Final

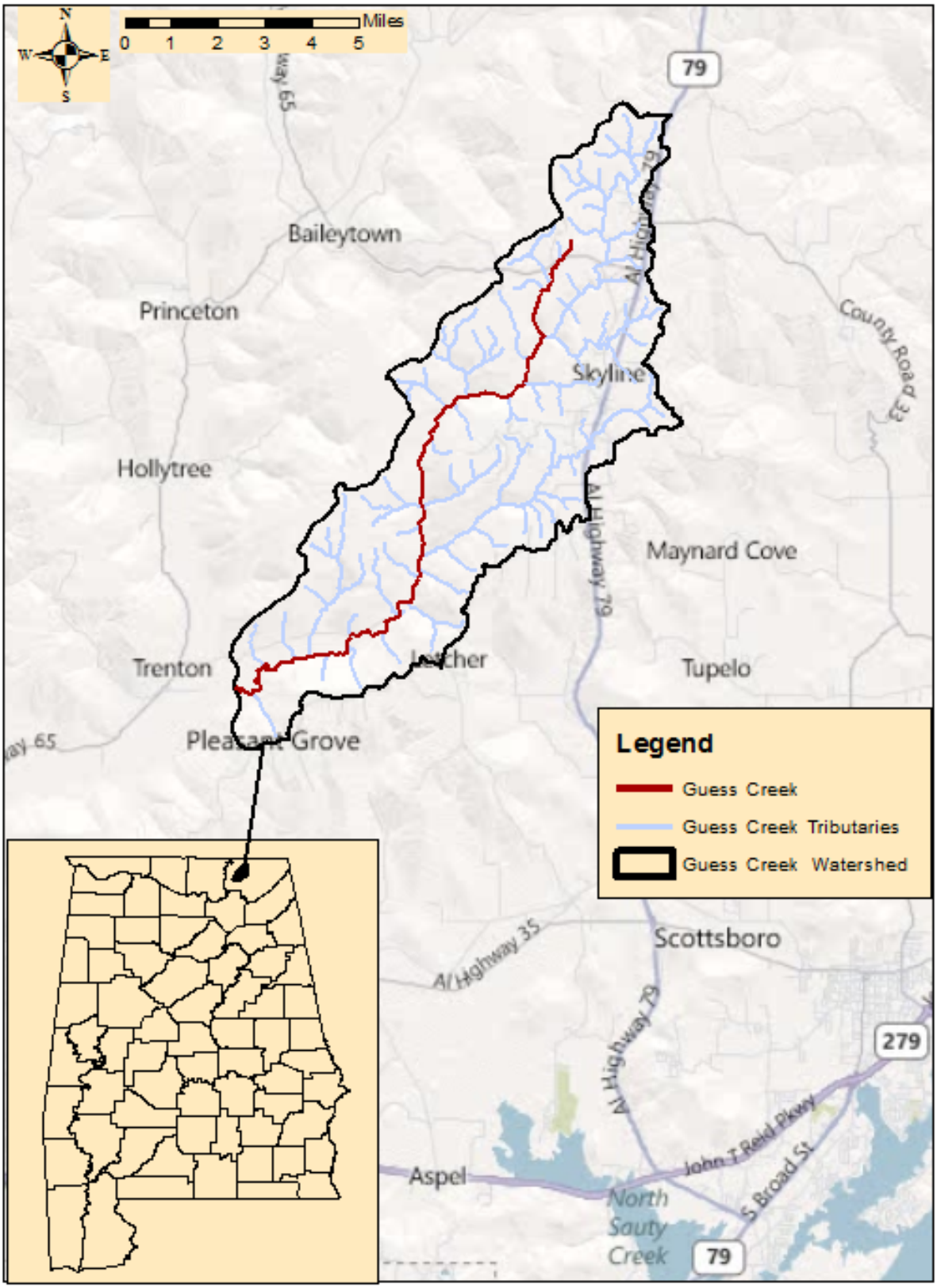
Total Maximum Daily Load (TMDL)
for
Guess Creek

Assessment Unit ID # AL06030002-0106-101

Pathogens (E. coli)

Alabama Department of Environmental Management
Water Quality Branch
Water Division
August 2012

Figure I. Guess 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).

Guess Creek is on the §303(d) list for pathogens from the Paint Rock River to Bee Branch. Guess Creek forms in Jackson County near the town of Skyline, in the Tennessee River Basin. It flows through a rural setting in Jackson County and empties into the Paint Rock River. The total length of Guess Creek is 13.68 miles, of which 11.08 miles are on the §303(d) list for pathogens. The total drainage area of the Guess Creek watershed is 34.45 square miles. Guess Creek has a use classification of Fish & Wildlife (F&W).

Guess Creek was first listed on the §303(d) list in 1998 based on data collected in 1997 by the Tennessee Valley Authority (TVA). This data indicated the stream was impaired for fecal coliform and can be found in Appendix 7.3. Guess Creek was also sampled by the Alabama Department of Environmental Management (ADEM) beginning in 1997, again in 2004, and was found to exceed the fecal coliform geometric mean water quality criterion for June-September of 200 colonies/100 mL at station GUES-1. This data can be found in Appendix 7.2, Table 7-3. Guess Creek has subsequently been listed on the 1998 - 2012 §303(d) lists of impaired waterbodies. Its Assessment Unit ID is AL06030002-0106-101.

In 2004, 2009, and 2011, §303(d) sampling studies were performed by ADEM on Guess Creek to further assess the water quality of the impaired stream. For purposes of this TMDL, the 2009 and 2011 data will be used to assess the water quality of Guess Creek because it is the most current data and provides the best picture of the current water quality conditions 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 GUES-1 in 2009 and 2011 even though the 1997 data that prompted the listing of Guess Creek was based on the fecal coliform criteria. The 2009 and 2011 bacterial data is listed in Appendix 7.2 for reference. ADEM collected 50 samples from Guess Creek in 2009 and 2011. According to the data collected in 2009 and 2011, Guess 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) for Guess Creek.

A mass balance approach was used for calculating the pathogen TMDL for Guess Creek. The mass balance approach utilizes the conservation of mass principle. Existing loads were calculated by multiplying the E. coli concentration times the respective in-stream flows and a conversion factor. The mass loading was calculated using the single or geometric mean sample

exceedance event which resulted in the highest percent reduction. In this case it was determined that the highest percent reduction was calculated for a single sample violation of 686.7 colonies/100mL measured on 9/07/2011 at GUES-1. This violation calls for a reduction of 36%. There was also a geometric mean violation of 174.2 colonies/100 mL. This violation resulted in a reduction of only 35%. In the same manner as existing loads were calculated, an allowable load was calculated for the single sample E. coli criterion of 438.3 colonies/100 mL (487 colonies/100 mL – 10% Margin of Safety).

The existing pathogen loading for this TMDL was calculated using the single sample exceedance at Station GUES-1 (9/07/2011) with a reported concentration of 686.7 colonies/100 mL times the estimated flow of 40.24 cfs and a conversion factor. The flow was estimated using the measured flow from GUES-2 on the same day the exceedance was reported. Given the close proximity of GUES-2 to GUES-1 and the same Streamflow Recession Index (SRI) values for both location, it is safe to assume that there is a direct correlation between the flow rate and the drainage areas for the two stations. Utilizing this assumption, one can essentially ratio the drainage areas for GUES-1 and GUES-2 and multiply by the known flow rate at GUES-2 on 9/07/2011 to calculate a reliable flow estimate. The estimate was necessary due to flow on the day of the exceedance at GUES-1 being described as “flow conditions hazardous”. 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 438.3 colonies/100 mL (487 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 and then dividing by the existing loading. This violation calls for a reduction of 36%.

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

Table 1-1. 2011 E. coli Load and Required Reduction for AL06030002-0106-101

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Nonpoint Source Load Single Sample	6.76E+11	4.31E+11	2.45E+11	36%
Nonpoint Source Load Geometric Mean	7.60E+09	4.95E+09	2.65E+09	35%
Point Source Load	N/A	N/A	N/A	N/A

Table 1-2. E. coli TMDL for Guess 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)
4.79E+11	4.79E+10	N/A	N/A	0	4.31E+11	36%

a. There are no CAFOs in the Guess Creek watershed. Future CAFOs will be assigned a waste load allocation (WLA) of zero.
b. 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. N/A = 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 single sample criterion of 487 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 Guess 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 11.08 mile segment of Guess Creek from the Paint Rock River to Bee Branch in Jackson County as being impaired by pathogens (E. coli). The §303(d) listing was originally reported on Alabama's 1998 List of Impaired Waters based on TVA data collected in 1997, and subsequently included on the 2000 – 2012 lists. The source of the impairment is listed on the 2012 §303(d) list as unknown and pasture grazing.

2.2 Problem Definition

Waterbody Impaired:	Guess Creek – From the Paint Rock River to Bee Branch.
Impaired Reach Length:	11.08 miles
Impaired Drainage Area:	34.45 square miles
Water Quality Standard Violation:	Pathogens (Single Sample Max, E. coli)
Pollutant of Concern:	Pathogens (E. coli)
Water Use Classification:	Fish and Wildlife

Usage Related to Classification:
The impaired segment of Guess Creek is classified as Fish and Wildlife (F&W). Usage of waters in this classification are 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 the TVA in 1997 was used for listing Guess Creek on Alabama's 1998 §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.

The original listing of Guess Creek, according to "Alabama's 1998 Water Quality Report to Congress," was based on data collected by the TVA in 1997. This data indicated a single sample exceedance of 3080 colonies/100 mL on 10/08/1997 on Guess Creek at TVA station 464101. Starting in 1997, ADEM collected samples from Guess Creek at station GUES-1. All of the samples collected by ADEM were in compliance with the applicable fecal coliform criteria until 2004. Of the 10 samples collected by ADEM in 2004, one geometric mean sampling event

exceeded the 200 colonies/100 mL geometric mean criterion for fecal coliform. In 2009, ADEM collected 18 samples, of which none of the samples exceeded the single sample criterion; however, both the geometric mean sampling events exceeded the geometric mean criterion for fecal coliform. In 2011, ADEM also collected single sample data at station GUES-1. Of the 16 samples collected, two geometric means of 5 samples each exceeded the 126 colonies/100 mL geometric mean criterion for E. coli., and one single sample exceeded the 487 colonies/100 mL single sample criterion for E. coli.

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 were 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 GUES-1; even though the 1997 data that prompted the listing of Guess Creek was based on fecal coliform criteria.

The impaired segment of Guess Creek is classified as Fish and Wildlife (F&W). For the purpose of this TMDL a single sample maximum E. coli target of 438.3 colonies/100 mL will be used. This target was derived by using a 10% explicit margin of safety from the single sample maximum of 487 colonies/100 mL criterion. This target is considered protective of water quality standards and should not allow the single sample maximum of 487 colonies/100 mL to be exceeded.

3.2 Source Assessment

3.2.1 Point Sources in the Guess 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 Guess 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 Guess Creek watershed.

Also, according to the ADEM database, there have been no reported sanitary sewer overflows (SSOs) that have occurred in the Guess 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 Guess 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 Guess 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 80% forested, 17% agriculture, and 2% developed, with the remaining 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 Guess 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 Guess Creek watershed. Figure 3-1 is a graph depicting the primary land uses in the Guess Creek watershed.

The majority of the Guess Creek watershed is 80% Forest, and 17% Agricultural. Other major land uses within the watershed account for approximately 2% Developed, and less than 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 Guess Creek Watershed

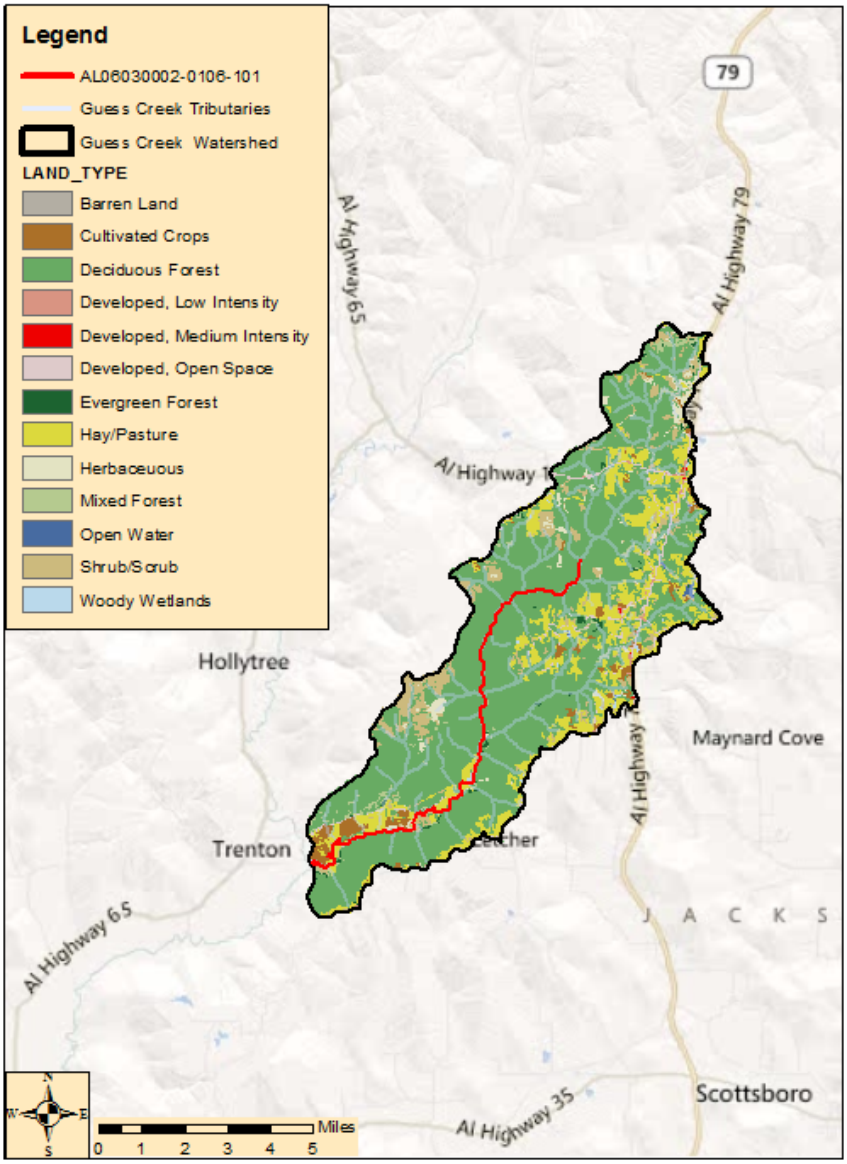
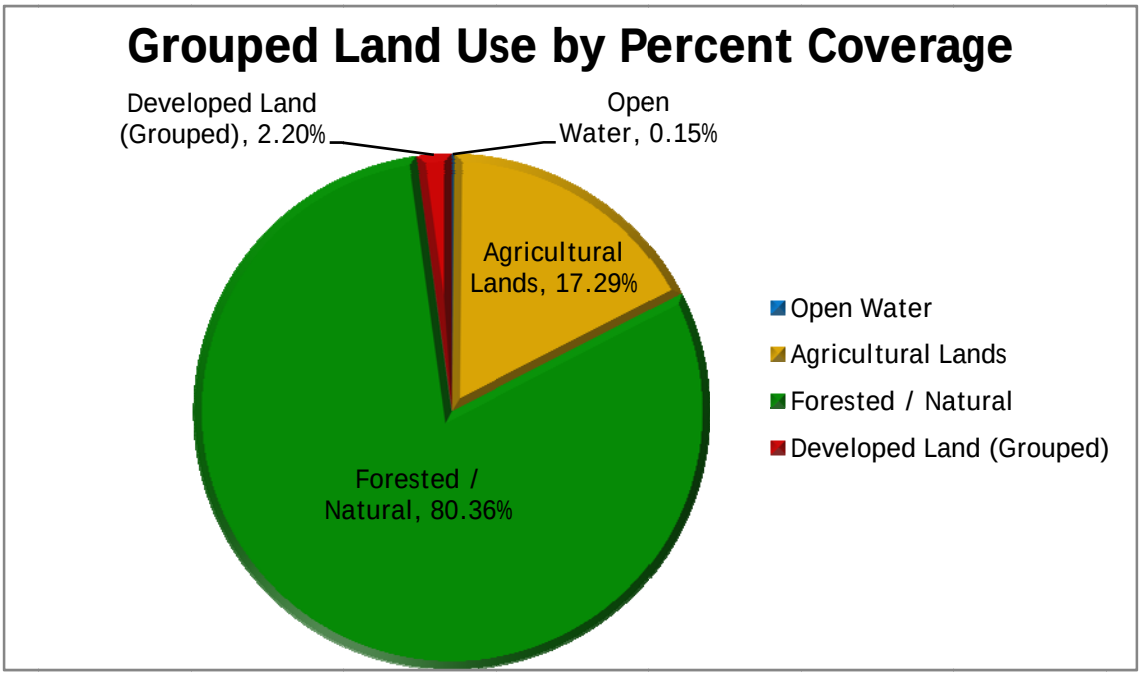


Table 3-1. Land Use Areas for the Guess Creek Watershed

Land Use	Square Miles	Acres	Percent
Open Water	0.05	32.25	0.15%
Developed, Open Space	0.64	406.98	1.86%
Developed, Low Intensity	0.10	61.60	0.28%
Developed, Medium Intensity	0.02	10.90	0.05%
Barren Land	0.00	1.11	0.01%
Deciduous Forest	23.66	15140.19	69.32%
Evergreen Forest	0.19	120.54	0.55%
Mixed Forest	0.52	330.26	1.51%
Shrub/Scrub	2.39	1529.85	7.00%
Herbaceous	0.61	391.64	1.79%
Hay/Pasture	5.06	3240.29	14.84%
Cultivated Crops	0.84	537.08	2.46%
Woody Wetlands	0.06	39.36	0.18%
TOTALS →	**34.13**	**21842.06**	**100.00%**
Cumulative Land Use	Mi^2	Acres	Percent
Open Water	0.05	32.25	0.15%
Agricultural Lands	5.90	3777.38	17.29%
Forested / Natural	27.42	17551.84	80.36%
Developed Land (Grouped)	0.75	479.48	2.20%
TOTALS →	**34.13**	**21840.95**	**100.00%**

Figure 3-2 Graph of Primary Land Uses in the Guess Creek Watershed



3.4 Linkage Between Numeric Targets and Sources

The Guess Creek watershed has three main land uses, namely forested/natural, agriculture, and developed. 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 Guess Creek are from the agricultural land uses, urban run-off from rain events, unpermitted discharges of wastewater, and failing septic systems. These sources appear to be more prevalent below station GUES-2 since station GUES-1 had multiple violations while GUES-2 had zero violations. 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

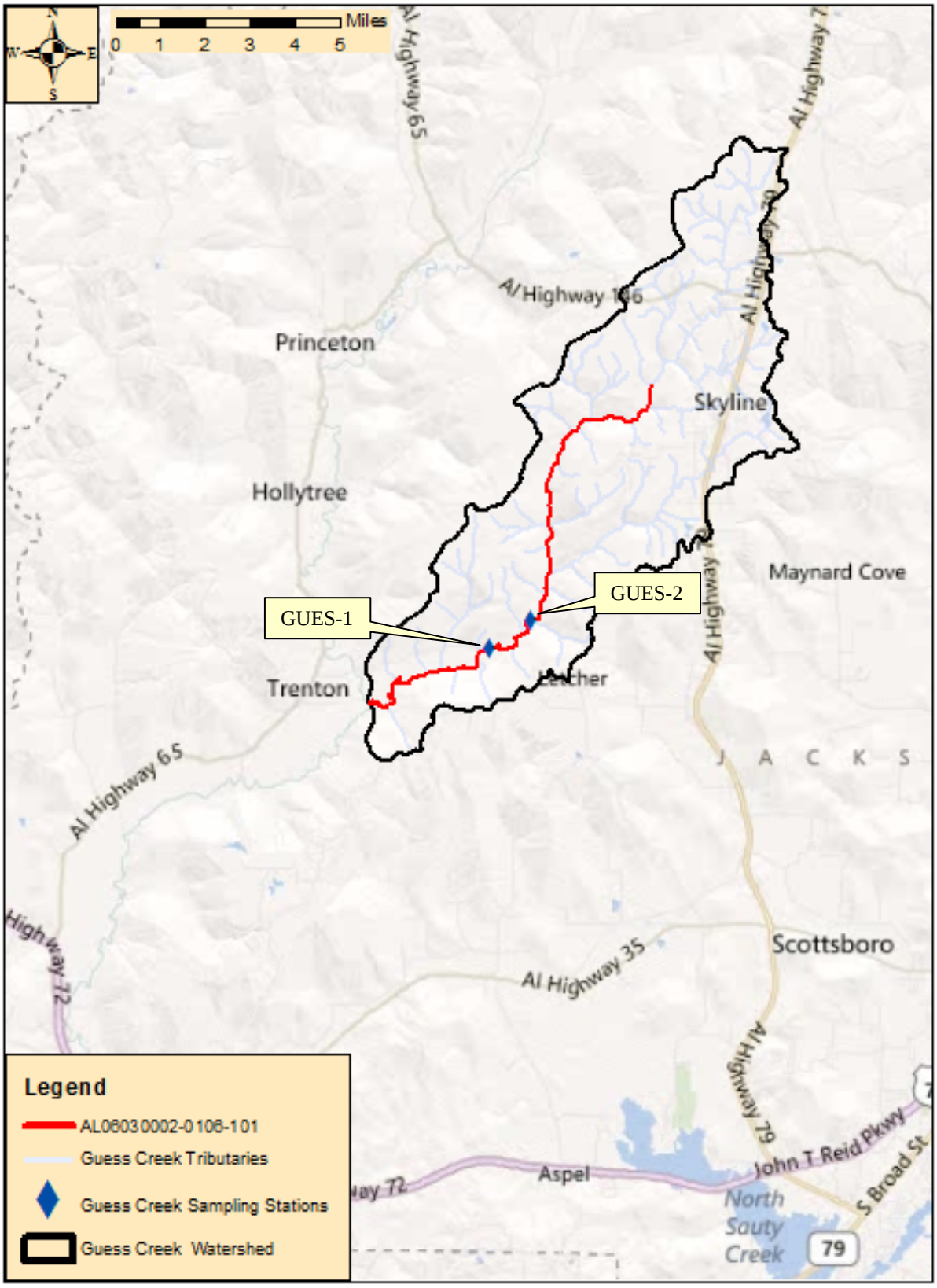
ADEM collected monthly water quality data for Guess Creek at two stations (GUES-1 and GUES-2) along the impaired section in 2009 and 2011. There were 22 samples collected at station (GUES-1) with 1 single sample violation and 2 geometric mean violations. At station (GUES-2), 7 samples were collected with 0 single sample violations and 0 geometric mean violations. The breakdown of the violations are as follows:

A single sample violation occurred at GUES-1 on September 7, 2011. An E. coli concentration of 686.7 colonies/100 mL was measured on this day. No flow was taken at this time, the flow conditions were considered hazardous. Since no flow was measured on the day of this exceedance, a flow (40.24 cfs) was estimated by utilizing the ratio method using flow measured on the same day at GUES-2. This flow was used in conjunction with the exceedance concentration to determine an accurate mass loading. Also at GUES-1, the geometric mean criterion for E. coli, 126 colonies for the summer months, was exceeded twice. These exceedances occurred once in June with a geometric mean of 166.6 colonies/100 mL and once in August with a geometric mean of 174.2 colonies/100 mL.

Table 3-2 E. coli Exceedances on Guess Creek

Station ID	Visit Date	E Coli (col/100mL)	E Coli Dc	Geometric Mean (col/100mL)	Flow Measured	Flow (cfs)
GUES-1	6/2/2011	150		166.6	YES-ADEM	4.1668
GUES-1	6/7/2011	142.1			YES-ADEM	3.0812
GUES-1	6/13/2011	129.1			YES-ADEM	2.6106
GUES-1	6/20/2011	195.6			YES-ADEM	2.2634
GUES-1	6/22/2011	238.2			YES-ADEM	2.094
GUES-1	8/1/2011	307.6		174.2	YES-ADEM	1.8663
GUES-1	8/8/2011	201.4			YES-ADEM	4.0655
GUES-1	8/15/2011	93.3			YES-ADEM	1.113
GUES-1	8/18/2011	224.7			YES-ADEM	0.8702
GUES-1	8/22/2011	123.6			YES-ADEM	0.9986
GUES-1	9/7/2011	686.7			NO-FLOW CONDITIONS HAZARDOUS	

Figure 3-3. Map of ADEM Sampling Stations on Guess 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 Guess 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 686.7 colonies/100 mL and occurred on September 7, 2011 at station GUES-1. No flow was measured when the sample was taken due to the flow conditions being hazardous.

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 were 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 geometric mean criterion concentration by ten percent and calculating a mass loading target with measured flow data. The single sample maximum value of 487 colonies/100 mL was reduced by 10% to 438.3 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 Guess 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 E. coli exceedance concentration of 686.7 colonies/100 ml times the estimated flow of 40.24 cfs. This concentration was calculated based on measurements at GUES-1 on September 7, 2011 and can be found in Appendix 7.2, Table 7-1. The product of these two values and a conversion factor gives the total mass loading (colonies per day) of E. coli to Guess Creek under a single sample exceedance condition.

$$\frac{40.24\,\text{ft}^3}{\text{s}} \times \frac{686.7\,\text{colonies}}{100\,\text{mL}} \times \frac{24{,}465{,}755 \;\; 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{6.76 \times 10^{11}\,\text{colonies}}{\text{day}}$$

The **geometric mean** mass loading was calculated by multiplying the highest geometric mean exceedance concentration of 174.2 colonies/100 ml times the average flow of the five samples. This concentration was calculated based on measurements at GUES-1 between August 1 and August 22, 2011 and can be found in Appendix 7.2, Table 7-1. The average stream flow was determined to be 1.78 cfs. The product of these two values times the conversion factor gives the total mass loading (colonies per day) of E. coli to Guess Creek under the geometric mean exceedance condition.

$$\frac{1.78\,\text{ft}^3}{\text{s}} \times \frac{174.2\,\text{colonies}}{100\,\text{mL}} \times \frac{24{,}465{,}755 \;\; 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{7.60 \times 10^{9}\,\text{colonies}}{\text{day}}$$

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/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 target concentration of 438.3 colonies/100 mL. The allowable E. coli loading is:

$$\frac{40.24\ \text{ft}^3}{\text{s}} \times \frac{438.3\ \text{colonies}}{100\,\text{mL}} \times \frac{24{,}465{,}755\ \ 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{4.31 \times 10^{11}\ \text{colonies}}{\text{day}}$$

The explicit margin of safety of 48.7 colonies/100 mL equals a daily loading of:

$$\frac{40.24\,\text{ft}^3}{\text{s}} \times \frac{48.7\ \text{colonies}}{100\,\text{mL}} \times \frac{24{,}465{,}755\ \ 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{4.79 \times 10^{10}\ \text{colonies}}{\text{day}}$$

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

$$\frac{1.78\ \text{ft}^3}{\text{s}} \times \frac{113.4\ \text{colonies}}{100\,\text{mL}} \times \frac{24{,}465{,}755\ \ 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{4.95 \times 10^{9}\ \text{colonies}}{\text{day}}$$

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

$$\frac{1.78\ \text{ft}^3}{\text{s}} \times \frac{12.6\ \text{colonies}}{100\,\text{mL}} \times \frac{24{,}465{,}755\ \ 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{5.49 \times 10^{8}\ \text{colonies}}{\text{day}}$$

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 Guess Creek as evaluated at station GUES-1. Table 4-1 and Table 4-2 shows the results of the E. coli TMDL and percent reductions for each criterion.

Table 4-1 is a summary of the estimated existing loads, allowable loads, 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 Guess Creek which are protective of E. coli water quality standards year round.

Table 4-1. 2011 E. coli Load and Required Reduction for AL06030002-0106-101 at GUES-1

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Nonpoint Source Load Single Sample	6.76E+11	4.31E+11	2.45E+11	36%
Nonpoint Source Geometric Mean	7.60E+09	4.95E+09	2.65E+09	35%
Point Source Load	N/A	N/A	N/A	N/A

From Table 4-1, compliance with the single sample criterion of 487 colonies/100ml requires the greatest reduction in the E. coli load of 36%. 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 Guess 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)
4.79E+11	4.79E+10	N/A	N/A	0	4.31E+11	36%

a. There are no CAFOs in the Guess Creek watershed. Future CAFOs will be assigned a waste load allocation (WLA) of zero.
b. 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. N/A = 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 single sample criterion of 487 colonies/100ml.

4.3 TMDL Summary

Guess Creek was placed on Alabama's §303(d) list in 1998 based on data collected by the TVA in 1997. In 2009 and 2011, ADEM collected additional water quality data using the newly adopted pathogen criteria, E. coli, as the primary pathogen indicator. The data collected by ADEM in 2009 and 2011 confirmed the pathogen impairment on AL06030002-0106-101 and provided the basis for TMDL development.
A mass balance approach was used to calculate the E. coli TMDL for Guess Creek. Based on the TMDL analysis, it was determined that a 36% 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 Guess 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
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. 2009 & 2011. ADEM.

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

Alabama Department of Environmental Management (ADEM), Alabama's Water Quality Report to Congress, Appendix III Tennessee Valley Authority North Alabama Water Quality Survey 1997 Summary Information.

Alabama Department of Environmental Management (ADEM), Alabama's Water Quality Report to Congress, Appendix VIII Additions to the 1998 303(d) List by ADEM.

Alabama's §303(d) List and Fact Sheet. 1998, 2000, 2002, 2004, 2006, 2008, 2010 & 2012. 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, 1999. Decision Document Concerning EPA's Addition of Waters and Pollutants to Alabama's §303(d) List.

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. E. coli Data for GUES-1

Station ID	Visit Date	E Coli (col/100mL)	E Coli Dc	Geometric Mean (col/100mL)	Flow Measured	Flow (cfs)
GUES-1	8/24/2009	172.3			YES-ADEM	1.91
GUES-1	8/25/2009	184.2			YES-ADEM	1.65
GUES-1	8/26/2009	142.1			NO-FLOW NOT VISIBLE	
GUES-1	8/26/2009	142.1			YES-ADEM	1.51
GUES-1	9/30/2009	325.5			YES-ADEM	8.90
GUES-1	10/28/2009	115.3			YES-ADEM	63.90
GUES-1	3/14/2011	34.1			NO-FLOW CONDITIONS HAZARDOUS	
GUES-1	4/7/2011	37.3			NO-FLOW CONDITIONS HAZARDOUS	
GUES-1	5/17/2011	108.6			YES-ADEM	16.12
GUES-1	6/2/2011	150		166.6	YES-ADEM	4.17
GUES-1	6/7/2011	142.1			YES-ADEM	3.08
GUES-1	6/13/2011	129.1			YES-ADEM	2.61
GUES-1	6/20/2011	195.6			YES-ADEM	2.26
GUES-1	6/22/2011	238.2			YES-ADEM	2.09
GUES-1	7/12/2011	344.8			YES-ADEM	3.08
GUES-1	8/1/2011	307.6		174.2	YES-ADEM	1.87
GUES-1	8/8/2011	201.4			YES-ADEM	4.07
GUES-1	8/15/2011	93.3			YES-ADEM	1.11
GUES-1	8/18/2011	224.7			YES-ADEM	0.87
GUES-1	8/22/2011	123.6			YES-ADEM	1.00
GUES-1	9/7/2011	686.7			NO-FLOW CONDITIONS HAZARDOUS	
GUES-1	10/6/2011	387.3			YES-ADEM	2.61

Exceedances are highlighted in red

Table 7-2. E. coli Data for GUES-2

Station ID	Visit Date	E Coli (col/100mL)	E Coli Dc	Geometric Mean (col/100mL)	Flow Measured	Flow (cfs)
GUES-2	9/30/2009	178.5	JH		YES-ADEM	4.40
GUES-2	10/28/2009	49.6	JH		YES-ADEM	33.90
GUES-2	3/14/2011	18.5			YES-ADEM	90.06
GUES-2	4/7/2011	38.8			NO-FLOW CONDITIONS HAZARDOUS	
GUES-2	5/17/2011	20.1			YES-ADEM	16.01
GUES-2	6/2/2011	36.4			NO-VISIBLE, BUT NOT MEASURABLE WITH METER	
GUES-2	9/7/2011	410.6			YES-ADEM	45.88

J: The reported microbiological result is an estimate
H:Analytical holding times for analysis were exceeded

Table 7-3. Fecal Coliform Data for GUES-1

Station ID	Visit Date	Fecal Coliform (col/100mL)	Fecal Coliform Dc	Geometric Mean (col/100mL)	Flow Measured	Flow (cfs)
GUES-1	7/23/1997	370				4.30
GUES-1	8/25/1997	260				
GUES-1	9/24/1997	1000				
GUES-1	10/21/1997	320				1.40
GUES-1	11/18/1997	92				
GUES-1	12/16/1997	12				27.60
GUES-1	2/5/1998	49				
GUES-1	2/25/1998	7				78.20
GUES-1	3/24/1998	10				104.00
GUES-1	5/26/1998	296				9.00
GUES-1	6/22/1998	800				10.60
GUES-1	8/18/1998	340				4.10
GUES-1	10/27/1998	116				
GUES-1	1/25/1999	30				125.20
GUES-1	4/27/1999	230				29.80
GUES-1	4/28/1999	32				28.80
GUES-1	8/24/1999	980				1.10
GUES-1	1/19/2000	25				19.80
GUES-1	3/26/2003	11	J		NO-NOT WADEABLE	
GUES-1	4/8/2003	70			NO-NOT WADEABLE	
GUES-1	5/14/2003	43	J		NO-NOT WADEABLE	
GUES-1	6/3/2003	97	H			26.20
GUES-1	6/12/2003	150			NO-NOT WADEABLE	
GUES-1	7/8/2003	120	H		NO-NOT WADEABLE	
GUES-1	8/13/2003	100	H		NO-NOT WADEABLE	
GUES-1	9/2/2003	180	H			
GUES-1	10/14/2003	110	H		NO-VISIBLE, BUT NOT MEASURABLE WITH METER	
GUES-1	6/22/2004	7			YES-ADEM	3.10
GUES-1	6/24/2004	11			YES-ADEM	4.60
GUES-1	6/29/2004	148		**26.1**	YES-ADEM	13.70
GUES-1	7/6/2004	132			YES-ADEM	46.00
GUES-1	7/7/2004	8			NO-FLOW CONDITIONS HAZARDOUS	

J: The reported microbiological result is an estimate
H:Analytical holding times for analysis were exceeded

Table 7-3. (cont.) Fecal Coliform Data for GUES-1 (cont.)

Station ID	Visit Date	Fecal Coliform (col/100mL)	Fecal Coliform Dc	Geometric Mean (col/100mL)	Flow Measured	Flow (cfs)
GUES-1	8/19/2004	200		202.4	YES-ADEM	2.40
GUES-1	8/23/2004	196			YES-ADEM	2.80
GUES-1	8/30/2004	430			YES-ADEM	5.60
GUES-1	9/2/2004	123			YES-ADEM	4.30
GUES-1	9/13/2004	164			YES-ADEM	3.00
GUES-1	3/24/2009	49	JH		YES-ADEM	45.10
GUES-1	4/29/2009	68	JH		YES-ADEM	30.90
GUES-1	5/27/2009	52	JH		YES-ADEM	54.00
GUES-1	6/24/2009	148	JH		YES-ADEM	6.20
GUES-1	7/15/2009	120		335.9	YES-ADEM	4.89
GUES-1	7/22/2009	220			YES-ADEM	3.90
GUES-1	7/23/2009	420			YES-ADEM	2.47
GUES-1	7/28/2009	360			YES-ADEM	1.29
GUES-1	7/29/2009	600	GH		NO-VISIBLE, BUT NOT MEASURABLE WITH METER	
GUES-1	7/29/2009	600	G		YES-ADEM	2.49
GUES-1	8/11/2009	210		254.6	YES-ADEM	2.39
GUES-1	8/12/2009	600	G		YES-ADEM	5.08
GUES-1	8/24/2009	410			YES-ADEM	1.91
GUES-1	8/25/2009	310			YES-ADEM	1.65
GUES-1	8/26/2009	100	JH		NO-FLOW NOT VISIBLE	
GUES-1	8/26/2009	170			YES-ADEM	1.51
GUES-1	9/30/2009	9	JH		YES-ADEM	8.90
GUES-1	10/28/2009	52	JH		YES-ADEM	63.90

J: The reported microbiological result is an estimate
H:Analytical holding times for analysis was exceeded
G: The actual Number is probably greater than the number reported
Exceedances are highlighted in red

Table 7-4. Fecal Coliform Data for GUES-2

Station ID	Visit Date	Fecal Coliform (col/100mL)	E Coli Dc	Geometric Mean (col/100mL)	Flow Measured	Flow (cfs)
GUES-2	3/24/2009	4	JH		YES-ADEM	28.30
GUES-2	4/29/2009	4	JH		YES-ADEM	33.90
GUES-2	5/27/2009	35	JH		YES-ADEM	32.60
GUES-2	6/23/2009	35			YES-ADEM	1.50
GUES-2	6/24/2009	140			YES-ADEM	0.70
GUES-2	6/24/2009	124	JH	105.0	YES-ADEM	0.90
GUES-2	7/8/2009	230			YES-ADEM	6.27
GUES-2	7/9/2009	200	J		YES-ADEM	3.83
GUES-2	7/15/2009	48			YES-ADEM	1.01
GUES-2	9/30/2009	136	JH		YES-ADEM	4.40
GUES-2	10/28/2009	38	JH		YES-ADEM	33.90

J: The reported microbiological result is an estimate
H:Analytical holding times for analysis was exceeded

Appendix 7.3
Tennessee Valley Authority (TVA) Data

Table 7-5. Fecal Coliform Data for TVA Station 464101

TVA Station Number	Date	Streamflow (cfs)	Fecal Coliform (#/100mL)
464101	8/6/1997	NM	160
464101	9/4/1997	NM	660
464101	10/8/1997	NM	3080

NM: Not Measured
Exceedances in red

Table 7-6 Fecal Coliform Data for TVA Station 464102

TVA Station Number	Date	Streamflow (cfs)	Fecal Coliform (#/100mL)
464102	8/6/1997	2.1	140
464102	10/8/1997	2.4	400

Appendix 7.4
Guess Creek Watershed Photos

Photo 7-1 GUES-1 Looking Upstream

Photo 7-2 GUES-1 Looking Downstream

Photo 7-3 GUES-2 Looking Upstream

Photo 7-4 GUES-2 Looking Downstream