WATERSHED MANAGEMENT PLAN FOR THE BRUSHY CREEK WATERSHED

Wrens, Georgia

prepared for
Georgia Soil and Water
Conservation Commission

November 2018

PREPARED BY

NUTTER & ASSOCIATES, INC.

Nutter & Associates, Inc.
Corporate Headquarters
360 Hawthorne Lane
Athens, GA 30606
Office Phone: 706.354.7925

NC Office
304 New Leicester Hwy
Suite B
Asheville, NC 28806
Office Phone: 828.539.3008

Nutter & Associates
environmental consultants

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ACKNOWLEDGMENTS

The Brushy Creek Watershed Management Plan was developed by Nutter & Associates with the assistance and guidance from the Brushy Creek Watershed Advisory Committee (WAC) and Stakeholder Group. The following individuals and organizations contributed their time, knowledge, and energy developing this final plan:

Watershed Advisory Committee and Stakeholder Group

Member	Association/Organization
Scott Thackston	Georgia Forestry Commission
Greg Klett	
Toms Mims	Brier Creek Soil and Water Conservation District
Pam Sapp	UGA Cooperative Extension – Jefferson County
Dustin Rushing	UGA Cooperative Extension Water Educator, Georgia Soil and Water Conservation Commission (GSWCC)
Jerry Dowdy	Brier Creek Soil and Water Conservation District, Jefferson County, local producer
David Hall	UGA Cooperative Extension Educator

Project Coordinators

Member	Association/Organization
Jessica Mimbs	GSWCC Rural Water Resources Program Manager
Ben Hyer	GSWCC Program Coordinator
Veronica Craw	Georgia Environmental Protection Division (EPD) Grants Unit Manager
Erin M. Harris	Nutter & Associates, Inc. (NAI)
Krisha J. Faw	Nutter & Associates, Inc.

EXECUTIVE SUMMARY

The watershed of Brushy Creek has been identified by the Georgia Soil and Water Conservation Commission (GSWCC) as a suitable project area for implementation of a Watershed Management Plan (WMP) because of the interest of local stakeholders and the current listing status on the GA EPD 305(b)/303(d) integrated report.

The watershed of Brushy Creek encompasses approximately 41,178 acres and is located in Burke and Jefferson Counties, in east-central Georgia. The Brushy Creek watershed is located within the Brier Creek sub-basin (HUC 03060108) of the larger Savannah River basin. An approximately 15-mile segment of Brushy Creek that extends from Wrens, Georgia to its confluence with Brier Creek is listed on the 2016 GA EPD 305(b)/303(d) integrated report for not supporting its designated use of fishing. The segment is listed for fecal coliform water quality exceedances potentially caused by nonpoint source (NPS) pollution. In 2005, the Georgia Environmental Protection Division (GA EPD) implemented a Total Maximum Daily Load (TMDL) evaluation for Brushy Creek, which determined the need for a 45 percent reduction of fecal coliform loading.

The objective of the project was to develop a nine-key element WMP using the US Environmental Protection Agency (US EPA) *Handbook for Developing Watershed Plans to Restore and Protect Our Waters.* The plan includes the long-term goal of meeting the recommended fecal coliform bacteria load reductions in the TMDL with the intent of delisting Brushy Creek. This WMP was a collaborated effort of the Watershed Advisory Committee and Stakeholder Group, GSWCC, GA EPD, and Nutter & Associates (NAI). Funding for the WMP was financed through a grant from the US EPA to the GA EPD of the Department of Natural Resources (GA DNR) under Provisions of the Section 319(h) of the Federal Water Pollution Control Act.

To aid in the development of the WMP, a watershed characterization was conducted that assessed the current conditions of the watershed, established baseline conditions prior to management initiatives, identified pollutant sources, and prioritized areas for best management practices (BMPs) implementation. Fecal coliform bacteria has been identified as the primary pollutant within the Brushy Creek watershed while sediment and nutrients have been identified as secondary pollutants within each watershed. Major sources of pollutants that flow into Brushy Creek have been identified as illegal dumping of deer carcasses and household trash, feral hogs, and stormwater runoff associated with urban and agricultural land and unpaved roads. Failing septic systems, livestock access to the stream, illicit discharges, and leaking sewer lines associated with the City of Wrens were other potential sources.

For the entire Brushy Creek watershed, BMPs that address illegal dumping of household trash and wildlife carcasses are considered a high priority. Further, 2,020 acres of agricultural land, 1,904 acres of urban and residential land, and 45 linear miles of unpaved roads have been identified in the entire Brushy Creek watershed for potential installation of BMPs that address stormwater runoff from agricultural and urban land. To address other potential sources of fecal coliform, the entire watershed will be considered for maintenance and repairs of existing or failing on-site wastewater systems and for management measures that address livestock access to streams, leaking sewer lines in and around the City of Wrens, and illicit discharges throughout the entire watershed.

In order to achieve the 45 percent reduction in fecal coliform load recommended by the TMDL, BMPs that address illegal dumping and feral hogs along with a series of recommended agricultural, urban, and unpaved road BMPs should be implemented throughout the Brushy Creek watershed. It is expected that with implementation of BMPs that control the input of fecal coliform bacteria and other pollution such as sediment and nutrients, that the watershed will contribute a lower pollutant loading rate and allow for the achievement of the long-term goal of delisting Brushy Creek.

The WMP has been written to cover a 10-year time period and interim milestones and measures of success of the plan are broken down into three phases: short-term, mid-term, and long-term. To determine if load reductions are being achieved over time and substantial progress is being made towards the ultimate goal of delisting Brushy Creek, a set of success criteria, milestones, and a long-term monitoring plan has been developed as a means to evaluate the success of the WMP.

1.0 INTRODUCTION

1.1 Location

The watershed of Brushy Creek encompasses approximately 41,178 acres and is located in Burke and Jefferson Counties, in east-central Georgia (Figure 1). A small portion of the watershed, which contains the headwaters of Brushy Creek is located in Glascock County. Potential management activities within the headwaters portion of the watershed were not included in this Watershed Management Plan (WMP) as this portion of Brushy Creek was not determined to be impaired during 305(b)/303(d) evaluations. The Brushy Creek watershed is located within the Brier Creek sub-basin (HUC 03060108) of the larger Savannah River basin (Figure 2).

1.2 Project Background

An approximately 15-mile segment of Brushy Creek that extends from Wrens, Georgia to its confluence with Brier Creek is listed on the 2016 GA EPD 305(b)/303(d) integrated report for not supporting its designated use of fishing. The segment is listed for fecal coliform water quality exceedances potentially caused by nonpoint source (NPS) pollution. A *Total Maximum Daily Load (TMDL) Evaluation for 32 Stream Segments in the Savannah River Basin for Fecal Coliform* was completed in 2005 by the Georgia Department of Natural Resources (GA DNR) and submitted to the US Environmental Protection Agency (US EPA) to assess in-stream water quality conditions in accordance with GA Code 391-3-6-03 Water Use Classifications and Water Quality Standards (GA DNR, 2005a). According to the TMDL, fecal coliform subsamples were collected over four 30-day periods in February to March, June to July, August to September, and December 2002, and geometric means were calculated for each 30-day period subsample (GA DNR, 2005a).

Brushy Creek was listed as "not supporting" the designated use classification of fishing because more than 25 percent of the geometric mean subsamples collected exceeded the fecal coliform water quality standard of 200/100 mL (May to October) and 1000/100 mL (November to April). As part of the TMDL, GA DNR conducted point and non-point source (NPS) assessments and determined the need for a 45 percent reduction in fecal coliform loading for Brushy Creek in order to meet instream water quality standards (GA DNR, 2005a). The TMDL identifies one Water Pollution Control Plant (WPCP) that discharges to Brushy Creek, which is the City of Wrens WPCP. However, no fecal coliform violations have been reported for that facility, and the TMDL determined waste treatment facilities did not significantly contribute to the impairment of the listed stream (GA DNR, 2005a). The elevated fecal coliform concentrations in Brushy Creek were attributed to urban sources such as wastes from domestic animals, leaks and overflows from sewer systems, illicit discharges from sanitary wastes, leaking on-site wastewater systems, urban runoff, and landfill leachate (GA DNR, 2005a). Management practices recommended by the TMDL included compliance with NPDES permits and limits, adoption of NRCS conservation practices, and utilization of best management practices (BMPs) for agricultural and urban land uses.

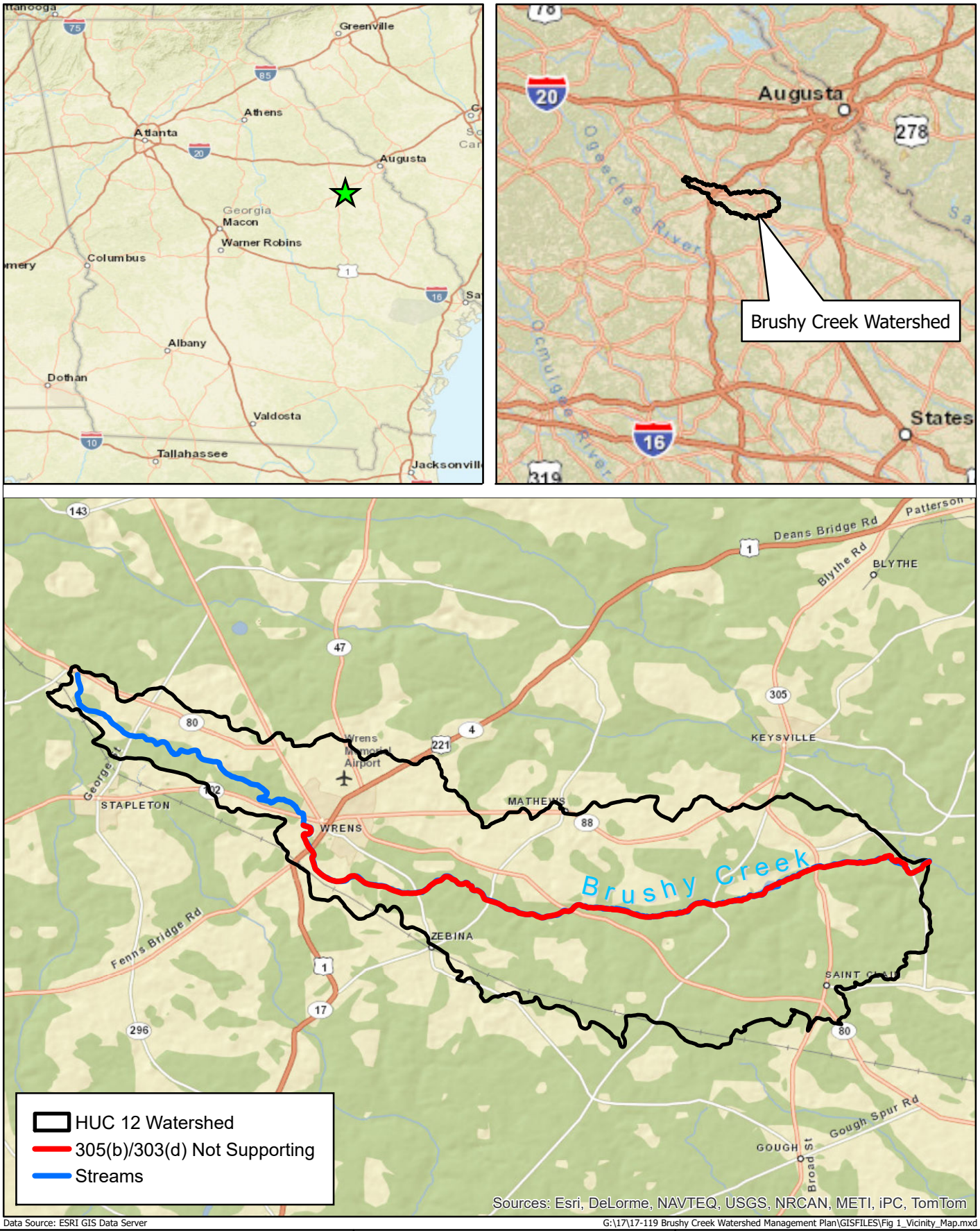

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Figure 1. Brushy Creek Watershed Management Plan project area in Burke, Glascock, and Jefferson Counties, Georgia.

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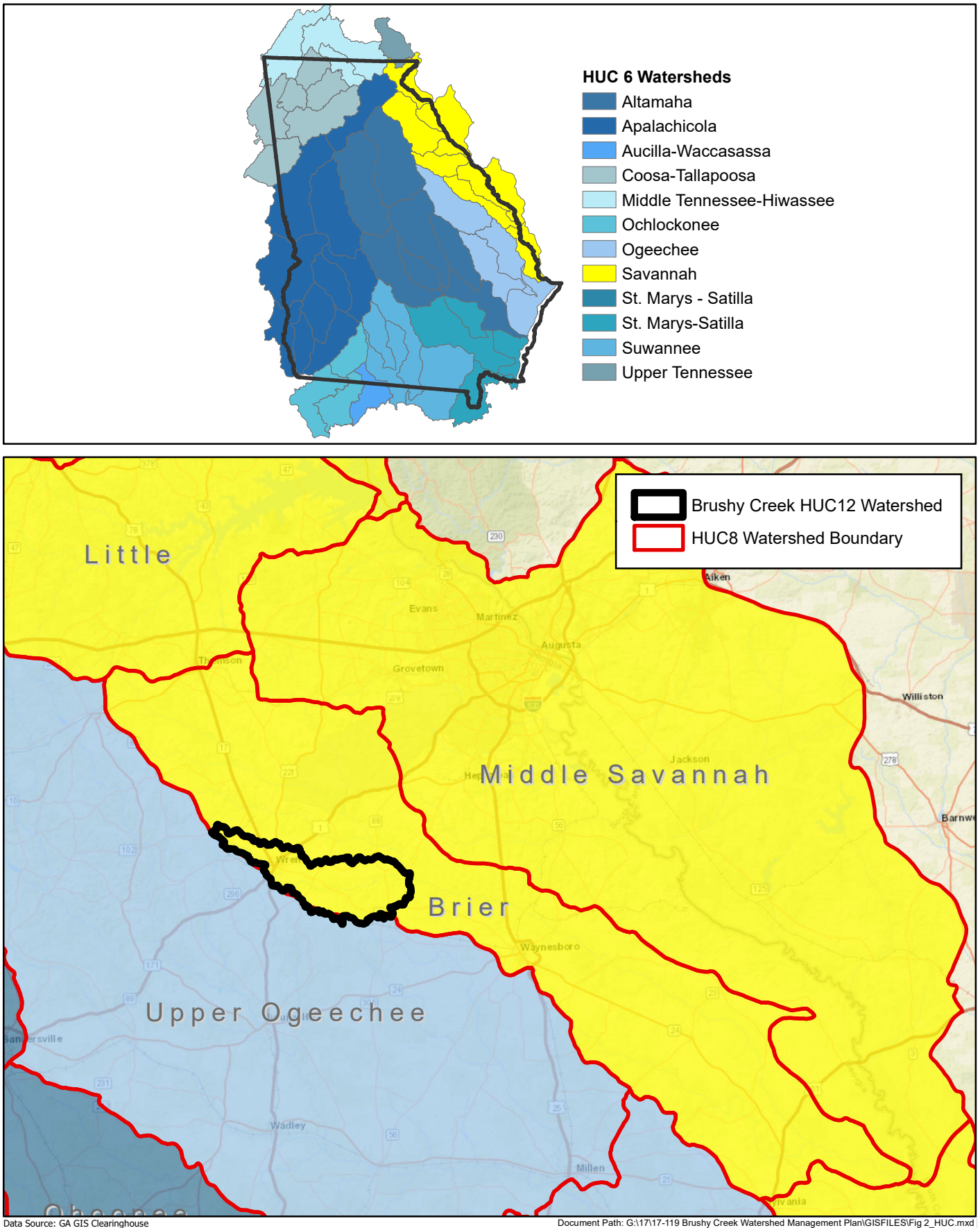

Figure 2. Location of the Brushy Creek HUC12 watershed within the larger Savannah River basin.

1.3 Project Objectives

The objective of the project is to develop and implement a nine-key element WMP. The nine key elements for watershed planning are:

1. Identification of causes and sources of pollution that need to be controlled;
2. Determine load reductions needed for each pollutant;
3. Develop NPS management measures that will be implemented to achieve reduction goals and critical areas where measures will be needed;
4. Identify technical and financial assistance needed to implement the plan;
5. Develop an information/education component that identifies education and/or outreach activities for plan implementation;
6. Schedule for implementing NPS management measures;
7. Develop interim milestones to track implementation of management measures;
8. Set of criteria to determine if load reductions are being met; and,
9. Develop a long-term monitoring component to evaluate effectiveness of management measures or BMPs over time.

To aid in the development of the WMP, a watershed characterization and fecal coliform assessment was conducted to evaluate the current conditions of the watershed, establish baseline conditions prior to management initiatives, identify potential pollutant sources, and prioritize areas for implementation of BMPs. The primary pollutant addressed during the characterization was fecal coliform; secondary pollutants included nutrients and sediment.

The goal of the WMP is to achieve a 20 percent reduction in fecal coliform one year following implementation of management measures in the WMP. Based on the TMDL, long-term goals include a 45 percent reduction in fecal coliform following implementation of management measures in the WMP and delisting and removal of Brushy Creek from the 305(b)/303(d) integrated report.

1.4 Community Based Planning

Public involvement is a crucial aspect of the watershed planning process. It allows the stakeholders within the Brushy Creek watershed to provide insight and input in the decision-making processes that set goals, objectives, and actions for improving water quality within the assessment area. This WMP was a collaboration of the Brushy Creek Advisory Committee and Stakeholder Group, GSWCC, GA EPD, and Nutter & Associates (NAI). Funding for the WMP was provided by the US EPA to the GA EPD under Provisions of Section 319(h) of the Federal Water Pollution Control Act.

A Watershed Advisory Committee and Stakeholder Group was formed, which included local business and landowners, farmers, forestry and logging industry representatives, and County and regional representatives, to provide input on the development of the WMP. The group was formed to assist with the watershed planning process and the WMP development and implementation. Additionally, the group was responsible for identifying issues or concern within the watershed and creating a vision for the WMP.

2.0 WATERSHED INVENTORY

2.1 Watershed Characterization

2.1.1 Watershed Reconnaissance and GIS Background Analysis

A windshield survey of the watershed was conducted on November 29, 2017. The purpose of the survey was to verify watershed land use data, identify problem areas or "hot spots" for fecal coliform pollution within the watershed, and determine suitable monitoring stations for the baseline fecal coliform monitoring. A collection of background information and a GIS desktop analysis of the Brushy Creek watershed was also conducted as part of the watershed characterization. Results of the watershed windshield survey and GIS desktop analysis are included in Appendix A.

2.1.2 Land Use and Land Cover

Based on 2001 land use and land cover data from the TMDL report, land cover within the Brushy Creek watershed was mostly forested (39%) and agricultural (43%) (GA DNR, 2005a). Smaller 2001 land cover components included woody wetlands (10%), residential (1%), and high intensity urban/industrial and commercial areas (<1%) (GA DNR, 2005a). In 2011, existing land cover in the watershed was predominately forested (Figure 3). Specifically, forested land made up approximately 53% of the Brushy Creek watershed while agricultural land cover accounted for approximately 26% of the watershed. A smaller percentage of the watershed land cover was comprised of wetlands and open water (11%) and urban land and residential (9%) land cover. From the urban and residential land cover, approximately 1.5 percent was impervious surface. Based on the visual assessment and field verification, the land cover data presented in Figure 3 from 2011 is generally accurate and was used for development of the WMP. Since the TMDL was conducted, the watershed of Brushy Creek has experienced a decrease in agricultural land use and an increase in forested, residential, and high intensity urban land cover (See Table 1 below).

Table 1. 2001 and 2011 Land cover characteristics of the Brushy Creek watershed.

	2001	2011	Percent Change	2001	2011
Land cover	Percent			Acres	
Open Water	0.30	0.37	0.07	137	152
Low Intensity Urban/Residential	1.4	9.2	7.8	2,589	3,788
High Intensity Urban/Commercial & Industrial	0.80	0.17	-0.63	343	70
Clearcut/Sparse	5.0	0.16	-0.63	36	66
Quarries, Strip mines, Rock	0.60	0.00	-0.60	257	0
Forest	39.7	52.5	12.8	16,272	21,168
Row Crops & Pasture	43.0	26.3	-16.7	17,624	10,830
Forested Wetland	9.1	11.3	2.2	3,760	4,653
Total	100	100	--	41,018	41,178

Data Source: NLCD, 2011

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Figure 3. 2011 National Landcover Database land use classification for the Brushy Creek watershed.

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2.1.3 Ecoregion

A majority of the watershed area is located within the Coastal Plain Red Uplands (65k) Level IV Ecoregion of the larger Southeastern Plains (65) Level III Ecoregion (Griffith et al., 2001). The Coastal Plain Red Uplands formed on mostly well-drained loamy or sandy soils formed from brown and reddish clay formations. The ecoregion is dominated by cropland and pasture, with some wooded areas located along the steeper slopes (Griffith et al., 2001). This ecoregion has more rolling, hilly topography than the southern coastal plain but generally less than that of the Piedmont. Streams within the region are typically sand bottomed and low gradient systems (Griffith et al., 2001).

2.1.4 Water Resources and Hydrology

The watershed of Brushy Creek is located in the southern portion of the Brier Creek HUC8 watershed (03060108), which is part of the larger Savannah HUC6 watershed (030601) (Figure 2). Generalized areas of significant groundwater recharge in the State of Georgia are mapped in Georgia Geological Survey Hydrologic Atlas 18. The Brushy Creek watershed has been delineated within the Cretaceous – Tertiary aquifer system groundwater recharge area (Figure 4). Groundwater pollution susceptibility for the State of Georgia is presented in the Georgia Geologic Survey Hydrologic Atlas 20. The entire portion of the Brushy Creek watershed is mapped as being of high groundwater pollution susceptibility (Trent, 1992).

2.1.5 Geology, Soils, and Topography

The watershed of Brushy Creek is located in the Sea Island Section of the Coastal Plain Province on a divide between the Fall Line Hills and the Vidalia Upland Districts (Clark and Zisa, 1976). Portions of the Brushy Creek watershed located within Jefferson and Burke Counties and downstream of the City of Wrens are located within the Vidalia Uplands District, which is characterized by moderately dissected but well-developed dendritic drainage patterns. Relief in the district ranges from 100 to 500 feet. Higher elevations around 500 feet occur within the northwestern portion of the district, which drop to around 100 feet in the southeastern portion of the district, indicative of a regional dip.

Based on soil mapping published by the Soil Conservation Service (SCS) in Burke County (issued 1986) and Glascock and Jefferson Counties (issued 1994), soil series mapped within the vicinity of the watershed include: Ailey, Arundel, Bibb, Blanton, Bonifay, Carnegie, Chipley, Clarendon, Cowarts, Dogue, Dothan, Esto, Faceville, Fuquay, Grady, Greenville, Herod, Lucy, Muckalee, Nankin, Ocilla, Orangeburg, Osier, Rains, Rembert, Tifton, Troup, and Wahee soil types (Figure 5).

Data Source: NLCD, 2011

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Figure 4. Location of environmentally sensitive areas in the Brushy Creek Watershed.

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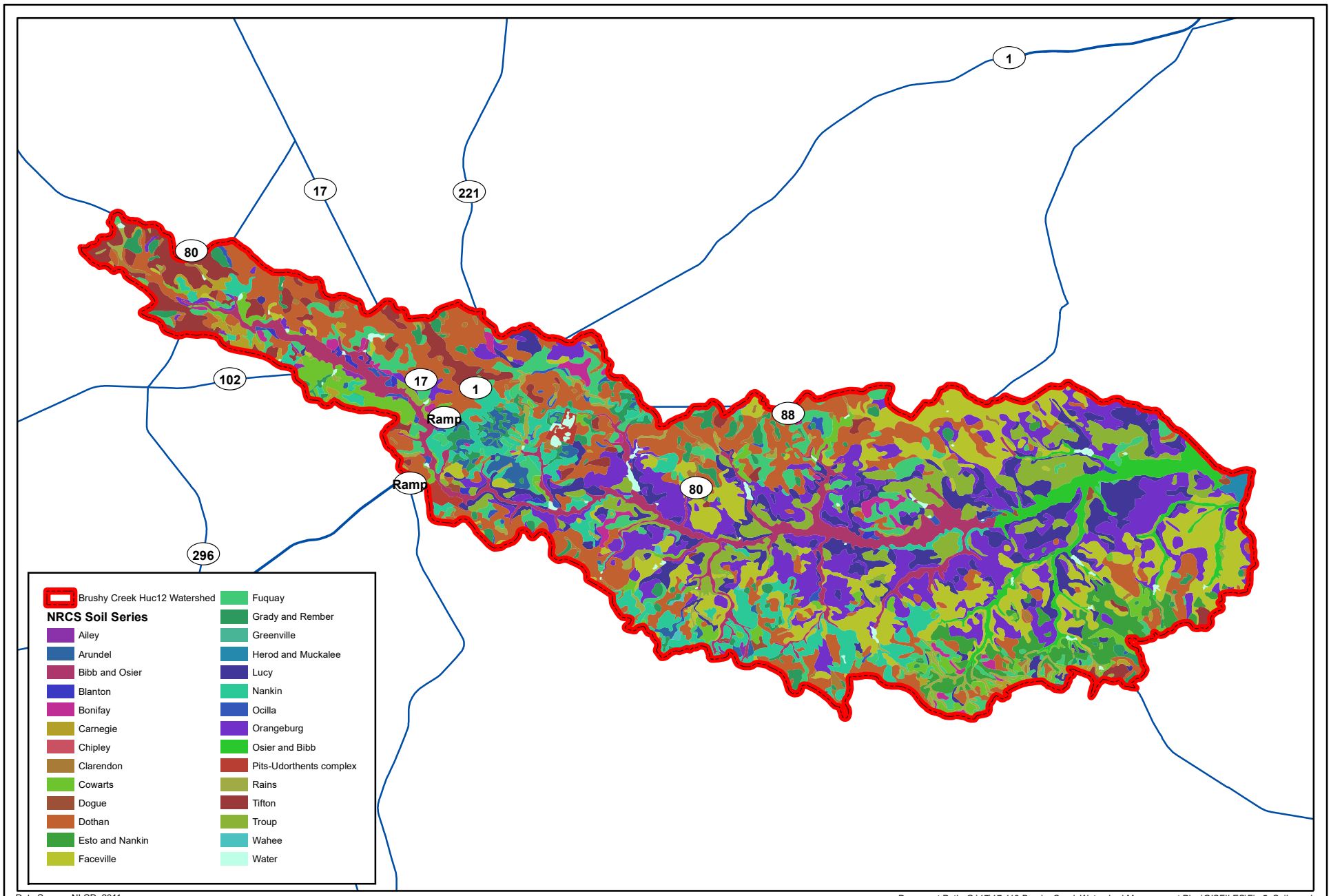

Data Source: NLCD, 2011

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Figure 5. The NRCS Soil Series for the Brushy Creek Watershed.

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Most soils in the area have a sandy surface and loamy subsurface layer or a sandy surface with a clayey subsurface layer. Depending on the topography and location, the sandy surface may extend to depths up to and greater than 20 inches while the clay rich horizons typically contain plinthitic nodules in the lower portions of the profiles. Well drained soils are located along smooth, convex slopes on nearly level to gently sloping topography. Poorly drained soils are located along concave slopes adjacent to depressions and drainageways. Floodplain soils in the area are typically poorly drained, located along rivers and creeks, and are loamy throughout the profile. The soils within the watershed typically formed in parent materials weathered from Eocene aged marine sediments consisting of predominately sand and sandy clay deposits within the northern portions of Burke County (Paulk, 1986) and marine sediment deposited in the late Eocene age forming gray to yellow sands and sandy clay within Jefferson County (Paulk, 1994). Soils are considered to be one of the region's most basic and fragile natural resources.

2.1.6 Environmentally Sensitive Areas

Environmentally sensitive areas within and surrounding the Brushy Creek watershed include but are not limited to: various wetland habitats, water supplies, groundwater recharge areas, endangered and protected species habitat, and recreational areas (Figure 4).

According to the GA DNR Rare Species & Natural Community Database, several rare element (plant and animal taxa and natural communities) occurrences are located within and surrounding the Brushy Creek watershed. These include: (1) plant species such as the Carolina bogmint (*Macbridea caroliniana*); Indian olive (*Nestronia umbellule*), few-flower blazingstar (*Liatris pauciflora*), silky camellia (*Stewartia malacodendron*), and Carolina campion (*Silene caroliniana*) and (2) protected animal species, such as the tiger salamander (*Ambystoma tigrinum*), Savannah slimy salamander (*Plethodon savannah*), gopher tortoise (*Gopherus polyphemus*), southern hog-nosed snake (*Heterodon simus*), red-cockaded woodpecker (*Picoides borealis*), Savannah darter (*Etheostoma fricksium*), ironcolor shiner (*Notropis chalybaeus*), pine snake (*Pituophis melanoleucus mugitus*), and bald eagle (*Haliaeetus leucocephalus*).

2.1.7 Potential Water Quality Stressors

Nutter & Associates searched GA DNR, GA EPD and US EPA databases (http://www.epa.gov/enviro/index.html) to identify water intakes, landfills, hazardous waste (CERCLIS) facilities, wastewater treatment plants, land application sites and other regulated facilities within the Brushy Creek watershed. Results of the database search are included in Appendix A.

2.1.8 Historic Water Quality Data

In accordance with State of Georgia Water Use Classifications and Water Quality Standards (GA Code 391-3-6-03), fecal coliform concentrations shall not exceed a geometric mean of 200 MPN/100 mL for the months of May through October and 1,000 MPN/100 mL for the months of November through April. The geometric mean is calculated from at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours. During the months of November through April, fecal coliform concentrations shall not exceed a maximum concentration of 4,000 MPN/100 mL for any sample. Further, based on the *Total Maximum Daily Load (TMDL) Evaluation for 32 Stream Segments in the Savannah River Basin for Fecal Coliform* completed in 2005 by the GA DNR, stream segments (including the listed section of Brushy Creek) were listed as not supporting their designated use if more than 25% of the subsamples exceeded the water quality standard.

In 1997 and 2002, the GA EPD conducted fecal coliform monitoring within the listed reach of Brushy Creek (See Table 2 for results). For the 1997 assessment, the GA EPD collected fecal coliform samples monthly between January and December 1997 on Brushy Creek at State Hwy 80 (See Station BC04 on Figures 6 and 7). As such, the calculation of a geometric mean was not possible for the data collected in 1997, and the data could not be used to make a designated use evaluation. Over the 1997 monitoring year, four of the 12 subsamples (33%) collected exceeded the water quality standard, with 67% (2 of the 6 samples) of the warm season subsamples (May – October) exceeding the water quality standard (Table 2).

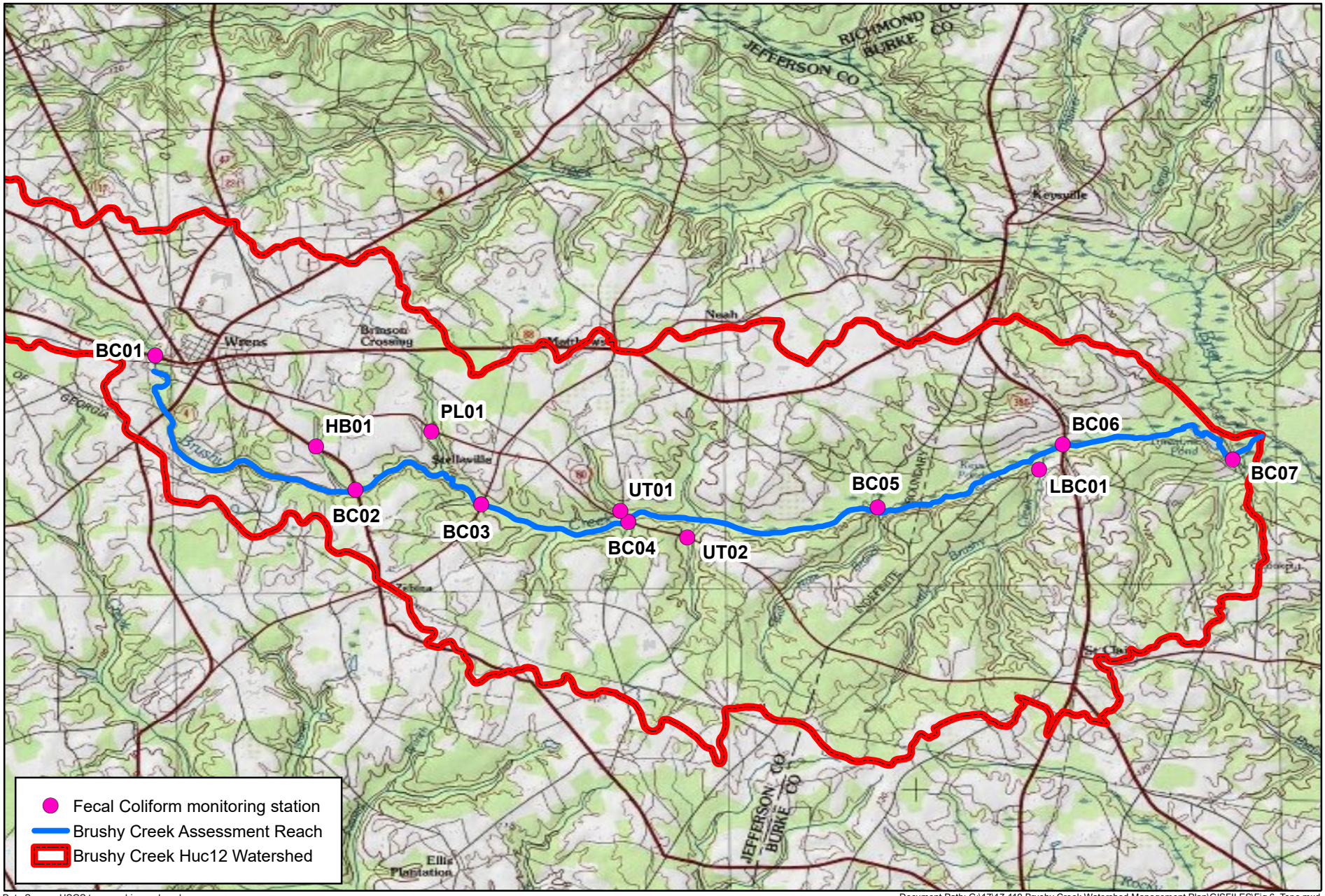
Samples collected in 2002 from Brushy Creek at Campground Road (See Station BC03 on Figures 6 and 7). were collected at a frequency that made the calculation of a geometric mean possible. In total, 17 discrete fecal coliform samples were collected in 2002 which allowed for the calculation of four unique fecal coliform geometric means. Of the four geometric mean determinations, two exceeded the water quality criteria. Further, approximately 78 percent of the individual samples collected exceeded the water quality standard for May to October (See Table 2 for results).

Based on the historic water quality data for fecal coliform and according to the TMDL, Brushy Creek was listed for not supporting the designated use of fishing because more than 25 percent of the fecal coliform subsamples collected from May to October in 2002 exceeded the fecal coliform water quality standard of 200 MPN/100 mL (GA DNR, 2005a).

Table 2. Summary of historic fecal coliform water quality monitoring data acquired from the GA EPD Online Water Quality Database and calculated geometric means for Brushy Creek.[1-3]

Station ID	Location	Date	Fecal Coliform MPN/100 mL	Geometric Mean MPN/100 mL	Geometric Mean Water Quality Exceedance	Percent Subsample Water Quality Exceedance
RV_01_101	Campground Rd or Station BC03	2/28/2002	294	207	No	0%
		3/4/2002	170			
		3/14/2002	460			
		3/18/2002	80			
		5/20/2002	60	--	--	78%
		6/4/2002	1,100	417	Yes	
		6/10/2002	490			
		6/20/2002	170			
		7/2/2002	330			
		8/12/2002	330	364	Yes	
		8/19/2002	330			
		8/27/2002	330			
		9/9/2002	490			
		12/2/2002	20	43	No	0%
		12/3/2002	110			
		12/10/2002	20			
		12/17/2002	80			
RV_01_102	State Road 80 or Station BC04	1/23/1997	490	Could not be calculated due to sample frequency	Could not be determined	0%
		2/19/1997	230			
		3/19/1997	490			
		4/16/1997	270			
		5/21/1997	460			67%
		6/18/1997	490			
		7/23/1997	170			
		8/20/1997	230			
		9/17/1997	330			
		10/15/1997	130			
		11/5/1997	230			0%
		12/3/1997	170			

[1]Geometric mean = calculated based on four subsamples collected over a 30-day period at intervals not less than 24 hours
[2]Water quality standard is a geometric mean of 200 MPN/100 mL from May to October and 1,000 MPN/100 mL from November to April
[3]Streams were listed by the GA EPD if more than 25% of the subsamples exceeded the water quality standard



Data Source: USGS topographic quadrangle

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Figure 6. Baseline fecal coliform monitoring stations, Brushy Creek Watershed Management Plan.

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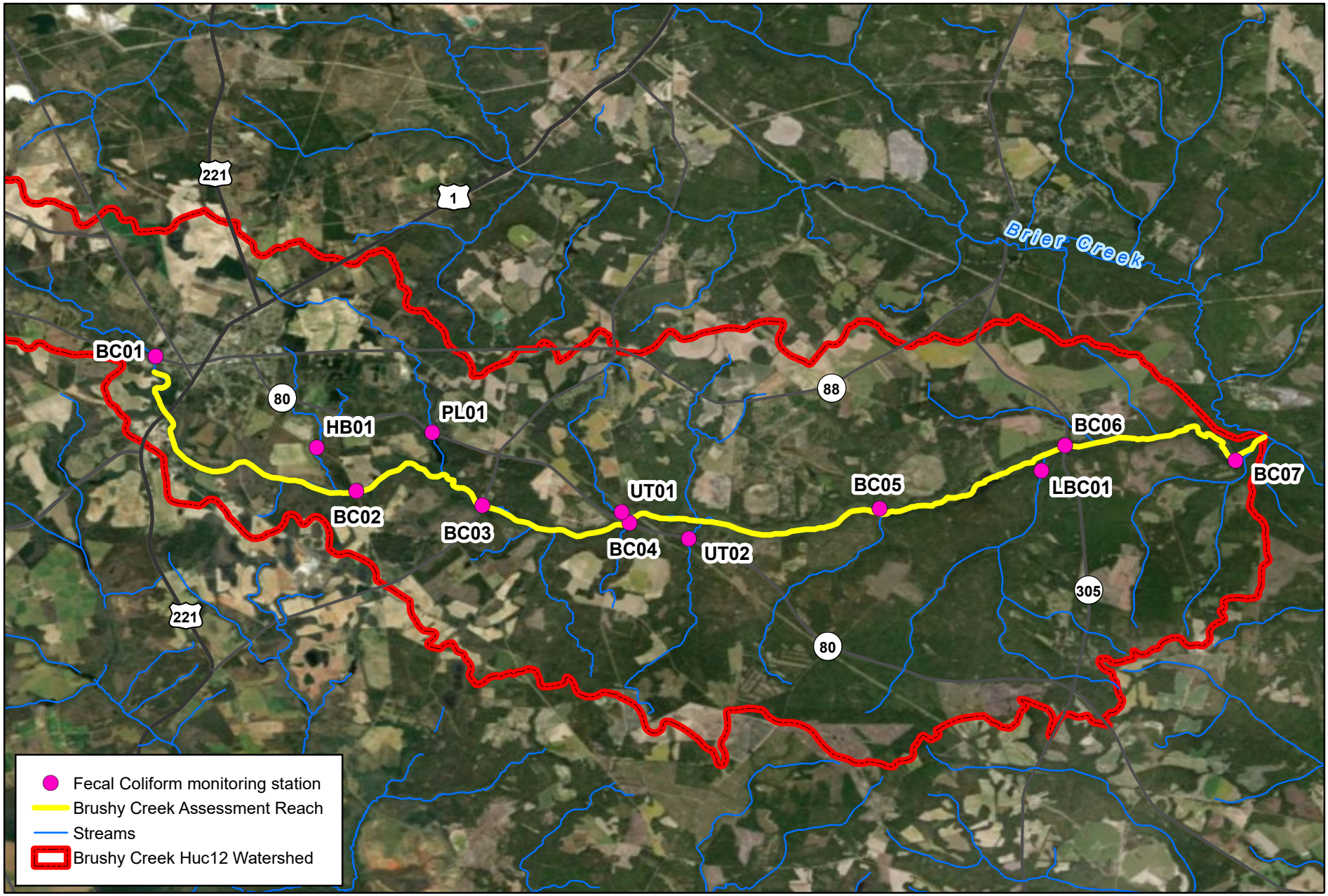

Figure 7. Baseline fecal coliform monitoring stations and 2015 aerial imagery, Brushy Creek Watershed Management Plan.

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2.1.9 Agricultural Producers

According to the Jefferson County Cooperative Extension Service, Burke and Jefferson Counties contain no commercial feedlots and one poultry house. Four concentrated animal feeding operations (CAFOs) are located in Jefferson County and five in Burke County. However, based on the watershed reconnaissance and GIS analysis, none of the CAFOs are located within the Brushy Creek watershed. Table 3 below summarizes the agricultural commodities for both Burke and Jefferson Counties according to the 2017 University of Georgia (UGA) Farmgate Survey.

Table 3. 2017 UGA Farmgate Survey for agricultural commodities for Burke and Jefferson Counties.

Commodity	County	Quantity
Ornamental Horticulture (nurseries, greenhouses, and turfgrass)	Burke	60 acres
	Jefferson	207 acres
Fruit and Nuts (Blueberries, Strawberries, and Pecans)	Burke	1,329 acres
	Jefferson	1,247 acres
Forestry	Burke	4,810 acres
	Jefferson	2,204 acres
Poultry and Eggs (Quail)	Burke	90,000 birds
	Jefferson	--
Beef Cows and Stockers	Burke	9,400 head
	Jefferson	3,100 head
Dairy Cows	Burke	8,300 head
	Jefferson	3,100 head
Pork	Burke	310 head
	Jefferson	45 head
Horses	Burke	525 horses
	Jefferson	35 horses
Row and Forage Crops	Burke	100,508 acres
	Jefferson	50,433 acres
Hunting Leases	Burke	62,600 acres
	Jefferson	26,000 acres

As discussed in previous sections, agricultural land use encompasses approximately 10,830 acres in the Brushy Creek watershed.

2.1.10 On-Site Wastewater Management Systems

Based on information provided by the East Central Health District, Environmental Health Section in Richmond County (District Office), approximately 340 and 122 new on-site wastewater system permits were issued in Burke and Jefferson County, respectively, from July 2015 through June 2018. Since July 2015, 99 repair permits have been issued in Burke County while 63 have been issued in Jefferson County. This equates to a 29% and 52% failure rate in Burke and Jefferson County, respectively, for existing on-site systems when comparing the number of new permits issued to the number of repair permits issued. Based on this data, failing septic systems are a potential source of fecal coliform pollution in the Brushy Creek watershed.

2.2 Current Conditions of Brushy Creek

2.2.1 Fecal Coliform and Nutrient Monitoring Events

In accordance with the *Quality Assurance (QA) and Quality Control (QC) Targeted Monitoring Plan* (Plan) for fecal coliform sampling (Nutter & Associates, January 2018), bacteriological density data for fecal coliform bacteria was collected as a geometric mean based on four samples collected within a 30-day period at intervals not less than 24 hours. For the baseline assessment, one geometric mean per quarter (winter, spring, and summer) was conducted, for a total of three discrete geometric means, in accordance with the schedule included in Table 4.

Table 4. Sampling schedule for the Brushy Creek fecal coliform baseline analysis.

	2018		
	Feb	May	Aug
Fecal Coliform Baseline Assessment			
In-Situ Water Quality Analysis	✓	✓	✓
Fecal Coliform Geometric Mean (4 individual events for two geomeans at 12 stations)	✓	✓	
Fecal Coliform Geometric Mean (4 individual events for one geomean at 7 stations)			✓
Nutrient Analysis (4 individual events at 3 stations)			✓

In-situ water quality measurements, including air and water temperature (°C), dissolved oxygen (percent saturation and concentration in mg/L), pH (standard units), specific conductance (μS/cm), and turbidity (NTUs) were collected in conjunction with each bacteriological grab sample event. For the February (winter) and May (spring) events, fecal coliform water quality monitoring was conducted for the Brushy Creek watershed at 12 monitoring locations (See Table 5 below and Figures 6 and 7 for location information). Based on the results from the first two rounds of sampling, the QA/QC Plan was modified for the summer (August) sampling event and fecal coliform monitoring was only conducted at seven stations (BC01, HB01, BC03, UT01, UT02, LBC01, and BC07). During the summer event, total nitrogen and phosphorus water quality samples were also collected at stations UT01, UT02, and LBC01.

Table 5. Location of the fecal coliform water quality monitoring stations for the Brushy Creek Watershed Management Plan baseline line assessment.

Station Name	Location (DD)		Station ID
	Latitude	Longitude	
Brushy Creek at Hwy 88	33.209264	-82.397629	BC01
Brushy Creek at Zebina Rd	33.183205	-82.358694	BC02
Haden Branch at Zebina Rd	33.191656	-82.366377	HB01
Pilcher Lake at Hwy 80	33.194547	-82.343922	PL01
Brushy Creek at Campground Road	33.180402	-82.334195	BC03
Brushy Creek at Hwy 80	33.177001	-82.305628	BC04
Unnamed Tributary at Owens Mill Rd	33.179089	-82.307201	UT01
Unnamed Tributary at Hwy 80	33.173897	-82.294188	UT02
Brushy Creek at Brushy Creek Rd	33.179757	-82.257151	BC05
Little Brushy Creek at Butler Mill Rd	33.187103	-82.225733	LBC01
Brushy Creek at Hwy 305	33.192088	-82.221134	BC06
Brushy Creek at Key-Boggs Academy Rd	33.189104	-82.188053	BC07

2.2.2 Results

The results of the fecal coliform and nutrient baseline sampling events are detailed in Appendix B and summarized below (See Figure 8 for results of fecal coliform monitoring):

- Identified pollutants of concern within the watershed include bacteria, sediment, and nutrients.

- The highest total nitrogen concentrations were observed at station UTS01. However according to the GA EPD Online Water Quality Database, total nitrogen concentrations at all stations (UTS01, UTS02, and LBC01) were below the average total nitrogen concentration for 35 streams located within the Coastal Plain Red Uplands (65k) Level IV Ecoregion.

- According to the GA EPD Online Water Quality Database total phosphorus concentrations at all stations were below the average for 80 streams in the ecoregion.

- The highest fecal coliform concentrations were observed during the spring sampling event (May 2018), which correlated with above average precipitation and increased stormwater runoff primarily associated with unpaved roads, agricultural, and urban/ residential lands.

- During WMP sampling, only one station on Brushy Creek exceeded the water quality standard from May to October (BC03 during spring sampling). For all stations located on Brushy Creek, approximately 32.5 percent of the subsamples exceeded the water quality standard for the months of May to October, which is 45 percent lower compared to the historic water quality data.

- During dry weather conditions, potential sources of fecal coliform and nutrients are illicit discharges or leaking sewer lines, livestock access to streams, wildlife such as feral hogs and geese, illegal dumping into streams and riparian areas, and leaking septic systems.

- For wet weather conditions, potential sources are stormwater runoff from nonpoint sources such as urban (includes residential) and agricultural lands and runoff from unpaved roads.

- Based on the results from the baseline assessments, the watersheds of UT01, UT02, and HB01 have been identified as high priority watersheds for the implementation of best management practices that can address stormwater runoff and reduce fecal coliform loading to streams.

- The entire Brushy Creek watershed may benefit from implementation of BMPs that address stormwater runoff from agricultural and urban land uses, unpaved roads, illicit discharges and illegal dumping, livestock access to the stream, wildlife, and failing on-site wastewater systems.

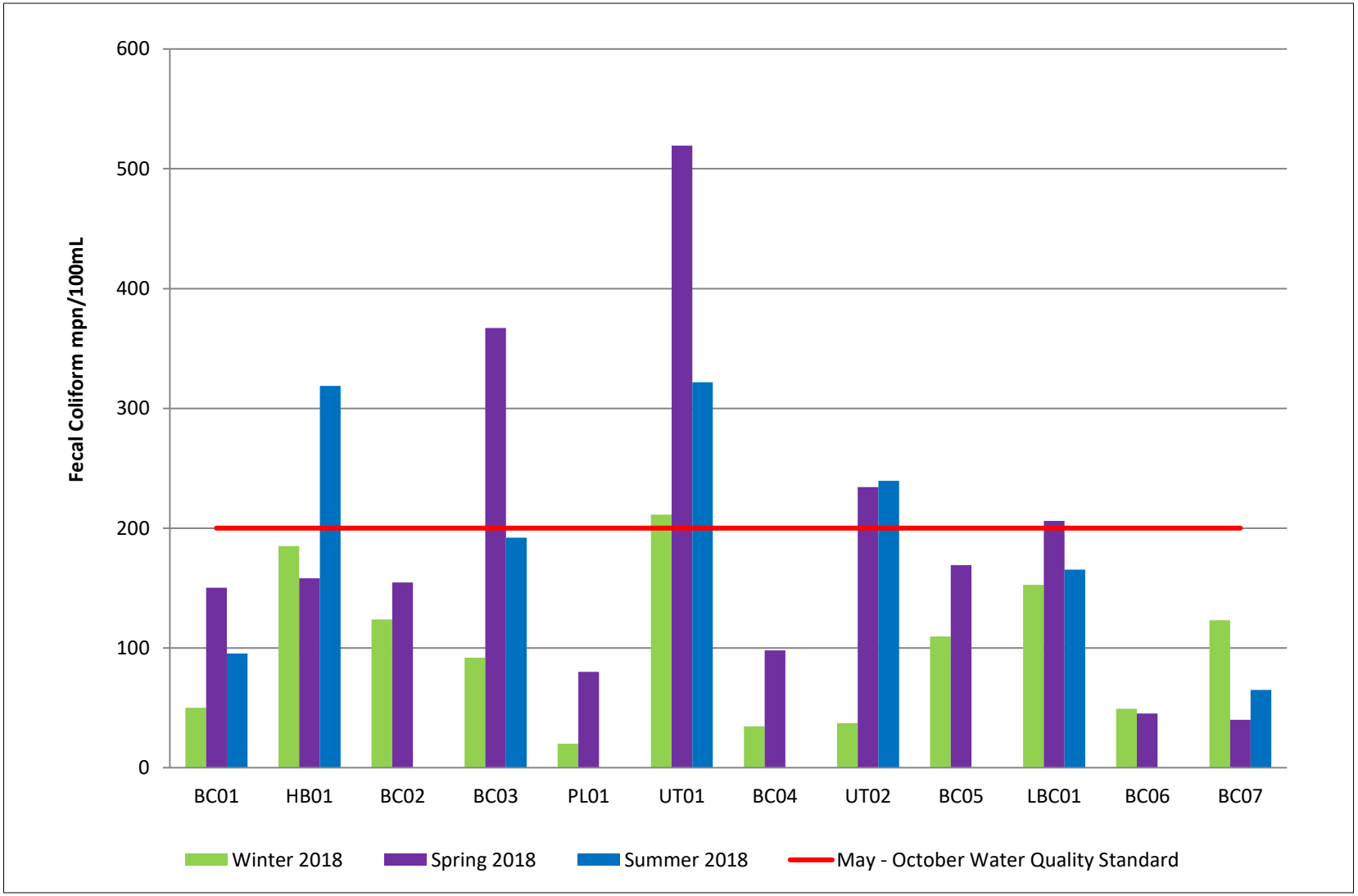

Figure 8. Calculated geometric mean concentrations for all stations during the winter, spring, and summer sampling events.

3.0 POLLUTANT SOURCE IDENTIFICATION

Based on the results of the watershed characterization, baseline assessment, public input, and the TMDL (GA DNR, 2005a), fecal coliform has been identified as the primary pollutant within the Brushy Creek watershed, while sediment and nutrients have been identified as secondary pollutants. Major sources of pollutants in the Brushy Creek watershed have been identified as illegal dumping of deer carcasses and household trash, feral hogs, and stormwater runoff associated with urban and agricultural land and unpaved roads. Failing septic systems, livestock access to streams, illicit discharges, and leaking sewer lines associated with the City of Wrens were other potential sources that were not observed during the watershed reconnaissance or baseline assessment that could be additional sources of fecal coliform pollution within the watershed.

3.1 Evaluation and Location of BMP Priority Areas

Areas of the Brushy Creek watershed has been identified for prioritization of best management measures that address illegal dumping of household trash and wild game carcasses, feral hogs, and stormwater runoff associated with urban and agricultural land and unpaved roads. Illegal dumping and feral hogs were identified as the primary source of fecal coliform throughout the Brushy Creek watershed based on public input and the watershed reconnaissance and monitoring, while stormwater runoff was identified based on the baseline fecal coliform monitoring. The highest fecal coliform concentrations during the baseline monitoring were observed in watersheds HB01, UT01, and UT02, especially during periods of increased stormwater runoff. Watershed HB01 has been identified as high priority sub-watershed for the implementation of best management practices that address stormwater runoff associated urban and agricultural land and unpaved roads. Sub-watershed UT01 has been identified as a high priority watershed for implementation of management measures that address stormwater runoff from agricultural land and unpaved roads. Finally, sub-watershed UT02 has been identified as a high priority sub-watershed for implementation of management measures that address stormwater runoff from unpaved roads.

Figure 9 presents the potential areas identified for implementation of management measures for the entire Brushy Creek watershed and within each high priority sub-watershed. Acreages of agricultural land for potential BMP installation within each high priority watershed were estimated based on observed conditions during the watershed reconnaissance, aerial photography, and the property's proximity to environmentally sensitive areas (wetlands or streams). Total linear miles of unpaved roads for each watershed were estimated based on the GA Department of Transportation 2016 road shapefile and aerial photography. It is assumed all public unpaved roads are potential sources of fecal coliform pollution for each watershed.

Table 6 compares the total watershed size, total acres of agricultural and urban (including residential) land, and the total acreage of each land cover or linear miles of unpaved roads identified as potential properties or locations where target BMPs could be implemented. Percent impervious surface within the entire Brushy Creek watershed and sub-watersheds UT01, UT02, and HB01 based on 2011 land use data was also compared (Table 7).

Table 6. Pollutant source identification within the Brushy Creek watershed and the high priority sub-watershed units.

Watershed or Sub-watershed	Watershed Size	Land Use		Potential BMP Implementation		
		Agricultural	Urban[1]	Agricultural	Urban	Unpaved Road
	Acres					Linear Miles
Brushy Creek HUC12[2]	41,4178	10,830	3,858	2,020	1,904	45
UT01	1,574	536	146	150	0	2.4
UT02	2,003	280	90	0	0	2.0
HB01	1,587	87	479	55	561	0.48

[1]Includes residential land use
[2]Includes watersheds UT01, UT02, and HB01

Table 7. Percent impervious surface within the Brushy Creek watershed and the high priority sub-watershed units.

Watershed	Percent Impervious Surface
Whole Brushy Creek[1]	1.7
UT01	2.0
UT02	0.38
HB01	6.3

[1]Includes watersheds UT01, UT02, and HB01

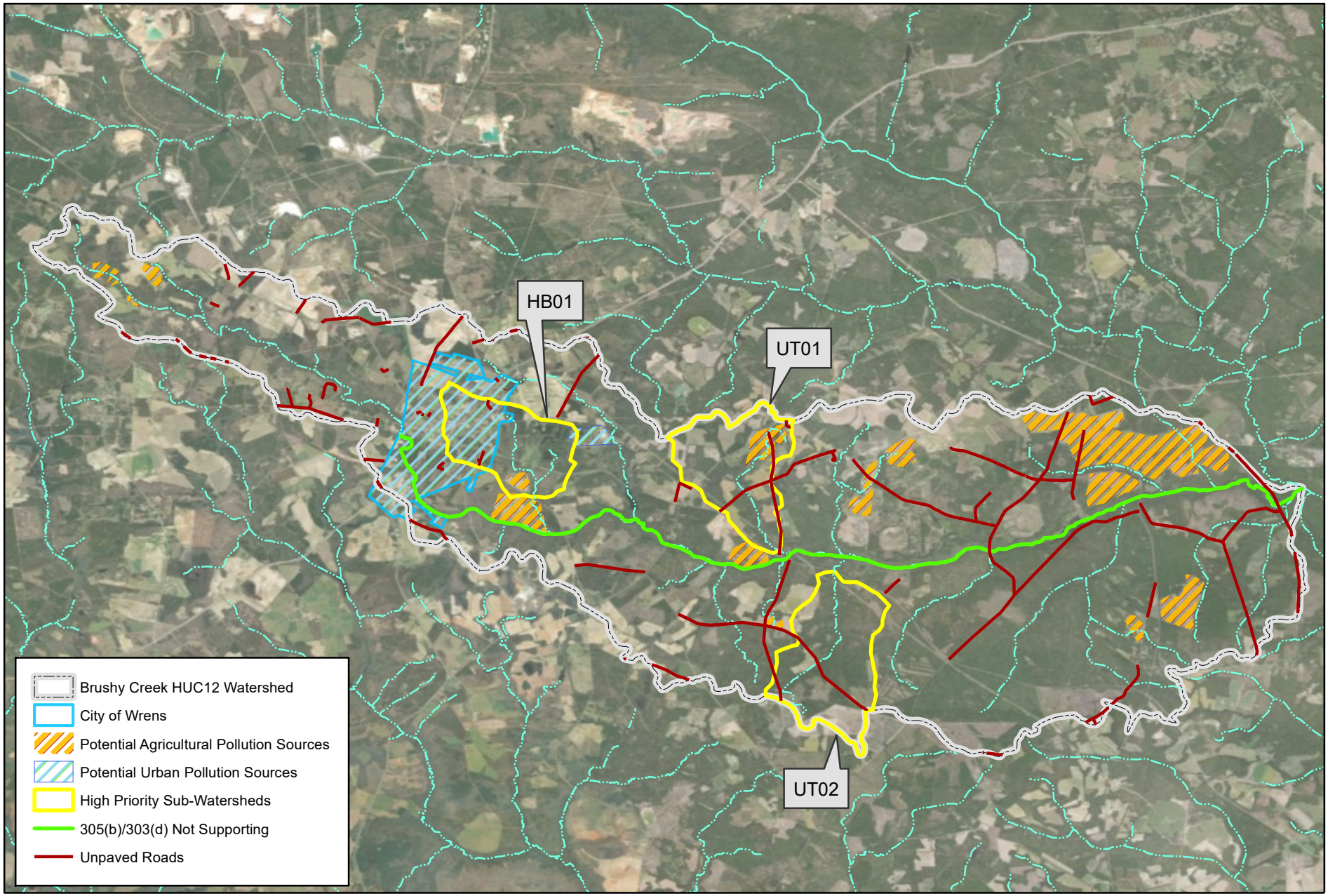

Figure 9. Potential areas identified for implementation of management measures and each high priority sub-watershed.

0 1.25 2.5 5 Miles

N

Nutter & Associates
environmental consultants

3.2 Summary of Management Needs

For the entire Brushy Creek watershed, BMPs that address illegal dumping of household trash and wildlife carcasses are considered a high priority. Further, 2,020 acres of agricultural land, 1,904 acres of urban and residential land, and 45 linear miles of unpaved roads have been identified in the entire Brushy Creek watershed for potential installation of BMPs that address stormwater runoff (Table 6). To address fecal coliform that persists in surface water during dry weather conditions, the entire watershed will be considered for maintenance and repairs of existing or failing on-site wastewater systems and for management measures that address livestock access to streams, leaking sewer lines in and around the City of Wrens, and illicit discharges. The following high priority sub-watershed units located within the Brushy Creek watershed have been identified for potential installation of BMPs:

UT01 - 150 acres of agricultural land and 2.4 miles of unpaved roads;

UT02 - 2 miles of unpaved roads, and,

HB01 - 55 acres of agricultural land, 561 acres of urban land, and 5 miles of unpaved roads.

According to the UGA Cooperative Extension Service, no commercial feedlots or dairy farms are located within the Brushy Creek watershed. However, several small-scale cattle operations (100-150 heads of cattle) are located within of the watershed (Figure 9). According to the UGA Cooperative Extension Service, an exact number of small scale facilities could not be determined because the operations were located within individual properties where access and total heads of cattle was not provided. Therefore, the acreage of small-scale cattle facilities is included as part of the agricultural land in Table 6.

4.0 POLLUTANT LOAD REDUCTIONS

4.1 Goals

Goals for the Brushy Creek WMP have been divided into three categories: short-term, mid-term, and long-term.

Short-term goals of the watershed management plan include:

1. Receive funding for implementation of the WMP;

2. Solicit participation of landowners, farmers, and the Jefferson and Burke Counties Road Department in implementation of the WMP;

3. Identify exact site locations for management measures; and,

4. Initiate and implement recommendations from the WMP within one year of receiving additional funding.

Mid-term goals of the WMP include:

1. Twenty percent reduction in fecal coliform after initial implementation of WMP recommendations.

Long-term goals of the WMP were set based on the existing TMDL developed by the GA EPD in 2005 and include:

1. Sustained community involvement in water quality protection;

2. TMDL goal of 45 percent reduction in fecal coliform concentration in Brushy Creek; and,

3. Delisting of Brushy Creek to meet the Clean Water Act (CWA) mandate to ensure the Brushy Creek meets the designated use of fishing.

Short-term goals should be achieved within three years following approval of the WMP; mid-term goals range should be achieved within three to six years following approval of the WMP; and long-term goals should be achieved within six to ten years following implementation of approval of the WMP.

4.2 Fecal Coliform Reductions

4.2.1 TMDL and Baseline Results

As discussed in section 2.1.7 and Table 2 above, Brushy Creek was listed as not supporting the designated use of fishing because more than 25 percent of fecal coliform subsamples collected in 2002 exceeded the fecal coliform water quality standard of 200 MPN/100 mL (May to October) and 1,000 MPN/100 mL (November to April), or because the calculated geometric mean based on the subsamples exceeded the water quality standard (GA DNR, 2005a).

No geometric means collected from the mainstem Brushy Creek stations during the winter or summer sampling events of the WMP baseline water quality assessment exceeded the water quality standard for fecal coliform. However, the calculated geomean at station BC03 exceeded the water quality standard during the spring sampling event (Table 8). During the winter sampling period, only four percent of the individual subsamples collected from the Brushy Creek stations exceeded the water quality standard (Table 8). Conversely, more than 25 percent of the individual subsamples for Brushy Creek stations exceeded the fecal coliform water quality standard during the spring of 2018 and only 17 percent exceeded the water quality standard during the summer sampling (Table 8). Overall, from May to October, approximately 32.5percent of the individual samples collected exceeded the water quality standard (Table 8).

Table 8. Percentage of subsamples and calculated geometric means that exceeded the water quality standard during the winter, spring, and summer baseline assessment.

Event	Station	Fecal Coliform (MPN/100mL)				
		2/6/2018	2/13/2018	2/20/2018	2/27/2018	Geomean
Winter	BC01	<20	80	130	30	50
	BC02	20	70	2,400	70	124
	BC03	110	20	170	190	92
	BC04	20	70	<20	50	34
	BC05	70	70	210	140	110
	BC06	70	140	<20	30	49
	BC07	80	80	900	40	123
Subsample Percent Exceedance[1]		**4%**				
	Station	5/1/2018	5/8/2018	5/15/2018	5/21/2018	Geomean
Spring	BC01	130	700	80	70	150
	BC02	40	500	130	220	155
	BC03	110	1,100	500	300	367
	BC04	40	20	230	500	98
	BC05	110	140	230	230	169
	BC06	20	<20	20	230	37
	BC07	<20	20	80	40	34
Subsample Percent Exceedance[2]		**39%**				
	Station	8/7/2018	8/14/2018	8/21/2018	8/28/2018	Geomean
Summer	BC01	110	170	110	40	95
	BC03	260	170	140	220	192
	BC07	20	40	130	170	65
Subsample Percent Exceedance[2]		**17%**				
Spring and Summer Subsample Percent Exceedance[2]		**33%**				

[1]Water quality exceedance for the months of November to April is 1,000 MPN/100mL
[2]Water quality exceedance for the months of May to October is 200 MPN/100mL

4.2.2 Comparison of Historic Sampling to Current Conditions

For the 1997 monitoring period, fecal coliform samples were collected from Brushy Creek at State Road 80, which was established as station BC04 during the baseline assessment. During the 2002 sampling, fecal coliform samples were collected from Brushy Creek at Campground Road (station BC03 during the baseline assessment). In 1997, 78 percent of the individual subsamples collected at station BC04 exceeded the water quality standard of

200 MPN/100mL for the months of May to October while only 25 percent exceeded during the WMP baseline sampling. For station BC03, 67 percent of the individual subsamples collected in 2002 exceeded the May to October water quality standard while 50 percent of the individual subsamples exceeded the standard during the WMP baseline monitoring (Table 9). Overall, the percent of individual subsamples that exceeded the May to October water quality standard for fecal coliform has decreased at both stations since the 1997 and 2002 monitoring (Table 9).

Table 9. Comparison of Historic Fecal Coliform Water Quality Sampling on Brushy Creek to Current Conditions.

Station	Monitoring Period	Percent Individual Subsample Exceedance[1]
BC03	2002	78
	2018	25
BC04	1997	67
	2018	50

[1]Water quality exceedance for the months of May to October is 200 MPN/100mL

4.3 Expected Fecal Coliform Load Reductions and Proposed BMPs

The expected percent reductions for fecal coliform associated with each agricultural BMP listed in Table 10 is based on reductions provided in *Best Management Practices for Georgia Agriculture: Conservation Practices to Protect Surface Water Quality* (GSWCC, 2013). To determine the approximate percent reductions expected for urban and stormwater BMPs, the GA Stormwater Management Manual BMP Selection Guide (Table 4.1.3-1 in Volume 2) was utilized. Management Practices listed in Table 10 were the only BMPs that have quantified removal efficiencies for fecal coliform; however, other BMPs were selected for implementation that were also effective for removal of sediment and nutrients.

Table 10. Fecal coliform removal efficiency of each potential BMP and the average fecal coliform removal efficiency calculated for each land use.

Land Use	BMP	Fecal Coliform Removal Efficiency	Average of Combined BMPs
		Percent	
Agriculture	Anaerobic Digesters	99	83
	Field Borders	60	
	Filter Strips	60	
	Fencing and Access Control	99	
	Waste Storage Facilities	96	
Unpaved Roads	Buffer Strip/Buffer	60	60
	Vegetated Filter Strips	60	
Urban	Stormwater Bioretention Cells	90	80
	Stormwater Planter or Tree Boxes	80	
	Stormwater Ponds	70	

To calculate the expected percent reduction from implementation of BMPs within the Brushy Creek watershed, an average fecal coliform removal efficiency of all of the combined BMPs was calculated for each land use cover type. For example, for agriculture land use, the average fecal coliform removal efficiency listed in Table 10 was used to determine the overall expected percent reduction within the watershed. A more comprehensive list of examples of BMPs that can be used to reduce fecal coliform for agriculture and urban land and unpaved roads are included in Tables 11 through 13.

In addition to fecal coliform reductions, each BMP selected in Tables 11 through 13 will also help to reduce nutrient and sediment loads, which were both identified as secondary pollutants within the Brushy Creek watershed. Based on the baseline assessment, the percentage of water quality exceedances for fecal coliform has decreased since the 1997 and 2002 assessments (Table 9). Based on the percent reductions expected in Table 10, fecal coliform loading in the watershed would be expected to be reduced following BMP implementation.

Table 11. Potential urban and residential NPS management measures to be implemented to achieve fecal coliform load reductions.

Pollutant Source	Causes of Impairment	Best Management and Maintenance Practices (BMPs)
Urban and Residential Land	Illegal Dumping	Public outreach and education about litter control in local schools, hardware stores, and deer processors
		Stream clean ups
		Develop a community hotline
		Litter and illegal dumping enforcement program utilizing the local sheriff's office, cameras, and signage
		Increase in trash and recycling facilities
	Stormwater Runoff	Public outreach and education campaign
		Establish or re-establish riparian buffers
		Avoid discharging or minimize discharging to sensitive areas (wetlands and streams)
		Enforcement of proper erosion, sediment, and pollution control for land disturbing activities
		Protection of sensitive areas
		Enhancement and development of community greenspaces and parks
		Bioswales
		Encourage land conservation and urban tree canopy
		Use or permeable pavement in urban areas
	Failing Septic Systems	Education and outreach campaign about the importance of proper septic system maintenance
		Establish a cost share program to assist with repairs to failing septic systems
	Illicit Discharges	Stream walks to detect and address
		Develop local ordinances to prohibit
		Develop plan to detect and address
		Public outreach and education with mailings, flyers, social media, signage, and kiosks
		Develop a community hotline
	Leaking Sanitary Sewer System	City of Wrens establishes a leak detection system.

Table 12. Potential agricultural NPS management measures to be implemented to achieve fecal coliform, sediment, and nutrient load reductions.

Pollutant Source	**Causes of Impairment**	**Best Management Practices (BMPs)**	
		Structural Practices	Non-Structural Practices
Agricultural Land Use	Row Crops	Field Borders Filter Strips Contour Buffer Strips Grassed Waterways Riparian Buffer or Buffer Strips Terraces Contour Farming Diversions	Conservation Tillage Reduced Tillage Systems Cover Crops Education Materials Field Days Erosion and Sediment Control Plans
	Small Scale Cattle/Livestock Operations	Anaerobic Digesters Fencing and Access Control Waste Storage Facilities Heavy Use Areas Watering Facilities Stream Crossings Water Well	Access Control Nutrient Management Plans GSWCC Farm Assessment Prescribed Grazing Residue Management Rotational Grazing Animal Trails and Walkways

Table 13. Potential best management and maintenance practices for unpaved roads.

Pollutant Source	Causes of Impairment	Best Management and Maintenance Practices
Unpaved Road	Road Surface Runoff and Erosion	Vegetated Shoulders, Banks, and Roadside Ditches
		Use of Turnouts
		Avoid Discharging or minimize discharge to Sensitive Areas
		Installation of Gravel
		Hydro seeding
		Use of Rock Filter Dams
		Use of Bottomless Culverts
		Maintenance of Proper Road Surface Conditions
		Use of Proper Surface Materials
		Following Proper Maintenance Operations
		Protection of Sensitive Areas (Wetlands and Streams)
		Vegetated Right of Ways
		Avoid channelized runoff
		Avoid grading during dry periods
		Avoid grading following heavy rains (> 1 inch)
		Adding Water for Dust Control
		Adding New Materials or Aggregates to the Road
		Use of Geotextiles
		Installation of Underdrains or cross drains
	Road Drainage Issues	Reduce Areas of Concentrated Flow
		Avoid Discharging of Concentrated Flow into Sensitive Areas
		Install Broad-based Dips
		Proper Ditch Maintenance
		Install Frequent Turnouts in Roadside Ditches
		Use Drop Inlet Structures
		Install Rock Check Damns in Ditches
		Install Culverts and Cross Drains
		Install Plunge Basins
	Slope Stabilization and Erosion	Terracing
		Tracking
		Gabions
		Vegetation
		Silt Fence or Other Sediment Barriers
		Hay Bales
		Matting and Blankets
	Road Materials and Additives	Geotextiles
		Dust Control

5.0 NON-POINT SOURCE (NPS) MANAGEMENT MEASURES & PROPOSED BMPs

5.1 Critical Areas

In order to achieve the percent fecal coliform reductions detailed in Section 4.3 above, BMPs that address illegal dumping and feral hogs along with a series of recommended agricultural, urban, and unpaved road BMPs should be implemented throughout the Brushy Creek watershed (Tables 10 through 12). Priority should be given to areas adjacent to streams and wetlands and to roads that run along or cross environmentally sensitive areas. A collaborative effort should be made between stakeholders within the Brushy Creek watershed and project coordinators to carefully select BMPs and management measures which will achieve the long-term goal of delisting Brushy Creek.

5.2 Feral Hog Control and Litter Control

The need for further feral hog control has been identified as a high priority for reducing fecal coliform loading within the Brushy Creek watershed. Potential BMPs discussed during the public meetings include implementation of live traps and trap custodians at select locations throughout the watershed. The program will be developed and implemented with the goal of reducing as many feral pigs within the watershed as possible. Management measures that address fecal coliform pollution associated with illegal dumping of household trash and wild game carcasses are summarized in Table 11. Specific management ideas discussed during the public meetings to address these sources include an education and outreach campaign to distribute flyers to local deer processors and hardware stores, establishment of an educational campaign in local schools, and the development of a litter and illegal dumping enforcement program in partnership with the local sheriff's office that uses cameras and signage. Further, the Burke County Sheriff's Department has established an Adopt-a-Road litter prevention initiative, which enables residents of the County to participate in removal of trash and illegal signage along the county roads. Information about this program can be found at: http://www.burkecountysheriff.com/clean-beautiful.cfm.

5.3 Urban Management Measures

Potential BMPs and low impact development management measures that address stormwater runoff associated with urban land, maintenance and repairs for on-site wastewater systems, illicit discharges, and leaking sanitary sewer systems are also summarized in Table 11. Management measures in Table 11 were selected to address fecal coliform, sediment, and nutrient loading within the Brushy Creek watershed.

5.4 Agricultural Management Measures

Table 12 summarizes the possible agricultural NPS management measures to be implemented in order to achieve fecal coliform reductions discussed in Section 4.0 above. Proposed BMPs listed in Table 12 are targeted toward the protection or establishment of riparian buffers, stormwater management strategies, and controlling agricultural runoff

associated with row crops and small-scale livestock operations. Management measures were also selected to address additional pollutants such as sediment and nutrients.

5.5 Unpaved Roads Management Measures

The Georgia Better Back Roads Program is a collaboration of several agencies which published the *Georgia Better Back Roads Field Manual* (Manual) (2009). As discussed in the public meetings, specific strategies included in this Manual and listed in Table 13 should be utilized by the Burke and Jefferson Counties and City of Wrens Road Departments. BMPs from the Manual should be adopted in order to achieve a reduction in runoff associated with erosion and sedimentation from unpaved roads in the Brushy Creek watershed.

Table 13 summarizes the possible unpaved roads NPS management measures that could be implemented in order to achieve fecal, sediment, and nutrient reductions discussed in Section 4.0 above. Proposed management measures should be targeted towards the protection of sensitive areas such as wetlands and streams through the elimination of discharging runoff into sensitive areas, the elimination of concentrated flow along roads and roadside ditches, erosion and sediment control, dust control, and the adoption of proper maintenance and management practices that protect sensitive areas with the watershed.

In addition to the Manual, other resources for the management and maintenance of unpaved roads include the Georgia Department of Transportation (GA DOT), Georgia Forestry Commission (GFC), GSWCC, GA EPD, NRCS, and the US EPA. Specific references include the GA DOT listing of qualified products and materials, GFC BMP Manual, GSWCC Field Manual for Erosion and Sediment Control in Georgia and manual for BMPs for Georgia Agriculture, US EPA Environmentally Sensitive Maintenance for Dirt and Gravel Roads, and US EPA Gravel Roads: Maintenance and Design Manual.

6.0 FINANCIAL AND TECHNICAL ASSISSTANCE

6.1 Associated Costs

Costs associated with each proposed task that must be implemented to make the WMP a success were estimated (Table 14). For each identified task, the personnel, planning, time for implementation, operation, maintenance, and equipment costs is included in the total costs. Additionally, the party responsible for implementation of each task and proposed funding source has been identified. Several authorities, organizations, and individual producers will be relied upon for successful implementation of the Brushy Creek WMP, which are identified below.

Potential Authorities or Organizations for WMP implementation	
GSWCC	Georgia College and State University
NRCS	UGA Sustainable Agriculture, Crop Production, and Animal Waste
GA EPD	Burke and Jefferson County Board of Commissioners
US FWS	Warnell School of Forestry and Natural Resources
GFC	Burke and Jefferson County Extension Office
Brier Creek SWCD	Individual Producers and Landowners
City of Wrens	Burke and Jefferson County Roads Department
Watershed Stakeholders	Burke and Jefferson County Health Departments (On-site Wastewater Divisions)

Table 14. Approximate Costs for Implementation of WMP.

Objective 1			
Primary: Reduce fecal coliform, sediment, and nutrient loads associated with illegal dumping, feral hogs, agricultural and urban land, and unpaved roads.			
Secondary: Reduce fecal coliform, sediment, and nutrients load associated with failing septic systems, livestock, illicit discharges, and leaking sanitary sewer system within the City of Wrens.			
Tasks	**Responsible Party**	**Cost**	**Funding**
Identify agricultural producers within the watershed	USDA Farm Service Agency	$0	319(h) Grant
Identify other landowners/areas for BMP implementation	Watershed Stakeholders	$0	
Contact producers/landowners for participation in cost-share program	GSWCC	$2,500	
Identify unpaved roads for implementation of BMPs	Jefferson and Burke Counties	$0[1]	
Implementation of Agricultural and Urban BMPs	GSWCC, NRCS, Counties, City of Wrens, Stakeholders	--	
Structural		$115,000	
Non-structural		$16,500	
Implementation of Unpaved Road BMPs	GSWCC, Counties	$60,000	
Implementation of Wildlife Control BMPs (four traps) and custodians	US FWS, Brier Creek SWCD	$20,000	
Stream walks and inventory of illicit discharges	Watershed Volunteers	$0[1]	
Implementation of septic system maintenance and repairs program	GSWCC, Health Departments	$10,000	
	Subtotal	**$224,000**	
Objective 2			
Information and Education Component			
Tasks	**Responsible Party**	**Cost**	**Funding**
Advertising, news articles, public notices, and public meetings	Advisory Committee, Stakeholders, GSWCC, Brier Creek SWCD, County, City of Wrens	$1,500	319(h) Grant, US EPA Environmental Education (EE) Grant, US EPA Surface Water Grant and Loan Programs, US FWS Grants, NRCS EQIP, Georgia Environmental Finance Authority (GEFA), Clean Water State Revolving Fund, Southeastern Regional Water Quality Assistance Network, Catalog for Federal Funding
Educational brochures, quarterly fact sheets, direct mailings, fliers		$600	
Watershed signage		$3,000	
Website development and maintenance		$5,500	
Farm Assessment	GSWCC, NRCS	$0[1]	
Nutrient Management Plans		$5,000	
Promotional materials for conservation agricultural programs and practices	GSWCC, NRCS, County	$600	
Meetings and trainings for producers	GSWCC, Brier Creek SWCD, County, Local AAS	$800	
	Subtotal	**$17,000**	

Table 14. Approximate Costs for Implementation of WMP. (continued)

Objective 3			
Long-term Monitoring to measure success of project			
Tasks	**Responsible Party**	**Cost**	**Funding**
Conduct AAS monitoring (*in-situ* water quality analysis)	Local AAS, GSWCC, County, Volunteers, Advisory Committee, Stakeholders	$9,000[2]	319(h) Grant, US EPA Environmental Education (EE) Grant, US EPA Surface Water Grant and Loan Programs, US FWS Grants, GEFA, Clean Water State Revolving Fund, Southeastern Regional Water Quality Assistance Network, Catalog for Federal Funding
Secure funding for future long-term monitoring	Brier Creek SWCD	$0[2]	
Contract consultant to conduct long-term monitoring (annually)	Brier Creek SWCD	$22,000	
Post BMP monitoring	NRCS, County, Brier Creek SWCD, volunteers	$5,000	
	Subtotal	**$36,000**	
	Project Total	**$277,000**	

[1]No cost is associated with task due to the use of in-kind hours
[2]Cost includes equipment (turbidity meter and water quality meter)

7.0 INFORMATION AND EDUCATION

An integral part of a WMP is to gather public support, promote the WMP, and educate the citizens of the Brushy Creek watershed about the importance of water quality. Many of the recommended management measures require volunteer hours and public participation and increasing the public's understanding of the WMP which is important to the success and implementation of the plan. Providing adequate education, outreach, and awareness of how land management practices influence NPS loading of sediment, nutrients, and bacteria to surface water resources may then motivate changes in behavior.

Specifically, the education and outreach components should be designed to teach producers and other stakeholders about the pollution issues facing the Brushy Creek watershed. The goal of the education and outreach component is to bring attention to what impact each individual's land use and management decisions will have on water quality in the Brushy Creek watershed, how they can address those impacts, and what opportunities and innovative solutions exist. The table below summarizes outreach and education activities recommended for the Brushy Creek watershed.

Tasks	Actions
Gather public support and participation, Promote WMP, Public Education	Work with local media through advertising, publishing news articles and public notices, and continue to conduct public meetings
	Educational brochures, quarterly fact sheets, direct mailings, fliers
	Develop watershed signage to promote activities in the watershed
	Develop a website
	Develop a local Adopt-a-stream program
Educate Producers	GSWCC Farm Assessment
	Nutrient Management Plans
	Promotional materials for reduced tillage systems, cover crops, crop rotations, and biological controls
	Conduct meetings and trainings

Advertising through published articles or notices and educational brochures such as quarterly fact sheets, direct mailings, or fliers (public educational materials) should contain information on the project, challenges, proposed solutions, and project updates. The public education materials can also contain information about water quality, the effects of NPS pollution on water quality, and the importance of BMPs for the protection of water quality.

Watershed signage can include watershed boundary signs, information about illegal dumping, proper disposal of wildlife carcasses, yard signs, or recognition of watershed improvements. Yard signs can promote individual property owners and recognize conservation practices that have been implemented. Recognition can be given to landowners or others through signs that display "Stream-Friendly Farm", "River-Friendly Farm", or "Roads Improvement Project funded by the Brushy Creek WMP".

A project website can also be developed and maintained by a webpage designer, which promotes the project, provides quarterly updates, and recognizes agricultural producers and volunteers. As discussed in the public meetings, the Advisory Committee and Stakeholder Group can also establish a local adopt-a-stream (AAS) group. The goals of the AAS program are to increase public awareness of NPS pollution, provide citizens with tools and training to evaluate, monitor, and protect their local waterways, to encourage partnerships between local stakeholders, citizens, and local governments, and to collect water quality data. The AAS group could select streams to adopt within the Brushy Creek watershed, conduct an outreach event, conduct AAS monitoring, and attend AAS workshops. The level of AAS participation and involvement can be determined by the Advisory Committee and Stakeholder Group and volunteer interest. More information concerning the AAS program and contact information for the program coordinator can be found at www.GeorgiaAdoptAStream.org.

To educate producers, promotional materials can be distributed, or meeting and trainings can be conducted about sustainable agricultural practices, agricultural BMP implementation and maintenance, land owner recognition, and the progress of the WMP. Other education and outreach activities that specifically target producers include the GSWCC Farm Assessment. The Farm Assessment is a voluntary program, which is a multi-phased nutrient planning initiative available to farmers. Updates can be made to existing nutrient management plans or new plans can be established. Other incentives of the Farm Assessment include record keeping protocols, identification of areas within each farm for improvements for the protection of natural resources, and the assistance in identifying potential funding sources to complete improvements based on the assessment.

8.0 IMPLEMENTATION SCHEDULE

Table 15 presents the proposed approach for implementing the Brushy Creek WMP. The implementation schedule is meant to serve as a reference tool to recognize tasks that are scheduled immediately following plan approval in the upcoming year. The proposed schedule is also dependent on funding, producer and County participation, and public support. The schedule should be adaptable and updated on a regular basis due to shifting priorities, new opportunities, and expected delays.

Table 15. Proposed Implementation Schedule for the WMP.

Activity	2018			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
	Oct	Nov	Dec										
Secure funding to implement the WMP													
Identify agricultural Producers and other interest parties within the watershed													
Contact producers for participation in cost-share program													
Identify unpaved roads for implementation of BMPs													
Implementation of agricultural BMPs													
Implementation of urban and residential BMPs													
Implementation of unpaved roads BMPs													
Implementation of feral hog BMPs													
Post BMP inspections													
Education, Outreach, and Public Information Components													
Establish Adopt-a-stream (AAS) Program													
Conduct AAS monitoring													
Secure funding for long-term monitoring													
Conduct Post-Construction BMP Monitoring													
Conduct Long-term monitoring for delisting													
Review WMP and make changes as needed													

Monthly
First Six Months
Quarterly
Annually

9.0 INTERIM MILESTONES, SUCCESS CRITERIA, AND LONG-TERM MONITORING

9.1 Milestones and Success Criteria

The WMP was written to cover a 10-year time period. Interim milestones and measures of success of the plan are broken down into three phases: short-term, mid-term, and long-term. A summary of each interim milestone and success criteria for each phase of the WMP is included within Table 16.

Table 16. Interim milestones for the short-term, mid-term, and long-term phases of the WMP.

Phase	Time after Implementation	Milestones	Measure of Success
Short-term	3 months to 1 year	Secure funding for implementation of the WMP, Participation and partnerships with landowners, producers, volunteers, & County Road Departments	90% involvement of stakeholders and advisory committee
			Public attendance and participation in public meetings
			Distribution of flyers or installation of signage or kiosk
			Establishment of AAS program
			Development of cooperative partnerships
			40 man hours per volunteer per year
			In-kind donation of County equipment, man hours, and resources
	Within 1 year to 2 years	Initiation and implementation of management measures from WMP	90% of recommendations implemented according to schedule
			Implementation of management measures on approximately 25 linear miles of unpaved roads
			Implementation of agricultural, urban, and residential management measures for approximately 2,000 acres
			In-kind donation of County equipment, man hours, and resources
			Implementation of wildlife control BMPs on 6 properties
			Conduct stream walks and determine need to illicit discharge elimination system
			Initiate outreach and education campaign about proper septic system maintenance and repair
	2 years to 3 years	Post BMP Success Monitoring	Examine for vegetation establishment and success
			Examine for effectiveness for stormwater control, proper maintenance, or need for reinstallation
			Establish tracking system to monitoring success over wildlife control
			Establish recording keeping system with local County health departments to track septic maintenance and repairs
Mid term	3 years	20% reduction in fecal coliform loads	Measured by conducting fecal coliform monitoring
	3 to 6 years	Sustained landowner, producers, volunteers, and County involvement	Quarterly AAS monitoring events
			Continued support and donations from County and volunteers
			Continued public and stakeholder participation

Table 16. Interim milestones for the short-term, mid-term, and long-term phases of the WMP (continued).

Phase	Time after Implementation	Milestones	Measure of Success
Long-term	6 to 10 years	Sustained community involvement in water quality protection	Quarterly AAS monitoring events, continued public and stakeholder participation
	1 or 2 years to 10 years	Establish long-term monitoring program	Contract and hire consulting firm to conduct fecal coliform monitoring
			Conduct quarterly AAS events
			Reduction in fecal coliform, sediment, and nutrients
	10 years plus	45% reduction in fecal coliform for Brushy Creek	Measured by long-term monitoring and delisting of Brushy Creek

9.2 Long-term Monitoring

Water quality monitoring is an integral part of assessing the progress and success of the WMP. Long-term monitoring shall be conducted to determine the success of the implemented BMPs and to provide a basis for delisting of Brushy Creek. In order to meet the percent reduction loads in the TMDL, Brushy Creek requires a 45 percent reduction in fecal coliform loading. The sections below describe recommendations and needs for future monitoring for documenting the water quality improvements that occur due to the implementation of the WMP. Results of the long-term monitoring will also be an effective measure of determining the success of the WMP, or the need for future revisions.

9.2.1 BMP Success Monitoring

Post Construction BMP Inspections

It is anticipated that implementation of BMPs will assist in reducing fecal coliform, sediment, and nutrient loads within the Brushy Creek watershed. Post-construction inspections should occur immediately following installation of the structural BMPs and should include the examination of effectiveness for stormwater and pollution control, proper installation, design, installation, and maintenance of each BMP, and/or the need for additional stabilization measures. Following the post-construction inspections, success monitoring should be conducted quarterly for the first two years following implementation and on an annual basis thereafter. Success monitoring of installed BMPs should include examination for proper maintenance, vegetation establishment and success, presence of erosion rills or gullies, or the need for

reinstallation or additional measures. A tracking program should be established to monitor the success of the wildlife control measures throughout the watershed.

For non-structural BMPs, watershed "windshield surveys" should be conducted to determine the effectiveness of the signage or other litter control and dumping and illegal dumping management measures. Additional stream walks should be conducted to survey the success of elimination programs for illicit discharges and records should be kept to track the success outreach campaign for septic system maintenance and repairs. The parties responsible for conducting post-BMP monitoring, associated costs, and potential funding sources are summarized in Table 13.

Post Construction BMP Fecal Coliform Monitoring

Analyses should include laboratory determination of fecal coliform concentration and should be conducted quarterly following the implementation of management measures. Monitoring should be conducted in accordance with the *Quality Assurance (QA) and Quality Control (QC) Targeted Monitoring Plan* (Plan) for fecal coliform sampling (Nutter & Associates, January 2018), GA EPD Watershed Protection Branch *Quality Assurance Manual* (2005b), and *Title 40* of the *Code of Federal Regulations*, *Part 136*. At a minimum, monitoring should be conducted at the seven monitoring stations sampled during the summer assessment (Appendix B).

In accordance with GA Water Quality Standards, a minimum of four individual samples per station will be collected per quarter to calculate a geometric mean in accordance with the proposed schedule in Table 17. Fecal coliform samples should be collected on a regular schedule on the same day of the week over a four-week period (i.e., every Monday for four weeks) regardless of weather. *In-situ* water quality measurements, including air and water temperature (°C), dissolved oxygen (percent saturation and mg/L), pH (standard units), specific conductance (µS/cm), and turbidity (NTUs) will be conducted in conjunction with each bacteriological grab sample event. Data collected following BMP implementation will be compared to data collected prior to implementation of BMPs and during the baseline monitoring to determine if a reduction in fecal coliform has occurred.

Table 17. Sampling schedule for the Brushy Creek fecal coliform baseline analysis.

	Sample Events			
	Feb	May	Aug	Nov
Fecal Coliform Long-term Monitoring				
In-Situ Water Quality Analysis	✓	✓	✓	✓
Fecal Coliform Geometric Mean (4 individual events for four geomeans on an annual basis)	✓	✓	✓	✓

9.2.2 Long-term Monitoring Plan for Delisting

To determine if fecal coliform load reductions are being achieved over time and substantial progress is being made towards the ultimate goal of delisting Brushy Creek, a fecal coliform long-term monitoring plan has been developed as a means to evaluate the success of the WMP. Long-term success monitoring shall be collected and submitted in accordance with the quality assurance/quality control requirements described in GA EPD's *Guidance on Submitting Water*

Quality Data for use by the Georgia Environmental Protection Division in 305(b)/303(d) Listing Assessments (October 2002) and the GA EPD's *Water Protection Branch Quality Assurance Manual* (June 1999, revised January 2005). Samples should be collected at the same site used to previously list Brushy Creek (Brushy Creek at Campground Road or Station BC03). Brushy Creek could be delisted if the calculated fecal coliform geometric means collected during the long-term monitoring are below the water quality standard. The table below summarizes the minimum sample requirements for fecal coliform monitoring in order to delist Brushy Creek and the GA water quality standard.

Pollutant	Summary of Water Quality Standards	Required Number of Samples
Fecal Coliform	Geomean 1,000 MPN/100mL (Nov to April) or Geomean 200 MPN/100mL (May to Oct)	16 samples per site (4 samples collected within 30-day period during each of 4 calendar quarters to calculate 4 geometric means[1])

[1]30-day sampling period must not overlap the months of April to May or October to November

Adopt-a-Stream Monitoring

If enough volunteer interest is shown, a community or watershed AAS program can be organized by the stakeholder group, City of Wrens, Burke or Jefferson Counties, or other local agency. An AAS monitoring program would be an effective tool in monitoring the implementation of the WMP, establishing local partnerships, and increasing community involvement and education about NPS pollution. Training workshops can be scheduled to train local officials and volunteers on the proper procedures for collecting chemical and biological water quality data.

10.0 FUTURE REVISIONS AND PLAN SUCCESS

Periodic reviews should be conducted by the Advisory Committee and Stakeholder Group of the implementation schedule, accomplishments, and monitoring results to determine whether or not the goals of the WMP are being met. The WMP is a "living" document, meaning that the goals and objectives contained within can be modified, strengthened, and/or removed based upon water quality monitoring results and the needs of the stakeholders in the watershed. For long term success of the plan, it is recommended that the WMP be reviewed and evaluated on an annual basis to determine if milestones and associated success criteria are being accomplished. Revisions to the WMP should be made following the annual review process. It is expected that with implementation of BMPs that control the input of fecal coliform bacteria and other pollution such as sediment and nutrients, that the watershed will contribute a lower pollutant loading rate and allow for the achievement of the long-term goal of delisting Brushy Creek.

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APPENDIX A

Watershed Reconnaissance and Background Analysis Report

Brushy Creek watershed reconnaissance and GIS background analysis

A windshield survey of the watershed was conducted on November 29, 2017. The purpose of the survey was to verify watershed land use data, identify problem areas or "hot spots" for fecal coliform pollution within the watershed, and determine suitable monitoring stations for the baseline fecal coliform monitoring. Figure 1 presents the location of the Brushy Creek watershed and surrounding vicinity and Figure 2 shows the 2011 land use coverage.

As part of the visual assessment, land use data (Figure 2) was verified in the watershed and any potential sources of fecal coliform pollution were notated with GPS coordinates. Additionally, a visual inspection was conducted at approximately 15 potential monitoring locations within the Brushy Creek watershed. The locations of the 15 monitor stations that were evaluated are presented in Figure 3 and summarized in Table 1.

Table 1. Location of potential monitoring stations that were evaluated for fecal coliform monitoring during the visual survey of the Brushy Creek watershed.

Station Name	**Location (DD)**		**Suitable Station[1]**
	Latitude	Longitude	
Brushy Creek at Hwy 88	33.209264	-82.397629	Yes
Brushy Creek at Zebina Rd	33.183205	-82.358694	Yes
Haden Branch at Zebina Rd	33.191656	-82.366377	Yes
Pilcher Lake at Hwy 80	33.194547	-82.343922	Yes
Brushy Creek at Campground Road	33.180402	-82.334195	Yes
Brushy Creek at Hwy 80	33.177001	-82.305628	Yes
Unnamed Tributary at Owens Mill Rd	33.179089	-82.307201	Yes
Unnamed Tributary at Pecan Place Rd	33.193067	-82.315573	No
Brushy Creek at Brushy Creek Rd	33.179757	-82.257151	Yes
Unnamed Tributary at Hwy 80	33.173897	-82.294188	Yes
Little Brushy Creek at Butler Mill Rd	33.187103	-82.225733	Yes
Brushy Creek at Hwy 305	33.192088	-82.221134	Yes
Brushy Creek at Key-Boggs Academy Rd	33.189104	-82.188053	Yes
Unnamed Tributary at Hwy 305	33.197267	-82.221412	No
Unnamed Tributary[2]	33.187373	-82.29351	No

[1]Suitability of monitoring stations for fecal coliform analysis was based on surrounding land use, potential pollution sources, and site accessibility

[2]No public access at this monitoring location

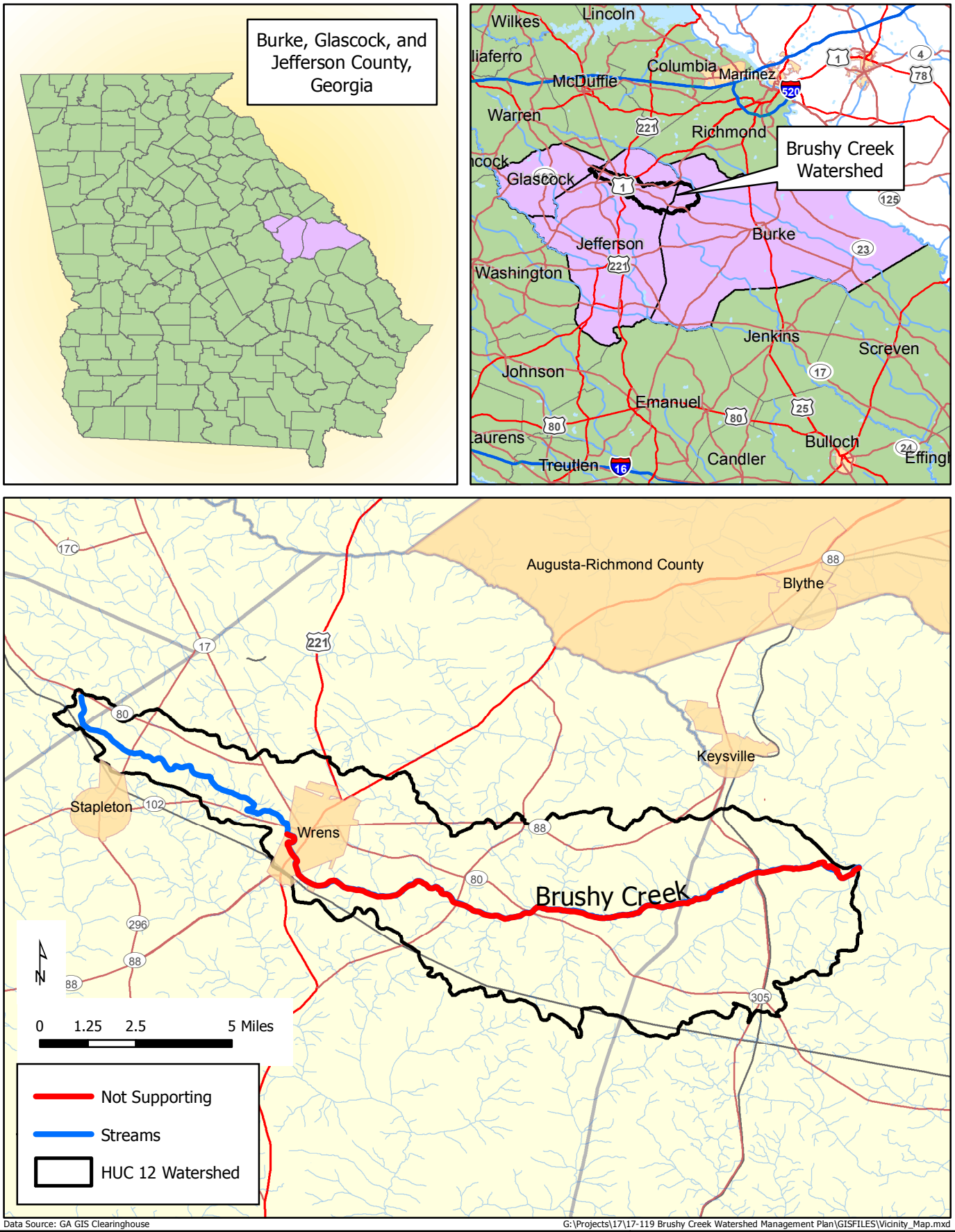

Figure 1. Brushy Creek and vicinity.

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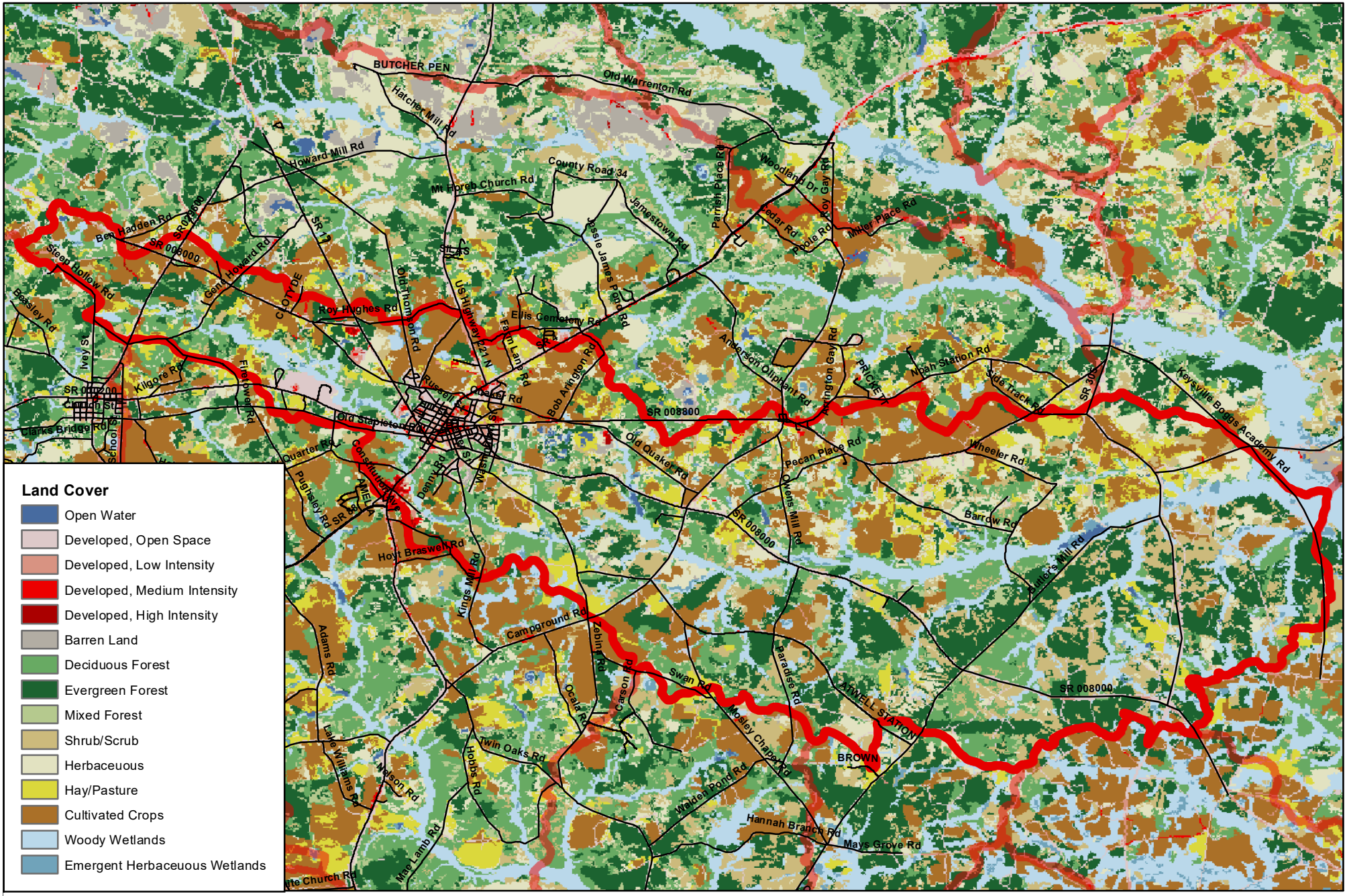

Figure 2. Land use data for the Brushy Creek watershed

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Photo documentation of the visual assessment is included in the plates section below. In conclusion, the land use data presented in Figure 2 was verified to be accurate and two potential "hot spots" were identified during the visual assessment. The coordinates of the two potential sources of fecal coliform pollution are summarized in the table below. In addition to the two potential sources below, multiple decomposing deer carcasses were observed within and adjacent to Brushy Creek.

Location (DD)		Land Use	Details
33.16918	-82.3369	Agricultural	Large scale livestock operation
33.20726	-82.3498	Industrial	Georgia Web, Inc.

Proposed Fecal Coliform Monitoring

Following the visual assessment, we propose to conduct the baseline fecal coliform analysis at twelve (12) monitoring stations. Details of the proposed baseline fecal coliform monitoring will be detailed in the draft Targeted Monitoring Plan. Based on the location of the proposed monitoring stations and the results of the monitoring, other potential sources of pollution could be identified during the baseline fecal coliform study and based on public input during future project meetings.

Collection of Background Information and GIS Desktop Analysis

A collection of background information and GIS desktop analysis for the Brushy Creek watershed has been completed. Background information collected includes:

1. Historic land use and land cover;
2. Aerial delineation of problem areas;
3. Buffer inventories;
4. Historic water quality data;
5. Evaluation of TMDL;
6. Identification of possible data gaps based on current land usage; and,
7. Determination of potential causes and sources of pollutants.

Further, as part of the development of the WMP and background data analysis, we will coordinate with the GSWCC and agencies in Burke, Jefferson, and Glascock Counties to determine agricultural extension information (number of livestock, agricultural tillage practices, etc.). Land use data for the Brushy Creek watershed is presented in Figure 2.

Other Potential Water Quality Stressors

As part of the GIS analysis, Nutter & Associates (NAI) searched Georgia Department of Natural Resources, GA EPD and U.S. Environmental Protection Agency (US EPA) databases to identify landfills, RCRA sites, hazardous waste (CERCLIS) facilities, wastewater treatment plants, land application sites and other regulated facilities that could be potential water quality stressors within the Brushy Creek watershed (Figure 3). Land use data (Figure 2) was used to identify any industrial areas located within the watershed. A summary of the potential stressors is included below:

- One wastewater pollution control plant (WPCP), the City of Wrens WPCP, with a National Pollutant Discharge Elimination System (NPDES) permit exists in the northernmost portion of the watershed and at the top of the 305(b)/303(d) listed reach. The facility is located at 415 Walker Street (NPDES GA0021857) and discharges to Brushy Creek. Notices for noncompliance were issued for the facility in February and December 2017, respectively, for flow exceedances. No fecal coliform violations have been reported for the facility.

- No Phase I municipal separate storm sewer system (MS4) or industrial stormwater discharge permits have been issued to facilities within the Brushy Creek watershed.

- No solid waste disposal facilities were identified in the watershed. However, one industrial landfill, the Wren's Industrial Landfill, currently operates in the Brushy Creek watershed. The facility is located along Industrial Street in the City of Wrens.

- No Land Application Sites (LAS) are in use or known to be located within the Brushy Creek watershed.

- Two Concentrated Animal Feed Operations (CAFOs) are known to be located within Burke County. To determine if these CAFOs are located within the Brushy Creek watershed, we have reached out the Burke County Agricultural Extension Office and will include this information in future status reports.

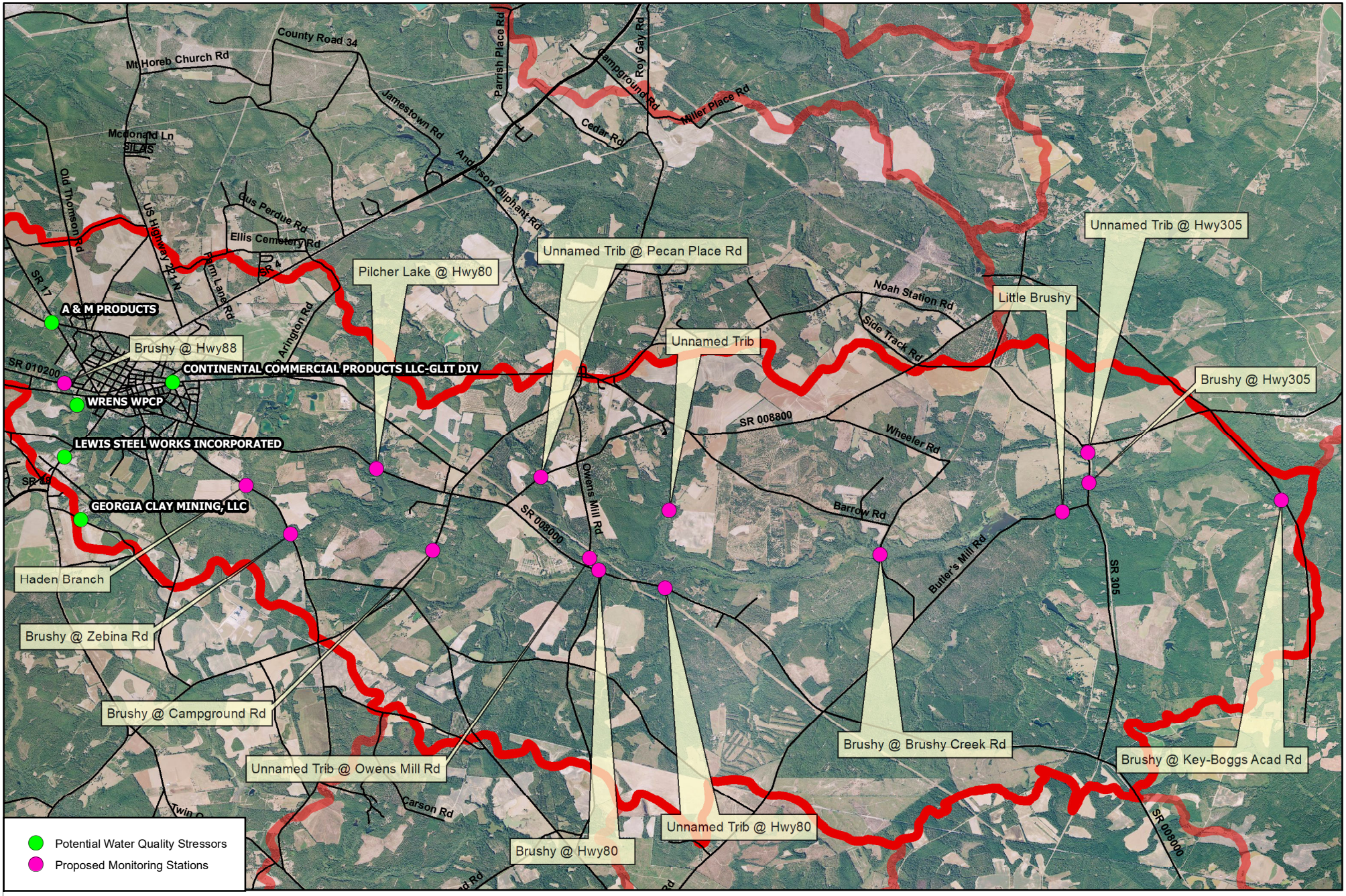

Figure 3. Proposed monitoring stations and potential water quality stressors for the Brushy Creek watershed reconnaissance.

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The EPD Hazardous Site Inventory website, www.gaepd.org/Documents/hazsiteinv.html, was used to search for hazardous waste sites located within the Brushy Creek watershed. Further, the EPA Envirofacts website, www.epa.gov/emefdata/em4ef.home, was used to search Aerometric Information Retrieval System/AIRS Facility Subsystem (AIRS/AFS), Toxic Release Inventory System (TRI), Toxic Substances Control Act (TSCA), Section Seven Tracking System (SSTS), Permit Compliance System (PCS), Integrated Compliance Information System (ICIS), National Emission Inventory (NEI), Hazardous Site Inventory (HSI), and Geographic Information Management System (GEIMS) databases to identify small quantity generators and potential polluters in the service area. While four sites have been identified, they do not likely attribute to fecal coliform pollution within the Brushy Creek watershed. The following information was obtained and the locations of the noted facilities are presented in Figure 3.

- The former Georgia Clay Mining site (GA EPD HSI ID# 10245), is a former clay mining facility located on Industrial Street in Wrens, Jefferson County, Georgia. This site has a known release of Vinyl Chloride at levels exceeding the reportable quantity. Cleanup activities are being conducted for source materials, soil, and groundwater. The nearest drinking water well is less than 0.5 miles from the area affected by the release.

- The Lewis Steel Works, Inc. (TRI 30833LWSSTUSHWY) is listed in the US EPA toxic release sites inventory, RCRA information system, and a GEIMS facility. The facility is a TRI reporter for emitting Xylene (mixed isomers) to the air and is listed on the RCRA system as a small quantity generator of an unspecified hazardous waste. The site also has an underground storage tank and as such is listed on the GEIMS. No compliance issues have been reported for the facility.

- Continental Commercial Products, LLC is listed as an AFS listed facility (FRS ID 110000765379) and is located at 809 Broad Street, Wrens, Ga. The facility produces coated fabrics and is also listed as an RCRA small quantity hazardous waste generator and TRI facility. No violations have been reported for the facility.

- A & M Products is located at 1560 Old Quaker Road in Wrens, GA and is listed as an AFS facility (1316300025) for air emissions associated with treated and ground minerals. No violations have been reported for the facility.

PLATES

View upstream of Brushy Creek at Highway 88.

View downstream of Brushy Creek at Highway 88.

View upstream of Brushy Creek at Zebina Road.

View of deer carcass in Brushy Creek at Zebina Road.

View downstream of Brushy Creek at Zebina Road.

View upstream of Hayden Branch at Zebina Road.

View downstream of Haden Branch at Zebina Road.

View upstream of Pilcher Lake at Highway 80.

View downstream of Pilcher Lake at Highway 80.

View of USGS gauge on Brushy Creek at Campground Road.

View upstream of Brushy Creek at Campground Road.

View downstream of Brushy Creek at Campground Road.

View upstream of Brushy Creek at Highway 80.

View downstream of Brushy Creek at Highway 80.

View upstream of unnamed Tributary to Brushy Creek at Owens Mill.

View downstream of unnamed tributary to Brushy Creek at Owens Mill.

View of deer carcass in unnamed tributary at Owens Mill.

View upstream of unnamed tributary to Brushy Creek at Pecan Place.

View downstream of unnamed tributary at Pecan Place.

View upstream of Brushy Creek at Brushy Creek Road.

View downstream of Brushy Creek at Brushy Creek Road.

View upstream of unnamed tributary at Highway 80.

View downstream of unnamed tributary at Highway 80.

View upstream of Little Brushy Creek at Butler Mill.

View downstream of Little Brushy Creek at Butler Mill.

View of trash along Brushy Creek at Highway 305.

View of trash at Highway 305.

View upstream of Brushy Creek at Highway 305.

View downstream of Brushy Creek at Highway 305.

View upstream of Brushy Creek at Key-Boggs Academy Road.

View downstream of Brushy Creek at Key-Boggs Academy Road.

View upstream of dry unnamed tributary to Brushy Creek at Highway 305.

View downstream of dry unnamed tributary to Brushy Creek at Highway 305.

APPENDIX B

Baseline Fecal Coliform and Nutrient Assessment Report

Nutter & Associates
environmental consultants

360 Hawthorne Lane
Athens, GA 30606-2152
P (706) 354-7925
F (706) 354-7928
www.NutterInc.com

Brushy Creek
Watershed Management Plan Baseline Fecal Coliform Monitoring

Methodology

In accordance with the Quality Assurance (QA) and Quality Control (QC) Targeted Monitoring Plan (Plan) for fecal coliform sampling (Nutter & Associates, January 2018), bacteriological density data for fecal coliform bacteria was collected as a geometric mean based on at least four samples collected within a 30-day period at intervals not less than 24 hours. For the baseline assessment, one geometric mean per quarter (winter, spring, and summer) was conducted, for a total of three discrete geometric means, in accordance with the schedule in Table 1. *In-situ* water quality measurements, including air and water temperature (°C), dissolved oxygen (percent saturation and mg/L), pH (standard units), specific conductance (µS/cm), and turbidity (NTUs) were measured in conjunction with each bacteriological grab sample event. For the February (winter) and May (spring) events, fecal coliform water quality monitoring was conducted for the Brushy Creek watershed at 12 monitoring locations (Table 2; Figures 1 and 2). Based on the results from the first two rounds of sampling, the QA/QC Plan was modified for the summer (August) sampling event. Specifically, fecal coliform monitoring was only conducted at seven stations (BC01, HB01, BC03, UT01, UT02, LBC01, and BC07). In addition, during the summer event total nitrogen and phosphorus water quality samples were collected at stations UT01, UT02, and LBC01.

Table 1. Sampling schedule for the Brushy Creek fecal coliform baseline analysis.

	2018		
	Feb	May	Aug
Fecal Coliform Baseline Assessment			
In-Situ Water Quality Analysis	✓	✓	✓
Fecal Coliform Geometric Mean (4 individual events for two geomeans at 12 stations)	✓	✓	
Fecal Coliform Geometric Mean (4 individual events for one geomean at 7 stations)			✓
Nutrient Analysis (4 individual events at 3 stations)			✓

Table 2. Location of the fecal coliform water quality monitoring stations for the Brushy Creek Watershed Management Plan baseline line assessment.

Station Name	**Location (DD)**		**Station ID**
	Latitude	Longitude	
Brushy Creek at Hwy 88	33.209264	-82.397629	BC01
Brushy Creek at Zebina Rd	33.183205	-82.358694	BC02
Haden Branch at Zebina Rd	33.191656	-82.366377	HB01
Pilcher Lake at Hwy 80	33.194547	-82.343922	PL01
Brushy Creek at Campground Road	33.180402	-82.334195	BC03
Brushy Creek at Hwy 80	33.177001	-82.305628	BC04
Unnamed Tributary at Owens Mill Rd	33.179089	-82.307201	UT01
Unnamed Tributary at Hwy 80	33.173897	-82.294188	UT02
Brushy Creek at Brushy Creek Rd	33.179757	-82.257151	BC05
Little Brushy Creek at Butler Mill Rd	33.187103	-82.225733	LBC01
Brushy Creek at Hwy 305	33.192088	-82.221134	BC06
Brushy Creek at Key-Boggs Academy Rd	33.189104	-82.188053	BC07

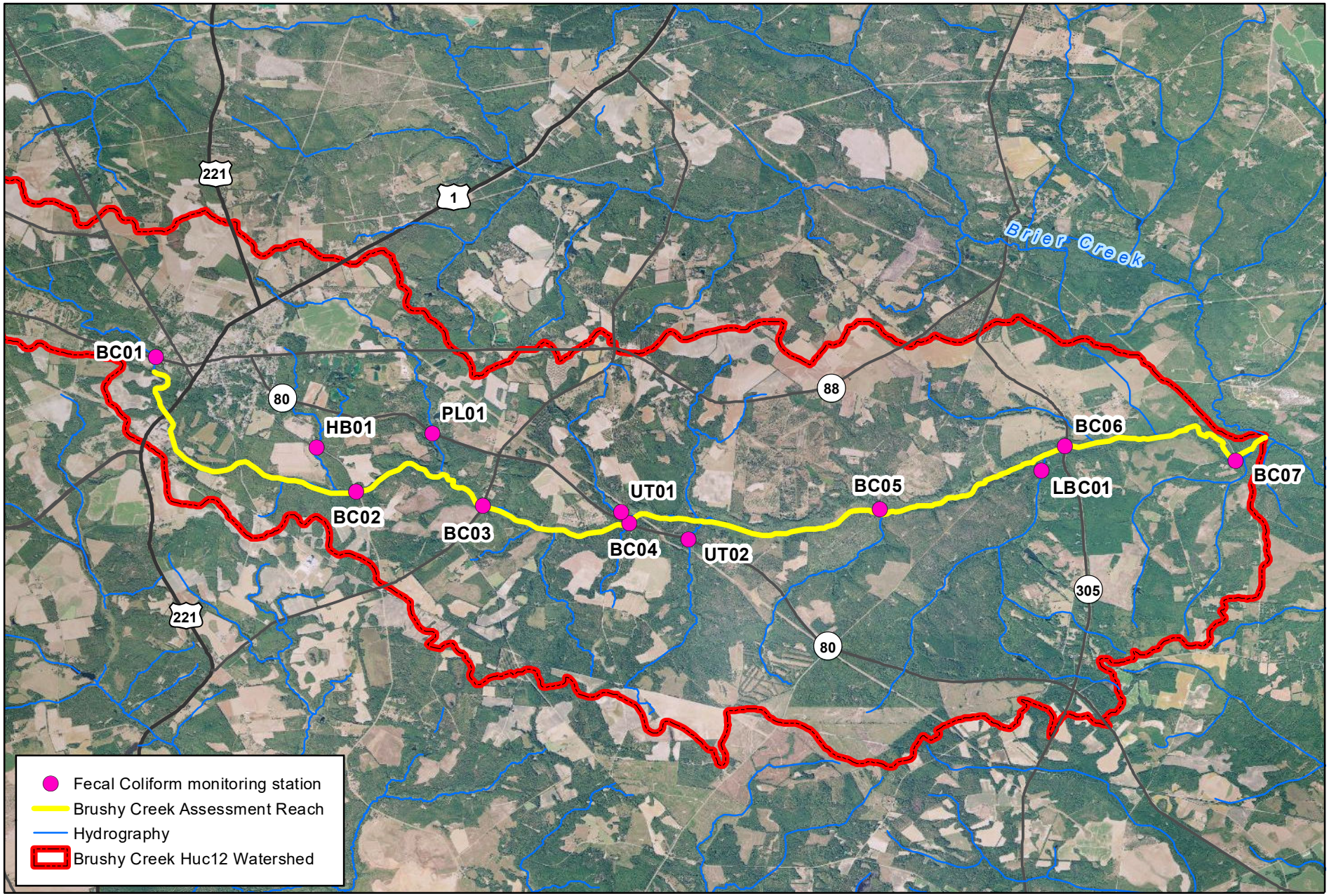

Figure 2. Baseline fecal coliform monitoring stations and 2015 aerial imagery, Brushy Creek Watershed Management Plan.

0 1 2 4 Miles

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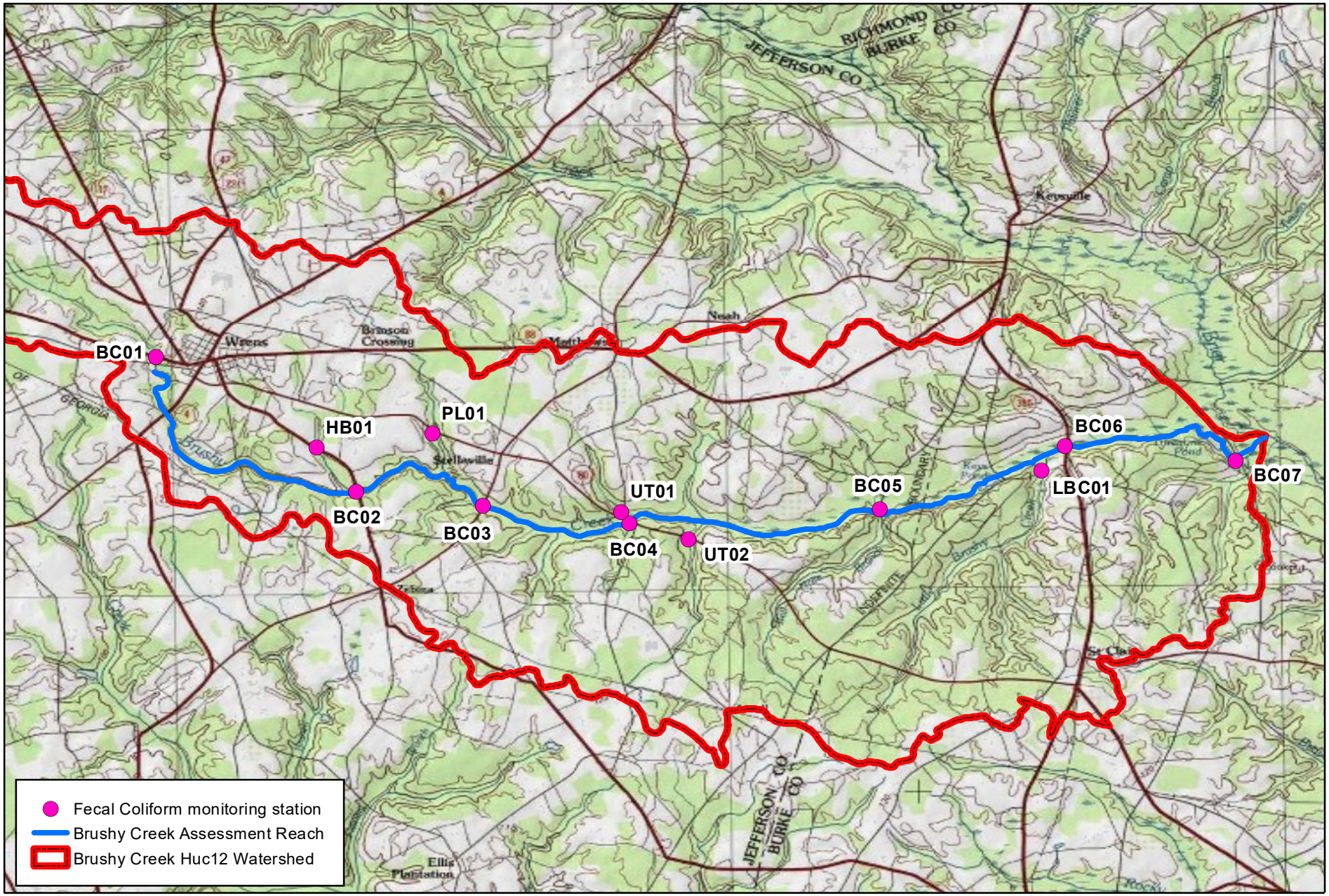

Data Source: USGS topographic quadrangle

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Figure 1. Baseline fecal coliform monitoring stations, Brushy Creek Watershed Management Plan.

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MONITORING RESULTS

The winter fecal coliform geometric mean for the baseline monitoring was calculated from four individual samples collected by Nutter & Associates, Inc. (NAI) personnel between February 6 and March 1, 2018; the spring round was collected between May 1 and May 21, 2018; and the summer round between August 7 and August 28, 2018 (Table 3; Figure 3). The table below summarizes the Georgia Water Use Classification and water quality standards (Chapter 391-3-6-.03).

Parameter	**Units**	**Water Quality Standard**
Water Temperature	°C	32.2℃ (equivalent to 90℉)
pH	S.U.	Within the range 6.0 - 8.5
Dissolved Oxygen	mg/L & % saturation	A daily average of 5.0 mg/L; no less than 4.0 mg/l at all times
Specific Conductance	µS/cm	--
Turbidity	NTU	Refer to 391-3-6-.03(5)(d)
Fecal Coliform	mpn/ 100 ml	May-Oct: 200 mpn/100mL
		Nov-Apr: 1,000 mpn/100ml

Table 3. Results of the individual fecal coliform sampling events and calculated geometric mean determinations collected for the baseline assessment period of the Brushy Creek WMP during the winter, spring, and summer 2018 sampling events.

	Station	**Fecal Coliform (MPN/100mL)**				
Round		**2/6/2018**	**2/13/2018**	**2/20/2018**	**2/27/2018**	**Geomean**
Winter	BC01	<20	80	130	30	50
	HB01	230	170	300	100	185
	BC02	20	70	2,400	70	124
	BC03	110	20	170	190	92
	PL01	20	<20	<20	20	20
	UT01	300	300	170	130	211
	BC04	20	70	<20	50	34
	UT02	20	40	80	30	37
	BC05	70	70	210	140	110
	LBC01	500	80	80	170	153
	BC06	70	140	<20	30	49
	BC07	80	80	900	40	123

Table 3. Results of the individual fecal coliform sampling events and calculated geometric mean determinations collected during the baseline assessment period of the Brushy Creek WMP during the winter, spring, and summer 2018 sampling events (continued).

Round	Station	Fecal Coliform (MPN/100mL)				
		5/1/2018	**5/8/2018**	**5/15/2018**	**5/21/2018**	**Geomean**
Spring	BC01	130	700	80	70	150
	HB01	20	80	300	1,300	158
	BC02	40	500	130	220	155
	BC03	110	1,100	500	300	367
	PL01	<20	80	<20	<20	80
	UT01	500	1,400	800	130	519
	BC04	40	20	230	500	98
	UT02	230	70	170	1,100	234
	BC05	110	140	230	230	169
	LBC01	220	130	210	300	206
	BC06	20	<20	20	230	45
	BC07	<20	20	80	40	40
Summer		**8/7/2018**	**8/14/2018**	**8/21/2018**	**8/28/2018**	**Geomean**
	BC01	110	170	110	40	95
	HB01	230	110	170	2,400	319
	BC03	260	170	140	220	192
	UT01	300	700	300	170	322
	UT02	130	230	500	220	239
	LBC01	500	170	80	110	165
	BC07	20	40	130	170	65

During the winter geometric mean determination, all stations met the State of Georgia Water Use Classifications and Water Quality Standard (Chapter 391-3-6-03) of 1,000 MPN/100 mL for the months of November through April. Further, apart from station UT01, all stations met the stricter warm weather (May through October) Water Quality Standard of 200 MPN/100 mL. During the spring geometric mean determination, all stations met the State of Georgia Water Use Classifications and Water Quality Standard of 200 MPN/100 mL for the months of May through October excluding stations BC03, UT01, UT02, and LBC01. For the summer geometric mean determination, stations HB01, UT01, and UT02 exceeded the warm weather water quality standard of 200 MPN/100mL. Figure 3 presents the calculated geometric mean for fecal coliform for all three sample events for each station.

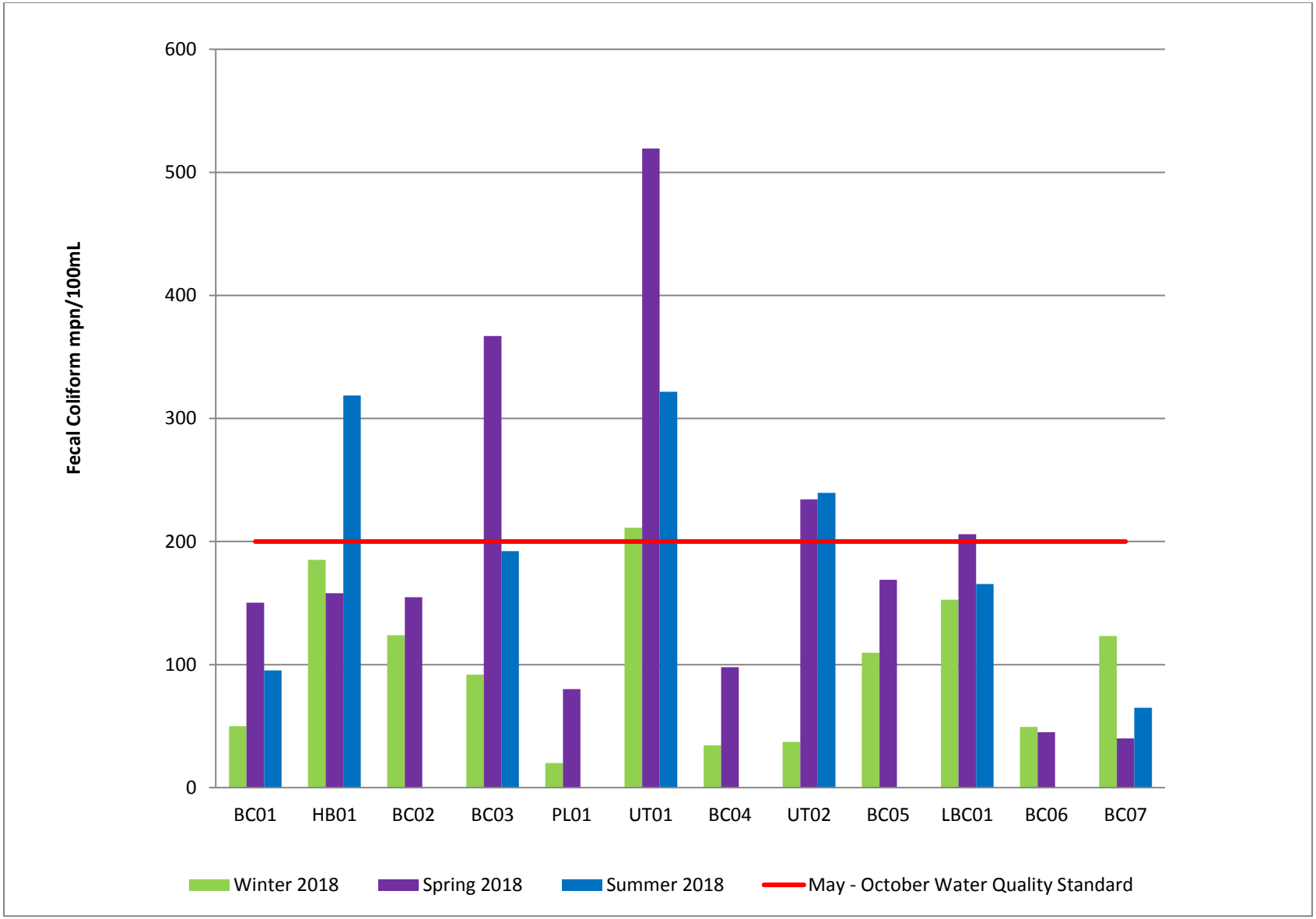

Figure 3. Calculated geometric mean concentrations for all stations during the winter, spring, and summer sampling events.

Table 4 presents the results of *in-situ* physiochemical monitoring during the fecal coliform baseline assessment. All physiochemical parameters including water temperature, pH, and dissolved oxygen (DO) were within ranges specified in GA Code 391-3-6-03 Water Use Classifications and water quality standards with few exceptions. Water quality exceedances occurred for pH during the baseline assessment at stations BC01, HB01, BC02, BC03, and UT01 (Table 4). However, the regulations recognize that certain natural waters of the State may have pH readings that are not within the 6.0 to 8.5 range. Low pH readings are characteristic of many streams in Georgia and these circumstances do not constitute violations of the Water Quality Standard. During the winter sampling, a water quality exceedance for DO was observed at station BC04 on February 20, 2018; however, all other DO readings were within acceptable range for all other stations during the winter sampling (Table 4). For the spring event, station HB01 had depressed DO on May 15, 2018 (Table 4). Low DO concentrations often correlate with low stream flow and high temperatures (i.e., critical conditions) and low flow conditions were observed at station HB01 during this event. Finally, dung the summer sampling water quality exceedances for DO were observed at stations BC01, HB01, and UT01 (Tables 4) when low stream flow and high air temperatures were observed. Generally, for all sampling events, the highest turbidity concentrations were associated with rainfall with the exception of station UT01. This station had elevated turbidity readings during the summer sampling events due to grading activities along the unpaved portions of Owens Mill Road. During dry weather conditions, sediment was observed being transported from unpaved portions of the road and into the stream. The State of Georgia does not publish water quality standards for specific conductivity, but the highest specific conductivity readings were observed at station BC01 on August 21, 2018 (193 µS/cm), station BC04 on February 20, 2018 (265 µS/cm), and on May 15, 2018 and August 28, 2018 at station LBC01 (124 and 125 µS/cm, respectively) (Table 4). All other physiochemical parameters were within acceptable range during all other sampling events.

Table 4. Results of the physiochemical water quality monitoring.

Station	Sampling Event Season	Date	Temperature		Sp. Cond.	Dissolved Oxygen		pH	Turbidity
			Water	Air					
			°C		µS/cm	mg/L	%	S.U.	NTU
BC01	Winter	2/6/2018	11.6	17.0	45	9.5	87.5	5.5	5.5
		2/13/2018	16.7	16.7	54	7.0	70.9	5.1	4.7
		2/20/2018	20.5	24.1	51	5.7	63.5	5.7	12.1
		3/1/2018	22.4	28.8	43	4.3	69.3	5.6	6.5
	Spring	5/1/2018	22.0	27.7	64	6.1	82.0	6.3	5.1
		5/8/2018	21.8	24.2	50	6.4	72.2	5.6	9.7
		5/15/2018	23.3	26.2	56	5.3	62.5	7.0	12.2
		5/21/2018	23.1	24.2	100	5.8	68.1	4.8	6.9
	Summer	8/7/2018	26.0	30.6	52	4.8	58.8	6.3	41.2
		8/14/2018	27.9	32.6	53	4.6	58.2	6.0	32.0
		8/21/2018	25.1	27.7	193	6.3	75.6	6.8	6.4
		8/28/2018	23.3	29.6	73	2.0	23.6	5.8	4.7
		AVERAGE	22.0	25.8	69	5.6	66.0	5.9	12.3

Table 4. Results of the physiochemical water quality monitoring (continued).

Station	Sampling Event Season	Date	Temperature		Sp. Cond	Dissolved Oxygen		pH	Turbidity
			Water	Air					
			°C		µS/cm	mg/L	%	S.U.	NTU
HB01	Winter	2/6/2018	11.4	18.7	42	9.2	81.1	5.7	16.3
		2/13/2018	13.7	16.5	54	7.8	74.0	5.7	18.1
		2/20/2018	18.9	25.0	54	6.7	71.1	5.9	9.3
		3/1/2018	20.3	29.0	52	10.0	112.8	5.9	7.6
	Spring	5/1/2018	20.3	30.2	37	6.3	68.8	6.6	9.7
		5/8/2018	21.3	28.4	40	6.0	67.5	5.6	5.7
		5/15/2018	23.2	27.3	39	3.8	42.0	6.7	6.5
		5/21/2018	22.3	28.7	38	5.1	57.1	7.3	24.1
	Summer	8/7/2018	24.3	31.7	46	5.5	65.3	6.2	22.2
		8/14/2018	28.1	32.5	47	4.0	52.2	6.1	10.8
		8/21/2018	25.2	29.6	45	4.8	58.7	6.9	7.9
		8/28/2018	23.3	29.1	42	3.8	44.8	5.8	11.6
	AVERAGE		21.0	27.2	45	6.1	66.3	6.2	12.5
BC02	Winter	2/6/2018	20.6	65.2	65	10.4	100.1	6.0	4.1
		2/13/2018	13.9	15.4	72	9.6	92.3	6.0	5.9
		2/20/2018	19.3	25.2	78	8.3	100.5	6.6	53.1
		3/1/2018	21.3	28.4	73	8.4	96.0	6.4	10.7
	Spring	5/1/2018	19.4	27.5	65	9.2	100.5	6.3	9.3
		5/8/2018	21.9	28.7	71	8.4	96.2	5.7	28.3
		5/15/2018	23.6	26.7	88	7.8	90.9	6.7	51.0
		5/21/2018	23.9	30.4	97	7.8	92.6	6.7	14.0
	AVERAGE		20.5	30.9	76.2	8.7	96.1	6.3	22.0
BC03	Winter	2/6/2018	12.4	21.9	60	10.4	97.8	6.6	6.3
		2/13/2018	13.9	15.5	65	9.8	93.8	6.2	8.6
		2/20/2018	19.4	25.6	71	9.3	100.3	6.8	8.8
		3/1/2018	20.1	28.7	54	8.1	90.3	6.5	9.8
	Spring	5/1/2018	18.9	28.1	59	9.8	105.4	6.5	5.1
		5/8/2018	22.0	29.5	63	8.2	93.5	6.0	6.0
		5/15/2018	21.5	26.4	74	7.5	85.6	6.8	7.2
		5/21/2018	22.2	31.8	59	7.5	85.6	6.9	13.5
	Summer	8/7/2018	26.3	31.7	73	7.7	95.2	6.1	26.9
		8/14/2018	26.6	31.1	71	7.7	95.8	6.7	12.9
		8/21/2018	25.6	30.9	70	7.5	91.5	7.0	8.6
		8/28/2018	22.5	28.0	74	7.7	88.6	5.9	8.6
	AVERAGE		20.9	27.4	66	8.4	93.6	6.5	10.2

Table 4. Results of the physiochemical water quality monitoring (continued).

Station	Sampling Event Season	Date	Temperature		Sp. Cond	Dissolved Oxygen		pH	Turbidity
			Water	Air					
			°C		µS/cm	mg/L	%	S.U.	NTU
PL01	Winter	2/6/2018	15.2	23.6	32	9.9	95.6	6.7	3.4
		2/13/2018	14.4	16.4	37	9.0	86.5	6.4	5.3
		2/20/2018	20.2	26.2	39	8.6	84.1	6.2	4.0
		3/1/2018	20.8	NM	34	10.0	114.1	6.6	4.8
	Spring	5/1/2018	22.6	28.8	36	9.6	111.2	6.6	3.8
		5/8/2018	23.2	29.7	40	8.4	100.7	6.1	14.3
		5/15/2018	25.2	26.9	40	8.0	98.0	6.9	5.0
		5/21/2018	25.8	32.7	40	8.4	103.8	6.9	9.0
	AVERAGE		20.9	26.3	37	9.0	99.2	6.5	6.2
UT01	Winter	2/6/2018	12.6	23.3	57	9.1	83.3	6.2	6.9
		2/13/2018	13.5	15.1	65	8.5	79.0	6.0	7.1
		2/20/2018	18.3	26.7	64	8.4	88.3	6.3	6.9
		3/1/2018	21.6	25.9	59	10.5	121.6	6.4	10.6
	Spring	5/1/2018	24.3	29.6	63	8.0	89.0	6.5	10.3
		5/8/2018	23.5	30.1	70	7.3	84.6	6.0	15.4
		5/15/2018	24.2	27.5	74	6.1	73.4	6.7	19.3
		5/21/2018	26.4	34.8	64	7.1	88.5	6.9	11.2
	Summer	8/7/2018	27.3	32.9	72	5.2	66.3	6.2	12.5
		8/14/2018	26.1	30.1	76	3.5	41.9	6.3	15.7
		8/21/2018	26.8	31.4	79	3.4	43.0	6.5	23.4
		8/28/2018	27.2	28.3	96	3.4	46.3	5.8	28.9
	AVERAGE		22.7	28.0	70	6.7	75.4	6.3	14.0
BC04	Winter	2/6/2018	15.7	24.3	51	8.1	72.9	6.5	6.1
		2/13/2018	13.1	16.1	64	6.8	61.6	6.3	9.0
		2/20/2018	19.8	26.3	265	3.2	33.0	6.7	4.5
		3/1/2018	20.8	NM	56	8.0	89.5	6.7	6.2
	Spring	5/1/2018	21.5	30.5	57	6.5	71.6	6.5	5.9
		5/8/2018	22.9	30.3	69	6.0	69.6	6.1	11.7
		5/15/2018	24.4	28.4	74	4.8	59.0	6.7	12.4
		5/21/2018	24.6	34.3	63	3.9	46.5	6.8	11.3
	AVERAGE		20.3	27.2	87	5.9	63.0	6.5	8.4

Table 4. Results of the physiochemical water quality monitoring (continued).

Station	Sampling Event Season	Date	Temperature		Sp. Cond	Dissolved Oxygen		pH	Turbidity
			Water	Air					
			°C		µS/cm	mg/L	%	S.U.	NTU
UT02	Winter	2/6/2018	15.5	23.9	31	NM	86.2	6.5	9.8
		2/13/2018	12.5	15.6	38	9.0	83.5	6.3	11.0
		2/20/2018	20.6	26.7	37	7.4	81.1	6.3	13.1
		3/1/2018	20.6	25.3	47	7.6	85.9	6.8	19.4
	Spring	5/1/2018	19.8	30.4	37	7.8	85.1	6.5	18.3
		5/8/2018	21.9	30.3	38	7.3	83.2	6.2	22.1
		5/15/2018	23.9	29.1	47	6.9	82.7	6.7	21.6
		5/21/2018	23.9	33.8	38	6.7	79.5	6.7	19.9
	Summer	8/7/2018	27.8	34.4	40	6.9	86.8	6.3	8.5
		8/14/2018	26.1	30.0	39	6.9	85.4	6.5	9.6
		8/21/2018	26.5	31.7	40	7.1	89.1	6.7	9.2
		8/28/2018	23.4	29.22	41	6.7	79.4	6.0	9.7
	AVERAGE		21.9	28.3	39	7.3	84.0	6.5	14.3
BC05	Winter	2/6/2018	19.4	25.4	49	9.9	102.6	6.4	4.0
		2/13/2018	13.2	16.0	59	9.3	87.5	6.4	5.5
		2/20/2018	21.9	27.5	63	7.9	89.0	6.5	7.2
		3/1/2018	21.1	25.9	60	8.0	91.4	6.7	9.5
	Spring	5/1/2018	19.9	30.7	56	8.0	87.7	6.5	23.3
		5/8/2018	23.1	30.8	60	7.1	82.8	6.4	20.2
		5/15/2018	23.7	29.3	64	6.4	75.5	6.6	19.4
		5/21/2018	25.2	34.3	59	6.4	78.4	6.7	15.2
	AVERAGE		20.9	27.5	59	7.9	86.9	6.5	13.0
LBC01	Winter	2/6/2018	14.5	25.7	74	10.2	95.3	6.7	10.1
		2/13/2018	13.0	16.1	87	9.7	92.5	6.5	12.0
		2/20/2018	20.9	27.3	97	8.6	95.6	6.9	17.5
		3/1/2018	21.3	26.0	83	8.0	91.8	6.6	12.1
	Spring	5/1/2018	19.9	29.7	87	8.8	95.8	6.5	21.6
		5/8/2018	22.3	31.3	104	8.3	94.5	6.3	22.5
		5/15/2018	23.5	29.0	124	7.5	88.5	6.7	22.0
		5/21/2018	25.8	36.0	78	7.6	93.3	6.8	22.0
	Summer	8/7/2018	27.8	37.5	92	7.4	93.7	6.2	13.2
		8/14/2018	26.0	27.6	99	7.5	92.4	7.0	13.0
		8/21/2018	27.2	32.0	111	7.1	88.6	7.1	13.9
		8/28/2018	24.6	32.5	125	7.5	87.1	6.2	18.4
	AVERAGE		22.2	29.2	97	8.2	92.4	6.6	16.5

Table 4. Results of the physiochemical water quality monitoring (continued).

Station	Sampling Event Season	Date	Temperature		Sp. Cond	Dissolved Oxygen		pH	Turbidity
			Water	Air					
			°C		µS/cm	mg/L	%	S.U.	NTU
BC06	Winter	2/6/2018	15.3	23.9	56	10.1	100.8	6.9	6.2
		2/13/2018	14.5	16.9	80	9.6	92.3	6.7	6.8
		2/20/2018	23.0	28.2	71	11.3	131.3	7.0	4.8
		3/1/2018	20.0	23.0	70	8.4	94.1	7.0	7.6
	Spring	5/1/2018	21.6	29.3	63	8.4	95.5	6.7	5.3
		5/8/2018	22.2	31.2	71	7.8	91.1	6.4	5.5
		5/15/2018	24.0	29.4	78	7.2	86.6	6.8	7.0
		5/21/2018	25.9	35.6	61	7.2	88.1	7.1	7.5
	AVERAGE		20.8	27.2	69	8.7	97.5	6.8	6.3
BC07	Winter	2/6/2018	13.5	23.8	54	9.8	92.8	6.9	6.3
		2/13/2018	14.0	17.6	85	9.2	88.8	6.9	7.3
		2/20/2018	21.0	29.3	69	8.2	90.6	6.9	6.8
		3/1/2018	20.3	NM	72	8.0	88.0	7.0	8.2
	Spring	5/1/2018	21.4	29.0	65	8.4	94.2	6.8	7.1
		5/8/2018	22.7	31.3	72	8.2	95.2	6.5	8.4
		5/15/2018	25.0	29.9	78	7.4	89.4	6.9	7.8
		5/21/2018	25.6	35.1	63	7.3	89.0	7.2	12.3
	Summer	8/7/2018	26.9	37.8	64	6.9	85.7	6.3	6.7
		8/14/2018	26.2	27.0	71	7.6	94.7	7.1	5.8
		8/21/2018	27.4	32.4	72	7.2	90.3	7.4	6.8
		8/28/2018	25.2	28.8	82	7.3	88.8	6.4	4.5
	AVERAGE		22.4	29.3	71	8.0	90.6	6.9	7.3

Precipitation observed 72 hours and seven days preceding each sampling event is included in Table 5 as reported at the Dearing, McDuffie County, GA gage from the UGA Weather Network, which is approximately 15 miles north of the site. Table 6 summarizes the monthly precipitation observed during the winter (February), spring (May), and summer (August) sampling events compared to the average annual precipitation between 1915 and 2016 at the Dearing rain gage.

Table 5. Observed precipitation at the UGA Weather Network Dearing, McDuffie County, GA station three and seven days prior to each sampling event for the baseline fecal coliform assessment.

Precipitation (inches)	Sampling Date											
	2/6	2/13	2/20	2/27	5/1	5/8	5/15	5/21	8/7	8/14	8/21	8/28
3 Days	0.07	0.28	0.00	0.35	0.00	0.00	0.15	0.00	0.00	0.03	0.01	0.00
7 days	0.08	1.12	0.14	0.35	0.26	0.00	0.15	1.03	2.75	0.47	0.04	0.00

Table 6. Observed precipitation during each sampling event compared to the historic monthly average at the UGA Weather Network Dearing, McDuffie County, GA station.

Sample Event	Observed Precipitation (inches)	1915 – 2016 Monthly Average (inches)	Departure from Average (inches)
February 2018	2.26	4.36	-2.10
May 2018	6.31	3.57	2.74
August 2018	2.71	4.37	-1.66

While no rain gage is located within close proximity to the project area, the USGS has a monitoring station located on Brushy Creek at Campground Road (Station No. 02197598, see station BC03 on Figures 1 and 2) that measures gage height and discharge. For the winter sampling event, the subsamples with the highest concentrations of fecal coliform were stations BC02 (2,400 MPN/100mL on February 20, 2018), LBC01 (500 MPN/100mL on February 6, 2018), and BC07 (900 MPN/100mL on February 20, 2018). These elevated fecal coliform concentrations did not correlate with an increased discharge at the USGS station on Brushy Creek (Table 3; Figure 4). Although an increase in fecal coliform bacteria in surface water often correlates with precipitation and stormwater runoff, these monitoring events did not provide a clear indication of such a relationship during the winter 2018 sampling period. However, there was a rainfall deficit of just over two inches during the February sampling event (Table 6), which could have attributed to the lower fecal coliform concentrations observed during the winter subsample events.

For the spring subsample event, the highest fecal coliform concentrations for all stations generally occurred during the May 21 sampling event, which coincides with increased discharge at the USGS station on Brushy Creek (Table 3; Figure 5). Overall, fecal coliform concentrations were generally higher during the spring sampling event excluding HB01(Table 3; Figure 3). A rainfall surplus of approximately 2.74 inches was also observed during the spring 2018 sampling periods potentially attributing to the higher fecal coliform concentrations (Table 6). For the summer 2018 sampling event, a deficit of approximately 1.66 inches was observed (Table 6). The highest fecal coliform subsample concentrations were observed at stations HB01 (2,400 MPN/100mL on August 28, 2018), UT01 (700 MPN/100mL on August 14, 2018), UT02 (500 MPN/100mL on August 21, 2018), and LBC01 (500 MPN/100mL on August 7, 2018) (Table 3; Figure 3). During the summer event, fecal coliform concentrations varied throughout the watershed regardless of precipitation inputs and stream discharge (Figure 6).

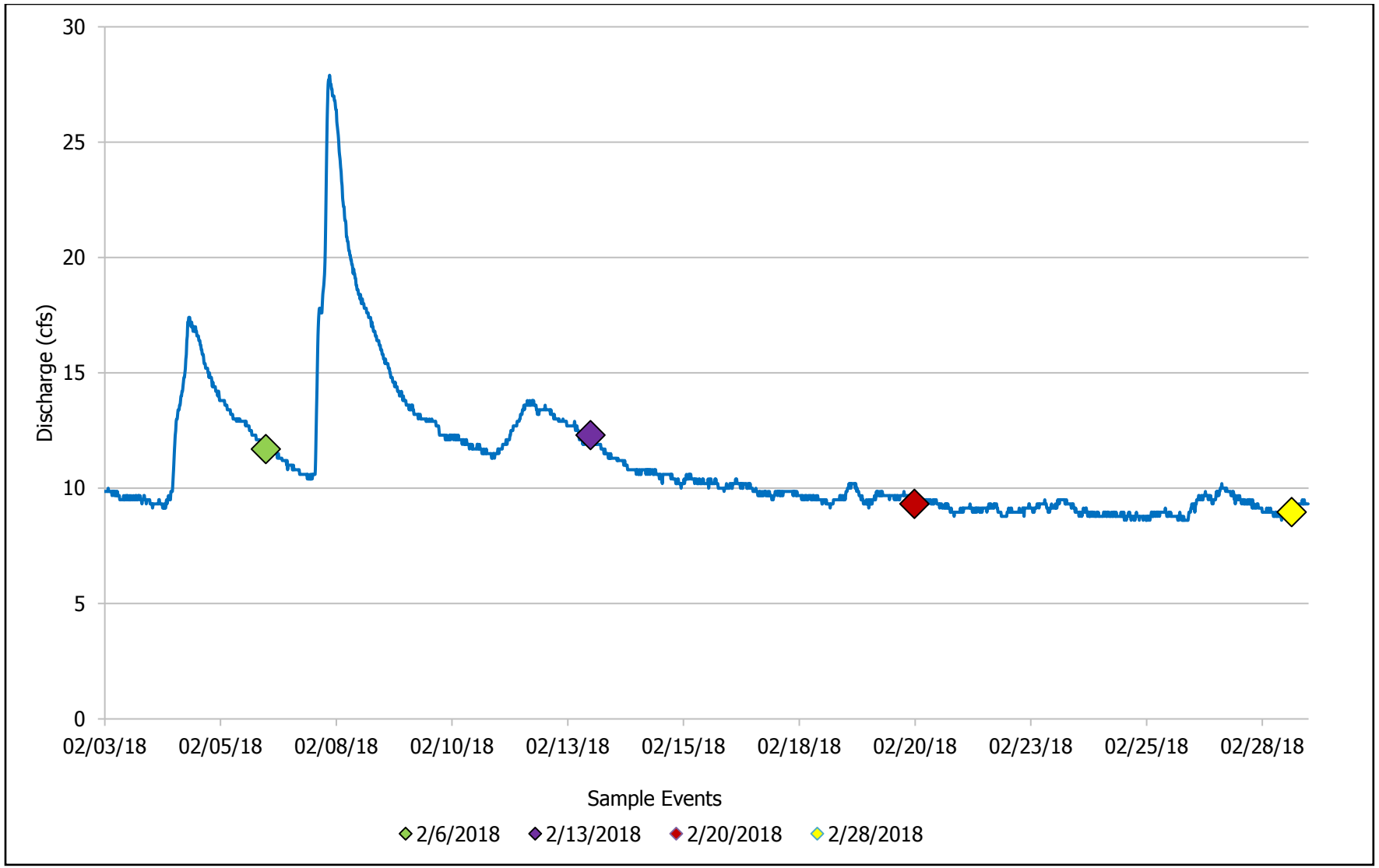

Figure 4. Stream discharge at the USGS Brushy Creek Station during the winter 2018 sampling events.

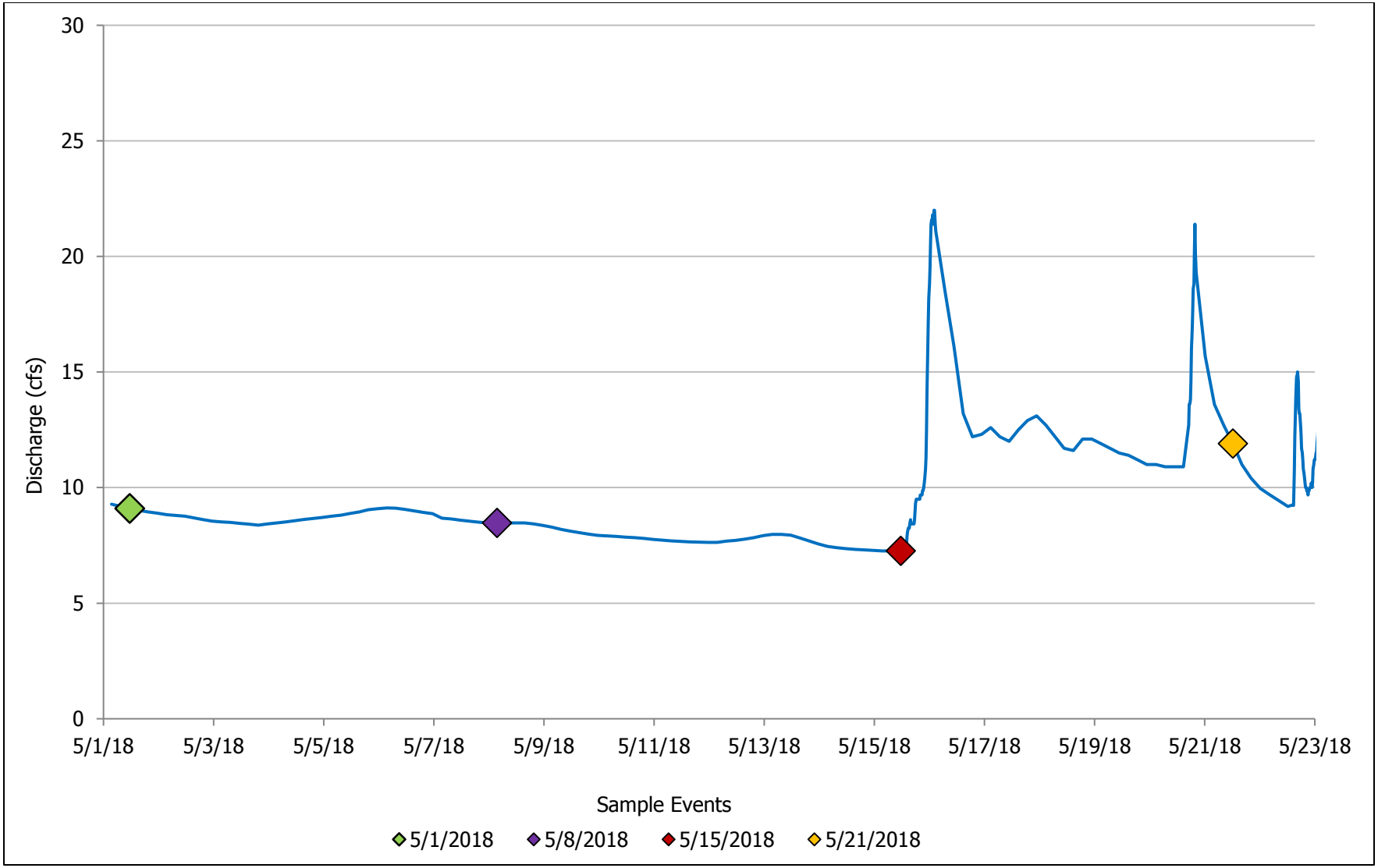

Figure 5. Stream discharge at the USGS Brushy Creek Station during the spring 2018 sampling events.

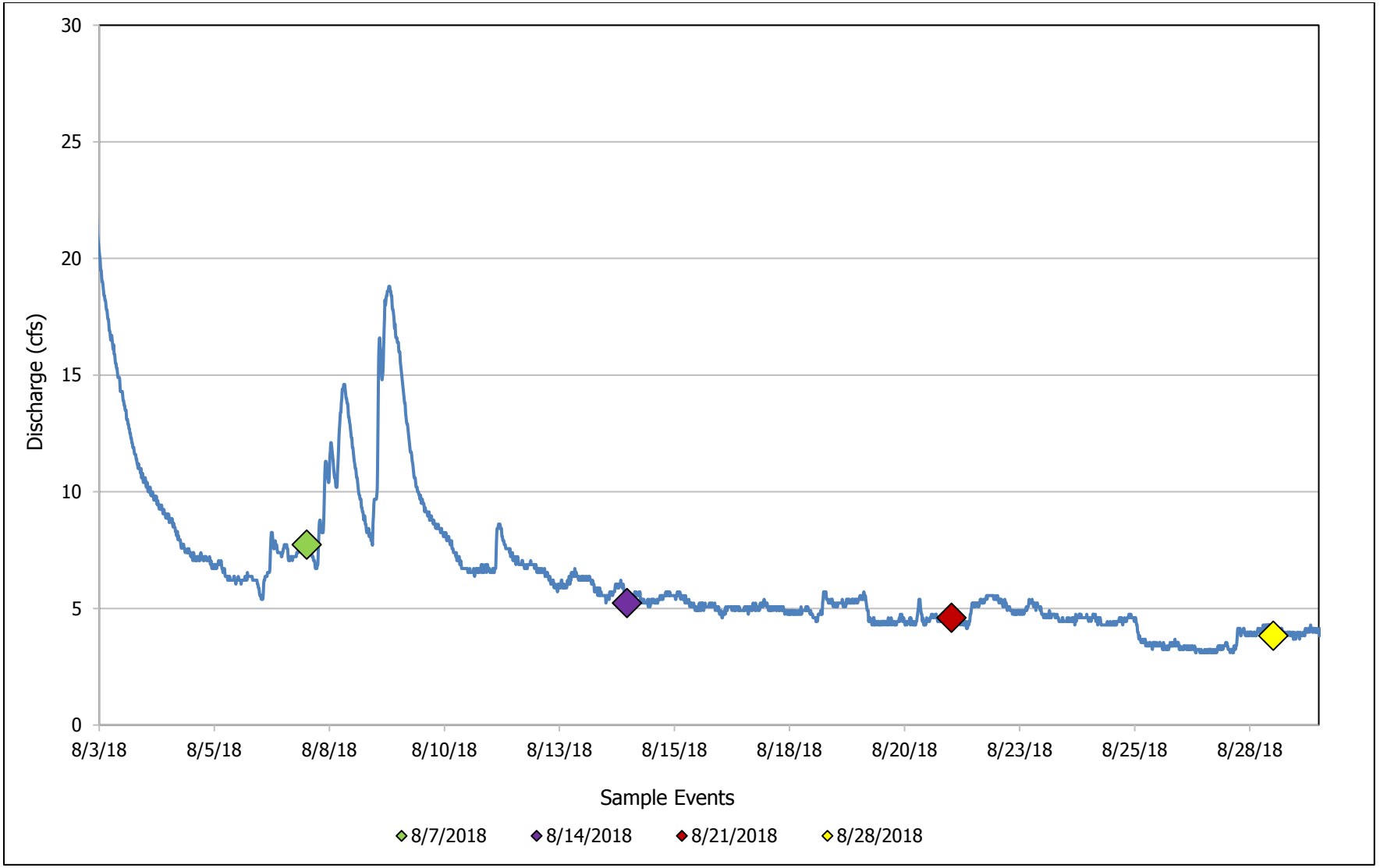

Figure 6. Stream discharge at the USGS Brushy Creek Station during the summer 2018 sampling events.

In accordance with the *Total Maximum Daily Load (TMDL) Evaluation for 32 Stream Segments in the Savannah River Basin for Fecal Coliform* completed in 2005 by the Georgia Department of Natural Resources (DNR), Brushy Creek was listed for not supporting the designated use for fishing because more than 25 percent of the geometric mean subsamples collected exceeded the fecal coliform water quality standard of 200 MPN/100 mL (May to October) and 1,000 MPN/100 mL (November to April) or the calculated geometric mean based on the subsamples exceeded the water quality standard. Based on the data collected for the baseline assessment, none of the stations located on Brushy Creek met this criterion during the winter or summer sampling events (Table 7). Conversely, more than 25 percent of the geometric mean subsamples for stations located on Brushy Creek exceeded the fecal coliform water quality standard of 200 MPN/100 mL during the spring 2018 (Table 7). Overall, from May to October, approximately 32.5% of the samples exceeded the water quality standard (Table 7). Further, the geometric mean at station BC03 exceed the water quality standard during the spring 2018 sampling (Table 7).

Table 7. Percentage of subsamples and calculated geometric means that exceeded the water quality standard during the winter, spring, and summer baseline assessment.

		Fecal Coliform (MPN/100mL)				
Round	**Station**	2/6/2018	2/13/2018	2/20/2018	2/27/2018	Geomean
Winter	BC01	<20	80	130	30	50
	BC02	20	70	2,400	70	124
	BC03	110	20	170	190	92
	BC04	20	70	<20	50	34
	BC05	70	70	210	140	110
	BC06	70	140	<20	30	49
	BC07	80	80	900	40	123
Percent Exceedance		**4%**				
		5/1/2018	5/8/2018	5/15/2018	5/21/2018	Geomean
Spring	BC01	130	700	80	70	150
	BC02	40	500	130	220	155
	BC03	110	1,100	500	300	367
	BC04	40	20	230	500	98
	BC05	110	140	230	230	169
	BC06	20	<20	20	230	37
	BC07	<20	20	80	40	34
Percent Exceedance		**39%**				
		8/7/2018	8/14/2018	8/21/2018	8/28/2018	Geomean
Summer	BC01	110	170	110	40	95
	BC03	260	170	140	220	192
	BC07	20	40	130	170	65
Percent Exceedance		**17%**				
May to October Percent Exceedance		**32.5%**				

During the summer event, nutrient analysis for total nitrogen and total phosphorus were also conducted at stations UTS01, UTS02, and LBC01 (Table 8). The average total nitrogen concentrations ranged from below detection limits (<0.75 mg/L) to 1.084 at station UTS01. The highest total nitrogen concentrations were observed at station UTS01 during the summer sampling events. Total nitrogen concentrations as stations UT02 and LBC01 were generally below or near method detection limits during the summer sampling. According to the GA EPD Online Water Quality Database, total nitrogen analysis was conducted on 35 streams located within the Coastal Plain Red Uplands (65k) Level IV Ecoregion from 1990 to 2014. The average calculated total nitrogen concentration for the 65k ecoregion was 1.32 mg/L. Total nitrogen concentrations at all stations were below the average for the 65k ecoregion during the summer sampling event. The EPD sampled for total phosphorus on approximately 80 streams from 1973 to 2014. The average total phosphorus concentrations for all streams located within the 65k ecoregion was 0.370 mg/L. Total phosphorus concentrations at the Brushy Creek monitoring stations were below the average for the 65k ecoregion for all stations during the summer sampling period.

Table 8. Total nitrogen and phosphorus concentrations measured during the summer (August 2018) baseline sampling event for the baseline assessment.

Station	Date	Total Nitrogen	Total Phosphorus
		mg/L	
UT01	8/7/2018	1.084	0.026
	8/14/2018	1.059	0.028
	8/21/2018	<0.75	0.062
	8/28/2018	0.876	0.077
UT02	8/7/2018	<0.75	0.088
	8/14/2018	0.754	0.100
	8/21/2018	<0.75	0.106
	8/28/2018	1.067	0.127
LBC01	8/7/2018	<0.75	0.052
	8/14/2018	<0.75	0.054
	8/21/2018	<0.75	0.062
	8/28/2018	0.769	0.068

CONCLUSIONS

Based on the results from the baseline assessments, the watersheds of UT01, UT02, and HB01 have been identified as high priority watersheds for the implementation of best management practices (BMPs). Elevated fecal coliform concentrations were also observed at station BC03 during the assessment; however, no other stations on Brushy Creek located upstream or downstream of this station exceeded the water quality standard for fecal coliform. As such, this station was not included as a high priority area. For the nutrient analysis, only station UT01 was identified as a high priority area for total nitrogen; however, total nitrogen concentrations at that station were below the total nitrogen concentration for all streams located within the 65(k) ecoregion. BMPs should be selected that will address a variety of pollution sources including bacteria, nutrients, and sediment.

During dry weather conditions, potential sources of fecal coliform and nutrients are illicit discharges, livestock access to the stream, wildlife such as feral hogs and geese, illegal dumping into streams and riparian areas, leaking septic systems, and grading of unpaved roads into adjacent streams. For wet weather events, potential sources are stormwater runoff from nonpoint sources such as urban, residential, and agricultural land use. Best management practices to address these potential sources include a public outreach and education campaign that could include brochures, fliers, signage or kiosks to educate citizens that live and work within the watershed regarding the importance of litter control, proper disposal of deer carcases and other game, and the importance of septic system maintenance. Other management measures include the implementation and usage of the GA EPD Better Backroads Manual. Vegetative and structural BMPs could also be utilized that control runoff associated with urban and agricultural land uses. Feral hogs were also identified during the public meetings as a potential source of fecal coliform pollution although no signs of hogs were observed during the baseline assessment. Live trapping of the hogs could also be an effective BMP that could be installed throughout the entire watershed to address the problem.