quality data collected by the Alabama Department of Environmental Management (ADEM).

In 2010 §303(d) sampling studies were performed by ADEM on Goose Creek to further assess the water quality of the impaired stream. For purposes of this TMDL, the 2010 data will be used to assess the water quality of Goose Creek because it was collected less than six years ago and provides the best picture of the current water quality of the stream. The January 2010 edition of ***Alabama's Water Quality Assessment and Listing Methodology*** section 4.8.2, prepared by ADEM, provides the rationale for the Department to use the most recent data to prepare a TMDL for an impaired waterbody when that data indicates a change in water quality has occurred. Also, as a result of the Alabama Environmental Management Commission's (EMC) adoption of the Escherichia coli (E. coli) criteria as the new bacterial indicator, this TMDL will be developed from E. coli data collected at stations GOOM-1 and GOOM-2 in 2010. The 2010 bacterial data is listed in Appendix 7.2, Table 7-2 for reference. ADEM collected 13 single samples and two geometric means from Goose Creek at 2 stations in 2010. According to the data collected in 2010, Goose Creek was not meeting the pathogen criterion applicable to its use classification of Fish and Wildlife. Therefore, a TMDL will be developed for pathogens (E. coli) on the listed reach.

A mass balance approach was used for calculating the pathogen TMDL for Goose Creek. The mass balance approach utilizes the conservation of mass principle. Loads were calculated by multiplying the E. coli concentration times the respective instream flow and a conversion factor. The mass loading was calculated using the geometric mean exceedance that resulted in the highest percent reduction (Appendix 7.2, Table 7-2). More specifically, the existing pathogen loading for this TMDL was calculated using the geometric mean exceedance concentration of 179.61 colonies/100 mL from 6/9/2010 through 6/30/2010 times the average of the flows from

the samples (3.38 cfs) and a conversion factor. The allowable loading, defined by the geometric mean criterion including a margin of safety, was calculated using the same flow value times the E. coli geometric mean target of 113.4 colonies/100 mL (126 colonies/100 mL – 10% Margin of Safety). The reduction required to meet the allowable loading was then calculated by subtracting the allowable loading from the existing loading. This violation calls for a reduction of 35%. In the same manner, an allowable load was calculated for the single sample E. coli criterion of 487 colonies/100 mL. More specifically, the existing pathogen loading for this was calculated using the single sample exceedance concentration of 648.8 colonies/100 mL from 6/9/2010 times the flow of the sample (2.02 cfs) and a conversion factor. This violation calls for a reduction of 32%. There was also an additional geometric mean violation of 141.9 colonies/100 mL. This violation resulted in a reduction of only 20%, and therefore will have no bearing in this TMDL.

Table 1-1 is a summary of the estimated existing load, allowable load, and percent reduction for the geometric mean and single sample criterion. Table 1-2 provides the details of the TMDL along with the corresponding reductions for Goose Creek which are protective of E. coli water quality standards year round.

Table 1-1. 2010 E. coli Loads and Required Reductions

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Nonpoint Source Load Single Sample	3.21E+9	2.17E+10	1.04E+10	32%
Nonpoint Source Load Geometric Mean	1.44E+10	9.38E+9	5.06E+9	35%
Point Source Load	NA[a]	NA[a]	NA[a]	NA[a]

a. No NPDES permitted outfalls.

Table 1-2. E. coli TMDL for Goose Creek

TMDL[e]	Margin of Safety (MOS)	Waste Load Allocation (WLA)[a]			Load Allocation (LA)	
		WWTPs[b]	MS4s[c]	Leaking Collection Systems[d]		
(col/day)	(col/day)	(col/day)	(% reduction)	(col/day)	(col/day)	(% reduction)
1.04E+10	1.04E+9	NA	NA	0	9.38E+9	35%

Note: NA = not applicable
a. There are no CAFOs in the Goose Creek watershed. Future CAFOs will be assigned a waste load allocation (WLA) of zero.
b. Future WWTPs must meet the applicable instream water quality criteria for pathogens at the point of discharge.
c. Future MS4 areas would be required to demonstrate consistency with the assumptions and requirements of this TMDL.
d. The objective for leaking collection systems is a WLA of zero. It is recognized, however, that a WLA of 0 colonies/day may not be practical. For these sources, the WLA is interpreted to mean a reduction in E. coli loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality criteria for E. coli.
e. TMDL was established using the geometric mean criterion of 126 colonies/100ml.

Compliance with the terms and conditions of existing and future NPDES permits will effectively implement the WLA and demonstrate consistency with the assumptions and requirements of the TMDL. Required load reductions in the LA portion of this TMDL can be implemented through voluntary measures and may be eligible for CWA §319 grants.

The Department recognizes that adaptive implementation of this TMDL will be needed to achieve applicable water quality criteria and we are committed towards targeting the load reductions to improve water quality in the Goose Creek watershed. As additional data and/or information become available, it may become necessary to revise and/or modify the TMDL accordingly.

2.0 Basis for §303(d) Listing

2.1 Introduction

Section §303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to identify waterbodies which are not meeting their designated uses and to determine the total maximum daily load (TMDL) for pollutants causing use impairment. The TMDL process establishes the allowable loading of pollutants for a waterbody based on the relationship between pollution sources and instream water quality conditions, so that states can establish water-quality based controls to reduce pollution and restore and maintain the quality of their water resources (USEPA, 1991).

The State of Alabama has identified the 8.89 miles of Goose Creek as impaired for pathogens. The §303(d) listing was originally reported on Alabama's 1998 List of Impaired Waters for unknown toxicity based on TVA macroinvertebrate/EPT assessment in 1994 and 1995 and subsequently included on the 2000, 2002, 2004, 2006, 2008 and 2010 lists. The source of the impairment is listed on the 2010 §303(d) list as agriculture. On the Draft 2012 §303(d) list the listing has been changed from unknown toxicity to pathogens based on 2009 and 2010 water quality data collected by ADEM.

2.2 Problem Definition

Waterbody Impaired:	Goose Creek – From Flint River to its source
Impaired Reach Length:	8.89 miles
Impaired Drainage Area:	13.90 square miles
Water Quality Standard Violation:	Pathogens (single sample, geomean)
Pollutant of Concern:	Pathogens (E. coli)
Water Use Classification:	Fish and Wildlife

Usage Related to Classification:
The impaired stream segment is classified as Fish and Wildlife (F&W). Usage of waters in this classification is described in ADEM Admin. Code R. 335-6-10-.09(5)(a), (b), (c), and (d).

(a) Best usage of waters: fishing, propagation of fish, aquatic life, and wildlife, and any other usage except for swimming and water-contact sports or as a source of water supply for drinking or food-processing purposes.

(b) Conditions related to best usage: the waters will be suitable for fish, aquatic life and wildlife propagation. The quality of salt and estuarine waters to which this classification is assigned will also be suitable for the propagation of shrimp and crabs.

(c) Other usage of waters: it is recognized that the waters may be used for incidental water contact and recreation during June through September, except that water contact is strongly discouraged in the vicinity of discharges or other conditions beyond the control of the Department or the Alabama Department of Public Health.

(d) Conditions related to other usage: the waters, under proper sanitary supervision by the controlling health authorities, will meet accepted standards of water quality for outdoor swimming places and will be considered satisfactory for swimming and other whole body water-contact sports.

E. coli Criterion:
Criterion for acceptable bacteria levels for the F&W use classification is described in ADEM Admin. Code R. 335-6-10-.09(5)(e)7(i) and (ii) as follows:

7. Bacteria:

(i) In non-coastal waters, bacteria of the E. coli group shall not exceed a geometric mean of 548 colonies/100 ml; nor exceed a maximum of 2,507 colonies/100 ml in any sample. In coastal waters, bacteria of the enterococci group shall not exceed a maximum of 275 colonies/100 ml in any sample. The geometric mean shall be calculated from no less than five samples collected at a given station over a 30-day period at intervals not less than 24 hours.

(ii) For incidental water contact and recreation during June through September, the bacterial quality of water is acceptable when a sanitary survey by the controlling health authorities reveals no source of dangerous pollution and when the geometric mean E. coli organism density does not exceed 126 colonies/100 ml nor exceed a maximum of 487 colonies/100 ml in any sample in non-coastal waters. In coastal waters, bacteria of the enterococci group shall not exceed a geometric mean of 35 colonies/100 ml nor exceed a maximum of 158 colonies/100 ml in any sample. The geometric mean shall be calculated from no less than five samples collected at a given station over a 30-day period at intervals not less than 24 hours. When the geometric bacterial coliform organism density exceeds these levels, the bacterial water quality shall be considered acceptable only if a second detailed sanitary survey and evaluation discloses no significant public health risk in the use of the waters. Waters in the immediate vicinity of discharges of sewage or other wastes likely to contain bacteria harmful to

humans, regardless of the degree of treatment afforded these wastes, are not acceptable for swimming or other whole body water contact sports.

Criteria Exceeded:
Goose Creek was first listed for unknown toxicity on the §303(d) list in 1998 based on a very poor macroinvertebrate/EPT from 1994 through 1995 by TVA. Data collected by ADEM in 2003 had no fecal coliform violations.

ADEM collected single sample and geometric mean E. Coli data on Goose Creek at GOOM-1 and GOOM-2 in 2010. According to the 2012 §303(d) list fact sheet, the cause of the impairment was changed from unknown to pathogens for Goose Creek based on pathogen data collected by ADEM in 2010 at stations GOOM-1, and GOOM-2. The geometric mean values calculated from E. coli data collected at ADEM Station GOOM-1 and GOOM-2 between 6/9/2010 and 6/30/2010 were 175 col/100mL and 142 col/100mL respectively. In addition, 1 of 5 samples exceeded the 487 colonies/100 mL single sample criterion for E. Coli at GOOM-2.

3.0 Technical Basis for TMDL Development

3.1 Water Quality Target Identification

On December 11, 2009, the Alabama EMC adopted the E. coli criteria as the bacterial indicator to assess the levels of bacteria in freshwater. Prior to the adoption of the E. coli criteria, the fecal coliform criteria were used by ADEM as the bacterial indicator for freshwater. The E. coli criteria was recommended by the EPA as a better correlation to swimming and incidental water contact associated health effects than fecal coliform in the 1986 publication ***Quality Criteria for Water***, (EPA 440/5-86-001). As a result of this bacterial indicator change, this TMDL will be developed from E. coli data collected at station GOOM-1 in 2010.

For the purpose of this TMDL a geometric mean E. coli target of 113.4 colonies/100 mL will be used. This target was derived by using a 10% explicit margin of safety from the geometric mean criterion of 126 colonies/100 mL criterion. This target is considered protective of water quality standards and should not allow the single sample criterion of 487 colonies/100 mL (June-September F&W criteria) to be exceeded.

3.2 Source Assessment

3.2.1 Point Sources in the Goose Creek Watershed

A point source can be defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source contributions can typically be attributed to municipal wastewater facilities, illicit discharges, and leaking sewers in urban areas. Municipal wastewater treatment facilities are permitted through the National Pollutant Discharge Elimination System (NPDES) process administered by ADEM. In urban settings sewer lines can typically run parallel to streams in the floodplain. If there is a leaking sewer line, high concentrations of E. coli can flow into the stream or leach into the groundwater. Illicit

discharges are found at facilities that are discharging E. coli bacteria when they are not permitted, or they are violating their defined permit limit by exceeding the E. coli concentration.

Continuous Point Sources

There are no point sources in the Goose Creek watershed which would cause or contribute to the E. coli loading. Therefore, the WLA portion of this TMDL is not applicable.

Any future NPDES regulated discharges that are considered by the Department to be a pathogen source will be required to meet the instream water quality criteria for pathogens at the point of discharge.

Non-Continuous Point Sources

Currently there are no Municipal Separate Stormwater Sewer System (MS4) areas located within the Goose Creek watershed.

Also, according to the ADEM database, there have been no reported sanitary sewer overflows (SSOs) that have occurred in the Goose Creek watershed. SSOs have the potential to severely impact water quality and can often result in the violation of water quality standards. It is the responsibility of the NPDES wastewater discharge or collection system operator for non-permitted "collection only" systems, to ensure that releases do not occur. Unfortunately releases to surface waters from SSOs are not always preventable or reported.

Future NPDES regulated stormwater discharges will be required to demonstrate consistency with the assumptions and requirements of this TMDL.

3.2.2 Nonpoint Sources in the Goose Creek Watershed

Nonpoint sources of E. coli bacteria do not have a defined discharge point, but rather, occur over the entire length of a stream or waterbody. On the land surface, E. coli bacteria can accumulate over time in the soil and then are washed off during rain events. As the runoff transports the sediment over the land surface, more E. coli bacteria are collected and carried to the stream or waterbody. Therefore, there is some net loading of E. coli bacteria into the stream as dictated by the watershed hydrology.

Nonpoint sources are believed to be the primary source of E. coli bacteria in the Goose Creek watershed. Land use in this watershed is primarily agriculture (pasture/hay and row crops) with 26.91%, and forested with 72.70%.

Agricultural land can be a source of E. coli bacteria. Runoff from pastures, animal feeding areas, improper land application of animal wastes, and animals with direct access to streams are all mechanisms that can contribute E. coli bacteria to waterbodies. To account for the potential influence from animals with direct access to stream reaches in the watershed, E. coli loads can be calculated as a direct source into the stream.

E. coli bacteria can also originate from forested areas due to the presence of wild animals such as deer, raccoons, turkey, waterfowl, etc. Wildlife deposit feces onto land surfaces where it can be transported during rainfall events to nearby streams. Control of these sources is usually limited to land management BMPs and may be impracticable in most cases. As a result, forested areas are not specifically targeted in this TMDL.

E. coli loading from urban areas is potentially attributable to multiple sources including storm water runoff, unpermitted discharges of wastewater, runoff from improper disposal of waste materials, failing septic tanks, and domestic animals. Septic systems are common in unincorporated portions of the watershed and may be direct or indirect sources of bacterial pollution via ground and surface waters. Onsite septic systems have the potential to deliver E. coli bacteria to surface waters due to system failure and malfunction.

3.3 Land Use Assessment

Land use for the Goose Creek watershed was determined using ArcMap with land use datasets derived from the 2006 National Land Cover Dataset (NLCD). Figure 3-1 and Table 3-1 display the land use areas for the Goose Creek watershed. Figure 3-2 is a graph depicting the primary land uses in the Goose Creek watershed.

The majority of the Goose Creek watershed is 26.91% Agricultural, and 72.70% Forest. Other major land uses include Developed which accounts for approximately 0.00% of the watershed, Open Water which accounts for approximately 0.39% of the watershed. If not managed properly, agriculture can have significant nonpoint source impacts. Also, septic systems can be a main source of bacteria if not properly installed and maintained. Developed land includes both commercial and residential land uses.

Figure 3-1. Land Use Map for the Goose Creek Watershed

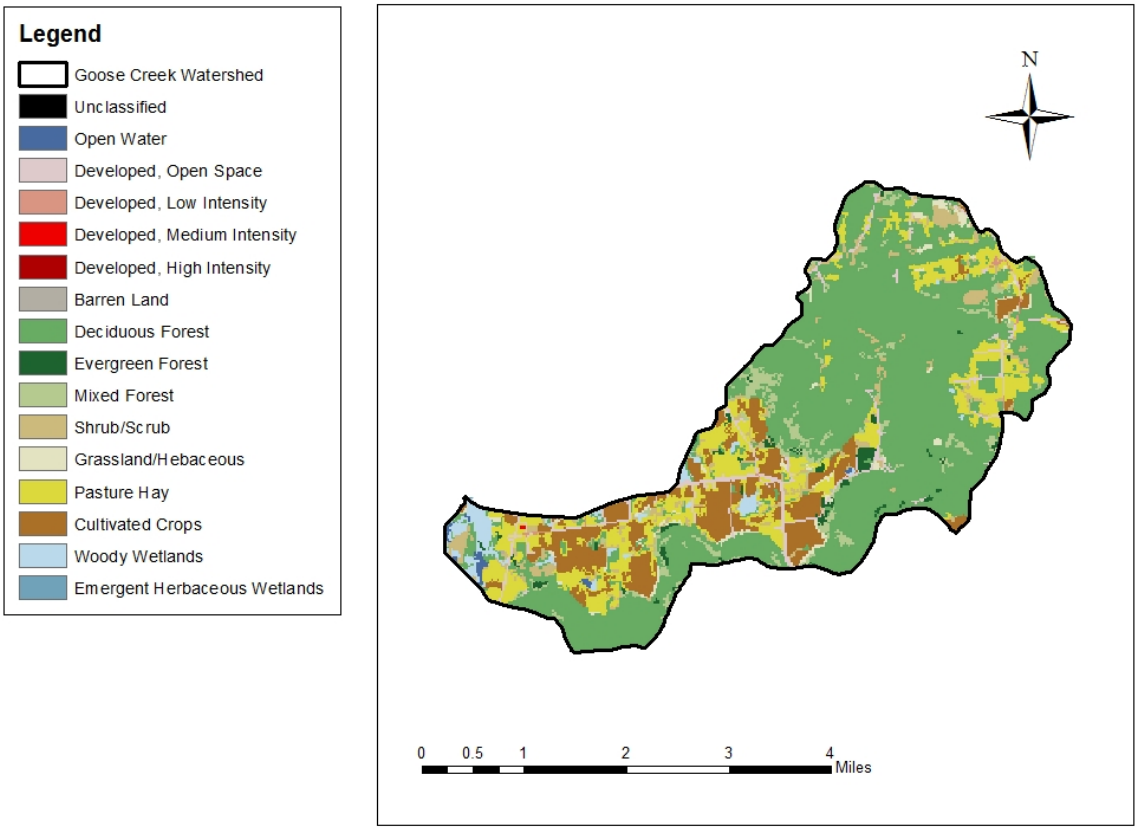
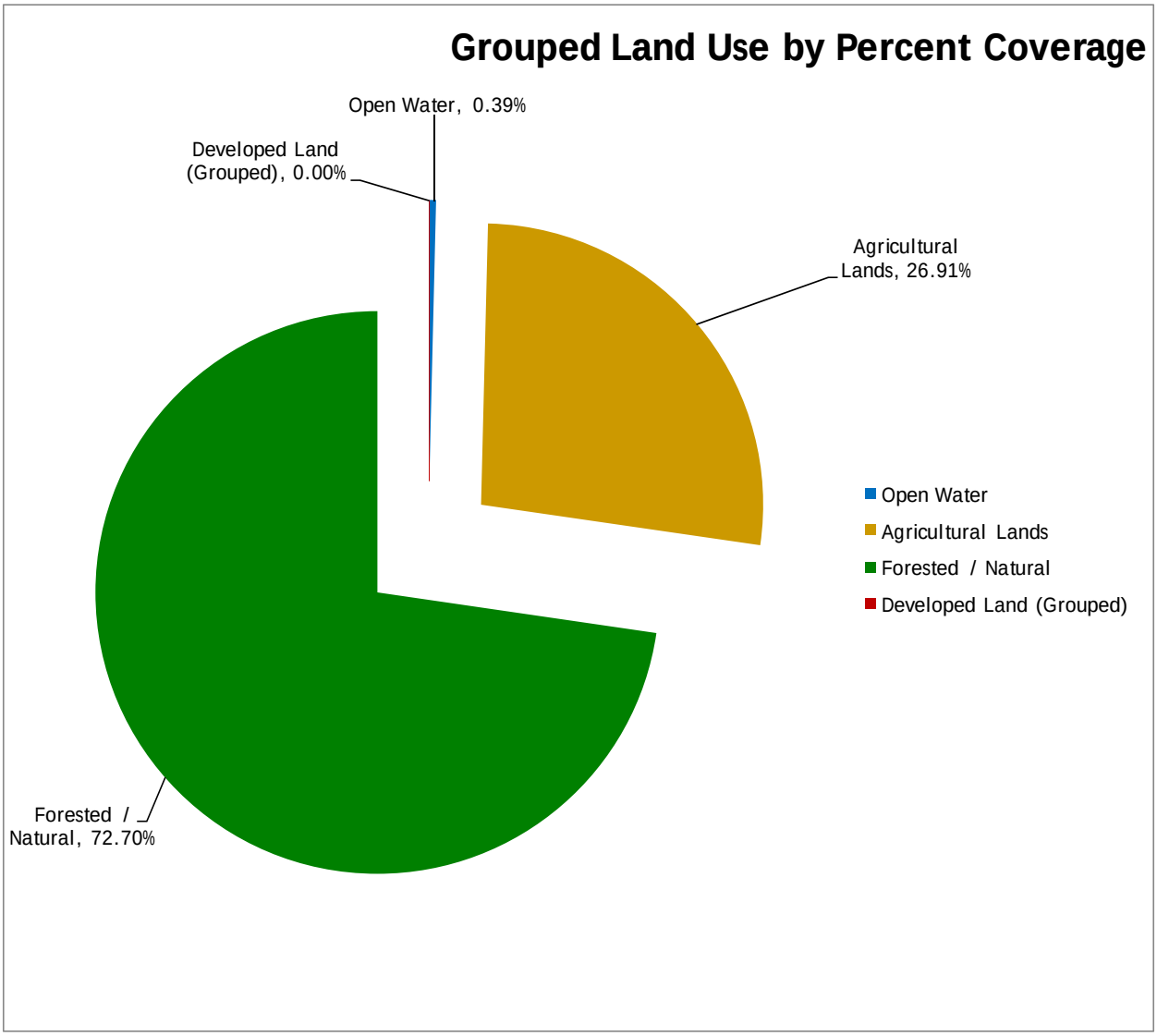


Table 3-1. Land Use Areas for the Goose Creek Watershed

Class Description	Count (30m)	mi²	Acres	Percent
Open Water	155	0.05	34.47	0.39%
Agricultural Lands	10764	3.74	2393.86	26.91%
Forested / Natural	29075	10.10	6466.13	72.70
Developed Land (Grouped)	0	0.00	0.00	0.00%
TOTALS →	**39994**	**13.90**	**8894.46**	**100.00%**

Figure 3-2. Graph of Primary Landuses in the Goose Creek Watershed



3.4 Linkage Between Numeric Targets and Sources

The Goose Creek watershed has two main landuses, namely forest, and agriculture. Pollutant loadings from forested areas tend to be low due to their filtering capabilities and will be considered as background conditions. The most likely sources of pathogen loadings in Goose Creek are from the agricultural land uses, urban run-off from rain events, unpermitted discharges of wastewater, and failing septic systems. It is not considered a logical approach to calculate individual components for nonpoint source loadings. Hence, there will not be individual loads or reductions calculated for the various nonpoint sources. The loadings and reductions will only be calculated as a single total nonpoint source load and reduction.

3.5 Data Availability and Analysis

TVA collected macroinvertebrate/EPT and fish IBI assessments for Goose Creek in 1994 and 1995. The macroinvertebrate/EPT assessment results were rated very poor/poor or very poor. This assessment is the bases of the 1998 §303(d) unknown toxicity listing. ADEM collected pathogens data (fecal coliform) for Goose Creek in 2003 and 2009. Of the 16 monthly samples that were collected in 2003, 1 sample exceeded the 2000 colonies/100 mL single sample criterion for fecal coliform bacteria. Of the 8 monthly samples that were collected in 2009, none exceeded the 2000 colonies/100 mL single sample criterion for fecal coliform bacteria. This data can be viewed in Appendix 7.2, Table 7-1.

In 2010, ADEM again collected water quality data on Goose Creek as part of Alabama's §303(d) Monitoring Program at two stations, namely GOOM-1 and GOOM-2. As previously mentioned, the 2010 data will only be used for this assessment because it is less than 6 years old. The January 2010 edition of ***Alabama's Water Quality Assessment and Listing Methodology*** section 4.8.2 prepared by ADEM provides the rationale for the Department to use the most recent data to prepare a TMDL for an impaired waterbody when that data indicates a change in water quality has occurred.

Figure 3-3 and Table 3-3 display location and description for the ADEM sampling stations. Of the five E. coli samples collected at GOOM-1 in 2010, zero violated the single sample F&W maximum criterion of 487 col/100 ml. Of the samples that qualified for a geometric mean calculation at GOOM-1 in 2010, one geometric mean event of 174.61 col/100ml (6/9/2010 through 6/30/210) exceeded the E. coli criterion of 126 col/100ml. Of the five E. coli samples collected at GOOM-2 in 2010, one violated the single sample F&W maximum criterion of 487 col/100 ml. The geometric mean sampling event at GOOM-2 resulted in a violation of 141.89 col/100mL, which exceeded the geometric mean E. coli criterion of 126 col/100ml. The single sample violation resulted in a 32% reduction, which was lower than the geometric mean event, therefore will not be used for TMDL development. The geometric mean exceedance event which resulted in the highest percent reduction (35%) was used in calculating the E. coli loading to Goose Creek (refer to Appendix 7.2, Table 7-2).

Direct stream flow measurements or representative drainage area ratioed equivalent streamflows from USGS gauging stations are necessary when relating fecal coliform samples to total mass loading of E-Coli. Actual streamflow measurements and representative drainage area ratioed equivalent streamflows from USGS gauging stations are not always feasible at the time of E-Coli sampling due to low flow, unsafe or non-wadeable conditions. Direct streamflows could not be measured for all of the E-Coli samples collected at GOOM-1 and GOOM-2 due to low flow, dangerous or non-wadeable conditions. United States Geological Survey (USGS) does not have a stream flow gauge that is a continuously recording gauge which provides real-time streamflow and stage measurements that is representative of Goose Creek at GOOM-1 or GOOM-2. Flow for GOOM-1 geometric mean load calculation was derived from averaging the measured flows (3.38 cfs). Flow for GOOM-2 geometric mean and single sample load calculations was derived from the average measured flows from GOOM-1 (3.38 cfs) ratioed using the two stations drainage area (2.02 cfs).

Table 3-2.
2010 E-Coli Exceedances for the Goose Creek Watershed

Station ID	Date	E Coli – Single Sample (col/100ml)	E Coli – Geomean (col/100ml)
GOOM-1	6/9/10	307.6	174.61
GOOM-1	6/14/10	191.8	
GOOM-1	6/17/10	117.8	
GOOM-1	6/22/10	172.8	
GOOM-1	6/30/10	135.4	
GOOM-2	6/9/10	648.8	141.89
GOOM-2	6/14/10	172.2	
GOOM-2	6/17/10	209.8	
GOOM-2	6/22/10	93.3	
GOOM-2	6/30/10	26.3	

Figure 3-3. Map of ADEM Sampling Station on Goose Creek

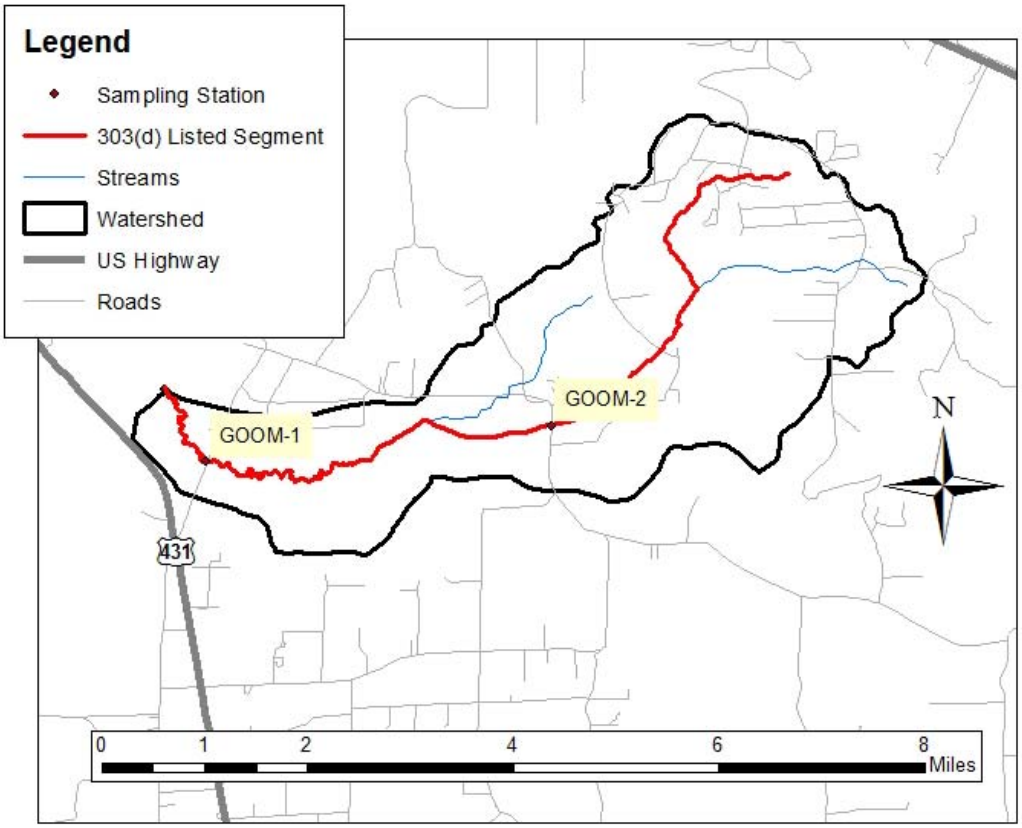


Table 3-3. Goose Creek Sampling Station Description

Years	Station ID	Data Source	Station Location	Latitude	Longitude
2003 2009 2010	GOOM-1	ADEM	Goose Creek at Old Highway 431.	34.62978	-86.45234
2003 2009 2010	GOOM-2	ADEM	Goose Creek at County Road 28 (Cherry Tree Road)	34.63486	-86.40368

3.6 Critical Conditions

Summer months (June-September) are generally considered critical conditions. This can be explained by the nature of storm events in the summer versus the winter. In summer, periods of dry weather interspersed with thunderstorms allow for the accumulation and washing off of E. coli bacteria into streams, resulting in spikes of E. coli bacteria counts. In winter, frequent low intensity rain events are more typical and do not allow for the build-up of E. coli bacteria on the land surface, resulting in a more uniform loading rate.

The impaired portion of the Goose Creek watershed generally follows the trends described above for the summer months of June through September. The critical condition for this pathogen TMDL was taken to be the highest E. coli geometric mean exceedance value. That value was 174.61 colonies/100 mL that occurred on the June 9, 2010 through June 30, 2010 sampling period at station GOOM-1. The average flow of 3.38 cfs was obtained during this sampling event.

3.7 Margin of Safety

There are two methods for incorporating a Margin of Safety (MOS) in the analysis: 1) implicitly incorporate the MOS using conservative model assumptions to develop allocations, or 2) by explicitly specifying a portion of the TMDL as the MOS and using the remainder for allocations.

Both an explicit and implicit MOS was incorporated into this TMDL. The MOS accounts for the uncertainty associated with the limited availability of E. coli data used in this analysis. An explicit MOS was applied to the TMDL by reducing the E. coli target geometric mean criterion concentration by ten percent and calculating a mass loading target with measured flow data. The geometric mean criterion was reduced by ten percent to achieve a target concentration of 113.4 colonies/100 mL. An implicit MOS was incorporated in the TMDL by basing the existing condition on the highest measured E. coli concentration that was collected during critical conditions.

4.0 TMDL Development

4.1 Definition of a TMDL

A total maximum daily load (TMDL) is the sum of individual wasteload allocations for point sources (WLAs), load allocations (LAs) for nonpoint sources including natural background levels, and a margin of safety (MOS). The margin of safety can be included either explicitly or implicitly and accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. As discussed earlier, the MOS is explicit in this TMDL. A TMDL can be denoted by the equation:

$$TMDL = \Sigma\ WLAs + \Sigma\ LAs + MOS$$

The TMDL is the total amount of pollutant that can be assimilated by the receiving waterbody while achieving water quality standards under critical conditions.

For some pollutants, TMDLs are expressed on a mass loading basis (e.g. pounds per day). However, for pathogens, TMDL loads are typically expressed in terms of organism counts per day (colonies/day), in accordance with 40 CFR 130.2(i).

4.2 Load Calculations

A mass balance approach was used to calculate the pathogen TMDL for Goose Creek. The mass balance approach utilizes the conservation of mass principle. Total mass loads can be calculated by multiplying the E. coli concentration times the instream flow times and a conversion factor. The existing load was calculated for the violation in 2010 that resulted in the highest percent reduction. This violation was a geometric mean exceedance. In the same manner, the allowable load was calculated for the single sample criterion of 438.3 colonies/100 mL. Although there were multiple single-sample and geometric mean violations in 2010, the TMDL was based on the highest calculated E. coli load percent reduction to achieve applicable water quality criteria.

Existing Conditions

The **geometric mean** mass loading was calculated by multiplying the geometric mean exceedance concentration of 174.61 colonies/100 ml times the average flow of the samples. This concentration was calculated based on measurement at GOOM-1 for the June 9, 2010 through June 30, 2010 sampling period, and can be found in Table 7-2, Appendix 7.2. The average stream flow was 3.38 cfs at the time of the violation. The product of these two values times the conversion factor gives the total mass loading (colonies per day) of E. coli to Goose Creek.

$$\frac{3.38\,\text{ft}^3}{\text{s}} \times \frac{174.61\ \text{colonies}}{100\,\text{mL}} \times \frac{24465755\ \ 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{1.44 \times 10^{10}\ \text{colonies}}{\text{day}}$$

Allowable Conditions

The **allowable load** to the watershed was calculated under the same physical conditions as discussed above for the geometric mean criterion. This is done by taking the product of the average flow used for the violation event times the conversion factor times the allowable concentration.

For the **geometric mean** E. coli target concentration of 113.4 colonies/100 mL. The allowable E. coli loading is:

$$\frac{3.38\ \text{ft}^3}{\text{s}} \times \frac{113.4\ \text{colonies}}{100\,\text{mL}} \times \frac{24465755\quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{9.38 \times 10^9\ \text{colonies}}{\text{day}}$$

The explicit margin of safety of 12.6 colonies/100 mL equals a daily loading of:

$$\frac{3.38\,\text{ft}^3}{\text{s}} \times \frac{12.6\ \text{colonies}}{100\,\text{mL}} \times \frac{24465755\quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{1.04 \times 10^9\ \text{colonies}}{\text{day}}$$

The difference in the pathogen loading between the existing condition (violation event) and the allowable condition converted to a percent reduction represents the total load reduction needed to achieve the E. coli water quality criterion. The TMDL was calculated as the total daily E. coli load to Goose Creek as evaluated at station GOOM-1. Table 4-1 shows the result of the E. coli TMDL and percent reduction for the geometric mean criterion.

Table 4-1. 2010 E. coli Load and Required Reduction

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Nonpoint Source Load Single Sample	3.21E+10	2.17E+10	1.04E+10	32%
Nonpoint Source Load Geometric Mean	1.44E+10	9.38E+9	5.06E+9	35%
Point Source Load	NA[a]	NA[a]	NA[a]	NA[a]

a. No NPDES permitted outfalls.

From Table 4-1, compliance with the geometric mean criterion of 126 colonies/100 mL requires a reduction in the E. coli load of 35%. The TMDL, WLA, LA and MOS values necessary to achieve the applicable E. coli criterion are provided in Table 4-2 below.

Table 4-2. E. coli TMDL for Goose Creek

TMDL[e]	Margin of Safety (MOS)	Waste Load Allocation (WLA)[a]			Load Allocation (LA)	
		WWTPs[b]	MS4s[c]	Leaking Collection Systems[d]		
(col/day)	(col/day)	(col/day)	(% reduction)	(col/day)	(col/day)	(% reduction)
1.04E+10	1.04E+9	NA	NA	0	9.38E+9	35%

Note: NA = not applicable
a. There are no CAFOs in the Goose Creek watershed. Future CAFOs will be assigned a waste load allocation (WLA) of zero.
b. Future WWTPs must meet the applicable instream water quality criteria for pathogens at the point of discharge.
c. Future MS4 areas would be required to demonstrate consistency with the assumptions and requirements of this TMDL.
d. The objective for leaking collection systems is a WLA of zero. It is recognized, however, that a WLA of 0 colonies/day may not be practical. For these sources, the WLA is interpreted to mean a reduction in E. coli loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality criteria for E. coli.
e. TMDL was established using the geometric mean criterion of 126 colonies/100ml.

4.3 TMDL Summary

Goose Creek was originally placed on Alabama's §303(d) list in 1998 for unknown toxicity based on the TVA macroinvertebrate/EPT assessment in 1994 and 1995. On the Draft 2012 §303(d) list, the listing has been changed from unknown toxicity to pathogens based on 2009 and 2010 water quality data collected by ADEM. The 2009 and 2010, ADEM collected water quality data confirmed the pathogen impairment and provided the basis for TMDL development.

A mass balance approach was used to calculate the E. coli TMDL for Goose Creek. Based on the TMDL analysis, it was determined that a 35% reduction in E. coli loading was necessary to achieve compliance with applicable water quality standards.

Compliance with the terms and conditions of existing and future NPDES sanitary and stormwater permits will effectively implement the WLA and demonstrate consistency with the assumptions and requirements of the TMDL. Required load reductions in the LA portion of this TMDL can be implemented through voluntary measures and may be eligible for CWA §319 grants.

The Department recognizes that adaptive implementation of this TMDL will be needed to achieve applicable water quality criteria, and we are committed towards targeting the load reductions to improve water quality in the Goose Creek watershed. As additional data and/or information become available, it may become necessary to revise and/or modify the TMDL accordingly.

5.0 Follow Up Monitoring

ADEM has adopted a basin approach to water quality management; an approach that divides Alabama's fourteen major river basins into five groups. Each year, ADEM's water quality resources are concentrated in one of the five basin groups. One goal is to continue to monitor §303(d) listed waters. Monitoring will help further characterize water quality conditions resulting from the implementation of best management practices in the watershed. This monitoring will occur in each basin according the schedule shown.

Table 5-1. 303(d) Follow Up Monitoring Schedule

River Basin Group	Year to be Monitored
Black Warrior / Cahaba	2012
Tennessee	2013
Chattahoochee / Chipola / Choctawhatchee / Perdido-Escambia	2014
Alabama / Coosa / Tallapoosa	2015
Escatawpa / Mobile / Lower Tombigbee / Upper Tombigbee	2016

6.0 Public Participation

As part of the public participation process, this TMDL was placed on public notice and made available for review and comment. The public notice was prepared and published in the four major daily newspapers in Montgomery, Huntsville, Birmingham, and Mobile, as well as submitted to persons who have requested to be on ADEM's postal and electronic mailing distributions. In addition, the public notice and subject TMDL was made available on ADEM's Website: www.adem.state.al.us. The public can also request paper or electronic copies of the TMDL by contacting Mr. Chris Johnson at 334-271-7827 or cljohnson@adem.state.al.us. The public was given an opportunity to review the TMDL and submit comments to the Department in writing. At the end of the public review period, all written comments received during the public notice period became part of the administrative record. ADEM considered all comments received by the public prior to finalization of this TMDL and subsequent submission to EPA Region 4 for final review and approval.

7.0 Appendices

Appendix 7.1
References

ADEM Administrative Code, 2010. Water Division - Water Quality Program, Chapter 335-6-10, Water Quality Criteria.

ADEM Administrative Code, 2010. Water Division - Water Quality Program, Chapter 335-6-11, Use Classifications for Interstate and Intrastate Waters.

Alabama's §303(d) Monitoring Program. 2003, 2009, & 2010. ADEM.

Alabama Department of Environmental Management (ADEM), Alabama's Water Quality Assessment and Listing Methodology, January 2010.

Alabama Department of Environmental Management, 1998, 2000, 2002, 2004, 2006, & 2008 §303(d) Lists and Fact Sheets. ADEM.

Alabama Department of Environmental Management (ADEM) Laboratory QA Manual, Chapter 5, Table 5-2: ADEM Laboratory Qualifier Codes and, June 13, 2005.

United States Environmental Protection Agency, 1991. Guidance for Water Quality-Based Decisions: The TMDL Process. Office of Water. EPA 440/4-91-001.

United States Environmental Protection Agency, 1986. Quality Criteria for Water. Office of Water. EPA 440/4-91-001.

Appendix 7.2
Water Quality Data

Table 7-1. ADEM Pathogen Data Collected on Goose Creek (2003, 2009)

Station ID	Visit Date	Flow (cfs)	Flow Stage	Fecal Coliform (col/100 ml)	Percent Reduction (Single Sample)	Fecal Coliform dc
GOOM-1	3/26/2003	21.5	NORMAL	90		
GOOM-1	4/10/2003		ABOVE NORMAL	184		
GOOM-1	5/15/2003		ABOVE NORMAL	228		
GOOM-1	5/29/2003	11.5	NORMAL	450		H
GOOM-1	6/24/2003		NORMAL	560		
GOOM-1	7/29/2003		NORMAL	290		
GOOM-1	8/11/2003		LOW	630		
GOOM-1	9/24/2003		ABOVE NORMAL	760		
GOOM-1	10/15/2003		LOW	80		
GOOM-1	3/23/2009	14.4	ABOVE NORMAL	13		JH
GOOM-1	4/14/2009		ABOVE NORMAL	600		G
GOOM-1	5/13/2009	23.1019	NORMAL	43		
GOOM-1	6/11/2009	3.526	NORMAL	210		
GOOM-1	7/8/2009	0.0888	LOW	380		
GOOM-1	8/13/2009	0.0501	NORMAL	130		
GOOM-1	10/20/2009	1.6094	NORMAL	210		
GOOM-2	3/26/2003		NORMAL	48		
GOOM-2	4/10/2003		LOW	100		
GOOM-2	5/15/2003		ABOVE NORMAL	2720	34%	
GOOM-2	6/24/2003		NORMAL	320		
GOOM-2	7/29/2003		LOW	136		
GOOM-2	8/11/2003		LOW	360		
GOOM-2	9/24/2003		NORMAL	820		
GOOM-2	10/15/2003		LOW	64		
GOOM-2	3/23/2009	0.1	LOW	136		JH

G = The analyte is present, but the amount of the analyte is determined to be above an acceptable level for quantitation. QC measurements indicate a low bias for the sample result reported or an accurate result cannot be calculated, but is determined to be greater than the value given (Micro: The actual number was greater than the number reported)

H = The analytical hold times for analysis was exceeded.

JH = The identification of the analyte is acceptable; the reported value is an estimate. The reported value is between the method detection limit and the practical Quantization limit.

Table 7-2. 2010 ADEM Pathogen DataCollected with Percent Reductions from Goose Creek

Station ID	Visit Date	Flow (cfs)	Flow Stage	E Coli (col/100 ml)	Percent Reduction (Single Sample)	E Coli dc	E Coli - Geomean (col/100 ml)	Percent Reduction (Geomean)
GOOM-1	6/9/2010		LOW	307.6			174.61	35%
GOOM-1	6/14/2010		LOW	191.8				
GOOM-1	6/17/2010	5.6054	NORMAL	117.8				
GOOM-1	6/22/2010	1.1492	LOW	172.5				
GOOM-1	6/30/2010		LOW	135.4				
GOOM-1	10/26/2010		LOW	2419.6		GH		
GOOM-1	11/30/2010		FLOOD	2419.6		G		
GOOM-2	6/9/2010		LOW	648.8	32%		141.89	20%
GOOM-2	6/14/2010		LOW	172.2				
GOOM-2	6/17/2010		LOW	209.8				
GOOM-2	6/22/2010		LOW	93.3				
GOOM-2	6/30/2010		LOW	26.3				
GOOM-2	11/30/2010		FLOOD	2419.6		G		

G = The analyte is present, but the amount of the analyte is determined to be above an acceptable level for quantitation. QC measurements indicate a low bias for the sample result reported or an accurate result cannot be calculated, but is determined to be greater than the value given (Micro: The actual number was greater than the number reported)

GH = The analytical holding times for analysis are exceeded. The actual number was probably greater than the number reported.

Appendix 7.3
Goose Creek Watershed Photos

Photo 7-1 Goose Creek at GOOM-1 (Old Highway 431) August 17, 2009 Looking Upstream

Photo 7-2 Goose Creek at GOOM-1 (Old Highway 431) August 17, 2009 Looking Downstream

Photo 7-3 Goose Creek Upstream of GOOM-1 (Old Highway 431) August 17, 2009 #1

Photo 7-4 Goose Creek Upstream of GOOM-1 (Old Highway 431) August 17, 2009 #2

Photo 7-5 Goose Creek at GOOM-1 (Old Highway 431) September 13, 2010 Looking Upstream

Photo 7-6 Goose Creek at GOOM-1 (Old Highway 431) September 13, 2010 Looking Downstream

Photo 7-7 Goose Creek at GOOM-2 (Cherry Tree Road) August 17, 2009 Looking Upstream

Photo 7-7 Goose Creek at GOOM-2 (Cherry Tree Road) August 17, 2009 Looking Downstream

Photo 7-7 Goose Creek at GOOM-2 (Cherry Tree Road) September 13, 2010 Looking Upstream

Photo 7-7 Goose Creek at GOOM-2 (Cherry Tree Road) September 13, 2010 Looking Downstream