Final
Total Maximum Daily Load (TMDL)
For
Cottondale Creek

Assessment Unit ID # AL03160112-0503-100

Tuscaloosa County

Pathogens (*E. coli*)

Alabama Department of Environmental Management Water Quality Branch
Water Division
August 2022

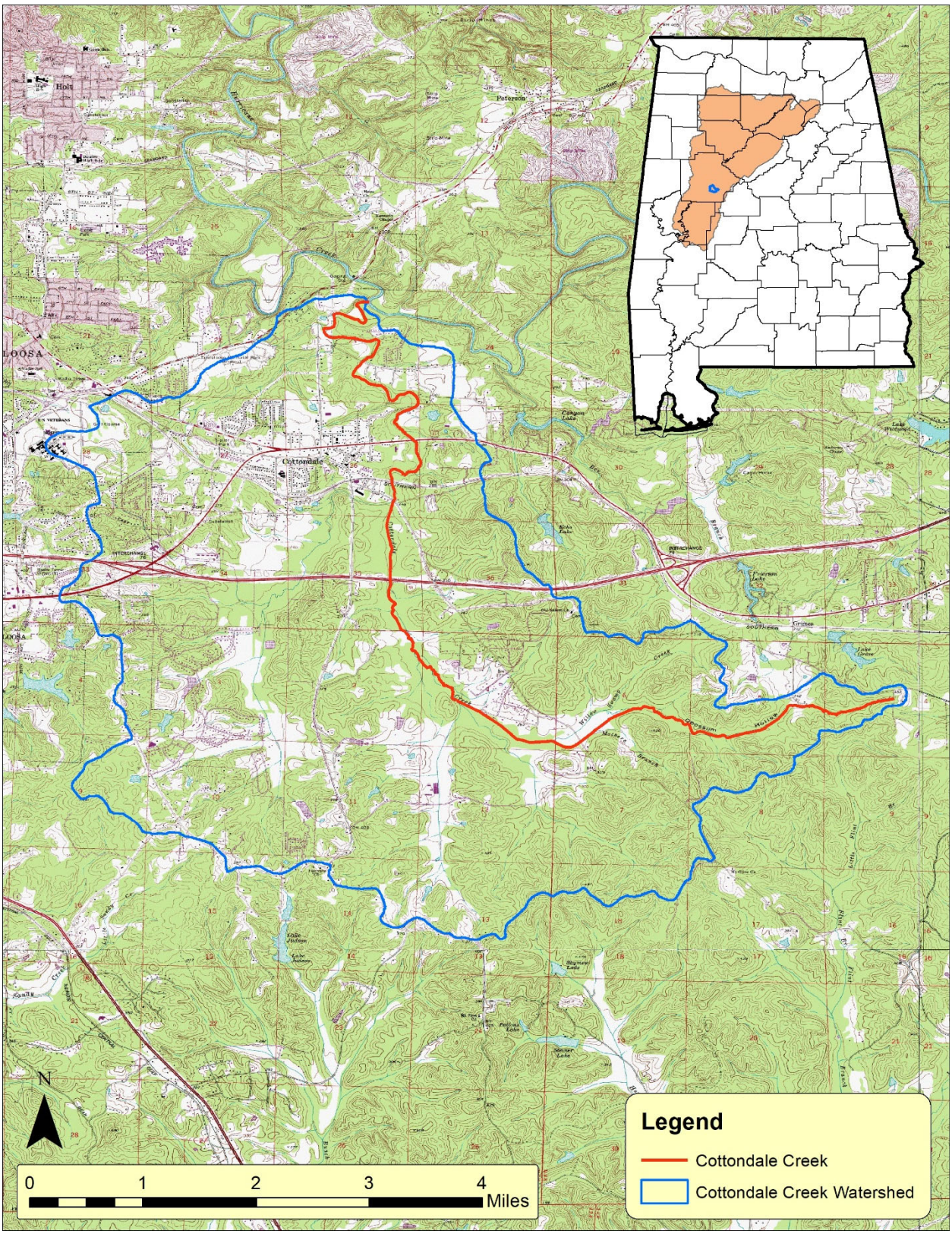

Figure 1: **Cottondale Creek Watershed**

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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 waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources including natural background levels, and a margin of safety (MOS).

Cottondale Creek in Tuscaloosa County is currently included on Alabama's §303(d) list as impaired for pathogens (*E. coli)* from Hurricane Creek to its source. Cottondale Creek has a designated use classification of Fish and Wildlife (F&W). The headwater source of Cottondale Creek begins southeast of the city of Cottondale. Cottondale Creek flows northwest for a total length of 9.58 miles, ending at the confluence with Hurricane Creek. The total drainage area for the Cottondale Creek watershed is approximately 18.4 square miles.

Cottondale Creek was first included on the §303(d) list for pathogens (*E. coli)* in 2016 based on data collected by the Alabama Department of Environmental Management (ADEM) in 2012. The *E. coli* exceedances were found at station CTNT-1. This data, which can be found in Table 3, indicated the stream was impaired for pathogens (*E. coli*), which will be the basis for this TMDL.

In 2021, §303(d) sampling studies were performed by ADEM on Cottondale Creek to further assess the water quality of the impaired stream. ADEM collected 16 *E. coli* samples from Cottondale Creek at station CTNT-1. A review of the general water quality and intensive *E. coli* study revealed that the listed segment of Cottondale Creek was still not meeting the pathogen criteria applicable to its use classification (F&W).

A mass balance approach was used for calculating the pathogen TMDL for Cottondale Creek. The mass balance approach utilizes the conservation of mass principle. The TMDL was calculated using the single sample or geometric mean sample exceedance event that resulted in the highest percent reduction. Existing loads were calculated by multiplying the *E. coli* concentrations times the respective in-stream flows and a conversion factor. In the same manner as existing loads were calculated, allowable loads were calculated for the single sample *E. coli* target of 268.2 colonies/100 ml (298 colonies/100 ml – 10% Margin of Safety) and geometric mean *E. coli* target of 113.4 colonies/100 ml (126 colonies/100 ml – 10% Margin of Safety). In this case, it was determined that the highest percent reduction was calculated from a single sample maximum *E. coli* exceedance at station CTNT-1 on August 19, 2021, with a value of 2419.6 colonies/100 ml. This violation calls for a reduction of 89%.

Table 1 is a summary of the estimated existing load, allowable load, and percent reduction for the single sample criterion and the geometric mean criterion. Table 2 lists the TMDL, defined as the maximum allowable *E. coli* loading under critical conditions for Cottondale Creek.

Table 1: *E. coli* Loads and Required Reductions

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Single Sample Load	2.52×10^{11}	2.79×10^{10}	2.24×10^{11}	89%
Geometric Mean Load	5.32×10^{10}	1.47×10^{10}	3.84×10^{10}	72%

Table 2: E. coli TMDL for Cottondale Creek

TMDL[e]	Margin of Safety (MOS)	Waste Load Allocation (WLA)[a]			Load Allocation (LA)	
		WWTPs[b]	MS4s[c]	Leaking Collection Systems[d]		
(col/day)	(col/day)	(col/day)	% reduction	(col/day)	(col/day)	% reduction
3.11×10^{10}	3.11×10^{9}	NA	89%	0	2.79×10^{10}	89%

Note: NA = not applicable
a. There are no CAFOs in the Cottondale Creek watershed. Future CAFOs will be assigned a waste load allocation (WLA) of zero.
b. Future WWTPs must meet the applicable in-stream water quality criteria for pathogens at the point of discharge.
c. Future MS4 areas would be required to demonstrate consistency with the assumptions and requirements of this TMDL.
d. The objective for leaking collection systems is a WLA of zero. It is recognized, however, that a WLA of 0 colonies/day may not be practical. For these sources, the WLA is interpreted to mean a reduction in *E. coli* loading to the maximum extent practical, 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 maximum criterion of 298 colonies/100 ml.

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 to targeting the load reductions to improve water quality in the Cottondale 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 Cottondale Creek as impaired for pathogens. The §303(d) listing was originally reported on Alabama's 2016 List of Impaired Waters based on data collected in 2012 and was included on all subsequent lists.

2.2 Problem Definition

Waterbody Impaired:	Cottondale Creek – from Hurricane Creek to its source
Impaired Reach Length:	9.58 miles
Impaired Drainage Area:	18.4 sq. miles
Water Quality Standard Violation:	Pathogens (Single Sample Maximum, Geometric Mean)
Pollutant of Concern:	Pathogens (*E. coli*)
Water Use Classification:	Fish and Wildlife

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

(a) Best usage of waters: fishing, propagation of fish, aquatic life, and wildlife.

(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 year-round and whole body water-contact recreation during the months of May through October, 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 areas and will be considered satisfactory for swimming and other whole body water-contact sports.

E. coli Criteria:

Criteria for acceptable bacteria levels for the F&W use classification are described in ADEM Admin. Code R. 335-6-10-.09(5)(e)7(i) and (ii) as follows:

7. Bacteria:

(i) In non-coastal waters, bacteria of the E. coli group shall not exceed a geometric mean of 548 colonies/100 ml; nor exceed a maximum of 2,507 colonies/100 ml in any sample. In coastal waters, bacteria of the enterococci group shall not exceed a maximum of 275 colonies/100 ml in any sample. The geometric mean shall be calculated from no less than five samples collected at a given station over a 30-day period at intervals not less than 24 hours.

(ii) For incidental water contact and whole body water-contact recreation during the months of May through October, 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 298 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:

Cottondale Creek was placed on the §303(d) list for pathogens in 2016 based on data collected during 2012 at station CTNT-1. At the time of the original listing, the geometric mean criterion was 126 col/100 ml, and the single sample criterion was 487 col/100 ml during the months of June – September. During the months of October – May, the geometric mean criterion was 548 col/100 ml, and the single sample criterion was 2507 col/100 ml. *E. coli* sampling at ADEM monitoring station CTNT-1 showed that the applicable single sample criterion was exceeded in two of eight samples. At the time of listing, the source of pathogens was linked to on-site wastewater systems and pasture grazing. The listing data is summarized below in Table 3.

Table 3: Data for §303(d) Listing - Ambient Monitoring (2012)

Station ID	Visit Date/Time	*E. coli* (col/100ml)	*E. coli* Detect Criteria	Single Sample Criteria	Flow (cfs)	Flow Measured
CTNT-1	4/3/2012 8:50	259.5		2507	6.82	Yes - ADEM
CTNT-1	5/8/2012 17:03	193.5	H	2507	2.71	Yes - ADEM
CTNT-1	6/14/2012 10:06	108.1		487	1.16	Yes - ADEM
CTNT-1	7/12/2012 11:20	206.4		487	1.61	Yes - ADEM
CTNT-1	8/9/2012 9:49	2419.6	G	487		No
CTNT-1	9/6/2012 9:26	488.4		487	12.85	Yes - ADEM
CTNT-1	10/3/2012 11:02	290.9		2507	4.97	Yes - ADEM
CTNT-1	11/1/2012 10:39	67.7		2507	2.10	Yes - ADEM
G denotes that the analyte is present, but is above an acceptable level for quantitation						
H denotes the analytical holding times for analysis were exceeded						

3.0 Technical Basis for TMDL Development

3.1 Water Quality Target Identification

For the purpose of this TMDL, a single sample maximum *E. coli* target of 268.2 colonies/100 ml will be used. This target was derived by using a 10% explicit margin of safety from the single sample maximum criterion of 298 colonies/100 ml. This target is considered protective of water quality standards and should not allow the single sample maximum criterion to be exceeded. In addition, a geometric mean target of 113.4 colonies/100 ml will be used for a series of five samples taken at least 24 hours apart over the course of 30 days. This target was also derived by using a 10% explicit margin of safety from the geometric mean criterion of 126 colonies/100 ml. This target is considered protective of water quality standards and should not allow the geometric mean criterion to be exceeded.

3.2 Source Assessment

A point source can be defined as a discernible, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source contributions of pathogens 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 bacteria can flow into the stream or leach into the groundwater. Illicit discharges are found at facilities that are discharging bacteria when not permitted, or when the pathogens criterion established in the issued NPDES permit is not being upheld.

3.2.1 Continuous Point Sources in the Cottondale Creek watershed

Currently, there are no NPDES-regulated continuous point source discharges located within the Cottondale Creek watershed. Any future NPDES regulated continuous 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.

3.2.2 Non-Continuous Point Sources in the Cottondale Creek watershed

There are currently six NPDES general discharge permits within the Cottondale Creek watershed, shown below in Table 4. None of these facilities are considered to be a source of pathogens due to the nature of their operations. As such, no *E. coli* loading to Cottondale Creek will be attributed to these facilities, nor will they receive an allocation in this TMDL.

Table 4: Non-Continuous Point Sources in the Cottondale Creek watershed

Facility Name	Permit Number
Ballard Concrete	ALG110534
Southeast Fabricators Inc.	ALG120420
McLeod Truck Parts	ALG140151
Troy Bruce Sellers, LLC	ALG180164
Former Circle C #32	ALG340398
Clements Road Borrow/Spoil Site	ALG890607

3.2.3 Municipal Separate Storm Sewer Systems (MS4s)

Urban areas designated as part of the Municipal Separate Storm Sewer System (MS4) program are regulated by NPDES, and as such, are considered to be point sources by EPA and receive waste load allocations (WLAs) in TMDLs. The EPA defines an MS4 as *"a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):*

(i) Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law);
(ii) Designed or used for collecting or conveying stormwater;
(iii) Which is not a combined sewer; and
(iv) Which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2."

During rain events in an urbanized watershed, stormwater runoff has the potential to collect pollutants which are transported through MS4 systems before discharging into state waters. Therefore, in 1990 the EPA developed the NPDES stormwater program, which promulgated rules, in two different phases, in order to address the potential negative water quality effects associated with stormwater runoff. In 1990, the EPA issued Phase I regulations under the NPDES stormwater program, which required both medium and large cities and also counties with populations of 100,000 or more to obtain NPDES permit coverage specifically for their stormwater discharges. In

1999, the second phase of the NPDES stormwater program amended existing regulations in addition to requiring NPDES permits for stormwater discharges from certain small MS4 systems.

There are currently two Phase II MS4 areas within the Cottondale Creek watershed. Any future MS4 stormwater discharges will be required to demonstrate consistency with the assumptions and requirements of this TMDL.

Table 5: NPDES Phase II MS4 Municipalities in the Cottondale Creek watershed

Permittee Name	Permit Number
Tuscaloosa County	ALR040001
City of Tuscaloosa	ALR040021

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 files, it was found that 25 SSOs were reported from 2019 to 2021 within the Cottondale Creek watershed. The numerous SSOs are considered to be a source of pathogens to Cottondale Creek. The reported SSOs are listed in Appendix 7.3.

3.2.4 Nonpoint Sources in the Cottondale Creek Watershed

Nonpoint sources of bacteria do not have a defined discharge point, but rather occur over the entire length of a stream or waterbody. On the land surface, bacteria can accumulate over time and be washed into streams or waterbodies during rain events. Therefore, there is some net loading of bacteria into streams as dictated by the watershed hydrology.

Agricultural land is commonly a large 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 bacteria to waterbodies. To account for the potential influence from animals with direct access to stream reaches in the watershed, *E. coli* loads can be calculated as a direct source into the stream.

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

E. coli loading from developed areas is potentially attributable to multiple sources including storm water runoff, unpermitted discharges of wastewater, runoff from improper disposal of waste materials, failing septic tanks, and domestic animals. On-site septic systems may be direct or

indirect sources of bacterial pollution via ground and surface waters due to system failures and malfunctions.

The nature and extent of additional nonpoint sources of bacteria in the watershed will be identified more specifically during the implementation phase of the TMDL, and any resulting Best Management Practices will be noted for future monitoring and listing/de-listing efforts.

3.3 Land Use Assessment

Land use percentages for the Cottondale Creek watershed were determined from the 2019 National Land Cover Dataset (NLCD). The total drainage area of the Cottondale Creek watershed is approximately 18.4 square miles. Table 6 lists the various land uses and their associated percentages for the Cottondale Creek watershed. A pie chart illustrating the major cumulative land use types for the Cottondale Creek watershed is shown in Figure 2.

Table 6: Cottondale Creek Watershed Landuse (2019 NLCD)

2019 NLCD Land Cover	**NLCD Legend**	**Area (miles ^{2})**	**Percentage (%)**
Open Water	11	0.10	0.543%
Developed, Open Space	21	2.57	13.942%
Developed, Low Intensity	22	1.83	9.962%
Developed, Medium Intensity	23	1.09	5.943%
Developed, High Intensity	24	0.27	1.457%
Barren Land	31	0.04	0.197%
Deciduous Forest	41	4.48	24.375%
Evergreen Forest	42	1.61	8.745%
Mixed Forest	43	2.86	15.558%
Shrub/Scrub	52	0.77	4.170%
Herbaceous	71	0.33	1.817%
Hay/Pasture	81	1.15	6.253%
Woody Wetlands	90	1.23	6.707%
Emergent Herbaceous Wetlands	95	0.06	0.331%
Cumulative Land Cover	**NLCD Legend**	**Area (miles ^{2})**	**Percentage (%)**
Open Water	11	0.10	0.543%
Developed	21,22,23,24	5.76	31.305%
Barren Land	31	0.04	0.197%
Forested	41,42,43	8.96	48.678%
Grassland/Shrub	52,71	1.10	5.987%
Agriculture	81	1.15	6.253%
Wetlands	90,95	1.29	7.038%

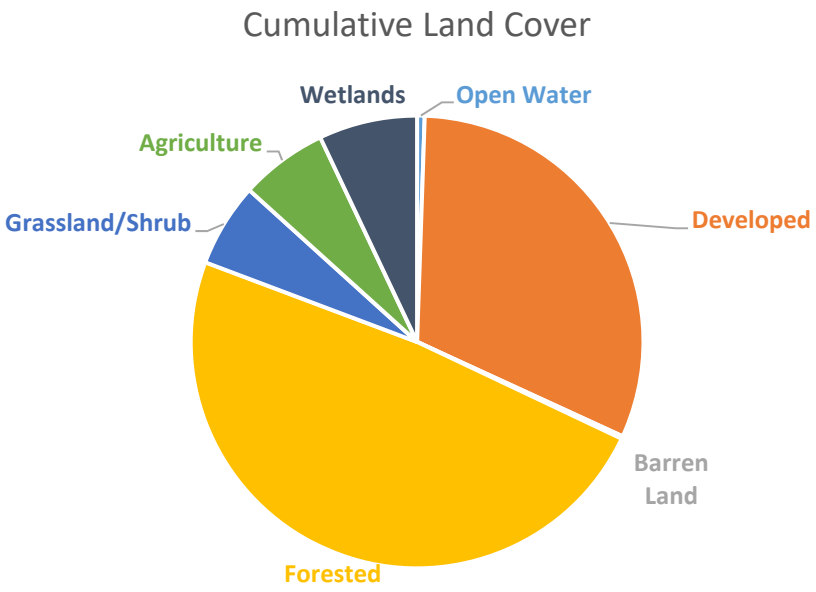

Figure 2: Cottondale Creek Watershed Cumulative Land Use

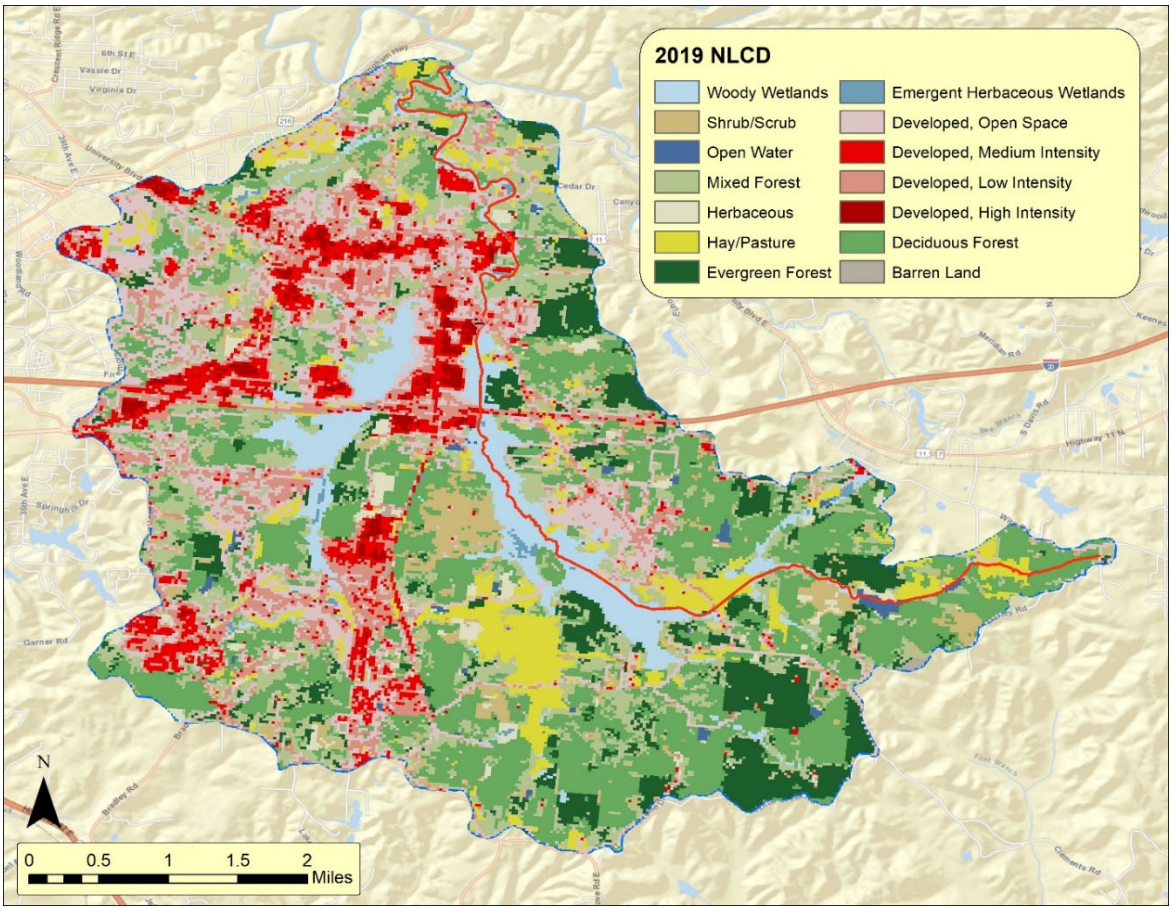

Figure 3: 2019 NLCD Map of the Cottondale Creek watershed

As can be seen from an inspection of the table and map, forested land is the predominant land use in the watershed at nearly 50 percent. Developed land, which covers approximately 30 percent of the watershed, represents both commercial and residential urbanized land uses, and includes the following individual land use categories: Developed – Open Space, Developed – Low Intensity, Developed – Medium Intensity, and Developed – High Intensity. Developed land is found mainly in the western portion of the Cottondale Creek watershed.

3.4 Linkage between Numeric Targets and Sources

The dominant land use coverage in the Cottondale Creek watershed is forested/natural, followed by developed land. 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 Cottondale Creek are from urban run-off from rain events, sanitary sewer system failures, and failing septic systems. Pollutant loadings from agricultural land uses such as pasture grazing may also be contributing to the pathogen impairment. 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

In 2021, §303(d) sampling studies were performed by ADEM on Cottondale Creek to further assess the water quality of the impaired stream. For purposes of this TMDL, the 2021 data will be used to assess the water quality of Cottondale Creek because it is the most recent data and provides the best picture of the current water quality conditions of the stream. The 2022 edition of *Alabama's Water Quality Assessment and Listing Methodology*, prepared by ADEM, provides the rationale for the Department to use the most recent data to prepare a TMDL for an impaired waterbody.

In 2021, ADEM collected monthly water quality data for Cottondale Creek at station CTNT-1. Sampling efforts included collecting water quality samples each month from March through October. Intensive bacteria studies were also conducted at the station during 2021. Each intensive bacteria study consisted of collecting at least five *E. coli* bacteria samples over a thirty day time window, with a minimum of 24 hours between each sample collection. The individual samples and geometric means were evaluated against the applicable *E. coli* bacteria criteria.

A total of 16 *E. coli* samples were collected at station CTNT-1 in 2021. Intensive bacteria studies were performed during the months of June/July and August/September. Of the 16 total *E. coli* samples, nine exceeded the single sample maximum criterion of 298 colonies/100 ml. Furthermore, both geometric means violated the geometric mean criterion of 126 colonies/100 ml. A summary of the *E. coli* results is provided in Table 8. All *E. coli* criteria exceedances are highlighted in red.

Table 7: Station Description

Station	Agency	Latitude	Longitude	Description
CTNT-1	ADEM	33.200562	-87.446348	Cottondale Creek @ Keenes Mill Rd (Tuscaloosa Co Rd 32)

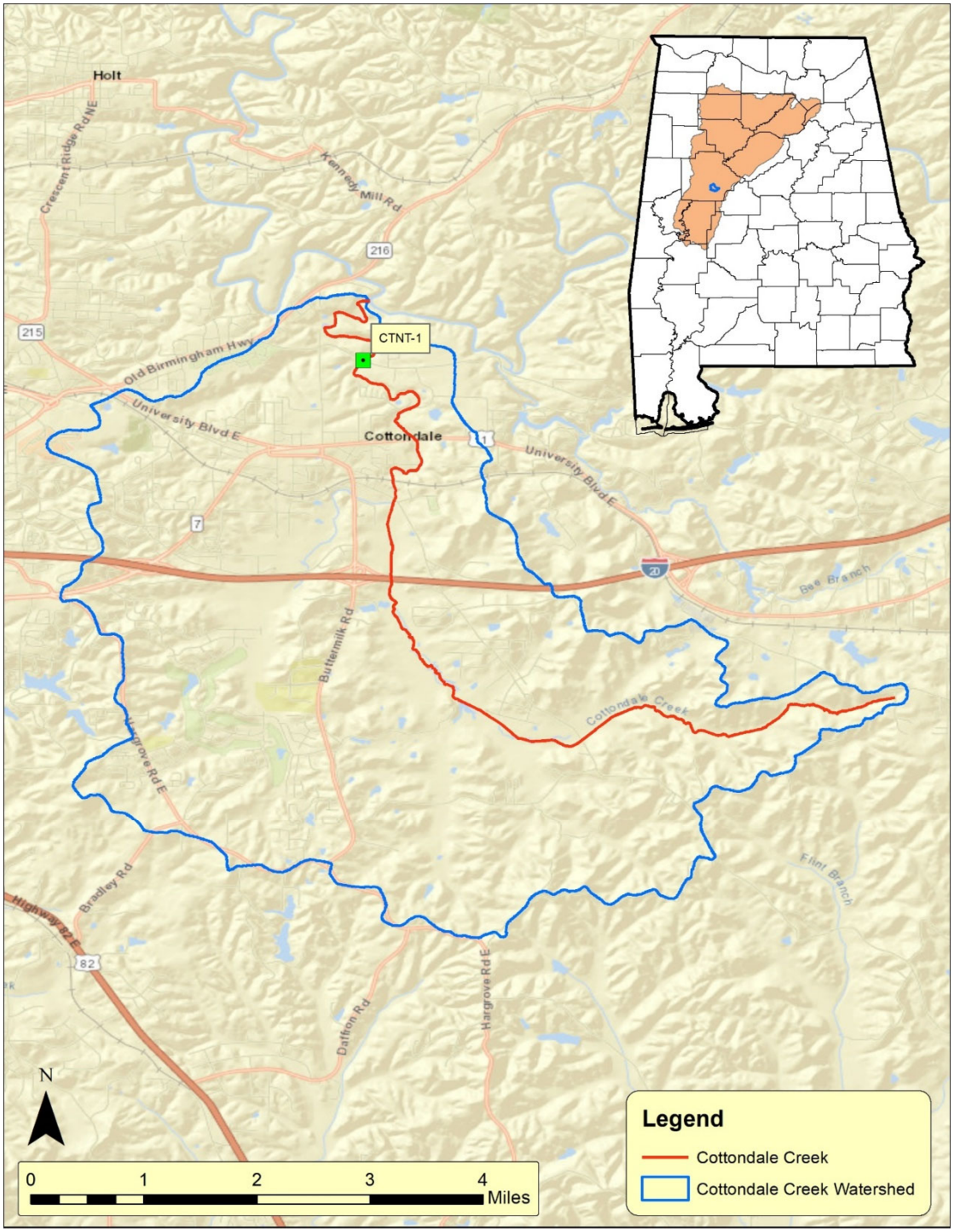

Figure 4: ADEM 2021 Sampling Station in the Cottondale Creek Watershed

Table 8: 2021 *E. coli* Data for Cottondale Creek

Station ID	Visit Date/Time	E. Coli (col/100ml)	Single Sample Criteria (col/100ml)	Flow (cfs)	Flow Measured	E. Coli Geometric Mean (col/100ml)	Geometric Mean Criteria (col/100ml)
CTNT-1	3/11/2021 9:43	307.6	2507	9.30	Yes - ADEM		
CTNT-1	4/8/2021 9:24	325.5	2507	12.94	Yes - ADEM		
CTNT-1	5/11/2021 9:05	410.6	298	10.29	Yes - ADEM		
CTNT-1	6/29/2021 9:19	117.8	298	9.48	Yes - ADEM		
CTNT-1	7/13/2021 8:58	344.6	298	16.55	Yes - ADEM		
CTNT-1	7/15/2021 9:31	142.1	298	9.64	Yes - ADEM	317.9	126
CTNT-1	7/20/2021 9:21	1454	298	24.80	Yes - ADEM		
CTNT-1	7/27/2021 9:10	387.3	298	14.52	Yes - ADEM		
CTNT-1	8/10/2021 9:33	172.2	298	5.32	Yes - ADEM		
CTNT-1	8/17/2021 9:29	223.8	298	4.18	Yes - ADEM		
CTNT-1	8/18/2021 9:35	497.8	298	3.48	Yes - ADEM		
CTNT-1	8/19/2021 9:36	2419.6 G	298	4.26	Yes - ADEM	409.3	126
CTNT-1	8/23/2021 9:20	372	298	6.01	Yes - ADEM		
CTNT-1	8/24/2021 9:21	323.2	298	5.75	Yes - ADEM		
CTNT-1	9/8/2021 9:20	344.8	298	8.17	Yes - ADEM		
CTNT-1	10/5/2021 9:22	238.2	298	6.66	Yes - ADEM		

G denotes that the analyte is present, but is above an acceptable level for quantitation

3.6 Critical Conditions/Seasonal Variation

Critical conditions typically occur during the summer months (May-October). 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 bacteria into streams, resulting in spikes of bacteria counts. In winter, frequent low intensity rain events are more typical and do not allow for the build-up of bacteria on the land surface, resulting in a more uniform loading rate.

Cottondale Creek generally follows the trends described above for the summer months of May through October. The critical condition for this pathogen TMDL was taken to be the one with the highest *E. coli* single sample exceedance value. The single sample concentration of 2419.6 colonies/100 ml was collected on August 19, 2021 at station CTNT-1. A streamflow of 4.26 cfs was measured at station CTNT-1 during this sampling event. The use of the highest exceedance to calculate the TMDL is expected to be protective of water quality in Cottondale Creek year-round.

3.7 Margin of Safety

There are two methods for incorporating a Margin of Safety (MOS) in the TMDL analysis: 1) by implicitly incorporating 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.

The MOS accounts for the uncertainty associated with the limited availability of data used in this analysis. An explicit MOS was applied to the TMDL by reducing the appropriate target criterion concentration by ten percent and calculating a mass loading target with measured flow data. The single sample *E. coli* maximum value of 298 colonies/100 ml was reduced by 10% to 268.2 colonies/100 ml, while the geometric mean criterion was reduced in the same fashion to 113.4 colonies/100 ml.

4.0 TMDL Development

4.1 Definition of a TMDL

A total maximum daily load (TMDL) is the sum of individual waste load allocations (WLAs) for point sources, 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:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

The TMDL is the total amount of a pollutant that can be assimilated by the receiving waterbody while achieving water quality standards under critical conditions. Pathogen 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 Cottondale Creek. The mass balance approach utilizes the conservation of mass principle. Total mass loads can be calculated by multiplying the *E. coli* concentration times the in-stream flow times 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 298 col/100 ml and the geometric mean criterion of 126 col/100 ml. 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.

Existing Conditions

The **single sample** mass loading was calculated by multiplying the highest *E. coli* single sample exceedance concentration of 2419.6 colonies/100 ml by the measured flow on the day of the

exceedance. The calculation for the existing condition was based on the measurement at CTNT-1 on August 19, 2021, as shown in Table 8. The product of the concentration, measured flow, and a conversion factor gives the total mass loading (colonies per day) of *E. coli* to Cottondale Creek under the single sample exceedance condition.

$$\frac{4.26\ \text{ft}^3}{\text{s}} \times \frac{2419.6\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{2.52 \times 10^{11}\text{colonies}}{\text{day}}$$

The **geometric mean** mass loading was calculated by multiplying the highest geometric mean exceedance concentration of 409.3 colonies/100 ml times the average of the measured stream flows. This concentration was calculated based on measurements at CTNT-1 between August 10, 2021 and September 8, 2021, as shown in Table 8. The average stream flow was determined to be 5.31 cfs. The product of these two values times the conversion factor gives the total mass loading (colonies per day) of *E. coli* to Cottondale Creek under the geometric mean exceedance condition.

$$\frac{5.31\ \text{ft}^3}{\text{s}} \times \frac{409.3\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{5.32 \times 10^{10}\text{colonies}}{\text{day}}$$

Allowable Conditions

The **allowable load** to the watershed was calculated under the same physical conditions as discussed above for the single sample and geometric mean criteria. This was done by taking the product of the measured flow for the violation event, the allowable concentration, and the conversion factor.

For the **single sample** *E. coli* target concentration of 268.2 colonies/100 ml, the allowable *E. coli* loading is:

$$\frac{4.26\ \text{ft}^3}{\text{s}} \times \frac{268.2\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{2.79 \times 10^{10}\text{colonies}}{\text{day}}$$

The explicit margin of safety of 29.8 colonies/100 ml equals a daily loading of:

$$\frac{4.26\ \text{ft}^3}{\text{s}} \times \frac{29.8\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{3.11 \times 10^{9}\text{colonies}}{\text{day}}$$

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

$$\frac{5.31\ ft^3}{s} \times \frac{113.4\ colonies}{100\ mL} \times \frac{24{,}465{,}755 * 100mL * s}{ft^3 * day} = \frac{1.47 \times 10^{10} colonies}{day}$$

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

$$\frac{5.31\ ft^3}{s} \times \frac{12.6\ colonies}{100\ mL} \times \frac{24{,}465{,}755 * 100\ mL * s}{ft^3 * day} = \frac{1.64 \times 10^{09} colonies}{day}$$

The difference 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 criteria. The table below depicts the existing and allowable *E. coli* loads and required reductions for the Cottondale Creek watershed.

Table 9: *E. coli* Loads and Required Reductions

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Single Sample Load	2.52×10^{11}	2.79×10^{10}	2.24×10^{11}	89%
Geometric Mean Load	5.32×10^{10}	1.47×10^{10}	3.84×10^{10}	72%

The TMDL was calculated as the total daily *E. coli* load to Cottondale Creek as evaluated at station CTNT-1. As seen in Table 9, compliance with the single sample maximum criterion of 298 colonies/100 ml requires a reduction of 89% in the *E. coli* load. The TMDL, WLA, LA and MOS values necessary to achieve the applicable *E. coli* criteria are provided in the table below.

Table 10: *E. coli* TMDL for Cottondale Creek

TMDL[e]	Margin of Safety (MOS)	Waste Load Allocation (WLA)[a]			Load Allocation (LA)	
		WWTPs[b]	MS4s[c]	Leaking Collection Systems[d]		
(col/day)	(col/day)	(col/day)	% reduction	(col/day)	(col/day)	% reduction
3.11×10^{10}	3.11×10^{9}	NA	89%	0	2.79×10^{10}	89%

Note: NA = not applicable

a. There are no CAFOs in the Cottondale Creek watershed. Future CAFOs will be assigned a waste load allocation (WLA) of zero.

b. Future WWTPs must meet the applicable in-stream water quality criteria for pathogens at the point of discharge.

c. Future MS4 areas would be required to demonstrate consistency with the assumptions and requirements of this TMDL.

d. The objective for leaking collection systems is a WLA of zero. It is recognized, however, that a WLA of 0 colonies/day may not be practical. For these sources, the WLA is interpreted to mean a reduction in *E. coli* loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality criteria for *E. coli*.

e. TMDL was established using the single sample maximum criterion of 298 colonies/100 ml.

4.3 TMDL Summary

Cottondale Creek was placed on Alabama's §303(d) list in 2016 based on data collected in 2012 at station CTNT-1. In 2021, ADEM collected additional water quality data, which confirmed the pathogen impairment and provided the basis for TMDL development.

A mass balance approach was used to calculate the *E. coli* TMDL for Cottondale Creek. Based on the TMDL analysis, it was determined that an 89% 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 will be implemented through voluntary measures/best management practices (BMPs). Cooperation and active participation by the general public and various other groups is critical to successful implementation of TMDLs. Local citizen-led and implemented management measures offer the most efficient and comprehensive avenue for reduction of loading rates from nonpoint sources. Therefore, TMDL implementation activities for nonpoint sources will be coordinated through interaction with local entities and may be eligible for CWA §319 grants through the Department's Nonpoint Source Unit.

The Department recognizes that adaptive implementation of this TMDL will be needed to achieve applicable water quality criteria, and we are committed to targeting the load reductions to improve water quality in the Cottondale 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 monitoring, an approach that divides Alabama's sixteen major river basins into three groups. Each year, ADEM's water quality resources are concentrated in one of the three basin groups and are divided among multiple priorities including §303(d) listed waterbodies, waterbodies with active TMDLs, and other waterbodies as determined by the Department. Monitoring will help further characterize water quality conditions resulting from the implementation of best management practices and load reductions in the watershed. This monitoring will occur in each basin according the schedule shown in Table 11.

Table 11: Follow-up Monitoring Schedule

River Basin Group	Years to be Monitored
Coosa, Escatawpa, Tennessee (Guntersville), Tombigbee	2022/2025
Alabama, Cahaba, Mobile, Tallapoosa, Tennessee (Pickwick and Wilson)	2023/2026
Black Warrior, Blackwater, Chattahoochee, Chipola, Choctawhatchee, Escambia, Perdido, Tennessee (Wheeler), Yellow	2024/2027

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 newspapers in Montgomery, Huntsville, Birmingham, and Mobile, as well as submitted to persons who requested to be on ADEM's postal and electronic mailing distributions. In addition,

the public notice and subject TMDL were made available on ADEM's Website. The public could also request paper or electronic copies of the TMDL by contacting Ms. Kimberly Minton at 334-271-7826 or kminton@adem.alabama.gov. The public was given an opportunity to review the TMDL and submit comments to the Department in writing. No written comments were received during the public notice period.

7.0 Appendices

7.1 References

ADEM Administrative Code, 2021. Water Division - Water Quality Program, Chapter 335-6-10, Water Quality Criteria.

ADEM Administrative Code, 2021. Water Division - Water Quality Program, Chapter 335-6-11, Use Classifications for Interstate and Intrastate Waters.

Alabama's Monitoring Program. 2012, 2021. ADEM.

Alabama Department of Environmental Management (ADEM), Alabama's Water Quality Assessment and Listing Methodology, 2022.

Alabama's §303(d) List and Fact Sheet. 2016, 2018, 2020. ADEM.

Alabama Department of Environmental Management (ADEM), Laboratory Data Qualification SOP #4910 Revision 7.2, 2022.

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.

7.2 Cottondale Creek Photos

Figure 5: At CTNT-1: Upstream View of Cottondale Creek (5/11/2021)

Figure 6: At CTNT-1: Downstream View of Cottondale Creek (5/11/2021)

Figure 7: At CTNT-1: Upstream View of Cottondale Creek (7/20/2021)

Figure 8: At CTNT-1: Downstream View of Cottondale Creek (7/20/2021)

Figure 9: At CTNT-1: Upstream View of Cottondale Creek (8/19/2021)

Figure 10: At CTNT-1: Downstream View of Cottondale Creek (8/19/2021)

Figure 11: At CTNT-1: Upstream View of Cottondale Creek (9/8/2021)

Figure 12: At CTNT-1: Downstream View of Cottondale Creek (9/8/2021)

7.3 Reported SSOs in the Cottondale Creek Watershed

Table 12: SSOs in the Cottondale Creek watershed (2019-2021)

Permittee Name	Date SSO Began	Duration (hours)	SSO Volume (gallons)	Latitude	Longitude
City of Tuscaloosa	2/21/2019	4	2620	33.202103	-87.450164
City of Tuscaloosa	10/26/2019	2	5550	33.202103	-87.450164
City of Tuscaloosa	10/30/2019	3	15000	33.202103	-87.450164
City of Tuscaloosa	10/30/2019	1	32000	33.147118	-87.473389
City of Tuscaloosa	12/2/2019	<1	4000	33.147119	-87.473392
City of Tuscaloosa	12/22/2019	8	34725	33.202103	-87.450164
City of Tuscaloosa	1/2/2020	13	40550	33.202102	-87.450165
City of Tuscaloosa	1/12/2020	6	12550	33.19394	-87.439645
City of Tuscaloosa	2/6/2020	5	7850	33.202103	-87.450164
City of Tuscaloosa	2/10/2020	38	407838	33.202103	-87.450164
City of Tuscaloosa	2/11/2020	1	19520	33.173744	-87.455791
City of Tuscaloosa	2/21/2020	<1	150	33.15248	-87.460098
City of Tuscaloosa	3/3/2020	<1	5	33.165353	-87.46367
City of Tuscaloosa	3/4/2020	15	100318	33.202103	-87.450164
City of Tuscaloosa	4/19/2020	13	45050	33.147119	-87.473392
City of Tuscaloosa	4/19/2020	11	95200	33.202103	-87.450164
City of Tuscaloosa	7/7/2020	1	6327	33.202103	-87.450164
City of Tuscaloosa	7/7/2020	1	343700	33.173744	-87.455791
City of Tuscaloosa	9/13/2020	<1	5000	33.173744	-87.455791
City of Tuscaloosa	10/19/2020	<1	10	33.168664	-87.475107
City of Tuscaloosa	2/18/2021	<1	2000	33.173749	-87.455791
City of Tuscaloosa	3/17/2021	1	42000	33.147048	-87.473426
City of Tuscaloosa	6/19/2021	9	59000	33.202103	-87.450164
City of Tuscaloosa	6/19/2021	3	31476	33.173744	-87.455791
City of Tuscaloosa	7/23/2021	2	13545	33.173744	-87.455791