Final

Total Maximum Daily Load (TMDL)
for
Cubahatchee Creek

Assessment Unit ID # AL03150110-0702-102 (2008 ID)
Assessment Unit ID # AL03150110-0603-102 (2010 ID)

Pathogens (E. coli)

Alabama Department of Environmental Management
Water Quality Branch
Water Division
September 2011

Figure I. Cubahatchee Creek Watershed

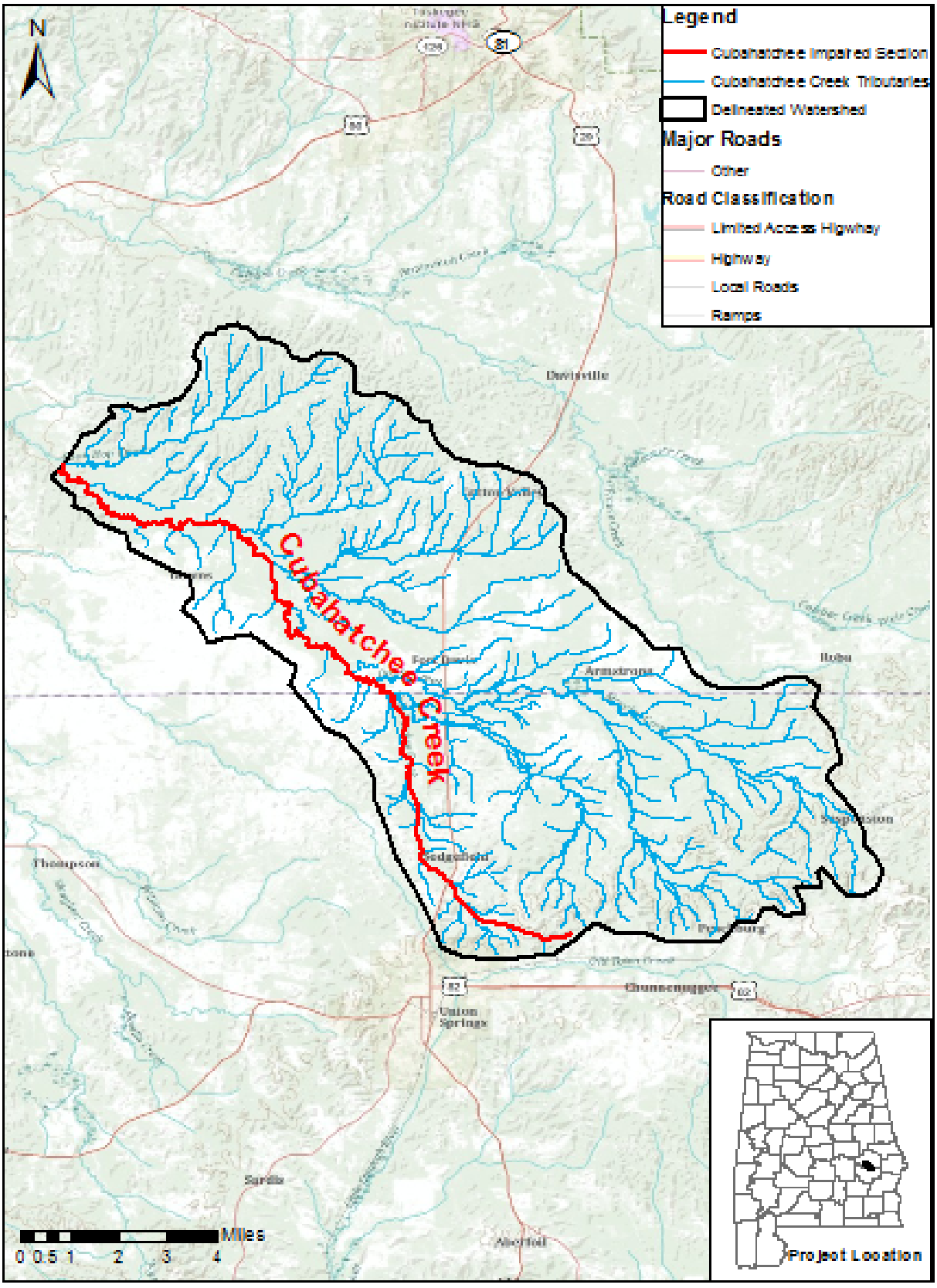


Table of Contents *Page*

List of Figures

List of Tables

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).

Cubahatchee Creek is on the §303(d) list for pathogens from Coon Hop Creek to its source. Cubahatchee Creek forms in Bullock and Macon Counties north of the city of Union Springs, in the Tallapoosa River basin. It flows through Macon County and into the Tallapoosa River. The total length of Cubahatchee Creek is 44.44 miles, of which 22.37 miles are on the §303(d) list for pathogens. The total drainage area of the Cubahatchee Creek watershed is 604.3 square miles, of which 86.1 square miles drains to the impaired segment. Cubahatchee Creek has a use classification of Swimming and Fish & Wildlife (S/F&W). During the 2006 and 2008 listing cycles, Cubahatchee Creek's Assessment Unit ID was AL03150110-0702-102. During the development of the 2010 Integrated Report its Assessment Unit ID was revised to AL03150110-0603-102. For purposes of this report and future tracking the new Assessment Unit ID will be used.

Cubahatchee Creek was first listed on the §303(d) list in 2006 based on data collected in 2000 by ADEM which indicated the stream was impaired for fecal coliform. The data was collected from stations CUBM-1 and CUBM-2 and can be found in Appendix 7.2, Table 7-4. Cubahatchee Creek has subsequently been listed on the 2008 and 2010 §303(d) lists of impaired waterbodies.

In 2010, §303(d) sampling studies were performed by ADEM on Cubahatchee 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 Cubahatchee 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 CUBB-1, CUBM-1, and CUBM-2 in 2010; even though the 2000 data that prompted the listing of Cubahatchee Creek was based on the fecal coliform criteria. ADEM collected 20 samples from Cubahatchee Creek at 3 stations in 2010. According to the data collected in 2010, Cubahatchee Creek was not meeting the pathogen criterion applicable to its use classification of Swimming/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 Cubahatchee 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 single sample exceedance that resulted in the

highest percent reduction. In the same manner, an allowable load was calculated for the single sample E. coli criterion of 235 colonies/100 mL. More specifically, the existing pathogen loading for this TMDL was calculated using the single sample exceedance concentration of 579.4 colonies/100 mL from 8/23/2010 times the estimated flow of the sample (0.33 cfs) and a conversion factor. The allowable loading, defined by the single sample criterion including a margin of safety, was calculated using the same flow value times the E. coli single sample target of 211.5 colonies/100 mL (235 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 63%.

Table 1-1 is a summary of the estimated existing load, allowable load, and percent reduction for the single sample criterion. Table 1-2 provides the details of the TMDL along with the corresponding reductions for Cubahatchee 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	4.68E+09	1.71E+09	2.97E+09	63%
Nonpoint Source Load Geometric Mean	1.20E+09	2.56E+09	0	0%
Point Source Load	N/A	N/A	N/A	N/A

Table 1-2. E. coli TMDL for Cubahatchee 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)
1.90E+09	1.90E+08	N/A	N/A	0	1.71E+09	63%

a. There are no CAFOs in the Cubahatchee Creek watershed. Future CAFOs will be assigned a waste load allocation (WLA) of zero.
b. WLAs for WWTPs are expressed as a daily maximum; N/A = not applicable, no point sources. 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 single sample criterion of 235 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 Cubahatchee 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 in-stream 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 22.37 mile segment of Cubahatchee Creek from Coon Hop Creek to its source in Bullock and Macon Counties as being impaired by pathogens (E. coli). The §303(d) listing was originally reported on Alabama's 2006 List of Impaired Waters based on ADEM data collected in 2000, and subsequently included on the 2008 and 2010 lists. The source of the impairment is listed on the 2010 §303(d) list as pasture grazing.

2.2 Problem Definition

Waterbody Impaired:	Cubahatchee Creek – From Coon Hop Creek to its source.
Impaired Reach Length:	22.37 miles
Impaired Drainage Area:	86.1 square miles
Water Quality Standard Violation:	Pathogens (single sample)
Pollutant of Concern:	Pathogens (E. coli)
Water Use Classification:	Swimming/Fish and Wildlife

Usage Related to Classification:
The impaired segment of Cubahatchee Creek is classified as Swimming/Fish and Wildlife (S/F&W). Usage of waters in this classification are described in ADEM Admin. Code R. 335-6-10-.09(3)(a), and (b); & ADEM Admin. Code R. 335-6-10-.09(5)(a), (b), (c), and (d).

335-6-10-.09(3):

(a) Best usage of waters: swimming and other whole body water-contactsports.

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

335-6-10-.09(5):

(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 Swimming use classification are described in ADEM Admin. Code R. 335-6-10-.09(3)(c)6(i), (ii), and (iii) as follows:

6. Bacteria:

(i) 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.*

(ii) In all other areas, 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 235 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 104 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 mean bacterial 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.

(iii) The policy of nondegradation of high quality waters shall be stringently applied to bacterial quality of recreational waters.

Criterion for acceptable bacteria levels for the Fish and Wildlife use classification are 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 watercontact sports.

<u>Criteria Exceeded:</u>
Fecal coliform data collected by ADEM Field Operations in 2000 was used for listing Cubahatchee Creek on Alabama's 2006 §303(d) list. At the time of the listing, the binomial

distribution function was employed to calculate the number of exceedances in each range of sample sizes collected over a six year period that exceed the single-sample maximum criterion of 2,000 colonies/100 mL for pathogens needed to say with 90% confidence that the criterion is exceeded in more than 10% of the population represented by the available samples. Waters in which samples collected over a six year period exceeding the single-sample maximum of 2,000 colonies/100 mL is less than or equal to the allowable exceedances for that sample size or a geometric mean less than or equal to 200 colonies/100 mL (June-September) or 1000 colonies/100 mL (October-May) in at least five samples collected in a thirty day period were considered to comply with Alabama's water quality standard for pathogen's. Waters in which the samples collected over a six year period exceeding the single-sample maximum of 2000 colonies/100 mL is greater than the allowable exceedances for that sample size or a geometric mean greater than 200 colonies/100 mL (June-September) or 1000 colonies/100 mL (October-May) in at least five samples collected in a thirty day period were considered impaired and listed for pathogens on Alabama's §303(d) list.

ADEM collected single sample data on Cubahatchee Creek at stations CUBM-1 and CUBM-2 in 2000. According to the 2006 §303(d) fact sheet, Cubahatchee Creek was listed as impaired based on pathogen data collected at station CUBM-1. Of 10 samples collected by ADEM in 2000 at stations CUBM-1 and CUBM-2 3 samples exceeded the 2000 colonies/100 mL single sample criterion for fecal coliform causing the stream to be placed on the list of impaired streams.

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 developed from E. coli data collected at stations CUBM-1, CUBM-2, and CUBB-1; even though the 2000 data that prompted the listing of Cubahatchee Creek was based on fecal coliform criteria.

The impaired segment of Cubahatchee Creek is classified as Swimming/Fish and Wildlife (S/F&W), because the water has two uses (and two applicable criterion), the TMDL will use the stricter of the limits for the TMDL target, which applies to the Swimming use. For the purpose of this TMDL a single sample E. coli target of 211.5 colonies/100 mL will be used. This target was derived by using a 10% explicit margin of safety from the single sample maximum of 235 colonies/100 mL criterion. This target is considered protective of water quality standards and should not allow the single sample of 235 colonies/100 mL to be exceeded.

3.2 Source Assessment

3.2.1 Point Sources in the Cubahatchee 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 sewer systems 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 typically run parallel to streams in the floodplain. If a leaking sewer line is present, 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 not permitted, or when E. coli criterion established in the issued NPDES permit is not being upheld.

Continuous Point Sources
There are no continuous NPDES discharges located in the Cubahatchee Creek watershed. However, any future NPDES regulated discharges that are considered by the Department to be a pathogen source will be required to meet the in-stream 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 Cubahatchee Creek watershed.

Also, according to the ADEM database, there have been no reported sanitary sewer overflows (SSOs) that have occurred in the Cubahatchee 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 discharger, 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 Cubahatchee 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 and be washed into streams or waterbodies during rain events. Therefore, there is some net loading of E. coli bacteria into streams as dictated by the watershed hydrology.

Due to the absence of major point sources in the Cubahatchee Creek watershed, nonpoint sources are believed to be the primary source of E. coli bacteria. Land use in this watershed is primarily forest and agriculture. Approximate land use proportions are 74% forested, 10% agriculture, and 3% developed, with the remaining 13% being spread among open water, and wetlands.

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, turkeys, 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 Cubahatchee 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 Cubahatchee Creek watershed. Figure 3-1 is a graph depicting the primary land uses in the Cubahatchee Creek watershed.

The majority of the Cubahatchee Creek watershed is 74% Forest, and 10% Agricultural. Other major land uses within the watershed account for approximately 3% Developed, 12% Woody Wetlands, and 1% for the other remaining uses. 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 Cubahatchee Creek Watershed

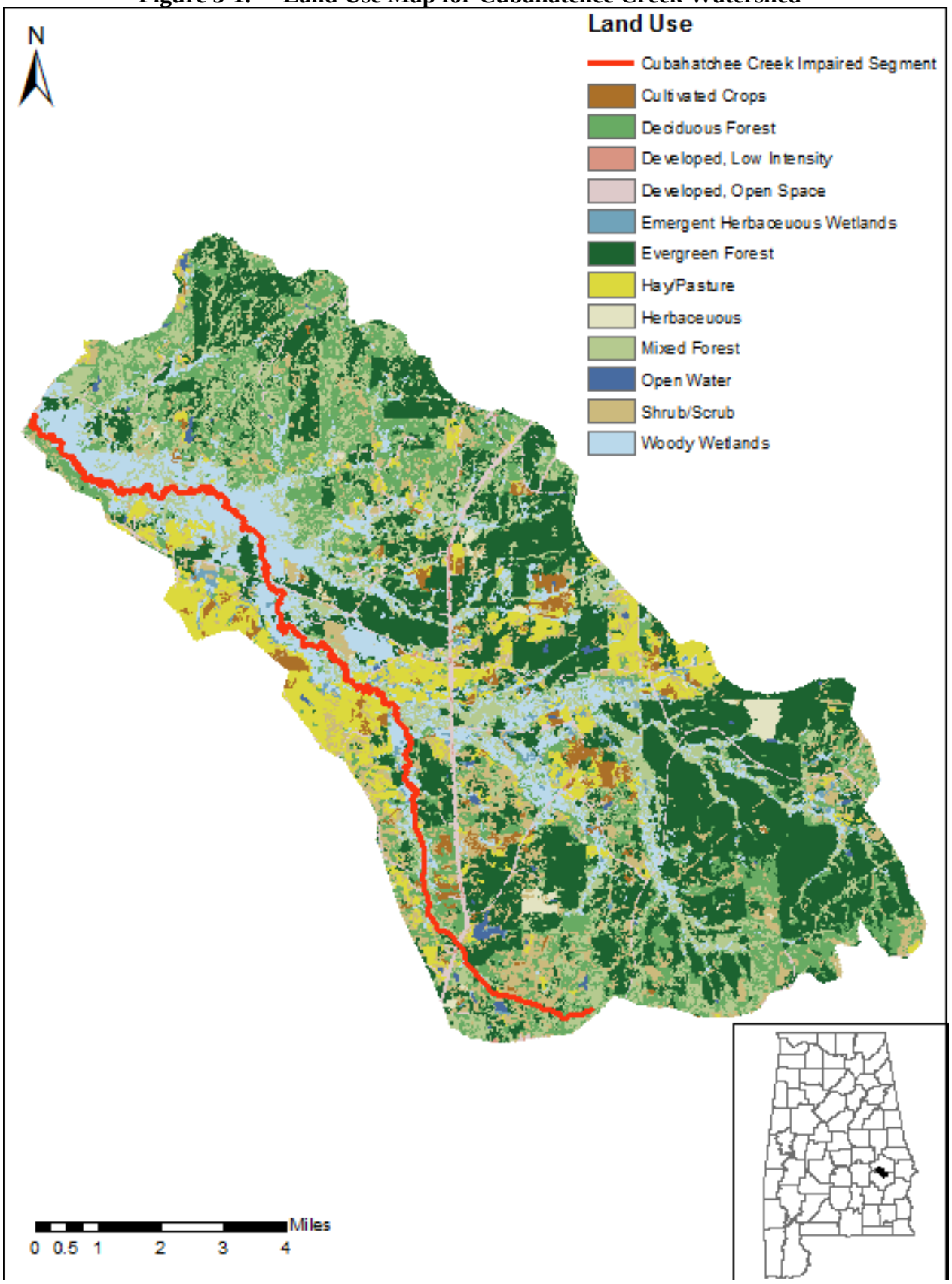
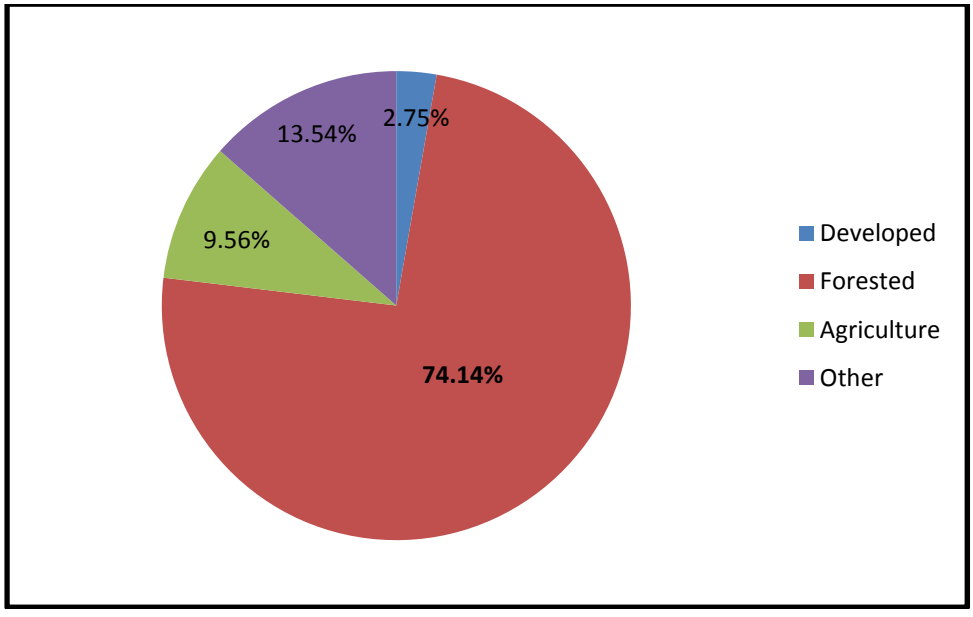


Table 3-1. Land Use Areas for the Cubahatchee Creek Watershed

Land Use	Square Miles	Acres	Percentage
Open Water	0.46	297.45	0.54%
Developed, Open Space	2.30	1,473.45	2.67%
Developed, Low Intensity	0.07	43.57	0.08%
Deciduous Forest	13.53	8,657.32	15.71%
Evergreen Forest	27.17	17,392.00	31.56%
Mixed Forest	14.66	9,381.82	17.03%
Shrub/Scrub	7.70	4,925.44	8.94%
Herbaceous	0.78	497.97	0.90%
Hay/Pasture	6.44	4,122.25	7.48%
Cultivated Crops	1.79	1,148.00	2.08%
Woody Wetlands	10.42	6,670.33	12.10%
Emergent Herbaceous Wetlands	0.77	494.41	0.90%
Total	**86.10**	**55,104.00**	**100.00%**
Cumulative Land Use			
Developed	2.37	1,517.03	2.75%
Forested	63.84	40,854.54	74.14%
Agriculture	8.23	5,270.24	9.56%
Other	11.66	7,462.19	13.54%
Total	**86.10**	**55,104.00**	**100.00%**

Figure 3-2 Graph of Primary Land uses in the Cubahatchee Creek Watershed



3.4 Linkage Between Numeric Targets and Sources

The Cubahatchee Creek watershed has three main land uses, namely developed, forested, 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 Cubahatchee 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.

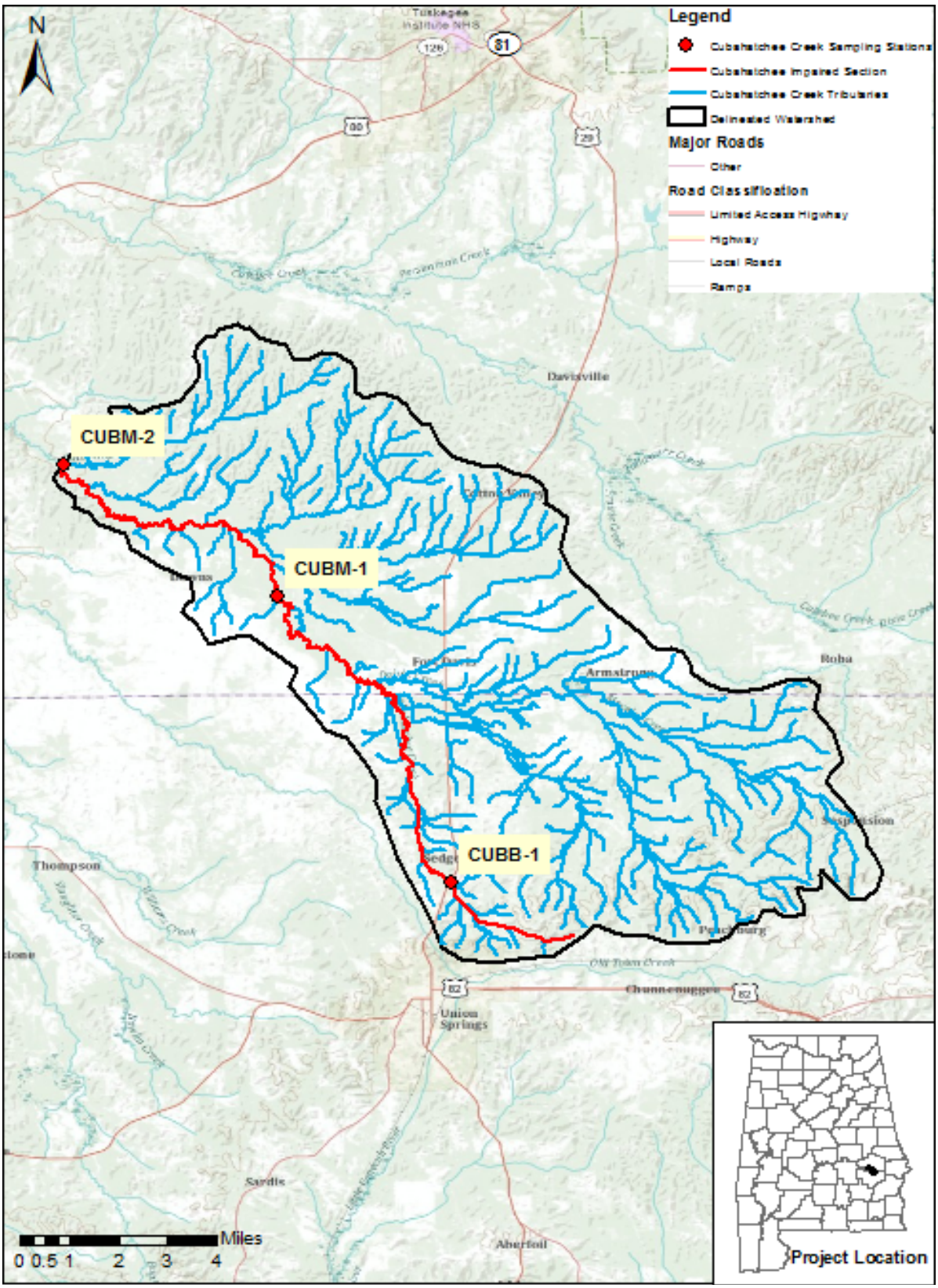
3.5 Data Availability and Analysis

ADEM collected monthly water quality data for Cubahatchee Creek at 3 stations (CUBB-1, CUBM-1, & CUBM-2) along the impaired water body in 2010. The following are the number of samples collected at each station: CUBB-1 (4), CUBM-1 (8), & CUBM-2 (8). No violations occurred at CUBB-1 and CUBM-2, and there was 1 single sample violation at CUBM-1. The breakdown of the violation is as follows: A single sample violation occurred at CUBM-1 on August 23, 2010. An E. coli concentration of 579.4 colonies/100 mL was measured on this day. No flow was taken at this time, the flow was described as not visible and not measurable with a meter. Since no flow was measured on the day of this exceedance, a flow was estimated by utilizing the ratio method and USGS Gage 02421000 at Catoma Creek near Montgomery, AL. This flow was used in conjunction with the exceedance concentration to determine an accurate mass loading. Of the two sampling events that qualified for a geometric mean calculation in 2010, no samples exceeded the E. coli geometric mean criterion of 126 col/100 mL. Therefore the geometric mean samples will not be used for the development of the TMDL.

Table 3-3 E. coli Single Sample Violation on Cubahatchee Creek

Station	Date	E. coli (col/100 mL)	Flow (cfs)	Flow Measured (?)
CUBM-1	8/23/2010	579.4		NO-VISIBLE, BUT NOT MEASURABLE WITH METER

Figure 3-3. Map of ADEM Sampling Stations on Cubahatchee Creek



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 Cubahatchee 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 one with the highest E. coli single sample exceedance value. That value was 579.4 colonies/100 mL that occurred on August 23, 2010 at station CUBM-1. A flow of 0.33 cfs was estimated for CUBM-1 at the time of the sample collection.

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 target single sample criterion concentration by ten percent and calculating a mass loading target with measured flow data. The single sample maximum value of 235 colonies/100 mL was reduced by 10% to 211.5 colonies/100 mL. An implicit MOS was also 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 both implicit and 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 Cubahatchee 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 in-stream 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 single sample exceedance. In the same manner, the allowable load was calculated for the single sample criterion of 211.5 colonies/100 mL.

Existing Conditions

The **single sample** mass loading was calculated by multiplying the highest single sample E. coli exceedance concentration of 579.4 colonies/100 ml times the estimated flow of 0.33 cfs. This concentration was calculated based on measurements at CUBM-1 on August 23, 2010 and can be found in Table 7-2, Appendix 7.2. The product of these two values and a conversion factor gives the total mass loading (colonies per day) of E. coli to Cubahatchee Creek under a single sample exceedance condition.

$$\frac{0.33\,\text{ft}^3}{\text{s}} \times \frac{579.4\,\text{colonies}}{100\,\text{mL}} \times \frac{24{,}465{,}755 \quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{4.68 \times 10^9\ \text{colonies}}{\text{day}}$$

Allowable Conditions

The **allowable load** to the watershed was calculated under the same physical conditions as discussed above for the single sample criterion. This is done by taking the product of the estimated flow used for the violation event times the conversion factor times the allowable concentration which are as follows:

For the **single sample** E. coli concentration of 211.5 colonies/100 mL. The allowable E. coli loading is:

$$\frac{0.33\ \text{ft}^3}{\text{s}} \times \frac{211.5\ \text{colonies}}{100\,\text{mL}} \times \frac{24{,}465{,}755 \quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{1.71 \times 10^9\ \text{colonies}}{\text{day}}$$

The explicit margin of safety of 23.5 colonies/100 mL equals a daily loading of:

$$\frac{0.33\,\text{ft}^3}{\text{s}} \times \frac{23.5\ \text{colonies}}{100\,\text{mL}} \times \frac{24{,}465{,}755 \quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{1.90 \times 10^8\ \text{colonies}}{\text{day}}$$

The difference in the pathogen loading between the existing conditions (violation event) and the allowable conditions 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 Cubahatchee Creek as evaluated at station CUBM-1. Table 4-1 shows the results of the E. coli TMDL and percent reductions for each 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	4.68E+09	1.71E+09	2.97E+09	63%
Nonpoint Source Load Geometric Mean	1.20E+09	2.56E+09	0	0%
Point Source Load	N/A	N/A	N/A	N/A

From Table 4-1, compliance with the single sample criterion of 211.5 colonies/100ml requires a reduction in the E. coli load of 63%. 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 Cubahatchee 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)
1.90E+09	1.90E+08	N/A	N/A	0	1.71E+09	63%

a. There are no CAFOs in the Cubahatchee Creek watershed. Future CAFOs will be assigned a waste load allocation (WLA) of zero.
b. WLAs for WWTPs are expressed as a daily maximum; N/A = not applicable, no point sources. 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 single sample criterion of 235 colonies/100ml.

4.3 TMDL Summary

Cubahatchee Creek was placed on Alabama's §303(d) list in 2006 based on data collected by ADEM in 2000. In 2010, ADEM collected additional water quality data using the newly adopted pathogen impairment criteria, with E. coli serving as the primary pathogen indicator. The data collected by ADEM in 2010 confirmed the pathogen impairment and provided the basis for TMDL development.

A mass balance approach was used to calculate the E. coli TMDL for Cubahatchee Creek. Based on the TMDL analysis, it was determined that a 63% 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 Cubahatchee Creek watershed. As additional data and/or information becomes 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, the ADEM 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 in Table 5-1.

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

River Basin Group	Year to be Monitored
Escatawpa / Mobile / Lower Tombigbee / Upper Tombigbee	2011
Black Warrior / Cahaba	2012
Chattahoochee / Chipola / Choctawhatchee / Perdido-Escambia	2013
Tennessee	2014
Alabama / Coosa / Tallapoosa	2015

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. 2000, & 2010. ADEM.

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

Alabama's §303(d) List and Fact Sheet. 2006, 2008, & 2010. 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

ADEM Water Quality Data

Table 7-1. 2010 E. coli Data for CUBB-1

Station ID	Visit Date	E. Coli (col/100mL)	Flow (cfs)	Geometric Mean (col/100mL)
CUBB-1	4/7/2010	178.5	0.113	
CUBB-1	5/25/2010	214.2		
CUBB-1	6/30/2010	52.9		
CUBB-1	7/7/2010	224.7		

Table 7-2. 2010 E. coli Data for CUBM-1

Station ID	Visit Date	E. Coli (col/100mL)	Flow (cfs)	Geometric Mean (col/100mL)
CUBM-1	4/7/2010	72.7		
CUBM-1	5/25/2010	104.6		
CUBM-1	6/21/2010	47.9		42.5
CUBM-1	6/30/2010	111.2		
CUBM-1	7/7/2010	33.1		
CUBM-1	7/19/2010	18.7		
CUBM-1	7/20/2010	42		
CUBM-1	8/23/2010	579.4		

Table 7-3. 2010 E. coli Data for CUBM-2

Station ID	Visit Date	E. Coli (col/100mL)	Flow (cfs)	Geometric Mean (col/100mL)
CUBM-2	4/7/2010	49.6	9.682	
CUBM-2	5/25/2010	107.6	5.037	
CUBM-2	6/21/2010	58.3	0.8031	55.0
CUBM-2	6/30/2010	88.2		
CUBM-2	7/7/2010	16.1		
CUBM-2	7/19/2010	160.7	1.03	
CUBM-2	7/20/2010	37.9	0.693	
CUBM-2	8/23/2010	71.7		

Table 7-4. 2000 Fecal Coliform Data for CUBM-1 & CUBM-2

Station ID	Visit Date	Fecal Coliform (col/100 mL)
CUBM-1	5/11/2000	1530
CUBM-1	7/18/2000	3667
CUBM-1	8/9/2000	3200
CUBM-1	10/4/2000	5500
CUBM-1	11/21/2000	1500
CUBM-2	6/7/2000	21
CUBM-2	7/18/2000	18
CUBM-2	8/9/2000	27
CUBM-2	10/4/2000	1
CUBM-2	11/21/2000	580

Appendix 7.3
Cubahatchee Creek Watershed Photos

Photo 7-1 Cubahatchee Creek at CUBM-2

Photo 7-2 Cubahatchee Creek at CUBM-1

Photo 7-3 Cubahatchee Creek at CUBB-1

Photo 7-4 Cows Alongside Cubahatchee Creek Tributary

Photo 7-5 Pasture Land in Cubahatchee Creek Watershed #1

Photo 7-6 Pasture Land in Cubahatchee Creek Watershed #2