Alabama Department of Environmental Management

Final

Total Maximum Daily Load (TMDL)
for
Mud Creek

Assessment Unit ID # AL03150105-0807-200

Pathogens (E. coli)

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

Figure I: Mud Creek Watershed

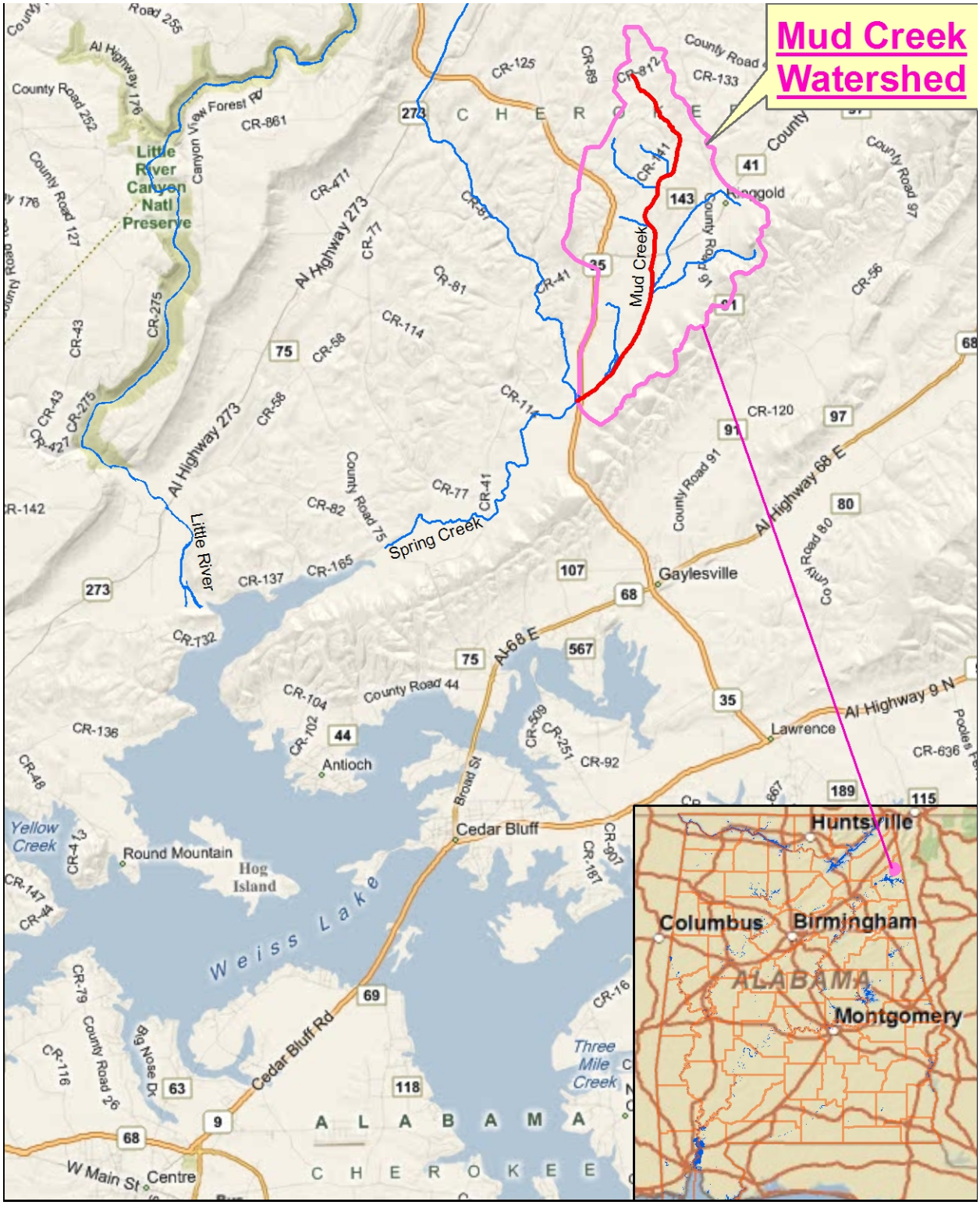

Table of Contents *Page*

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).

Mud Creek is on the §303(d) list for pathogens from its source to Spring Creek. Mud Creek forms in Cherokee County near the town of Gaylesville, in the Coosa River Basin. It flows through a rural setting into Spring Creek. The total length of Mud Creek is 5.24 miles, of which all is on the §303(d) list. The total drainage area of the Mud Creek watershed is 7.3 square miles, of which all drains to the impaired segment. Mud Creek has a use classification of Fish & Wildlife (F&W). Mud Creek was placed on the 2004 - 2010 §303(d) lists based on the geometric mean of 5 samples, collected during 2002, exceeding the 200 colonies/100 ml fecal coliform criterion. Its Assessment Unit ID is AL03150105-0807-200.

In 2010, §303(d) sampling studies were performed by ADEM on Mud 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 Mud 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 station MUDC-10 in 2010; even though the 2002 data that prompted the listing of Mud Creek was based on the fecal coliform criteria. The 2010 bacterial data is listed in Appendix 7.2, Table 7-1 for reference. ADEM collected 9 samples from Mud Creek in 2010. According to the data collected in 2010, Mud 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 Mud Creek. The mass balance approach utilizes the conservation of mass principle. Loads were calculated by multiplying the E. coli concentrations times the respective instream flows and a conversion factor. The mass loading was calculated using the geometric mean violation which resulted in the highest percent reduction. In the same manner, an allowable load was calculated for the geometric mean E. coli criterion of 126 colonies/100 mL. The TMDL was based on this violation and resulted in a percent reduction of E. coli loading necessary to achieve applicable water quality for the geometric mean criterion.

The existing pathogen loading for this TMDL was calculated using the geometric mean exceedance at Station MUDC-10 (6/22/10 - 6/28/10) with a reported concentration of 217 colonies/100 ml times the average flow of the five samples (1cfs) and a conversion factor. The

allowable loading, defined by the geometric mean criterion including a margin of safety, was calculated using the same average 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.

Table 1-1 is a summary of the estimated existing load, allowable load, and percent reduction for the geometric mean versus the single sample criterion. Table 1-2 provides the details of the TMDL along with the corresponding reductions for Mud 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	1.78 E+10	1.07 E+10	7.07E+09	40%
Nonpoint Source Load Geometric Mean	5.31E+09	2.77 E+09	2.54E+09	48%
Point Source Load	NA	NA	NA	NA

Table 1-2. E. coli TMDL for Mud 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)
3.08E+09	3.08E+08	NA	NA	0	2.77E+09	48%

a. There are no CAFOs in the Mud Creek watershed. Future CAFOs will be assigned a waste load allocation (WLA) of zero.
b. NA = not applicable, no point sources. Future WWTPs must meet the applicable instream water quality criteria for pathogens at the point of discharge.
c. NA = not applicable, no regulated MS4 areas. 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 Mud 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 5.24 miles of Mud Creek as impaired for pathogens. The §303(d) listing was originally reported on Alabama's 2004 List of Impaired Waters based on ADEM data collected in 2002 and subsequently included on the 2004, 2006, 2008 and 2010 lists. The source of the impairment is listed on the 2010 §303(d) list as Unknown sources.

2.2 Problem Definition

Waterbody Impaired:	Mud Creek – From Spring Creek to its source
Impaired Reach Length:	5.24 miles
Impaired Drainage Area:	7.3 square miles
Water Quality Standard Violation:	Pathogens (geometric mean)
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:

Fecal coliform data collected by ADEM Field Operations in 2002 was used for listing Mud Creek on Alabama's 2004 §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 of 2000 colonies/100 mL. This number is the number of exceedances of the single-sample maximum criterion of 2000 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 2000 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 pathogens. 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.

Mud Creek was placed on the State of Alabama's 2004-2010 §303(d) list for pathogens by the Alabama Department of Environmental Management (ADEM) based on data acquired in 2002 from ADEM sampling station MUDC-10 (Table 7-1). This station was sampled in 2002 once a month from January through July. Additionally, an intensive fecal survey was performed in May/June of 2002 at MUDC-10. A total of 12 samples were collected from both the monthly sampling and the intensive fecal survey. None of the samples exceeded the year round single sample maximum criterion of 2,000 colonies/100 mL. However, the geometric mean criteria of 200 colonies/100 ml for 5 samples collected within 30 days was exceeded during the intensive survey. Based on this analysis, ADEM added Mud Creek from Spring Creek to its source to the 2004-2010 §303(d) list for pathogens. Although, all five of the samples used in the geometric mean calculation, that exceeded the criteria, were not collected in the (June-September) time period, it was still felt to be representative of summer time conditions.

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 MUDC-10 in 2010; even though the 2002 data that prompted the listing of Mud Creek was based on the fecal coliform criteria.

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 maximum of 126 colonies/100 ml criterion. This target is considered protective of water quality standards and should not allow the geometric mean of 126 colonies/100 ml (June-September F&W criteria) to be exceeded.

3.2 Source Assessment

3.2.1 Point Sources in the Mud 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 Mud 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 Storm Sewer System (MS4) areas located within the Mud Creek watershed.

Also, according to the ADEM database, there have been no reported sanitary sewer overflows (SSOs) in the Mud 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. There are no known collection systems in the Mud Creek watershed.

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 Mud 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.

Due to the absence of point sources, nonpoint sources are believed to be the primary source of E. coli bacteria in the Mud Creek watershed. Land use in this watershed is primarily forest (55%) and agriculture (30%). Only 5% of the watershed is developed. The remaining 10% is shrub and grassland.

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 developed 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 the unincorporated 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 Mud Creek watershed was determined using ArcView with land use datasets derived from the 2001 National Land Cover Dataset (NLCD). Figure 3-1 and Table 3-1 display the land use areas for the Mud Creek watershed.

Land use in this watershed is primarily forest (55%) and agriculture (30%). Only 5% of the watershed is developed. The remaining 10% is shrub and grassland. 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.

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

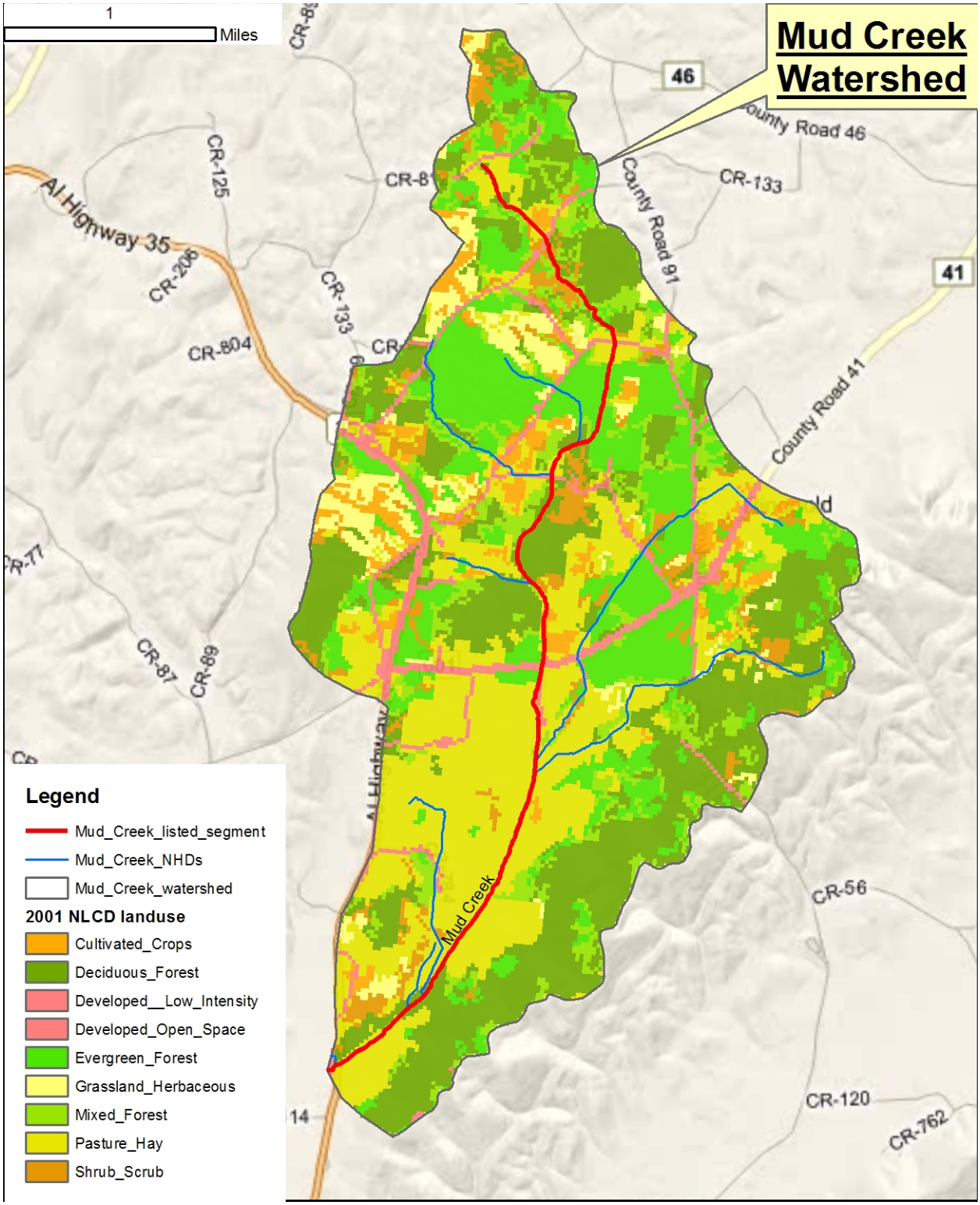

Table 3-1. Land Use Areas for the Mud Creek Watershed

Mud Creek Watershed Land Cover/Use		
2001 NLCD name	**sq.miles**	**%**
Developed Open Space	0.36	5%
Developed Low Intensity	0.03	0%
Deciduous Forest	1.98	27%
Evergreen Forest	1.38	19%
Mixed Forest	0.65	9%
Shrub/Scrub	0.37	5%
Grassland/Herbaceous	0.35	5%
Pasture/Hay	1.94	27%
Cultivated Crops	0.26	4%
Total	**7.30**	**100%**
Aggregate	**sq.miles**	**%**
Developed	0.38	5%
Agriculture	2.20	30%
Forest	4.00	55%
Other	0.72	10%
Total	**7.30**	**100%**

3.4 Linkage Between Numeric Targets and Sources

The Mud 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 Mud Creek are from the agricultural land uses, 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 water quality data for Mud Creek at Station MUDC-10 at Al Hwy 35, in 2002 once a month from January through July. Additionally, an intensive fecal survey was performed in May/June of 2002 at MUDC-10. A total of 12 samples were collected from both the monthly sampling and the intensive fecal survey. None of the samples exceeded the year round single sample maximum criterion of 2,000 colonies/100 mL. However, the geometric mean criteria of 200 colonies/100 ml for 5 samples collected within 30 days was exceeded during the intensive survey. Based on this analysis, ADEM has added Mud Creek from Spring Creek to its source to the 2004-2010 §303(d) lists for pathogens. This data can be viewed in Appendix 7.2, Table 7-1. Although, all five of the samples used in the geometric mean calculation, that exceeded the criteria, were not collected in the (June-September) time period, it was still felt to be representative of summer time conditions.

In 2010, ADEM again collected water quality data on Mud Creek as part of Alabama's §303(d) Monitoring Program at Station MUDC-10 at Al Hwy 35. 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 3-2 display location and description for the ADEM sampling station. MUDC-10 is the only ADEM sampling station on Mud Creek and is located off Al Hwy 35, in the lower portion of the watershed just prior to its confluence with Spring Creek.

As can be visualized from the pictures in Appendix 7.2, Mud Creek at the location of sampling station MUDC-10 can be characterized as unwadeable with slow velocity, under normal flow conditions. Then as the 2010 dry summer season approaches, Mud Creek goes to a "noncontiguous pool/dry streambed". During sampling visits when Mud Creek did not have a continuous flow, no samples were collected.

Of the E. coli samples collected at MUDC-10 in 2010, one of them violated the summer time single sample F&W maximum criterion of 487 col/100 mL. There was only one set of samples that qualified for a geometric mean calculation in 2010, (6/2/2010 through 6/28/2010) and it also exceeded the E. coli geometric mean criterion of 126 col/100 mL. An attempt was made to collect necessary data to compute another geometric in the month of August 2010, but there was not sufficient flow.

During the 2010 sampling period, flow measurements were only able to be collected twice, due to unwadeable conditions or the flow was not sufficient enough to measure with flow meters. Flow was measured during one of the five samples collected for the geometric mean calculation. This flow measurement was 1.02 cfs. It is not believed that the other samples collected for the geometric mean varied significantly from the measured flow sampling event. therefore a 1 cfs flow will be used to represent existing conditions and calculate loads for the TMDL.

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

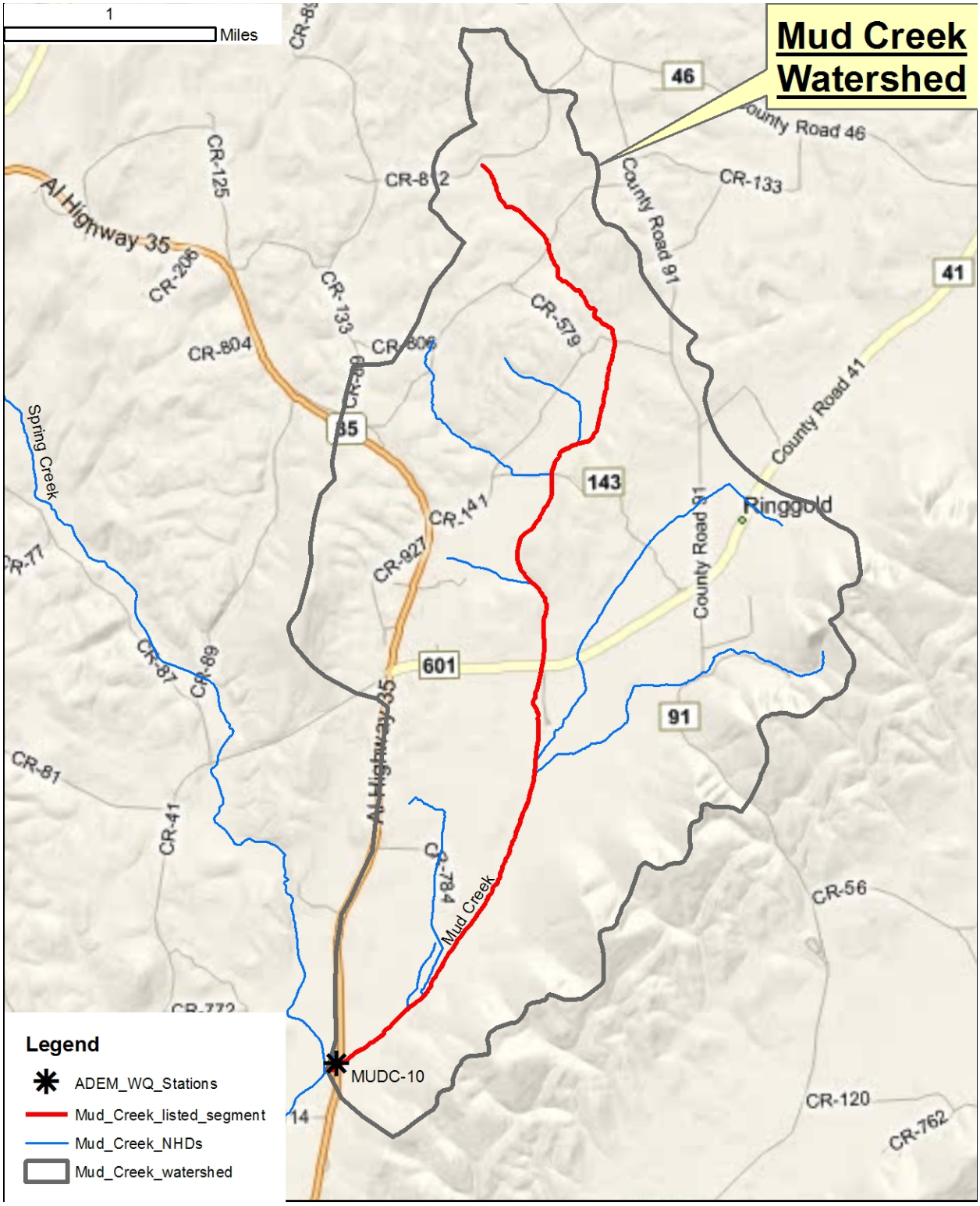

Table 3-2. Mud Creek Sampling Station Description

Years	Station ID	Data Source	Station Location	Latitude	Longitude
2002 & 2010	MUDC-10	ADEM	Mud Cr @ Co. Rd. 35	34.30175	85.57748

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 Mud 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 geometric mean exceedance value. That value was 217 colonies/100 ml and occurred in June of 2010 at station MUDC-10.

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 Mud 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 a conversion factor. Existing loads were calculated for the highest geometric mean sample exceedance and the highest single sample exceedance. In the same manner, allowable loads were calculated for both the single sample criterion of 487 col/100ml and the geometric mean criterion of 126 col/100ml. The TMDL was based on the violation that produced the highest percent reduction of E. coli loads necessary to achieve applicable water quality criteria, whether it be the single sample or geometric mean criterion.

Existing Conditions

The **single sample** mass loading was calculated by multiplying the highest single sample exceedance concentration of 727 colonies/100 ml times the average flow of the five samples. This sample was taken at MUDC-10 on June 2, 2010, and can be found in Table 7-2, Appendix 7.2. The average stream flow was determined to be 1 cfs. The product of these two values times the conversion factor gives the total mass loading (colonies per day) of E. coli to Mud Creek under the geometric mean exceedance condition.

$$\frac{1\,ft^3}{s} \times \frac{727\ colonies}{100\,mL} \times \frac{24465755\quad 100\,mL * s}{ft^3 * day} = \frac{1.78 \times 10^{10}\ colonies}{day}$$

The **geometric mean** mass loading was calculated by multiplying the geometric mean exceedance concentration of 217 colonies/100 ml times the average flow of the five samples. This concentration was calculated based on measurements at MUDC-10 between June 2 and June 28, 2010, and can be found in Table 7-2, Appendix 7.2. The average stream flow was determined to be 1 cfs. The product of these two values times the conversion factor gives the total mass loading (colonies per day) of E. coli to Mud Creek under the geometric mean exceedance condition.

$$\frac{1\text{ft}^3}{\text{s}} \times \frac{217\ \text{colonies}}{100\,\text{mL}} \times \frac{24465755\quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{5.31 \times 10^9\ \text{colonies}}{\text{day}}$$

Allowable Conditions

The **allowable load** to the watershed was calculated under the same physical conditions as discussed above for the single sample and 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 **single sample** E. coli target concentration of 438 colonies/100 mL, the allowable E. coli loading is:

$$\frac{1\ \text{ft}^3}{\text{s}} \times \frac{438\ \text{colonies}}{100\,\text{mL}} \times \frac{24465755\quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{1.07 \times 10^{10}\ \text{colonies}}{\text{day}}$$

The explicit margin of safety of 49 colonies/100 ml equals a daily loading of:

$$\frac{1\text{ft}^3}{\text{s}} \times \frac{49\ \text{colonies}}{100\,\text{mL}} \times \frac{24465755\quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{1.20 \times 10^9\ \text{colonies}}{\text{day}}$$

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

$$\frac{1\ \text{ft}^3}{\text{s}} \times \frac{113.4\ \text{colonies}}{100\,\text{mL}} \times \frac{24465755\quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{2.77 \times 10^9\ \text{colonies}}{\text{day}}$$

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

$$\frac{1\text{ft}^3}{\text{s}} \times \frac{12.6\ \text{colonies}}{100\,\text{mL}} \times \frac{24465755\quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{3.08 \times 10^8\ \text{colonies}}{\text{day}}$$

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 Mud Creek as evaluated at station MUDC-10.

Table 4-1 is a summary of the estimated existing load, allowable load, and percent reduction for both the geometric mean and single sample criterion. Table 4-2 provides the details of the

TMDL along with the corresponding reductions for Mud Creek which are protective of E. coli water quality standards year round.

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	1.78 E+10	1.07 E+10	7.07E+09	40%
Nonpoint Source Load Geomean	5.31E+09	2.77 E+09	2.54E+09	48%
Point Source Load	NA	NA	NA	NA

From Table 4-1, compliance with the geometric mean criterion of 126 colonies/100 ml requires the greatest reduction in the E. coli load of 48%. 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 Mud 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)
3.08E+09	3.08E+08	NA	NA	0	2.77E+09	48%

a. There are no CAFOs in the Mud Creek watershed. Future CAFOs will be assigned a waste load allocation (WLA) of zero.
b. NA = not applicable, no point sources. Future WWTPs must meet the applicable instream water quality criteria for pathogens at the point of discharge.
c. NA = not applicable, no regulated MS4 areas. 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

Mud Creek was placed on Alabama's §303(d) list in 2004 based on data collected by ADEM in 2002. In 2010, ADEM collected additional water quality data which confirmed the pathogen impairment and provided the basis for TMDL development.

A mass balance approach was used to calculate the E. coli TMDL for Mud Creek. Based on the TMDL analysis, it was determined that a 48% 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 Mud 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
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. 1999, 2004, & 2008. ADEM.

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

Alabama Department of Environmental Management, 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 Mud Creek (2002-2010)

Station ID	Visit Date	Fecal Col 100ml	E Coli Col 100ml	Flow Stage	Flow (cfs)	Flow Measured
MUDC-10	11/8/2001	64				
MUDC-10	1/28/2002	270		NORMAL	6.40	YES-ADEM
MUDC-10	2/14/2002	280		ABOVE NORMAL		NO-FLOW NOT VISIBLE
MUDC-10	3/14/2002	168		ABOVE NORMAL		NO-FLOW NOT VISIBLE
MUDC-10	4/2/2002			ABOVE NORMAL		NO-NOT WADEABLE
MUDC-10	4/11/2002	620		ABOVE NORMAL		NO-NOT WADEABLE
MUDC-10	5/14/2002	440		LOW		NO-VISIBLE, BUT NOT MEASURABLE WITH METER
MUDC-10	5/20/2002	90		LOW		NO-FLOW NOT VISIBLE
MUDC-10	5/21/2002	210		ABOVE NORMAL		NO-NOT WADEABLE
MUDC-10	5/28/2002	148		ABOVE NORMAL		NO-NOT WADEABLE
MUDC-10	6/6/2002	800		LOW		NO-FLOW NOT VISIBLE
	Geomean	250				
MUDC-10	7/8/2002	1200		ABOVE NORMAL		NO-NOT WADEABLE
MUDC-10	7/11/2002	240		ABOVE NORMAL		NO-NOT WADEABLE
MUDC-10	7/17/2002					NO-NONCONTIGUOUS POOLS/DRY STREAMBED
MUDC-10	7/30/2002					NO-NONCONTIGUOUS POOLS/DRY STREAMBED
MUDC-10	4/14/2010		461.1	NORMAL	3.06	YES-ADEM
MUDC-10	5/4/2010		686.7	ABOVE NORMAL		NO-NOT WADEABLE
MUDC-10	6/2/2010		727	UNKNOWN		NO-NOT WADEABLE
MUDC-10	6/8/2010		178.2	UNKNOWN		NO-NOT WADEABLE
MUDC-10	6/14/2010		93.2	UNKNOWN		NO-FLOW NOT VISIBLE
MUDC-10	6/21/2010		387.3	UNKNOWN	1.02	YES-ADEM
MUDC-10	6/28/2010		103.9	LOW		NO-FLOW NOT VISIBLE
		Geomean	217			
MUDC-10	8/2/2010			DRY		NO-NONCONTIGUOUS POOLS/DRY STREAMBED
MUDC-10	8/4/2010			DRY		NO-NONCONTIGUOUS POOLS/DRY STREAMBED
MUDC-10	8/12/2010			DRY		NO-NONCONTIGUOUS POOLS/DRY STREAMBED
MUDC-10	8/16/2010		378.4	LOW		NO-VISIBLE, BUT NOT MEASURABLE WITH METER
MUDC-10	8/23/2010		157.6	NORMAL		NO-FLOW NOT VISIBLE

indicates violation

Appendix 7.3
MUDC-10 pictures

Mud Creek monthly pictures taken at MUDC-10 in the year 2010 at Alabama Hwy 35.

3/23/2010
recon picture


04/14/2010 11:22


05/04/2010 14:10


06/09/2010 08:51


07/14/2010 14:32


08/11/2010 14:36


09/15/2010 15:20


10/06/2010 14:11


11/03/2010 13:20