Final
Total Maximum Daily Load (TMDL)
For
Buxahatchee Creek

Assessment Unit ID # AL03150107-0405-100

Pathogens (*E. coli*)

Alabama Department of Environmental Management
Water Quality Branch
Water Division
July 2020

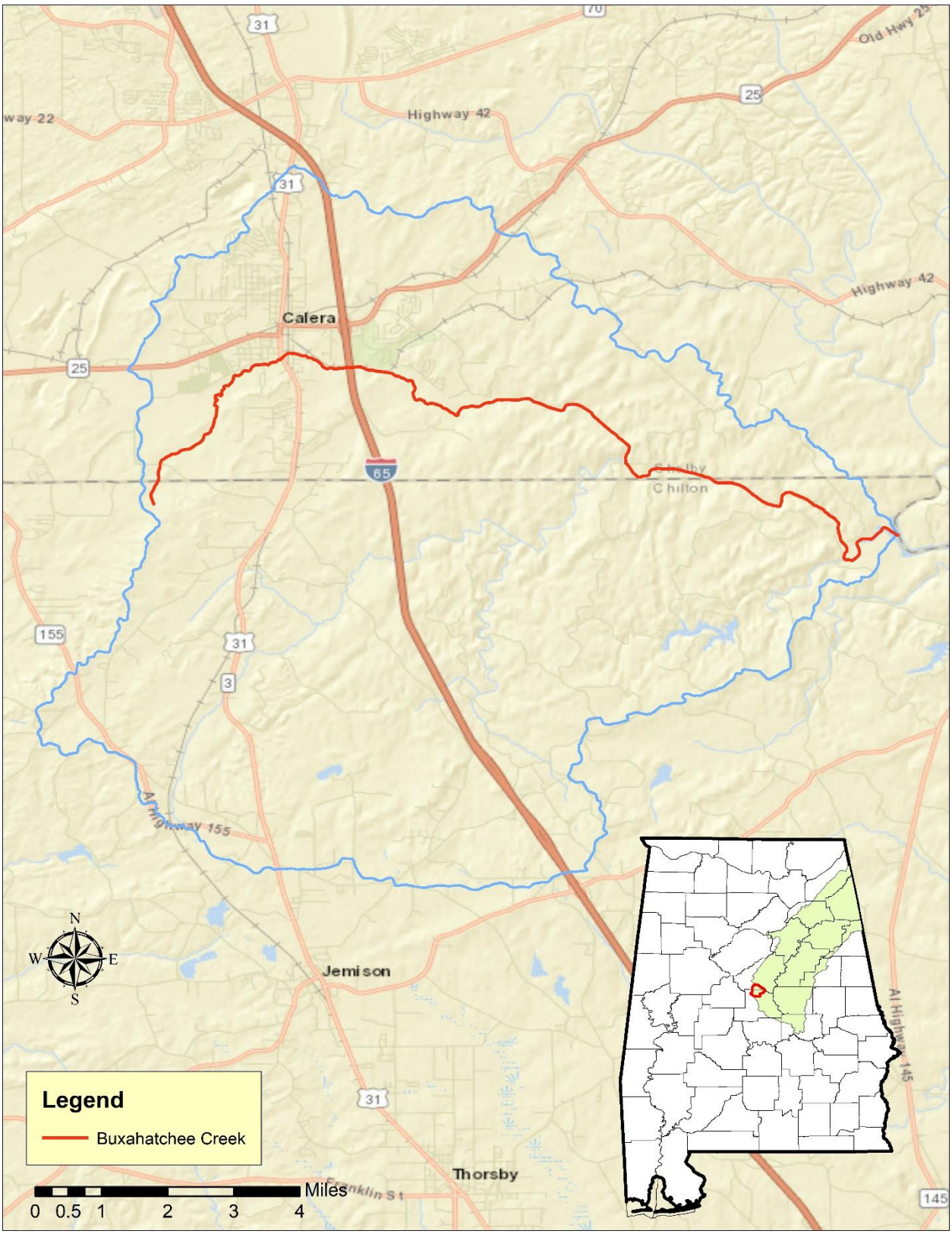

Figure 1: **Buxahatchee Creek Watershed**

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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).

Buxahatchee Creek is currently included on Alabama's §303(d) list as impaired for pathogens (*E. coli)* from Waxahatchee Creek to its source. Buxahatchee Creek has a designated use classification of Fish and Wildlife (F&W). The headwater source of Buxahatchee Creek begins south of the city of Calera. Buxahatchee Creek flows east for a total length of 14 miles, ending at the confluence with Waxahatchee Creek. The total drainage area for the Buxahatchee Creek watershed is approximately 71.36 square miles.

Buxahatchee Creek was first included on the §303(d) list for pathogens in 2016 based on data collected by the Alabama Department of Environmental Management (ADEM) in 2013-14. The *E. coli* exceedances were found at stations BXHS-2 and BXHS-3A. 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 2019, §303(d) sampling studies were performed by ADEM on Buxahatchee Creek to further assess the water quality of the impaired stream. ADEM collected 47 *E. coli* samples from Buxahatchee Creek at stations BXHS-2, BXHS-3A, and BXHS-4. A review of the general water quality and intensive *E. coli* study revealed that the listed segment of Buxahatchee 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 Buxahatchee 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 BXHS-4 (July 10, 2019) 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 Buxahatchee 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	4.97×10^{11}	5.51×10^{10}	4.42×10^{11}	89%
Geometric Mean Load	1.25×10^{10}	9.43×10^{09}	3.07×10^{09}	25%
Point Source Load (WWTPs)^	2.43×10^{09}	1.70×10^{10}	0	0

^Point source allowable load and load reduction are based on permit limits during the month of the highest in-stream *E. coli* exceedance.

Table 2: E. coli TMDL for Buxahatchee 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
6.12×10^{10}	6.12×10^{09}	1.70×10^{10}	NA	0	3.81×10^{10}	89%

Note: NA = not applicable
a. There are no CAFOs in the Buxahatchee Creek watershed. Future CAFOs will be assigned a waste load allocation (WLA) of zero.
b. WLA for WWTPs is expressed as a daily maximum. 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 Buxahatchee 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 14 miles of Buxahatchee 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 2013-14 and was included on all subsequent lists.

2.2 Problem Definition

Waterbody Impaired:	Buxahatchee Creek – from Waxahatchee Creek to its source
Impaired Reach Length:	14.00 miles
Impaired Drainage Area:	71.36 sq. miles
Water Quality Standard Violation:	Pathogens (Single Sample Maximum, Geometric Mean)
Pollutant of Concern:	Pathogens (*E. coli*)
Water Use Classification:	Fish and Wildlife

<u>Usage Related to Classification:</u>
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:

Buxahatchee Creek was placed on the §303(d) list for pathogens in 2016 based on data collected during 2013-14 at stations BXHS-2, BXHS-3, and BXHS-3A. 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 stations BXHS-2, BXHS-3, and BXHS-3A showed that the applicable

single sample criterion was exceeded in 3 out of 18 samples, 5 out of 20 samples, and 1 out of 20 samples, respectively. The geometric mean criterion was also exceeded at station BXHS-3 during 2014. At the time of listing, the source of pathogens was linked to collection system failure and municipal sources. The listing data is summarized below in Table 3.

Table 3: Data for §303(d) Listing- Ambient Monitoring (2013-14)

Station ID	Visit Date	*E. coli* (col/100ml)	*E. coli* Detect Criteria	Single Sample Criteria	Flow (cfs)	Flow Measured
BXHS-2	3/13/2013 12:42	2419.6		2507	8	Yes - ADEM
BXHS-2	4/10/2013 11:47	387.3		2507	4	Yes - ADEM
BXHS-2	5/7/2013 11:51	689.6		2507	9.9	Yes - ADEM
BXHS-2	6/12/2013 11:13	2419.6	G	487	0.2	Yes - ADEM
BXHS-2	7/18/2013 11:01	1632.8		487	2.9	Yes - ADEM
BXHS-2	8/7/2013 12:31	98.7		487	1.3	Yes - ADEM
BXHS-2	9/10/2013 11:39	4839.2	G	487	1.6	Yes - ADEM
BXHS-2	10/10/2013 11:00	882		2507		No
BXHS-2	3/26/2014 11:58	52		2507	3.4	Yes - ADEM
BXHS-2	4/17/2014 11:24	2419.6	G	2507	12.5	Yes - ADEM
BXHS-2	5/21/2014 12:03	37.8		2507	1.1	Yes - ADEM
BXHS-2	6/19/2014 10:58	52		487	0.7	Yes - ADEM
BXHS-2	6/17/2014 11:04	61.3		487	1.1	Yes - ADEM
BXHS-2	6/23/2014 10:38	50.4		487	0.6	Yes - ADEM
BXHS-2	6/24/2014 11:28	30.9		487	0.5	Yes - ADEM
BXHS-2	7/1/2014 11:15	30.1		487	0.7	Yes - ADEM
BXHS-2	7/30/2014 11:46	34.5		487		No
BXHS-2	10/30/2014 11:55	44.1		2507		No
BXHS-3	3/13/2013 12:09	2419.6	G	2507	11.3	Yes - ADEM
BXHS-3	4/10/2013 11:15	461.1		2507	4.9	Yes - ADEM
BXHS-3	5/7/2013 11:22	1034.4		2507	12.5	Yes - ADEM
BXHS-3	6/12/2013 10:52	1119.9		487		No
BXHS-3	7/18/2013 10:30	280.2		487	5.5	Yes - ADEM
BXHS-3	8/7/2013 11:50	167.4		487	2.2	Yes - ADEM
BXHS-3	9/10/2013 11:11	1454		487	2.2	Yes - ADEM
BXHS-3	10/10/2013 10:37	21.8		2507		No
BXHS-3	3/26/2014 11:27	121.1		2507	4.4	Yes - ADEM
BXHS-3	4/17/2014 10:52	816.4		2507	16.8	Yes - ADEM
BXHS-3	5/21/2014 11:28	145		2507	1.8	Yes - ADEM
BXHS-3	6/19/2014 10:27	517.2		487	1.9	Yes - ADEM
BXHS-3	6/17/2014 10:46	816.4		487	2.3	Yes - ADEM
BXHS-3	6/23/2014 10:15	272.3		487	0.7	Yes - ADEM
BXHS-3	6/24/2014 11:02	119.8		487	1.4	Yes - ADEM
BXHS-3	7/1/2014 10:53	90.9		487	0.4	Yes - ADEM

Station ID	Visit Date	*E. coli* (col/100ml)	*E. coli* Detect Criteria	Single Sample Criteria	Flow (cfs)	Flow Measured
BXHS-3	7/30/2014 11:22	148.3		487	0.2	Yes - ADEM
BXHS-3	8/27/2014 10:51	298.7		487		No
BXHS-3	9/24/2014 9:59	547.5		487		No
BXHS-3	10/30/2014 11:23	298.7		2507		No
BXHS-3A	3/13/2013 11:07	410.6		2507	17.2	Yes - ADEM
BXHS-3A	4/10/2013 10:17	224.7		2507	9.5	Yes - ADEM
BXHS-3A	5/7/2013 10:14	648.8		2507	25.6	Yes - ADEM
BXHS-3A	6/12/2013 10:07	137.6		487	1.6	Yes - ADEM
BXHS-3A	7/18/2013 11:51	104.6		487	6.5	Yes - ADEM
BXHS-3A	8/7/2013 10:49	325.5		487	4.8	Yes - ADEM
BXHS-3A	9/10/2013 10:26	821.2		487	3.4	Yes - ADEM
BXHS-3A	10/10/2013 11:43	96.2		2507	1.1	Yes - ADEM
BXHS-3A	3/26/2014 10:21	125.9		2507	9.2	Yes - ADEM
BXHS-3A	4/17/2014 10:01	686.7		2507	27.4	Yes - ADEM
BXHS-3A	5/21/2014 9:53	172.5		2507	4	Yes - ADEM
BXHS-3A	6/19/2014 9:33	137.6		487	3	Yes - ADEM
BXHS-3A	6/17/2014 9:57	140.1		487	3.4	Yes - ADEM
BXHS-3A	6/23/2014 9:39	143.9		487	3	Yes - ADEM
BXHS-3A	6/24/2014 10:10	140.1		487	1.9	Yes - ADEM
BXHS-3A	7/1/2014 10:10	30.1		487	1.8	Yes - ADEM
BXHS-3A	7/30/2014 10:29	39.7		487	0.5	Yes - ADEM
BXHS-3A	8/27/2014 10:11	15.8		487	0.5	Yes - ADEM
BXHS-3A	9/24/2014 9:02	30.5		487	0.5	Yes - ADEM
BXHS-3A	10/30/2014 10:12	410.6		2507	1	Yes - ADEM
G denotes that the analyte is present, but is above an acceptable level for quantitation						
J Reported microbiological result is an estimate.						

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 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 Buxahatchee Creek watershed

Currently, there are two NPDES regulated continuous point source discharges located within the Buxahatchee Creek watershed, but only one has *E. coli* limitations included in its permit. The Calera Pollution Control Plant (AL0050938) discharges directly to Buxahatchee Creek and has a design flow of 1.5 MGD. The current NPDES permit for this facility includes *E. coli* limitations equivalent to the water quality criteria, as follows:

May – October (monthly average): 126 colonies/100mL
May – October (daily maximum): 298 colonies/100mL
November – April (monthly average): 548 colonies/100mL
November – April (daily maximum): 2507 colonies/100mL

Mining is not currently being conducted at Lhoist's Eagle Quarry (AL0079308), but the facility maintains an active NPDES permit. The permit for this quarry does not include any *E. coli* limitations and this facility is not considered to be a source of pathogens; therefore, the facility will not be given an allocation in this TMDL.

Table 4: Continuous Point Sources in the Buxahatchee Creek watershed

Facility Name	Permit Number	Receiving Stream	Latitude	Longitude
Calera Pollution Control Plant	AL0050938	Buxahatchee Creek	33.094101	-86.7444
Eagle Quarry	AL0079308	Buxahatchee Creek	33.083447	-86.774108

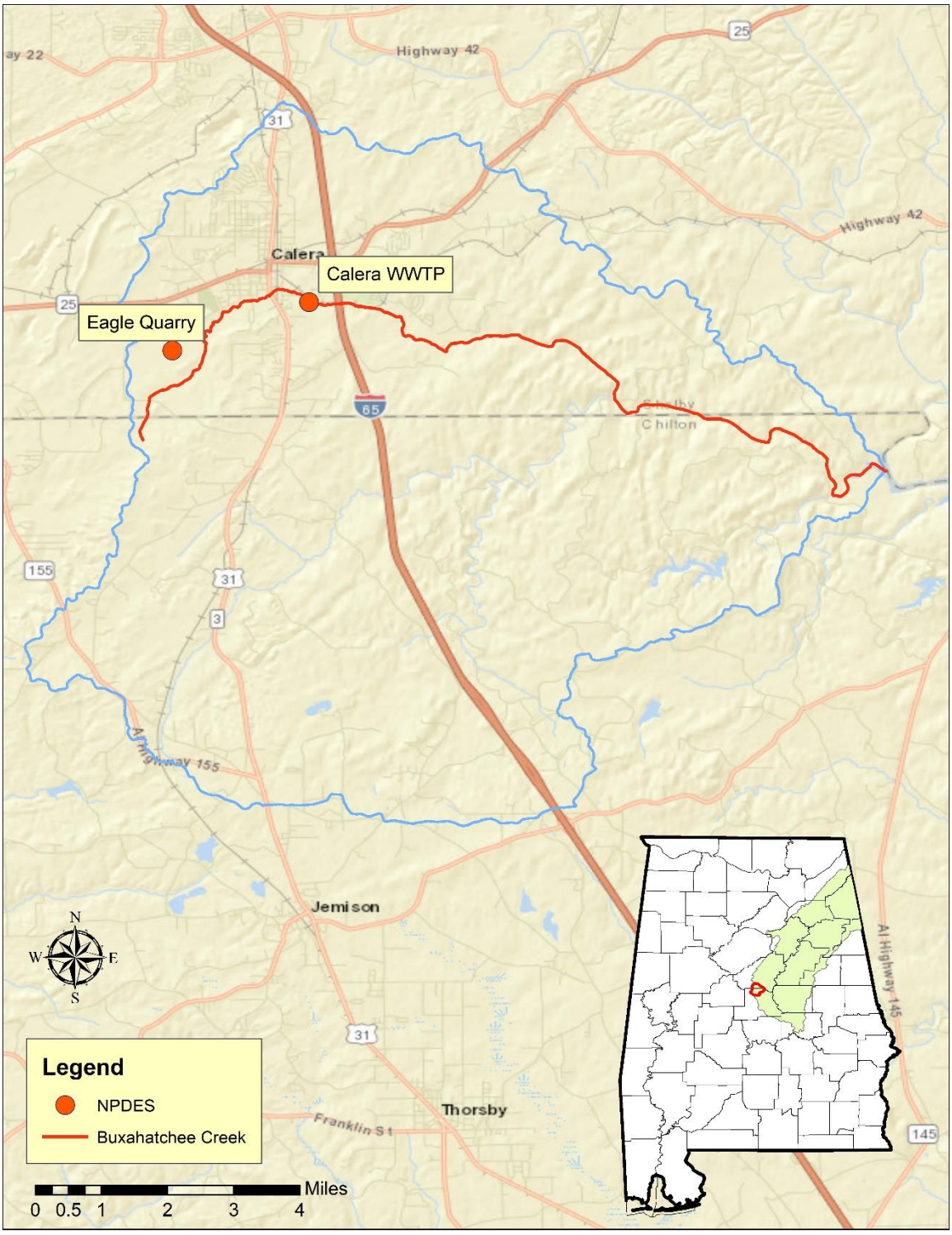

Figure 2: Point Sources in the Buxahatchee Creek Watershed

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 Buxahatchee Creek watershed

There are currently nine general NPDES discharge permits within the Buxahatchee Creek watershed. See Table 5 below for a list of the non-continuous facilities located within the Buxahatchee Creek watershed. None of these facilities are considered to be a source of pathogens due to the lack of process discharges and the nature of their operations. As such, no *E. coli* loading to Buxahatchee Creek will be attributed to these facilities, nor will they receive an allocation in this TMDL.

Table 5: Non-Continuous Point Sources in the Buxahatchee Creek watershed

Facility Name	Permit Number	Latitude	Longitude
Alabama Dynamics	ALG120809	33.095556	-86.739444
Billy's Toyota Parts, Inc.	ALG180218	33.075833	-86.737222
Circle K Industries LLC	ALG180814	33.045833	-86.758889
CSX Transportation, Inc.	ALG141009	33.106995	-86.750977
Glidewell Specialties Foundry	ALG120692	33.095833	-86.738333
Mid-South Fabrications Inc	ALG120805	32.989986	-86.754047
Southern Haulers, LLC.	ALG140995	33.106389	-86.766944
Throckmorton PreCast Concrete, Inc.	ALG110331	33.004578	-86.759872
USA Rail, LLC	ALG120665	33.103270	-86.755350

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 no MS4 areas within the Buxahatchee Creek watershed. Any future MS4 stormwater discharges will be required to demonstrate consistency with the assumptions and requirements of this TMDL.

3.2.4 Nonpoint Sources in the Buxahatchee 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. Confined livestock or concentrated animal feeding operations (CAFOs) can produce a considerable amount of waste in a limited area. 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, sewer overflows, 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.

ADEM's Nonpoint Source Unit and the Shelby County Environmental Services Department participated in a project in the Buxahatchee Creek watershed in which five Best Management Practices (BMPs) were implemented and three educational workshops were held between February 2009 and August 2011. The locations of the BMPs are shown in Figure 3.

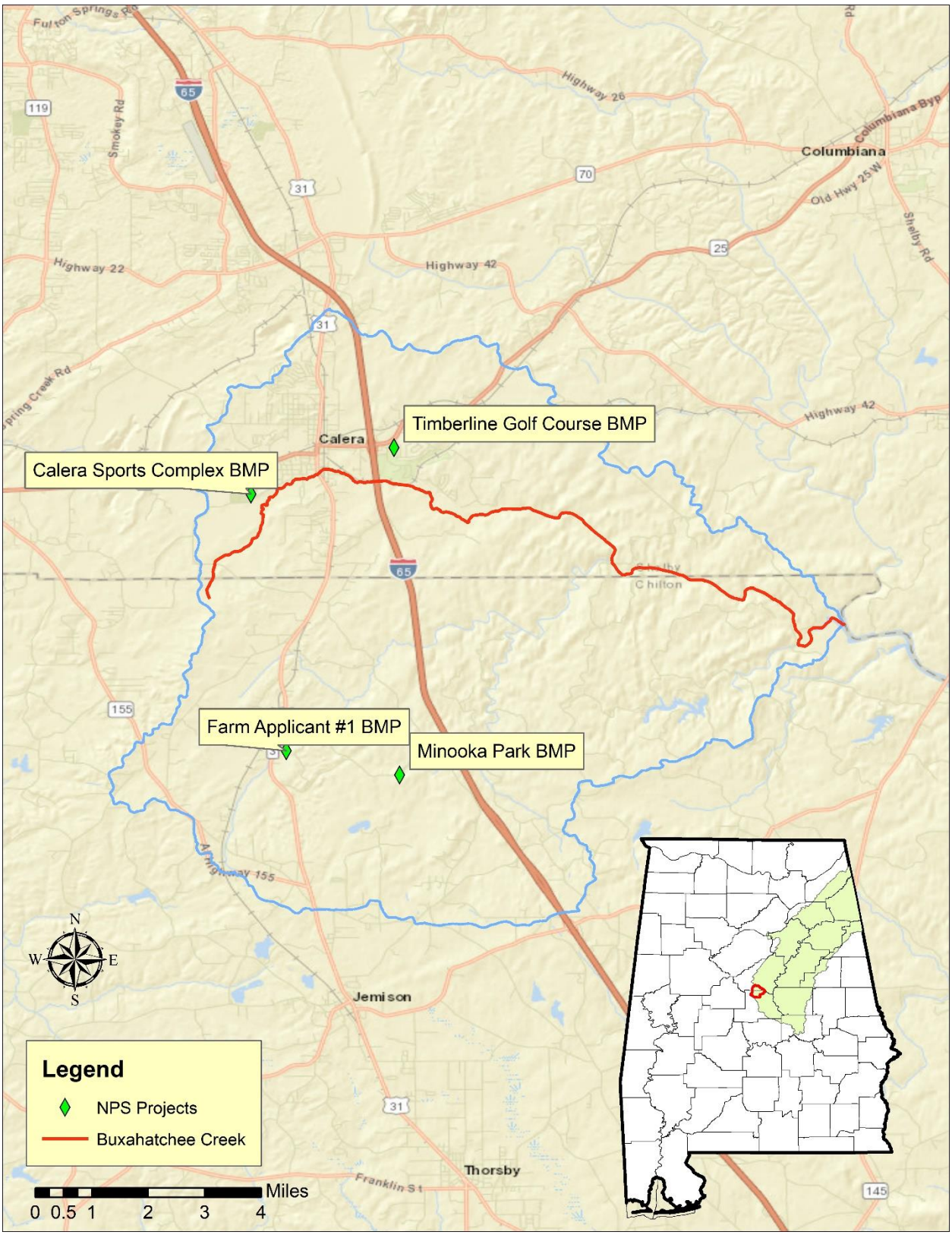

Figure 3: Nonpoint Source BMP Projects in the Buxahatchee Creek Watershed

For Farm Applicant #1, 4000 linear feet of exclusion and cross fencing was installed along with 5.5 acres of 20 foot riparian buffer zone planted on both sides of streams running through the property. Timberline Golf Course had 825 linear feet of stream restoration performed on its property, and Calera Sports Complex installed three bioswales to mitigate runoff and reduce runoff concentrations. The Minooka Park project was a demonstration of a PuraFlo system- a peat based biofilter that treats water before sending it to a leach field system for final treatment. Lastly, as part of a pumpout program, 261 pumpouts were performed on septic tanks in the Buxahatchee Creek watershed.

Although additional efforts are still needed to address the existing pathogen impairment, these projects are expected to contribute to improved water quality in Buxahatchee Creek. 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.

3.3 Land Use Assessment

Land use percentages for the Buxahatchee Creek watershed were determined from the 2016 National Land Cover Dataset (NLCD). The total drainage area of the Buxahatchee Creek watershed is approximately 71.36 square miles. Table 6 lists the various land uses and their associated percentages for the Buxahatchee Creek watershed. A pie chart illustrating the major cumulative land use types for the Buxahatchee Creek watershed is shown in Figure 4.

Table 6: Buxahatchee Creek Watershed Landuse (2016 NLCD)

2011 NLCD Land Cover	NLCD Legend	Area (miles ^{2})	Percentage (%)
Open Water	11	0.52	0.729%
Developed, Open Space	21	3.49	4.893%
Developed, Low Intensity	22	2.17	3.047%
Developed, Medium Intensity	23	0.82	1.150%
Developed, High Intensity	24	0.18	0.252%
Barren Land	31	0.17	0.239%
Deciduous Forest	41	18.68	26.178%
Evergreen Forest	42	22.28	31.223%
Mixed Forest	43	8.77	12.287%
Shrub/Scrub	52	3.92	5.495%
Herbaceous	71	2.75	3.859%
Hay/Pasture	81	6.49	9.092%
Cultivated Crops	82	0.15	0.212%
Woody Wetlands	90	0.93	1.307%
Emergent Herbaceous Wetlands	95	0.03	0.036%

Cumulative Land Cover	NLCD Legend	Area (miles ^{2})	Percentage (%)
Open Water	11	0.52	0.729%
Developed	21,22,23,24	6.67	9.341%
Barren Land	31	0.17	0.239%
Forested	41,42,43	49.73	69.689%
Grassland/Shrub	52,71	6.68	9.354%
Agriculture	81,82	6.64	9.304%
Wetlands	90,95	0.96	1.343%

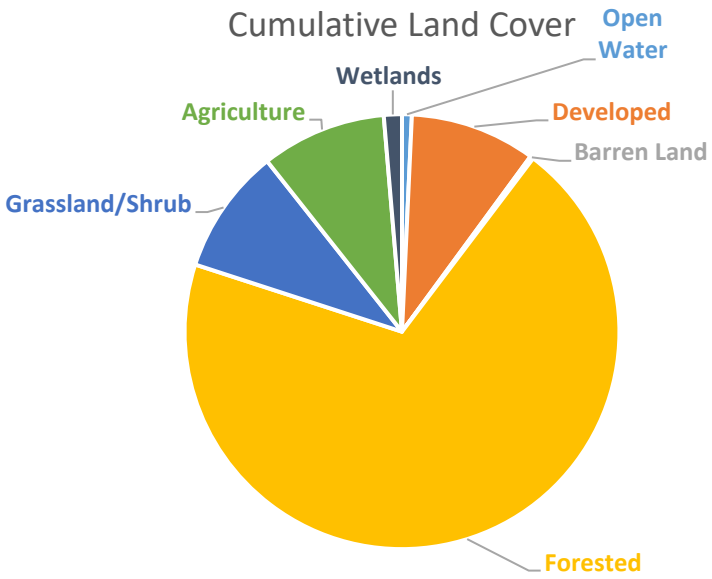

Figure 4: Buxahatchee Creek Watershed Cumulative Land Use

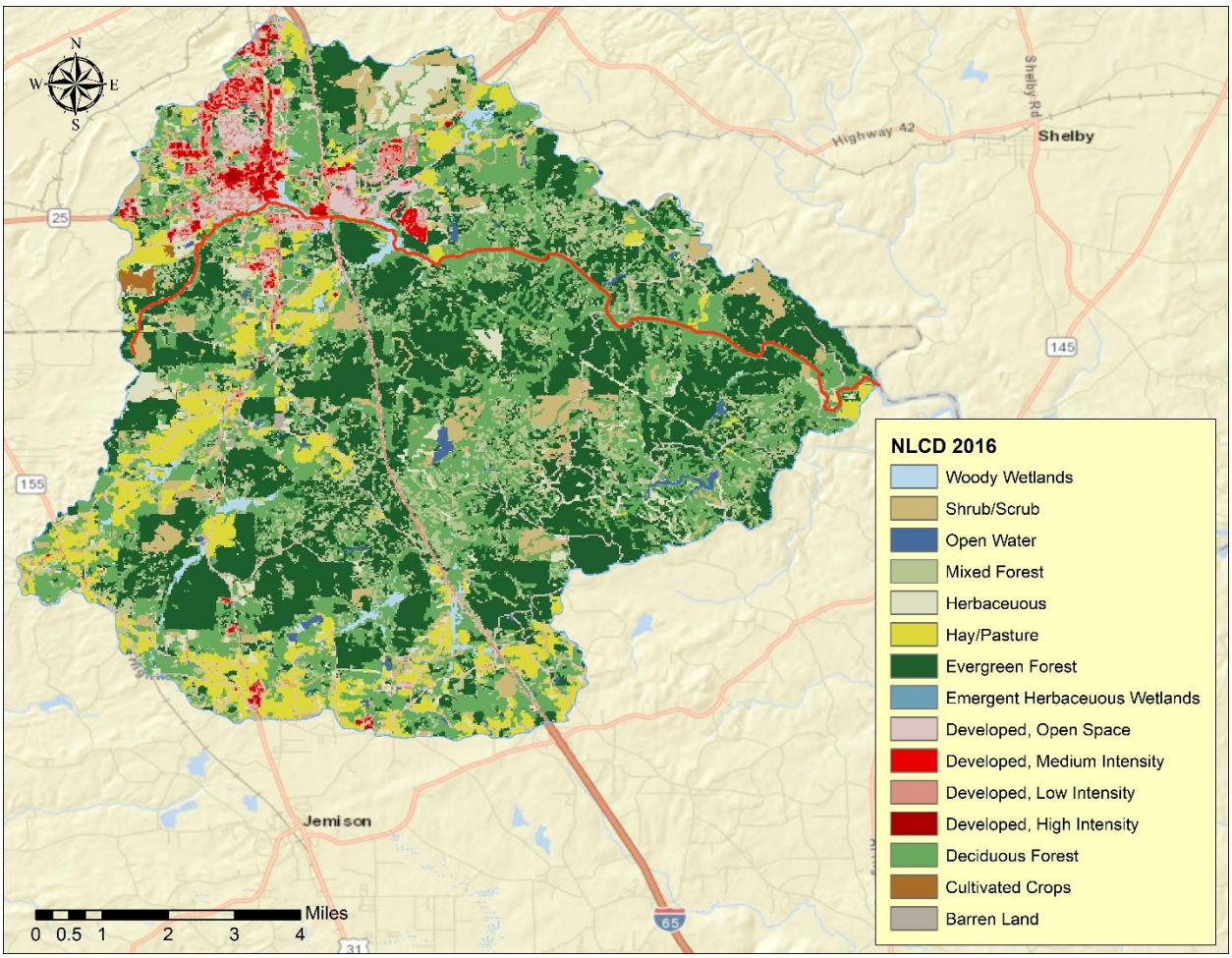

Figure 5: 2016 NLCD Map of the Buxahatchee Creek watershed

As can be seen from an inspection of the table and map, forested land is the predominant land use in the watershed at 70 percent. Developed land, which covers approximately 10 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 upper portion of the Buxahatchee Creek watershed.

3.4 Linkage between Numeric Targets and Sources

The dominate land use coverage in the Buxahatchee Creek watershed is forested/natural, followed by developed land and agriculture. Pollutant loadings from forested areas tend to be low due to their filtering capabilities and will be considered as background conditions. The most likely sources of pathogen loadings in Buxahatchee Creek are from urban run-off from rain events, unpermitted discharges of wastewater, and failing septic systems. Pollutant loadings from agricultural land uses 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 2019, §303(d) sampling studies were performed by ADEM on Buxahatchee Creek to further assess the water quality of the impaired stream. For purposes of this TMDL, the 2019 data will be used to assess the water quality of Buxahatchee Creek because it is the most recent data and provides the best picture of the current water quality conditions of the stream. The 2020 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 2019, ADEM collected monthly water quality data for the Buxahatchee Creek watershed at stations BXHS-2, BXHS-3A, and BXHS-4. Sampling efforts included collecting water quality samples each month from March through October. Intensive bacteria studies were also conducted at all three stations during 2019. 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. A geometric mean was calculated from each intensive bacteria study. The individual samples and geometric mean were evaluated against the applicable *E. coli* bacteria criteria to determine if Buxahatchee Creek is supporting its designated use.

A total of 47 *E. coli* samples were collected at stations BXHS-2, BXHS-3A, and BXHS-4 during 2019. Intensive bacteria studies were performed during the months of June and September. Of the 47 total *E. coli* samples, five samples exceeded the single sample maximum criterion of 298 colonies/100 ml. Furthermore, one of the *E. coli* geometric means violated the geometric mean criterion of 126 colonies/100 ml. A summary of the *E. coli* results is provided below in Table 8. All *E. coli* criteria exceedances are highlighted in red.

Table 7: Station Description

Station	Agency	Latitude	Longitude	Description
BXHS-2	ADEM	33.0943	-86.7439	Buxahatchee Creek upstream of the Calera WWTP outfall
BXHS-3A	ADEM	33.08583	-86.72083	Buxahatchee Creek at power line crossing approximately 0.2 miles downstream of UT
BXHS-4	ADEM	33.0735	-86.67749	Buxahatchee Creek upstream of Hiawatha Road (Shelby Co. Rd. 161) and Watson Creek

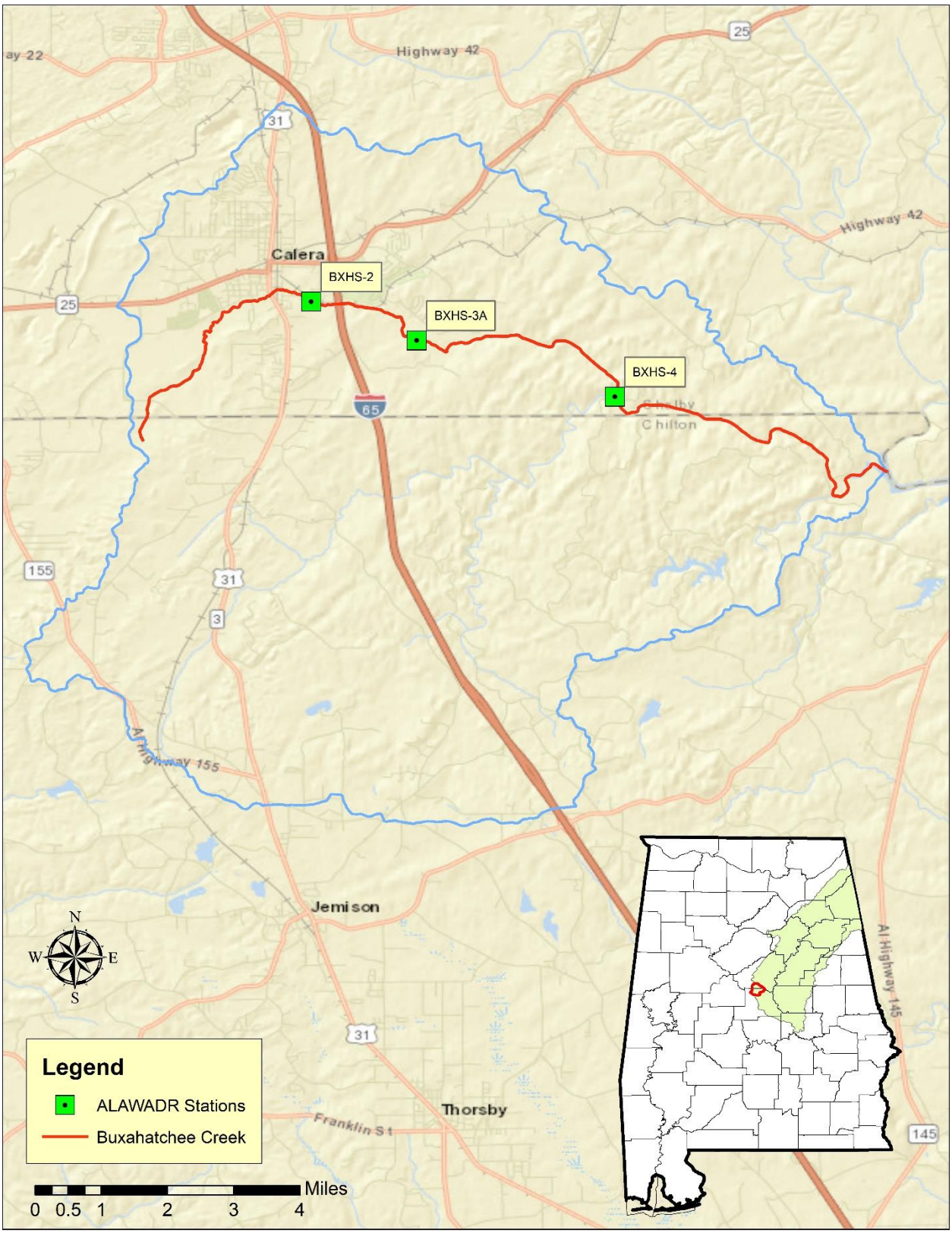

Figure 6: ADEM 2019 Sampling Stations in the Buxahatchee Creek Watershed

Table 8: 2019 *E. coli* Data for Buxahatchee Creek

Station ID	Visit Date	E. Coli (col/100ml)	Single Sample Criteria (col/100ml)	Flow (cfs)	Flow Measured	E. Coli Geometric Mean (col/100ml)	Geometric Mean Criteria (col/100ml)
BXHS-2	3/6/2019 11:40	1732.9	2507	10.2	Yes - ADEM		
BXHS-2	4/3/2019 10:45	51.2	2507	1.2	Yes - ADEM		
BXHS-2	5/9/2019 11:12	98.8	298	0.8	Yes - ADEM		
BXHS-2	6/12/2019 10:14	166.4	298	0.7	Yes - ADEM	103.5	126
BXHS-2	6/14/2019 14:54	63.1	298	0.6	Yes - ADEM		
BXHS-2	6/20/2019 14:31	307.6	298	2.8	Yes - ADEM		
BXHS-2	6/27/2019 15:42	21.1	298	0.6	Yes - ADEM		
BXHS-2	7/2/2019 15:44	16.1	298		No		
BXHS-2	7/10/2019 10:14	1119.9	298	1.1	Yes - ADEM		
BXHS-2	8/5/2019 9:56	57.3	298	0.2	Yes - ADEM		
BXHS-2	9/11/2019 14:45	410.6	298	0.1	Yes - ADEM	46.4	126
BXHS-2	9/16/2019 14:24	33.6	298	0.1	Yes - ADEM		
BXHS-2	9/18/2019 10:43	49.5	298	0	Yes - ADEM		
BXHS-2	9/26/2019 15:10	7.3	298		No		
BXHS-2	9/30/2019 14:11	43.2	298		No		
BXHS-3A	3/6/2019 10:57	866.4	2507	21.8	Yes - ADEM		
BXHS-3A	4/3/2019 9:51	66.3	2507	3.6	Yes - ADEM		
BXHS-3A	5/9/2019 10:26	145	298	1.8	Yes - ADEM		
BXHS-3A	6/12/2019 9:35	209.8	298	3.5	Yes - ADEM	150.2	126
BXHS-3A	6/14/2019 15:35	70.8	298	2.2	Yes - ADEM		
BXHS-3A	6/20/2019 15:10	290.9	298	6.3	Yes - ADEM		
BXHS-3A	6/27/2019 16:27	55.6	298	1.5	Yes - ADEM		
BXHS-3A	7/2/2019 16:09	52	298	1	Yes - ADEM		
BXHS-3A	7/10/2019 9:35	920.8	298	5.9	Yes - ADEM		
BXHS-3A	8/5/2019 9:14	73.8	298	1.7	Yes - ADEM		
BXHS-3A	9/11/2019 13:48	8.5	298	0.7	Yes - ADEM	22.9	126
BXHS-3A	9/16/2019 13:43	16	298	0.2	Yes - ADEM		
BXHS-3A	9/18/2019 9:52	59.1	298	0.5	Yes - ADEM		
BXHS-3A	9/26/2019 14:15	26.9	298	0.5	Yes - ADEM		
BXHS-3A	9/30/2019 13:25	29.2	298	0.5	Yes - ADEM		
BXHS-3A	10/23/2019 9:22	129.6	298	1	Yes - ADEM		
BXHS-4	3/6/2019 9:53	214.3	2507		No		
BXHS-4	4/3/2019 8:47	24.1	2507	5.7	Yes - ADEM		
BXHS-4	5/9/2019 9:05	86	298	3.2	Yes - ADEM		

Station ID	Visit Date	E. Coli (col/100ml)	Single Sample Criteria (col/100ml)	Flow (cfs)	Flow Measured	E. Coli Geometric Mean (col/100ml)	Geometric Mean Criteria (col/100ml)
BXHS-4	6/12/2019 8:43	148.3	298	4.5	Yes - ADEM	66.8	126
BXHS-4	6/14/2019 14:02	95.9	298	8.3	Yes - ADEM		
BXHS-4	6/20/2019 13:52	151.5	298	13.9	Yes - ADEM		
BXHS-4	6/27/2019 14:56	45.7	298	4.6	Yes - ADEM		
BXHS-4	7/2/2019 14:48	13.5	298	2.7	Yes - ADEM		
BXHS-4	7/10/2019 8:40	2419.6 G	298	8.4	Yes - ADEM		
BXHS-4	8/5/2019 8:27	121.1	298	1.2	Yes - ADEM		
BXHS-4	9/11/2019 12:52	57.3	298		No	52.9	126
BXHS-4	9/16/2019 12:55	57.1	298		No		
BXHS-4	9/18/2019 8:49	186	298	0.9	Yes - ADEM		
BXHS-4	9/26/2019 13:20	38.8	298		No		
BXHS-4	9/30/2019 12:48	17.6	298		No		
BXHS-4	10/23/2019 8:33	135.4	298	1.1	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.

The impaired portion of Buxahatchee 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 maximum concentration of 2419.6 colonies/100 ml was collected on July 10, 2019 at station BXHS-4. A streamflow of 8.4 cfs measured at station BXHS-4 during this sampling event. The use of the highest exceedance to calculate the TMDL is expected to be protective of water quality in Buxahatchee 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 Buxahatchee 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 BXHS-4 on July 10, 2019, which is shown above 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 Buxahatchee Creek under the single sample exceedance condition.

$$\frac{8.4\ \text{ft}^3}{\text{s}} \times \frac{2419.6\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{4.97 \times 10^{11}\text{colonies}}{\text{day}}$$

The **geometric mean** mass loading was calculated by multiplying the highest geometric mean exceedance concentration of 150.2 colonies/100 ml times the average of the five measured streamflows. This concentration was calculated based on measurements at BXHS-3A between June 12, 2019, and July 10, 2019, which are shown above in Table 8. The average stream flow was determined to be 3.4 cfs. The product of these two values times the conversion factor gives the total mass loading (colonies per day) of *E. coli* to Buxahatchee Creek under the geometric mean exceedance condition.

$$\frac{3.4\ \text{ft}^3}{\text{s}} \times \frac{150.2\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{1.25 \times 10^{10}\text{colonies}}{\text{day}}$$

The **point source** mass loading was calculated by multiplying the July 2019 monthly average flow from the Calera Pollution Control Plant (AL0050938) by the maximum reported *E. coli* concentration for the same month and the conversion factor. The flow and *E. coli* concentration were found on the July 2019 discharge monitoring report (DMR) submitted by the facility.

$$0.428\ \text{MGD} \times \frac{1.55\ \text{ft}^3}{\text{s} \times \text{MGD}} \times \frac{150\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{2.43 \times 10^{09}\text{colonies}}{\text{day}}$$

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:

$$\frac{8.4\ \text{ft}^3}{\text{s}} \times \frac{268.2\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{5.51 \times 10^{10}\text{colonies}}{\text{day}}$$

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

$$\frac{8.4\ \text{ft}^3}{\text{s}} \times \frac{29.8\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{6.12 \times 10^{09}\text{colonies}}{\text{day}}$$

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

$$\frac{3.4\ ft^3}{s} \times \frac{113.4\ colonies}{100\ mL} \times \frac{24{,}465{,}755 * 100 mL * s}{ft^3 * day} = \frac{9.43 \times 10^{09} colonies}{day}$$

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

$$\frac{3.4\ ft^3}{s} \times \frac{12.6\ colonies}{100\ mL} \times \frac{24{,}465{,}755 * 100\ mL * s}{ft^3 * day} = \frac{1.05 \times 10^{09} colonies}{day}$$

The **point source** allowable loading was calculated by multiplying the design flow of the Calera Pollution Control Plant (1.5 MGD) by the *E. coli* daily maximum permit limitation of 298 colonies/100 ml and the conversion factor:

$$1.5\ \text{MGD} \times \frac{1.55\ \text{ft}^3}{\text{s} \times \text{MGD}} \times \frac{298\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{1.70 \times 10^{10}\text{colonies}}{\text{day}}$$

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. Table 9 below depicts the existing and allowable *E. coli* loads and required reductions for the Buxahatchee 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	4.97×10^{11}	5.51×10^{10}	4.42×10^{11}	89%
Geometric Mean Load	1.25×10^{10}	9.43×10^{09}	3.07×10^{09}	25%
Point Source Load (WWTPs)^	2.43×10^{09}	1.70×10^{10}	0	0

^Point source allowable load and load reduction are based on permit limits during the month of the highest in-stream *E. coli* exceedance.

The TMDL was calculated as the total daily *E. coli* load to Buxahatchee Creek as evaluated at station BXHS-4. From 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 Table 10 below.

Table 10: *E. coli* TMDL for Buxahatchee 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
6.12×10^{10}	6.12×10^{09}	1.70 x 10^{10}	NA	0	3.81×10^{10}	89%

Note: NA = not applicable
a. There are no CAFOs in the Buxahatchee Creek watershed. Future CAFOs will be assigned a waste load allocation (WLA) of zero.
b. WLA for WWTPs is expressed as a daily maximum. 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

Buxahatchee Creek was placed on Alabama's §303(d) list in 2016 based on data collected in 2013-14 at stations BXHS-2, BXHS-3, and BXHS-3A. In 2019, ADEM collected additional water quality data with *E. coli* serving as the primary pathogen indicator. The data collected by ADEM in 2019 confirmed the pathogen impairment and provided the basis for TMDL development. A mass balance approach was used to calculate the *E. coli* TMDL for Buxahatchee 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 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 Buxahatchee 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 statewide approach to water quality management. Each year, ADEM's water quality resources are divided among multiple priorities statewide 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.

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 were made available on ADEM's Website: www.adem.alabama.gov. 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. 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 final completion of this TMDL and subsequent submission to EPA Region 4 for final approval.

7.0 Appendices

7.1 References

ADEM Administrative Code, 2017. Water Division - Water Quality Program, Chapter 335-6-10, Water Quality Criteria.

ADEM Administrative Code, 2017. Water Division - Water Quality Program, Chapter 335-6-11, Use Classifications for Interstate and Intrastate Waters.

Alabama's Monitoring Program. 2013-2014, 2019. ADEM.

Alabama Department of Environmental Management (ADEM), Alabama's Water Quality Assessment and Listing Methodology, 2020.

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

Alabama Department of Environmental Management (ADEM), Laboratory Data Qualification SOP #4910 Revision 6.2, 2016.

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 Buxahatchee Creek Watershed Photos

BXHS-2

Figure 7: At BXHS-2: Upstream View of Buxahatchee Creek upstream of the Calera WWTP outfall (3/6/2019)

Figure 8: At BXHS-2: Downstream View of Buxahatchee Creek upstream of the Calera WWTP outfall (3/6/2019)

Figure 9: At BXHS-2: Upstream View of Buxahatchee Creek upstream of the Calera WWTP outfall (7/10/2019)

Figure 10: At BXHS-2: Downstream View of Buxahatchee Creek upstream of the Calera WWTP outfall (7/10/2019)

Figure 11: At BXHS-2: Upstream View of Buxahatchee Creek upstream of the Calera WWTP outfall (9/18/2019)

Figure 12: At BXHS-2: Downstream View of Buxahatchee Creek upstream of the Calera WWTP outfall (9/18/2019)

BXHS-3A

Figure 13: At Station BXHS-3A: Upstream View of Buxahatchee Creek at power line crossing approximately 0.2 miles downstream of UT (3/6/2019)

Figure 14: At Station BXHS-3A: Downstream View of Buxahatchee Creek at power line crossing approximately 0.2 miles downstream of UT (3/6/2019)

Figure 15: At Station BXHS-3A: Upstream View of Buxahatchee Creek at power line crossing approximately 0.2 miles downstream of UT (7/10/2019)

Figure 16: At Station BXHS-3A: Downstream View of Buxahatchee Creek at power line crossing approximately 0.2 miles downstream of UT (7/10/2019)

Figure 17: At Station BXHS-3A: Upstream View of Buxahatchee Creek at power line crossing approximately 0.2 miles downstream of UT (9/18/2019)

Figure 18: At Station BXHS-3A: Upstream View of Buxahatchee Creek at power line crossing approximately 0.2 miles downstream of UT (9/18/2019)

BXHS-4

Figure 19: At Station BXHS-4: Upstream View of Buxahatchee Creek upstream of Hiawatha Road (Shelby Co. Rd. 161) and Watson Creek (3/6/2019)

Figure 20: At Station BXHS-4: Downstream View of Buxahatchee Creek upstream of Hiawatha Road (Shelby Co. Rd. 161) and Watson Creek (3/6/2019)

Figure 21: At Station BXHS-4: Upstream View of Buxahatchee Creek upstream of Hiawatha Road (Shelby Co. Rd. 161) and Watson Creek (7/10/2019)

Figure 22: At Station BXHS-4: Downstream View of Buxahatchee Creek upstream of Hiawatha Road (Shelby Co. Rd. 161) and Watson Creek (7/10/2019)

Figure 23: At Station BXHS-4: Upstream View of Buxahatchee Creek upstream of Hiawatha Road (Shelby Co. Rd. 161) and Watson Creek (9/18/2019)

Figure 24: At Station BXHS-4: Downstream View of Buxahatchee Creek upstream of Hiawatha Road (Shelby Co. Rd. 161) and Watson Creek (9/18/2019)