Alabama Department of Environmental Management

Final
Total Maximum Daily Load (TMDL)
for
Spring Creek

Assessment Unit ID # AL03150105-0807-102
Assessment Unit ID # AL03150105-0807-103

Pathogens (E. coli)

Alabama Department of Environmental Management
Water Quality Branch
Water Division
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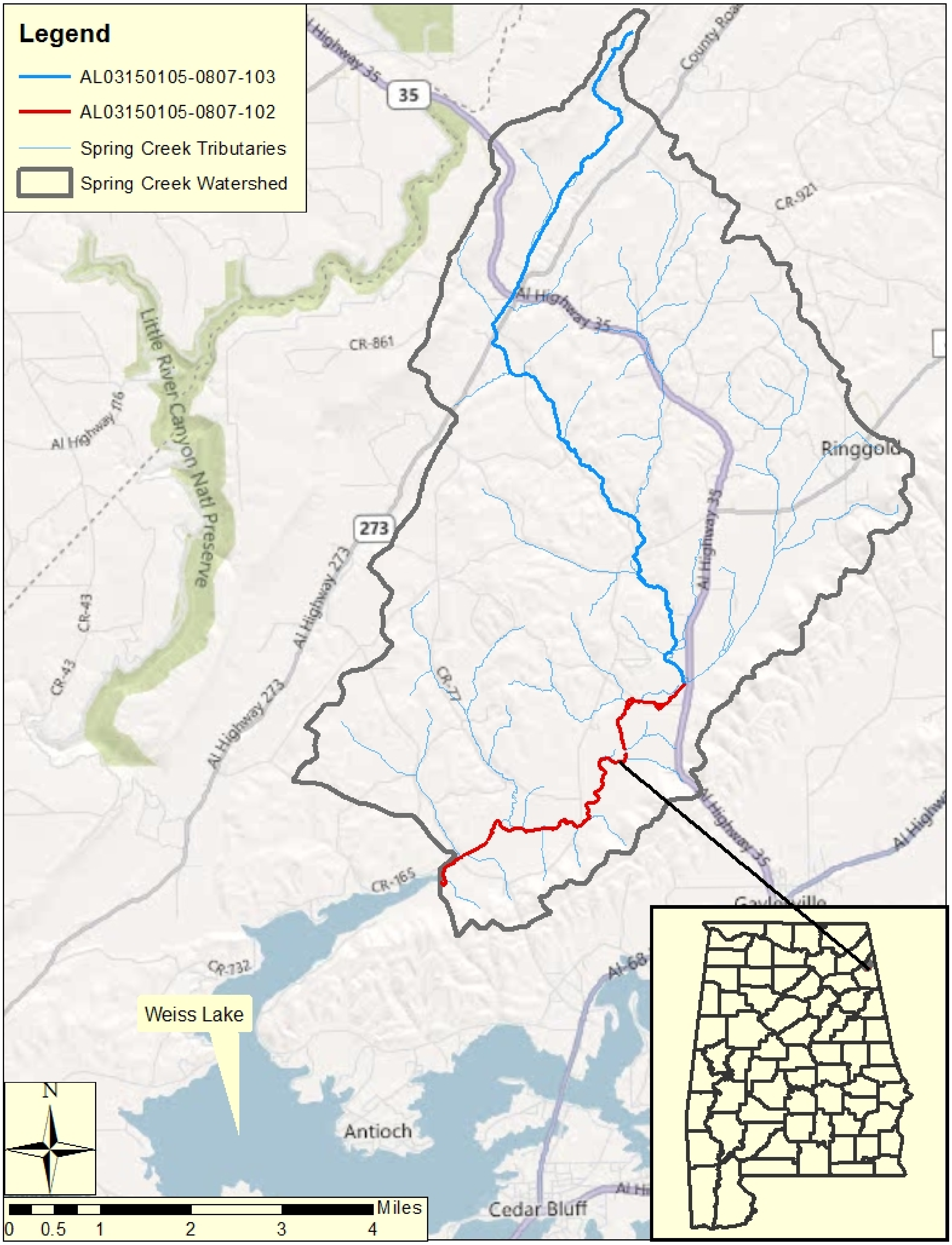
Figure I. Spring Creek Watershed



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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).

Spring Creek is on the §303(d) list for pathogens from the Coosa River to Mud Creek. Spring Creek forms in Cherokee County near the town of Gaylesville, in the Coosa River Basin. It flows through a rural setting in Cherokee County and empties into Weiss Lake on the Coosa River. The total length of Spring Creek is 15.27 miles, of which 5.39 miles are on the §303(d) list for pathogens. The total drainage area of the Spring Creek watershed is 40.94 square miles, of which 34.54 square miles drains to the impaired segment. Spring Creek has a use classification of Fish & Wildlife (F&W).

Spring Creek was first listed on the §303(d) list in 2004 based on data collected in 2002 by ADEM which indicated the stream was impaired for fecal coliform. During that time, Spring Creek was found to exceed the geometric mean water quality criterion for June-September of 200 colonies/100 mL at station SPRC-1, this data can be found in Appendix 7.2, Table 7-3. Spring Creek has subsequently been listed on the 2004 - 2010 §303(d) lists of impaired waterbodies. Its Assessment Unit ID is AL03150105-0807-102.

In 2010, §303(d) sampling studies were performed by ADEM on Spring 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 Spring Creek because it was collected less than six years ago 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 stations SPNC-1 and SPRC-2 in 2010; even though the 2002 data that prompted the listing of Spring Creek was based on the fecal coliform criteria.

The station that yielded the highest percent reduction was SPRC-2. It is located on Spring Creek 1.93 miles upstream of the pathogen impaired segment, within the 2010 §303(d) nutrient impaired segment AL03150105-0807-103. While collecting nutrient data at SPRC-2, ADEM field operations also collected E. coli data samples because it is within the contributing watershed for the pathogen impaired segment. ADEM found that this segment was impaired for pathogens, it will be included in this TMDL and thus will be added to Category 4A as part of the 2012 Integrated Report. The SPRC-2 data will be used to calculate the percent reduction for Spring Creek, given that it will provide the most conservative E. coli reduction. ADEM collected 36 E. coli samples from Spring Creek at 2 stations in 2010. According to the data collected in 2010, Spring 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 and AL03150105-0807-103 will be added to Category 4A as part of the 2012 Integrated Report.

A mass balance approach was used for calculating the pathogen TMDL for Spring Creek. The mass balance approach utilizes the conservation of mass principle. Loads were calculated by multiplying the E. coli concentration times the respective instream flow and a conversion factor. The mass loading was calculated using the geometric mean 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 SPRC-2 (6/2/2010 – 6/28/2010) with a reported concentration of 340.9 colonies/100 mL times the average flow of the five samples (16.57 cfs) and a conversion factor. The allowable loading, defined by the geometric mean criterion including a margin of safety, was calculated using the same flow value times the E. coli geometric mean target of 113.4 colonies/100 mL (126 colonies/100 mL – 10% Margin of Safety). The reduction required to meet the allowable loading was then calculated by subtracting the allowable loading from the existing loading. This violation calls for a reduction of 67%.

Tables 1-1 and 1-2 are a summary of the estimated existing loads, allowable loads, and percent reduction for the geometric mean versus the single sample criterion. Table 1-3 provides the details of the TMDL along with the corresponding reductions for Spring Creek which are protective of E. coli water quality standards year round.

Table 1-1. 2010 E. coli Load and Required Reduction for AL03150105-0807-102

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Nonpoint Source Load Single Sample	1.22E+12	6.95E+11	5.25E+11	43%
Nonpoint Source Load Geometric Mean	2.79E+11	1.64E+11	1.15E+11	41%
Point Source Load	N/A	N/A	N/A	N/A

Table 1-2. 2010 E. coli Load and Required Reduction for AL03150105-0807-103

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Nonpoint Source Load Single Sample	6.18E+10	5.23E+10	9.50E+09	15%
Nonpoint Source Load Geometric Mean	1.38E+11	4.60E+10	9.20E+10	67%
Point Source Load	N/A	N/A	N/A	N/A

Table 1-3. E. coli TMDL for Spring 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)
5.11E+10	5.11E+09	N/A	N/A	0	4.60E+10	67%

a. There are no CAFOs in the Spring 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. 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 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 Spring 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 5.39 mile segment of Spring Creek from the Coosa River to Mud Creek in Cherokee County as being impaired by pathogens (E. coli). 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. During monitoring in 2010, ADEM found the 9.88 mile upstream portion of Spring Creek (Assessment Unit ID AL03150105-0807-103) from Mud Creek to its source was also impaired for pathogens; therefore, is included in this TMDL and will be added to Category 4A as part of the 2012 Integrated Report.

2.2 Problem Definition

Waterbody Impaired:	Spring Creek – From the Coosa River to its source.
Impaired Reach Length:	15.27 miles
Impaired Drainage Area:	34.54 square miles
Water Quality Standard Violation:	Pathogens (Geometric Mean Violation)
Pollutant of Concern:	Pathogens (E. coli)
Water Use Classification:	Fish and Wildlife

Usage Related to Classification:
The impaired segment of Spring 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)(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.

Criteria Exceeded:

Fecal coliform data collected by ADEM Field Operations in 2002 was used for listing Spring 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 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 Spring Creek at station SPRC-1 in 2002. According to the 2004 §303(d) fact sheet, Spring Creek was listed as impaired based on pathogen data collected at station SPRC-1. Of 15 samples collected by ADEM in 2002 at station SPRC-1, one geometric mean of 5 samples exceeded the 200 colonies/100 mL geometric mean criterion for fecal coliform causing the stream to be placed on the list of impaired streams.

ADEM collected single sample data on the upper portion of Spring Creek at station SPRC-2 in 2010. Of 18 samples collected, two geometric means of 5 samples each exceeded the 126 colonies/100 mL geometric mean criterion for E. coli causing the upper portion to be included in the TMDL.

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 SPRC-2; even though the 2002 data that prompted the listing of Spring Creek was based on fecal coliform criteria.

The impaired segment of Spring Creek is classified as Fish and Wildlife (F&W). 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 113.4 colonies/100 mL to be exceeded.

3.2 Source Assessment

3.2.1 Point Sources in the Spring 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 Spring 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 Spring Creek watershed.

Also, according to the ADEM database, there have been no reported sanitary sewer overflows (SSOs) that have occurred in the Spring 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 Spring 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 Spring 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 76% forested, 19% agriculture, and 5% 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 Spring 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 Spring Creek watershed. Figure 3-1 is a graph depicting the primary land uses in the Spring Creek watershed.

The majority of the Spring Creek watershed is 76% Forest, and 19% Agricultural. Other major land uses within the watershed account for approximately 5% 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 Spring Creek Watershed

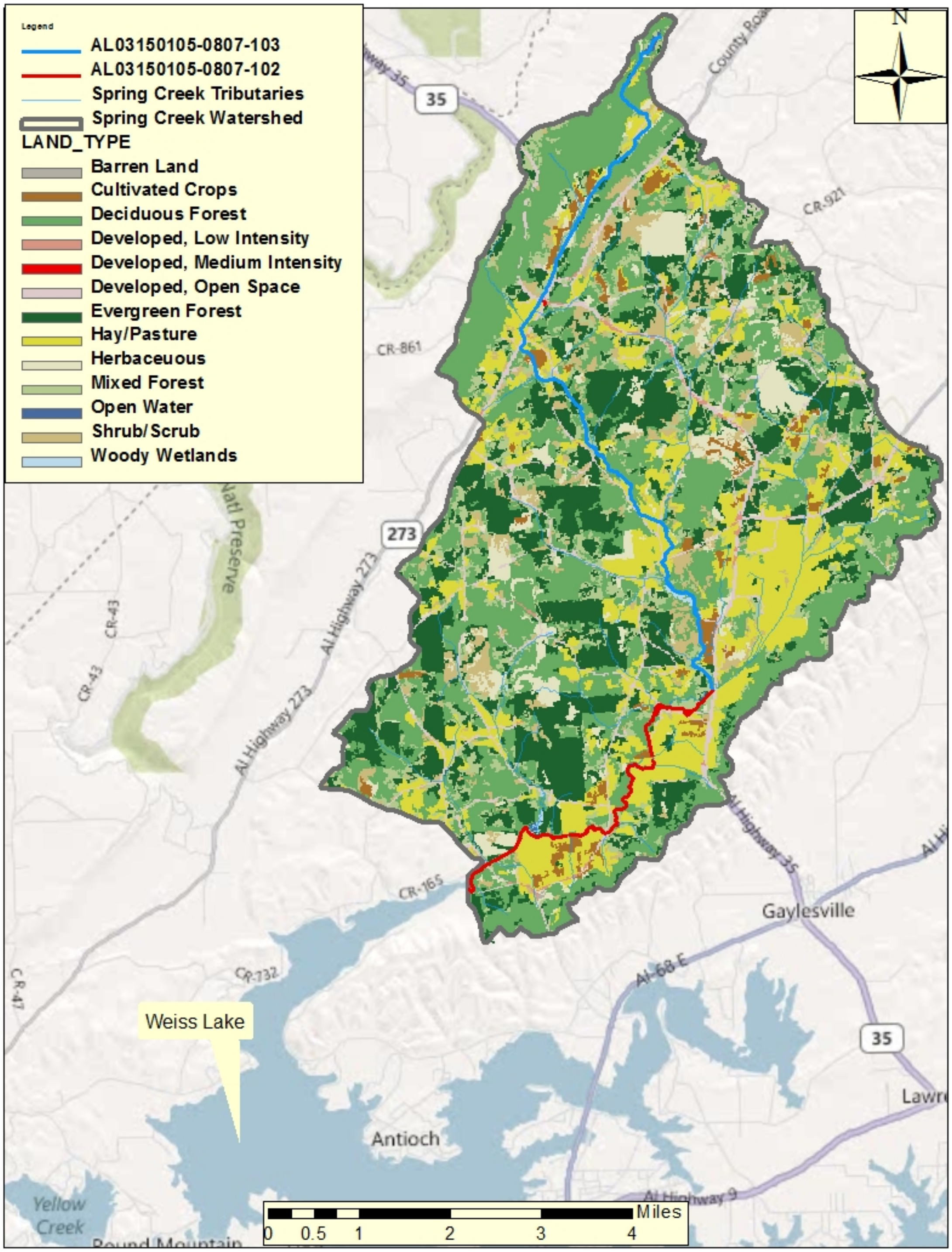
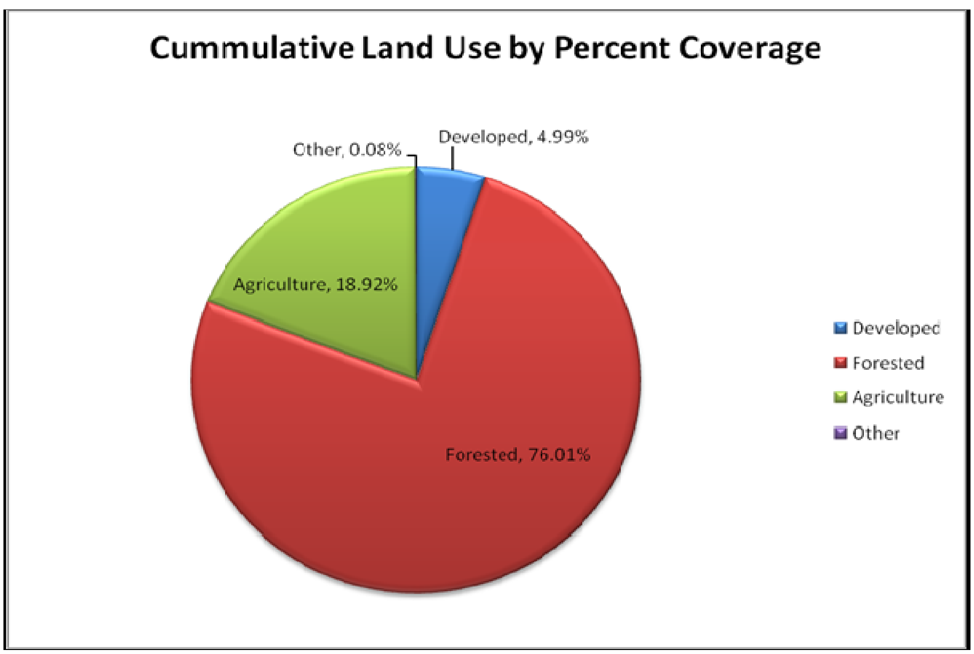


Table 3-1. Land Use Areas for the Spring Creek Watershed

Land Use	Square Miles	Acres	Percentage
Open Water	0.02	15.57	0.07%
Developed, Open Space	1.60	1024.57	4.63%
Developed, Low Intensity	0.12	76.73	0.35%
Developed, Medium Intensity	0.00	2.22	0.01%
Deciduous Forest	11.30	7230.95	32.69%
Evergreen Forest	7.28	4658.06	21.06%
Mixed Forest	3.57	2287.55	10.34%
Shrub/Scrub	2.11	1350.16	6.10%
Herbaceous	1.96	1255.42	5.68%
Hay/Pasture	5.72	3663.07	16.56%
Cultivated Crops	0.81	520.63	2.35%
Woody Wetlands	0.05	28.91	0.13%
Barren Land	0.00	2.67	0.01%
Total	**34.54**	**22,116.50**	**100.00%**
Cumulative Land Use			
Developed	1.72	1,103.52	4.99%
Forested	26.26	16,811.05	76.01%
Agriculture	6.53	4,183.69	18.92%
Other	0.03	18.24	0.08%
Total	**34.54**	**22,116.50**	**100.00%**

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



3.4 Linkage Between Numeric Targets and Sources

The Spring Creek watershed has three main land uses, namely forested, 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 Spring 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 Spring Creek at 1 station (SPNC-1) along the impaired section and 1 station (SPRC-2) upstream of the impaired section in 2010. There were 18 samples collected at station (SPNC-1) with 1 single sample violation and 1 geometric mean violation. At station (SPRC-2) 18 samples were collected with 2 single sample violations and 2 geometric mean violations. The breakdown of the violations are as follows:

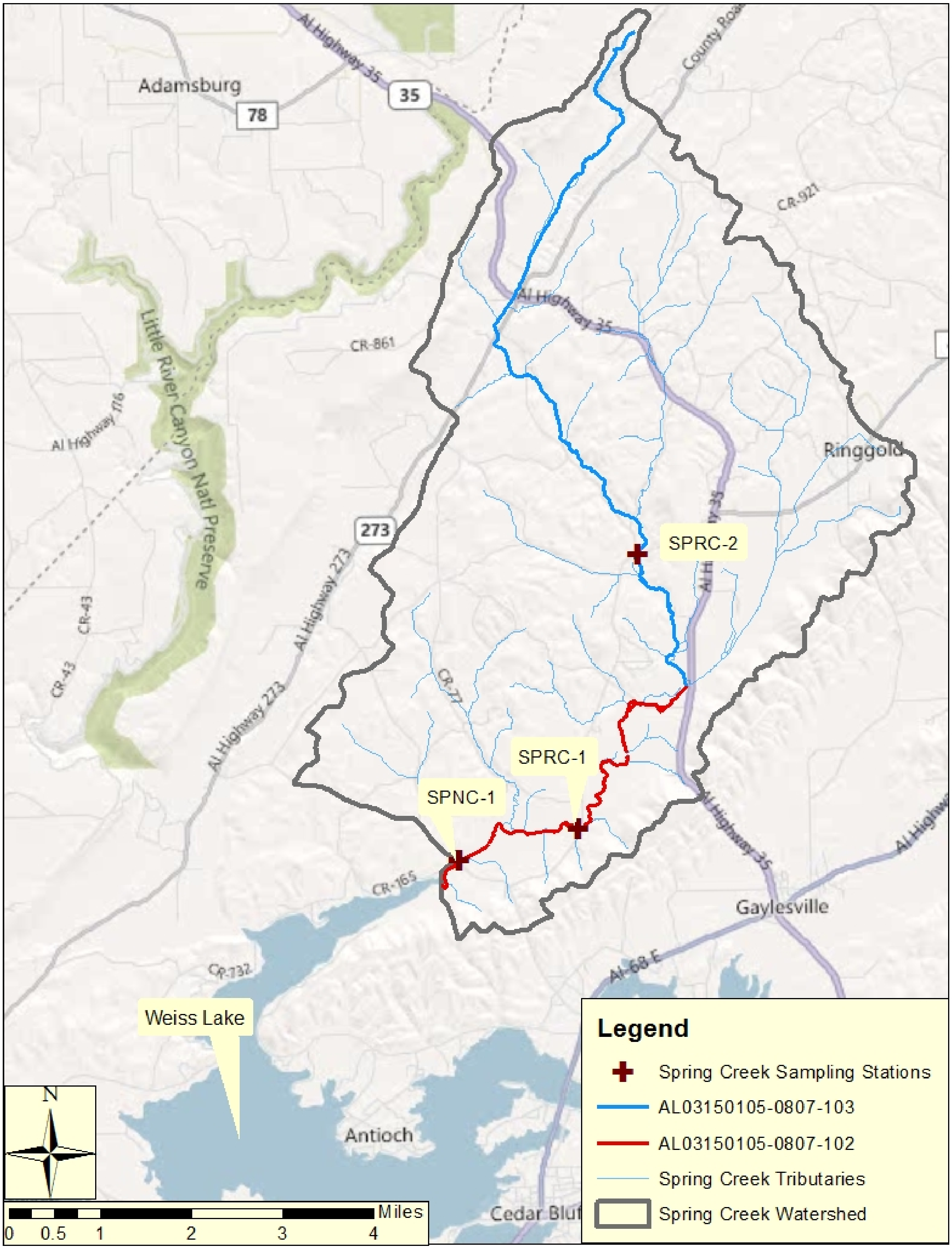
A single sample violation occurred at SPNC-1 on June 2, 2010. An E. coli concentration of 770.1 colonies/100 mL was measured on this day. No flow was taken at this time, the flow was described as not wadeable. Since no flow was measured on the day of this exceedance, a flow (64.82 cfs) was estimated by utilizing the ratio method and interpolating between measured flows on 5/4/2010 and 6/8/2010 at SPRC-2. 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 at SPNC-1 in 2010, 1 geometric mean of 193.0 col/100 mL (6/2/2010 – 6/28/2010) exceeded the E. coli geometric mean criterion of 126 col/100 mL.

Two single sample violations occurred at SPRC-2, on June 14, 2010 and August 23, 2010. E. coli concentrations of 488.4 colonies/100 mL (6/14/2010) and 517.2 colonies/100 mL (8/23/2010) were measured. A flow of 16.48 cfs was measured by ADEM on 6/14/2010 and no flow was measured on 8/23/2010 due to a flow meter malfunction. Of the two sampling events that qualified for a geometric mean calculation at SPRC-2 in 2010, both samples exceeded the E. coli geometric mean criterion of 126 col/100 mL. These geometric mean violations were 340.9 col/100 mL (6/2/2010–6/28/2010) and 288.3 col/100 mL (8/2/2010-8/23/2010). A flow of 16.57 cfs was averaged from the measured data collected between 6/2/2010 – 6/28/2010. This flow was used in conjunction with the exceedance concentration to calculate loads for the TMDL.

Table 3-2 E. coli Exceedances on Spring Creek

Station	Date	E. coli (col/100 mL)	Geometric Mean	Flow Measured (?)	Flow (cfs)
SPNC-1	6/2/2010	770.1	193.0	NO-NOT WADEABLE	
SPNC-1	6/8/2010	133.4		NO-NOT WADEABLE	
SPNC-1	6/8/2010	290.9		NO-NOT WADEABLE	
SPNC-1	6/14/2010	90.5		NO-NOT WADEABLE	
SPNC-1	6/21/2010	85.7		NO-NOT WADEABLE	
SPNC-1	6/28/2010	154.1		NO-NOT WADEABLE	
SPRC-2	6/2/2010	325.5	340.9	NO-NOT WADEABLE	
SPRC-2	6/8/2010	275.5		YES-ADEM	23.4715
SPRC-2	6/8/2010	461.1		NO-NOT WADEABLE	
SPRC-2	6/14/2010	488.4		YES-ADEM	16.48
SPRC-2	6/21/2010	452.9		YES-ADEM	15.82
SPRC-2	6/28/2010	410.6		YES-ADEM	10.5
SPRC-2	8/2/2010	365.4	288.3	YES-ADEM	4.62
SPRC-2	8/4/2010	461.1		YES-ADEM	4.68
SPRC-2	8/11/2010	178.9		YES-ADEM	5.053
SPRC-2	8/12/2010	178.5		YES-ADEM	4.4
SPRC-2	8/16/2010	206.4		YES-ADEM	4.85
SPRC-2	8/23/2010	517.2		NO-METER MALFUNCTIONED	

Figure 3-3. Map of ADEM Sampling Stations on Spring 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 Spring 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 340.9 colonies/100 mL and occurred between June 2, 2010 and June 28, 2010 at station SPRC-2. A flow of 16.57 cfs was averaged for SPRC-2 at the time of the sample collections.

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 geometric mean criterion concentration by ten percent and calculating a mass loading target with measured flow data. The geometric mean maximum value of 126 colonies/100 mL was reduced by 10% to 113.4 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 Spring 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.

<u>Existing Conditions</u>

The **single sample** mass loading was calculated by multiplying the highest single sample E. coli exceedance concentration of 770.1 colonies/100 ml times the estimated flow of 64.82 cfs. This concentration was calculated based on measurements at SPNC-1 on June 2, 2010 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 Spring Creek under a single sample exceedance condition.

$$\frac{64.82\,\text{ft}^3}{\text{s}} \times \frac{770.1\,\text{colonies}}{100\,\text{mL}} \times \frac{24{,}465{,}755 \quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{1.22 \times 10^{12}\ \text{colonies}}{\text{day}}$$

The following is the highest single sample E. coli exceedance concentration at SPRC-2 of 517.2 colonies/100 ml times the estimated flow of 4.88 cfs. This concentration was calculated based on measurements at SPRC-2 on August 23, 2010 and can be found in Appendix 7.2, Table 7-2

$$\frac{4.88\,\text{ft}^3}{\text{s}} \times \frac{517.2\,\text{colonies}}{100\,\text{mL}} \times \frac{24{,}465{,}755 \quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{6.18 \times 10^{10}\ \text{colonies}}{\text{day}}$$

The **geometric mean** mass loading was calculated by multiplying the geometric mean exceedance concentration of 340.9 colonies/100 ml times the average flow of the five samples. This concentration was calculated based on measurements at SPRC-2 between June 2 and June 28, 2010, and can be found in Appendix 7.2, Table 7-2. The average stream flow was determined to be 16.57 cfs. The product of these two values times the conversion factor gives the total mass loading (colonies per day) of E. coli to Spring Creek under the geometric mean exceedance condition.

$$\frac{16.57\,\text{ft}^3}{\text{s}} \times \frac{340.9\,\text{colonies}}{100\,\text{mL}} \times \frac{24{,}465{,}755 \quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{1.38 \times 10^{11}\ \text{colonies}}{\text{day}}$$

The following is the highest geometric mean exceedance concentration at SPNC-1 of 193.0 colonies/100 ml times the estimated flow of 59.1 cfs. This concentration was calculated based on measurements at SPNC-1 between June 2 and June 28, 2010 and can be found in Appendix 7.2, Table 7-1

$$\frac{59.1\,ft^3}{s} \times \frac{193.0\,colonies}{100\,mL} \times \frac{24{,}465{,}755 \quad 100\,mL * s}{ft^3 * day} = \frac{2.79 \times 10^{11}\ colonies}{day}$$

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:

$$\frac{64.82\ ft^3}{s} \times \frac{438.3\ colonies}{100\,mL} \times \frac{24{,}465{,}755 \quad 100\,mL * s}{ft^3 * day} = \frac{6.95 \times 10^{11}\ colonies}{day}$$

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

$$\frac{64.82\,ft^3}{s} \times \frac{48.7\ colonies}{100\,mL} \times \frac{24{,}465{,}755 \quad 100\,mL * s}{ft^3 * day} = \frac{7.72 \times 10^{10}\ colonies}{day}$$

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

$$\frac{16.57\ ft^3}{s} \times \frac{113.4\ colonies}{100\,mL} \times \frac{24{,}465{,}755 \quad 100\,mL * s}{ft^3 * day} = \frac{4.60 \times 10^{10}\ colonies}{day}$$

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

$$\frac{16.57\ ft^3}{s} \times \frac{12.6\ colonies}{100\,mL} \times \frac{24{,}465{,}755 \quad 100\,mL * s}{ft^3 * day} = \frac{5.11 \times 10^{9}\ colonies}{day}$$

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 Spring Creek as evaluated at stations SPNC-1 and SPRC-2. Tables 4-1 and 4-2 show the results of the E. coli TMDL and percent reductions for each criterion.

Tables 4-1 and 4-2 are a summary of the estimated existing loads, allowable loads, and percent reduction for both the geometric mean and single sample criterion. Table 4-3 provides the details of the TMDL along with the corresponding reductions for Spring Creek which are protective of E. coli water quality standards year round.

Table 4-1. 2010 E. coli Load and Required Reduction for AL03150105-0807-102 at SPNC-1

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Nonpoint Source Load Single Sample	1.22E+12	6.95E+11	5.25E+11	43%
Nonpoint Source Load Geometric Mean	2.79E+11	1.64E+11	1.15E+11	41%
Point Source Load	N/A	N/A	N/A	N/A

Table 4-2. 2010 E. coli Load and Required Reduction for AL03150105-0807-103 at SPRC-2

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Nonpoint Source Load Single Sample	6.18E+10	5.23E+10	9.50E+09	15%
Nonpoint Source Load Geometric Mean	1.38E+11	4.60E+10	9.20E+10	67%
Point Source Load	N/A	N/A	N/A	N/A

From Table 4-2, compliance with the geometric mean criterion of 126 colonies/100ml requires the greatest reduction in the E. coli load of 67%. The TMDL, WLA, LA and MOS values necessary to achieve the applicable E. coli criterion are provided in Table 4-3 below.

Table 4-3. E. coli TMDL for Spring 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)
5.11E+10	5.11E+09	N/A	N/A	0	4.60E+10	67%

a. There are no CAFOs in the Spring 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. 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 geometric mean criterion of 126 colonies/100ml.

4.3 TMDL Summary

Spring 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 using the newly adopted pathogen criteria, E. coli, as the primary pathogen indicator. The data collected by ADEM in 2010 confirmed the pathogen impairment on AL03150105-0807-102 and AL03150105-0807-103 and provided the basis for TMDL development. AL03150105-0807-103 is currently not listed on the 303(d) list, but will be added to Category 4A as part of the 2012 Integrated Report.

A mass balance approach was used to calculate the E. coli TMDL for Spring Creek. Based on the TMDL analysis, it was determined that a 67% 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 Spring 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. 2002 & 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. 2004, 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 SPNC-1

Station ID	Visit Date	E. Coli (col/100mL)	Geometric Mean (col/100mL)	Flow Measured	Flow (cfs)
SPNC-1	4/13/2010	63.7		NO-NOT WADEABLE	
SPNC-1	5/4/2010	365.4		NO-NOT WADEABLE	
SPNC-1	6/2/2010	770.1	193.0	NO-NOT WADEABLE	
SPNC-1	6/8/2010	133.4		NO-NOT WADEABLE	
SPNC-1	6/8/2010	290.9		NO-NOT WADEABLE	
SPNC-1	6/14/2010	90.5		NO-NOT WADEABLE	
SPNC-1	6/21/2010	85.7		NO-NOT WADEABLE	
SPNC-1	6/28/2010	154.1		NO-NOT WADEABLE	
SPNC-1	7/14/2010	49.5		NO-NOT WADEABLE	
SPNC-1	8/2/2010	52.4	87.4	NO-NOT WADEABLE	
SPNC-1	8/4/2010	64.4		NO-NOT WADEABLE	
SPNC-1	8/11/2010	73.3		YES-ADEM	27.086
SPNC-1	8/12/2010	190.4		NO-NOT WADEABLE	
SPNC-1	8/16/2010	128.1		NO-NOT WADEABLE	
SPNC-1	8/23/2010	73.8		NO-NOT WADEABLE	
SPNC-1	9/15/2010	178.5		YES-ADEM	19.982
SPNC-1	10/6/2010	186		YES-ADEM	22.45
SPNC-1	11/3/2010	95.9		YES-ADEM	21.5571

Table 7-2. 2010 E. coli Data for SPRC-2

Station ID	Visit Date	E. Coli (col/100mL)	Geometric Mean (col/100mL)	Flow Measured	Flow (cfs)
SPRC-2	4/13/2010	82		YES-ADEM	21.7496
SPRC-2	5/4/2010	198.9		YES-ADEM	22.2972
SPRC-2	6/2/2010	325.5	340.9	NO-NOT WADEABLE	
SPRC-2	6/8/2010	275.5		YES-ADEM	23.4715
SPRC-2	6/8/2010	461.1		NO-NOT WADEABLE	
SPRC-2	6/14/2010	488.4		YES-ADEM	16.48
SPRC-2	6/21/2010	452.9		YES-ADEM	15.82
SPRC-2	6/28/2010	410.6		YES-ADEM	10.5
SPRC-2	7/14/2010	70.5		YES-ADEM	7.818
SPRC-2	8/2/2010	365.4	288.3	YES-ADEM	4.62
SPRC-2	8/4/2010	461.1		YES-ADEM	4.68
SPRC-2	8/11/2010	178.9		YES-ADEM	5.053
SPRC-2	8/12/2010	178.5		YES-ADEM	4.4
SPRC-2	8/16/2010	206.4		YES-ADEM	4.85
SPRC-2	8/23/2010	517.2		NO-METER MALFUNCTIONED	
SPRC-2	9/15/2010	90.8		YES-ADEM	4.989
SPRC-2	10/6/2010	51.2		YES-ADEM	1.4972
SPRC-2	11/3/2010	260.3		YES-ADEM	

Table 7-3. 2002 Fecal Coliform Data for SPRC-1

Station ID	Visit Date	Fecal Coliform (col/100 mL)	Geometric Mean (col/100 mL)
SPRC-1	1/28/2002	80	
SPRC-1	2/14/2002	30	
SPRC-1	3/14/2002	44	
SPRC-1	4/11/2002	148	
SPRC-1	5/14/2002	270	165.3
SPRC-1	5/20/2002	68	
SPRC-1	5/21/2002	88	
SPRC-1	5/28/2002	360	
SPRC-1	6/6/2002	212	
SPRC-1	7/8/2002	390	327.0
SPRC-1	7/11/2002	430	
SPRC-1	7/17/2002	410	
SPRC-1	7/18/2002	136	
SPRC-1	7/30/2002	400	

Appendix 7.3
Spring Creek Watershed Photos

Photo 7-1 Cattle Crossing in Spring Creek at AL HWY 273

Photo 7-2 Small farm with various animals in Spring Creek watershed

Photo 7-3 Spring Creek at CR-89 with cattle access

Photo 7-4 Cattle in Spring Creek off CR-87

Photo 7-5 Spring Creek with cattle access off CR-87

Photo 7-6 Pasture Land within the Spring Creek Watershed