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Chickasawhatchee Creek Watershed Management Plan

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ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
BMP	Best Management Practice
CFS	Cubic Feet per Second
CWA	Clean Water Act
DO	Dissolved Oxygen
FT	Feet
GADNR	Georgia Department of Natural Resources
GAEPD	Georgia Environmental Protection Division
GIS	Geographic Information System
GLUT	Georgia Land Use Trends
GSWCC	Georgia Soil and Water Conservation Commission
mg/L	Milligrams per Liter
MGD	Million Gallons per Day
MPN/100 mL	Most Probable Number of Coliform Per 100 Milliliters
µS/cm	Micro Siemens per centimeter
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NTU	Nephelometric Turbidity Units
PPT	Parts per Trillion
STEPL	Spreadsheet Tool for Estimating Pollutant Load
SU	Standard Unit
TMDL	Total Maximum Daily Load
UGA CAES	University of Georgia College of Agricultural & Environmental Sciences
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WMP	Watershed Management Plan
WPCP	Water Pollution Control Plant

EXECUTIVE SUMMARY

The Chickasawhatchee Creek Watershed 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). It was selected because of the environmental conditions and impairments of the watershed, the number of agricultural producers located within the watershed, landowner needs, and the current listing status on the Georgia Environmental Protection Division (GAEPD) 305(b)/303(d) integrated report.

The Chickasawhatchee Creek Watershed comprises approximately 119,000 acres and is located in southwestern Georgia. Approximately 18 miles of streams in the Chickasawhatchee Creek Watershed (Chickasawhatchee Creek and Brantley Creek) are listed on the 2016 GAEPD 305(b)/303(d) integrated report for not supporting their designated uses for fishing. In 1998, the GAEPD calculated a Total Maximum Daily Load (TMDL) of 175 cfu/100 mL, a 69% reduction from the existing load, for Chickasawhatchee Creek due to impaired biological communities as a result of fecal coliform loading (GAEPD, 1998).

The objective of this project was to develop and a nine-key element WMP using the U.S. Environmental Protection Agency (USEPA) *Handbook for Developing Watershed Plans to Restore and Protect Our Waters*. The plan includes the long-term goal of meeting the recommended fecal coliform load reductions in the TMDL with the intent of delisting streams in the Chickasawhatchee Creek Watershed. This WMP was a collaborated effort of the advisory committee, stakeholder group, GSWCC, GAEPD, and Tetra Tech. Funding for the WMP was financed through a grant from the USEPA to the GAEPD of the Department of Natural Resources (GADNR) under provisions of the Section 319(h) of the Federal Water Pollution Control Act.

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 practice (BMP) implementation to aid in the development of the WMP. Bacteria (fecal coliform) has been identified as the primary pollutant within the Chickasawhatchee Creek Watershed based on a desktop analysis and visual site assessment. Major sources of pollutants that flow into Chickasawhatchee Creek have been identified as agricultural runoff, urban runoff, and baseflows.

In order to achieve the TMDL fecal coliform load reductions, a series of agricultural, septic system, and outreach BMPs should be implemented throughout the Chickasawhatchee Creek Watershed.

The WMP has been written to cover a 5-year time period and interim milestones and measures of success are broken down into two phases: short-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 Chickasawhatchee Creek and Brantley Creek, alternative success criteria and a long-term monitoring plan have been developed as a means to evaluate the success of the WMP.

1.0 INTRODUCTION

The Chickasawhatchee Creek Watershed (Hydrologic Unit Code 0313000908) is in southwest Georgia within the Flint River Basin, approximately 15 miles west of Albany, Georgia (**Figure 1**). The watershed is located primarily in Terrell County, but portions of the watershed are also located in Calhoun and Dougherty Counties and a small southern portion in Baker County.

Two streams in the watershed, Chickasawhatchee Creek (reach ID GAR031300090804) and Brantley Creek (reach ID GAR031300090808), are sampled by the Georgia Environmental Protection Division (GAEPD) and have designated uses of fishing (**Figure 1**). Water quality sampling in April and September of 1995 showed that these creeks were not supporting their designated uses because of fecal coliform impairments. GAEPD developed a Total Maximum Daily Load (TMDL) in February 1998 (GAEPD 1998) to address the impairment. The waters were listed as Category 4a waterbodies (not supporting, TMDL developed) on the 2016 Georgia Integrated 305(b)/303(d) List of Waters due to fecal coliform (GAEPD 2016).

This Watershed Management Plan (WMP) was developed to address the fecal coliform impairments in the Chickasawhatchee Creek Watershed through a plan that meets the nine elements recommended by U.S. Environmental Protection Agency (USEPA) and GAEPD guidelines.

1.1 WATERSHED DESCRIPTION

The Chickasawhatchee Creek Watershed is 119,000 acres and is predominately rural. The dominant land uses are forested (41,342 acres), agricultural (39,402 acres), and wetland (29,188 acres) (**Figure 2**). The remaining land uses total 8,809 acres and include developed, clearcut, and open water. More than 50% of the forested land use is managed pine plantations. The agricultural land use is dominated by row crops, and there are no known feed lots or large livestock operations. One chicken house operation was identified in Calhoun County. The largest developed area, the City of Dawson, covers 2,368 acres and is in the headwaters of the watershed. Brantley Creek flows through the City of Dawson. There is one other smaller town located in the watershed, the City of Sasser. Most of the wetlands are adjacent to Chickasawhatchee Creek and are predominately located in the southern portion of the watershed.

GAEPD most recently collected water quality data at station 1109070501 on Chickasawhatchee Creek in 2010, and station 1109070202 on Brantley Creek in 2011 (National Water Quality Monitoring Council, 2019). Three to four samples were collected within a 30-day period during each calendar quarter at each site (**Figure 3**). At station 1109070501, the winter geometric means were 269.4 most probable number of coliform per 100 milliliters (MPN/100 mL) and 217.9 MPN/100 mL, and the summer geometric means were 951.0 MPN/100 mL and 185.6 MPN/100 mL. At station 1109070202 on Brantley Creek, the winter geometric means were 119.3 MPN/100 mL and 986.5 MPN/100 mL, and the summer geometric means were 1,248.7 MPN/100 mL and 415.3 MPN/100 mL. GAEPD has a fecal coliform winter geometric mean water quality standard of 1,000 MPN/100 mL and summer standard of 200 MPN/100 mL. Both stations violated the summer water quality criterion.

1.2 PROJECT OBJECTIVES

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

1. Identification of causes and sources of pollution that need to be controlled;

2. Determine load reductions needed for each pollutant;
3. Develop nonpoint source (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 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 monitoring component to evaluate effectiveness of management measures or BMPs over time.

A watershed characterization was conducted to develop the WMP that assessed the current conditions of the watershed, established baseline conditions prior to management initiatives, identified pollutant sources, and prioritized areas for implementation of BMPs. The pollutant addressed during the characterization was fecal coliform.

1.3 PUBLIC INVOLVEMENT

Public involvement is a crucial aspect of the watershed planning process. It allows the citizens that live and work in the Chickasawhatchee Creek Watershed to provide insight and input in the decision-making processes that set goals, objectives, and actions for improving water quality in the watershed.

As part of the WMP development process, a watershed advisory committee was formed to assist in developing the WMP and to provide public education and outreach related to the plan. Committee members represent Flint River Soil & Water Conservation District, Flint River Water and Planning Policy Center, Flint Riverkeeper, Georgia Department of Natural Resources (GADNR), GAEPD, Georgia Forestry Commission, Natural Resources Conservation Service, and University of Georgia (UGA) College of Agricultural & Environmental Sciences (CAES) Extension Agent. The committee met on May 11, 2018 and November 14, 2018.

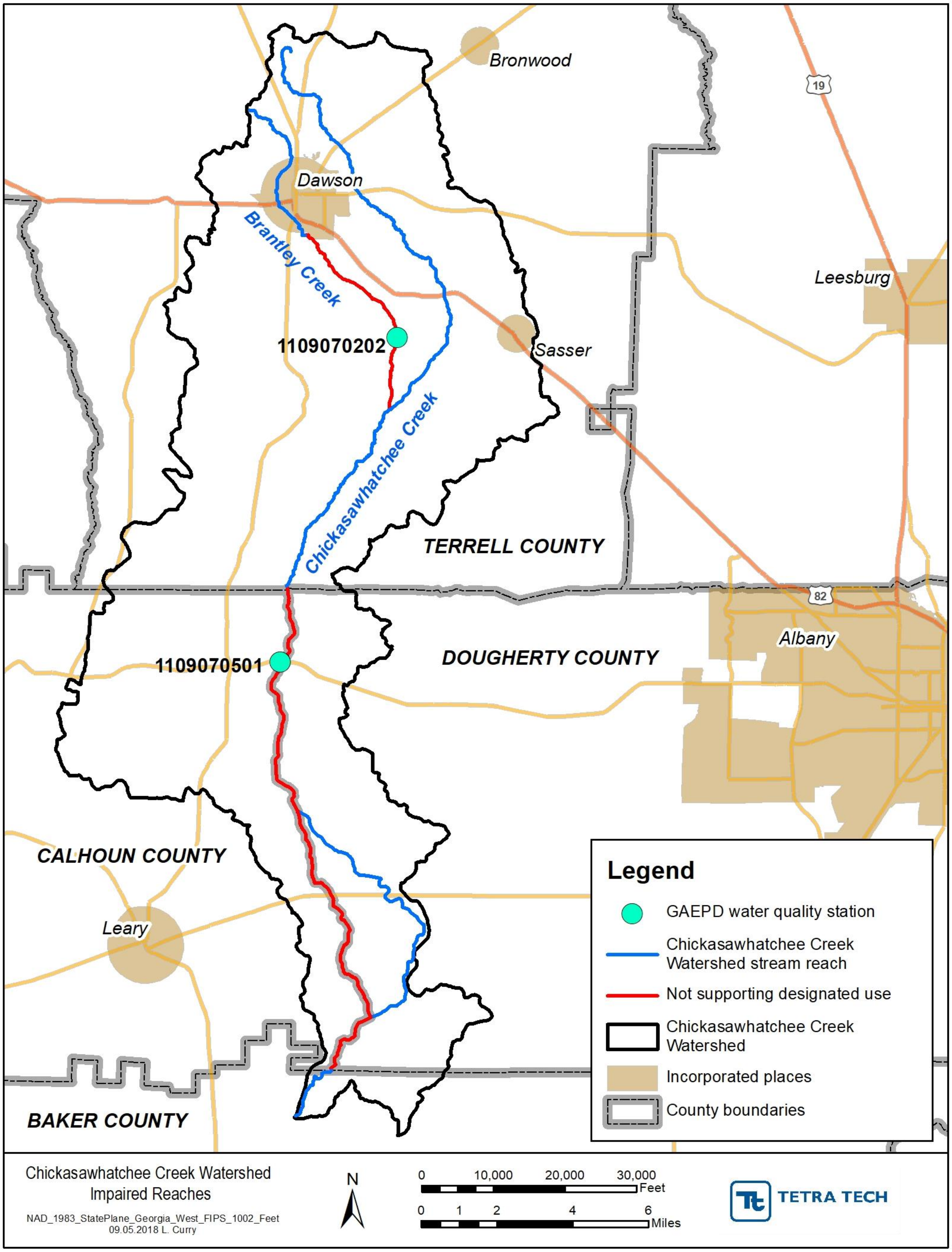

Figure 1. Chickasawhatchee Creek Watershed location and GAEPD water quality stations

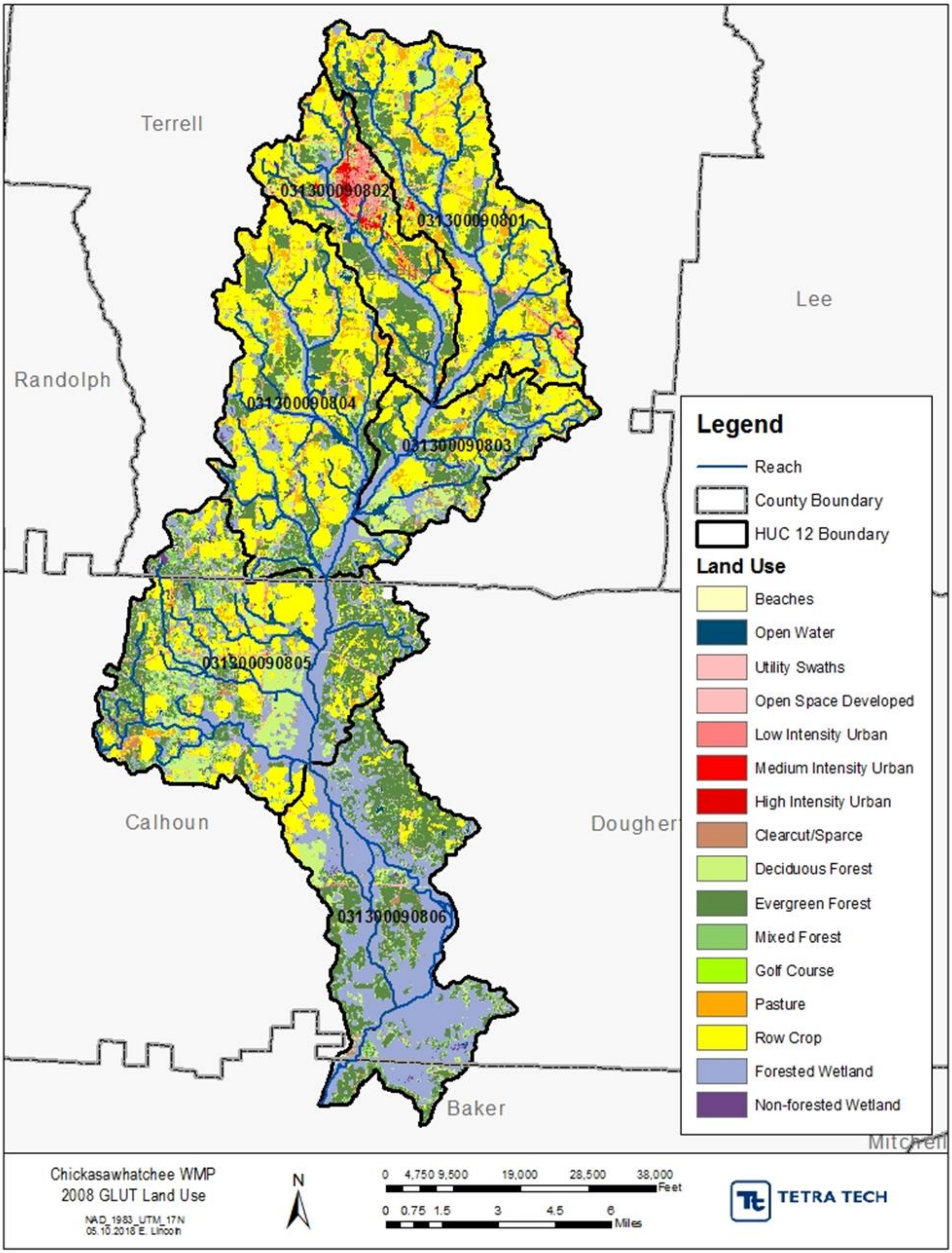

Figure 2. Chickasawhatchee Creek Watershed land use classifications

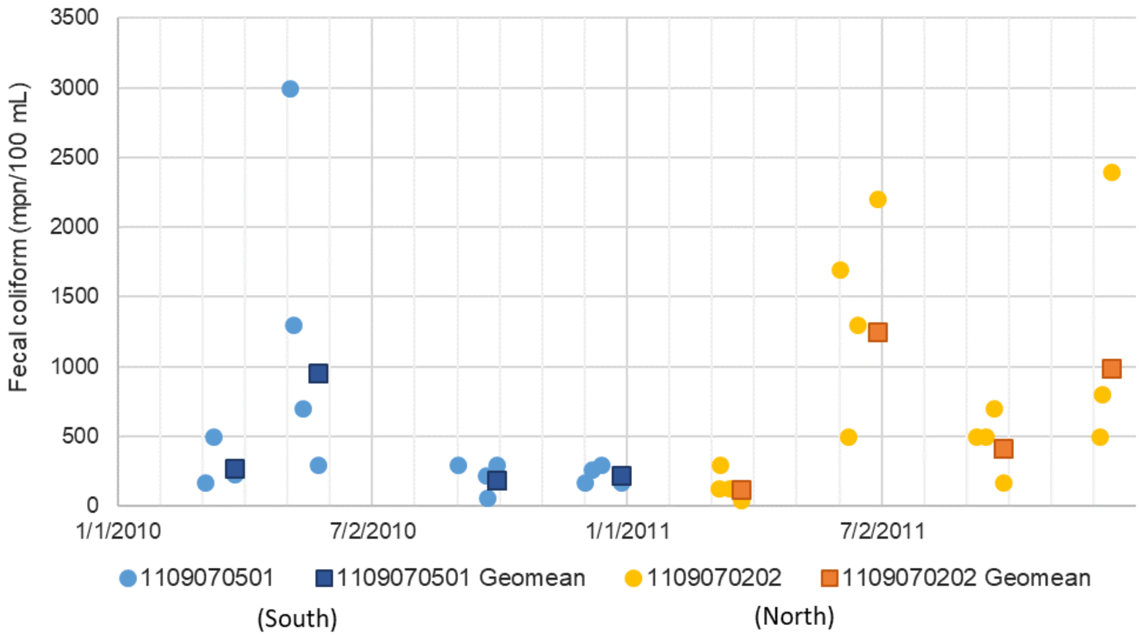

Figure 3. Fecal coliform water quality sampling results in the Chickasawhatchee Creek Watershed

2.0 WATERSHED DESCRIPTION

2.1 LOCATION AND ECOREGION

The Chickasawhatchee Creek Watershed (Hydrologic Unit Code 0313000908) is within the Dougherty Plain (65g) Level IV Ecoregion of the Southeastern Plains (65) Level III Ecoregion (Griffith, et al., 2001).

The Southeastern Plains contain broad interstream regions filled with cropland, pasture, woodland, and forest. Naturally vegetated areas consist of mostly Southern mixed forests with oak, hickory, and pine trees. Elevations in the Southeastern Plains are higher than in the Southern Coastal Plain to the southeast but generally lower than in the Piedmont around Central to North Georgia. This region's streams have relatively low gradients and contain sandy bottoms.

The Dougherty Plain Eco-region is characterized by a mostly flat topography with gentle slopes and a lower relief in the center, where the Chickasawhatchee Creek Watershed lies. The agricultural landscape provides extensive peanut, pecan, and cotton production as well as biological oases in limesink ponds and marshes where spring water surfaces to create lush ecosystems.

2.2 LAND USE AND LAND COVER

Based on 2008 Georgia Land Use Trends (GLUT) data, the Chickasawhatchee Creek Watershed is approximately 35% forested, 34% agricultural, and 25% wetlands. Forested areas are found throughout the watershed and dominated by evergreen forests planted to sustain timber and quail plantations. Agriculture is predominantly found in the north in Terrell County and Calhoun County, while southern regions of the watershed are covered with forested wetlands. Two small cities are located within the watershed in Terrell County, the City of Dawson and the City of Sasser, which contribute developed land use to about 5% of the watershed's area. GLUT data were used to develop the WMP and are summarized in **Table 1**.

Table 1. 2008 land use in the Chickasawhatchee Creek Watershed

Land Use	Acres	Percent
Beaches/Dunes/Mud	112	0.1
Open Water	999	0.8
Utility Swaths	277	0.2
Developed, Open Space	3,682	3.1
Developed, Low Intensity	1,923	1.6
Developed, Medium Intensity	350	0.3
Developed, High Intensity	160	0.1
Clearcut/Sparse	1,306	1.1
Deciduous Forest	12,578	10.6
Evergreen Forest	23,936	20.2
Mixed Forest	4,828	4.1
Pasture	4,308	3.6
Row Crop	35,094	29.6
Forested Wetland	28,449	24.0
Non-forested Wetland (Freshwater)	739	0.6
Total	**118,741**	**100**

2.3 WATER RESOURCES AND HYDROLOGY

The Chickasawhatchee Creek Watershed is located in the eastern half of the Ichawaynochaway subbasin of the Flint River basin (**Figure 4**). The watershed contains about 39 miles of Chickasawhatchee Creek, including the headwaters four miles north of the City of Dawson, before the creek meets its confluence with the Ichawaynochaway Creek in Baker County.

Discharge has been measured since 2010 at U.S. Geological Survey (USGS) stream gage 02354350 on the Chickasawhatchee Creek near Albany, GA. Discharge ranges from a monthly mean of 21 cubic feet per second (cfs) in October to 199 cfs in February (**Figure 5**). For 2018, the daily discharge ranged from a minimum of 2.11 cfs to a maximum of 846 cfs with discharge peaks coinciding with heavy precipitation events (**Figure 6**). This gage shares its location with the GAEPD Water Quality Station 1109070501 and accounts for the drainage of about 75,000 acres, or 65%, of the Chickasawhatchee Creek Watershed. This includes almost all of the watershed's developed land and a significant portion of its agricultural land.

The majority of the watershed lies above the mostly confined Floridan aquifer system which discharges to 56 springs in Georgia (U.S. Geological Survey, ND); however, part of the northwestern border is above the Southeastern Coastal Plain aquifer system (Miller, 2000) **(Figure 5**). Two other, mostly confined and deeper, major aquifer systems cover the entire Chickasawhatchee Creek Watershed, the Claiborne and Clayton aquifers and the Cretaceous aquifer system.

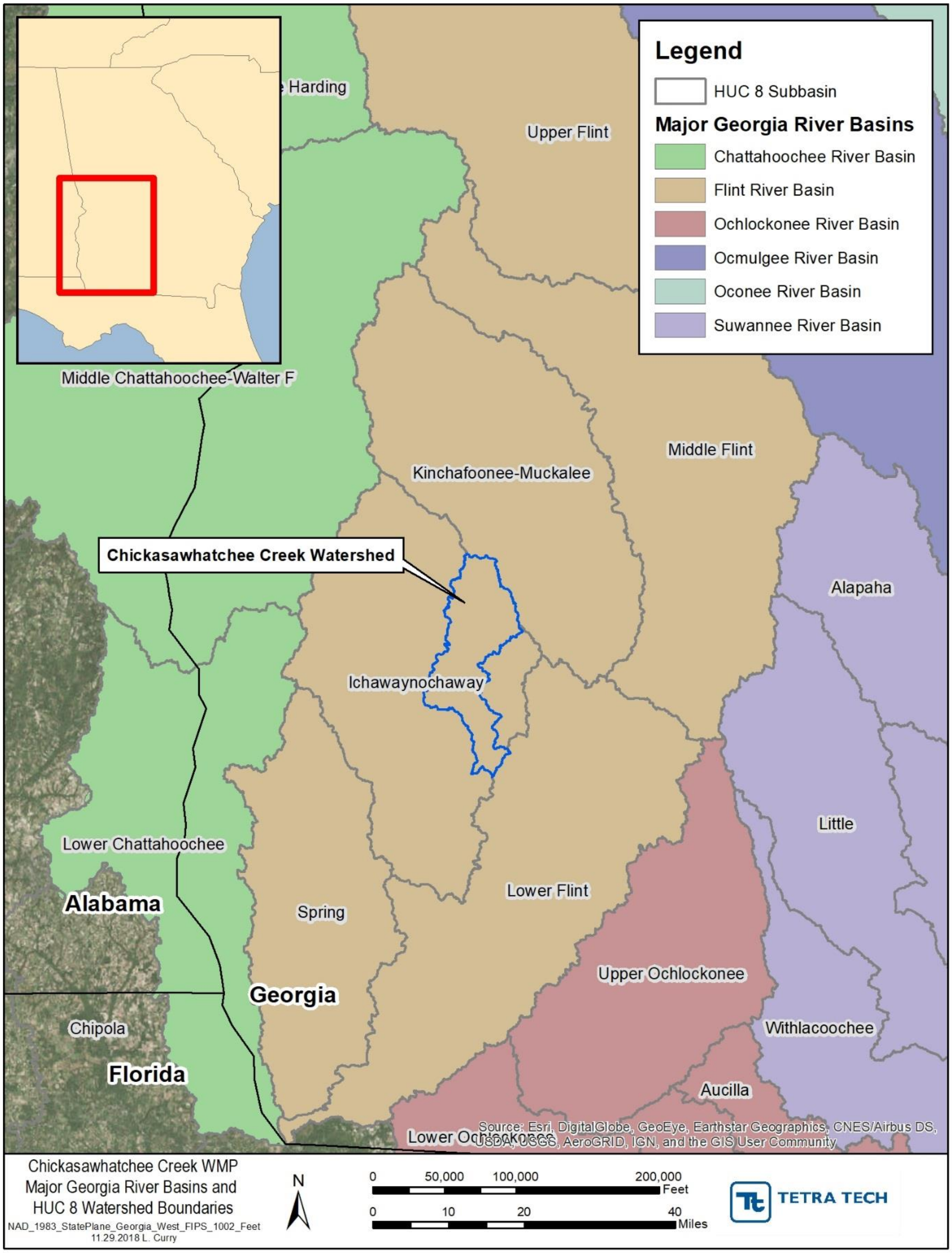

Figure 4. Hydrological Unit Code 8 watershed boundaries and major river basins in Georgia

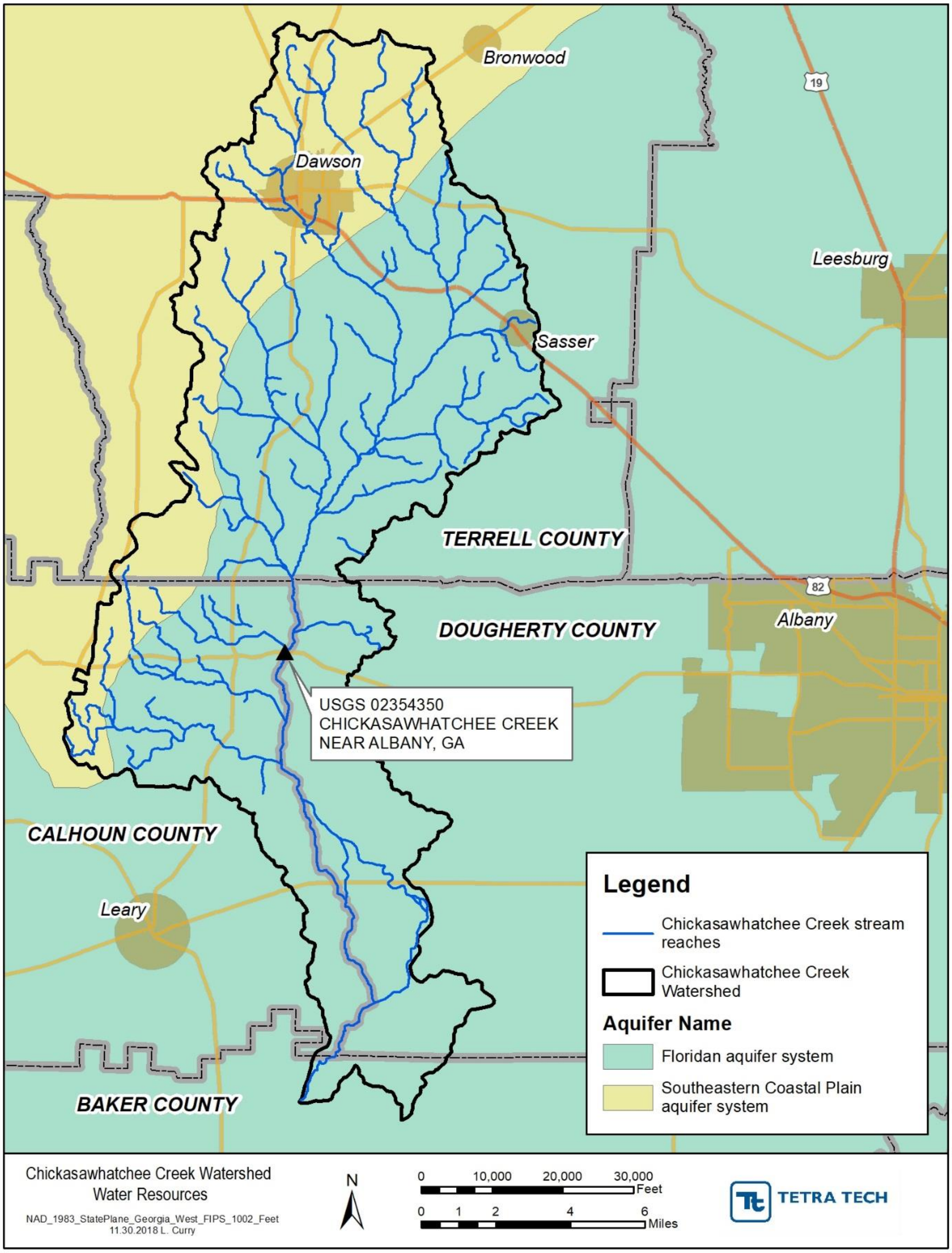

Figure 5. Principal aquifer systems recharged by the Chickasawhatchee Creek

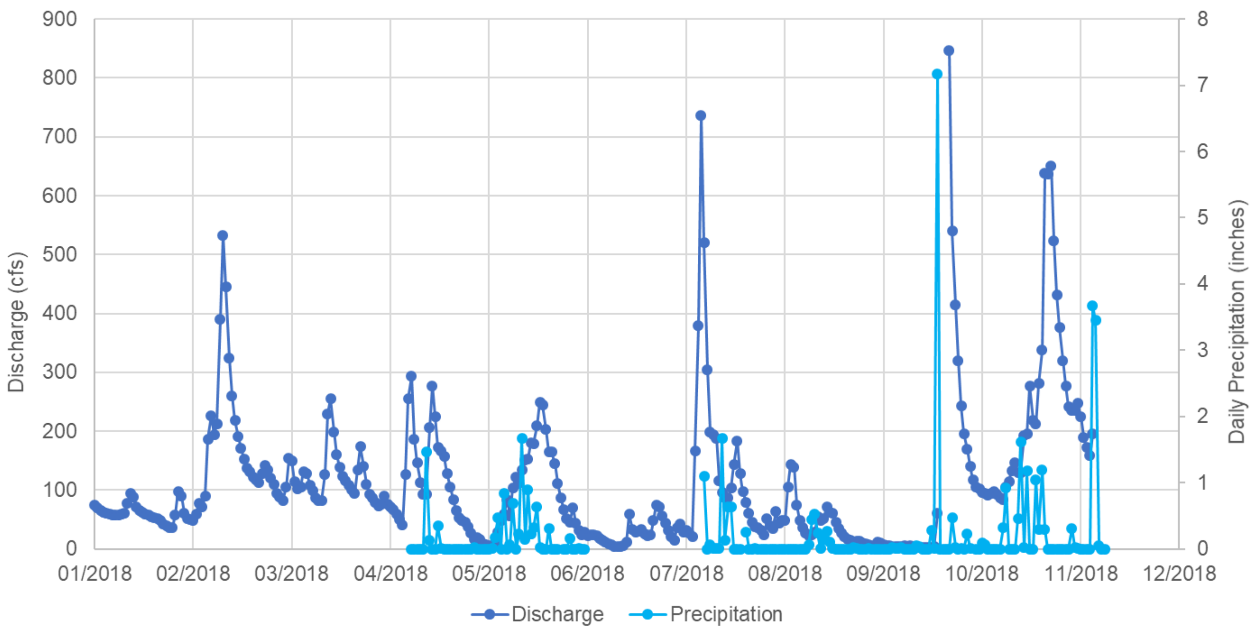

Figure 6. Discharge and precipitation at USGS stream gage 02354350 for the year 2018

2.4 GEOLOGY, SOILS, AND TOPOGRAPHY

Physiographic maps of Georgia (Clark & Zisa, 1976) depict the Chickasawhatchee Creek Watershed on the divide between the Dougherty Plain District in the southern half of the watershed and the Fall Line Hills District in the north. Most of Terrell County is located in the Fall Line Hills District.

The Dougherty Plain District has a gradational northwestern boundary that meets the Fall Line Hills District at an elevation of around 250 feet. The southeastern boundary connects with the Pelham Escarpment in the Tifton Upland District. The area contains numerous ponds and marshes that form because of Karst topography and actively forming sinkholes. The Fall Line Hills District, in the northwest, consists of a dissected topography with some areas marked by marshy floodplains and stream terraces.

The Natural Resources Conservation Service (NRCS) classifies about 35% of soil in the Chickasawhatchee Creek Watershed as either Tifton or Greenville sandy loams. These sandy loams are well drained soils with moderate to moderately slow permeability and are moderate to well suited for use in field crops and pasture land (Pilkinton, 2003). A significant area in and around Chickasawhatchee Creek and its northern stream reaches contains soils classified as Herod and Muckalee soils that are poorly drained with very slow runoff and moderate permeability, while areas around the creek's southern reaches are dominated by soils classified as swamp (Natural Resources Conservation Service, 2018). Wetland areas, like those in southern Chickasawhatchee Creek Watershed, develop hydric soils after exposure to water for extended periods of time keeps the soil in anaerobic conditions and leads to changes in soil properties (Michigan Department of Environmental Quality, 2001).

2.5 PROTECTED AQUATIC ELEMENTS

The Georgia Department of Natural Resources lists four federally protected aquatic elements in the Chickasawhatchee Creek Watershed including three animals, the Shinyrayed Pocketbook (*Hamiota subangulata*), the Gulf Moccasinshell (*Medionidus penicillatus*), and the Oval Pigtoe (*Pleurobema pyriforme*), and one plant, Pondberry (*Lindera melissifolia*). Additionally 10 other aquatic elements are listed with Georgia protection status including seven animals, the Dougherty Plain Cave Crayfish (*Cambarus cryptodytes*), the Delicate Spike (*Elliptio arctata*), the Inflated Spike (*Elliptio purpurella*), the Goldstripe Darter (*Etheostoma parvipinne*), Barbour's Map Turtle (*Graptemys barbouri*), the Alligator Snapping Turtle (*Macrochelys temminckii*), and the Bluenose Shiner (*Pteronotropis welaka*), and three plants, Corkwood (*Leitneria floridana*), Yellow Flytrap (*Sarracenia flava*), and Swamp Buckthorn (*Sideroxylon thornei*).

3.0 WATER QUALITY MONITORING

Targeted monitoring occurred as part of WMP development to create a baseline water quality dataset for the watershed. Water quality data collected included fecal coliform, water temperature, pH, dissolved oxygen (DO), specific conductance, and turbidity. Water quality monitoring was performed via discrete grab samples that were collected from mid-stream and in the middle of the water column in visibly flowing water whenever possible.

3.1 WATER QUALITY MONITORING

Nine locations were selected for water quality monitoring. These locations were selected to help determine pollutant loading "hot spots" for fecal coliform bacteria and were located upstream of major tributary confluences with Chickasawhatchee Creek, as well as at three locations on Chickasawhatchee Creek. Site names and locations are shown in **Figure 7** and **Table 2**.

Table 2. Chickasawhatchee Creek WMP water quality sampling locations

Station ID	Location Description	Latitude	Longitude
CC1	Chickasawhatchee Creek at State Road 118	31.792420	-84.427570
CC2	Chickasawhatchee Creek at County Road 164	31.703760	-84.389960
BC1	Brantley Creek at County Road 133	31.718350	-84.401120
HC1	Herod Creek at State Road 55	31.681180	-84.451260
UT1	Unnamed Tributary at State Road 55	31.644340	-84.466390
CC3	Chickasawhatchee Creek at State Road 234	31.593611	-84.453333
HL1	Horse Lot Branch at State Road 55	31.577520	-84.477230
MB1	Market Branch at State Road 55	31.558050	-84.482290
CC4	Chickasawhatchee Creek at State Road 62	31.503963	-84.405711

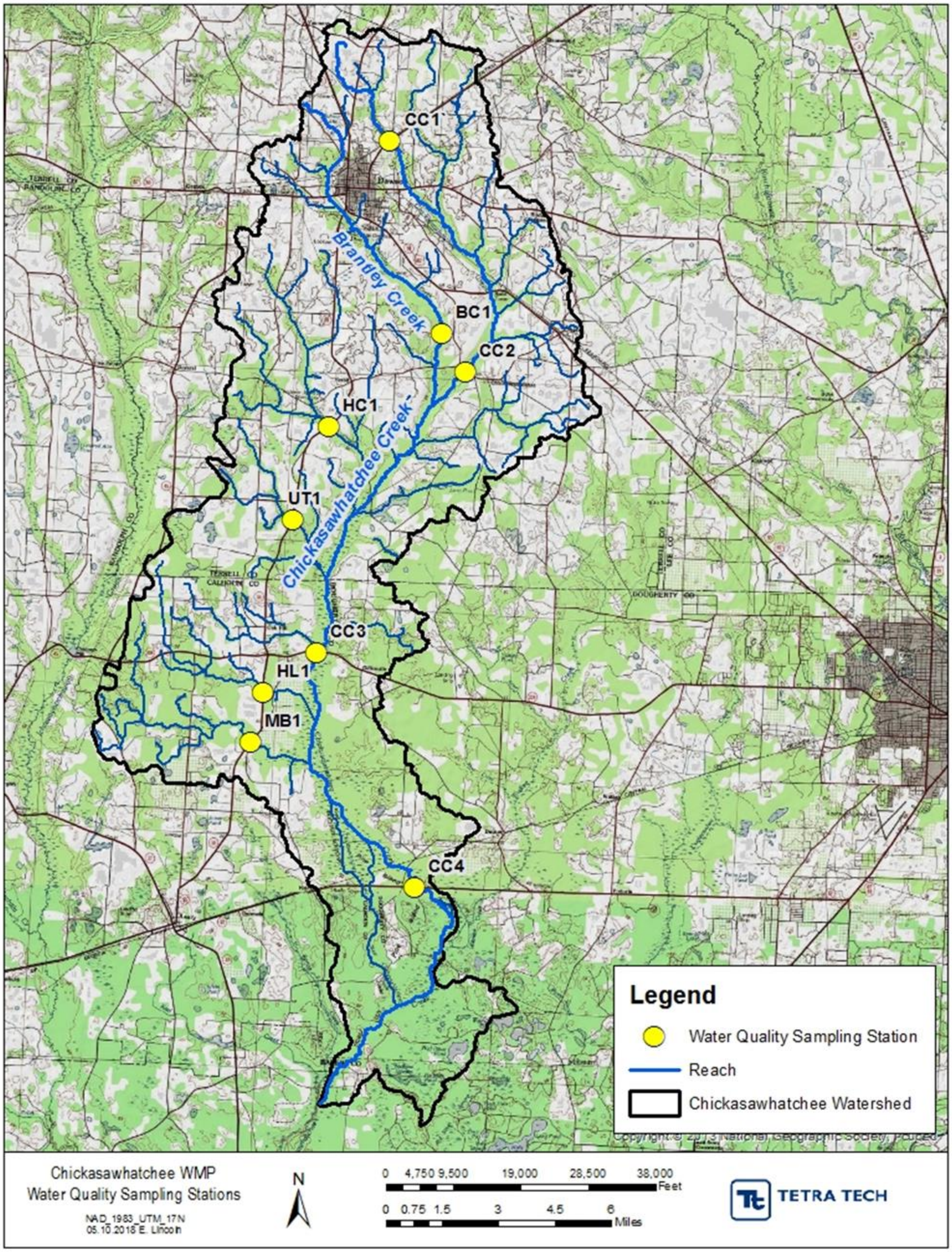

Figure 7. Chickasawhatchee Creek WMP water quality sampling locations

Table 3 summarizes the water quality data collected to develop the baseline condition and identify hot spots. Three dry weather samples were collected in 2018 on June 13/14, August 6, and October 24 and one wet weather sample was collected on October 12.

Table 3. WMP baseline water quality data

Analyses	Date	Event	CC1	CC2	BC1	HC1	UT1	CC3	HL1	MB1	CC4
Fecal Coliform (cfu/100 mL)	6/13/18	Dry	60	1000	70	411	47	173	162	70	141
	8/6/18	Dry	1600	280	1600	900	70	220	900	1600	300
	10/12/18	Wet	3400	900	3700	1200	1900	5500	4000	2000	900
	10/24/18	Dry	113	249	1300	548	2500	548	687	1120	218
Temperature (°C)	6/13/18	Dry	23.9	23.8	23.6	23.3	25.3	25.0	27.4	26.8	24.9
	8/6/18	Dry	19.8	27.1	25.5	23.7	25.6	25.6	26.5	26.5	26.1
	10/12/18	Wet	21.9	22.4	21.9	21.8	23.7	22.5	23.2	22.2	20.4
	10/24/18	Dry	17.7	20.0	18.6	17.3	20.3	19.4	17.3	19.4	19.9
pH (s.u.)	6/13/18	Dry	6.52	6.56	6.84	6.22	6.48	6.83	6.92	6.87	7.06
	8/6/18	Dry	6.78	6.83	6.92	6.52	6.57	7.00	6.57	6.51	6.96
	10/12/18	Wet	6.68	6.73	6.33	6.39	6.61	6.57	6.41	6.33	6.54
	10/24/18	Dry	6.78	6.82	6.93	6.47	6.57	6.60	6.79	6.81	6.80
Specific Conductance (µS/cm)	6/13/18	Dry	112	97	207	101	127	140	158	169	166
	8/6/18	Dry	253	86	179	100	124	116	89	91	138
	10/12/18	Wet	84	79	74	62	89	89	50	48	103
	10/24/18	Dry	123	98	167	122	158	157	129	180	203
Turbidity (NTU)	6/13/18	Dry	8.6	7.1	8.8	12.4	5.5	5.6	5.7	5.7	6.9
	8/6/18	Dry	9.4	10.3	11.5	11.3	6.6	10.1	8.5	10.1	9.3
	10/12/18	Wet	23.5	12.2	16.5	30.9	13.6	30.4	21.6	15.7	11.2
	10/24/18	Dry	10.2	6.9	9.9	9.1	16.4	5.8	6.2	5.7	7.1
Dissolved Oxygen (mg/L)	6/13/18	Dry	4.36	5.04	6.88	1.57	3.53	6.35	6.09	5.14	6.14
	8/6/18	Dry	2.44	5.21	6.62	2.24	3.83	6.25	3.72	4.56	6.12
	10/12/18	Wet	4.61	4.06	3.81	1.42	3.60	2.01	1.99	2.44	3.56
	10/24/18	Dry	3.13	2.92	5.46	0.17	3.34	2.51	1.44	0.56	1.36
Dissolved Oxygen (%)	6/13/18	Dry	49.2	59.8	81.6	18.3	39.2	77.2	77.8	64.7	74.1
	8/6/18	Dry	26.8	65.6	31.0	27.0	46.9	76.5	47.2	56.8	75.6
	10/12/18	Wet	53.6	47.2	44.0	16.4	59.8	23.4	23.5	28.2	39.7
	10/24/18	Dry	33.9	32.2	58.5	1.8	39.2	27.4	15.9	6.1	14.9
Salinity (ppt)	6/13/18	Dry	0.05	0.05	0.10	0.04	0.05	0.06	0.08	0.09	0.07
	8/6/18	Dry	0.12	0.04	0.08	0.05	0.06	0.05	0.04	0.04	0.06
	10/12/18	Wet	0.04	0.04	0.03	0.03	0.04	0.04	0.02	0.02	0.05
	10/24/18	Dry	0.06	0.05	0.08	0.06	0.07	0.07	0.06	0.09	0.10

Note: cfu/100 mL = colony forming units per 100 mililiters, °C = degrees Celsius; s.u.=standard units; mg/L = milligrams per liter; % = percent of saturation; µS/cm = microsiemens per centimeter; NTU = Nephelometric Turbidity Unit, ppt = parts per thousand

Laboratory analyses indicated that dissolved oxygen concentrations were regularly below 5 mg/L at most stations. June sampling had the highest concentrations with a median of 5.1 mg/L. Wet weather samples tested below 5 mg/L of dissolved oxygen at all stations with a median of 3.6 mg/L. Downstream stations, which have wider wetland riparian areas, had lower concentrations and analysis results from the Herod Creek station (HC1) showed less than 2.24 mg/L.

Turbidity concentrations were below 12 NTU during dry weather sampling with a median concentration of 8.6 NTU. Wet weather sample results indicated concentrations between 11 NTU and 31 NTU. Average and median turbidity concentrations were similar at all stations.

Fecal coliform concentrations ranged from 47 cfu/100 mL to 2,500 cfu/100 mL in dry weather samples and from 900 cfu/100 mL to 5,500 cfu/100 mL in wet weather samples (**Figure 8**, **Figure 9**, **Figure 10**, and **Figure 11**). Concentrations were frequently greater than 200 cfu/100 mL at all stations during dry weather monitoring and greater than 1,000 cfu/100 mL during wet weather monitoring (**Figure 12** and **Figure 13**). Data did not indicate that one section of Chickasawhatchee Creek or its tributaries was the dominant source of fecal coliform. Results show that multiple sources throughout the watershed are contributing to the elevated fecal coliform concentrations.

Water quality data from GAEPD were not categorized as wet weather or dry weather but high fecal coliform concentrations did not necessarily coincide with precipitation events measured at nearby USGS stream gages. Concentrations did, however, fall within a similar range as the samples in 2018, from 20 MPN/100 mL to 3,000 MPN/100 mL (GAEPD samples were analyzed for most probable number, the statistical probability of the number of organisms, while samples collected in 2018 were analyzed for colony forming units, an actual count of the number of colonies. The two analyses can differ but are comparable).

3.2 FECAL COLIFORM LOADING

The fecal coliform concentrations of the four samples collected at CC3 were 173 cfu/100 mL, 220 cfu/100 mL, 5,500 cfu/100 mL, and 548 cfu/100 mL. The average concentration was 1,610 cfu/100 mL which requires an 89% reduction to meet the 175 cfu/100 mL TMDL.

The TMDL was expressed by the USEPA as a concentration and not as a load; however, the approximate load in 2018 is estimated. With a 2018 annual discharge of 134 cfs measured at USGS gage 02354350, the TMDL allows a daily load of about 5.73E11 cfu. The average load of the four samples collected in 2018 was 5.28E12 cfu.

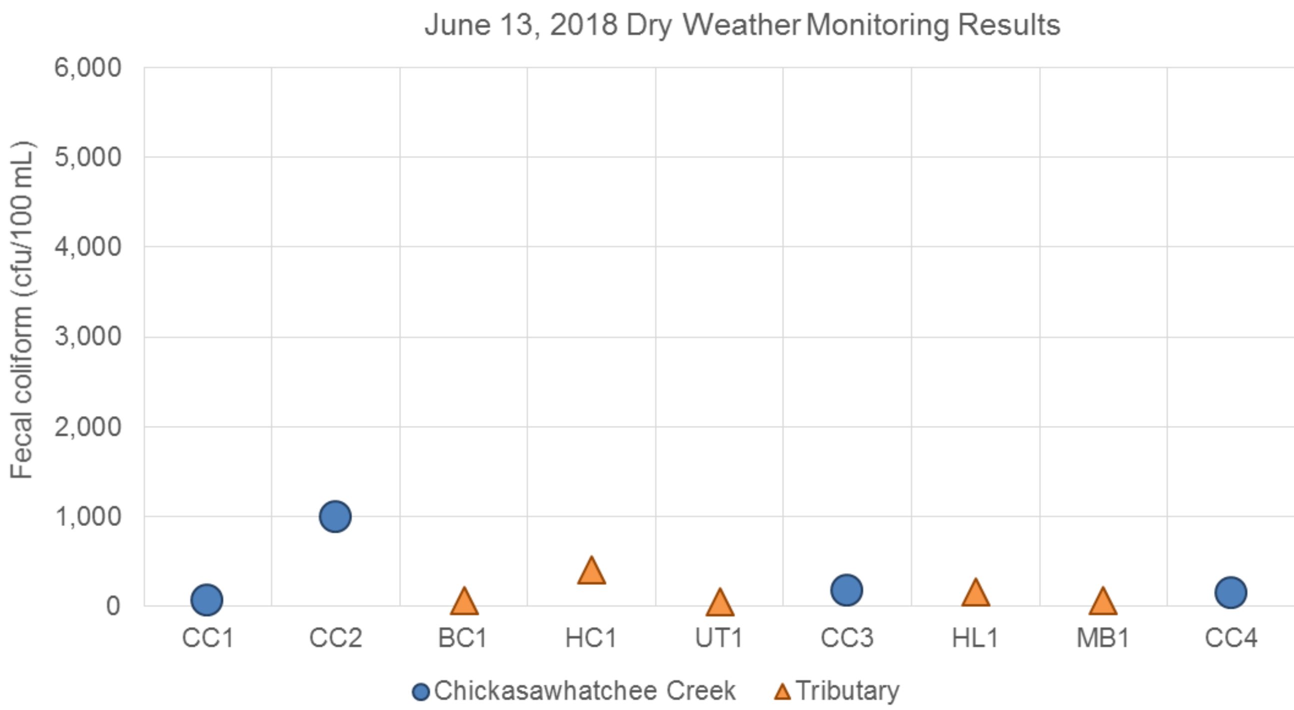

Figure 8. Chickasawhatchee Creek WMP water quality sampling locations

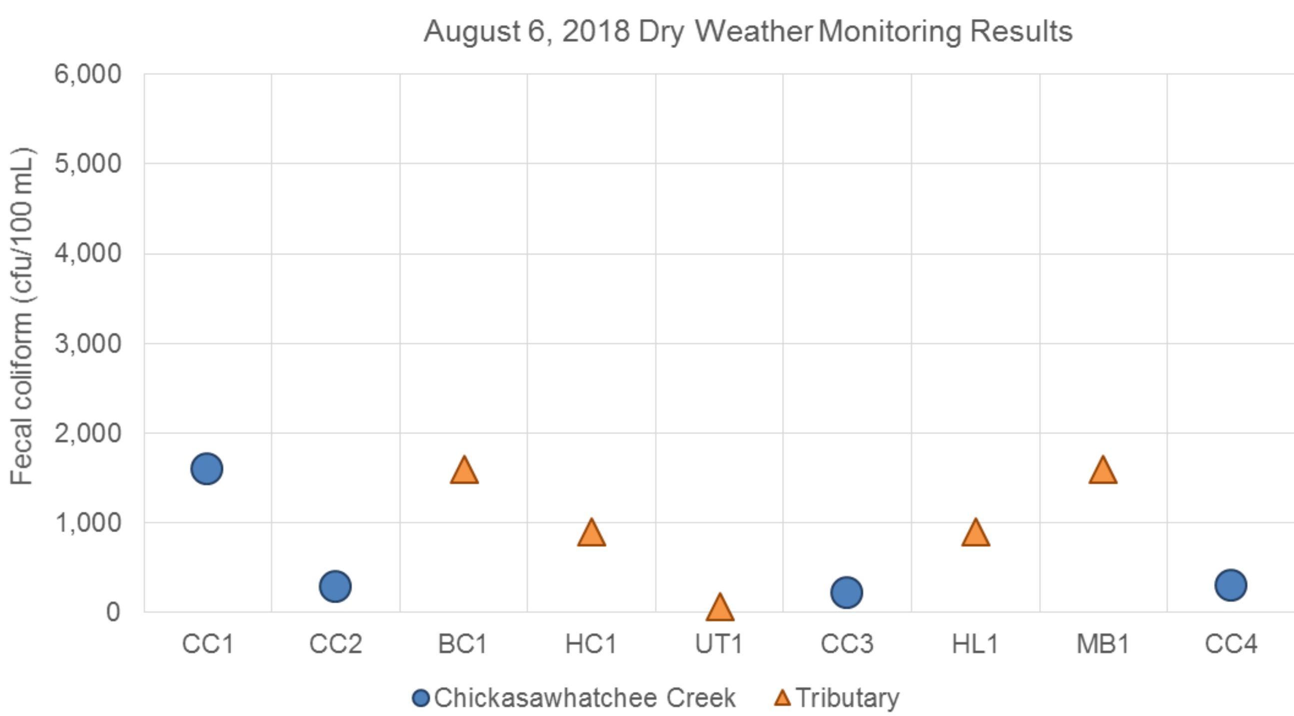

Figure 9. Chickasawhatchee Creek WMP water quality sampling locations

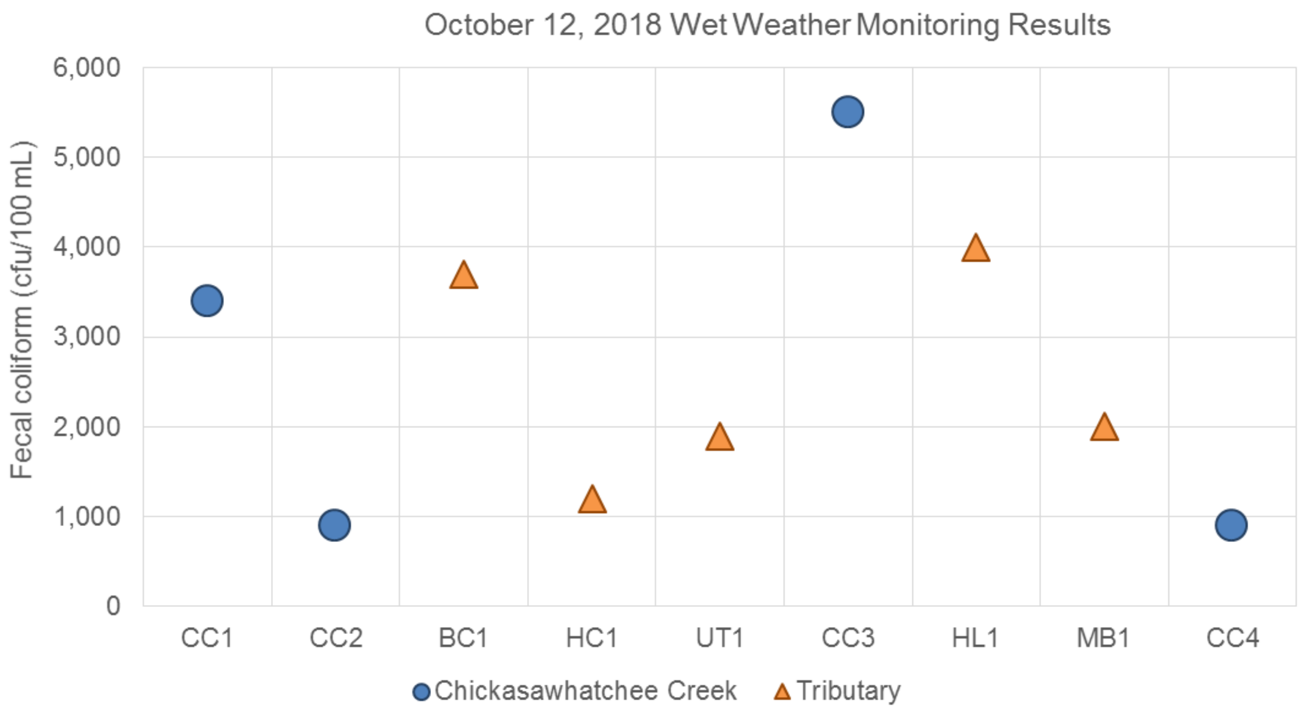

Figure 10. Chickasawhatchee Creek WMP water quality sampling locations

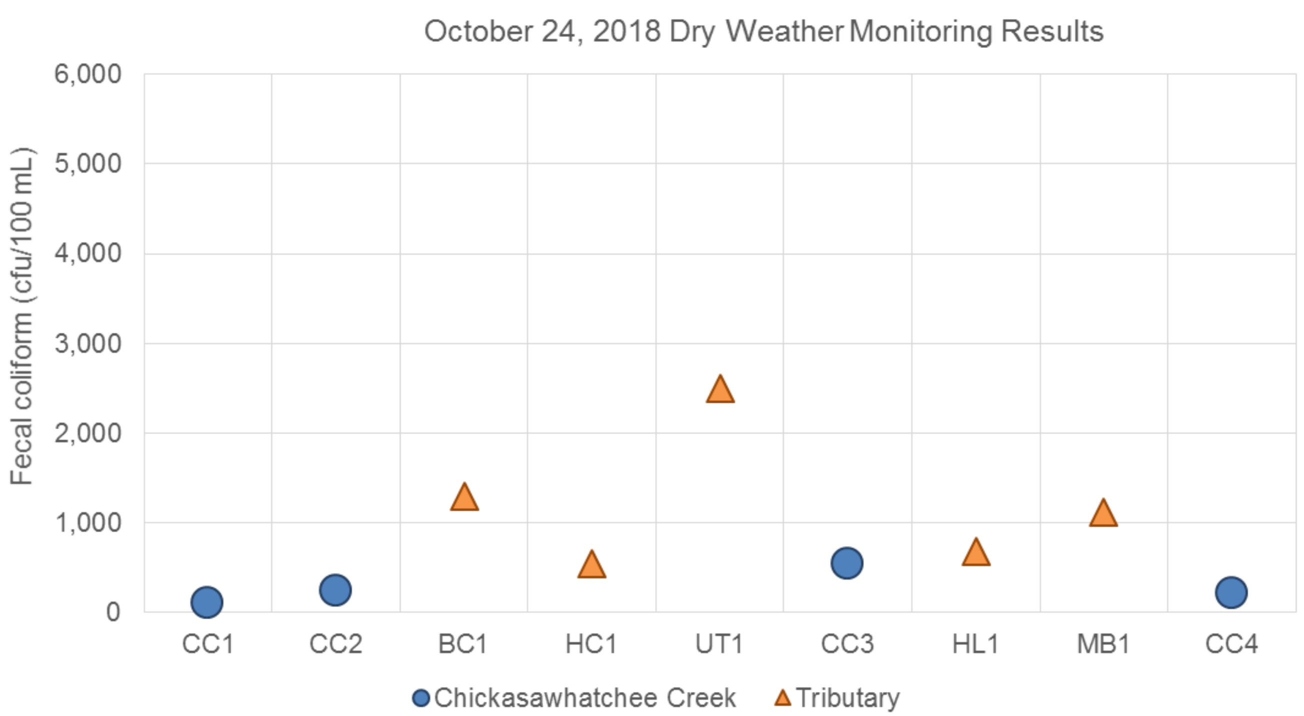

Figure 11. Chickasawhatchee Creek WMP water quality sampling location

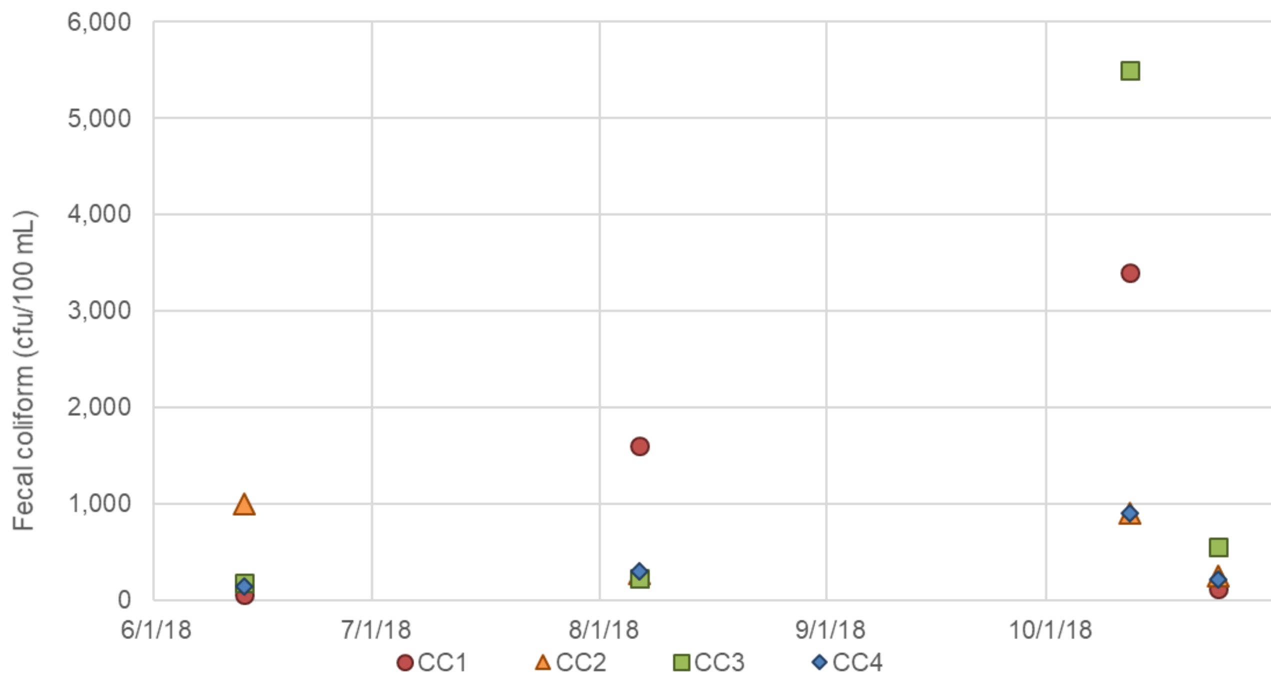

Figure 12. Chickasawhatchee Creek WMP water quality sampling locations

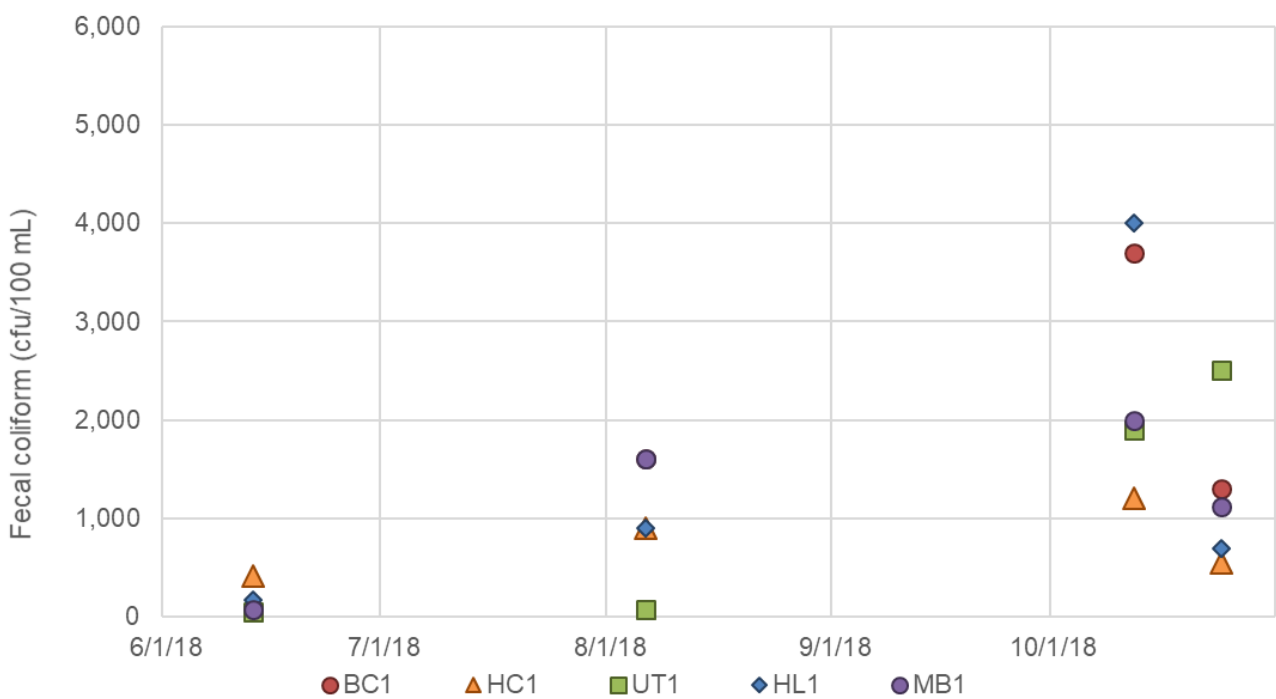

Figure 13. Chickasawhatchee Creek WMP water quality sampling locations

4.0 POLLUTANT SOURCE IDENTIFICATION

A desktop and visual stream assessment of the watershed were conducted to identify potential sources of fecal coliform to Chickasawhatchee Creek and Brantley Creek. Aerial imagery of the watershed and land use classifications were reviewed as part of the desktop analysis and to prepare for the visual stream assessments performed on May 3 and 4, 2018.

The land use review revealed that the most likely sources of fecal coliform in the watershed included wildlife (forested areas), livestock (pasture areas), and humans (City of Dawson Water Pollution Control Plant, stormwater runoff, failing septic systems). Aerial imagery was examined to confirm findings from the land use review, and major features of the watershed were identified, including pastures, livestock barns, and houses. Tree plantations and forested areas were also identified; however, because wildlife is frequently dispersed in these areas, they were not targeted for the visual assessment.

The pasture and residential areas identified as potential fecal coliform sites during the aerial imagery review were visited in the field and were viewed from public roadways. Photos were taken of the sites and observations were noted. For sites and/or site areas that were not visible from roads, observations were made at the nearest downstream road/stream crossing. Several potential sources not identified during aerial imagery review were discovered while traveling between previously identified sites. Observations were made, and photos were taken at these discovered sites.

4.1 DESKTOP ANALYSIS

A statistical and geographic information system (GIS) analysis was conducted to determine the location and possible magnitudes of fecal coliform pollution sources in the Chickasawhatchee Creek Watershed. Publicly available data were used to identify the number and locations of domesticated animals, number and general locations of septic systems, and presence of wildlife. All of these represent likely sources of fecal coliform in the rural Chickasawhatchee Creek Watershed. However, available information was limited, and more thorough surveys and evaluations can be conducted in the future to help identify the location(s) of additional sources.

4.1.1 Domesticated Animals

Domesticated animals, including pets (dogs and cats), livestock (cattle, horses, and goats), and chicken, are potential sources of fecal coliform bacteria. Even if they do not have direct access, they can deposit feces onto land surfaces that can be transported to nearby waterbodies during rain events if there are no riparian zones. Confined animal feeding operations, such as beef cattle in feedlots, poultry houses, and confined dairy cattle and swine, generate large quantities of fecal material within a limited area with potential for significant bacterial runoff.

There are no accurate counts of domesticated animals in the Chickasawhatchee Creek Watershed. Domesticated animal waste may come from dogs or cats located in the watershed's residential areas. Dog and cat waste may come from both domesticated pets and feral animals. According to the American Veterinary Medical Association, in 2012, 36.5% of households owned an average of 1.6 dogs each. Approximately 30.4% of households owned an average of 2.1 cats each (American Veterinary Medical Association, 2012). Of the households that own cats, approximately 25% to 50% may be outdoor cats that can defecate outdoors. Residences and neighborhoods owning dogs and outdoor cats may see an accumulation of pet waste if owners do not engage in appropriate cleaning practices. This accumulation can lead to an increase in fecal coliform in receiving waters, especially after storm events when the waste is washed into the stormwater drainage systems. According to the U.S. Census

Bureau's 2017 American Community Survey, there are about 1,974 households in the City of Dawson and 127 in Sasser which could house up to 1,783 pets and 115 pets in each city, respectively (**Table 4**).

Table 4. Estimated number of household pets in Chickasawhatchee Creek Watershed cities

City	Est. No. Households	Est. No. Dogs	Est. No. Outdoor Cats	Est. Total No. Pets
Dawson	1,974	1,153	630	1,783
Sasser	127	74	41	115
Total	**2,101**	**1,227**	**671**	**1,898**

The Center for Agribusiness and Economic Development produces an annual database, the Georgia Farm Gate Value Report, that includes estimates of livestock and chickens in each county in Georgia. The estimates are provided by the University of Georgia County Extension Agents. According to the 2016 Farm Gate Value Report, no livestock were present in Baker County, which may have been an error in the report as livestock are likely present in the county. Calhoun County had the largest share of livestock with a total of 7,550 cattle, while Terrell County and Dougherty County had 3,530 and 3,050 heads of livestock respectively (The Center for Agribusiness & Economic Development 2017).

In addition to livestock, poultry farming is active in these four counties. According to the 2016 Farm Gate Value Report, 72 chicken broiler houses were operating in Baker, 48 in Calhoun, and 4 in Dougherty County. Baker County also had 22 hatching layers and 65,000 quail and Dougherty County had 8,000 quail (The Center for Agribusiness & Economic Development, 2017).

The location of the livestock and chickens within the counties was not provided. These animals may be evenly distributed or could be clustered in specific areas. The livestock density was calculated assuming that the animals were evenly distributed in each pasture in each county. The total acreage of pasture for each county was calculated using 2008 GLUT data (**Table 5**). These pasture areas, along with the estimated number of livestock in the counties, were used to estimate the density of livestock per pasture acre. Calhoun County, Dougherty County, and Terrell County were estimated to have densities of 0.9, 0.4, and 0.3 livestock per acre of pasture, respectively.

Table 5. Estimated density of livestock on pasture land in Chickasawhatchee Creek Watershed

	County Wide		Chickasawhatchee Creek Watershed	
County	Est. Pasture Acres	Est. Livestock per Acre Pasture	Est. Pasture Acres	Est. No. Livestock
Baker	15,697	0.0	1	0
Calhoun	8,842	0.9	531	478
Dougherty	7,142	0.4	117	47
Terrell	12,697	0.3	3,659	1,100
Total	**44,378**		**4,308**	**1,625**

The total acreage of pastures in Chickasawhatchee Creek Watershed were also calculated using the 2008 GLUT data. Terrell County has an estimated 3,659 acres in pasture, nearly seven times greater than Calhoun County and 31 times greater than Dougherty County. Assuming the same livestock density applies to the acres of pasture within the Chickasawhatchee Creek Watershed, there are an estimated 1,100 livestock head in Terrell County and an estimated 478 livestock head in Calhoun County.

These numbers are estimated and could be significantly different than the number of livestock residing in the county. In addition, the locations of the livestock, their proximity to the creek and its tributaries, and if they have unrestricted access to the stream, are not known. If livestock are provided unrestricted access to streams and water bodies of the Chickasawhatchee Creek Watershed, they may contaminate the water and create a source of fecal coliform loading to Chickasawhatchee Creek.

The number of pastures adjacent to stream reaches that could contribute fecal coliform was approximated by further examining GLUT data. A pasture was estimated to consist of 50 acres of land, approximately 1,500 feet (ft) x 1,500 ft. Pastures potentially contributing contamination were identified by creating a 1,500-ft buffer (selected based on estimated pasture width) around streams acquired from the National Hydrography Dataset (**Figure 14**). The total area classified as pasture land use in the GLUT dataset was calculated in the buffer zone and divided by 50 acres to approximate the number of pastures adjacent to streams (**Table 6**). The number of pastures, within the stream buffer, holding livestock with stream access is estimated at 18% (based on results from the visual stream assessment described in Section 4.2), resulting in 9 pastures, 1 in Calhoun County and 8 in Terrell County.

Table 6. Number of pastures potentially providing stream access

County	Total No. of Pastures Near Streams		Est. No. Pastures Providing Stream Access	
	Visited During Stream Assessment	Desktop Analysis	Visited During Stream Assessment	Desktop Analysis
Baker	0	0	0	0
Calhoun	1	7	0	1
Dougherty	1	0	0	0
Terrell	9	47	2	8
Total	**11**	**54**	**2**	**9**

Poultry litter can also contaminate a waterbody after application as fertilizer for row crops. Fecal coliform bacteria can survive up to eight weeks after application to a field (Shumacher, 2003) and still pose a risk to surface water contamination. In South Georgia, between one and six tons of poultry litter, depending on the crop, may be applied as fertilizer to meet nitrogen requirements (The University of Georgia Cooperative Extension, 2017). The application of this litter can increase median fecal coliform and E. coli densities in crop slurry-water from less than 60 colonies (col)/100 mL to between 40,000 and 420,000 col/100 mL. After excessive irrigation or heavy precipitation events, this slurry-water could easily be transported to nearby waterbodies (Shumacher, 2003).

Total acreage of row crops within 1,500 ft of streams in the Chickasawhatchee Creek Watershed was calculated using 2008 GLUT data (**Figure 14**). Up to 117,636 tons of chicken litter could potentially be applied on row crops near these streams every year with about 83% in Terrell County and 16% in

Calhoun County (**Table 7**). While these estimates are at the extreme, high end of potential use, they do demonstrate the risk of contamination by row crop fertilizer in each county.

Table 7. Potential tons of chicken litter applied to fields of row crops in the Chickasawhatchee Creek Watershed

County	Chickasawhatchee Creek Watershed		1,500-ft Stream Buffer	
	Est. Row Crop Acres	Potential Tons Chicken Litter Applied	Est. Row Crop Acres	Potential Tons Chicken Litter Applied
Baker	10	60	6	36
Calhoun	5,689	34,134	3,154	18,924
Dougherty	1,260	7,562	99	594
Terrell	28,135	168,810	16,347	98,082
Total	**35,094**	**210,566**	**19,606**	**117,636**

Analysis of aerial imagery of the watershed indicates a total of 147 cultivated plots of land in the Chickasawhatchee Creek Watershed that are intersected by streams (**Figure 14**). These plots of land represent pastures and row crops in close proximity to the stream that may contribute fecal coliform.

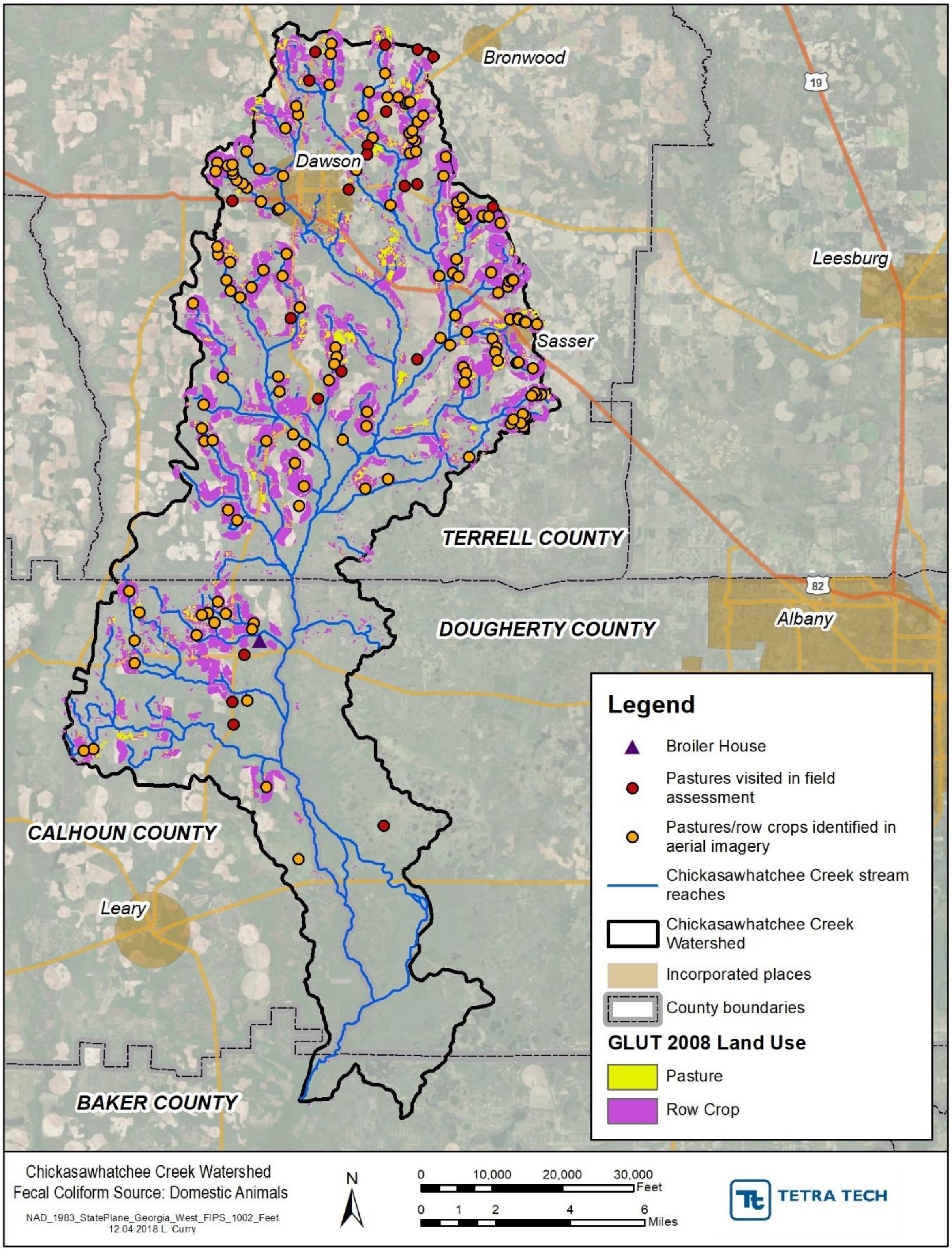

Figure 14. Pastures and row crops in the Chickasawhatchee Creek Watershed stream buffer

Only one chicken house operation was identified in the Chickasawhatchee Creek Watershed using aerial imagery. The broiler house operation was located in northeastern Calhoun County, adjacent to a Chickasawhatchee Creek tributary, Willow Branch (**Figure 15**). This operation consists of 10 structures measuring approximately 510 ft long by 45 ft wide which could house an estimated 287,000 broiler chickens with 8/10 of a square foot per bird (National Chicken Council, 2018). An operation of this scale could increase fecal coliform levels in Willow Creek and downstream sections of Chickasawhatchee Creek, especially if waste by-products are improperly managed and are transported to surface water bodies along natural ground surface flow paths.

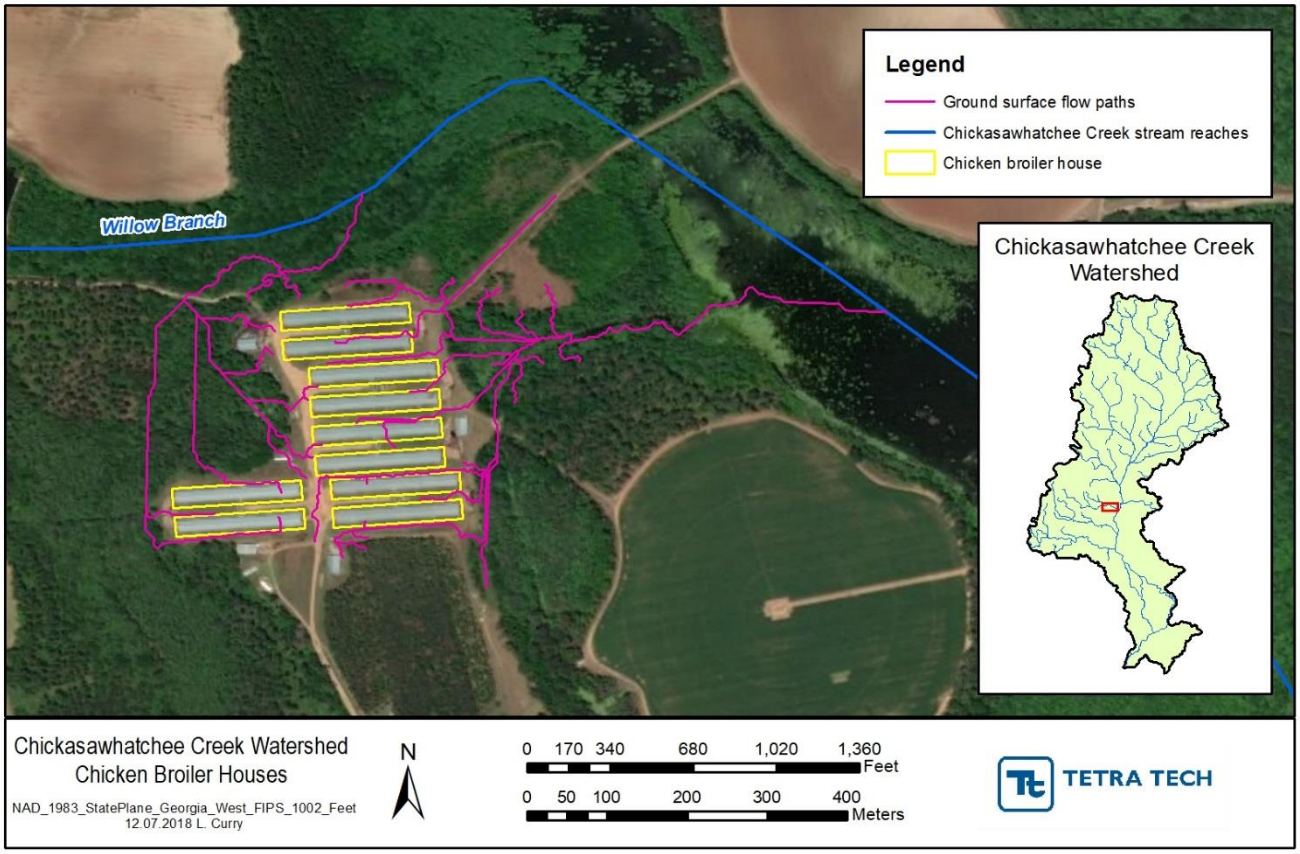

Figure 15. Ten chicken broiler houses located adjacent to Willow Branch in the Chickasawhatchee Creek Watershed

4.1.2 Human Sources

The City of Dawson in Terrell County has a Water Pollution Control Plant (WPCP) that treats the city's wastewater and discharges effluent into Brantley Creek, a tributary that meets Chickasawhatchee Creek about six miles downstream of the plant. The WPCP treats a flow that ranges from a monthly average of 0.5 million gallons per day (MGD) to 2.7 MGD. The effluent comprises from 0.5% to 91% of the average weekly measured flow at USGS stream gage 02354350 (**Figure 16**). The plant has a weekly geometric average fecal coliform concentration limit of 400 MPN/100 mL and has exceeded that limit 11 times since December 2015 by anywhere from 10% to 323%. These fecal coliform concentration violations account for about 28% of all measurements of weekly geometric means reported by the WPCP.

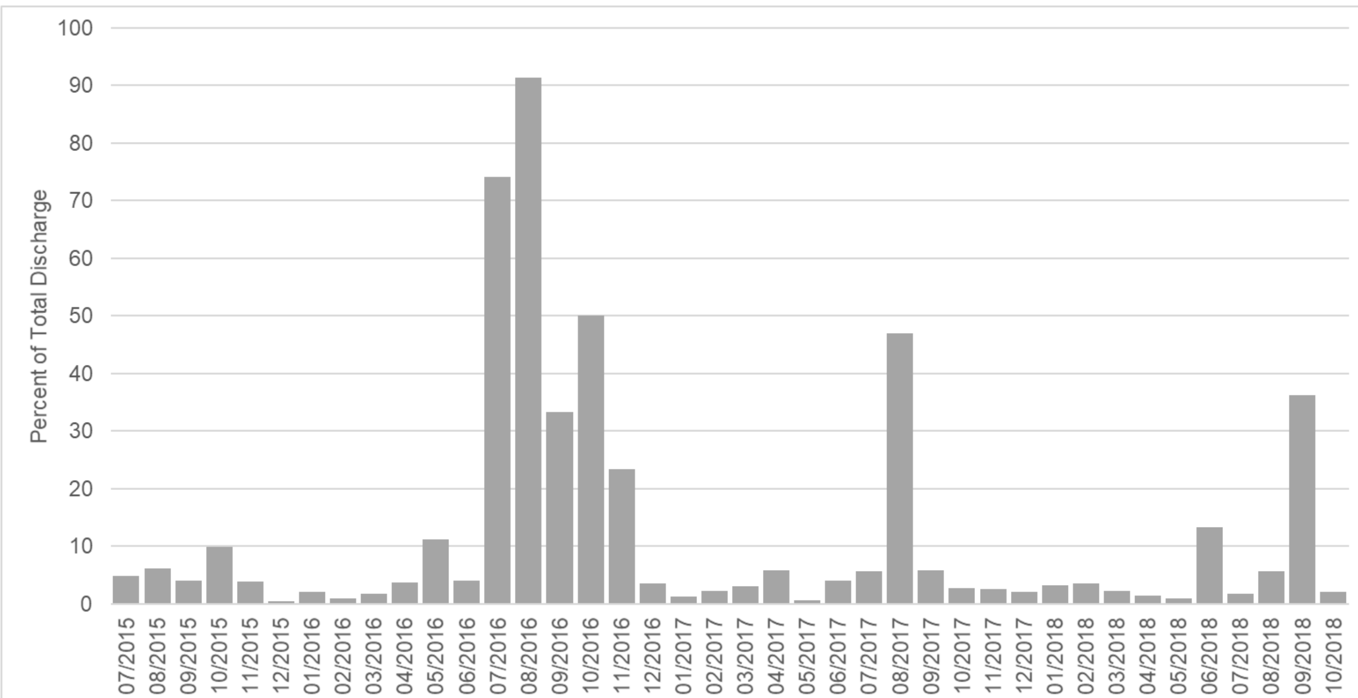

Figure 16. Percent of total discharge at USGS stream gage 02354350 originating from City of Dawson WPCP

Since a map of the City of Dawson WPCP service network is unavailable, all houses and businesses located outside of the city limits were assumed to be serviced by on-site septic systems. The number of septic systems in the Chickasawhatchee Creek Watershed and their locations are unknown but were approximated based on aerial imagery. All residential and commercial structures outside of the City of Dawson were marked in Google Earth and counted to estimate the number of installed septic systems in each county within the Chickasawhatchee Creek Watershed as well as those that are within the 1,500-ft stream buffer (**Figure 17**).

According to national statistics, approximately 15% of the septic systems in the United States are categorized as failing. Of the 753 septic systems counted in aerial imagery within the 1,500-ft stream buffer, approximately 113 are estimated to be failing and require repairs or replacement (**Table 8**). About 10% of the failing septic systems are in Calhoun County and 90% in Terrell County.

Table 8. Estimated number of septic systems counted in aerial imagery

County	Chickasawhatchee Creek Watershed		1,500-ft Stream Buffer	
	Est. Septic Systems	Est. Failing Septic Systems	Est. Septic Systems	Est. Failing Septic Systems
Baker	0	0	0	0
Calhoun	114	17	75	11
Dougherty	32	5	1	0
Terrell	1028	154	677	102
Total	**1,174**	**176**	**753**	**113**

A second method using GLUT land use data and estimates from the Georgia State Water Plan of existing septic systems by county was implemented. The total number of septic systems in each county was divided by the total area of developed land to calculate the density of septic systems per acre of developed land in each county (**Table 9**). This density was multiplied by the acres of developed land in the 1500-ft stream buffer (after subtracting all developed land within the Dawson City limits). The results showed a much higher number of septic systems than were counted in aerial imagery, especially in Dougherty and Terrell County. This difference could be accounted for by the high number of septic systems around other cities and towns, like Albany, that may increase the number of septic systems per acre in Dougherty County, and the potential presence of septic systems in the excluded area of Dawson City in Terrell County. Using the same 15% failure rate, 210 septic systems are estimated to be failing in the 1500-ft buffer around Chickasawhatchee Creek and its tributaries. There were slight differences in the distribution between the three counties with 6% of failing septic systems within the 1,500-ft stream buffer in Calhoun County, 2% in Dougherty County, and 92% in Terrell County.

Table 9. Estimated number of septic systems from county estimates

County	County Wide			1,500-ft Stream Buffer		
	Est. Acres Developed Land	No. Septic Systems	Est. Septic Systems per Acre Developed Land	Est. Acres Developed Land	Est. No. Septic Systems	Est. No. Failing Septic Systems
Baker	12,109	1,963	0.16	3	0	0
Calhoun	7,391	1,173	0.16	557	88	13
Dougherty	37,690	10,139	0.27	86	23	3
Terrell	10,670	5,089	0.48	2,713	1,294	194
Total	**67,860**	**18,364**		**3,359**	**1,405**	**210**

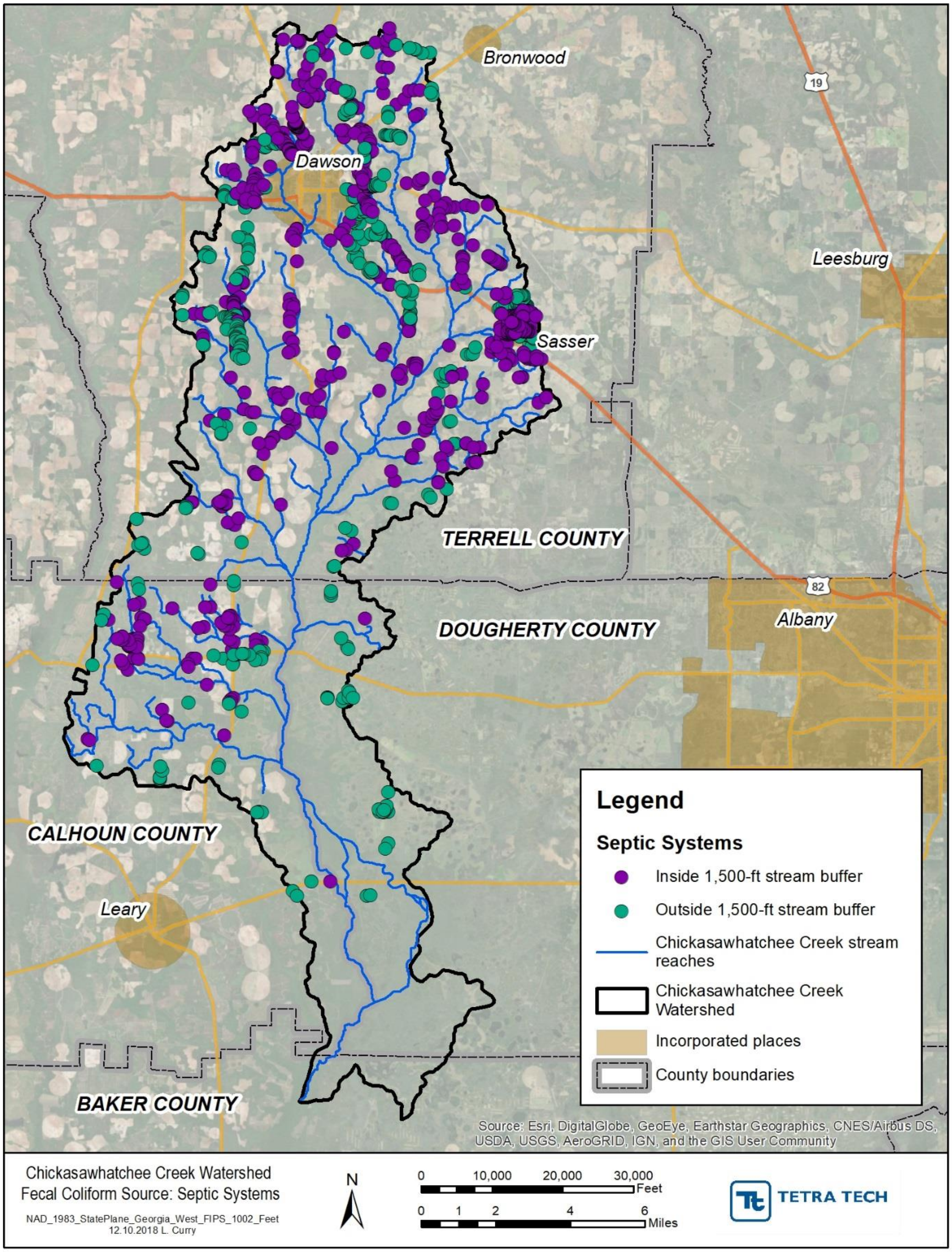

Figure 17. Chickasawhatchee Creek Watershed estimated septic system locations

4.1.3 Wildlife

Deer, feral hogs, and other wildlife inhabit areas of southwestern Georgia that contain suitable habitat. According to 2008 GLUT data, land use in the Chickasawhatchee Creek Watershed includes areas of forests and wetlands that attract significant populations of wild animals (**Figure 18**). These animals will use available water resources and are likely to contaminate them with fecal matter. This could be a factor that increases levels of fecal coliform and impairs reaches of Chickasawhatchee Creek. There are approximately 70,600 acres of forests and wetlands in this basin, more than half of the basin's area, where this source is likely present.

According to Georgia's Deer Management Plan released in 2014, this region of Georgia is inhabited by approximately 25 to 30 deer per square mile of suitable habitat. The Chickasawhatchee Creek Watershed could contain up to 3,300 deer (**Table 10**) with 3% in Baker County, 24% in Calhoun County, 27% in Dougherty County, and 46% in Terrell County.

Feral hog populations in Georgia present a variety of environmental concerns. Two ongoing research projects in nearby Stewart County and Dooly County, once of which is being conducted by the U.S. Department of Agriculture indicate that feral hogs are significant contributors to fecal coliform loading in streams. These animals inhabit similar areas as deer. Population estimates in the region were not available, but they could reach population densities of up to 10 hogs per square mile or greater (Conger, Young, & Heckmann, 1999). Up to 1,200 feral hogs could inhabit the Chickasawhatchee Creek Watershed.

Table 10. Deer and feral hog habitat and estimated populations

County	Total Forest and Wetland in Acres	Deer Population (30/sq. mi.)	Feral Hog Population (10/sq. mi.)
Baker	2,100	100	<100
Calhoun	17,500	800	300
Dougherty	18,500	900	300
Terrell	32,500	1,500	500
Total	**70,600**	**3,300**	**1,100**

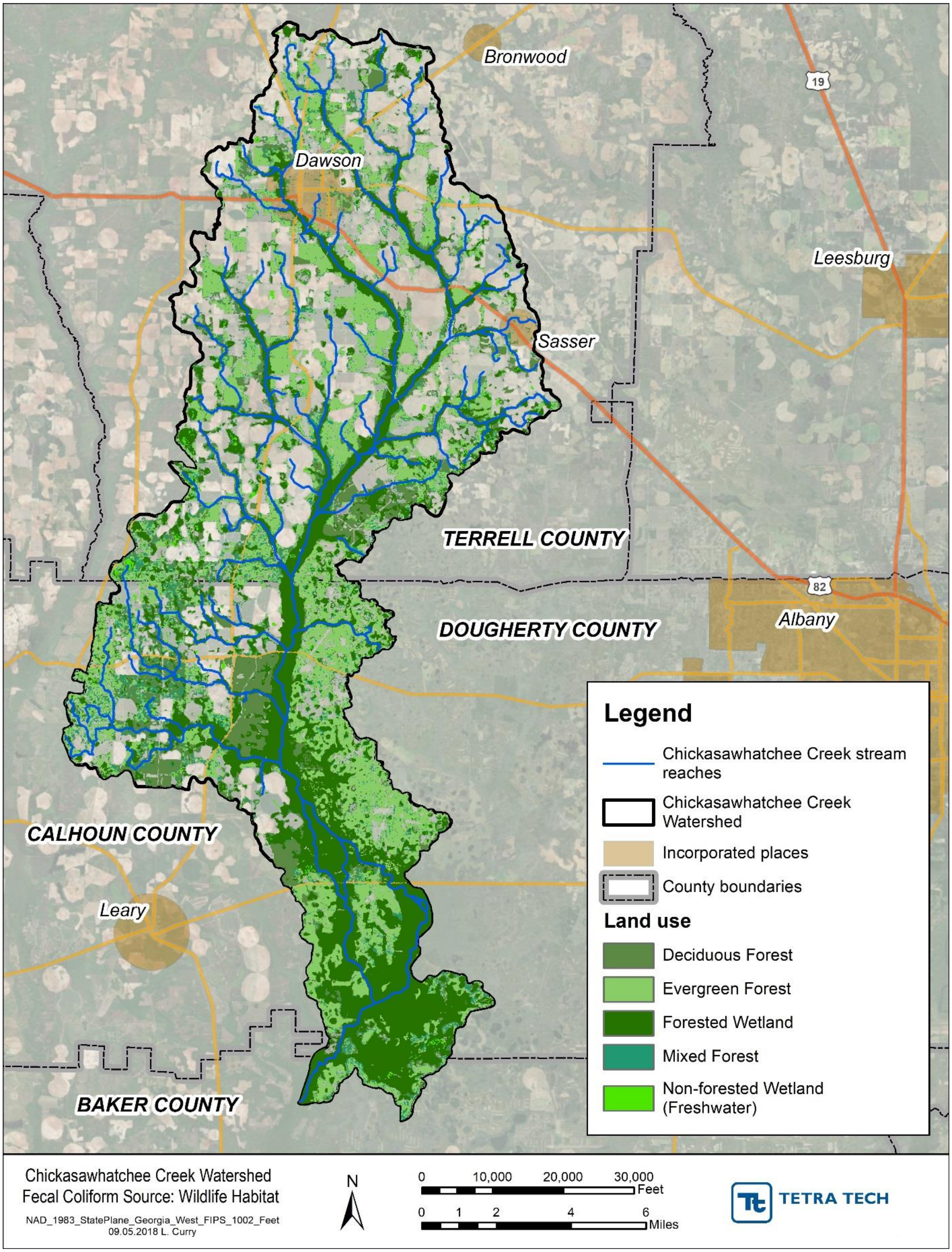

Figure 18. Chickasawhatchee Creek Watershed forested and wetlands land use

4.1.4 Conclusion of Desktop Analysis

While each identified source contributes fecal coliform loads to the Chickasawhatchee Creek Watershed, those contributions vary in the effect they have on fecal coliform concentration levels. Comparing estimated numbers of animals in the watershed reveals which source may have the greatest effect and require the most mitigation.

Between the potential 287,000 chickens in the 10 broiler houses and the potential 117,636 tons of chicken litter applied to row crops within 1,500 ft of Chickasawhatchee Creek stream reaches, chickens may represent a large source of fecal coliform loading in the watershed. Wildlife also presents a risk, with an estimated 3,300 deer and 1,100 feral hogs in the watershed. Dogs and cats also contribute a much smaller load to fecal coliform levels with an estimated 1,900 pets living in residential areas of the Chickasawhatchee Creek Watershed. Finally, the estimated 1,625 livestock produced in the watershed may also pose a risk, specifically when the animals have access to streams.

Not only do the chickens in the broiler houses represent such a large number of animals, their location is also directly upstream of the GAEPD monitoring station 1109070501, which could elevate this source’s contribution to the stream’s impairment. The wet weather sample from the water quality monitoring location CC3, collected from the same location as the GAEPD monitoring station 1109070501, showed the highest concentration of fecal coliform of all samples collected in 2018. This could also indicate the likelihood of this source’s runoff contributing to fecal coliform loading in Chickasawhatchee Creek.

Fecal coliform from human sources is contributed from the WPCP and from septic systems. Assuming that the failing septic systems receive approximately 167 gallons/day each (GAEPD, 2008), they could potentially leak a total of 35,070 gallons of untreated sewage near stream reaches. This compares to the 3,700,000 gallons per day weekly average of treated wastewater discharged from the WPCP.

The measurements of fecal coliform concentrations that were collected over 2018 from the CC3 sampling point show elevated levels that coincide with higher rates of discharge at the USGS stream gage in the same location. This indicates that fecal coliform loading is probably greatest during precipitation events when runoff may carry accumulated fecal matter into receiving waters.

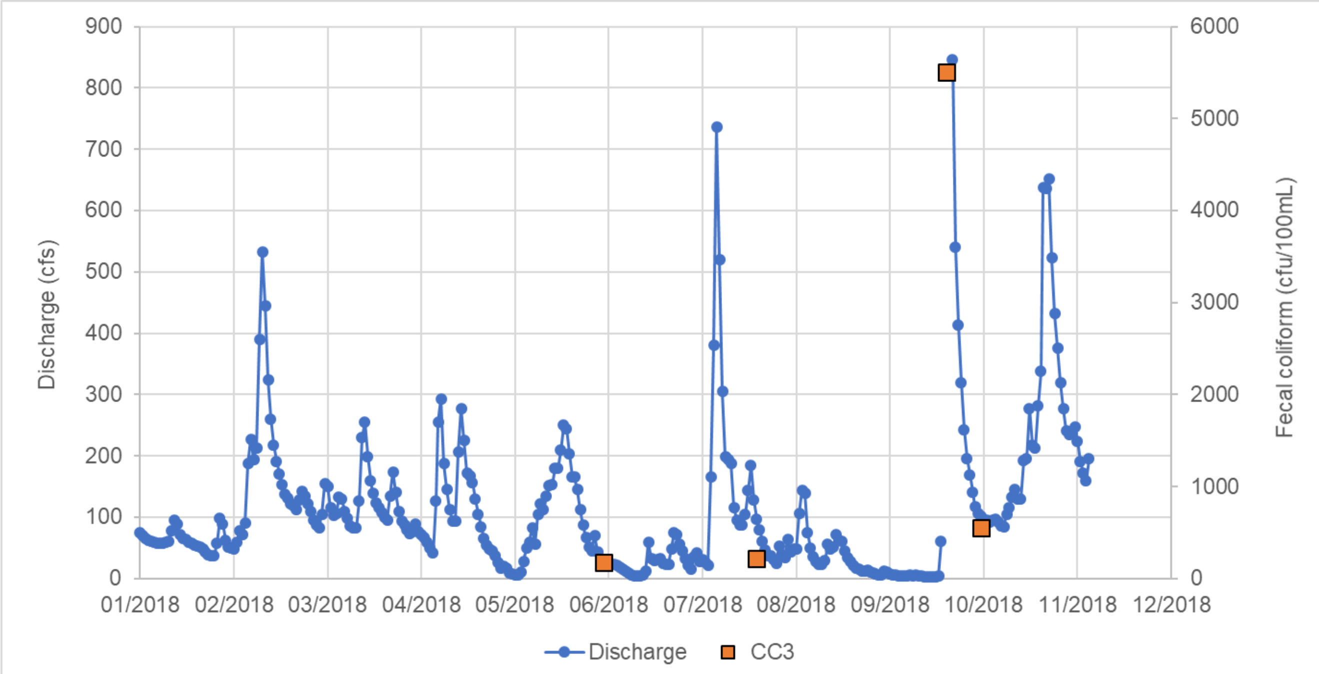

Figure 19. Discharge and fecal coliform concentrations at water quality sampling point CC3

4.2 FIELD OBSERVATIONS

The desktop analysis indicated that livestock in the Chickasawhatchee Creek Watershed, including cattle, horses, and goats, are potential sources of fecal coliform, especially when livestock have direct access to a stream. Out of 21 pastures visited during the visual stream assessment, there were only two locations that were identified where livestock had stream access: site 007 and site 059 (**Figure 20**). Of the other 19 locations, nine of the pastures had fences to keep livestock out of the streams (**Table 6**). Stream access could not be determined for the remaining 10 pasture locations because streams were not visible from the road.

The landscape, in general, was characterized as a low relief plain scattered with gentle depressions, and low-gradient streams that flow in broad, swampy, valleys. Of the observed depressions, some held water as cypress swamps, while others were dry on pasture land (**Figure 21**). It was not clear if rainfall runoff into the dry depressions is directly connected to groundwater aquifers. If there is connection, these could represent a potential source, specifically during baseflow.

Rural houses passed and visited during the visual assessment did not have any indicators of failed septic systems. These indicators typically include seepage from soils and odors.

Stream observations were made at 18 road crossing locations during the visual stream assessment. Notes were taken for excessive algae growth, which is frequently used as a surrogate for nutrient pollution associated with fecal coliform, water color, flow, and odor. Excessive algal growth was not noted at any sites. Minor amounts of algae were noted at five sites, and no algae was seen at the remaining 13 sites. Flows were either stagnant or very slow at all sites with the water typically tea-stained in color. No odors were noted at any site. The stream water at site 049, located on Brantley Creek below the City of Dawson where GAEPD samples water quality, was clear with a slight gray tint associated with urban streams (**Figure 22**).

Figure 20. Livestock with access to a spring that connects to a stream at Site 059

Figure 21. Depression with no surface runoff outlet in a pasture at Site 053

Figure 22. Stream flow with slight gray tint, note tuft of algae on rock on lower right, at Site 049

5.0 BEST MANAGEMENT PRACTICES

BMPs were selected that can be implemented to reduce the potential fecal coliform sources identified in the Chickasawhatchee Creek Watershed.

5.1 AGRICULTURAL BMPS

Using data from the visual stream assessment and desktop analyses, nine pastures in the Chickasawhatchee Creek Watershed, mostly in Terrell County, are estimated to provide stream access to livestock. These pastures require an agricultural BMP to reduce fecal coliform loading caused by direct contact between livestock and streams. Pastures where livestock have stream access should be equipped with alternative watering sources and fencing or vegetative buffers to prevent livestock stream access and to reduce surface water contamination. Additional vegetative buffers should be installed around the chicken broiler houses in Calhoun County to prevent runoff from carrying fecal coliform loads to Willow Branch, as well as around the potentially 147 row crops near Chickasawhatchee Creek stream reaches that could be applying chicken litter as fertilizer.

5.2 SEPTIC SYSTEM BMPS

Failing septic systems can lead to increased fecal coliform contamination from human sources and should be repaired to prevent further watershed contamination. Using aerial imagery, land use data, and national statistics, up to 210 septic systems in the Chickasawhatchee Creek Watershed stream buffer, out of approximately 1,405 total septic systems, are estimated to require maintenance and repair.

A program should be implemented to inspect all aging septic systems installed 15 or more years ago to determine more specifically which systems require repairs or replacement. These systems can be cost-prohibitive to replace or repair, but the watershed would benefit from a cost-share program that incentivizes landowners to report failing septic systems, invest in septic system maintenance, and repair or replace septic systems when necessary.

5.3 EDUCATION AND OUTREACH BMPS

Outreach to the public can be an effective tool that reduces input from fecal coliform sources within the community. This can consist of general education about the significance of watersheds as well as more specific, targeted outreach to address known sources.

The community is encouraged to form an Adopt-A-Stream group that is committed to monitoring, restoring, and protecting the Chickasawhatchee Creek Watershed. This group could take an active role in ensuring the implementation of BMPs and the reduction of fecal coliform levels to meet GAEPD targets.

Outreach to pet owners that educates them on, and provides resources for, proper pet waste management could aid in reducing fecal coliform loading from dogs and cats.

While replacement of failing septic systems is necessary to prevent current contamination of the watershed, education programs should be implemented to instruct landowners on proper maintenance of septic systems. Workshops should be provided as a proactive defense against future fecal coliform contamination.

Improper disposal of animal carcasses from hunting activities can lead to increased fecal coliform levels. Educational presentations and workshops should be provided to local hunting groups to teach residents about the potential contamination of creeks by improper carcass disposal.

6.0 FINANCIAL AND TECHNICAL ASSISTANCE

6.1 ESTIMATED COST OF BMP IMPLEMENTATION

Implementation of BMPs for the Chickasawhatchee Creek WMP would rely heavily on funding from the Clean Water Act (CWA) Section 319 grants provided by GAEPD, if available and awarded. Other stakeholders including landowners, local municipalities, and local public works departments could provide required matching funds or resources such as educational expertise and venues for workshops. Many local organizations and companies will be relied on to help communicate with residents, farmers, landowners, and hunters.

The total estimated cost of implementing all BMPs is approximately $1,635,217 (**Table 11**). This cost includes $354,717 to install fences and alternative water sources in nine locations where livestock currently have stream access and to install 10 acres of forest buffers in 167 locations that include pastures, row crops, and broiler houses that may contribute fecal coliform loads from agricultural runoff to Chickasawhatchee Creek; $1,261,500 for inspecting and replacing failing septic systems; and $19,000 to implement a pet waste management program and provide local landowners, farmers, and hunters with six educational workshops on septic system maintenance, wildlife management, and animal carcass disposal for one year. GAEPD's CWA Section 319 funds could cover 60% of the total cost, or $981,130, while the remaining $654,087 would need to be from local matching funds.

Table 11. BMP implementation cost estimates (Limestone Valley RC & D Council, 2013) (USDA NRCS, 2018)

BMP Type	Item	Quantity	Unit	Cost/Unit	Cost Estimate
Agricultural BMPs	Fencing	9,000	linear foot	$3	$27,000
	Water well	9	each	$6,172	$55,548
	Watering facility	9	each	$659	$5,931
	Riparian forest buffer	1570	acre	$318	$499,260
Total Agricultural BMPs					**$587,739**
Septic System BMPs	Septic system inspection	1,405	each	$300	$421,500
	Septic system replacement	210	each	$4,000	$840,000
Total Septic System BMPs					**$1,261,500**
Educational Workshops	Septic system maintenance workshop	3	each	$1,500	$4,500
	Wildlife management and carcass disposal workshop	3	each	$1,500	$4,500
	Pet waste management program	1	each	$10,000	$10,000
Total Education Workshops					**$19,000**
Total Cost					**$1,868,239**

The most cost-effective BMP options should be implemented first, which will help keep implementation costs manageable. Removing stream access for livestock on pastures and providing livestock with an alternative water supply as well as installing stream buffers around row crops and pastures will eliminate known sources of fecal coliform contamination. In combination with educational workshops, these BMPs may be sufficient to decrease fecal coliform concentrations to acceptable levels to remove the creeks within the Chickasawhatchee Creek Watershed from the list of impaired streams. Implementation of these two BMPs would cost $606,739and could be pursued in the first year of watershed restoration. Continued monitoring will be required to evaluate the success of these BMPs and to determine if the additional BMPs to inspect and replace septic systems are necessary or can be implemented only in key locations.

6.2 STAKEHOLDERS

Local agencies, companies, and organizations were identified as stakeholders that may have an interest in restoring the Chickasawhatchee Creek Watershed. These parties can be expected to contribute to the implementation of the WMP BMPs as noted in **Table 12**.

Table 12. Stakeholders and role in BMP implementation

Stakeholder	Organization Type	Role in BMP Implementation
Calhoun County Board of Commissioners	County agency	Provide matching funds for septic system replacement and agricultural BMPs
Calhoun County Consumer-Technology-Agricultural Education	County organization	Provide expertise in agricultural BMP implementation and communication with local landowners and farmers
Calhoun County Forestry Unit	County agency	Provide expertise in agricultural BMP implementation and communication with local landowners and farmers
Calhoun County Health Office	County agency	Provide expertise in septic system maintenance and communication with local landowners
Chickasawhatchee Wildlife Management Area	State agency	Provide expertise in wildlife management and animal carcass disposal and communication with local hunters, landowners, and farmers
City of Dawson	Municipality	Provide matching funds for septic system replacement
City of Sasser	Municipality	Provide matching funds for septic system replacement
Dougherty County - Environmental Health	County agency	Provide expertise in septic system maintenance and communication with local landowners
Dougherty County - Keep Albany-Dougherty Beautiful	County organization	Communication with local landowners
Dougherty County - Public Works	County agency	Provide matching funds for septic system replacement
Farmer/Landowner	Individual	Provide matching funds for septic system replacement and agricultural BMPs
Flint River Soil & Water Conservation District	Regional organization	Provide expertise in watershed management and communication with local landowners
Flint River Water and Planning Policy Center	Regional organization	Provide expertise in watershed management

Stakeholder	Organization Type	Role in BMP Implementation
Flint Riverkeeper	Regional organization	Provide expertise in watershed management and communication with local landowners
Flint Riverquarium - Environmental Education Center	Local organization	Communication with local landowners and residents
GADNR Fisheries Southwest Region 3	State agency	Provide expertise in wildlife management and animal carcass disposal and communication with local hunters, landowners, and farmers
GADNR Game Management Southwest Region 5	State agency	Provide expertise in wildlife management and animal carcass disposal and communication with local hunters, landowners, and farmers
GAEPD	State agency	Provide Clean Water Act Section 319 grants to fund agricultural, septic system, and education BMPs
Georgia Department of Community Affairs Region 10	State agency	Communication with local hunters, farmers, and landowners
Georgia Forestry Commission	State agency	Provide expertise in agricultural BMP implementation
Gillionville Plantation Lodge	Private establishment	Communication with local hunters, farmers, and landowners
Golden Triangle Resource Conservation & Development Council	Local organization	Provide expertise in agricultural BMP implementation and communication with local landowners and farmers
Hooks-Hanner Environmental Resource Center	Local organization	Provide expertise in agricultural BMP implementation and communication with local landowners and farmers
Joseph W. Jones Ecological Research Center at Ichauway	Local organization	Provide expertise in agricultural BMP implementation and communication with local landowners and farmers
Magnolia Plantation	Private establishment	Communication with local farmers and landowners
Mark's Melon Patch	Private establishment	Communication with local farmers and landowners
Natural Resources Conservation Service	U.S. agency	Provide expertise in agricultural BMP implementation and communication with local landowners and farmers
Quail Valley Farm	Private establishment	Communication with local farmers and landowners
Sudderth Chicken Houses	Private establishment	Communication with local farmers and landowners
Terrell County Board of Commissioners	County agency	Provide matching funds for septic system replacement and agricultural BMPs
UGA CAES Extension Agent- Calhoun	University program	Provide expertise in agricultural BMP implementation and communication with local landowners and farmers
UGA CAES Extension Agent- Dougherty	University program	Provide expertise in agricultural BMP implementation and communication with local landowners and farmers
UGA CAES Extension Agent- Terrell	University program	Provide expertise in agricultural BMP implementation and communication with local landowners and farmers

7.0 EDUCATION AND OUTREACH

A key component for success of the WMP is to educate the public about the importance of water quality in the Chickasawhatchee Creek Watershed and to provide information about the BMPs they can implement to help achieve the water quality goals. Many of the plan elements require public participation so outreach to improve the public's understanding of the WMP and the part they can play will be needed for successful plan implementation. The WMP education and outreach should focus on informing the local citizens and agricultural producers about the fecal coliform issues in the Chickasawhatchee Creek Watershed and how individual decisions can impact water quality, how they can address those impacts, and what solutions exist. **Table 13** summarizes the recommended outreach and education activities to support the WMP.

Table 13. Recommended education and outreach efforts

Tasks	Actions
Agricultural BMP Implementation	Distribute materials about livestock management options
	Conduct meetings and trainings to inform producers about options to limit fecal coliform impacts
Septic System Maintenance and Repairs	Prepare and distribute educational brochures, fliers, and direct mailers about septic system maintenance
	Conduct meetings and trainings to inform local citizens on proper septic system maintenance
Pet Waste Management	Prepare and distribute educational brochures, fliers, and direct mailers in water bill
	Develop and post signage throughout the watershed to promote picking up after a pet
Wildlife Management	Prepare and distribute educational brochures, fliers, and direct mailers
	Conduct feral swine workshops and trapping demonstrations
Proper Disposal of Animal Carcasses	Prepare and distribute educational brochures, fliers, and direct mailers
	Conduct meetings and trainings to inform local citizens on proper disposal of animal carcasses after hunting

In addition to the actions listed in the table above, the watershed advisory committee can start a local Adopt-A-Stream group. The goals of the Adopt-A-Stream Program are to increase public awareness of nonpoint sources of pollution; provide citizens with tools and training to evaluate, monitor, and protect their local waterways; encourage partnerships between local stakeholders, citizens, and local governments; and collect water quality data. The group could select streams to adopt within the Chickasawhatchee Creek Watershed, conduct outreach events, conduct monitoring, and attend workshops. The level of Adopt-A-Stream participation and involvement can be determined by the watershed advisory committee and volunteer interest. More information about the Adopt-A-Stream Program can be found at www.GeorgiaAdoptAStream.org.

The goal of the education and outreach efforts is to reach at least 50% of the population within the Chickasawhatchee Creek Watershed through educational workshops and distributed materials to help them understand how to manage nonpoint source pollution and the appropriate BMPs to implement to address their portion of the pollutant sources.

8.0 IMPLEMENTATION SCHEDULE AND PLAN EVALUATION

Table 14 presents the proposed schedule for implementing the Chickasawhatchee Creek WMP. The proposed schedule is dependent on funding, public support, and agricultural producer and citizen participation. The schedule is meant to be adaptable and should be updated on a regular basis to incorporate new information.

Table 14. Proposed implementation schedule for the Chickasawhatchee Creek WMP

Actions	Year 1	Year 2	Year 3	Year 4	Year 5
Identify agricultural producers and implement BMPs	X	X		X	X
Conduct education and outreach events about agricultural BMPs, pet waste management, wildlife management, proper animal carcass disposal, and septic system maintenance	X	X	X	X	X
Prepare and distribute educational brochures, fliers, and direct mailers	X	X	X	X	X
Develop and post signage throughout the watershed to promote pet waste management	X				
Establish and implement an Adopt-A-Stream group	X	X	X	X	X
Implement septic system inspections throughout the watershed		X	X		
Replace failing septic systems			X	X	X
Conduct water quality monitoring	X	X	X	X	X
Review WMP and modify as needed		X	X	X	X

9.0 MILESTONES AND SUCCESS CRITERIA

The WMP has been written to encompass a five-year period and interim milestones and measures of success of the plan are provided in **Table 15** for the short-term (WMP adoption through Year 1) and long-term (Year 2 through Year 5).

Table 15. Milestones and success criteria

Phase	Time After Implementation	Milestones	Measure of Success
Short-term	3 months	Implement education and outreach program components	25% involvement of local citizens, continued involvement by the watershed advisory committee, develop Adopt-A-Stream Program
	3 months to 1 year	Initiate implementation of agricultural BMPs	Implement BMPs on 33% of agricultural properties with livestock access to streams
	6 months to 1 year	Fecal coliform reduction	Achieve reductions in fecal coliform in creeks throughout the watershed
Long-term	2 to 5 years	Sustained community involvement in water quality protection	Continued and increased public involvement, continued watershed advisory committee meetings, regular activities by the Adopt-A-Stream group
	4 to 5 years	Sustained implementation of agricultural BMPs	Increase BMP implementation to 50% of agricultural properties with livestock access to streams
	3 months to 5 years	Establish long-term monitoring program	Conduct monitoring at select locations to track trends in fecal coliform concentrations in response to WMP implementation; conduct monitoring to quantify anthropogenic contributions
	2 to 3 years	Septic system inspections	Complete inspections of all septic systems in the watershed and identify systems in need of repair or replacement
	3 to 5 years	Septic system repairs and replacements	Complete repair or replacement of failing septic systems
	5 years	Achieve fecal coliform TMDL	Reduce anthropogenic sources of fecal coliform to achieve the watershed TMDL target for urban and agricultural lands

9.1 EVALUATION OF LONG-TERM EFFECTIVENESS

Water quality monitoring is an integral part of assessing the progress and success of the WMP. The sections below describe recommendations and needs for future monitoring to document the water quality improvements that occur after WMP implementation. Results of the long-term monitoring will also be an effective measure to determine the success of the WMP, or the need for future revisions.

9.1.1 Agricultural BMP Monitoring

Inspections should be conducted for the agricultural BMPs that are implemented. Inspections should occur immediately after installation and should include the examination for proper design, installation, and maintenance. Additional inspections should occur annually to ensure that the BMPs continue to be implemented and maintained properly to keep livestock out of the streams.

9.1.2 Septic System Maintenance

After the first year of plan implementation, if a determination has been made that additional fecal coliform reductions are needed, an inspection program should be implemented to evaluate the condition of septic systems within the Chickasawhatchee Creek Watershed. The septic systems identified as failing, should be scheduled for repair or replacement, with a goal of repairing or replacing enough failing septic systems to achieve the fecal coliform TMDL by the end of the five-year WMP timeline.

9.1.3 Fecal Coliform Analysis

Fecal coliform monitoring should be continued during the wet and dry seasons to track changes in fecal coliform counts as the WMP is implemented. The monitoring should occur at the nine sites that were used in the targeted monitoring before WMP implementation. All sample collection, field parameters, and lab analysis will be conducted in accordance with the GAEPD Adopt-A-Stream Program's Quality Assurance Project Plan and Quality Monitoring Plan developed and maintained by the GAEPD Adopt-A-Stream and previously approved by USEPA.

10.0 PLAN UPDATES

The watershed advisory committee should periodically review the monitoring results, BMP implementation, and schedule to determine whether the goals of the WMP are being met. The WMP goals and objectives should be modified, strengthened, and/or removed based upon 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 following BMP implementation, the streams in the Chickasawhatchee Creek Watershed will have a reduction in fecal coliform loading to achieve the goal of delisting Chickasawhatchee Creek and Brantley Creek.

11.0 SUMMARY OF NINE KEY ELEMENTS

The following is a summary of the Nine Key Elements addressed in the Chickasawhatchee Creek WMP.

1. An identification of the sources contributing to NPS pollution that require the introduction of BMPs to achieve load reductions that meet water quality standards.

Section 4.0 describes the results of the Chickasawhatchee Creek Watershed desktop analysis and visual stream assessment. The desktop analysis included a thorough statistical and GIS analysis to determine location and possible magnitudes of fecal coliform pollution sources in the Chickasawhatchee Creek Watershed. Publicly available data were used to identify the number and locations of domesticated animals, number and general locations of septic systems, and presence of wildlife. All of these represent likely sources of fecal coliform in the rural Chickasawhatchee Creek Watershed. The visual stream assessment included a review of land use and aerial imagery, followed by a field visit to visually confirm potential sources of fecal coliform loading and gather data.

2. An estimate of the load reductions expected for the management measures.

Management measures are needed to reduce fecal coliform concentrations by 89% to meet the 175 cfu/100 mL TMDL. This would be equivalent to a reduction in average daily load of about 4.70E12 cfu.

3. A description of the NPS management measures that will need to be implemented to achieve the load reductions established in the TMDL or to achieve water quality standards.

Section 5.0 lists BMPs that can be implemented to reduce loading from the potential fecal coliform sources identified in the Chickasawhatchee Creek Watershed. These include the installation of agricultural BMPs and septic system repairs as well as non-structural BMPs like educational workshops and Adopt-A-Stream monitoring.

4. An estimate of the amounts of financial and technical assistance needed, and/or the authorities that will be relied upon to implement the plan.

Section 6.1 presents the costs of implementing BMPs if all the landowners decided to participate and the work was done all at once. Section 6.2 lists the local organizations that could participate in carrying out the plan.

5. An informational/educational component that will be used to enhance public understanding of and participation in implementing the plan.

Section 7.0 summarizes recommended education and outreach efforts including programs that inform the public about agricultural BMPs, septic system maintenance, pet waste management, wildlife management, and animal carcass disposal. Information about Georgia's Adopt-A-Stream program is also provided.

6. A schedule for implementing the management measures that is reasonably expeditious.

Section 9.0 presents a timeline of milestones, categorized as short- or long-term, for five years following the implementation of this WMP.

7. A description of interim, measurable milestones (e.g., amount of load reductions and improvement of biological or habitat parameters) for determining whether management measures or other control actions are being implemented.

The milestones in section 9.0 were defined with quantifiable measures of success that measure progress during WMP implementation. Inspections and water quality monitoring are also suggested for measuring implementation progress and the effectiveness of BMPs on fecal coliform levels.

8. A set of criteria that can be used to determine whether substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the plan needs to be revised.

The measures of success in section 9.0 offer criteria that indicate short- and long-term progress of meeting the goals of the WMP. The milestones provide a timeline that may also indicate whether goals are met at appropriate stages in WMP implementation. These will reveal whether plan revisions are required.

9. A monitoring component to evaluate the effectiveness of the implementation efforts, measured against the criteria established under item (8).

Section 9.1 describes recommendations and needs for future monitoring to document the water quality improvements that occur after WMP implementation. Results of the long-term monitoring will also be an effective measure to determine the success of the WMP, or the need for future revisions. This includes inspections of agricultural and septic system BMPs as well as fecal coliform analyses.

12.0 REFERENCES

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