Alabama Department of Environmental Management

Final

Total Maximum Daily Load (TMDL)
For
Ryan Creek
Assessment Unit ID # AL03160110-0502-102
Pathogens (E. coli)

Alabama Department of Environmental Management
Water Quality Branch
Water Division
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Figure I: Ryan 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).

Ryan Creek is on the §303(d) list for pathogens from Lewis Smith Lake to its source, which is located in city of Cullman, Alabama. Ryan Creek forms in Cullman County and is included in the Black Warrior River Basin. The stream is formed within the city of Cullman and flows southwest for approximately 16 miles until it empties into Lewis Smith Lake. The total drainage area for the Ryan Creek watershed is 66.9 square miles. The primary use classification for Ryan Creek is Fish & Wildlife.

Ryan Creek was first listed on the §303(d) list in 2006 based on data collected in 2002 by the Alabama Department of Environmental Management (ADEM) which indicated the stream was impaired for fecal coliform. Ryan Creek was initially sampled in 2002 and was found to exceed the fecal coliform geometric mean water quality criterion for June-September of 200 colonies/100ml. The exceedances were found at stations RYNC-1 and RYNC-2. Ryan Creek was subsequently sampled in 2007 for fecal coliform, but the pathogen indicator was changed in December 2009 to Escherichia coli (E. coli). Due to this change, the creek was sampled in 2010 for E. coli, which will be the basis for this TMDL.

In 2010, §303(d) sampling studies were performed by ADEM on Ryan 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 Ryan 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 RYNC-3 in 2010; even though the 2002 data that prompted the listing of Ryan Creek was based on the fecal coliform criteria. The 2010 bacterial data is listed in Appendix 7.2 for reference. ADEM collected 65 samples from Ryan Creek in 2010. According to the data collected in 2010, Ryan 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 Ryan Creek.

A mass balance approach was used for calculating the pathogen TMDL for Ryan Creek. The mass balance approach utilizes the conservation of mass principle. Existing loads were calculated by multiplying the E. coli concentrations times 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 (Appendix 7.2, Table 7-3). In this case it was determined that the highest percent reduction was calculated for a single sample violation of 1,413.6 colonies/100 mL measured on 9/20/2010 at RYNC-3. This violation calls for a reduction of 69%. There was also a geometric mean violation of 129.8 colonies/100 mL. This violation resulted in a reduction of only 3%,

and therefore will have no bearing in this TMDL document. 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).

An E. coli concentration of 1,413.6 colonies/100 mL was measured on 9/20/2010 with a stream flow of 0.65 cubic feet per second (cfs) being estimated using USGS Gage 02450000 average discharge data for the same day. Given the close proximity of USGS Gage 02450000 to Ryan Creek and the same Streamflow Recession Index (SRI) values for both locations, it is safe to assume that there is a direct correlation between the flow rate and the drainage areas for the two streams. Utilizing this assumption, one can essentially ratio the drainage areas for the gage and Ryan Creek at RYNC-3 and multiply by the known flow rate at the gage on 9/20/2010 to calculate a reliable flow estimate. The estimate was necessary due to flow on the day of the exceedance being described as "visible but not measurable by meter".

The existing pathogen loading for this TMDL was calculated using the single sample exceedance concentration of 1,413.6 colonies/100 mL that was collected by ADEM on 9/20/2010. 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. 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 single sample criterion vs. the geometric mean criterion. Table 1-2 lists the TMDL defined as the maximum allowable E. coli loading under critical conditions (June-September) for Ryan Creek. Using critical conditions for the TMDL development will ensure that water quality is maintained throughout the year.

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	2.25E+10	6.97E+09	1.55E+10	69%
Nonpoint Source Load Geometric Mean	8.29E+09	8.05E+09	2.40E+08	3%
Point Source Load[a]	1.33E+08	1.33E+10	0	0%

a. PS loads and load reductions based on current permit limits of Fecal coliform as well as a design flow of 0.2 MGD for Good Hope WWTP. Therefore, units are actually Fecal coliform colonies/day vs. Escherichia coli colonies/day as in the NPS load reductions. Based on these figures, one can conclude that no reductions are necessary to achieve appropriate pathogen loading for the permitted facility.

Table 1-2 E. coli TMDL for Ryan Creek

TMDL	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)
7.74E+09	7.74E+08	3.69E+09	NA	0	3.28E+09	69%

a. There are no CAFOs in the Ryan Creek watershed. Future CAFOs will be assigned a waste load allocation (WLA) of zero.
b. WLAs for WWTPs are expressed as a daily maximum. Future WWTPs must meet the applicable in-stream water quality criteria for E. coli 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 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 Ryan 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 16.2 mile reach of Ryan Creek as impaired for pathogens. The §303(d) listing was originally reported on Alabama's 2006 List of Impaired Waters based on ADEM data collected in 2002 and subsequently included on the 2008 and 2010 lists. The source of the impairment is listed on the 2010 §303(d) list as pasture grazing.

2.2 Problem Definition

Waterbody Impaired:	Ryan Creek – Lewis Smith Lake to its source
Impaired Reach Length:	16.2 miles
Impaired Drainage Area:	66.9 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 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 Ryan Creek on Alabama's 2006 §303(d) list. At the time of the listing, the binomial distribution function was employed to calculate the number of exceedances in each range of sample sizes collected over a six year period that exceed the single-sample maximum 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.

The original listing of Ryan Creek, according to the 2006 §303(d) list fact sheet, was a geometric mean violation of 221 colonies/100 mL, which was measured at RYNC-1 as part of the Surface Water Quality Screening Assessment for the Cahaba Black Warrior River Basins 2002. Upon further observation, it was found that an error existed in the original listing document. It was stated that Ryan Creek was listed due to a geometric mean violation of 221 colonies/100 mL at RYNC-1, but since this geometric mean occurred in winter months, when a geometric mean of 1000 colonies/100 mL is permissible, this cannot be considered a violation. It was then found that a geometric mean of 308 colonies/100 mL measured at RYNC-2 was the actual cause for initial listing. This geometric mean was calculated from data taken between June and July 2002 which is considered the summer season and carries a geometric mean limit of 200 colonies/100 mL.

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 RYNC-3 in 2010; even though the 2002 data that prompted the listing of Ryan Creek was based on the fecal coliform criteria.

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 (June-September F&W criteria) to be exceeded.

3.2 Source Assessment

3.2.1 Point Sources in the Ryan 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 currently two NPDES permitted facilities in the Ryan Creek watershed. Good Hope WWTP, which is in the lower portion of the Ryan Creek watershed, discharges to Bavar Creek. Bavar Creek flows into Ryan Creek immediately upstream of RYNC-1. No E. coli violations have occurred downstream of this facility. Also, according to discharge monitoring reports (DMRs) for all of 2010, no pathogen violations were reported at the Good Hope WWTP. The second NPDES permitted facility is the South Vinemont WWTF, which does not discharge to surface water; instead, the plant utilizes a secure 14-acre spray field to apply the facility's treated wastewater. The wastewater is disinfected via chlorination before being applied to the field. Surrounding the spray field are 5 groundwater monitoring wells that are sampled semi-annually. Each January South Vinemont WWTF is required to submit a groundwater monitoring report to ADEM summarizing the results from the groundwater monitoring studies for the year. According to the January 2011 Groundwater Monitoring Report, all groundwater monitoring wells were non-detect for E. coli for the year 2010. Based on the conclusions from the report

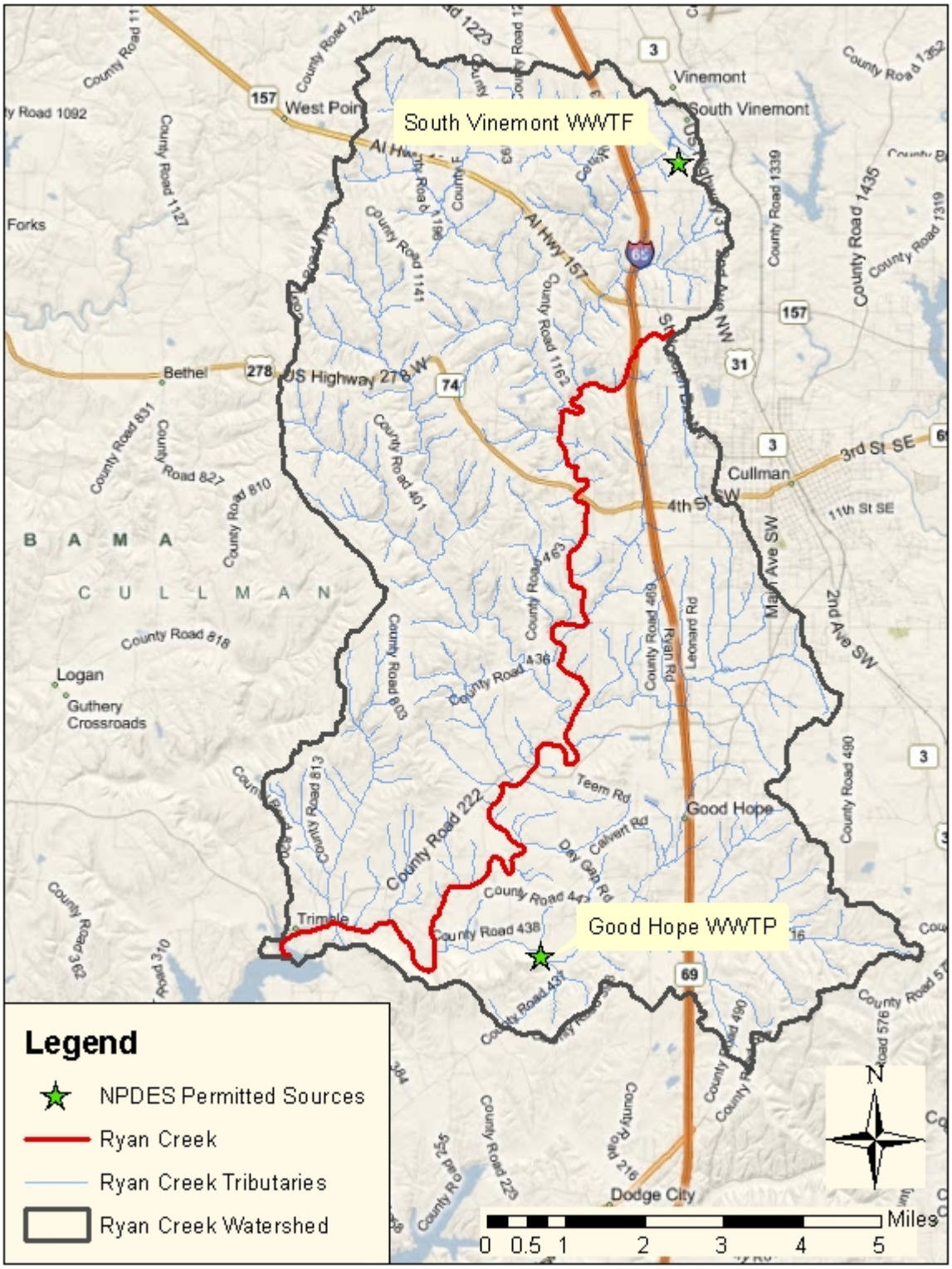
as well as the chlorine disinfection prior to field application, no E. coli loading to Ryan Creek will be attributed to the South Vinemont WWTF.

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. Currently, Good Hope WWTP is reporting their pathogen data in fecal coliform (colonies/100 mL). In addition, Good Hope WWTP has pathogen limits in the form of fecal coliform. During the next permit re-issuance pathogen criterion in the permit needs to be updated to ensure that applicable in-stream E. coli criterion for Ryan Creek is maintained.

Table 3-1 Permitted NPDES dischargers in the Ryan Creek Watershed

Type	NPDES #	Facility Name	Stream	Flow (MGD)
Municipal	AL0058343	Good Hope WWTP	Bavar Creek	0.20
Municipal	AL0075523	South Vinemont WWTP	N/A – Sprayfield System	0.095

Figure 3-1 NPDES Permitted Dischargers in the Ryan Creek Watershed



Non-Continuous Point Sources

Currently, there are no Municipal Separate Stormwater Sewer System (MS4) areas located within the Ryan Creek watershed. Future NPDES regulated stormwater discharges will be required to demonstrate consistency with the assumptions and requirements of this TMDL.

Sanitary sewer overflows (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. From review of ADEM DMR files it was found that South Vinemont WWTF has reported 3 SSOs between the years 2009 and 2010. Also, Good Hope WWTP reported 5 separate SSOs between 2003 and 2005. No SSOs were reported by Good Hope WWTP in 2010. Of the SSOs reported in 2010, none occurred on the days that violations were documented within Ryan Creek.

3.2.2 Nonpoint Sources in the Ryan 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 Ryan Creek watershed, nonpoint sources are believed to be the primary source of E. coli bacteria. Land use in this watershed is primarily agriculture and forest. Approximate land use proportions are 42% agricultural, 42% forested, and 15% developed, with the remaining 1% being spread among open water, wetlands, and barren land.

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 is all mechanisms that can contribute E. coli bacteria to waterbodies.

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

E. coli loading from urban areas is potentially attributable to multiple sources including storm water runoff, unpermitted discharges of wastewater, runoff from improper disposal of waste materials, failing septic tanks, and domestic animals. On-site 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 due to system failures and malfunctions.

3.3 Land Use Assessment

Land use for the Ryan Creek watershed was determined using ArcMap with land use datasets derived from the 2001 National Land Cover Dataset (NLCD). Figure 3-2 displays the land use areas for the Ryan Creek watershed. Table 3-2 depicts the primary land uses in the Ryan Creek watershed.

The majority of the Ryan Creek watershed is split evenly among forests and agriculture at 42% each. The remaining land use being approximately 15% developed. Developed land includes both commercial and residential land uses and is mostly contained within the city of Cullman. A further break down of the agricultural land use reveals that about 80% of the agricultural land is pasture/hay both of which can be utilized for cattle grazing during certain periods throughout the year and, in turn, contribute to pathogen run-off into streams if proper BMPs are not employed. On-site 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 due to system failures and malfunctions.

Figure 3-2 Land Use for the Ryan Creek Watershed

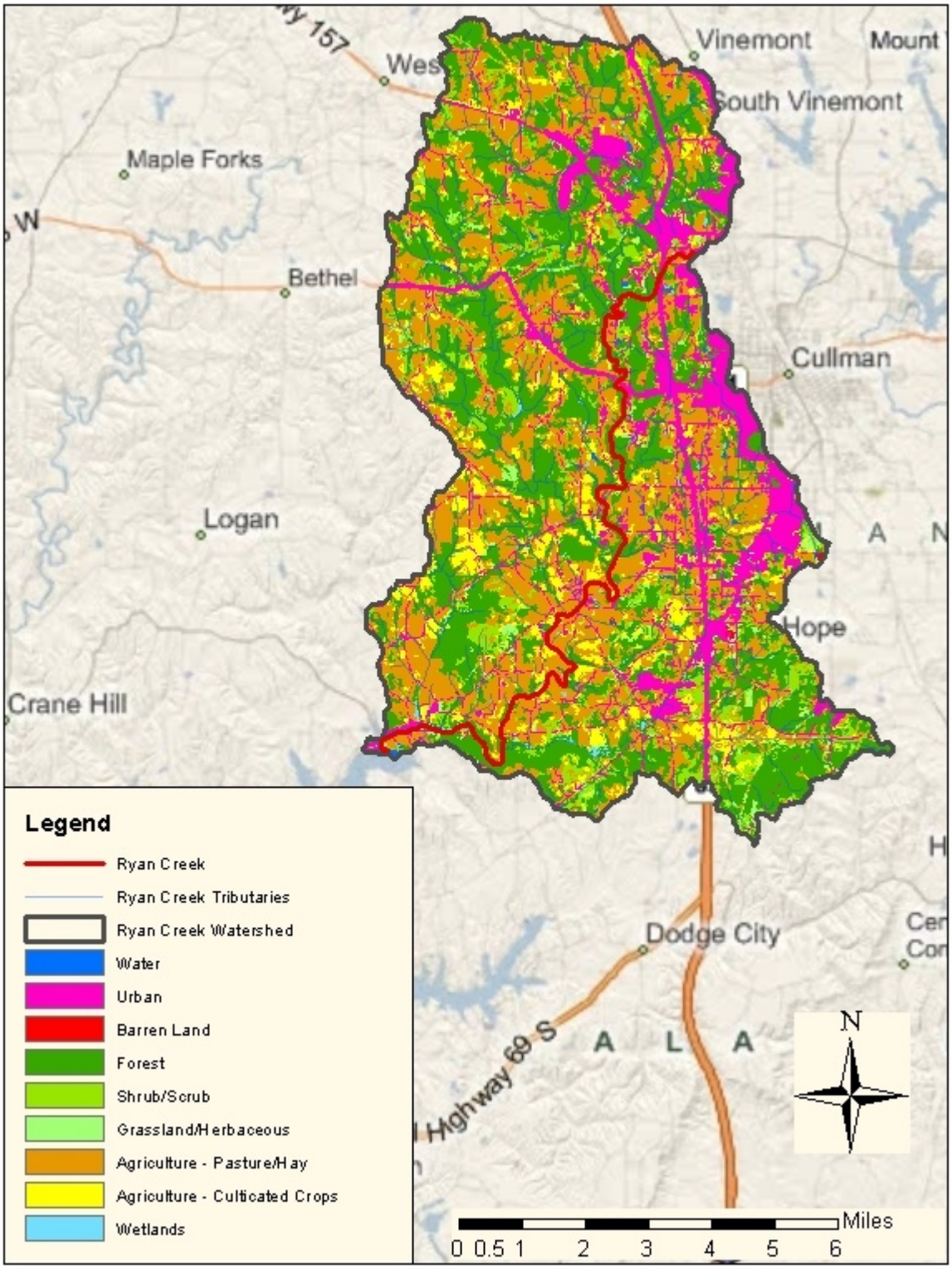


Table 3-2 Land Use in the Ryan Creek Watershed

Land Use	Sq. Miles	Acres	Percent
Open Water	0.23	148.11	0.35%
Developed Open Space	5.04	3,225.61	7.52%
Developed Low Intensity	3.87	2,479.70	5.78%
Developed Medium Intensity	0.89	572.22	1.33%
Developed High Intensity	0.42	266.43	0.62%
Barren Land (Rock/Sand/Clay)	0.06	36.92	0.09%
Deciduous Forest	16.63	10,644.71	24.83%
Evergreen Forest	2.99	1,911.04	4.46%
Mixed Forest	2.90	1,854.55	4.33%
Shrub/Scrub	5.36	3,430.44	8.00%
Grassland/Herbaceous	1.20	767.93	1.79%
Pasture/Hay	22.45	14,368.04	33.51%
Cultivated Crops	4.66	2,984.76	6.96%
Woody Wetlands	0.27	172.13	0.40%
Emergent Herbaceous Wetlands	0.02	13.34	0.03%
Total	**66.99**	**42,875.95**	**100.00%**
Cumulative Land Use			
Developed	10.22	6,543.97	15.26%
Forested	27.88	17,840.74	41.61%
Agriculture	28.31	18,120.73	42.26%
Other	0.58	370.51	0.86%
Total	**66.99**	**42,875.95**	**100.00%**

3.4 Linkage Between Numeric Targets and Sources

The Ryan Creek watershed has three main land uses, namely agriculture, forest, 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 the Ryan Creek watershed 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 monthly water quality data for Ryan Creek at 5 stations along the impaired water body in 2010, from which 65 samples were collected. Of the 65 samples, there were 5 single sample violations and 1 geometric mean violation. Breakdowns of the violations are as follows: A single sample violation occurred at RYNC-2 on September 16, 2010. An E. coli concentration of 613.1 colonies/100 mL was measured on this day. No flow was taken at this time, as flow was described as visible but not measurable with meter. No other violation occurred at this station. The highest violation that was recorded in 2010 was measured at RYNC-3. An E. coli concentration of 1413.6 colonies/100 mL was measured on September 20, 2010 at this location, but no flow was measured due to very low flow conditions. Since no flow was measured on the day of this exceedance, a flow was estimated utilizing USGS Gage 02450000. This flow was used in conjunction with the exceedance concentration to determine an accurate mass loading. The next highest concentration that was measured was at RYNC-5; a concentration of 1119.9 colonies/100 mL was measured on August 4, 2010, with an accompanying flow of 4.2 cfs. There was one other single sample exceedance measured at RYNC-5; on September 16, 2010 an E. coli concentration of 613.1 colonies/100 mL was recorded. Also at this same station, the geometric mean criterion for E. coli, 126 colonies/100 mL for summer months, was exceeded. This exceedance occurred between July and August of 2010. A geometric mean of 129.8 colonies/100 mL was recorded at the station, but did not command the high percent reduction that the single sample violation did. This violation only resulted in a reduction of 3%, and therefore, will not be considered for this TMDL report. One other single sample maximum violation occurred during the 2010 sampling season; 920.8 colonies/100 mL was measured at station RYNC-6. Again, flows were too low to be measured by the meter at the time.

E. coli data was also collected on Ryan Creek by Alabama Water Watch (AWW). Although this data did not show any impairment coincident with data collected by ADEM, it gives valuable insight to how Ryan Creek behaves under different hydrologic conditions. The AWW data can be found in Appendix 7.4.

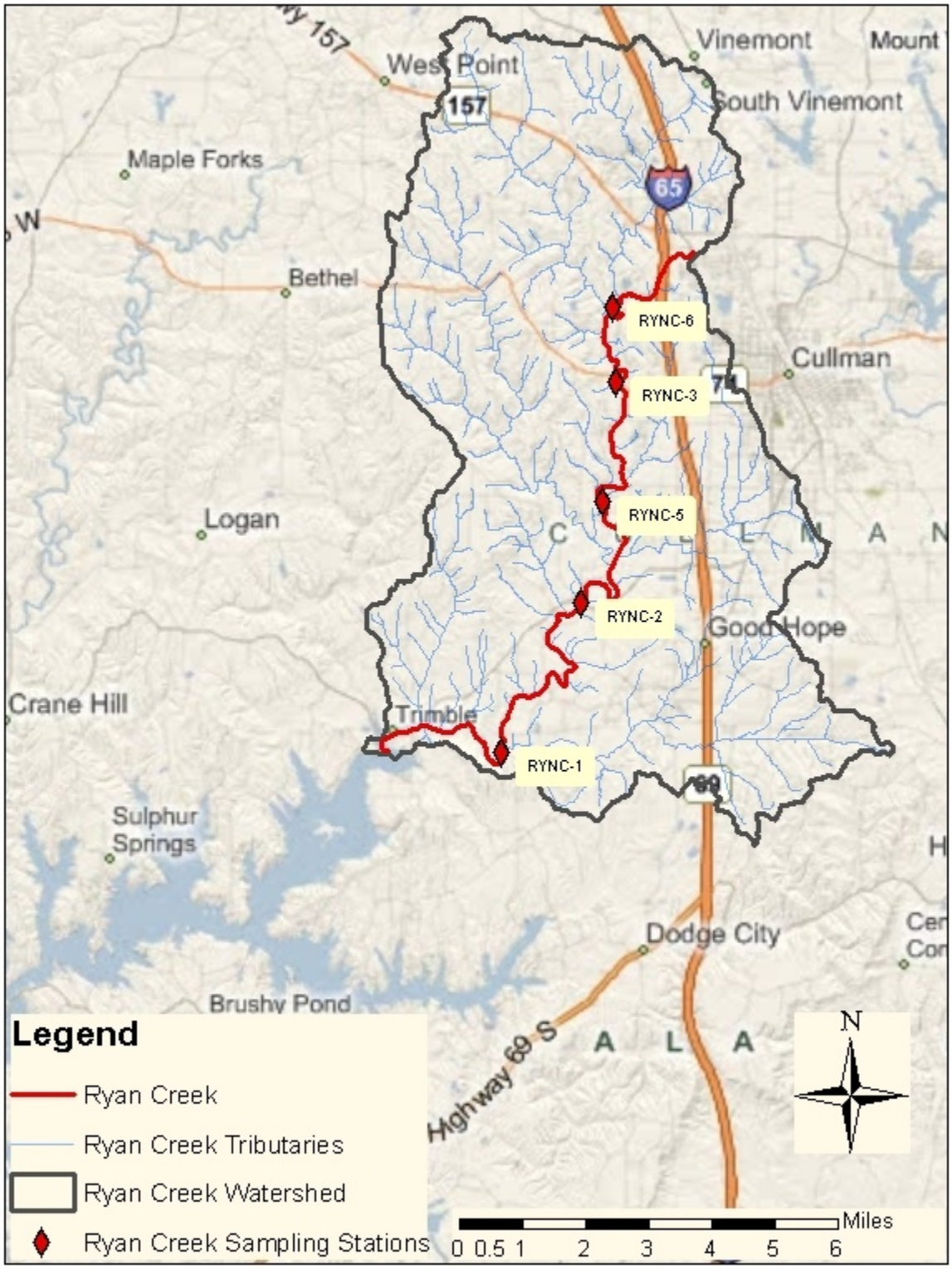
Table 3-3 E. coli Single Sample Maximum Violations on Ryan Creek

Station	Date	E.coli col/100mL	Flow (cfs)	Flow measured (?)
RYNC-2	9/16/2010	613.1		NO-VISIBLE, BUT NOT MEASURABLE WITH METER
RYNC-3	9/20/2010	1413.6		NO-VISIBLE, BUT NOT MEASURABLE WITH METER
RYNC-5	8/4/2010	1119.9	4.1959	YES-ADEM
RYNC-5	9/16/2010	613.1		NO-VISIBLE, BUT NOT MEASURABLE WITH METER
RYNC-6	9/16/2010	920.8		NO-VISIBLE, BUT NOT MEASURABLE WITH METER

Table 3-4 E. coli Geometric Mean Violations on Ryan Creek

Station	Violation	E.coli col/100mL	Date Range
RYNC-5	GEOMETRIC MEAN =	129.80	7/6/2010-8/4/2010

Figure 3-3 ADEM Sampling Stations on Ryan 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 Ryan 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 1,413.6 colonies/100 mL and occurred on September 20, 2010 at station RYNC-3. A flow of .65 cfs was estimated for RYNC-3 at the time of the sample collection.

3.7 Margin of Safety

There are two methods for incorporating a Margin of Safety (MOS) in the TMDL 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 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 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 E. coli TMDL for Ryan Creek. The mass balance approach utilizes the conservation of mass principle. Total mass loads can be calculated by multiplying the E. coli concentration and the estimated in-stream flow together. The existing load was calculated for the violation in 2010 that gave the highest percent reduction. This violation was a single sample exceedance. In the same manner, the allowable load was calculated for the single sample criterion of 438.3 colonies/100 mL. Although there were multiple single-sample and geometric mean violations in 2010, the TMDL was based on the highest calculated E. coli load percent reduction to achieve applicable water quality criteria.

Existing Conditions

The **single sample** mass loading was calculated by multiplying the E. coli single sample exceedance concentration of 1,413.6 colonies/100 mL by the estimated flow of .65 cfs. This concentration was calculated based on measurements at RYNC-3 on September 20, 2010. The product of these two values times the conversion factor gives the total mass loading (colonies per day) of E. coli to Ryan Creek under the single sample exceedance condition.

$$\frac{0.65\,\text{ft}^3}{\text{s}} \times \frac{1{,}413.6\ \text{colonies}}{100\,\text{mL}} \times \frac{24465755\quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{2.25 \times 10^{10}\ \text{colonies}}{\text{day}}$$

Allowable Conditions

The **allowable load** to the watershed was calculated under the same physical conditions as discussed above for the single sample criterion. This is done by taking the product of the estimated flow and the allowable concentration. This value is then multiplied by the conversion factor to calculate the allowable load.

For the **single sample** E. coli concentration of 438.3 colonies/100 mL, the allowable E. coli loading is:

$$\frac{0.65\ \text{ft}^3}{\text{s}} \times \frac{438.3\ \text{colonies}}{100\,\text{mL}} \times \frac{24465755\quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{6.97 \times 10^{9}\ \text{colonies}}{\text{day}}$$

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

$$\frac{0.65\,\text{ft}^3}{\text{s}} \times \frac{48.7\,\text{colonies}}{100\,\text{mL}} \times \frac{24465755\quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{7.74 \times 10^{8}\ \text{colonies}}{\text{day}}$$

The WLA portion of this TMDL was calculated by multiplying the design flow of Good Hope WWTP by the in-stream E. coli criteria for the summer months, June-September, of 487 colonies/100 mL. This

value was then multiplied by a conversion factor to come up with the appropriate loading. This calculation results in a loading of:

$$0.20 MGD \times \frac{1.55\,\text{ft}^3}{\text{s} * MGD} \times \frac{487\,\text{colonies}}{100\,\text{mL}} \times \frac{24465755 \quad 100\,\text{mL} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{3.69 \times 10^9\,\text{colonies}}{\text{day}}$$

The difference in the pathogen loading between the existing condition (violation event) and the allowable condition converted to a percent reduction represents the total load reduction needed to achieve the E. coli water quality criterion. The TMDL was calculated as the total daily E. coli load to Ryan Creek as evaluated at station RYNC-3. Table 4-1 shows the result of the E. coli TMDL and percent reduction for the single sample criterion.

Table 4-1 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	2.25E+10	6.97E+09	1.55E+10	69%
Nonpoint Source Load Geometric Mean	8.29E+09	8.05E+09	2.40E+08	3%
Point Source Load[a]	1.33E+08	1.33E+10	0	0%

a. PS loads and load reductions based on current permit limits of Fecal coliform as well as a design flow of 0.2 MGD for Good Hope WWTP. Therefore, units are actually Fecal coliform colonies/day vs. Escherichia coli colonies/day as in the NPS load reductions. Based on these figures, one can conclude that no reductions are necessary to achieve appropriate pathogen loading for the permitted facility.

From Table 4-1, compliance with the single sample criterion maximum of 487 colonies/100 mL requires a reduction in the E. coli load of 69%. 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 Ryan 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)
7.74E+09	7.74E+08	3.69E+09	NA	0	3.28E+09	69%

a. There are no CAFOs in the Ryan Creek watershed. Future CAFOs will be assigned a waste load allocation (WLA) of zero.
b. WLAs for WWTPs are expressed as a daily maximum. Future WWTPs must meet the applicable in-stream water quality criteria for E. coli 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 single sample criterion of 487 colonies/100ml.

4.3 TMDL Summary

Ryan Creek was placed on Alabama's §303(d) list in 2006 based on data collected by ADEM in 2002. In 2010, ADEM collected additional water quality data using the newly adopted pathogen impairment criteria, with E. coli serving as the primary pathogen indicator. The data collected by ADEM in 2010 confirmed the pathogen impairment and provided the basis for TMDL development.

A mass balance approach was used to calculate the E. coli TMDL for Ryan Creek. Based on the TMDL analysis, it was determined that a 69% reduction in E. coli loading was necessary to achieve compliance with applicable water quality standards.

Currently, Good Hope WWTP has fecal coliform limits as part of their NPDES permit. During the next permit re-issuance, the pathogen criterion in the permit needs to be updated to ensure that applicable in-stream E. coli criterion in Ryan Creek is maintained.

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 Ryan 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 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, 2006 & 2010. ADEM.

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

Alabama Department of Environmental Management, 2006 §303(d) List and Fact Sheet. 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 RYNC-1

Station ID	Visit Date	E Coli (col/100mL)	E Coli Dc	Flow (cfs)	Geometric Mean (col/100mL)
RYNC-1	7/1/2010	4.1			7.932
RYNC-1	7/6/2010	18.3			
RYNC-1	7/8/2010	2			
RYNC-1	7/15/2010	13			
RYNC-1	7/19/2010	16.1			
RYNC-1	9/13/2010	18.1			11.08
RYNC-1	9/16/2010	9.8			
RYNC-1	9/20/2010	16			
RYNC-1	9/30/2010	1	< MDL 1,		
RYNC-1	10/4/2010	58.8			
RYNC-1	10/19/2010	16			
RYNC-1	11/9/2010	98.8			

MDL: Minimum Detection Limit

Table 7-2 2010 E. coli data for RYNC-2

Station ID	Visit Date	E Coli (col/100mL)	E Coli Dc	Flow (cfs)	Geometric Mean (col/100mL)
RYNC-2	4/7/2010	43.2	H		
RYNC-2	5/18/2010	57.6	H		
RYNC-2	6/21/2010	191.8	H	31.0327	
RYNC-2	7/1/2010	50.4		6.0613	
RYNC-2	7/6/2010	74.9		3.9426	99.28
RYNC-2	7/8/2010	160.7		2.9838	
RYNC-2	7/15/2010	69.7		4.8799	
RYNC-2	7/19/2010	151.5		9.7172	
RYNC-2	8/3/2010	75.9	J	2.6364	
RYNC-2	9/13/2010	17.5		0.2937	96.51
RYNC-2	9/16/2010	613.1			
RYNC-2	9/20/2010	7.3			
RYNC-2	9/30/2010	410.6			
RYNC-2	10/4/2010	260.3			
RYNC-2	10/19/2010				
RYNC-2	11/9/2010	866.4			

J: The reported microbiological result is an estimate
H: Analytical holding times for analysis was exceeded
Exceedances are highlighted in red

Table 7-3 2010 E. coli data for RYNC-3

Station ID	Visit Date	E Coli (col/100mL)	E Coli Dc	Flow (cfs)	Geometric Mean (col/100mL)
RYNC-3	4/7/2010	38.4	H	18.0359	
RYNC-3	5/18/2010	34.5	H	9.6666	
RYNC-3	6/21/2010	156.5	H	7.7911	
RYNC-3	7/1/2010	33.6		2.5336	
RYNC-3	7/6/2010	43.5		0.8216	96.85
RYNC-3	7/8/2010	58.3			
RYNC-3	7/15/2010	156.5		1.3926	
RYNC-3	7/19/2010	124.6		1.9332	
RYNC-3	8/4/2010	172.3		1.3411	
RYNC-3	9/13/2010	42.8			
RYNC-3	9/16/2010	101.9			
RYNC-3	9/20/2010	1413.6			
RYNC-3	9/30/2010	44.1			
RYNC-3	10/4/2010				
RYNC-3	10/19/2010				
RYNC-3	11/9/2010	45.9			

H: Analytical holding times for analysis was exceeded
Exceedances are highlighted in red

Table 7-4 2010 E. coli data for RYNC-5

Station ID	Visit Date	E Coli (col/100mL)	E Coli Dc	Flow (cfs)	Geometric Mean (col/100mL)
RYNC-5	4/7/2010	35.5	H	22.3196	
RYNC-5	5/18/2010	31.3	H	12.4292	
RYNC-5	6/21/2010	101.7	H	12.41	
RYNC-5	7/1/2010	81.3		3.7723	
RYNC-5	7/6/2010	42.2		1.0861	129.80
RYNC-5	7/8/2010	61.7		1.0468	
RYNC-5	7/15/2010	46.4		2.4874	
RYNC-5	7/19/2010	272.3		4.2485	
RYNC-5	8/4/2010	1119.9		4.1959	
RYNC-5	9/13/2010	307.6			
RYNC-5	9/16/2010	613.1			
RYNC-5	9/20/2010	35.9			
RYNC-5	9/30/2010	62.4			
RYNC-5	10/4/2010				
RYNC-5	10/19/2010				
RYNC-5	11/9/2010	39.9			

H: Analytical holding times for analysis was exceeded
Exceedances are highlighted in red

Table 7-5 2010 E. coli data for RYNC-6

Station ID	Visit Date	E Coli (col/100mL)	E Coli Dc	Flow (cfs)	Geometric Mean (col/100mL)
RYNC-6	4/7/2010			8.3659	
RYNC-6	5/18/2010			5.5898	
RYNC-6	6/21/2010			4.5756	
RYNC-6	7/1/2010	65			90.03
RYNC-6	7/6/2010	90.5			
RYNC-6	7/8/2010	37.4			
RYNC-6	7/15/2010	228.2			
RYNC-6	7/19/2010	117.8			
RYNC-6	8/4/2010				
RYNC-6	9/13/2010	178.5			
RYNC-6	9/16/2010	920.8			
RYNC-6	9/20/2010	365.4			
RYNC-6	9/30/2010	123.6			
RYNC-6	10/4/2010				
RYNC-6	10/19/2010				
RYNC-6	11/9/2010	10.9			

Exceedances are highlighted in red

Table 7-6 2002 Fecal Coliform data for RYNC-1

Station ID	Visit Date	Fecal Col (col/100ml)	Fecal Col dc	Geometric Mean (col/100mL)
RYNC-1	1/30/2002	130		
RYNC-1	2/27/2002	2		
RYNC-1	3/11/2002	27		221.39
RYNC-1	3/19/2002	124		
RYNC-1	3/21/2002	1340		
RYNC-1	3/25/2002	304		
RYNC-1	4/2/2002	390		
RYNC-1	4/23/2002	196		
RYNC-1	5/21/2002	104		
RYNC-1	6/12/2002	38		143.23
RYNC-1	6/17/2002	270		
RYNC-1	6/24/2002	68		
RYNC-1	6/25/2002	1200	G	
RYNC-1	7/9/2002	72		

G: The actual number is probably greater than the number reported

Table 7-7 2002 Fecal Coliform data for RYNC-2

Station ID	Visit Date	Fecal Col (col/100ml)	Fecal Col dc	Geometric Mean (col/100mL)
RYNC-2	1/30/2002	120		
RYNC-2	2/27/2002	2		
RYNC-2	3/11/2002	23		186.98
RYNC-2	3/19/2002	276		
RYNC-2	3/21/2002	1200	G	
RYNC-2	3/25/2002	120		
RYNC-2	4/2/2002	250		
RYNC-2	4/23/2002	148		
RYNC-2	5/21/2002	174		
RYNC-2	6/12/2002	140		307.91
RYNC-2	6/17/2002	288		
RYNC-2	6/24/2002	260		
RYNC-2	6/25/2002	1200	G	
RYNC-2	7/9/2002	220		

G: The actual number is probably greater than the number reported
Exceedances are highlighted in red

Table 7-8 2002 Fecal Coliform data for RYNC-3

Station ID	Visit Date	Fecal Col (col/100ml)	Fecal Col dc	Geometric Mean (col/100mL)
RYNC-3	1/30/2002	64		
RYNC-3	2/26/2002	13		
RYNC-3	3/11/2002	19		131.08
RYNC-3	3/19/2002	104		
RYNC-3	3/21/2002	1200	G	
RYNC-3	3/25/2002	204		
RYNC-3	4/2/2002	80		
RYNC-3	4/23/2002	54		
RYNC-3	5/21/2002	192		
RYNC-3	6/12/2002	23		175.75
RYNC-3	6/17/2002	420		
RYNC-3	6/24/2002	80		
RYNC-3	6/25/2002	350		
RYNC-3	7/9/2002	620	G	

G: The actual number is probably greater than the number reported

Appendix 7.3
Alabama Water Watch Data

Table 7-9 2005-2010 E. coli data collected by AWW

Station_ID	Date	Alabama WW Site_Code	E. coli (cfu/100mL)
Alabama WW-(RC1) // ADEM-(RYNC-5)	2/16/2005	10029012	<100
Alabama WW-(RC1) // ADEM-(RYNC-5)	10/16/2006	10029012	150.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	11/8/2006	10029012	200.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	12/12/2006	10029012	100.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	1/16/2007	10029012	100.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	2/19/2007	10029012	<100
Alabama WW-(RC1) // ADEM-(RYNC-5)	3/19/2007	10029012	<100
Alabama WW-(RC1) // ADEM-(RYNC-5)	4/17/2007	10029012	100.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	5/14/2007	10029012	150.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	6/18/2007	10029012	233.33
Alabama WW-(RC1) // ADEM-(RYNC-5)	7/16/2007	10029012	100.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	8/13/2007	10029012	100.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	9/18/2007	10029012	250.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	10/10/2007	10029012	1100.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	11/28/2007	10029012	200.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	12/10/2007	10029012	100.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	1/15/2008	10029012	<100
Alabama WW-(RC1) // ADEM-(RYNC-5)	2/11/2008	10029012	<100
Alabama WW-(RC1) // ADEM-(RYNC-5)	3/10/2008	10029012	200.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	5/19/2008	10029012	100.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	6/16/2008	10029012	100.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	8/18/2008	10029012	<100
Alabama WW-(RC1) // ADEM-(RYNC-5)	9/15/2008	10029012	866.67
Alabama WW-(RC1) // ADEM-(RYNC-5)	10/20/2008	10029012	100.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	11/14/2008	10029012	100.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	12/22/2008	10029012	100.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	2/11/2009	10029012	<100
Alabama WW-(RC1) // ADEM-(RYNC-5)	3/16/2009	10029012	200.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	4/27/2009	10029012	1733.33
Alabama WW-(RC1) // ADEM-(RYNC-5)	5/21/2009	10029012	200.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	8/17/2009	10029012	150.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	9/9/2009	10029012	200.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	10/20/2009	10029012	<100
Alabama WW-(RC1) // ADEM-(RYNC-5)	2/16/2010	10029012	<100
Alabama WW-(RC1) // ADEM-(RYNC-5)	3/15/2010	10029012	233.33
Alabama WW-(RC1) // ADEM-(RYNC-5)	4/21/2010	10029012	100.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	5/12/2010	10029012	<100
Alabama WW-(RC1) // ADEM-(RYNC-5)	6/17/2010	10029012	200.00
Alabama WW-(RC1) // ADEM-(RYNC-5)	7/14/2010	10029012	133.33
Alabama WW-(RC1) // ADEM-(RYNC-5)	8/10/2010	10029012	<100
Alabama WW-(RC1) // ADEM-(RYNC-5)	11/18/2010	10029012	100.00

Appendix 7.4
Ryan Creek Watershed Photos

Photo 7-1 Ryan Creek at Headwaters in Cullman, AL

Photo 7-2 Pasture alongside Ryan Creek

Photo 7-3 Ryan Creek at Interstate 65

Photo 7-4 Ryan Creek at US Hwy. 278

Photo 7-5 Pasture-grazing in the Ryan Creek Watershed

Photo 7-6 Additional Pasture-grazing in the Ryan Creek Watershed

Photo 7-7 Pasture alongside Ryan Creek

Photo 7-8 Embayment portion of Ryan Creek at Cullman CR-813