Total Maximum Daily Load Document
Coosawhatchie River and Tributaries
Stations: CSTL-110, RS-03360, and CSTL-121
(Hydrologic Unit Codes: 030502080201, 030502080202, 030502080203, and 030502080204)
Escherichia coli Bacteria, Indicator for Pathogens

September 2018

Prepared for: Bureau of Water

SCDHEC Technical Document Number 0925-18

dhec
Healthy People. Healthy Communities.

Prepared by:

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Photographs on Title Page

Photographs, counterclockwise, beginning with the top left photograph: **a)** proximity of the South Carolina Department of Health and Environmental Control's (SCDHEC) Water Quality Monitoring (WQM) Station CSTL-121 in the Coosawhatchie River at SC Route 363 (Luray Highway) in Hampton County, SC (date of photography: November 30, 2017); **b)** proximity of the SCDHEC's WQM Station RS-03360 in Blood Hill Creek at County Route S-25-69 (South Main Street) northeast of the Town of Gifford in Hampton County, SC (date of photography: November 30, 2017); and, **c)** proximity of the SCDHEC's WQM CSTL-110 in the Coosawhatchie River at County Route S-03-47 (Revolutionary Trail) in Allendale County, SC (date of photography: November 28, 2017).

Abstract

§303(d) of the federal *Clean Water Act (CWA)* and the United States Environmental Protection Agency's (USEPA) *Water Quality Planning and Management* Regulations (40 CFR Part 130) require states to develop total maximum daily loads (TMDLs) for water bodies that are included on the §303(d) list of impaired waters. A TMDL is the maximum amount of pollutant a waterbody can assimilate while meeting water quality standards for the pollutant of concern. All TMDLs include a waste load allocation (WLA) for all National Pollutant Discharge Elimination System (NPDES)-permitted discharges, a load allocation (LA) for all nonpoint sources, and an explicit and/or implicit margin of safety (MOS). Beginning with the development of South Carolina's 2014 §303(d) list, any site that had been determined to be impaired for freshwater recreational use was listed for *Escherichia coli (E. coli)* bacteria. The following three (3) impaired water quality monitoring (WQM) stations in the Coosawhatchie River and tributaries are listed on the 2016 §303(d) list for *E. coli* bacteria: **a)** station CSTL-110 in the Coosawhatchie River in Allendale County; **b)** station RS-03360 in Blood Hill Creek in Hampton County; and, **c)** station CSTL-121 in the Coosawhatchie River in Hampton County. An *E. coli* bacteria TMDL was developed for WQM Station CSTL-121 using *E. coli* bacteria data collected between January 1999 and December 2014. And Fecal coliform (FC) bacteria TMDLs were developed for WQM Stations CSTL-110 and RS-03360 using FC bacteria data collected between January 1999 and December 2005. These two (2) FC bacteria TMDLs were converted to *E. coli* bacteria TMDLs for purposes of implementation of the current *E. coli* bacteria water quality standard (WQS). Furthermore, all three (3) sites will be included on future §303(d) lists due to exceedances of the current *E. coli* bacteria WQS until such time such that sufficient *E. coli* bacteria data are collected that demonstrate the standard is attained, or until such time that these TMDLs are approved to address the parameter of concern.

Probable sources of fecal contamination include direct loading by livestock, failing septic systems, surrounding wildlife, and other agricultural activities. The load-duration curve methodology was used to calculate existing and TMDL loads for each impaired segment. Existing pollutant loadings and proposed TMDL reductions for critical hydrologic conditions are presented in Table Ab-1. Critical hydrologic conditions were defined as either moist or dry depending on which condition demonstrated the highest load reductions necessary to meet WQSs. In order to achieve the target load (i.e., the TMDL minus a 5% MOS) for the Coosawhatchie River and tributaries, the following reductions in the existing loads at the respective WQM stations will be necessary: **a)** up to 36% at CSTL-110; **b)** up to 37% at RS-03360; and, **c)** up to 55% at CSTL-121. For the South Carolina Department of Transportation (SCDOT), existing and future NPDES municipal separate storm sewer system (MS4) permittees, compliance with terms and conditions of its NPDES permit is effective implementation of the WLA to the Maximum Extent Practicable (MEP) and demonstrates consistency with the assumptions and requirements of the TMDLs. For existing and future NPDES construction and Industrial stormwater permittees, compliance with terms and conditions of its permit is effective implementation of the WLA. Required load reductions in the LA portion of these TMDLs can be implemented through voluntary measures and are eligible for *CWA* §319 grants.

The Department recognizes that adaptive management/implementation of these TMDLs might be needed to achieve the WQS and the Department is committed towards targeting the load reductions to improve water quality in the Coosawhatchie River and Tributaries watersheds. As additional data and/or information become available, it may become necessary to revise and/or modify these TMDLs targets accordingly.

Table Ab-1. Total Maximum Daily Loads for the Coosawhatchie River and Tributaries Watershed (Loads are expressed as FC bacteria or *E. coli* bacteria count/day)

	Existing Load (count/day)		TMDL (count/day)		Margin of Safety (MOS) (count/day)		Waste Load Allocation (WLA): Continuous Source[3] (count/day)		Waste Load Allocation (WLA): Non-Continuous Sources[4,5] (%Reduction)	Waste Load Allocation (WLA): Non-Continuous SCDOT[5] (%Reduction)	Load Allocation (LA): Load Allocation (count/day)		Load Allocation (LA): % Reduction to Meet LA[5]
Station	FC (cfu/day)[1]	*E. coli* (MPN/day)[2]	FC (cfu/day)	*E. coli* (MPN/day)	FC (cfu/day)	*E. coli* (MPN/day)	FC (cfu/day)	*E. coli* (MPN/day)	(Percent)	(Percent)	FC (cfu/day)	*E. coli* (MPN/day)	(Percent)
CSTL-110	5.33E+10	---	3.60E+10	*3.14E+10*[7]	1.80E+09	*1.57E+09*[7]	See Note Below	*See Note Below*	36	36[6]	3.42E+10	*2.98E+10*[7]	36
RS-03360	7.34E+10	---	4.84E+10	*4.23E+10*[7]	2.42E+09	*2.11E+09*[7]	See Note Below	*See Note Below*	37	37[6]	4.60E+10	*4.01E+10*[7]	37
CSTL-121	---	*3.67E+10*	---	*1.90E+10*	---	*9.49E+08*	---	*1.45E+09*	55	55[6]	---	*1.66E+10*	55

Table Notes:

1. Existing fecal coliform loads were determined from the 90 percentile instream fecal coliform concentrations and stream flows during critical flow conditions. Fecal coliform concentrations were determined during the Department's water quality monitoring program.
2. Existing *E. coli* loads were determined from the 90 percentile instream *E. coli* concentrations and stream flows during critical flow conditions. *E. coli* concentrations were determined during the Department's 2009 Pathogen Indicator Study and during the Department's water quality monitoring program.
3. WLAs are expressed as a daily maximum. Existing and future continuous discharges are required to meet the prescribed loading for the pollutant of concern. For the purposes of NPDES permitting, continuous discharges may be required to meet a loading equivalent of FC bacteria, based upon permitted flow and an allowable permitted maximum FC bacteria concentration of 400 cfu/100ml, until such time that *E. coli* limits are incorporated into individual permits. *E. coli* limits will be developed based upon permitted flow and an allowable permitted maximum *E. coli* concentration of 349 MPN/100ml.
4. Percent reduction applies to all NPDES-permitted stormwater discharges, including current and future municipal separate storm sewer system (MS4), construction and industrial discharges covered under permits numbered SCS & SCR. Stormwater discharges are expressed as a percentage reduction due to the uncertain nature of stormwater discharge volumes and recurrence intervals. Stormwater discharges are required to meet percentage reduction or the existing instream standard for pollutant of concern in accordance with their NPDES Permit.
5. Percent reduction applies to existing instream FC bacteria or *E. coli.*
6. By implementing the best management practices that are prescribed in either the SCDOT annual SWMP or the SCDOT MS4 Permit to address fecal coliform or *E. coli,* the SCDOT will comply with these TMDLs and its applicable WLA to the maximum extent practicable (MEP) as required by its MS4 permit.
7. Expressed as *E. coli* (MPN/day). Loadings are developed by applying a conversion factor to values calculated for FC bacteria. This conversion is derived from an established relationship between FC bacteria and *E. coli* water quality standards in freshwaters.

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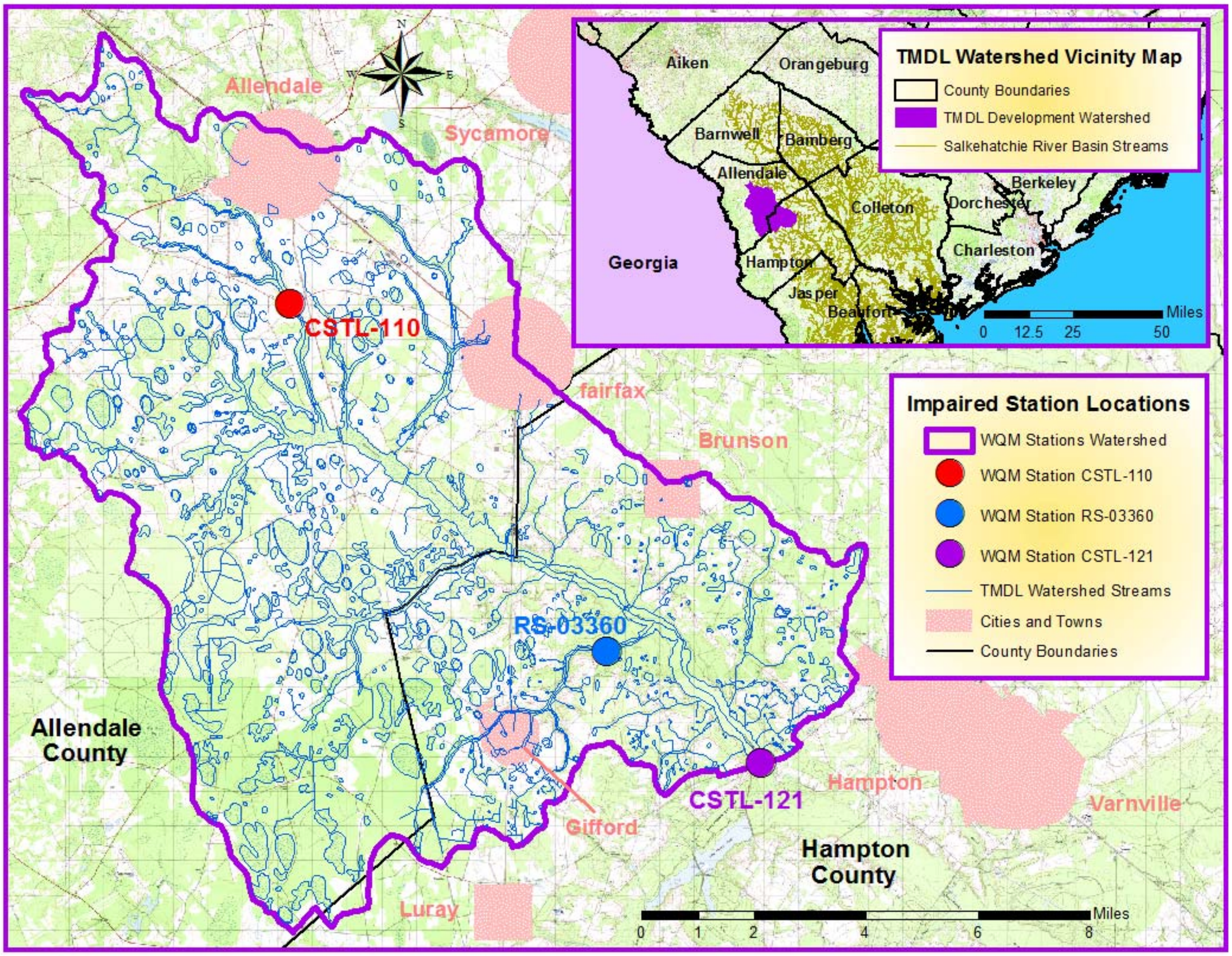
1.0 Introduction

1.1 Background

The federal *Clean Water Act (CWA)* directs each state to review the quality of its waters every two (2) years to determine if water quality standards (WQSs) are being met. If it is determined that the WQS is not being met, the states are to list the impaired water bodies under §303(d) of the *CWA*. Beginning with the development of South Carolina's 2014 §303(d) list, any site that had been determined to be impaired for freshwater recreational use was listed for *Escherichia coli (E. coli)* bacteria. The South Carolina Department of Health and Environmental Control (SCDHEC) placed the following three (3) impaired water quality monitoring (WQM) stations in South Carolina on the 2016 §303(d) list for *E. coli* bacteria: **a)** station CSTL-110 in the Coosawhatchie River in Allendale County; **b)** station RS-03360 in Blood Hill Creek in Hampton County; and, **c)** station CSTL-121 in the Coosawhatchie River in Hampton County. These three (3) WQM stations are identified in Figure 1 and Table 1.

Figure 1. Location of Water Quality Monitoring Stations CSTL-110, RS-03360, and CSTL-121 Impaired for Freshwater Recreational Use



A Total Maximum Daily Load (TMDL) is a written plan and analysis to determine the maximum pollutant load a waterbody can receive and still meet applicable WQSs. The TMDL process includes estimating pollutant loadings from all sources, linking pollutant sources to their impacts on water quality, allocation of pollutant sources to each source and establishment of control mechanisms to achieve WQSs (USEPA, 1999).

Table 1. Coosawhatchie River and Tributaries Watershed Recreational Use Impaired Waters

Waterbody	Station Number	Description
Coosawhatchie River	CSTL-110	Coosawhatchie River at County Route S-03-47 in Allendale County
Blood Hill Creek	RS-03360	Blood Hill Creek at County Route S-25-69, 2.4 miles northeast of the Town of Gifford in Hampton County
Coosawhatchie River	CSTL-121	Coosawhatchie River at SC 363 in Hampton County

All TMDLs include a waste load allocation (WLA) for all National Pollutant Discharge Elimination System (NPDES) permitted discharges, a load allocation (LA) for all unregulated nonpoint sources, and an explicit and/or implicit margin of safety (MOS). TMDLs are required to be developed for each waterbody and pollutant combination on the States' §303(d) lists by 40 CFR 130.31(a) (USEPA, 1999).

E. coli bacteria are members of the Fecal Coliform (FC) group of bacteria and are part of the normal flora of the gastrointestinal tract of warm-blooded animals including humans. These harmless bacteria play an important role in preventing the growth of harmful bacteria, vitamin K production, and lactose digestion as well as producing compounds necessary for fat metabolism (Starr and Taggart, 1992; Wolfson and Harrigan, 2010). Some verotoxin producing strains of *E. coli*, such as 0157:H7, a major cause of foodborne illnesses, can cause gastrointestinal illnesses, kidney failure and death (Nadakavukaren, 1995; Wolfson and Harrigan, 2010).

E. coli bacteria in surface waters are indicators of recent human or animal waste contamination and originate from failing septic systems, agricultural runoff, leaking sewers among other sources. Section §303(d) of the *CWA* and the U.S. Environmental Protection Agency's (USEPA) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop TMDLs for water bodies that are not meeting designated uses under technology-based pollution controls. The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and in stream water quality conditions so that states can establish water quality-based controls to reduce pollution and restore and maintain the quality of water resources (USEPA 1991).

This document documents the development of an *E. coli* bacteria TMDL for WQM Station CSTL-121 in the Coosawhatchie River in Hampton County using *E. coli* bacteria collected between 2009 and 2014, including data collected during the Department's Pathogen Indicator Study (PIS) in 2009 (see Section 5.1 of this TMDL development document). And, this document documents the development of a FC bacteria TMDL for WQMS Station CSTL-110 in the Coosawhatchie River in Allendale County, and a FC bacteria TMDL for WQM Station RS-03360 in Blood Hill Creek in Hampton County, using FC bacteria data collected between January 1999 and December 2003. The FC bacteria TMDLs for these two (2) WQM stations were converted to *E. coli* bacteria TMDLs for the purposes of implementation of the current *E. coli* bacteria WQS.

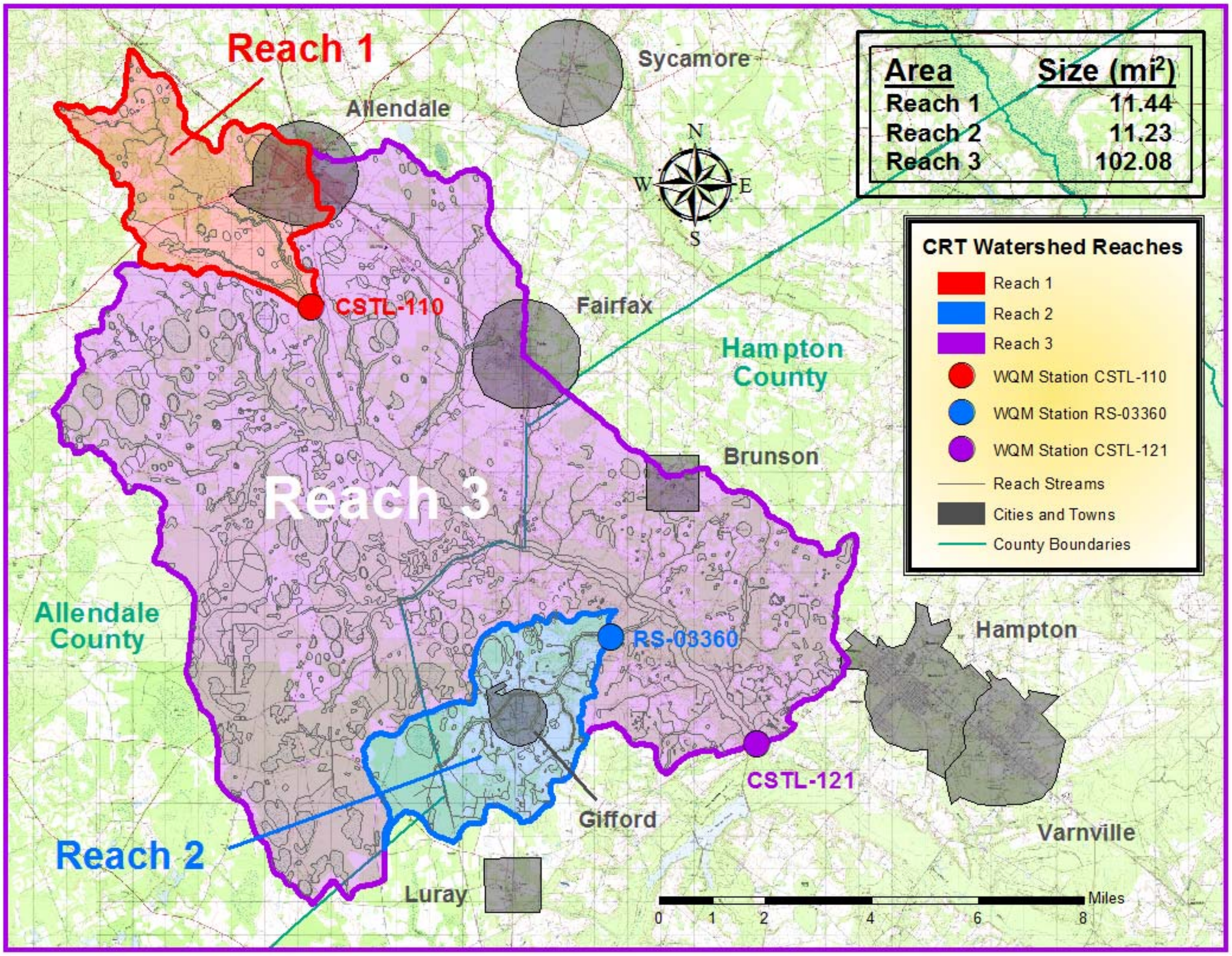
1.2 Watershed Descriptions

The watersheds for the three (3) aforementioned WQM stations that were placed on South Carolina's 2016 §303(d) list for impairment due to *E. coli* bacteria are addressed in this TMDL development document. The three watersheds are contiguous, and are hydrologically connected. Drainage from all three watersheds ultimately flows through WQM Station CSTL-121. Collectively, the three watersheds are referred to as the Coosawhatchie River and Tributaries (CRT) Watershed in this TMDL development document.

The CRT Watershed is 124.76 mi^2 (79,868.34 acres) in size, is located in Allendale and Hampton Counties in South Carolina, and lies in both the Southeastern Plains and Middle Atlantic Coastal Plains ecoregions of the State. The general stream flow direction in the CRT Watershed is in the east-southeastern direction. The upper northwestern part of the watershed is located at the City of Allendale in Allendale County, and the lower southeastern part of the CRT Watershed is located in Hampton County at the City of Hampton. According to the 2011 National Land Cover Database (NLCD), land use in the watershed is predominately Woody Wetlands (29.48%), and Evergreen Forest (18.95%).

As mentioned above, collectively, the aforementioned three (3) contiguous, hydrologically connected watersheds are referred to as the CRT Watershed. However, these three (3) watersheds under TMDL development in this document will be referred to individually as reaches of the CRT Watershed. These three (3) reaches are: **a)** Reach 1 – the reach draining through WQM Station CSTL-110; **b)** Reach 2 – the reach draining through WQM Station RS-03360; and, **c)** Reach 3 – the reach draining through WQM Station CSTL-121. The reaches of the CRT Watershed are shown in Figure 2.

Figure 2. Location of the Coosawhatchie River and Tributaries Watershed Reaches



1.2.1 Reach 1 of the CRT Watershed; Terminal WQM Station CSTL-110

Reach 1 of the CRT Watershed covers a drainage area of 11.44 mi^2 (7325.88 acres) in size that drains into the Coosawhatchie River and its tributaries from an area approximately three (3) miles northwest of the City of Allendale in Allendale County, in a general southeastern fashion to impaired station CSTL-110 in the Coosawhatchie River at County Route S-3-47, approximately 1.5 miles south of Allendale in Allendale County (Figure 2). The reach lies in the Southeastern Plains ecoregion of the State.

Land use within Reach 1 of the CRT Watershed is predominately Cultivated Crops (23.96%), and Woody Wetlands (18.09%) (Figure 3a, Table 2a). Developed lands (residential, commercial, industrial, or open urban space) comprise 13.04% of the reach (Table 3). At the time of the development of this TMDL, there were no animal feeding operations in the reach.

According to Geographic Information System (GIS) information (available at time of TMDL development), there are approximately forty-one (41) miles of streams within Reach 1 of the CRT Watershed. The streams are all classified as freshwater (FW). From WQM Station CSTL-110, the Coosawhatchie River flows for approximately fifty (50) stream miles to the Broad River on the Jasper and Beaufort County line approximately 7 miles northeast of Town of Ridgeland in Jasper County.

Figure 3a. Land Use Diagram for Reach 1 of the Coosawhatchie River and Tributaries Watershed

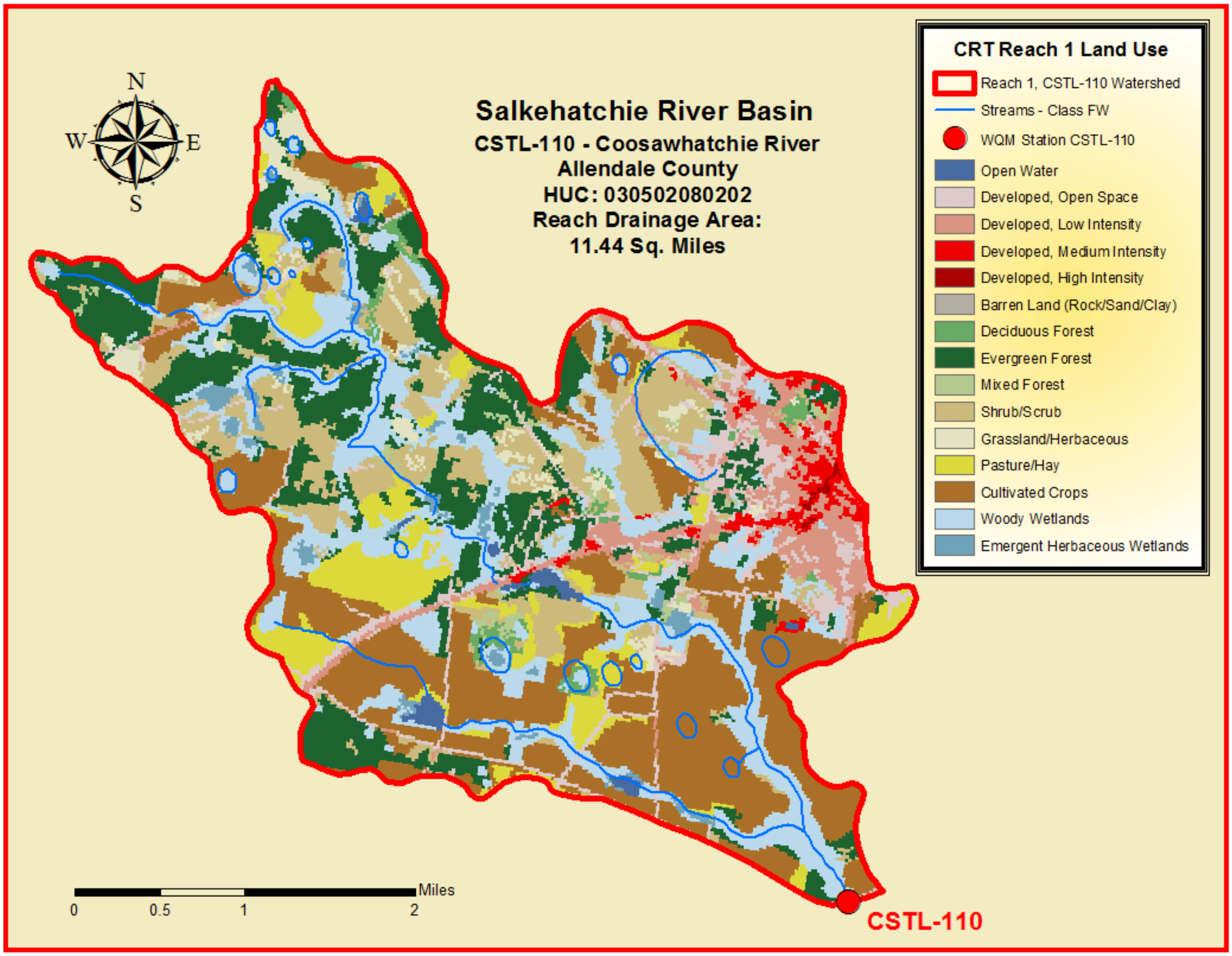


Table 2a. Coosawhatchie River and Tributaries Watershed: Land Use in Reach 1 (WQM Station CSTL-110) (Derived from National Land Cover Database (NLCD) 2011)

Description	Area (Acres)	Area ($Mile^2$)	Percent
Cultivated Crops	1755.13	2.74	23.96%
Woody Wetlands	1325.47	2.07	18.09%
Evergreen Forest	1216.72	1.90	16.61%
Shrub/Scrub	950.07	1.48	12.97%
Pasture/Hay	562.66	0.88	7.68%
Developed, Open Space	445.46	0.70	6.08%
Developed, Low Intensity	390.52	0.61	5.33%
Grassland/Herbaceous	208.61	0.33	2.85%
Emergent Herbaceous Wetlands	121.20	0.19	1.65%
Developed, Medium Intensity	110.53	0.17	1.51%
Deciduous Forest	89.62	0.14	1.22%
Mixed Forest	79.39	0.12	1.08%
Open Water	60.71	0.09	0.83%
Developed, High Intensity	8.45	0.01	0.12%
Barren Land (Rock/Sand/Clay)	1.33	0.00	0.02%
Totals	**7325.88**	**43.22**	**100.00%**

Table 3. Developed Areas in the Coosawhatchie River and Tributaries Watershed Reaches

Reach	Reach Description	Reach Area (mi^2)	Developed Area (mi^2)	Percent Developed
Reach 1 of the CRT Watershed	From an area approximately 3 miles northwest of the City of Allendale in Allendale County to impaired station CSTL-110 in the Coosawhatchie River at County Route S-3-47, approximately 1.5 miles south of Allendale in Allendale County.	11.44	1.49	13.04%
Reach 2 of the CRT Watershed	From an area in Allendale County approximately 2 miles northwest of the Town of Luray in Hampton County to impaired station RS-03360 in Blood Hill Creek at County Route S-25-69, 2.4 miles northeast of the Town of Gifford in Hampton County.	11.23	0.56	5.02%
Reach 3 of the CRT Watershed	From an area in Allendale County approximately 3 miles southwest of the City of Allendale to impaired station CSTL-121 in the Coosawhatchie River at SC 63 in Hampton County, approximately 2 miles west of the City of Hampton in Hampton County.	102.08	5.78	5.67%
Total Area in the Coosawhatchie River and Tributaries Reaches		124.76	7.84	6.28%

1.2.2 Reach 2 of the CRT Watershed; Terminal WQM Station RS-03360

Reach 2 of the CRT Watershed covers a drainage area of 11.23 mi^2 (7191.11 acres) in size that drains into Blood Hill Creek and its tributaries from an area in Allendale County approximately two (2) miles northwest of the Town of Luray in Hampton County, in a general northeastern fashion to impaired station RS-03360 in Blood Hill Creek at County Route S-25-69, 2.4 miles northeast of the Town of Gifford in Hampton County (Figure 2). The reach lies in the Middle Atlantic Coastal Plains ecoregion of the State.

Land use within Reach 2 of the CRT Watershed is predominately Woody Wetlands (27.19%), and Evergreen Forest (22.15%) (Figure 3b, Table 2b). Developed lands (residential, commercial, industrial, or open urban space) comprise 5.02% of the reach (Table 3). At the time of the development of this TMDL, there were no animal feeding operations in the reach.

According to GIS information, there are approximately seventy-four (74) miles of streams within Reach 2 of the CRT Watershed. The streams are all classified as FW. From WQM Station RS-03360, Blood Hill Creek flows for approximately one stream mile to the Coosawhatchie River in Hampton County approximately 2.7 miles northeast of City of Hampton.

1.2.3 Reach 3 of the CRT Watershed; Terminal WQM Station CSTL-121

Reach 3 of the CRT Watershed covers a drainage area of 124.76 mi^2 (79,868.34 acres) in size that drains into the Coosawhatchie River and its tributaries from an area in Allendale County approximately three (3) miles southwest of the City of Allendale, in a general eastern fashion to impaired station CSTL-121 in the Coosawhatchie River at SC 63 in Hampton County, approximately two (2) miles west of the City of Hampton in Hampton County (Figure 2). The reach lies in the Southeastern Plains and Middle Atlantic Coastal Plains ecoregion of the State.

Land use within Reach 3 of the CRT Watershed is predominately Woody Wetlands (31.01%), and Evergreen Forest (18.86%) (Figure 3c, Table 2c). Developed lands (residential, commercial, industrial, or open urban space) comprise 5.67% of the reach (Table 3). At the time of the development of this TMDL, there was one (1) active animal feeding operation in the reach (Figure 3c).

According to GIS information, there are approximately 550 miles of streams within Reach 3 of the CRT Watershed. The streams are all classified as FW. From WQM Station CSTL-121, the Coosawhatchie River flows for approximately thirty-seven (37) stream miles to the Broad River on the Jasper and Beaufort County line approximately 7 miles northeast of Town of Ridgeland in Jasper County.

Figure 3b. Land Use Diagram for Reach 2 of the Coosawhatchie River and Tributaries Watershed

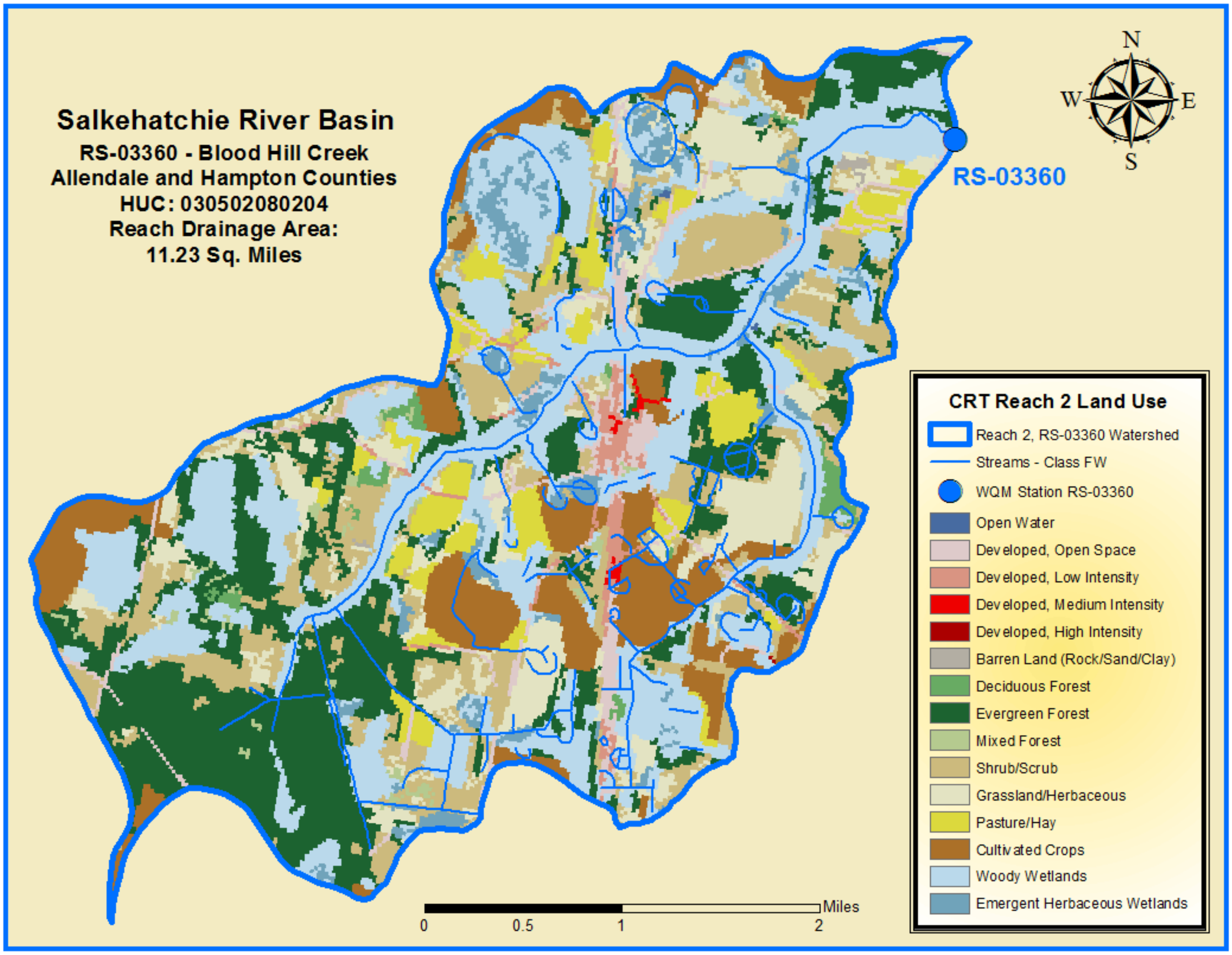


Table 2b. Coosawhatchie River and Tributaries Watershed: Land Use in Reach 2 (WQM Station RS-03360) (Derived from National Land Cover Database (NLCD) 2011)

Description	Area (Acres)	Area (Mile^2)	Percent
Woody Wetlands	1955.07	3.05	27.19%
Evergreen Forest	1593.01	2.49	22.15%
Shrub/Scrub	1067.94	1.67	14.85%
Cultivated Crops	739.68	1.16	10.29%
Grassland/Herbaceous	712.11	1.11	9.90%
Pasture/Hay	369.40	0.58	5.14%
Emergent Herbaceous Wetlands	272.65	0.43	3.79%
Developed, Open Space	253.53	0.40	3.53%
Developed, Low Intensity	96.30	0.15	1.34%
Deciduous Forest	61.16	0.10	0.85%
Mixed Forest	48.93	0.08	0.68%
Developed, Medium Intensity	10.45	0.02	0.15%
Barren Land (Rock/Sand/Clay)	8.01	0.01	0.11%
Open Water	2.22	0.00	0.03%
Developed, High Intensity	0.67	0.00	0.01%
Totals	**7191.11**	**11.23**	**100.00%**

Figure 3c. Land Use Diagram for Reach 3 of the Coosawhatchie River and Tributaries Watershed

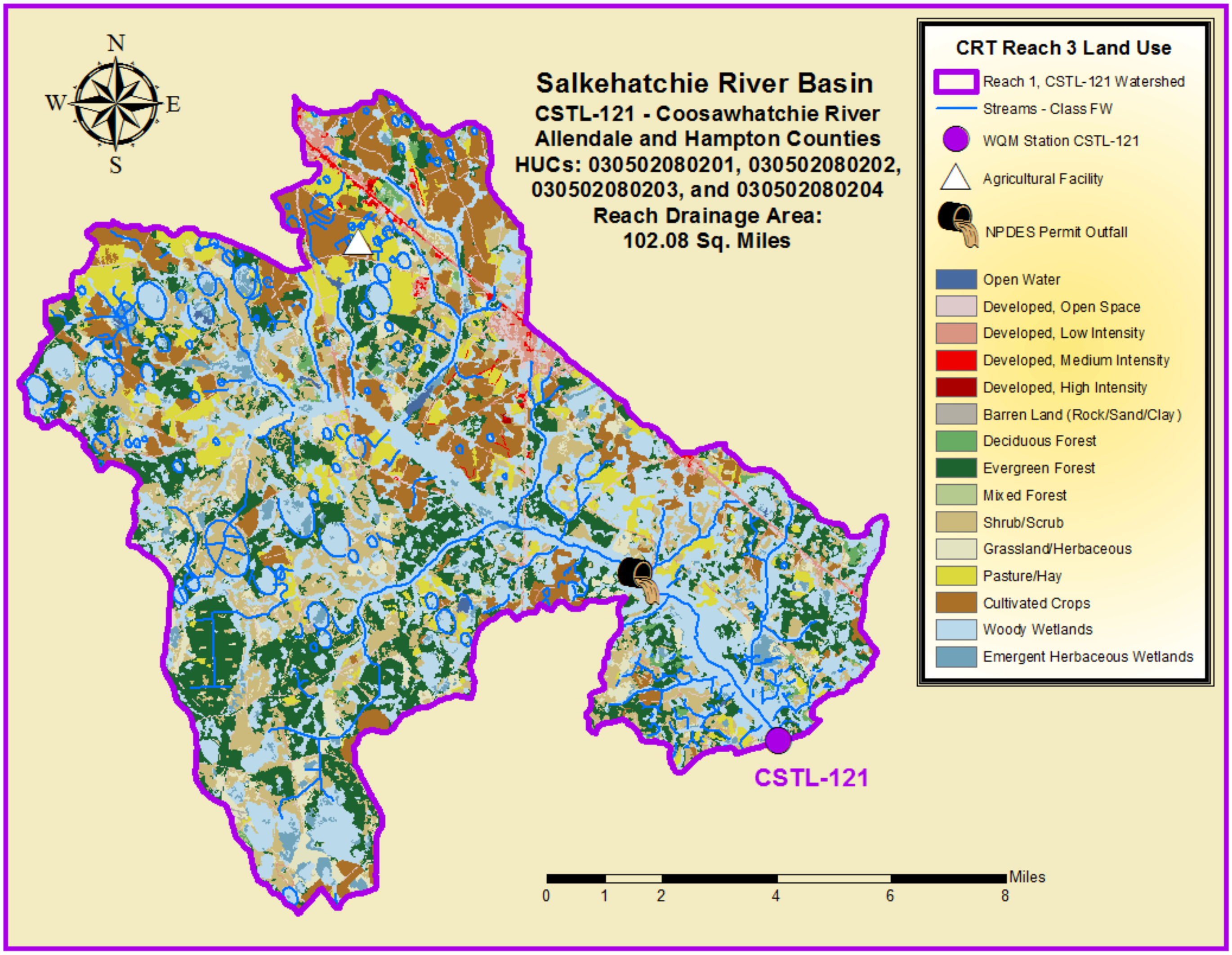


Table 2c. Coosawhatchie River and Tributaries Watershed: Land Use in Reach 3 (WQM Station CSTL-121)

Description	Area (Acres)	Area (Mile^2)	Percent
Woody Wetlands	20,265.20	31.66	31.01%
Evergreen Forest	12,328.41	19.26	18.86%
Shrub/Scrub	9933.89	15.52	15.20%
Cultivated Crops	8088.47	12.63	12.38%
Pasture/Hay	4569.08	7.14	6.99%
Grassland/Herbaceous	3458.23	5.40	5.29%
Developed, Open Space	2281.32	3.56	3.49%
Emergent Herbaceous Wetlands	1860.55	2.91	2.85%
Developed, Low Intensity	1099.29	1.72	1.68%
Deciduous Forest	542.64	0.85	0.83%
Mixed Forest	329.59	0.51	0.50%
Developed, Medium Intensity	291.78	0.46	0.45%
Open Water	211.72	0.33	0.32%
Barren Land (Rock/Sand/Clay)	60.94	0.10	0.09%
Developed, High Intensity	30.25	0.05	0.05%
Totals	**65,351.35**	**102.08**	**100.00%**

1.3 Water Quality Standard

The impaired stream segments of the CRT Watershed basins are designated as Class Freshwater (FW), which is defined in SC Regulation 61-69 (2012) as:

> "Freshwaters are suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the Department. Suitable for fishing and the survival and propagation of a balanced aquatic community of fauna and flora. Suitable also for industrial and agricultural uses."

South Carolina's current WQS for recreational use in freshwater is *E. coli* (R.61-68):

> "Not to exceed a geometric mean of 126/100 ml based on at least four samples collected from a given sampling site over a 30 day period, nor shall a single sample maximum exceed 349/100 ml (SCDHEC, 2012)."

Prior to February 28, 2013, South Carolina's WQS for recreational use in freshwaters was FC bacteria (R.61-68):

> "Not to exceed a geometric mean of 200/100 mL, based on five consecutive samples during any 30 day period; nor shall more than 10% of the total samples during any 30 day period exceed 400/100 mL." (R.61-68).

Primary contact recreation is not limited to large streams and lakes. Even streams that are too small to swim in, will allow small children the opportunity to play and immerse their hands and faces. Essentially all perennial streams should therefore be protected from pathogen impairment.

2.0 WATER QUALITY ASSESSMENT

In 1986, the USEPA documented that *E. coli* and *Enterococcus* bacteria are better indicators than FC bacteria group in predicting the presence of human gastroenteritis (upset stomach, nausea, diarrhea, vomiting) causing pathogenic bacteria in fresh waters. The USEPA study was based on data collected when swimmers were directly exposed in freshwater lakes with established public swimming areas. In almost all cases of water-borne illnesses, pathogens come from inadequately treated waste of humans or other warm-blooded animals. Also, *Enterococcus* and *E. coli* are more specific to sewage and fecal sources than the FC bacteria group. In light of this information, USEPA has recommended the use of either *E. coli* or *Enterococcus* as the pathogen indicator for fresh waters.

In order to determine which pathogen indicator bacteria is better suited in South Carolina as the recreational use WQS in fresh waters, the SCDHEC designed a PIS and conducted the study during 2009. Weekly water samples were collected from seventy-three (73) stations statewide and analyzed for *E. coli, Enterococcus* and for FC bacteria group. PIS results showed *E. coli* (a member of the FC bacteria group) is a better indicator for predicting the presence of pathogens in South Carolina freshwaters.

During 2012 and following the public participation, public comment period and legislative processes, the SDHEC submitted a proposed amendment to EPA to change the pathogen indicator from FC bacteria to *E. coli* in R. 61-68. The proposed amendment was approved by the USEPA on February 28, 2013 and *E. coli* has been promulgated in R. 61-68. *E. coli* is the applicable WQS for recreational use in fresh waters.

Beginning with the 2014 §303(d) list of impaired waters, sites included as impaired for recreational use due to FC bacteria on the 2012 §303(d) lists was listed as impaired for *E. coli.* bacteria. Once sufficient *E. coli* bacteria data are collected from impaired stations, future TMDLs will be calculated based on *E. coli* bacteria data. Until sufficient data are collected, TMDLs for currently FC bacteria impaired stations can be calculated using FC bacteria data. Then, these FC bacteria TMDLs can be converted to *E. coli* bacteria TMDLs by multiplying the FC bacteria TMDL number by 0.8725. A 0.8725 ratio was derived by dividing the current single sample maximum (SSM) WQS for *E. coli* bacteria, 349 MPN/100 ml by former SSM WQS for FC bacteria, 400 cfu/100 ml.

The SCDHEC currently has three (3) monitoring locations within the CRT Watershed described earlier in this TMDL development document. These three (3) WQM stations in the Coosawhatchie River and tributaries in Allendale and Hampton Counties, SC which the SCDHEC listed on the 2016 §303(d) list as impaired for recreational use due to *E. coli* bacteria are: **a)** station CSTL-110 in the Coosawhatchie River in Allendale County; **b)** station RS-03360 in Blood Hill Creek in Hampton County; and, **b)** station CSTL-121 in the Coosawhatchie River in Hampton County. For recreational use, if greater than 10% of the monthly geometric mean of available data collected during an assessment period exceeds the criterion, the station is included on South Carolina's §303(d) list. If there are not an adequate number of monthly samples to calculate a geometric mean, then the available sample results are compared against the SSM criterion. If greater than 10% of these samples exceed this criterion then the station is included on South Carolina's §303(d) list as impaired for recreational use. These stations will be included on future §303(d) lists due to exceedances of the current *E. coli* bacteria WQS until such time such time that sufficient *E. coli* bacteria data are collected and demonstrate the WQS is attained or such time that TMDLs are developed and approved to address the parameter of concern.

As discussed previously, this TMDL development document addresses the development of an *E. coli* bacteria TMDL for WQM Station CSTL-121 in the CRT Watershed listed on the 2016 §303(d) list as impaired for recreational use, using *E. coli* bacteria data collected between January 2009 and December 2014. And, this document addresses the development of FC bacteria TMDLs for WQM Station CSTL-110 and WQM Station RS-03360 in the watershed listed on the 2016 §303(d) list as impaired for recreational use, using FC bacteria data collected between January 1999 and December 2005. These two (2) FC bacteria TMDLs were converted to *E. coli* bacteria TMDLs for the purposes of implementation of the current *E. coli* bacteria WQS. Table 4 provides a summary of the number of samples collected, the number of exceedences and exceedence percentages.

Table 4. FC Bacteria and *E. coli* Bacteria WQS Exceedence Summary for Impaired Stations (1999-2014)

WQM Station	Waterbody	Sample Constituent	Maximum Concentration (units/100mL)[1]	Number of Samples	Number of Samples >WQS[2]	% Samples Exceeding WQS
CSTL-110	Coosawhatchie River	Fecal Coliform	600	36	5	14%
RS-03360	Blood Hill Creek	Fecal Coliform	620	12	2	17%
CSTL-121	Coosawhatchie River	*E. coli*	2419.6	56	10	18%

[1]Sampling results for FC are given as cfu (colony forming units)/100 mL; and, results for *E. coli* are given as MPN (most probable number)/100 mL.

[2]The number of FC samples exceeding 400 cfu/100 mL; and, the number of *E. coli* samples exceeding 349 MPN/100 mL.

Figure 4 illustrates precipitation and *E. coli* bacteria by data and date for WQM Station CSTL-121. The graph and Table 5 show that there is little or no correlation between the amount of precipitation and the temporal *E. coli* bacteria exceedences of WQSs (r = 0.053). The graphs for precipitation and FC bacteria by data and date for the other two (2) WQM stations in the CRT Watershed are shown in Appendix A. For WQM Station CSTL-110, its graph and Table 5 show that there is a moderate positive between the amount of precipitation and the temporal FC bacteria exceedences; and, for WQM Station RS-03360, there is little or no correlation between the amount of precipitation and the temporal FC bacteria exceedences.

3.0 SOURCE ASSESSMENT AND LOAD ALLOCATION

The SCDHEC has adopted a change of its pathogen indicator from FC bacteria to *E. coli* bacteria during 2012. The new WQS were approved by the USEPA on February 28, 2013. Starting with the effective date of February 28, 2013, *E. coli* bacteria is the new pathogen indicator for recreational use in freshwaters.

Even though there are tests for specific pathogens, it is difficult to determine beforehand which organism may be present, and test for those specific organisms. Indicators such as FC bacteria, enteroccoci, or *E. coli* bacteria, which are indicators for human pollution, are easier to measure, have similar sources as pathogens, and persist in surface waters for a similar or longer length of time (Tchobanoglous & Schroeder, 1987). These bacteria are not in themselves disease causing, but indicate the potential presence of organisms that may result in illness.

Figure 4. Precipitation and *E. coli* Bacteria Data by Date for Water Quality Monitoring Station CSTL-121

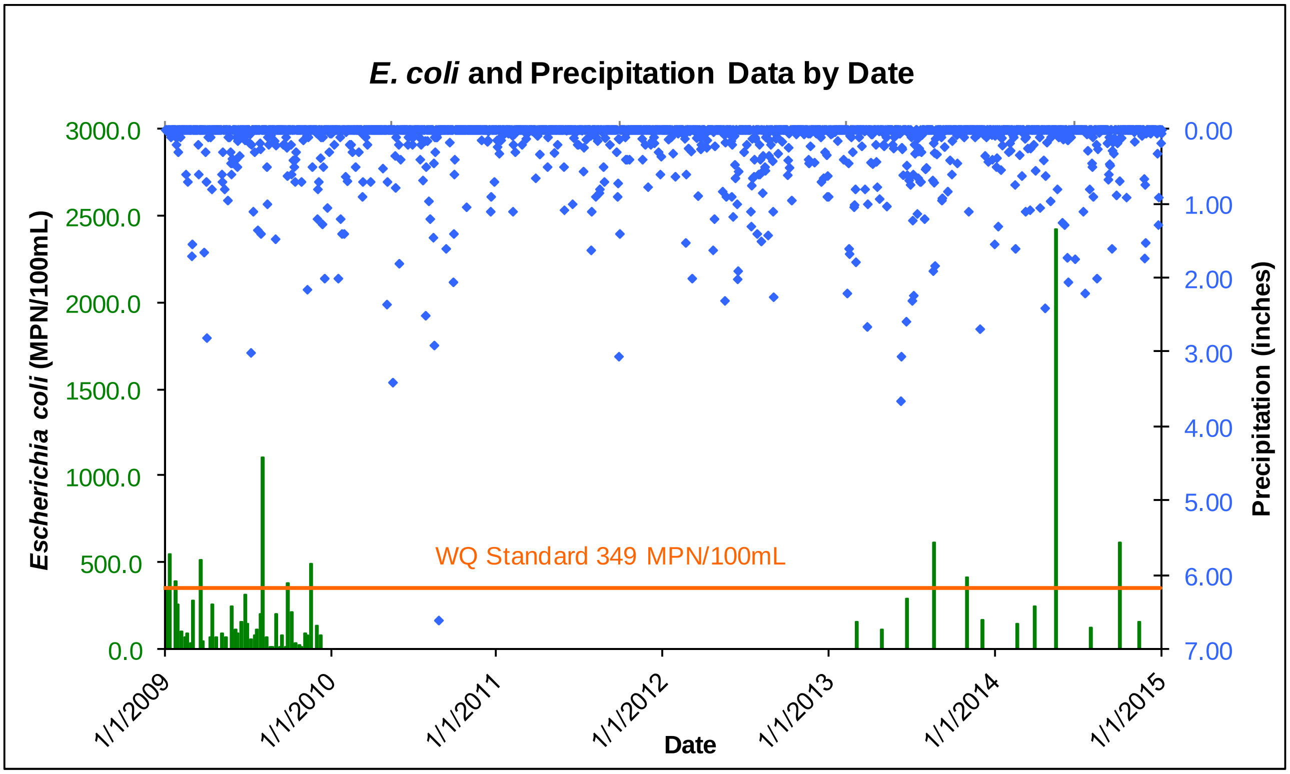


Table 5. Correlations Between Rainfall and *E. coli* Bacteria and FC Bacteria in the Coosawhatchie River and Tributaries Watershed

Station	Waterbody	Correlation Coefficient (r)	Coefficient of Determination (r^2)
CSTL-110	Coosawhatchie River	0.310	0.096
RS-03360	Blood Hill Creek	-0.084	0.007
CSTL-121	Coosawhatchie River	0.053	0.003

E. coli bacteria is used by the State of South Carolina as the indicator for pathogens in surface waters. Pathogens, which are usually difficult to detect, cause disease and make full body contact recreation in lakes and streams a risk to public health.

There are many sources of pathogen pollution in surface waters. In general, these sources may be classified as point and nonpoint sources. With the implementation of technology-based controls, pollution from continuous point sources, such as factories and wastewater treatment facilities (WWTF), has been greatly reduced. These point sources are required by the *CWA* to obtain a NPDES permit. In South Carolina NPDES permits require that dischargers of sanitary wastewater must meet the state standard for the relevant pathogen indicator at the point of discharge. Municipal and private sanitary WWTFs may occasionally be sources of pathogens. However, if these facilities are discharging wastewater that meets their permit limits, then the facilities are not causing impairment. If any of these facilities is not meeting its permit limits, enforcement actions/mechanisms are required.

Other non-continuous point sources required to obtain NPDES permits that may be a source of pathogens include MS4s and stormwater discharges from construction or industrial sites. MS4s may require NPDES discharge permits for industrial and construction activities under the NPDES stormwater regulations. These sources are also required to comply with the state standard for the pollutant(s) of concern. If MS4s and discharges from construction sites meet the percentage reduction or the WQS as prescribed in Section 5 of this TMDL development document and required in their MS4 permits, then the MS4s should not be causing or contributing to an instream pathogen impairment.

3.1 Point Sources

Point sources are defined as pollutant loads discharged at a specific location from pipes, outfalls, and conveyance channels from either municipal WWTFs, industrial waste treatment facilities, or regulated stormwater discharges. Point sources can also include pollutant loads contributed by tributaries to the main receiving water stream or river. Point sources can be further broken down into continuous and non-continuous.

3.1.1 Continuous Point Sources

There is only one *E. coli* bacteria related continuous point source in the CRT Watershed authorized under an NPDES permit issued by the SCDHEC. The Town of Brunson has a domestic WWTF located on County Route S-25-69 at the Coosawhatchie River, approximately 1.75 miles south of the town in Hampton County. The facility is authorized under the SCDHEC's NPDES Permit No. SC0042382 to discharge to the Coosawhatchie River in Reach 3 of the CRT Watershed (Figure 5 and Table 6). Under the terms and conditions of the permit, the facility has limitations on the discharge of *E. coli* bacteria, and is authorized to discharge a daily maximum of 349 MPN/100 ml. The permit was issued on August 25, 2014, and will expire on September 30, 2019. At the time of the development of these TMDLs, there were no other NPDES permitted FC bacteria or *E. coli* bacteria related continuous point sources in the CRT Watershed.

Figure 5. NPDES Permitted *E. coli* Bacteria Discharge in the Coosawhatchie River and Tributaries Watershed

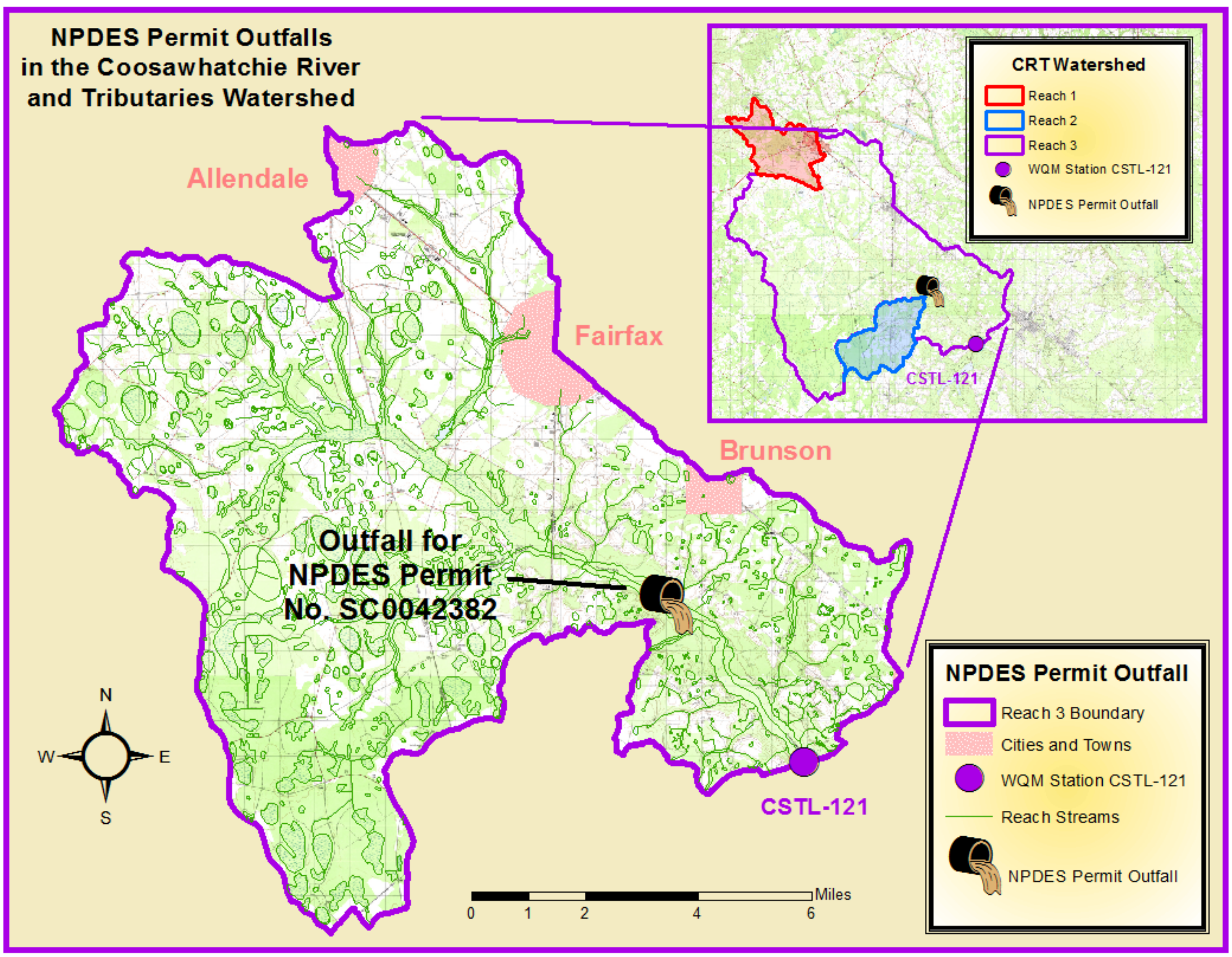


Table 6. NPDES Permitted *E. coli* Bacteia Discharge in the Coosawhatchie River and Tributaries Watershed

Impaired Station Watershed	Permitted Facility	NPDES Permit Number	Permit Type	Permit Limitation (*E. coli* x Unit/Volume)	Permitted Flow (MGD)	Outfall Stream
CSTL-121	Town of Brunson WWTF	SC0042382	Minor	349 MPN/100 mL	0.11	Coosawhatchie River

3.1.2 Non-Continuous Point Sources

Non-continuous point sources include all NPDES-permitted stormwater discharges, including current and future MS4s, construction and industrial discharges covered under permits numbered SCS and SCR and/or regulated under South Carolina Water Pollution Control Permits: R61-9, §122.26(b)(4),(7),(14) - (21) (SCDHEC, 2011). All regulated MS4 entities have the potential to contribute *E. coli* bacteria and other FC bacteria pollutant loadings in the delineated drainage area used in the development of this TMDL.

The South Carolina Department of Transportation (SCDOT), a large MS4, is the only regulated MS4 in the CRT Watershed. The SCDOT operates under the SCDHEC's NPDES MS4 Permit SCS040001, and owns and operates roads within all of the reaches in the CRT Watershed (Figure 6 and Table 7). However, the Department recognizes that SCDOT is not a traditional MS4 in that it does not possess statutory taxing or has enforcement powers. SCDOT does not regulate land use or zoning, issue building or development permits.

Figure 6. SCDOT Owned and Maintained Roads in the Coosawhatchie River and Tributaries Watershed Reaches

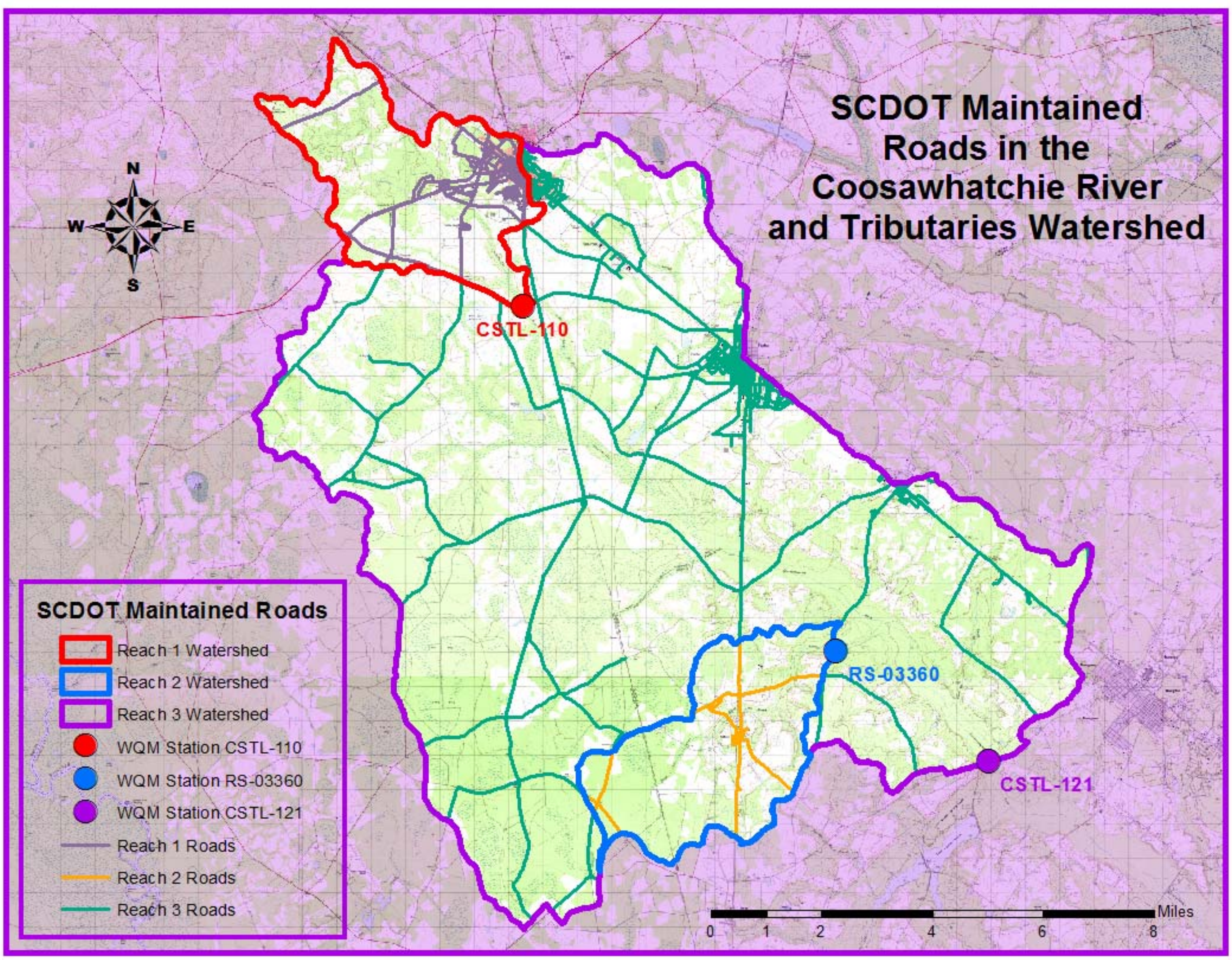


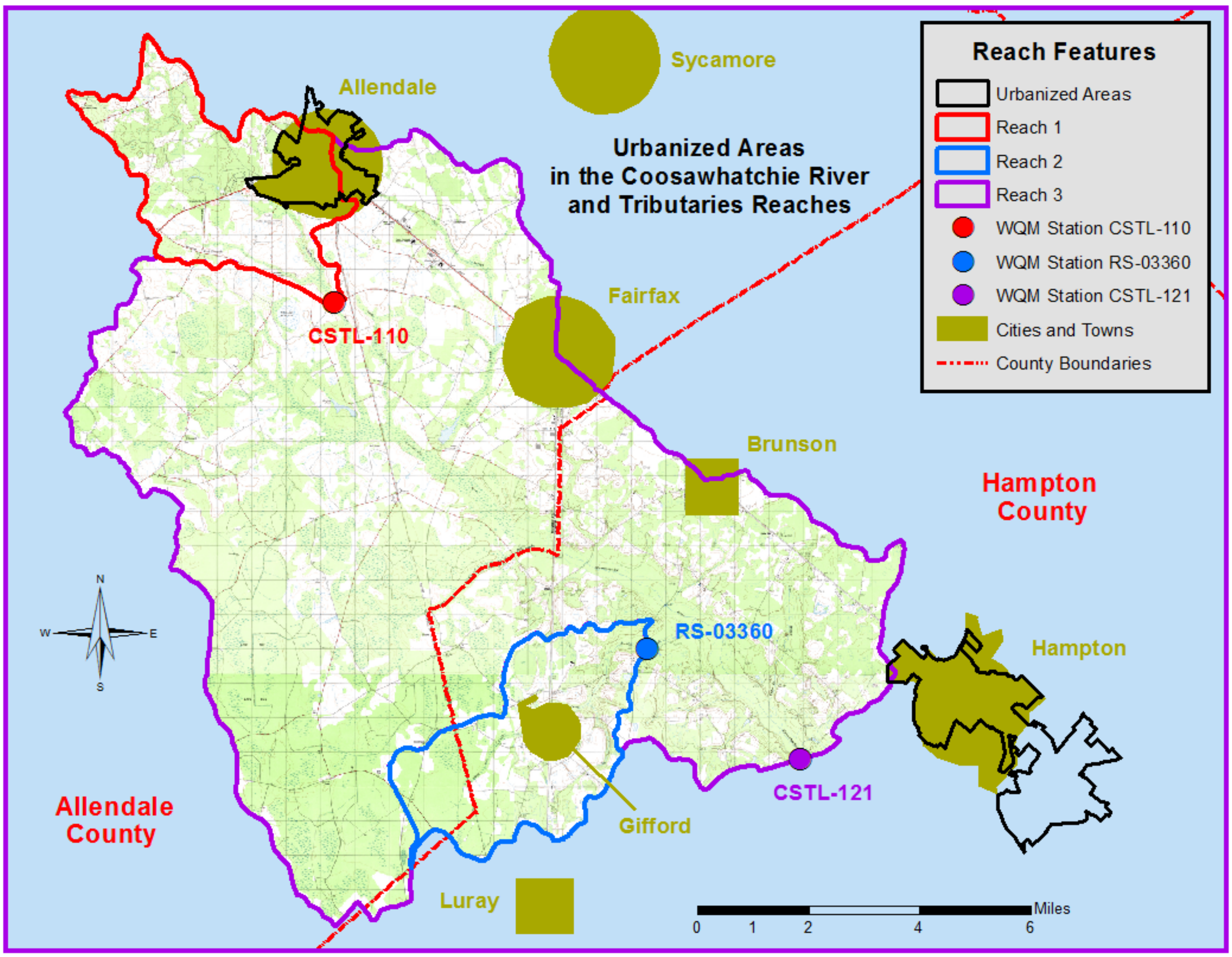
Table 7. SCDOT Maintained Road Miles in the Coosawhatchie River and Tributaries Watershed Reaches

Watershed Reach	Station	Road Miles
Watershed Reach 1	CSTL-110	37.6
Watershed Reach 2	RS-03360	13.1
Watershed Reach 3	CSTL-121	152.2
Total Miles in the CRT Watershed Reaches:		202.9

Current developed land use for the CRT Watershed range from 5.02% to 13.04% (Table 3). Based on GIS information, there is one SCDOT facility located in the CRT Watershed. The SCDOT facility is located in Reach 1 of the watershed at 720 Gum Street E in the City of Allendale, in Allendale County. And, based on information provided on the SCDOT website, there are no highway rest areas in the watershed areas.

Small MS4s that discharge stormwater in urbanized areas, as designated by the U.S. Bureau of Census, are regulated under SC *Water Pollution Control Permits* Regulation 122.26(b)(16) and 122.32. Urbanized areas in the CRT Watershed are shown in Figure 7. However, at the time of the development of these TMDLS, there were no defined small MS4s in the CRT Watershed.

Figure 7. Urbanized Areas in the Coosawhatchie River and Tributaries Watershed



In addition to stormwater discharges from small MS4s regulated under Regulation 122.26(b)(16) and 122.32, the SCDHEC may designate stormwater discharges from small MS4s for regulation under Regulation 122.26(a)(1)(v) and 122.32(f) and (g). At the time of the development of these TMDLs, there were no designated small MS4 in the CRT Watershed.

Other than the abovementioned MS4 owned and/or operated stormwater sewer system, there are currently no permitted stormwater systems that discharge into the CRT watershed. Future permitted sanitary sewer or stormwater systems in the referenced watersheds will be required to comply with the load reductions prescribed in the WLA and demonstrate consistency with the assumptions and requirements of the TMDLs in this TMDL development document.

Industrial facilities that have the potential to cause or contribute to a violation of a WQS are covered by the NPDES Storm Water Industrial General Permit (SCR000000). Construction activities are usually covered by the NPDES Storm Water Construction General Permit from the SCDHEC (SCR100000). Where the construction has the potential to affect water quality of a water body with a TMDL, the Storm Water Pollution Prevention Plan for the site must address any pollutants of concern and adhere to any WLAs in the TMDLs. Note that there may be other stormwater discharges not covered under permits numbered SCS and SCR that occur in the referenced watersheds. These activities are not subject to the WLA portion of the TMDLs.

Sanitary sewer overflows (SSOs) to surface waters have the potential to severely impact water quality. These untreated sanitary discharges result in violations of the WQS. It is the responsibility of the NPDES wastewater discharger, or sewer collection system operator for non-permitted 'collection only' systems, to ensure that releases do not occur. Unfortunately releases to surface waters from SSOs are not always preventable or reported.

According to GIS information (available at time of TMDL development), community sewer collection systems serve portions of Reach 1 and Reach 3 in the CRT Watershed. The City of Allendale's sewer collection system serves an area in the eastern portion of Reach 1 of the watershed (terminal WQM Station CSTL-110). The area served is 2.38 mi^2 (1522.61 acres). This represents approximately 21% of the 11.44 mi^2 reach being served by a sewer collection system (Table 8).

Table 8. Areas Served by Community Sewer Collection Systems in the Coosawhatchie River and Tributaries Watershed Reaches

WQM Station	Reach	Reach Area (mi^2)	Area Served by Sewer Collection Systems (mi^2)	% Reach Covered by Sewer Collection Systems
CSTL-110	Reach 1	11.44	2.38	21%
CSTL-121	Reach 3	102.08	5.80	6%

And, according to GIS information, the following municipalities' sewer collection systems serve the respective areas in the respective portions of Reach 3 of the CRT Watershed (terminal WQM Station CSTL-121): **a)** the City of Allendale's system serves 1.04 mi^2 (667.65 acres) in the northern portion of the reach; **b)** the Town of Fairfax's system serves 2.96 mi^2 (1892.86 acres) in the northeastern portion of the reach; **c)** the Town of Brunson's system serves 1.23 mi^2 (788.41 acres)[1] in the eastern portion of the reach; and, **d)** the City of Hampton's system serves 0.56 mi^2 (361.40 acres) in the southeastern portion of the reach. Together, the sewer collection systems serve 5.80 mi^2 (3710.32 acres) in the reach. This represents only approximately 6% of the 102.08 mi^2 reach being served by sewer collection systems (Table 8). There are no community sewer collection systems in Reach 2 of the CRT Watershed.

Similar to regulated MS4s, potentially designated MS4 entities (as listed in 64 FR, 235, P.68837) or other unregulated MS4 communities located in the CRT Watershed and surrounding watersheds may have the potential to contribute bacteria in stormwater runoff. These unregulated entities are subject to the LA for the purposes of this TMDL

[1] The area served by the Town of Brunson's sewer collection system was not shown in GIS. The area was calculated by extending a radius of approximately 350 yards around the town's sewer collection system lines in GIS. 350 yards was the average approximate radius around other sewer collection system lines where those sewer collection system services areas were shown in GIS.

The Department acknowledges that progress with the assumptions and requirements of the TMDLs by MS4s is expected to take one or more permit iteration. Progress towards achieving the WLA reduction for the TMDLs may constitute MS4 compliance with its SWMP, provided the Maximum Extent Practicable (MEP) definition is met, even where the numeric percent reduction may not be achieved in the interim.

3.2 Nonpoint Sources

Nonpoint source pollution is defined as pollution that is not released through pipes but rather originates from multiple sources over a relatively large area. Nonpoint sources can be divided into source activities related either to land or water use including failing septic tanks, improper animal-keeping practices, agriculture, forestry practices, wildlife and urban and rural runoff.

The Department recognizes that there may be wildlife, agricultural activities, grazing animals, septic tanks, and/or other nonpoint source contributors located within unregulated areas (outside of NPDES permitted area) of the CRT Watershed. Nonpoint sources located in unregulated areas are subject to the load LA and not the WLA of the TMDL development document.

Pathogenic forms of *E. coli,* found in the guts of ruminant animals such as cattle, goats, sheep, deer and elk, produce toxins and are called "Shiga toxin-producing" *E. coli* or STEC. Of these ruminant animals, cattle are the major source for human illnesses. STEC infections start with ingestion of human or animal feces, contact with cattle, unpasteurized apple cider, soft cheeses made from raw milk, consumption of contaminated unpasteurized raw milk and water (CDC, n.d.).

3.2.1 Wildlife

Resident and migrant wildlife (mammals and birds) can be a significant contributor of *E. coli* bacteria and other FC bacteria. Wildlife in this area typically includes deer, squirrels, raccoons, and other mammals as well as a variety of birds. Wildlife wastes are carried into nearby streams by runoff following rainfall or deposited directly in streams. According to the SC Department of Natural Resources (SCDNR) 2013 deer population density map and GIS information, there are 30 to 45 deer/mi^2 in all three reaches of the CRT Watershed (SCDNR, 2015) (Figure 8). A 2008 SCDNR study estimated deer density based on suitable habitat (forests, croplands, and pastures). The FC bacteria production rate for deer has been shown to be 347 x 10^6 cfu/head-day in a study conducted by Yagow (1999), of which only a portion will enter the CRT Watershed. Wildlife may contribute a significant portion of the overall *E. coli* bacteria and other FC bacteria load within the watersheds.

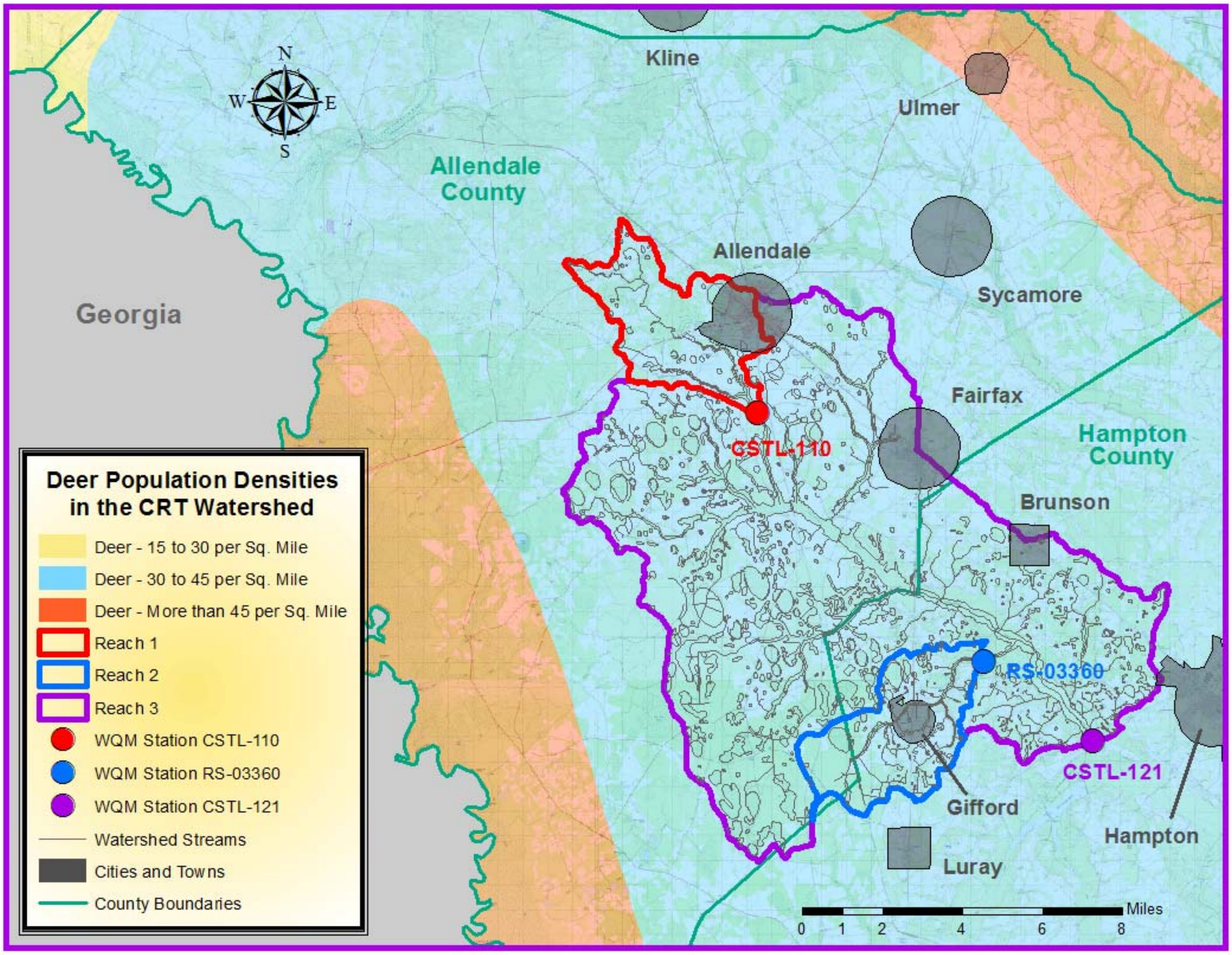
3.2.2 Agricultural Activities

Agricultural activities that involve livestock or animal wastes are potential sources of pathogen contamination of surface waters. Fecal matter can enter the waterway via runoff from the land or by direct deposition into the stream. Unstabilized soil directly adjacent to surface waters can contribute to pollutant loading during periods of runoff after rain events. During these events, fertilizer and wildlife wastes can be transported into the creek and carried downstream. Agricultural activities may represent a contributing source in the CRT Watershed where agricultural activities constitute a greater portion of the land use.

3.2.2.1 Agricultural Animal Facilities

Owners/operators of most commercial animal growing operations are required by South Carolina Regulation 61-43, *Standards for the Permitting of Agricultural Animal Facilities*, to obtain permits for the handling, storage, treatment (if necessary) and disposal of the manure, litter and dead animals generated at their facilities (SCDHEC, 2002). The requirements of R. 61-43 are designed to protect water quality; therefore, the Department has a reasonable assurance that facilities operating in compliance with this regulation should not contribute to downstream water quality impairments. South Carolina currently does not have any confined animal feeding operations (CAFOs) under NPDES coverage; however, the State does have permitted animal feeding operations (AFOs) covered under R. 61-43. These permitted operations are not allowed to discharge to waters of the State and are covered under 'no discharge' (ND) permits. Discharges from these operations to waters of the State are illegal and are subject to enforcement actions by the SCDHEC.

Figure 8. Deer Population Densities in the Coosawhatchie River and Tributaries Watershed Reaches (Based on the 2013 SCDNR South Carolina Deer Population Density Map)



At the time of the development of these TMDLs, there was one active AFO with regulated structures or activities in the CRT Watershed. JCO Farms, a dairy facility, is located in Reach 3 of the watershed, and is regulated under the SCDHEC's AFO Permit No. ND0000370 (Figure 3c). There were no poultry facilities in the watershed. Poultry operations are regulated according to Section 122.23 of SC Regulation 61-9, *Water Pollution Control Permits*. There may be land application sites associated with AFO facilities. These facilities are routinely inspected for compliance. Permitted agricultural facilities that operate in compliance with their permit are not considered to be sources of impairment.

3.2.2.2 <u>Grazing Animals</u>

Livestock, especially cattle, are frequently major contributors of FC bacteria or *E. coli* bacteria to streams. Cattle on average produce some 1.0E+11 cfu/day per animal of FC bacteria (ASAE 1998). Grazing cattle and other livestock may contaminate streams with FC bacteria (including *E. coli*) indirectly by runoff from pastures or directly by defecating into streams and ponds. Direct loading by cattle or other livestock to surface waters within the CRT Watershed is likely to be a contributing source of *E. coli* bacteria and other FC bacteria. However, the grazing of unconfined livestock (in pastures) is not regulated by the SCDHEC.

The United States Department of Agriculture's (USDA) National Agricultural Statistics Service reported 3109 and 1032 cattle and calves in Allendale and Hampton Counties, respectively, in 2012 (USDA 2014). According to the 2011 National Land Cover Database (NLCD), there are 12,767.64 and 13,308.55 acres of pastureland in Allendale and Hampton Counties, respectively. This relates to 0.24 and 0.08 cattle per acre of pastureland in Allendale and Hampton Counties, respectively, assuming an even distribution of cattle across pastureland in the counties. Table 9 shows the number of acres of pastureland in the reaches of the CRT Watershed and, based on this acreage, an estimate of the number of cattle in the reaches. And, based on the number of cattle, the table also shows an average of cfu/day of FC bacteria produced by cattle in the reaches. Based on the table, following is the average FC bacteria produced per day by the estimated total cattle and calves within each reach of the CRT Watershed: **a)** 1.37E+13 cfu/day by an estimated one hundred and thirty-seven (137) cattle and calves in Reach 1 (terminal WQM Station CSTL-110); **b)** 2.85E+12 cfu/day by an estimated twenty-nine (29) cattle and calves in Reach 2 (terminal WQM Station RS-03360)[2]; and, **c)** 9.36E+13 cfu/day by an estimated nine hundred and thirty-six (936) cattle and calves in Reach 3 (terminal WQM Station CSTL-121).

Table 9. Cattle FC Bacteria per Day in the Coosawhatchie River and Tributaries Watershed Reaches

Downstream Impaired Station	County	Pasture Area (Acre) per Watershed	Cattle per Watershed	Cattle Fecal Coliform, cfu/day
CSTL-110	Allendale	562.66	137	1.37E+13
RS-03360	Hampton	370.09	29	2.85E+12
CSTL-121	Allendale	3508.85	854	8.54E+13
	Hampton	1057.08	82	8.15E+12

3.2.3 Land Application of Industrial, Domestic Sludge or Treated Wastewater

NPDES-permitted industrial and domestic wastewater treatment processes may generate solid waste bi-products, also known as sludge. In some cases, facilities may be permitted to land apply sludge at designated locations and under specific conditions. There are also some NPDES-permitted facilities authorized to land apply treated effluent at designated locations and under specific conditions. Land application permits for industrial and domestic wastewater facilities may be covered under SC Regulation 61-9, Sections 503, 504, or 505. According to GIS information (available at time of TMDL development), there were no active land application sites in the CRT Watershed. If properly managed, waste is applied at a rate that ensures pollutants will be incorporated into the soil or plants and pollutants will not enter streams. Land applications sites can be a source of pathogen loadings and stream impairment if not properly managed. Similar to AFO land application sites, the permitted land application sites described in this section are not allowed to directly discharge to streams in the CRT Watershed. Direct discharges from land applications sites to surface waters of the State are illegal and are subject to enforcement actions by SCDHEC.

3.2.4 Leaking Sanitary Sewers and Illicit Discharges

Leaking sewer pipes and illicit sewer connections represent a direct threat to public health since they result in discharge of partially treated or untreated human wastes to the surrounding environment. Quantifying these sources is extremely speculative without direct monitoring of the source because the magnitude is directly proportional to the volume and its proximity to the surface water.

Illicit sewer connections into storm drains result in direct discharges of sewage via the storm drainage system outfalls. Monitoring of storm drain outfalls during dry weather is needed to document the presence or absence of sewage in the drainage systems. Besides the SCDOT, there are currently no entities subject to an NPDES MS4 permit within or with impact to the CRT Watershed.

3.2.5 Failing Septic Systems

Failing, leaking or non-conforming septic systems, however, can be a major contributor of *E. coli* bacteria and other FC bacteria to the CRT Watershed. Wastes from failing septic systems enter surface waters either as direct overland flow or via groundwater. Although loading to streams from failing septic systems is likely to be a continual source, wet weather events can increase the rate of transport of pollutants from

[2] According to GIS information available at the time of the development of these TMDLs, there were no pasturelands in the Allendale County portion of Reach 2 of the CRT Watershed.

failing septic systems because of the wash-off effect from runoff and the increased rate of groundwater recharge.

3.2.5.1. <u>Septic Systems in Reach 1 of the CRT Watershed (WQM Station CSTL-110)</u>

According to GIS information, sewer lines for the City of Allendale extend into the eastern portion of the 7325.88-acre Reach 1 of the CRT Watershed. However, the vast majority of Reach 1 (approximately 79%) is not served by the City of Allendale sewer systems, or any other community sewer system. Based on GIS information, 2015 USDA aerial photography of the watershed, and based on the 2010 U.S. population census, there are 140 households within the reach not served by a community sewer system. Therefore, assuming one (1) septic tank per household, it is estimated that there are approximately 140 septic tanks within the reach. This translates into 0.019 septic tanks per watershed acre. At the time of the development of these TMDLs, their status in relation to function was unknown.

3.2.5.2. <u>Septic Systems in Reach 2 of the CRT Watershed (WQM Station RS-03360)</u>

According to GIS information, there are no community sewer systems serving Reach 2 of the CRT Watershed. Based on current GIS information, 2015 USDA aerial photography of the reach, and based on the 2010 U.S. population census, there are 203 households within the 7191.11-acre reach. Therefore, assuming one (1) septic tank per household, it is estimated that there are approximately 203 septic tanks within the reach. This translates into 0.028 septic1 tanks per reach acre. At the time of the development of these TMDLs, their status in relation to function was unknown.

3.2.5.3. <u>Septic Systems in Reach 3 of the CRT Watershed (WQM Station CSTL-121)</u>

And, according to GIS information, the following municipalities' sewer lines extend into the respective portions of the 65,351.35-acre Reach 3 of the CRT Watershed: **a)** the City of Allendale's into a small portion of the northern part of the reach; **b)** the Town of Fairfax's into a small portion of the northeastern part of the reach; **c)** the Town of Brunson's into a small portion of the eastern part of the reach [3]; and, **d)** the City of Hampton's into a small portion of the southeastern part of the reach. However, the vast majority of Reach 2 (approximately 94%) is not served by the sewer systems for the aforementioned municipalities, or any other community sewer system. Based on GIS information, 2015 USDA aerial photography of the watershed, and based on the 2010 U.S. population census, there are 729 households within the reach not served by a community sewer system. Therefore, assuming one (1) septic tank per household, it is estimated that there are approximately 729 septic tanks within the reach. This translates into 0.011 septic tanks per watershed acre. At the time of the development of these TMDLs, their status in relation to function was unknown.

3.2.6 Urban and Suburban Runoff

Dogs, cats, and other domesticated pets are the primary source of *E. coli* bacteria and other FC bacteria deposited on the urban landscape. There are also 'urban' wildlife, squirrels, raccoons, pigeons, and other birds, all of which contribute to the FC bacteria (including *E. coli*) load. A small percentage of urban areas lie within the CRT Watershed. Based on GIS information, some portion of five (5) incorporated areas lie within the reaches of the CRT Watershed (Figure 2).

According to GIS information, 57.59% of the incorporated area of the City of Allendale (i.e., 1208.66 acres of 2098.60 acres) lie within in the eastern portion of the 7325.88-acre Reach 1 of the CRT Watershed (Figure 2). However, this translates to only 16.50% of the reach being incorporated areas.

According to GIS information, the entire incorporated area of the Town of Gifford (i.e., 622.45 acres) lie within in the central portion of the 7191.11-acre Reach 2 of the CRT Watershed (Figure 2). However, this translates to only 8.66% of the reach being incorporated areas.

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[3] The area served by the Town of Brunson's sewer collection system was not shown in GIS. The area was calculated by extending a radius of approximately 350 yards around the town's sewer collection system lines in GIS. 350 yards was the average approximate radius around other sewer collection system lines where those sewer collection system services areas were shown in GIS.

And, according to GIS information, the following percentages of the respective incorporated areas lie within the respective portions of the 65,351.35-acre Reach 3 of the CRT Watershed: **a)** 23.18% of the incorporated area of the City of Allendale (i.e., 486.47 acres of 2098.35 acres) in the northern portion of the reach; **b)** 61.66% of the incorporated area of the Town of Fairfax (i.e., 1301.39 acres of 2110.63 acres) in the northeastern portion of the reach; **c)** 72.46% of the incorporated area of the Town of Brunson (i.e., 469.93 acres of 648.50 acres) in the eastern portion of the reach; and, **d)** 0.59% of the incorporated area of the City of Hampton (i.e., 17.02 acres of 2903.68 acres) in the southeastern portion of the reach. Therefore, 2274.80 acres is the total incorporated areas within the reach. However, this translates to only 3.48% of the reach being incorporated areas.

Similar to regulated MS4s, potentially designated MS4 entities (as listed in FR 64, 235, p.68837) or other unregulated MS4 communities located in the CRT Watershed may have the potential to contribute pollutant loadings in stormwater runoff. According to GIS information, only 6.28% of the CRT Watershed is developed. Therefore, there is potential for growth in the CRT Watershed.

4.0 LOAD-DURATION CURVE METHOD

The load-duration curve method was developed as a means of incorporating natural variability, uncertainty, and risk assessment into TMDL development (Bonta and Cleland 2003). The analysis is based on the range of hydrologic conditions for which there are appropriate water quality data. The load-duration curve method uses the cumulative frequency distribution of stream flow and pollutant concentration data to estimate existing and TMDL loads for a water body. Development of the load-duration curve is described in this chapter.

The load-duration curve method depends on an adequate period of record for flow data. Three (3) United States Geological Survey (USGS) gages were used for collecting “real-time” flow data for the CRT Watershed TMDLs, based primarily on the size of the drainage area to the downstream gage, and secondarily on the general land use in the drainage area. The USGS gage used for collecting flow data for Reach 1 of the CRT Watershed (WQM Station CSTL-110) was the New River gage at Gum Branch, NC (Gage Number: 02093000). This gage has a drainage area of 94 square miles, began recording daily flows in 1949 and provides the flow data required to establish the flow duration curve for this impaired station.

The USGS gage used for collecting flow data for Reach 2 of the CRT Watershed (WQM Station RS-03360) was the Beaver Dam Creek gage at Sardis, GA (Gage Number: 02198100). This gage has a drainage area of 30.8 square miles, began recording daily flows in 1986 and provides the flow data required to establish the flow duration curve for this impaired station.

And, The USGS gage used for collecting flow data for Reach 3 of the CRT Watershed (WQM Station CSTL-121) was the Ebenezer Creek gage at Springfield, GA (Gage Number: 02198690). This gage has a drainage area of 162 square miles, began recording daily flows in 1990 and provides the flow data required to establish the flow duration curve for this impaired station.

For example, flow data for a 12-year period (January 1, 2005 to December 31, 2016) from the USGS Springfield, GA gage was used to establish the flow duration curve for Reach 3 of the CRT Watershed (WQM Station CSTL-121). The records for this period were complete (i.e., no missing dates). The drainage area of the sampling station was delineated using USGS topographic maps using ArcMap software. The cumulative area drained was calculated and used to estimate flow based on the ratio of the monitoring station drainage area to the downstream USGS gage. For example, the Springfield, GA gage records flow from 162 square miles (sq mi). The cumulative drainage area for the Reach 3 of the CRT Watershed at WQM Station CSTL-121 (in the Coosawhatchie River at SC 363 in Hampton County) is 124.76 sq mi, or 77.01% of the area drained at the Springfield, GA gage. Therefore, mean daily flow for the CSTL-121 monitoring location was assumed to be 77.01% of the daily flow at the Springfield, GA gage.

However, additional adjustments were necessary in order more accurately estimate stream flow at WQM Station CSTL-121. The Town of Brunson’s WWTF (NPDES Permit No. SC0042382) on County Route S-25-69 at the Coosawhatchie River, approximately 1.75 miles south of the town in Hampton County (Figure 5 and Table 6) is a minor domestic WWTP located upstream of WQM Station CSTL-121. It is believed that flow contributions from this facility may be large enough to influence downstream flow estimates, particularly during dry conditions. To better establish existing instream conditions, long-term average facility flow data for NPDES permits SC0042382 were added to the estimated time series described in the previous paragraph.

Figure 2 provides an illustration of monitoring and gage locations along with a summary of drainage area statistics used to establish flows at un-gaged monitoring stations in the CRT Watershed.

Flow duration curves were developed by ranking flows from highest to lowest and calculating the probability of occurrence (presented as a percentage or duration interval), where zero corresponds to the highest flow. The duration interval can be used to determine the percentage of time a given flow is achieved or exceeded, based on the period of record. The flow duration curves were divided into five (5) hydrologic condition categories (High Flows, Moist Conditions, Mid-Range, Dry Conditions and Low Flows). Categorizing flow conditions can assist in determining which hydrologic conditions result in the greatest number of exceedences. A high number of exceedences under dry conditions might indicate a point source or illicit connection issue, whereas moist conditions may indicate nonpoint sources. Data within the High Flow and Low Flow categories are generally not used in the development of a TMDL due to their infrequency.

For WQM Station CSTL-121, where the target load-duration curve was created using existing *E. coli* bacteria data, the curve was created by calculating the allowable load using daily flow, the former *E. coli* bacteria WQS concentration and a unit conversion factor. The water quality target was set at 349 MPN/100 ml for the instantaneous criterion, which is five (5) percent lower than the former water quality criterion of 349 MPN /100 ml. A five (5) percent explicit MOS was reserved from the water quality criteria in developing target load-duration curves. The load-duration curve for station CSTL-121 is presented in Figure 9 as an example.

For those WQM stations where the target load-duration curves were created using existing FC bacteria data (i.e., WQM Stations CSTL-110 and RS-03360), the curves were created by calculating the allowable load using daily flow, the former FC bacteria WQS concentration and a unit conversion factor. The water quality target was set at 380 cfu/100 ml for the instantaneous criterion, which is five (5) percent lower than the former water quality criterion of 400 cfu/100 ml. A five (5) percent explicit MOS was reserved from the water quality criteria in developing target load-duration curves. The load-duration curves for stations CSTL-110 and RS-03360 are presented in Appendix B.

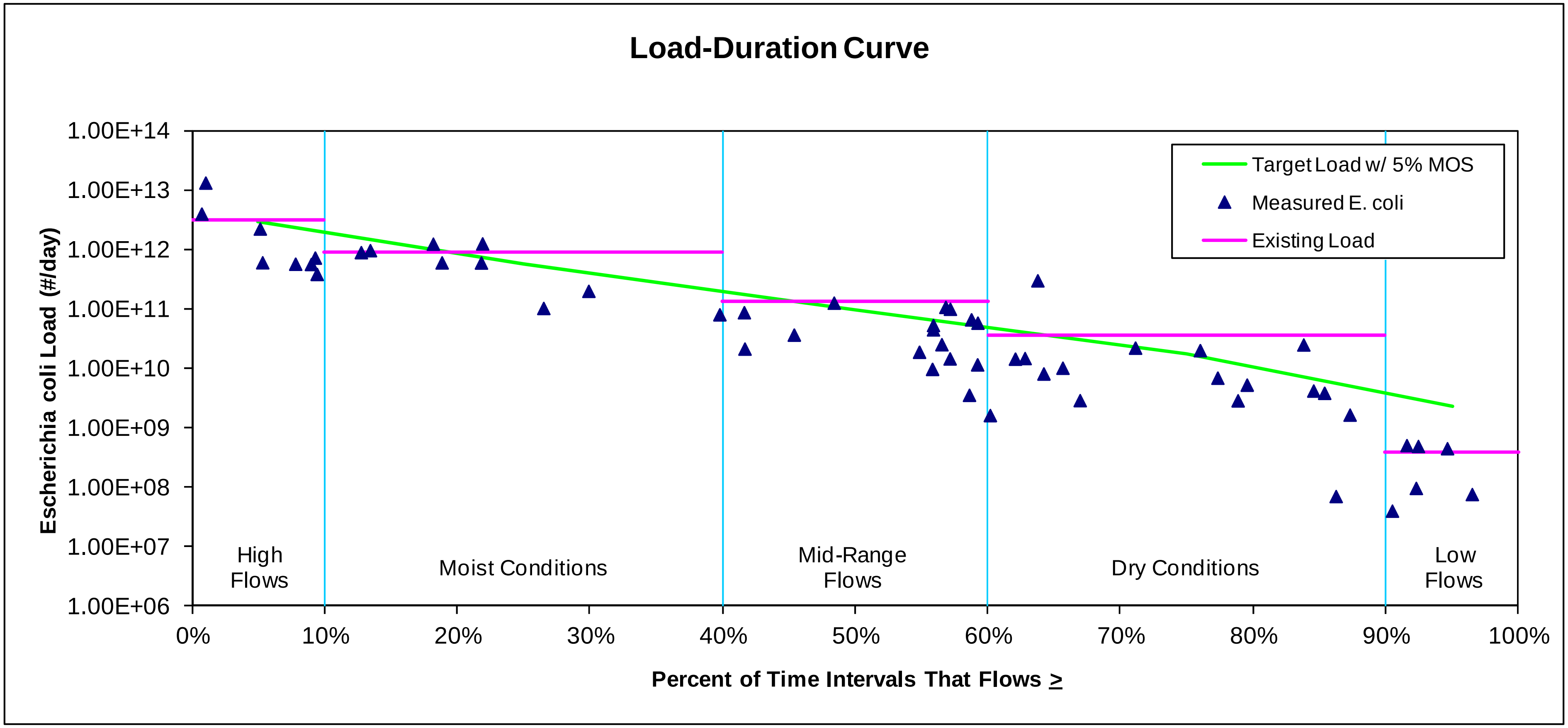
Target loads in freshwaters impaired for *E. coli* bacteria may alternatively be calculated as the ratio of *E.coli* bacteria MPN/100 ml to FC bacteria cfu/100 ml or (349/400=0.8725). This conversion is derived from an established relationship between FC bacteria and *E. coli* bacteria WQS in freshwaters determined during the SCDHEC's 2009 PIS. Accordingly, because SC has recently adopted a change from FC bacteria to *E. coli* bacteria as a recreational use standard in all freshwaters, this TMDL development document also includes converted *E. coli* bacteria TMDLs for WQM Stations CSTL-110 and RS-03360, for purposes of implementation of the current recreational use standard. For these calculations, the daily flow and a unit conversion factor were used and the water quality target was set at 332 MPN/100 ml for the instantaneous criterion, which is five (5) percent lower than the current water quality criteria of 349 MPN/100 ml. A five (5) percent explicit MOS was reserved from the water quality criteria in developing target load-duration curves. For the purposes of establishing these two (2) TMDLs, FC bacteria percent reductions should also be representative of reductions necessary to meet the *E. coli* bacteria WQS.

For all curves, including Figure 9, the independent variable (X-Axis) represents the percentage of estimated flows greater than value x. The dependent variable (Y-Axis) represents the *E. coli* bacteria or FC bacteria loading at each estimated flow expressed in terms of most probable number per day (MPN/day), or colony forming units per day (cfu/day). In each of the defined flow intervals for WQM Station CSTL-121, existing loads and LAs to achieve target loads were calculated by the following equations:

Existing Load (MPN/day) = Mid-Point Flow in Each Hydrologic Category, including long term average DMR flow for NPDES Permit SC0042382 (ft^3/s)) x 90^{th} Percentile E. coli Bacteria Concentration (MPN/100 ml) x Conversion Factor (24465758.4)

LA to Achieve Target Load (MPN/day) = (Mid-Point Flow in Each Hydrologic Category, including NPDES Permit SC0042382 Facility Design Flow (ft^3/s)) x 332 (E. coli Bacteria WQ criterion minus a 5% MOS (MPN/100 ml)) x Conversion Factor (24465758.4)) - (NPDES Permit SC0042382 Facility Design Flow (0.11 MGD = 0.17 ft^3/s) x 349 (E.coli Bacteria WQ criterion (cfu/100 ml)) x Conversion Factor (24465758.4))

Figure 9. Load Duration Curve for Reach 3 of the Coosawhatchie River and Tributaries Watershed, Water Quality Monitoring Station CSTL-121



Percent Reduction = (Existing Load – LA to Achieve Target Load) / Existing Load

In each of the defined flow intervals for WQM Stations CSTL-110 and RS-03360, existing loads and *LAs to achieve* target load were calculated by the following equations:

Existing Load (cfu/day) = Mid-Point Flow in Each Hydrologic Category (ft^3/s) x 90^{th} Percentile FC Concentration (cfu/100 ml) x Conversion Factor (24465758.4)

LA to Achieve Target Load (cfu/day) = Mid-Point Flow in Each Hydrologic Category (ft^3/s) x 380 (FC Bacteria WQ criterion minus a 5% MOS (cfu/100 ml)) x Conversion Factor (24465758.4)

Percent Reduction = (Existing Load – LA to Achieve Target Load) / Existing Load

Instantaneous loads for each of the impaired stations were calculated. Measured *E. coli* bacteria FC bacteria concentrations from 1999 through 2014 were multiplied by measured (or estimated flow based on drainage area) flow on the day of sampling and a unit conversion factor. These data were plotted on the load-duration graph based on the flow duration interval for the day of sampling. Samples above the target line are violations of the WQS while samples below the line are in compliance (see Figure 9, for example). Only the instantaneous water quality criterion was targeted because there is insufficient data to evaluate against the 30-day geometric mean.

An existing load was determined for each hydrologic category for the TMDL calculations. For the three (3) WQM stations in the CRT Watershed, the 90^{th} percentile of measured *E. coli* bacteria concentrations and FC bacteria concentrations within each hydrologic category were multiplied by the flow at each category midpoint (i.e., flow at the 25% duration interval for the Moist Conditions, 50% interval for Mid-Range, and 75% for Dry Condition).

Existing loads are plotted on the load-duration curves presented in Appendix A as well as the example for WQM Station CSTL-121 in Figure 9. These values were compared to the target loads (which includes an explicit 5% MOS) at each hydrologic category midpoint to determine the percent load reduction necessary to achieve compliance with the WQS. These TMDLs assumes that if the highest percent reduction is achieved, then the WQS will be attained under all flow conditions.

5.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOAD

A TMDL for a given pollutant and water body is comprised of the sum of individual WLAs for point sources, and LAs for both nonpoint sources and natural background levels. In addition, the TMDL must include a MOS, either implicitly or explicitly, to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving water body. Conceptually, this definition is represented by the equation:

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

The TMDL is the total amount of pollutant that can be assimilated by the receiving water body while still achieving compliance with WQS. In TMDL development, allowable loadings from all pollutant sources that cumulatively amount to no more than the TMDL must be established and thereby provide the basis to establish water quality-based controls.

For most pollutants, TMDLs are expressed as a mass load (e.g., kilograms per day). For bacteria, however, TMDLs are expressed in terms of number (#), colony forming units (cfu), organism counts (or resulting concentration), or MPN, in accordance with 40 CFR 130.2(l).

5.1 Critical Conditions

The critical condition is identified as the stream flow condition requiring the greatest percentage of pollutant loading reduction to meet the LA in the TMDL. Data within the High Flow and Low Flow categories are generally not used in the development of a TMDL due to their infrequency. Accordingly, the TMDLs for the three (3) WQM stations in the CRT Watershed were based on the flow recurrence interval between 10% and 90% and excludes extreme high and low flow conditions; flows that are characterized as ‘Low’ or ‘High.’ The critical conditions for the CRT Watershed pathogen impaired segments are listed in Table 10. This data indicates that for WQM Station CSTL-121, dry conditions result in larger bacteria loads and is therefore the

Table 10. Percent Reduction Necessary to Achieve Target Load by Hydrologic Category

WQM Station	Waterbody	Moist Conditions	Mid-Range Flow	Dry Conditions
CSTL-110	Coosawhatchie River	NRN	NRN	36
RS-03360	Blood Hill Creek	37	NRN	NM
CSTL-121	Coosawhatchie River	36	28	55

Highlighted cells indicate critical condition
NRN = No reduction needed. Existing load below target load
NM = Not measured. No fecal coliform bacteria measurements during the hydrologic category

critical condition for that station. The following flow conditions result in larger bacteria loads, and are therefore the critical conditions, for the other two (2) WQM stations in the CRT Watershed: **a)** dry conditions for CSTL-110; and, **b)** moist conditions for RS-03360.

5.2 Existing Load

An existing load was determined for each hydrologic category for the TMDL calculations as described in Section 4.0 of this TMDL development document. The existing load under the critical condition, described in Section 5.1 above was used in the TMDL calculations. Loadings from all sources are included in this value: cattle-in-streams, failing septic systems as well as wildlife. The existing load for the three (3) WQM stations in the CRT Watershed are provided in Appendix D.

5.3 Waste Load Allocation

The WLA is the portion of the TMDL allocated to NPDES-permitted point sources (USEPA, 1991). Note that all illicit dischargers, including SSOs, are illegal and not covered under the WLA of these TMDLs.

5.3.1 Continuous Point Sources

There is one active permitted domestic discharger of *E. coli* bacteria and other FC bacteria in the CRT Watershed. The facility is the Town of Brunson's WWTF, which is discharging in Reach 3 of the watershed (Figure 5) (see Section 3.1.1 of this TMDL development document). The Town is permitted under the SCDHEC's NPDES Permit No. SC0042382 to discharge *E. coli* bacteria from its WWTF to the Coosawhatchie River. To determine the WLA for the WWTF, the average design flow for the facility was multiplied by an allowable permitted maximum concentration of 349 MPN/100 mL and a unit conversion factor. The WLA for the WWTF, based on a permitted daily maximum of 349 MPN/100 mL, is presented in Table 11. The WLA for the WWTF is 1.45 billion counts per day (1.45E+09 MPN/day) based on a permitted average design flow of 0.11 MGD.

Table 11. Average Permitted Flow and *E. coli* Bacteria WLA for the NPDES Wastewater Discharge in the Coosawhatchie River and Tributaries Watershed

Impaired Station Watershed	Permitted Facility	Permit Number	Permitted Flow (MGD)	WLA *E. coli* (MPN/day)
CSTL-121	Town of Brunson's WWTF	SC0042382	0.11	1.45E+09

Because South Carolina has adopted a change from FC bacteria to *E. coli* bacteria as a recreational use standard in all freshwaters, future continuous discharges are required to meet the prescribed loading for *E. coli* bacteria based on permitted flow and an allowable permitted maximum concentration of 349MPN/100 mL.

5.3.2 Non-Continuous Point Sources

Non-continuous point sources include all NPDES-permitted stormwater discharges, including current and future MS4s, construction and industrial stormwater discharges covered under permits numbered SCS & SCR and regulated under SC *Water Pollution Control Permits* Regulation 122.26(b)(14) & (15) (SCDHEC, 2010. Illicit discharges, including SSOs, are not covered under any NPDES permit and are subject to enforcement mechanisms. Small MS4s that discharge stormwater in urbanized areas, as designated by the US Census, are required under the NPDES Phase II Stormwater Regulations to obtain a permit for the discharge of stormwater. Figure 7 shows the urbanized areas in the CRT Watershed. However, at the time of the development of these TMDLS, there were no defined small MS4s in the CRT Watershed. Other non-urbanized areas may be required under the NPDES Phase II Stormwater Regulations to obtain a permit for the discharge of stormwater.

WLAs for stormwater discharges are expressed as a percentage reduction instead of a numeric loading due to the uncertain nature of stormwater discharge volumes and recurrence intervals. All current and future stormwater discharges are required to meet the percentage reduction or the existing instream standard for the pollutant of concern. The percent reduction is based on the maximum percent reduction (critical condition) within any hydrologic category necessary to achieve target conditions. Table 12 presents the reduction needed for each impaired segment in the CRT Watershed. The reduction percentages in these TMDLs also apply to the FC bacteria or *E. coli* bacteria waste load attributable to those areas of the watershed that are covered or will be covered under NPDES MS4 permits.

Table 12. Percent Reduction Necessary to Achieve Target Load

WQM Station	Waterbody	% Reduction
CSTL-110	Coosawhatchie River	36
RS-03360	Blood Hill Creek	37
CSTL-121	Coosawhatchie River	55

As appropriate information is made available to further define the pollutant contributions for the permitted MS4, an effort can be made to revise these TMDLs. This effort will be initiated as resources permit and if deemed appropriate by the Department. For the Department to revise these TMDLs the following information should be provided, but not limited to:

1. An inventory of service boundaries of the MS4 covered in the MS4 permit, provided as ARCGIS compatible shape files.
2. An inventory of all existing and planned stormwater discharge points, conveyances, and drainage areas for the discharge points, provided as ARCGIS compatible shape files. If drainage areas are not known, any information that would help estimate the drainage areas should be provided. The percentage of impervious surface within the MS4 area should also be provided.
3. Appropriate and relevant data should be provided to calculate individual pollutant contributions for the MS4 permitted entities. At a minimum, this information should include precipitation, water quality, and flow data for stormwater discharge points.

Compliance with terms and conditions of existing and future NPDES sanitary and stormwater permits (including all construction, industrial and MS4) will effectively implement the WLA and demonstrate consistency with the assumptions and requirements of these TMDLs. However, the Department recognizes that the SCDOT is not a traditional MS4 in that it does not possess statutory taxing or enforcement powers. The SCDOT does not regulate land use of zoning, issue building or development permits.

5.4 Load Allocation

The LA applies to the nonpoint sources of *E. coli* bacteria and other FC bacteria and is expressed both as a load and as a percent reduction. The LA is calculated as the difference between the target load (i.e., the TMDL minus a 5% MOS) under the critical condition and the point source WLA. The LA is listed in Table 13. There may be other unregulated MS4s located in the CRT Watershed that are subject to the LA components of these TMDLs. At such time that the referenced entities, or other future unregulated entities become regulated NPDES MS4 entities and are subject to applicable provisions of SC Regulation 61-68D, these entities will be required to meet load reductions prescribed in the WLA component of these TMDLs. This also applies to future discharges associated with industrial and construction activities that will be subject to SC R.61-9.122.26(b)(14) & (15) (SCDHEC, 2011).

5.5 Seasonal Variability

Federal regulations require that TMDLs take into account the seasonal variability in watershed loading. The variability in these TMDLs is accounted for by using a 12-year hydrological and water quality sampling data set.

Table 13. Total Maximum Daily Loads for the Coosawhatchie River and Tributaries Watershed
(Loads are expressed as FC bacteria or *E. coli* bacteria count/day)

	Existing Load (count/day)		TMDL (count/day)		Margin of Safety (MOS) (count/day)		Waste Load Allocation (WLA)				Load Allocation (LA)		
							Continuous Source[3] (count/day)		Non-Continuous Sources[4,5] (%Reduction)	Non-Continuous SCDOT[5] (%Reduction)	Load Allocation (count/day)		% Reduction to Meet LA[5]
Station	FC (cfu/day)[1]	*E. coli (MPN/day)*[2]	FC (cfu/day)	*E. coli (MPN/day)*	FC (cfu/day)	*E. coli (MPN/day)*	FC (cfu/day)	*E. coli (MPN/day)*	(Percent)	(Percent)	FC (cfu/day)	*E. coli (MPN/day)*	(Percent)
CSTL-110	5.33E+10	---	3.60E+10	*3.14E+10*[7]	1.80E+09	*1.57E+09*[7]	See Note Below	*See Note Below*	36	36[6]	3.42E+10	*2.98E+10*[7]	36
RS-03360	7.34E+10	---	4.84E+10	*4.23E+10*[7]	2.42E+09	*2.11E+09*[7]	See Note Below	*See Note Below*	37	37[6]	4.60E+10	*4.01E+10*[7]	37
CSTL-121	---	*3.67E+10*	---	*1.90E+10*	---	*9.49E+08*	---	*1.45E+09*	55	55[6]	---	*1.66E+10*	55

Table Notes:

1. Existing fecal coliform loads were determined from the 90 percentile instream fecal coliform concentrations and stream flows during critical flow conditions. Fecal coliform concentrations were determined during the Department's water quality monitoring program.
2. Existing *E. coli* loads were determined from the 90 percentile instream *E. coli* concentrations and stream flows during critical flow conditions. *E. coli* concentrations were determined during the Department's 2009 Pathogen Indicator Study and during the Department's water quality monitoring program.
3. WLAs are expressed as a daily maximum. Existing and future continuous discharges are required to meet the prescribed loading for the pollutant of concern. For the purposes of NPDES permitting, continuous discharges may be required to meet a loading equivalent of FC bacteria, based upon permitted flow and an allowable permitted maximum FC bacteria concentration of 400 cfu/100ml, until such time that *E. coli* limits are incorporated into individual permits. *E. coli* limits will be developed based upon permitted flow and an allowable permitted maximum *E. coli* concentration of 349 MPN/100ml.
4. Percent reduction applies to all NPDES-permitted stormwater discharges, including current and future municipal separate storm sewer system (MS4), construction and industrial discharges covered under permits numbered SCS & SCR. Stormwater discharges are expressed as a percentage reduction due to the uncertain nature of stormwater discharge volumes and recurrence intervals. Stormwater discharges are required to meet percentage reduction or the existing instream standard for pollutant of concern in accordance with their NPDES Permit.
5. Percent reduction applies to existing instream FC bacteria or *E. coli.*
6. By implementing the best management practices that are prescribed in either the SCDOT annual SWMP or the SCDOT MS4 Permit to address fecal coliform or *E. coli,* the SCDOT will comply with these TMDLs and its applicable WLA to the maximum extent practicable (MEP) as required by its MS4 permit.
7. Expressed as *E. coli* (MPN/day). Loadings are developed by applying a conversion factor to values calculated for FC bacteria. This conversion is derived from an established relationship between FC bacteria and *E. coli* water quality standards in freshwaters.

5.6 Margin of Safety

The MOS may be explicit and/or implicit. The explicit MOS in the CRT Watershed TMDLs is 5% of the TMDL, or, in the case of FC bacteria TMDLs, 20 cfu/100 mL of the instantaneous criterion of 400 cfu/100 mL (380 cfu/100 mL); and, in the case of *E. coli* bacteria TMDLs, 17 MPN/100 mL of the instantaneous criterion of 349 MPN/100 mL (332 MPN/100 mL). The MOS is expressed as the value calculated from the critical condition defined in Section 5.1 and is the difference between the TMDL and the sum of the WLA and LA.

A 5% MOS in freshwaters impaired for *E. coli* bacteria may be calculated as the ratio of *E.coli* bacteria MPN/100 mL to FC bacteria cfu/100 mL or 20*0.8725 = 17 MPN/100 mL of the instantaneous *E. coli* bacteria criterion of 349 MPN/100 mL (332 MPN/100 mL). This conversion is deemed appropriate by the Department and derived from an established relationship between FC bacteria and *E. coli* bacteria WQS in freshwaters determined during the 2009 PIS.

5.7 Target Load

The Target Load is the sum of the WLA and the LA in the TMDL. A TMDL is the maximum amount of pollutant a waterbody can assimilate while meeting water quality standards for the pollutant of concern. In addition to a WLA for all NPDES-permitted discharges, and a LA for all nonpoint sources, all TMDLs must include a MOS, either implicitly or explicitly, to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving water body. An explicit MOS of 5% of the TMDL was used in the CRT Watershed TMDLs. Therefore, the allowable load, or the Target Load (which, again, is the sum of the NPDES-permitted WLA and the LA) for the CRT Watershed TMDLs is 95% of the assimilative capacity (or, 95% of the TMDL) of the waterbody. The Target Load values for the CRT Watershed TMDLs are calculated as the mid-point LA within the critical condition (i.e., the mid-point LA value within the hydrologic category that requires the greatest load reduction) plus the NPDES-permitted WLA in the watershed (or reach).

5.8 TMDL

For most pollutants, TMDLs are expressed as a mass load (e.g., kilograms per day). For bacteria, however, TMDLs are expressed in terms of cfu or organism counts (or resulting concentration), in accordance with 40 CFR 130.2(l). Only the instantaneous water quality criterion was targeted for the CRT Watershed because there is insufficient data to evaluate against the 30-day geometric mean. The target load is defined as the load (from point and nonpoint sources that a stream segment can receive while meeting the WQS) minus the MOS. The TMDL value is the mid-point target load within the critical condition (i.e., the middle value within the hydrologic category that requires the greatest load reduction) plus the MOS.

While TMDL development was primarily based on instantaneous water quality criterion, terms and conditions of NPDES permits for continuous discharges require facilities to demonstrate compliance with both geometric mean and instantaneous water quality criteria for FC bacteria in treated effluent. NPDES permits for continuous dischargers require data collection sufficient to monitor for compliance of both criteria at the point of outfall.

Table 13 indicates the percentage reduction or WQS required for each watershed (or reach) in the CRT Watershed. Note that all future regulated NPDES-permitted stormwater discharges will also be required to meet the prescribed percentage reductions, or the WQS. It should be noted that that in order to meet the WQS for FC bacteria or *E. coli* bacteria prescribed load reductions must be targeted from all sources, including NPDES permitted and nonpoint sources.

Based on the available information at this time, the portions of the CRT Watershed that drain directly to a regulated MS4 and that drain through the unregulated MS4 has not been clearly defined within the MS4 jurisdictional area. Loading from both types of sources (regulated and unregulated) typically occurs in response to rainfall events, and discharge volumes as well as recurrence intervals are largely unknown. Therefore, the regulated MS4 is assigned the same percent reduction as the non-regulated sources in the watershed. Compliance with the MS4 permit in regards to this TMDL development document is determined at the point of discharge to waters of the state. The regulated MS4 entity is only responsible for implementing the TMDL WLA in accordance with their MS4 permit requirements and is not responsible for reducing loads prescribed as LA in this TMDL development document.

5.9 Reasonable Assurance

NPDES permits are issued for regulated dischargers, including continuous and non-continuous sources of pathogenic bacteria. In freshwaters, the applicable recreation use water quality standard is *E. coli* bacteria. Continuous discharges are required to target the *E. coli* water quality standard at the point of discharge. For regulated non-continuous discharges, the *E. coli* standard should be targeted to the maximum extent practicable. There may be other regulated activities present that could contribute to *E. coli* loadings in the watershed. New septic tanks, animal feeding operations (AFOs), land application of treated sludge or wastewater also require permits that reduce the potential for runoff of bacteria into waters of the State.

Other unregulated sources of *E. coli* loadings in the watershed may include wildlife, improper agricultural or silviculture activities, urban and suburban runoff. These sources may be reduced through means such as best management practices, local ordinances, outreach education efforts as well as 319 grant opportunities. SCDHEC has fostered effective partnerships between other federal, state and local entities to help reduce the potential for runoff of bacteria into waters of the State. Collectively and once implemented, all of these reduction mechanisms will provide reasonable assurance that the recreation use water quality standard will be attained in this watershed.

6.0 IMPLEMENTATION

The implementation of both point source (i.e., WLA) and non-point source (i.e., LA) components of the TMDLs are necessary to bring about the required reductions in FC bacteria or *E. coli* bacteria loading to Coosawhatchie River and Tributaries in order to achieve WQSs. Using existing authorities and mechanisms, an implementation plan providing information on how point and non-point sources of pollution are being abated or may be abated in order to meet WQSs is provided. Sections 6.1.1-6.1.7 presented below correspond with sections 3.1.1-3.2.5 of the source assessment presented in the TMDL development document. As the implementation strategy progresses, the SCDHEC will continue to monitor the effectiveness of implementation measures and evaluate water quality where deemed appropriate.

Point sources are discernible, confined, and discrete conveyances of pollutants to a water body including but not limited to pipes, outfalls, channels, tunnels, conduits, man-made ditches, etc. The *CWA's* primary point source control program is the NPDES. Point sources can be broken down into continuous and non-continuous point sources. Some examples of a continuous point source are WWTFs and industrial facilities. Non-continuous point sources are related to stormwater and include MS4, construction activities, etc. Current and future NPDES discharges in the referenced watersheds are required to comply with the load reductions prescribed in the WLA.

Nonpoint source pollution originates from multiple sources over a relatively large area. It is diffuse in nature and indistinct from other sources of pollution. It is generally caused by the pickup and transport of pollutants from rainfall moving over and through the ground. Nonpoint sources of pollution may include, but are not limited to: wildlife, agricultural activities, illicit discharges, failing septic systems, and urban runoff. Nonpoint sources located in unregulated portions of the CRT Watershed are subject to the LA and not the WLA of the TMDL development document.

South Carolina has several tools available for implementing the non-point source components of these TMDLs. The *Implementation Plan for Achieving Total Maximum Daily Load Reductions From Nonpoint Sources for the State of South Carolina* (SCDHEC 1998) document is one example. Another key component for interested parties to control pollution and prevent water quality degradation in the CRT Watershed would be the establishment and administration of a program of BMPs. BMPs may be defined as a practice or a combination of practices that have been determined to be the most effective, practical means used in the prevention and/or reduction of pollution.

Interested parties (local stakeholder groups, universities, local governments, etc.) may be eligible to apply for *CWA* §319 grants to install BMPs that will implement the LA portions of these TMDLs and reduce nonpoint source FC bacteria or *E. coli* bacteria loading to Coosawhatchie River and Tributaries. TMDL implementation projects are given highest priority for 319 funding. *CWA* §319 grants are not available for implementation of the WLA component of this TMDL but may be available for the LA component within permitted MS4 jurisdictional boundaries. Additional resources are provided in Section 7.0 of this TMDL development document.

The SCDHEC will also work with the existing agencies in the area to provide nonpoint source education in the CRT Watershed. Local sources of nonpoint source education and assistance include the Natural Resource Conservation Service (NRCS), the Allendale and Hampton County Soil and Water Conservation Services, the Clemson University Cooperative Extension Service, and the South Carolina Department of Natural Resources.

The Department recognizes that adaptive management/implementation of these TMDLs might be needed to achieve the WQS and the Department is committed towards targeting the load reductions to improve water quality in the CRT Watershed. As additional data and/or information become available, it may become necessary to revise and/or modify the TMDL targets accordingly.

6.1 Implementation Strategies

The strategies presented in this document for implementation of the referenced TMDLs are not inclusive and are to be used only as guidance. The strategies are informational suggestions that may lead to the required load reductions being met for the referenced watersheds while demonstrating consistency with the assumptions and requirements of the TMDLs. Application of certain strategies provided within may be voluntary and are not a substitute for actual NPDES permit conditions.

6.1.1 Continuous Point Sources

Continuous point source WLA reductions will be implemented through NPDES permits. Existing and future continuous discharges are required to meet the prescribed loading for the pollutant of concern and demonstrate consistency with the assumptions and requirements of the TMDLs. FC bacteria loadings are developed based upon permitted flow and an allowable permitted maximum concentration of 400 cfu/100 mL. *E. coli* bacteria loadings are developed based upon permitted flow and an allowable permitted maximum *E. coli* bacteria concentration of 349 MPN/100 mL.

6.1.2 Non-Continuous Point Sources

An iterative BMP approach as defined in the general stormwater NPDES MS4 permit is expected to provide significant implementation of the WLA. Permit requirements for implementing WLAs in approved TMDLs will vary across waterbodies, discharges, and pollutant(s) of concern. The allocations within a TMDL can take many different forms – narrative, numeric, specific BMPs – and may be complimented by other special requirements such as monitoring.

The level of monitoring necessary, deployment of structural and non-structural BMPs, evaluation of BMP performance, and optimization or revisions to the existing pollutant reduction goals of the SWMP or any other plan is TMDL and watershed specific. Hence, it is expected that NPDES permit holders evaluate their existing SWMP or other plans in a manner that would effectively address implementation of these TMDLs with an acceptable schedule and activities for their permit compliance. The Department staff (permit writers, TMDL project managers, and compliance staff) is willing to assist in developing or updating the referenced plan as deemed necessary. Please see Appendix C which provides additional information as it relates to evaluating the effectiveness of an MS4 Permit as it related to compliance with approved TMDLs. For the SCDOT, existing and future NPDES MS4 permittees, compliance with terms and conditions of its NPDES permit is effective implementation of the WLA to the MEP and demonstrates consistency with the assumptions and requirements of the TMDLs. For existing and future NPDES construction and Industrial stormwater permittees, compliance with terms and conditions of its permit is effective implementation of the WLA. Required load reductions in the LA portion of these TMDLs can be implemented through voluntary measures and are eligible for *CWA* §319 grants.

The Department acknowledges that progress with the assumptions and requirements of the TMDLs by MS4s is expected to take one or more permit iteration. Achieving the WLA reduction for the TMDLs may constitute MS4 compliance with its SWMP, provided the MEP definition is met, even where the numeric percent reduction may not be achieved in the interim.

Regulated MS4 entities are required to develop a SWMP that includes the following: public education, public involvement, illicit discharge detection & elimination, construction site runoff control, post construction runoff control, and pollution prevention/good housekeeping. These measures are not exhaustive and may include additional criterion depending on the type of NPDES MS4 permit that applies. The following examples are recognized as acceptable stormwater practices and may be applied to unregulated MS4 entities or other interested parties in the development of a stormwater management plan.

An informed and knowledgeable community is crucial to the success of a stormwater management plan (USEPA, 2005). MS4 entities may implement a public education program to distribute educational materials to the community, or conduct equivalent outreach activities about the impacts of stormwater discharges on local waterbodies and the steps that can be taken to reduce stormwater pollution. Some appropriate BMPs may be brochures, educational programs, storm drain stenciling, stormwater hotlines, tributary signage, and alternative information sources such as web sites, bumper stickers, etc. (USEPA, 2005).

The public can provide valuable input and assistance to a stormwater management program and they may have the potential to play an active role in both the development and implementation of the stormwater program where deemed appropriate by the entity. There are a variety of practices that can involve public participation such as public meetings/citizens panels, volunteer water quality monitoring, volunteer educators, community clean-ups, citizen watch groups, and "Adopt a Storm Drain" programs which encourage individuals or groups to keep storm drains free of debris and monitor what is entering local waterways through storm drains (USEPA, 2005).

Illicit discharge detection and elimination efforts are also necessary. Discharges from MS4s often include wastes and wastewater from non-stormwater sources. These discharges enter the system through either direct connections or indirect connections. The result is untreated discharges that contribute high levels of pollutants, including heavy metals, toxics, oil and grease, solvents, nutrients, viruses, and bacteria to receiving waterbodies (USEPA, 2005). Pollutant levels from these illicit discharges have been shown in USEPA studies to be high enough to significantly degrade receiving water quality and threaten aquatic, wildlife, and human health. MS4 entities may have a storm sewer system map which shows the location of all outfalls and to which waters of the US they discharge for instance. If not already in place, an ordinance prohibiting non-stormwater discharges into a MS4 with appropriate enforcement procedures may also be developed. Entities may also have a plan for detecting and addressing non-stormwater discharges. The plan may include locating problem areas through infrared photography, finding the sources through dye testing, removal/correction of illicit connections, and documenting the actions taken to illustrate that progress is being made to eliminate illicit connections and discharges.

A program might also be developed to reduce pollutants in stormwater runoff to the MS4 area from construction activities. An ordinance or other regulatory mechanism may exist requiring the implementation of proper erosion and sediment controls on applicable construction sites. Site plans should be reviewed for projects that consider potential water quality impacts. It is recommended that site inspections should be conducted and control measures enforced where applicable. A procedure might also exist for considering information submitted by the public (USEPA, 2005). For information on specific BMPs please refer to the SCDHEC Stormwater Management BMP Handbook online at: https://www.scdhec.gov/Environment/WaterQuality/Stormwater/BMPHandbook/

Post-construction stormwater management in areas undergoing new development or redevelopment is recommended because runoff from these areas has been shown to significantly affect receiving waterbodies. Many studies indicate that prior planning and design for the minimization of pollutants in post-construction stormwater discharges is the most cost-effective approach to stormwater quality management (USEPA, 2005). Strategies might be developed to include a combination of structural and/or non-structural BMPs. An ordinance or other regulatory mechanism may also exist requiring the implementation of post-construction runoff controls and ensuring their long term-operation and maintenance. Examples of non-structural BMPs are planning procedures and site-based BMPs (minimization of imperviousness and maximization of open space). Structural BMPs may include but are not limited to stormwater retention/detention BMPs, infiltration BMPs (dry wells, porous pavement, etc.), and vegetative BMPs (grassy swales, filter strips, rain gardens, artificial wetlands, etc.).

Pollution prevention/good housekeeping is also a key element of stormwater management programs. Generally this requires the MS4 entity to examine and alter their programs or activities to ensure reductions in pollution are occurring. It is recommended that a plan be developed to prevent or reduce pollutant runoff from municipal operations into the storm sewer system and it is encouraged to include employee training on how to incorporate and document pollution prevention/good housekeeping techniques. To minimize duplication of effort and conserve resources, the MS4 operator can use training materials that are available from the USEPA or relevant organizations (USEPA, 2005).

MS4 communities are encouraged to utilize partnerships when developing and implementing a stormwater management program. Watershed associations, educational organizations, and state, county, and city governments are all examples of possible partners with resources that can be shared. For additional information on partnerships contact the SCDHEC Watershed Manager for the waterbody of concern online at: http://www.scdhec.gov/HomeAndEnvironment/Water/Watersheds/Contacts/ For additional information on stormwater discharges associated with MS4 entities please see the SCDHEC's NPDES web page online at https://www.scdhec.gov/environment/WaterQuality/Stormwater/RegulatedMS4s/ as well as the USEPA NPDES website online at http://cfpub.epa.gov/npdes/home.cfm?program_id=6 for information pertaining to the National Menu of BMPs, Urban BMP Performance Tool, Outreach Documents, etc.

6.1.3 Wildlife

Suggested forms of implementation for wildlife will vary widely due to geographic location and species. There are many forms of acceptable wildlife BMPs in practice and development at the present time. For example, contiguous forested areas could be set up and managed to keep wildlife from bedding down and defecating near surface waters. This management practice relies on concentrating wildlife away from water bodies to minimize their impact to pollutant loading. Additionally, contributions from wildlife could be reduced in protected areas by developing a management plan which would allow hunting access during certain seasons. Although this strategy might not work in all situations, it would decrease FC bacteria or *E. coli* bacteria loading from wildlife in areas where wildlife may be a significant contributor to the overall watershed. According to the 2011 NLCD, the CRT Watershed is 73.15 percent forest or otherwise vegetated (non-cultivated). On November 21st, 28th, and 30th in 2017, the SCDHEC conducted site visits in the CRT Watershed to assess pollutant sources potentially contributing to water quality impairment in the watershed. Potential pollutant sources found in the watershed during the November 2017 site visits are identified in Figure 10 and Tables Ap-1 through Ap-3 in Appendix E[4]. During the potential pollutant source assessment visits, the department found evidence of wild game in the CRT Watershed. This was evidenced by the presence of a hunt club in Reach 3 of the watershed (Figure F-1 in Appendix F).

According to the SCDNR 2013 deer population density map and GIS information, the estimated population of deer in Allendale and Hampton Counties in the areas of the CRT Watershed are thirty (30) to forty-five (45) deer per square mile (see Section 3.2.1 and Figure 8 in this TMDL development document) (SCDNR 2015). During the November 2017 potential pollutant source assessment visits in the CRT Watershed, the SCDHEC found evidence of their presence in the form of deer stands in all three reaches of the watershed (e.g., Figures F-2, F-3. F-4, and F-5).

Deterrents may also be used to keep wildlife away from docks and lawns in close proximity to surface waters. Non-toxic spray deterrents, decoys, eagles, kites, noisemakers, scarecrows, and plastic owls are a sample of what is currently available. Many waterfowl species are deterred by foreign objects on lawns and the planting of a shrub buffer along greenways adjacent to impoundments may also be effective.

In addition, homeowners and the hunting community should be educated on the impacts of feeding wildlife or planting wildlife food plots in close proximity to surface waters. Please check local and federal laws before applying deterrents or harassing wildlife. Additional information may be obtained from the "Managing Pet and Wildlife Waste to Prevent Contamination of Drinking Water" bulletin provided by the USEPA (2001)..

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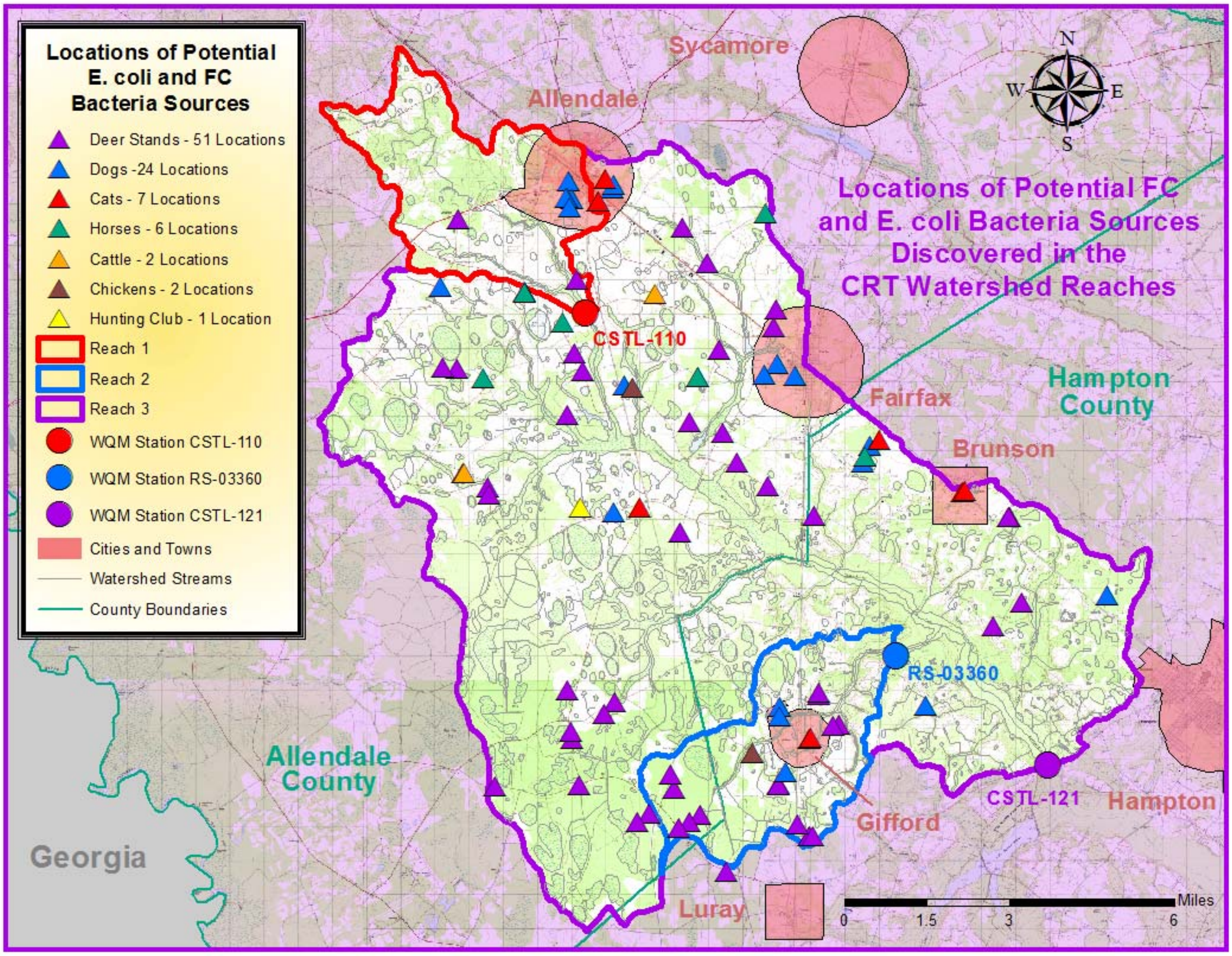
[4] Figure 10 and the tables in Appendix E depict only the locations of those potential sources discovered during the SCDHEC's November 2017 site visits, and are not to imply the totality of locations of such sources.

Figure 10. Locations of Potential E. coli and FC Bacteria Sources in the CRT Watershed (Depicts only sources discovered during the SCDHEC's November, 2017 watershed survey)



6.1.4 Agricultural Activities

Suggested forms of implementation for agricultural activities will vary based on the activity of concern. Agricultural BMPs can be vegetative, structural or management oriented. When selecting BMPs, it is important to keep in mind that nonpoint source pollution occurs when a pollutant becomes available, is detached and then transported to nearby receiving waters. Therefore, for BMPs to be effective, the transport mechanism of the pollutant, FC bacteria or *E. coli* bacteria, needs to be identified. For livestock in the referenced watersheds, installing fencing along the streams within the watershed and providing an alternative water source where livestock are present would eliminate direct contact with the streams. During the November 2017 potential pollutant source assessment visits in the CRT Watershed, the SCDHEC found two (2) cattle pastures in Reach 3 of the CRT Watershed (Figures F-6 and F-7).

During the potential pollutant source assessment visits in November 2017, the SCDHEC also found hobby farms within the CRT Watershed. Horses were found in Reach 3 of the CRT Watershed (e.g., Figures F-8, F-9, F-10, and F-11). And, chickens were found in Reaches 2 and 3 of the watershed (Figures F-12 and F-13).

If fencing is not feasible, it has been shown that installing water troughs within a pasture area reduced the amount of time livestock spent drinking directly from streams by 92% (ASABE 1997). An indirect result of this was a 77% reduction in stream bank erosion by providing an alternative to accessing the stream directly for water supply.

For row crop farms in the referenced watersheds, many common practices exist to reduce FC bacteria or *E. coli* bacteria contributions. Unstabilized soil directly adjacent to surface waters can contribute to FC bacteria or *E. coli* bacteria loading during periods of runoff after rain events. Agricultural field borders and filter strips (vegetative buffers) can provide erosion control around the border of planted crop fields. These borders can provide food for wildlife, may possibly be harvested (grass and legume), and also provide an area where farmers can turn around their equipment (SCDNR, 1997). A study conducted in 1998 by the American Society of Agricultural and Biological Engineers (ASABE 1998) has shown that a vegetative buffer measuring 6.1 meters in width can reduce fecal runoff concentrations from 2.0E+7 to an immeasurable amount once filtered through the buffer. A buffer of this width was also shown to reduce phosphorous and nitrogen concentrations by 75%.

The agricultural BMPs listed above are a sample of the many accepted practices that are currently available. Many other techniques such as conservation tillage, responsible pest management, and precision agriculture also exist and may contribute to an improvement in overall water quality in the CRT Watershed. Education should be provided to local farmers on these methods as well as acceptable manure spreading and holding (stacking sheds) practices.

For additional information on accepted agricultural BMPs you can obtain a copy of the "Farming for Clean Water in South Carolina" handbook by contacting Clemson University Cooperative Extension Service at (864) 656-1550. In addition, Clemson Extension Service offers a 'Farm-A-Syst' package to farmers. Farm-A-Syst allows the farmer to evaluate practices on their property and determine the nonpoint source impact they may be having. It recommends best management practices (BMPs) to correct nonpoint source problems on the farm. You can access Farm-A-Syst by going onto the Clemson Extension Service website: http://www.clemson.edu/waterquality/FARM.HTM.

NRCS provides financial and technical assistance to help South Carolina landowners address natural resource concerns, promote environmental quality, and protect wildlife habitat on property they own or control. The cost-share funds are available through the Environmental Quality Incentives Program (EQIP). EQIP helps farmers improve production while protecting environmental quality by addressing such concerns as soil erosion and productivity, grazing management, water quality, animal waste, and forestry concerns. EQIP also assists eligible small-scale farmers who have historically not participated in or ranked high enough to be funded in previous sign ups. Please visit www.sc.nrcs.usda.gov/programs/ for more information, including eligibility requirements.

Also available through NRCS, the Grassland Reserve Program (GRP) is a voluntary program offering landowners the opportunity to protect, restore and enhance grasslands on their property. NRCS and the Farm Service Agency (FSA) coordinate implementation of the GRP, which helps landowners restore and protect grassland, rangeland, pastureland, shrubland and certain other lands and provides assistance for rehabilitating grasslands. The program will conserve vulnerable grasslands from conversion to cropland or other uses and conserve valuable grasslands by helping maintain viable grazing operations. A grazing management plan is required for participants. NRCS has further information on their website for the GRP as well as additional programs such as the Conservation Reserve Program, Conservation Security Program, Farm and Ranch Lands Protection Program, etc. You can visit the NRCS website by going to: www.sc.nrcs.usda.gov/programs/.

6.1.5 Leaking Sanitary Sewers and Illicit Discharges

Leaking sanitary sewers and illicit discharges, although illegal and subject to enforcement, may be occurring in regulated or unregulated portions of the CRT Watershed at any time. Due to the high concentration of pollutant loading that is generally associated with these discharges, their detection may provide a substantial improvement in overall water quality in the watershed. Detection methods may include, but are not limited to: dye testing, air pressure testing, static pressure testing, and infrared photography.

The SCDHEC recognizes illicit discharge detection and elimination activities are conducted by regulated MS4 entities as pursuant to compliance with existing MS4 permits. Note that these activities are designed to detect and eliminate illicit discharges that may contain FC bacteria or *E. coli* bacteria. It is the intent of the SCDHEC to work with the MS4 entities to recognize FC bacteria or *E. coli* bacteria load reductions as they are achieved. The SCDHEC acknowledges that these efforts to reduce illicit discharges and SSOs are ongoing and some reduction may already be accountable (i.e., load reductions occurring during TMDL development process). Thus, the implementation process is an iterative and adaptive process. Regular communication between all implementation stakeholders will result in successful remediation of controllable sources over time. As designated uses are restored, the SCDHEC will recognize efforts of implementers where their efforts can be directly linked to restoration.

6.1.6 Failing Septic Systems

A septic system, also known as an onsite wastewater system, is defined as failing when it is not treating or disposing of sewage in an effective manner. The most common reason for failure is improper maintenance by homeowners. Untreated sewage water contains disease-causing bacteria and viruses, as well as unhealthy amounts of nitrate and other chemicals. Failed septic systems can allow untreated sewage to seep into wells, groundwater, and surface water bodies, where people get their drinking water and recreate. Pumping a septic tank is probably the single most important thing that can be done to protect the system. If the buildup of solids in the tanks becomes too high and solids move to the drainfield, this could clog and strain the system to the point where a new drainfield will be needed.

The SCDHEC's Office of Coastal Resource Management (OCRM) has created a toolkit for homeowners and local governments which includes tips for maintaining septic systems. These septic system Do's and Don'ts's are as follows:

Do's:

- Conserve water to reduce the amount of wastewater that must be treated and disposed of by your system. Doing laundry over several days will put less stress on your system.
- Repair any leaking faucets or toilets. To detect toilet leaks, add several drops of food dye to the toilet tank and see if dye ends up in the bowl.
- Divert down spouts and other surface water away from your drainfield. Excessive water keeps the soil from adequately cleansing the wastewater.
- Have your septic tank inspected yearly and pumped regularly by a licensed septic tank contractor.

Don'ts:

- Don't drive over your drainfield or compact the soil in any way.
- Don't dig in your drainfield or build anything over it, and don't cover it with a hard surface such as concrete or asphalt.
- Don't plant anything over or near the drainfield except grass. Roots from nearby trees and shrubs may clog and damage the drain lines.
- Don't use your toilet as a trash can or poison your system and the groundwater by pouring harmful chemicals and cleansers down the drain. Harsh chemicals can kill the bacteria that help purify your wastewater.

For additional information on how septic systems work, how to properly plan and maintain a septic system, or to link to the OCRM toolkit mentioned above, please visit the SCDHEC Environmental Health Onsite Wastewater page at the following link: http://www.scdhec.gov/HomeAndEnvironment/YourHomeEnvironmentalandSafetyConcerns/SepticTanks/

6.1.7 Urban Runoff

Urban runoff is surface runoff of rainwater created by urbanization outside of regulated areas which may pick up and carry pollutants to receiving waters. Pavement, compacted areas, roofs, reduced tree canopy and open space increase runoff volumes that rapidly flow into receiving waters. This increase in volume and velocity of runoff often causes stream bank erosion, channel incision and sediment deposition in stream channels. In addition, runoff from these developed areas can increase stream temperatures that along with the increase in flow rate and pollutant loads negatively affect water quality and aquatic life (USEPA 2017). This runoff can pick up FC bacteria or *E. coli* bacteria along the way. Many strategies currently exist to reduce FC loading from urban runoff and the USEPA nonpoint source pollution website provides extensive resources on this subject, which can be accessed online at: https://www.epa.gov/nps/nonpoint-source-urban-areas

Some examples of urban nonpoint source BMPs are street sweeping, stormwater wetlands, pet waste receptacles (equipped with waste bags), and educational signs which can be installed adjacent to receiving waters in the watershed such as parks, common areas, apartment complexes, trails, etc. Low impact development (LID) may also be effective. LID is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treats stormwater as a resource rather than a waste product. There are many practices that have been used to adhere to these principles such as bioretention facilities, rain gardens, vegetated rooftops, rain barrels, and permeable pavements (USEPA, 2009).

Some additional urban BMPs that can be adopted in public parks are doggy dooleys and pooch patches. Doggy dooleys are disposal units, which act like septic systems for pet waste, and are installed in the ground where decomposition can occur (USEPA, 2001). This requires that pet owners place the waste into the disposal units. During the SCDHEC potential pollutant source assessment visits in November 2017, cats and dogs were found in the CRT Watershed. Cats were found in Reaches 2 and 3 of the watershed (e.g., Figures F-14, F-15, F-16, and F-17). And, dogs were found in all three reaches of the watershed (e.g., Figures F-18, F-19, F-20, and F-21).

Although the CRT Watershed is primarily rural in nature, many of the urban runoff practices discussed in this section can be applied to individual households in the watersheds. Education should be provided to individual homeowners in the referenced watersheds on the contributions to FC bacteria or *E. coli* bacteria loading from pet waste. Education to homeowners in the watershed on the fate of substances poured into storm drain inlets should also be provided. For additional information on urban runoff please see the SCDHEC Nonpoint Source Runoff Pollution homepage at: https://www.scdhec.gov/HomeAndEnvironment/Docs/Watershed/Nonpoint%20Source%20Management%20Program.pdf

Clemson Extension's Home-A-Syst handbook can also help homeowners reduce sources of NPS pollution on their property. This document guides homeowners through a self-assessment of their property and can be accessed online at: http://www.clemson.edu/waterquality/HOMASYS.HTM

7.0 RESOURCES FOR POLLUTION MANAGEMENT

This section provides a listing of available resources to aid in the mitigation and control of pollutants. There are examples from across the nation, most of which are easily accessible on the world wide web.

7.1 General for Urban and Suburban Stormwater Mitigation

- National Management Measures to Control Nonpoint Source Pollution from Urban Areas – Draft. 2002. EPA842-B-02-003. Available at: http://link.library.in.gov/portal/National-management-measures-to-control-nonpoint/qhy7Z_3SYM0/
- Stormwater Management Volume Two: Stormwater Technical Manual. Massachusetts Department of Environmental Management. 1997. Available at: http://www.mass.gov/dep/brp/stormwtr/stormpub.htm
- Fact Sheets for the six (6) minimum control measures for storm sewers regulated under Phase I or Phase II. Available at: https://www3.epa.gov/npdes/pubs/fact2-0.pdf
- A Current Assessment of Urban Best Management Practices. 1992. Metropolitan Washington Council of Governments. Washington, DC

- Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. 1987. Metropolitan Washington Council of Governments. Washington, DC
- 2004 Stormwater Quality Manual. Connecticut Department of Environmental Protection 2004. Available at: http://www.ct.gov/deep/cwp/view.asp?a=2721&q=325704
- Stormwater Treatment BMP New Technology Report. California Department of Transportation. 2004. SW-04-069-.04.02. http://www.dot.ca.gov/hq/env/stormwater/special/newsetup/_pdfs/new_technology/CTSW-RT-04-069.pdf
- Moonlight Beach Urban Runoff Treatment facility: Using Ultraviolet Disinfection to Reduce Bacteria Counts. Rasmus, J. and K. Weldon. 2003. StormWater, May/June 2003.
- Operation, Maintenance, and Management of Stormwater Management Systems. Livingston, Shaver, Skupien, and Horner. August 1997. Watershed Management Institute. Call: (850) 926-5310.
- Stormwater O & M Fact Sheet Preventive Maintenance. USEPA 1999. 832-F-99-004. Available at: http://www.fxbrowne.com/html/gs-facts/prevmain.pdf
- The Mass Highway Stormwater Handbook. Massachusetts Highway Department. 2004. Available at: https://www.massdot.state.ma.us/Portals/8/docs/environmental/wetlands/Stormwater_Handbook.pdf
- University of New Hampshire Stormwater Center: Dedicated to the protection of water resources through effective stormwater management. Available at: https://www.unh.edu/unhsc/
- USEPA's Stormwater website: https://www.epa.gov/npdes/npdes-stormwater-program

7.2 Illicit Discharges

- Illicit Discharge Detection and Elimination Manual - A Handbook for Municipalities. 2003. New England Interstate Water Pollution Control Commission. Available at: http://www.neiwpcc.org/neiwpcc_docs/iddmanual.pdf

7.3 Pet Waste

- National Management Measure to Control Non Point Source Pollution from Urban Areas – Draft. USEPA 2002. EPA 842-B-02-2003.
- Septic Systems for Dogs? Nonpoint Source News-Notes 63. Pet Waste: Dealing with a Real Problem in Suburbia. Kemper, J. 2000. New Jersey Department of Environmental Protection. Available from: nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=2000E9C4.TXT (Copy and paste URL address).
- Stormwater Manager's Resource Center. Schueler, T., Center for Watershed Protection, Inc. http://www.stormwatercenter.net
- Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. USEPA, Office of Water 1993. Washington, DC.
- National Menu of Best Management Practices for Stormwater Phase II. USEPA. 2002. Available at: https://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater#edu

- Welcome to NVRC'S Four Mile Run Program. NVRC 2001. Available at: http://www.novaregion.org/fourmilerun.htm

- Boston's ordinance on dog waste. City of Boston Municipal Codes, Chapter XVI. 16-1.10A Dog Fouling. Available at: https://law.resource.org/pub/us/code/city/ma/Boston/chapter16.rtf

- Pet Waste and Water Quality. Hill, J.A., and D. Johnson. 1994. University of Wisconsin Extension Service.

- Long Island Sound Study. Pet Waste Poster. USEPA.

- Source Water Protection Practices Bulletin: Managing Pet and Wildlife Waste to Prevent Contamination of Drinking Water. USEPA. 2001. EPA 916-F-01-027. Available at: nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=901V1N00.TXT (Copy and paste URL address).

7.4 Wildlife

- An example of a bylaw prohibiting the feeding of wildlife: Prohibiting Feeding of Wildlife. Town of Bourne Bylaws Section 3.4.3. Available at: http://www.townofbourne.com/sites/bournema/files/file/file/14_town_bylaw_thru_2014_oct_stm.pdf

- Integrated Management of Urban Canadian Geese. M Underhill. 1999. Conference Proceedings, Waterfowl Information Network.

- Urban Canadian Geese in Missouri. Missouri Conservationist Online. Available at: https://mdc.mo.gov/conmag/2004/02/urban-canada-geese-missouri

7.5 Septic Systems

- National Management Measures to Control Nonpoint Source Pollution from Urban Areas – Draft. Chapter 6. New and Existing Onsite Wastewater Treatment Systems. USEPA 2002. EPA842-B-02-003. Available at: nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P10004FY.TXT (Copy and paste URL address).

- Septic Systems. USEPA Webpage: https://www.epa.gov/septic

7.6 Field Application of Manure

- Conservation Standard Practice-Irrigation Water Management. Number 449. United States Department of Agriculture (USDA) Natural Resources Conservation Service. 2003. Available at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046888.pdf

- Conservation Standard Practice-Filter Strip. Number 393. USDA Natural Resources Conservation Service (NRCS). 2003. Available at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1241319.pdf

- Buffer Strips: Common Sense Conservation. USDA Natural Resource Conservations Service. No Date. Website. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/home/?cid=nrcs143_023568

- Conservation Standard Practice-Riparian Forest Buffer. Number 391. USDA Natural Resource Conservation Service. 2003. Available at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_026098.pdf

- Conservation Standard Practice-Riparian Herbaceous Cover. Number 390 USDA Natural Resource Conservation Service. 2003. Available at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_026183.pdf

7.7 Grazing Management

- Conservation Standard Practice-Stream Crossing. Number 578. USDA Natural Resource Conservation Service. 2003. Available at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046923.docx

- Guidance Specifying Management Measures for Nonpoint Source Pollution in Coastal Waters. Chapter 2. Management Measures for Agricultural Sources. Grazing Management. USEPA. Available at: https://www.epa.gov/sites/production/files/2015-09/documents/czara_chapter2_agriculture.pdf

7.8 Animal Feeding Operations and Barnyards

- National Management Measures to Control Nonpoint Source Pollution from Agriculture. USEPA 2003. Report: EPA 841-B-03-004. Available at: https://www.epa.gov/nps/national-management-measures-control-nonpoint-source-pollution-agriculture

- Livestock Manure Storage. Software designed to asses the threat to ground and surface water from manure storage facilities. USEPA.

- National Engineering Handbook Part 651. Agricultural Waste Management Field Handbook. NRCS. Available At: https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/?&cid=stelprdb1045935

- Animal Waste Management. NRCS website: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/crops/npm/?cid=stelprdb1044732

- Animal Waste Management Software. A tool for estimating waste production and storage requirements. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/ecoscience/mnm/?cid=stelprdb1045812

- Manure Management Planner. Software for creating manure management plans. Available at: http://www.purdue.edu/agsoftware/mmp/

- Animal Feeding Operations Virtual Information Center. USEPA.

7.9 Federal Agriculture Resources: Program Overviews, Technical Assistance, and Funding

- USDA-NRCS assists landowners with planning for the conservation of soil, water, and natural resources. Local, state, and federal agencies and policymakers also rely on NRCS expertise. Cost shares and financial incentives are available in some cases. Most work is done with local partners. The NRCS is the largest funding source for agricultural improvements. To find out about potential funding, see: http://www.ma.nrcs.usda.gov/programs/. To pursue obtaining funding, contact a local NRCS coordinator. Contact information is available at: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/contact/ .

- NRCS provides a wealth of information and BMP fact sheets tailored to agricultural and conservation practices through the NRCS Electronic Field Office Technical Guide at: http://efotg.nrcs.usda.gov/efotg_locator.aspx?map=SC.

- The 2014 USDA Farm Bill (https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/farmbill/) provides a variety of programs related to conservation. Information can be found at: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/. The following programs can be linked to from the USDA Farm Bill website:

  - Conservation Security Program (CSP): https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/?&cid=stelprdb1047061
  - Conservation Reserve Program (CRP): https://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-program/index
  - Wetlands Reserve Program (WRP): https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/easements/wetlands/?cid=nrcs143_008419
  - Environmental Quality Incentives Program (EQIP): http://www.nrcs.usda.gov/programs/eqip/
  - Grassland Reserve Program (GRP): http://www.nrcs.usda.gov/programs/GRP/
  - Conservation of Private Grazing Land Program (CPGL): http://www.nrcs.usda.gov/programs/cpgl/
  - Wildlife Habitat Incentives Program (WHIP): https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/whip/
  - Farm and Ranch Land Protection Program (FRPP): http://www.nrcs.usda.gov/programs/frpp/
  - Resource Conservation and Development Program (RC&D): https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/16/stelprdb1042393.pdf

- CORE4 Conservation Practices. The common sense approach to natural resource conservation. USDA-NRCS (1999). This manual is intended to help USDA-NRCS personnel and other conservation and nonpoint source management professionals implement effective programs using four core conservation practices: conservation tillage, nutrient management, pest management, and conservation buffers, available at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_025540.pdf

- County soil survey maps are available from NRCS at: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

- Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. USEPA, Office of Water (1993). Developed for use by State Coastal Nonpoint Pollution Control Programs, Chapter 2 of this document covers erosion control, animal feeding operation management, grazing practices, and management of nutrients, pesticides, and irrigation water, available at: https://www.epa.gov/nps/guidance-specifying-management-measures-sources-nonpoint-pollution-coastal-waters

- Farm-A-Syst is a partnership between government agencies and private business that enables landowners to prevent pollution on farms, ranches, and in homes using confidential environmental assessments, available at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/vt/technical/dma/?cid=nrcs142p2_010561

- State Environmental Laws Affecting South Carolina Agriculture: A comprehensive assessment of regulatory issues related to South Carolina agriculture has been compiled by the National Association of State Departments.

- Waterborne Pathogens in Agricultural Wastewater. Rosen, B. H., 2000. USDA, NRCS, Watershed Science Institute. Available at: https://wmc.ar.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044366.pdf

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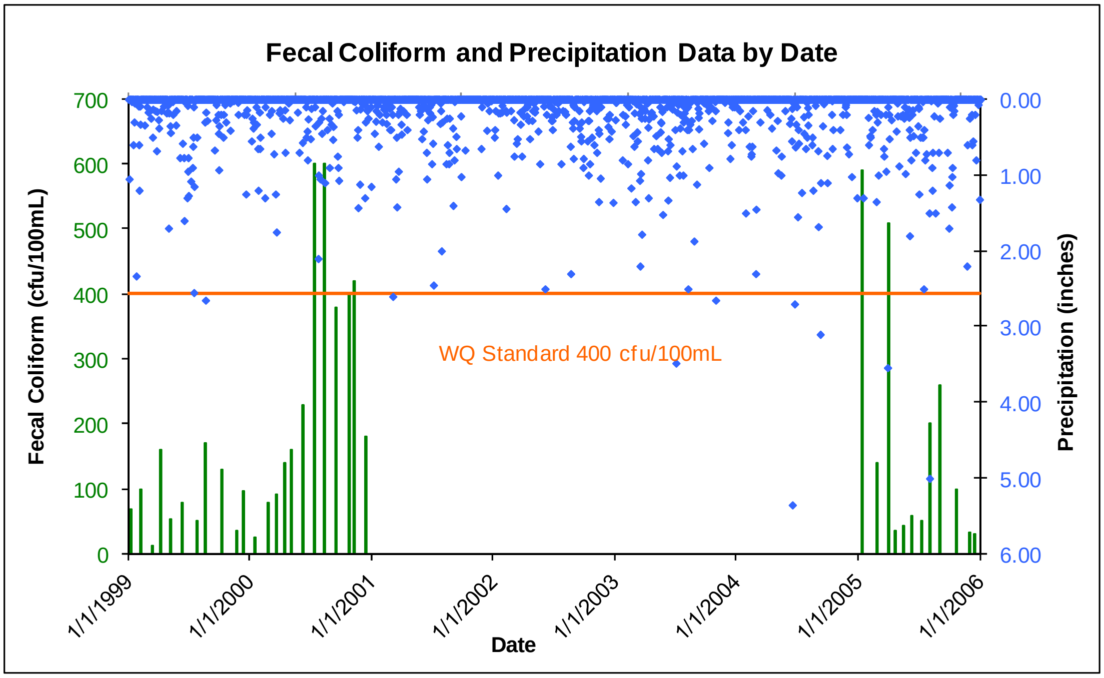
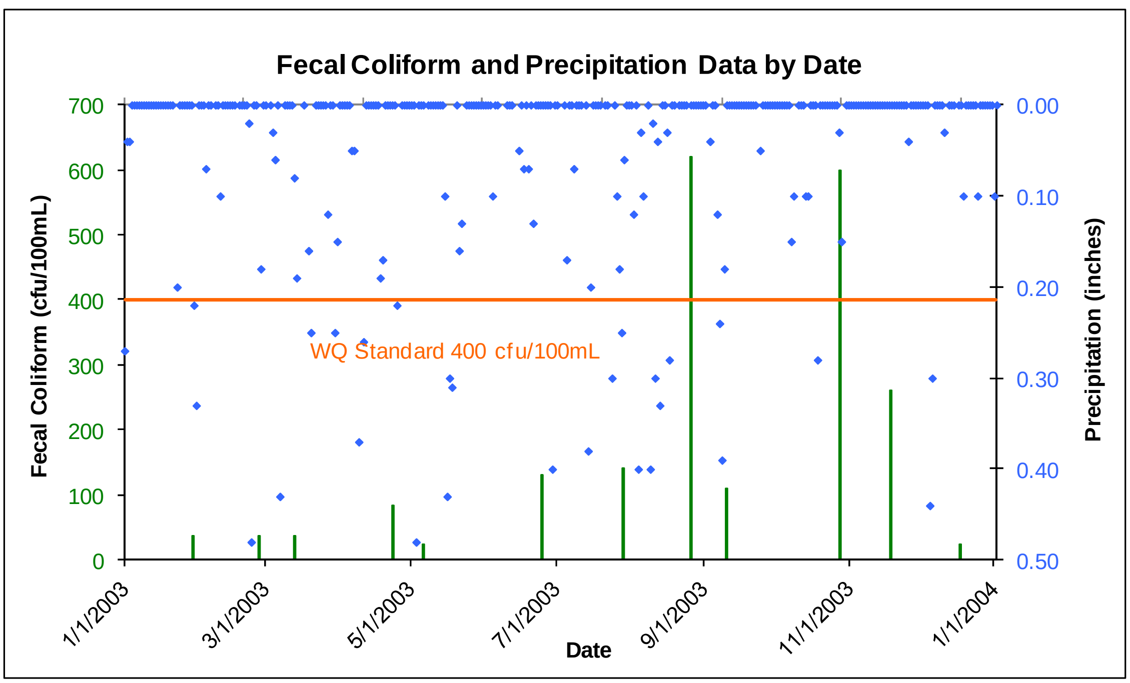
APPENDIX A
ADDITIONAL RAIN CHARTS BY STATION

Precipitation and FC Data by Date for Monitoring Station CSTL-110

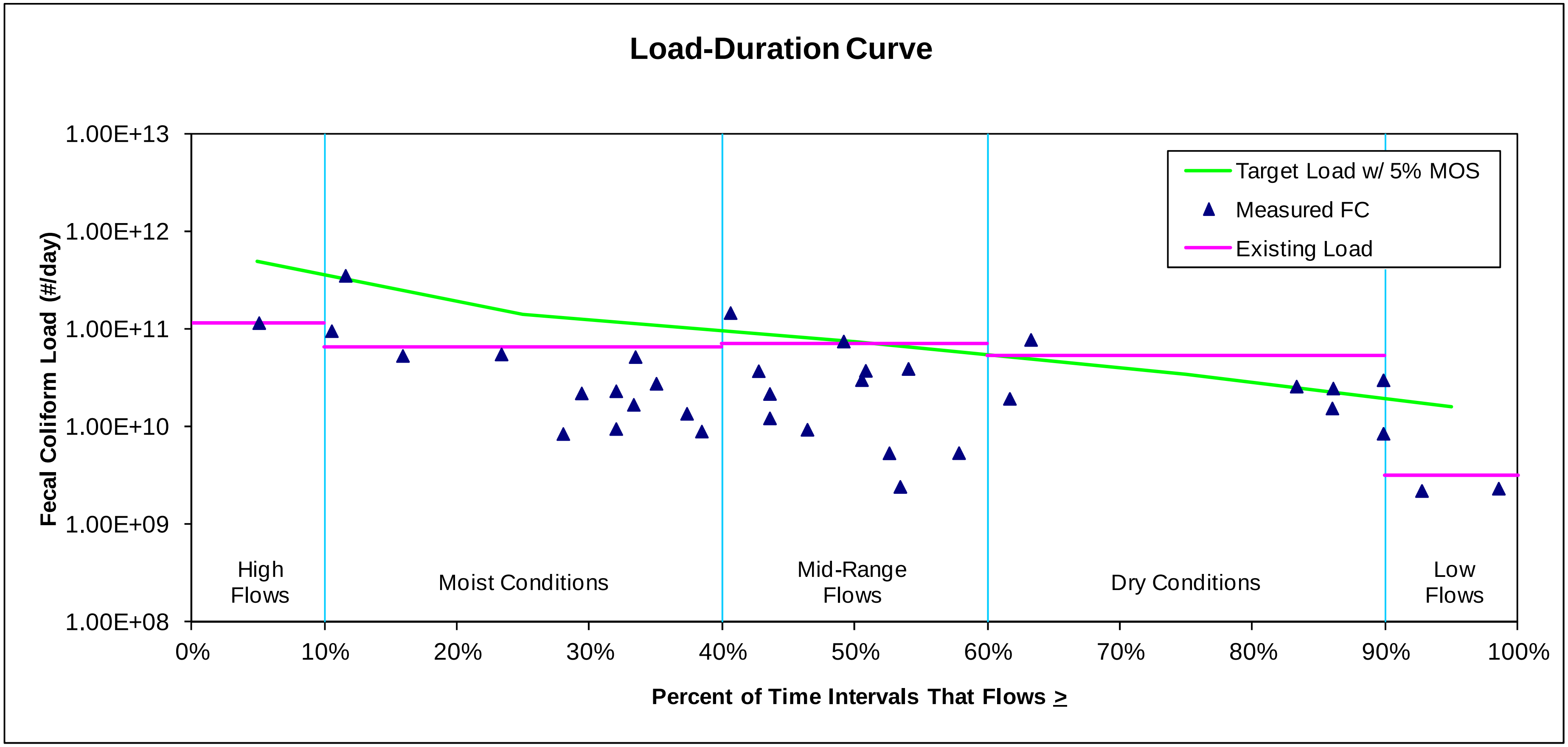


Precipitation and FC Data by Date for Monitoring Station RS-03360

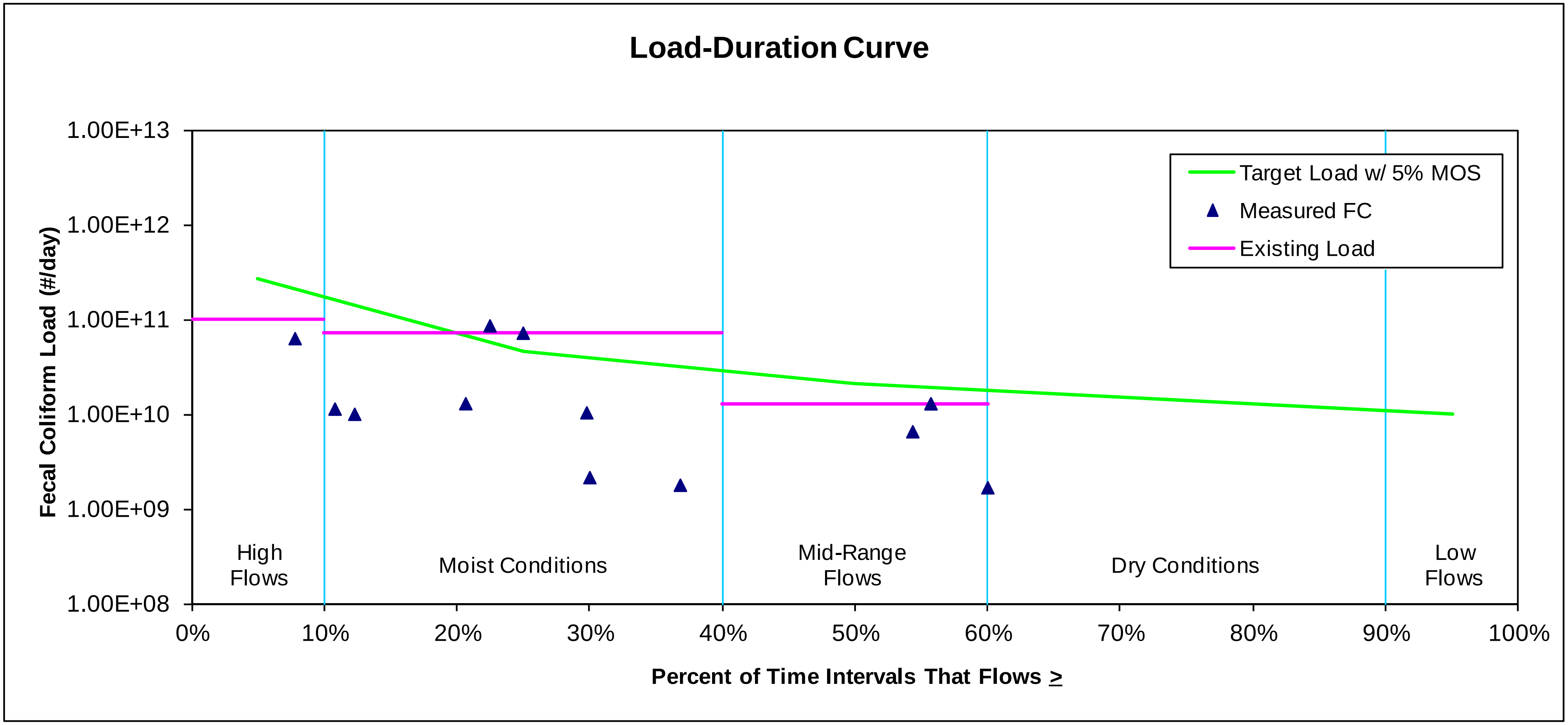


APPENDIX B
ADDITIONAL LOAD-DURATION CURVES BY STATION

Load Duration Curve for Reach 1 of the Coosawhatchie River and Tributaries Watershed, WQM Station CSTL-110



Load Duration Curve for Reach 2 of the Coosawhatchie River and Tributaries Watershed, WQM Station RS-03360



Appendix C

EVALUATING THE PROGRESS OF MS4 PROGRAMS

Evaluating the Progress of MS4 Programs:
Meeting the Goals of TMDLs and Attaining Water Quality Standards

Bureau of Water

August 2008

Described below are potential approaches that may be used by MS4 permit holders. These are recommendations and examples only, as the SCDHEC-BOW recognizes that other approaches may be utilized or employed to meet compliance goals.

1. Calculate pollutant load reduction for each best management practice (BMP) deployed:
    - Retrofitting stormwater outlets
    - Creation of green space
    - LID activities (e.g., creation of porous pavements)
    - Creations of riparian buffers
    - Stream bank restoration
    - Scoop the poop program (how many pounds of poop were scooped/collected)
    - Street sweeping program (amount of materials collected etc.)
    - Construction & post-construction site runoff controls
2. Description & documentation of programs directed towards reducing pollutant loading
    - Document tangible efforts made to reduce impacts to urban runoff
    - Track type and number of structural BMPs installed
    - Parking lot maintenance program for pollutant load reduction
    - Identification and elimination of illicit discharges
    - Zoning changes and ordinances designed to reduce pollutant loading
    - Modeling of activities & programs for reducing pollutant reductions
3. Description & documentation of social indicators, outreach, and education programs
    - Number/Type of training & education activities conducted and survey results
    - Activities conducted to increase awareness and knowledge – residents, business owners. What changes have been made based on these efforts? Any measured behavior or knowledge changes?
    - Participation in stream and/or lake clean-up events or activities
    - Number of environmental action pledges
4. Water quality monitoring: A direct and effective way to evaluate the effectiveness of stormwater management plan activities.
    - Use of data collected from existing monitoring activities (e.g., SCDHEC data for ambient monitoring program available through STORET; water supply intake testing; voluntary watershed group's monitoring, etc)
    - Establish a monitoring program for permitted outfalls and/or waterbodies within MS4 areas as deemed

necessary– use a certified lab

- Monitoring should focus on water quality parameters and locations that would both link pollutant sources and BMPs being implemented

5. Links:

- Evaluating the Effectiveness of Municipal Stormwater Programs. September 2007. EPA 833-F-07-010
- The BMP database - http://www.bmpdatabase.org/BMPPerformance.htm (this link is specifically to the BMP performance page, and lot more)
- USEPA's STORET data warehouse - http://www.epa.gov/storet/dw_home.html
- USEPA, Region 5: STEPL – Spreadsheet tool for estimating pollutant loads http://it.tetratech-ffx.com/stepl/
- Measurable goals guidance for Phase II Small MS4 - http://cfpub.epa.gov/npdes/stormwater/measurablegoals/index.cfm
- Environmental indicators for sotrmwater program- http://cfpub.epa.gov/npdes/stormwater/measurablegoals/part5.cfm
- National menu of stormwater best management practices (BMPs) - http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm
- SCDHEC – BOW: 319 grant program has attempted to calculate the load reductions for the following BMPs:

  - Septic tank repair or replacement
  - Removing livestock from streams (cattle, horses, mules)
  - Livestock fencing
  - Waste Storage Facilities (aka stacking sheds)
  - Strip cropping
  - Prescribed grazing
  - Critical Area Planting
  - Runoff Management System
  - Waste Management System
  - Solids Separation Basin
  - Riparian Buffers

Appendix D
DATA TABLES

Fecal Coliform WQS Exceedence Summary for Impaired Station CSTL-110 by Date

Date	FC (cfu/100 mL)
1/5/1999	68
2/3/1999	100
3/10/1999	14
4/6/1999	160
5/5/1999	54
6/7/1999	80
7/26/1999	50
8/16/1999	170
9/2/1999	0
10/5/1999	130
11/18/1999	35
12/9/1999	96

Date	FC (cfu/100 mL)
1/12/2000	25
2/22/2000	78
3/21/2000	92
4/11/2000	140
5/4/2000	160
6/7/2000	230
7/12/2000	**600**
8/8/2000	**600**
9/11/2000	380
10/24/2000	400
11/8/2000	**420**
12/11/2000	180

Date	FC (cfu/100 mL)
1/11/2005	**590**
2/24/2005	140
3/28/2005	**510**
4/20/2005	35
5/16/2005	44
6/8/2005	58
7/6/2005	52
8/4/2005	200
9/1/2005	260
10/20/2005	100
11/30/2005	32
12/14/2005	30

____ **WQS Exceeded**

90th Percentile FC Concentrations (#/100 mL)

Hydro Category Range	High Flow 0-10	Moist Cond. 10-40	Mid Range 40-60	Dry Flow 60-90	Low Flow 90-100	Samples
CSTL-110	92	172	365	593	77	36

Mid Point Hydrologic Category Flow (cfs)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
CSTL-110	52.19	15.46	7.91	3.68	1.70

Existing Load (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
CSTL-110	1.17E+11	6.50E+10	7.06E+10	5.33E+10	3.21E+09

LA to Achieve Target Load (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
CSTL-110	4.85E+11	1.44E+11	7.35E+10	3.42E+10	1.58E+10

Load Reduction Necessary (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
CSTL-110	N/A	NRN	NRN	1.92E+10	N/A

NRN = no reduction needed. Existing load below target load.

% Load Reduction Necessary

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
CSTL-110	N/A	NRN	NRN	36	N/A

NRN = no reduction needed. Existing load below target load.

Fecal Coliform WQS Exceedence Summary for Impaired Station RS-03360 by Date

Date	FC (cfu/100 mL)
1/29/2003	36
2/26/2003	37
3/13/2003	36
4/23/2003	85

Date	FC (cfu/100 mL)
5/6/2003	23
6/25/2003	130
7/29/2003	140
8/26/2003	**620**

Date	FC (cfu/100 mL)
9/10/2003	110
10/28/2003	**600**
11/18/2003	260
12/17/2003	25

____ **WQS Exceeded**

90th Percentile FC Concentrations (#/100 mL)

Hydro Category Range	High Flow 0-10	Moist Cond. 10-40	Mid Range 40-60	Dry Flow 60-90	Low Flow 90-100	Samples
RS-03360	140	606	234	NS	NS	12

NS = No samples

Mid Point Hydrologic Category Flow (cfs)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
RS-03360	28.80	4.95	2.22	1.52	1.09

Existing Load (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
RS-03360	9.87E+10	7.34E+10	1.27E+10	NM	NM

NM = Not measured

LA to Achieve Target Load (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
RS-03360	2.68E+11	4.60E+10	2.07E+10	141E+10	1.01E+10

Load Reduction Necessary (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
RS-03360	N/A	2.74E+10	NRN	NM	N/A

NRN = no reduction needed. Existing load below target load.
NM = Not measured

% Load Reduction Necessary

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
RS-03360	N/A	37	NRN	NM	N/A

NRN = no reduction needed. Existing load below target load.
NM = Not measured

E. coli WQS Exceedence Summary for Impaired Station CSTL-121 by Date

Date	*E. coli* (MPN/100 mL)	Date	*E. coli* (MPN/100 mL)	Date	*E. coli* (MPN/100 mL)
1/7/2009	344.8	2/11/2009	68.3	3/25/2009	46.4
1/12/2009	**547.5**	2/18/2009	85.7	4/8/2009	71.7
1/22/2009	**387.3**	2/24/2009	39.6	4/15/2009	261.3
1/28/2009	254.3	3/3/2009	275.5	4/22/2009	69.7
2/4/2009	104.3	**3/17/2009**	**517.2**	5/5/2009	96.0

____ **WQS Exceeded**

E. coli WQS Exceedence Summary for Impaired Station CSTL-121 by Date (continued)

Date	*E. coli* (MPN/100 mL)
5/13/2009	68.3
5/27/2009	242.8
6/3/2009	111.2
6/10/2009	95.9
6/16/2009	161.6
6/25/2009	310.4
6/30/2009	149.2
7/6/2009	58.0
7/15/2009	75.6
7/21/2009	108.6
7/28/2009	205.8
8/4/2009	**1102.0**
8/11/2009	64.4
818//2009	4.0

Date	*E. coli* (MPN/100 mL)
8/24/2009	4.0
9/1/2009	201.6
9/9/2009	12.4
9/15/2009	78.0
9/22/2009	16.4
9/28/2009	384.0
10/7/2009	214.8
10/12/2009	30.0
10/21/2009	20.4
10/26/2009	10.2
11/3/2009	93.2
11/9/2009	75.6
11/16/2009	**494.4**
12/1/2009	132.4

Date	*E. coli* (MPN/100 mL)
12/8/2009	78.8
2/28/2013	159.7
4/24/2013	110.0
6/20/2013	290.9
8/20/2013	**613.1**
10/29/2013	**410.6**
12/3/2013	172.2
2/18/2014	146.0
3/26/2014	248.9
5/15/2014	**2419.6**
7/31/2014	125.9
9/30/2014	**613.1**
11/13/2014	157.6

90th Percentile FC Concentrations (#/100 mL)

Hydro Category Range	High Flow 0-10	Moist Cond. 10-40	Mid Range 40-60	Dry Flow 60-90	Low Flow 90-100	Samples
CSTL-121	367	518	452	687	71	56

Mid Point Hydrologic Instream Category Including Long Term Average DMR Flow (cfs)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
CSTL-121	357.37	69.34	12.05	2.18	0.23

Mid Point Hydrologic Instream Category Including Facility Design Flow (cfs)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
CSTL-121	357.20	69.37	12.03	2.22	0.29

Existing Load (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
CSTL-121	3.21E+12	8.79E+11	1.33E+11	3.67E+10	3.98E+08

LA to Achieve Target Load (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
CSTL-121	2.90E+12	5.61E+11	9.61E+10	1.66E+10	8.64E+08

Load Reduction Necessary (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
CSTL-121	N/A	3.18E+11	3.72E+10	2.01E+10	N/A

% Load Reduction Necessary

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
CSTL-121	N/A	36	28	55	N/A

Appendix E

POTENTIAL POLLUTANT SOURCE IDENTIFICATION

Table Ap-1. Potential FC and *E. coli* Pollutant Sources in Reach 1 of the Coosawhatchie River and Tributaries Watershed (WQM Station CSTL-110)

Reach Station	Source	Vicinity of Road/Street	County	Location in Watershed	Latitude	Longitude	Date Observed	Source Notes
CSTL-110	Deer	Ashe Road	Allendale	Southwest	32.99684	-81.34604	11/21/2017	Deer stand on edge of field
CSTL-110	Deer	Barton Road	Allendale	Southwest	32.98111	-81.30864	11/21/2017	Deer stand in field near the Coosawhatchie River
CSTL-110	Dogs	Gum Street West	Allendale	East	33.00712	-81.31152	11/21/2017	Unattended dog in road
CSTL-110	Dogs	Moore Street	Allendale	East	33.00246	-81.31013	11/21/2017	Unattended dog in yard
CSTL-110	Dogs	South Mill Street	Allendale	East	33.00278	-81.31168	11/21/2017	Unattended dog in road in Allendale
CSTL-110	Dogs	South Mill Street	Allendale	East	33.00265	-81.31196	11/21/2017	Dogs in pen
CSTL-110	Dogs	Robin Street	Allendale	East	33.00010	-81.31108	11/21/2017	Chained dogs in yard

Table Ap-2. Potential FC and *E. coli* Pollutant Sources in Reach 2 of the Coosawhatchie River and Tributaries Watershed (WQM Station RS-03360)

Reach Station	Source	Vicinity of Road/Street	County	Location in Watershed	Latitude	Longitude	Date Observed	Source Notes
RS-03360	Cats	Lin Street	Hampton	Central	32.86041	-81.23504	11/30/2017	Unattended cat in yard in Gifford
RS-03360	Chickens	Murdaugh Street	Hampton	Central	32.85610	-81.25322	11/30/2017	Chickens in pen near Blood Hill Creek
RS-03360	Deer	County Route S-3-41	Allendale	Southwest	32.83990	-81.26971	11/30/2017	Deer stand by side of road
RS-03360	Deer	County Route S-3-41	Allendale	Southwest	32.83807	-81.27310	11/30/2017	Deer stand by side of road
RS-03360	Deer	County Route S-3-41	Allendale	Southwest	32.83647	-81.27621	11/30/2017	Deer stand in woods
RS-03360	Deer	County Route S-3-104	Allendale	Southwest	32.84686	-81.27773	11/30/2017	Deer stand on edge of field
RS-03360	Deer	County Route S-3-104	Allendale	Southwest	32.85042	-81.27882	11/30/2017	Deer stand at edge of woods at residence
RS-03360	Deer	Lin Street	Hampton	Northeast	32.86383	-81.22631	11/30/2017	Deer stand in woods near Blood Hill Creek
RS-03360	Deer	Lin Street	Hampton	Northeast	32.86341	-81.22809	11/30/2017	Deer stand on edge of field near Blood Hill Creek
RS-03360	Deer	Bring Bridge Road	Hampton	Northeast	32.87165	-81.23265	11/30/2017	Deer stand in field near Blood Hill Creek
RS-03360	Deer	Bring Bridge Road	Hampton	Northeast	32.87233	-81.23244	11/30/2017	Deer stand in woods near Blood Hill Creek
RS-03360	Deer	Risher Street	Hampton	Central	32.84799	-81.24513	11/30/2017	Deer stand in field
RS-03360	Deer	Risher Street	Hampton	Central	32.84790	-81.24518	11/30/2017	Deer stand on edge of field
RS-03360	Deer	Columbia Highway	Hampton	Central	32.83432	-81.23549	11/30/2017	Deer stand in field
RS-03360	Deer	Columbia Highway	Hampton	Central	32.83432	-81.23546	11/30/2017	Deer stand on edge of field
RS-03360	Deer	Columbia Highway	Hampton	Central	32.83432	-81.23449	11/30/2017	Deer stand on edge of field
RS-03360	Deer	Columbia Highway	Hampton	Central	32.83755	-81.23924	11/30/2017	Deer stand on edge of field
RS-03360	Deer	H Smart Road	Hampton	Southwest	32.82477	-81.26131	11/30/2017	Deer stand on edge of field
RS-03360	Dogs	Mekeda Street	Hampton	Central	32.86843	-81.24466	11/30/2017	Unattended dogs in yard near Blood Hill Creek
RS-03360	Dogs	Sumpter Street	Hampton	Central	32.86595	-81.24464	11/30/2017	Unattended dog in yard in Gifford near Blood Hill Creek
RS-03360	Dogs	Risher Street	Hampton	Central	32.85113	-81.24306	11/30/2017	Unattended dog in yard
RS-03360	Dogs	Laston Street	Hampton	Central	32.86016	-81.23559	11/30/2017	Chained dog in yard

Table Ap-3. Potential FC and *E. coli* Pollutant Sources in Reach 3 of the Coosawhatchie River and Tributaries Watershed (WQM Station CSTL-121)

Reach Station	Source	Vicinity of Road/Street	County	Location in Watershed	Latitude	Longitude	Date Observed	Source Notes
CSTL-121	Cats	Cohen Street	Allendale	Northeast	33.00751	-81.29995	11/21/2017	Unattended cats in street in Allendale
CSTL-121	Cats	Gillyard Street	Allendale	Northeast	33.00186	-81.30214	11/21/2017	Unattended cat in yard
CSTL-121	Cats	RoadCr-78	Allendale	Central	32.92111	-81.28891	11/28/2017	Unattended cat in yard
CSTL-121	Cats	Tinker Town Road	Hampton	Central	32.93895	-81.21399	11/30/2017	Unattended cat in yard
CSTL-121	Cats	Manker Street	Hampton	Southeast	32.92522	-81.18764	11/30/2017	Unattended cat in street
CSTL-121	Cats	Manker Street	Hampton	Southeast	32.92567	-81.18721	11/30/2017	Unattended cat in yard in Brunson
CSTL-121	Cattle	Terry Road	Allendale	Northwest	32.92994	-81.34394	11/21/2017	Pastured cattle
CSTL-121	Cattle	County Route S-3-103	Allendale	Northeast	32.97743	-81.28399	11/21/2017	Pastured cattle near stream-fed pond
CSTL-121	Chickens	St. James Road	Allendale	Northwest	32.95255	-81.29108	11/28/2017	Chickens in pen near Little Duck Branch
CSTL-121	Deer	Terry Road	Allendale	Northwest	32.92607	-81.33624	11/21/2017	Deer stand on edge of field
CSTL-121	Deer	Terry Road	Allendale	Northwest	32.92435	-81.33581	11/21/2017	Sign for a deer management area
CSTL-121	Deer	Terry Road	Allendale	Northwest	32.92997	-81.34402	11/21/2017	Deer stand in field
CSTL-121	Deer	County Route S-3-433	Allendale	Northwest	32.95739	-81.34626	11/21/2017	Deer stand in woods
CSTL-121	Deer	County Route S-3-433	Allendale	Northwest	32.95765	-81.35040	11/21/2017	Deer stand on edge of field
CSTL-121	Deer	County Route S-3-336	Allendale	Northeast	32.99488	-81.27574	11/21/2017	Deer stand on edge of field near Duck Branch
CSTL-121	Deer	Desert Road	Allendale	Northeast	32.98560	-81.26791	11/21/2017	Deer stand on edge of field near Duck Branch
CSTL-121	Deer	Cotton Patch Road	Allendale	Northeast	32.97348	-81.24619	11/21/2017	Deer stand in field
CSTL-121	Deer	Cotton Patch Road	Allendale	Northeast	32.96867	-81.24679	11/21/2017	Deer stand on edge of field
CSTL-121	Deer	County Route S-3-434	Allendale	Northeast	32.96257	-81.26418	11/21/2017	Deer stand in field near Duck Branch
CSTL-121	Deer	Bostick Road	Allendale	Northwest	32.96172	-81.30943	11/28/2017	Deer stand on edge of field
CSTL-121	Deer	Bostick Road	Allendale	Northwest	32.95689	-81.30674	11/28/2017	Deer stand on edge of field
CSTL-121	Deer	RoadCr-81	Allendale	Northwest	32.94522	-81.31135	11/28/2017	Deer stand in field
CSTL-121	Deer	County Route S-3-434	Allendale	Central	32.94361	-81.27330	11/28/2017	Deer stand on edge of field near Duck Branch
CSTL-121	Deer	South Old Orangeburg Road	Allendale	Central	32.94079	-81.26283	11/28/2017	Deer stand on edge of field near Duck Branch
CSTL-121	Deer	Melon Road	Allendale	Central	32.93280	-81.25835	11/28/2017	Deer stand in powerline right-of-way
CSTL-121	Deer	County Route S-3-69	Allendale	Central	32.92663	-81.24876	11/28/2017	Deer stand on edge of field near the Coosawhatchie River
CSTL-121	Deer	Road Cr-80	Allendale	Central	32.91452	-81.27610	11/28/2017	Deer stand on edge of field
CSTL-121	Deer	Barton Road	Allendale	Southwest	32.87283	-81.31143	11/28/2017	Deer stand in field
CSTL-121	Deer	Groton Road	Allendale	Southwest	32.86975	-81.29651	11/28/2017	Deer stand in field

Table Ap-3 (continued). Potential FC and *E. coli* Pollutant Sources in Reach 3 of the Coosawhatchie River and Tributaries Watershed (WQM Station CSTL-121)

Reach Station	Source	Vicinity of Road/Street	County	Location in Watershed	Latitude	Longitude	Date Observed	Source Notes
CSTL-121	Deer	Groton Road	Allendale	Southwest	32.86638	-81.29983	11/30/2017	Deer stand in field
CSTL-121	Deer	Barton Road	Allendale	Southwest	32.85999	-81.30968	11/30/2017	Deer stand in field
CSTL-121	Deer	Barton Road	Allendale	Southwest	32.86177	-81.31018	11/30/2017	Deer stand in field
CSTL-121	Deer	County Route S-3-41	Allendale	Southwest	32.84761	-81.30738	11/30/2017	Deer stand in woods
CSTL-121	Deer	County Route S-3-41	Allendale	Southwest	32.84726	-81.33385	11/30/2017	Deer stand in field
CSTL-121	Deer	County Route S-3-104	Allendale	Southwest	32.84016	-81.28546	11/30/2017	Deer stand in woods
CSTL-121	Deer	County Route S-3-104	Allendale	Southwest	32.83787	-81.28913	11/30/2017	Deer stand in field
CSTL-121	Deer	Pocotaligo Road	Hampton	Central	32.91878	-81.23427	11/28/2017	Deer stand on edge of field near the Coosawhatchie River
CSTL-121	Deer	Quanset Lane	Hampton	Southeast	32.89606	-81.16925	11/30/2017	Deer stand in field near Cedar Branch
CSTL-121	Deer	Pocotaligo Road	Hampton	Southeast	32.88989	-81.17821	11/30/2017	Deer stand in woods
CSTL-121	Deer	US 278	Hampton	Southeast	32.91865	-81.17311	11/30/2017	Deer stand in woods
CSTL-121	Deer	US 278	Hampton	Southeast	32.91863	-81.17316	11/30/2017	Deer stand on edge of field
CSTL-121	Deer	US 278	Hampton	Southeast	32.91864	-81.17316	11/30/2017	Deer stand on edge of field
CSTL-121	Dogs	Terry Road	Allendale	Central	32.91961	-81.29707	11/28/2017	Unattended dog in yard
CSTL-121	Dogs	Hay Street	Allendale	Northeast	33.00512	-81.29758	11/21/2017	Unattended dogs in yard
CSTL-121	Dogs	Hay Street	Allendale	Northeast	33.00617	-81.29741	11/21/2017	Unattended dogs in yard
CSTL-121	Dogs	Gillyard Street	Allendale	Northeast	33.00186	-81.30214	11/21/2017	Unattended dog in road
CSTL-121	Dogs	Ashe Road	Allendale	Northwest	32.97908	-81.35130	11/21/2017	Unattended dogs in yard
CSTL-121	Dogs	Bluff Road	Allendale	Northwest	32.97772	-81.32499	11/21/2017	Unattended dog in yard
CSTL-121	Dogs	St. James Road	Allendale	Northwest	32.95335	-81.29361	11/28/2017	Unattended dog in road near Little Duck Branch
CSTL-121	Dogs	County Route S-3-266	Allendale	Northeast	32.95541	-81.27087	11/28/2017	Unattended dog in yard
CSTL-121	Dogs	Old Orangebure Road	Allendale	Northeast	32.95893	-81.24566	11/28/2017	Unattended dog in yard
CSTL-121	Dogs	Union Avenue	Allendale	Northeast	32.95571	-81.24017	11/28/2017	Unattended dog in yard
CSTL-121	Dogs	South Old Orangeburg Road	Allendale	Northeast	32.95618	-81.24985	11/28/2017	Unattended dog in yard in Fairfax near Duck Branch
CSTL-121	Dogs	Tinker Town Road	Hampton	Central	32.93311	-81.21902	11/30/2017	Unattended dog in yard
CSTL-121	Dogs	Tinker Town Road	Hampton	Central	32.93751	-81.21698	11/30/2017	Unattended dog in yard
CSTL-121	Dogs	Hadwin Circle	Hampton	Southeast	32.86873	-81.19920	11/30/2017	Unattended dog in yard
CSTL-121	Dogs	Gate Road	Hampton	Southeast	32.89795	-81.14251	11/30/2017	Unattended dog in yard
CSTL-121	Game	Young Road	Allendale	Central	32.92088	-81.30728	11/28/2017	Sign for a hunting club

Table Ap-3 (continued). Potential FC and *E. coli* Pollutant Sources in Reach 3 of the Coosawhatchie River and Tributaries Watershed (WQM Station CSTL-121)

Reach Station	Source	Vicinity of Road/Street	County	Location in Watershed	Latitude	Longitude	Date Observed	Source Notes
CSTL-121	Horses	County Route S-3-433	Allendale	Northwest	32.95483	-81.33774	11/21/2017	Pastured horses
CSTL-121	Horses	Bluff Road	Allendale	Northwest	32.97751	-81.32493	11/21/2017	Pastured horses
CSTL-121	Horses	Desert Road	Allendale	Northeast	32.99877	-81.24961	11/21/2017	Pastured horses
CSTL-121	Horses	Bostick Road	Allendale	Northwest	32.96981	-81.31292	11/28/2017	Pastured horses near the Coosawhatchie River
CSTL-121	Horses	County Route S-3-266	Allendale	Northeast	32.95529	-81.27060	11/28/2017	Pastured horses near Duck Branch
CSTL-121	Horses	Tinker Town Road	Hampton	Central	32.93473	-81.21842	11/30/2017	Pastured horses

Appendix F

SOURCE ASSESSMENT PICTURES

Figure F-1

Sign for a hunting club (location: 32.92088 N, -81.30728 W) on Young Road in Allendale County. Found in Reach 3 of the CRT Watershed (Date of photography: November 28, 2017).

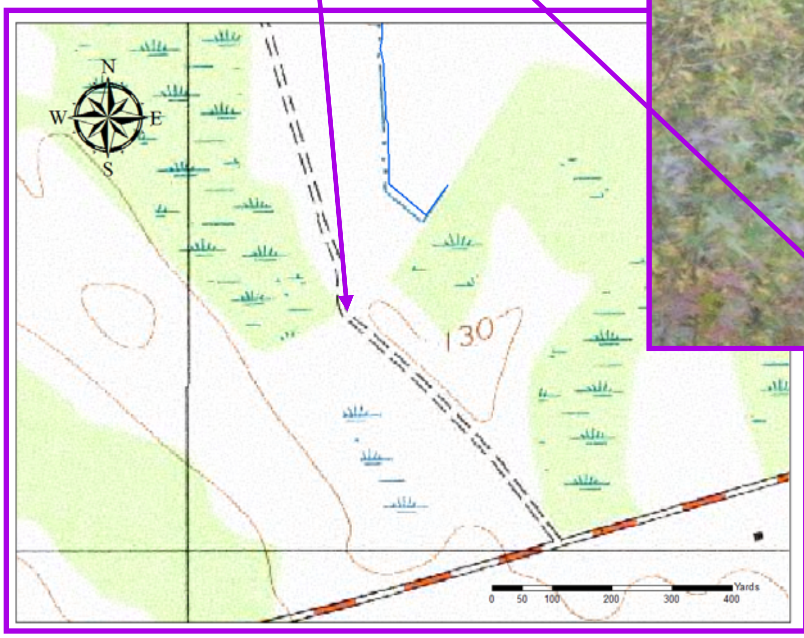


Figure F-2

Deer stand in field near the Coosawhatchie River (location: 32.98111 N, -81.30864 W) on Barton Road in Allendale County. Found in Reach 1 of the CRT Watershed (Date of photography: November 21, 2017).

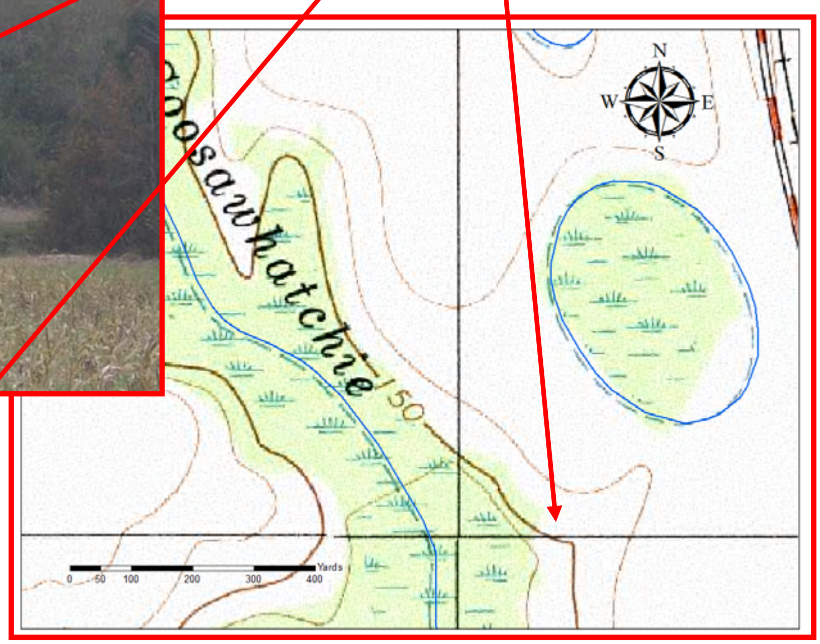


Figure F-3

Deer stand by side of road (location: 32.83990 N, -81.26971 W) near County Route S-3-41 in Allendale County. Found in Reach 2 of the CRT Watershed (Date of photography: November 30, 2017).

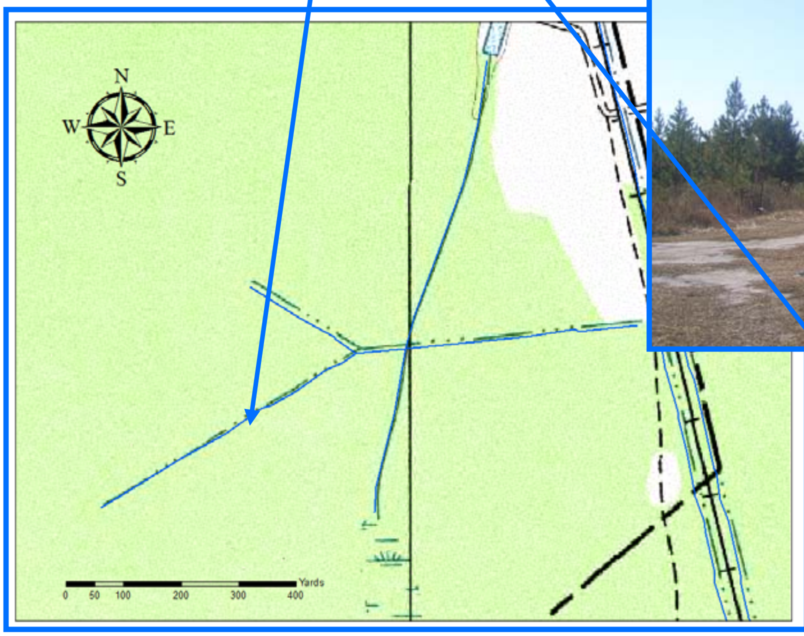


Figure F-4

Deer stand in woods near Blood Hill Creek (location: 32.86383 N, -81.22631 W) on Lin Street in Hampton County. Found in Reach 3 of the CRT Watershed (Date of photography: November 30, 2017).

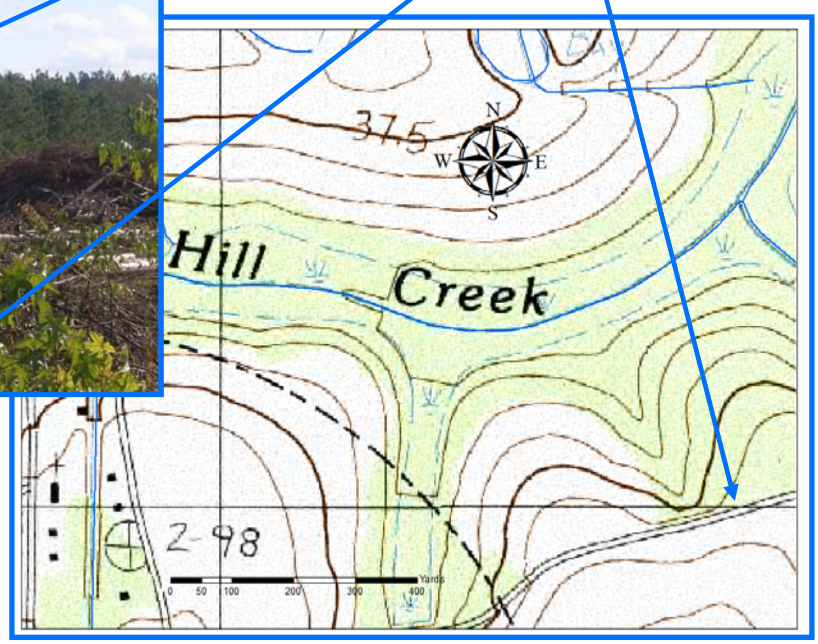


Figure F-5

Deer stand in field (location: 32.86638 N, -81.29983 W) on Groton Road in Allendale County. Found in Reach 3 of the CRT Watershed (Date of photography: November 30, 2017).

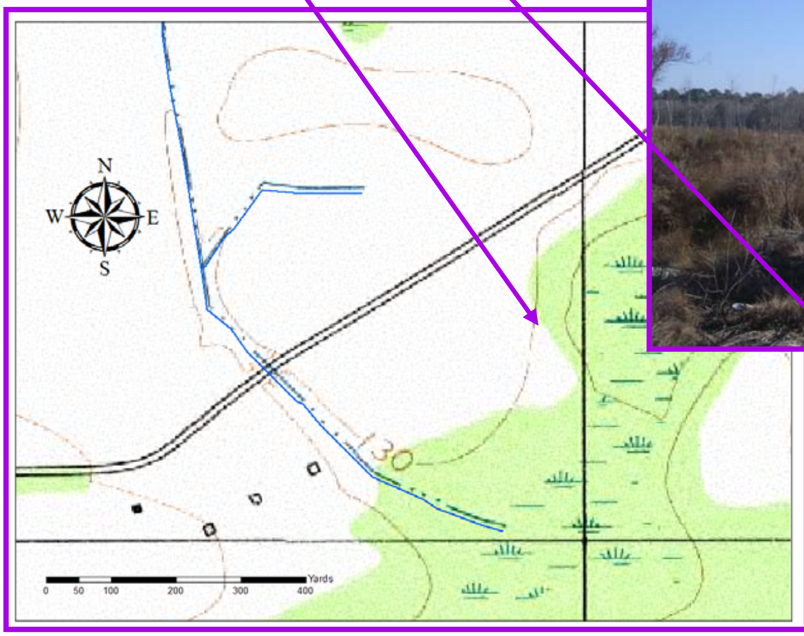


Figure F-6

Pastured cattle (location: 32.92994 N, -81.34394 W) on Terry Road in Allendale County. Found in Reach 3 of the CRT Watershed (Date of photography: November 21, 2017).

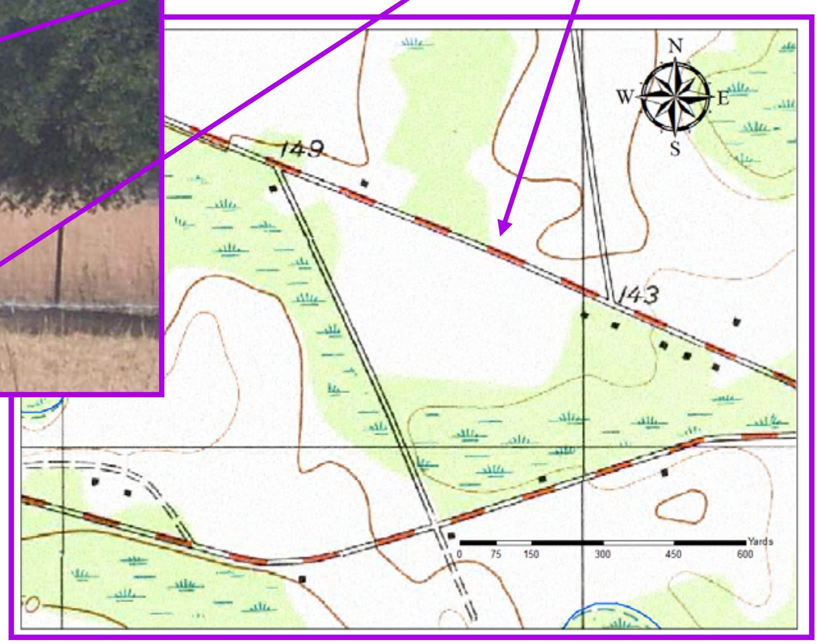


Figure F-7

Pastured cattle near stream-fed pond (location: 32.97743 N, -81.28399 W) on County Route S-3-103 in Allendale County. Found in Reach 3 of the CRT Watershed (Date of photography: November 21, 2017).

Figure F-8

Pastured horses near the Coosawhatchie River (location: 32.96981 N, -81.31292 W) on Bostick Road in Allendale County. Found in Reach 3 of the CRT Watershed (Date of photography: November 28, 2017).

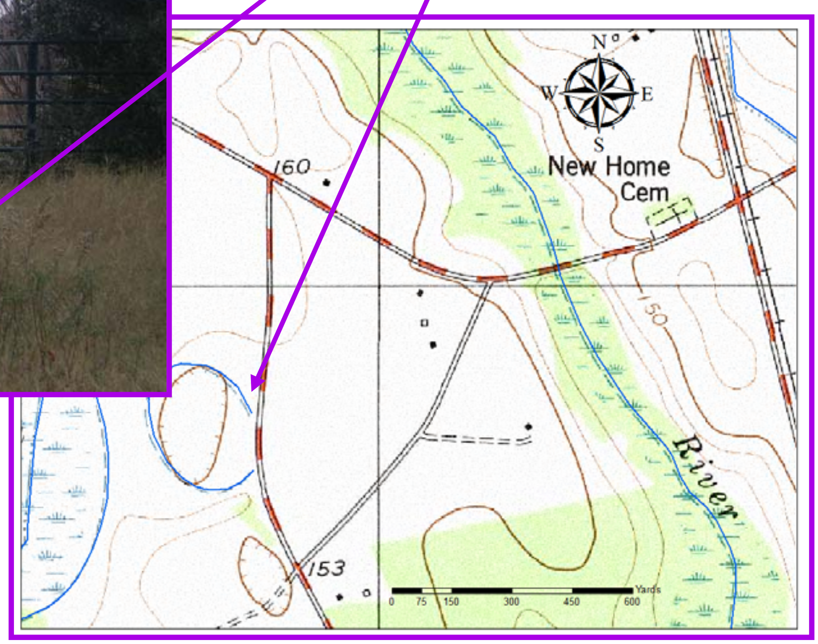
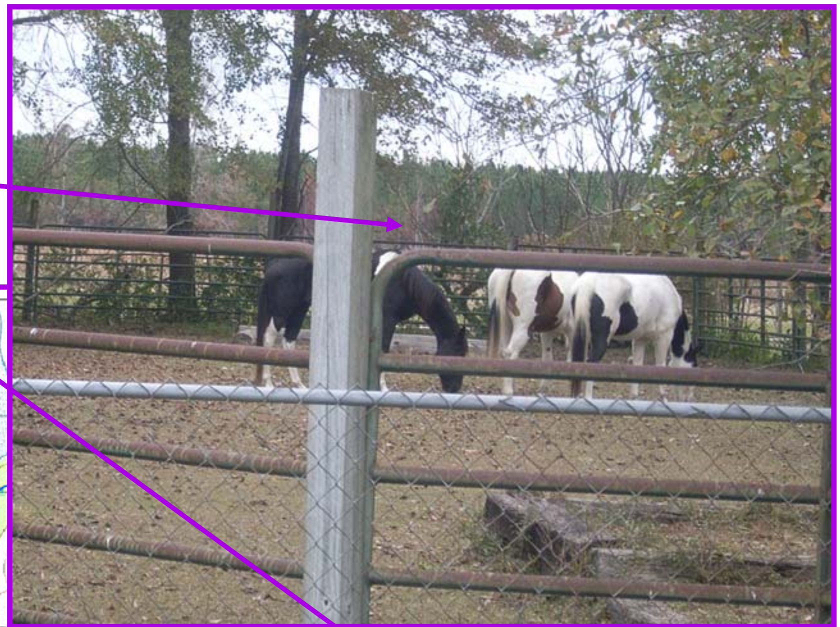


Figure F-9

Pastured horses near Duck Branch (location: 32.95529 N, -81.27060 W) on County Route S-3-266 in Allendale County. Found in Reach 3 of the CRT Watershed (Date of photography: November 28, 2017).



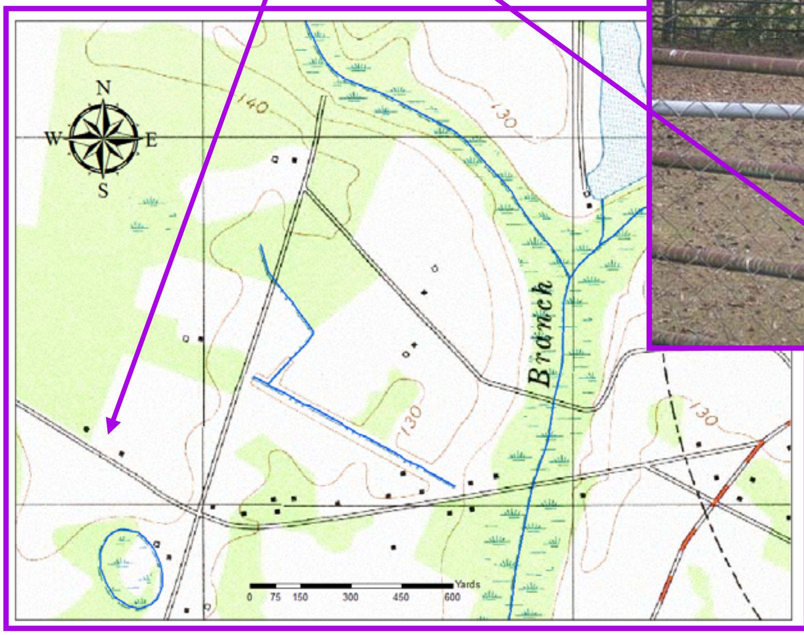


Figure F-10

Pastured horses (location: 32.95483 N, -81.33774 W) on County Route S-3-433 in Allendale County. Found in Reach 3 of the CRT Watershed (Date of photography: November 21, 2017).

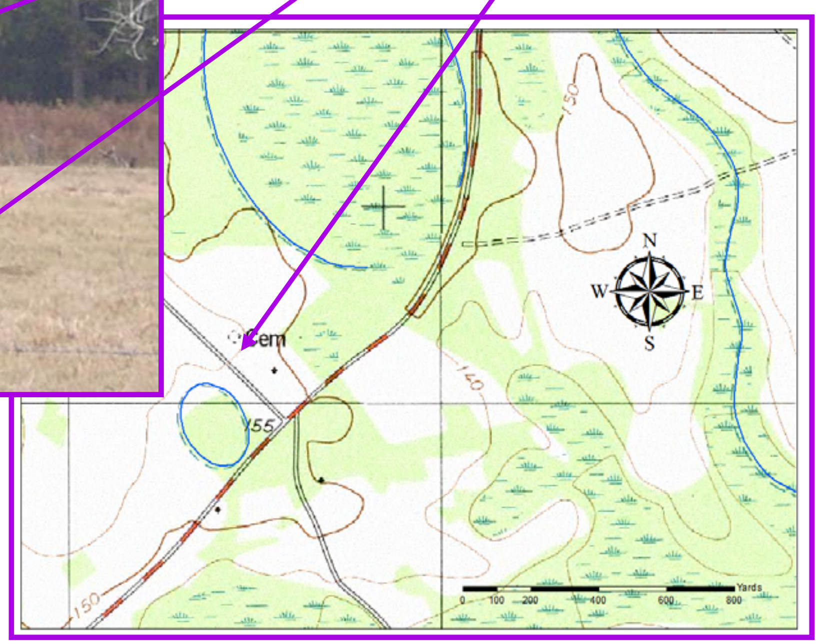


Figure F-11

Pastured horses (location: 32.93473 N, -81.21842 W) on Tinker Town Road in Hampton County. Found in Reach 3 of the CRT Watershed (Date of photography: November 30, 2017).

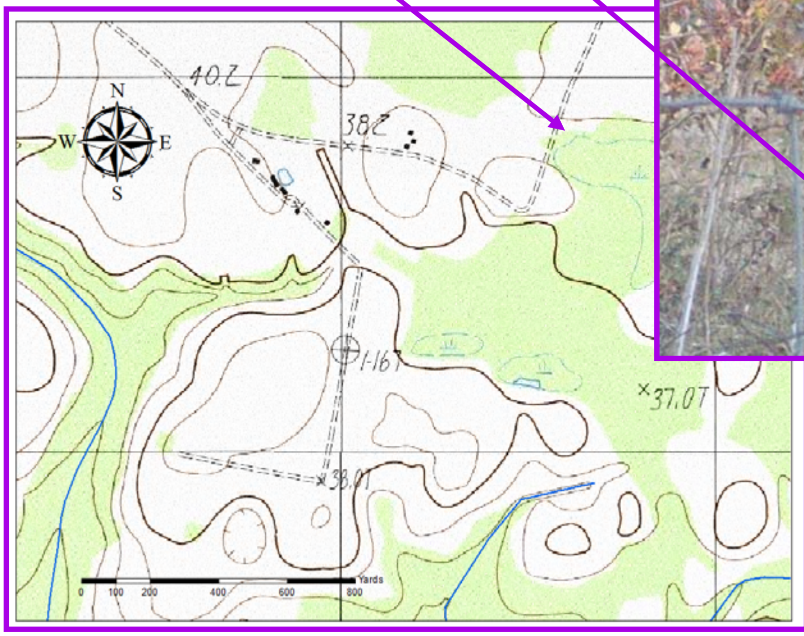
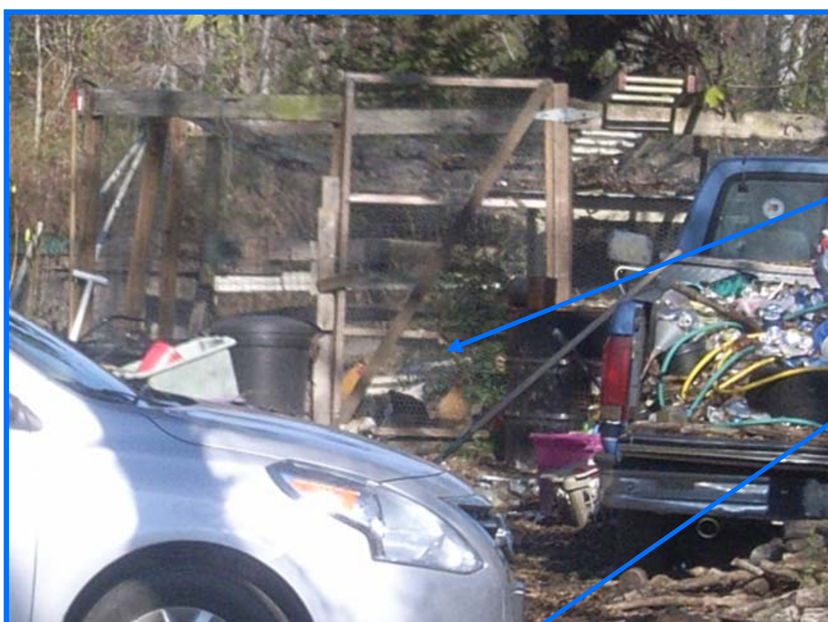


Figure F-12

Chickens in pen near Blood Hill Creek (location: 32.85610 N, -81.25322 W) on Murdaugh Street in Hampton County. Found in Reach 2 of the CRT Watershed (Date of photography: November 30, 2017).



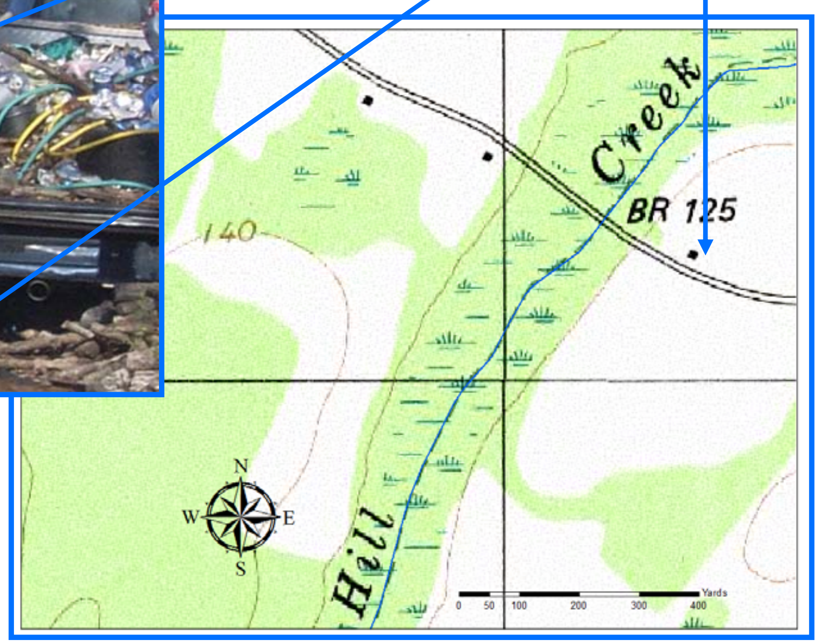


Figure F-13

Chickens in pen near Little Duck Branch (location: 32.95255 N, -81.29108 W) on St. James Road in Allendale County. Found in Reach 3 of the CRT Watershed (Date of photography: November 28, 2017).

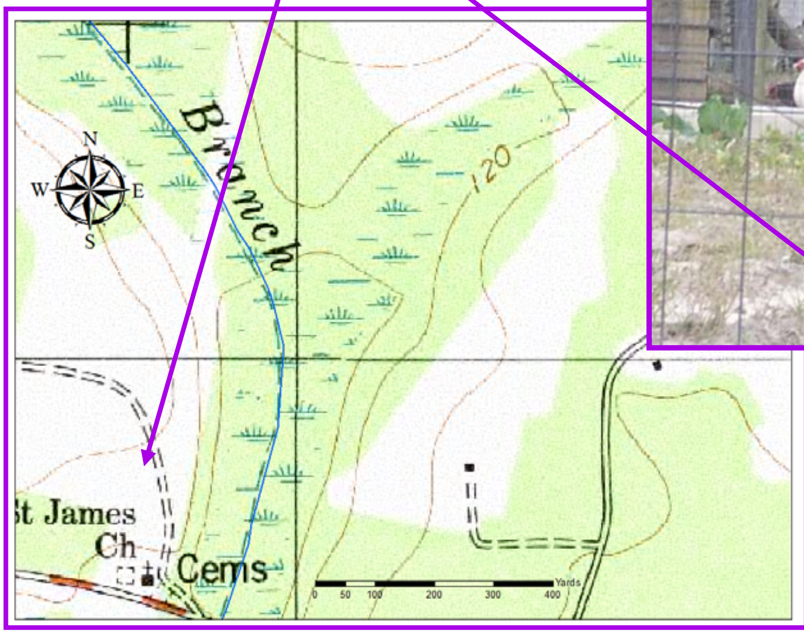


Figure F-14

Unattended cat in yard in Gifford (location: 32.86041 N, -81.23504 W) on Lin Street in Hampton County. Found in Reach 2 of the CRT Watershed (Date of photography: November 30, 2017).

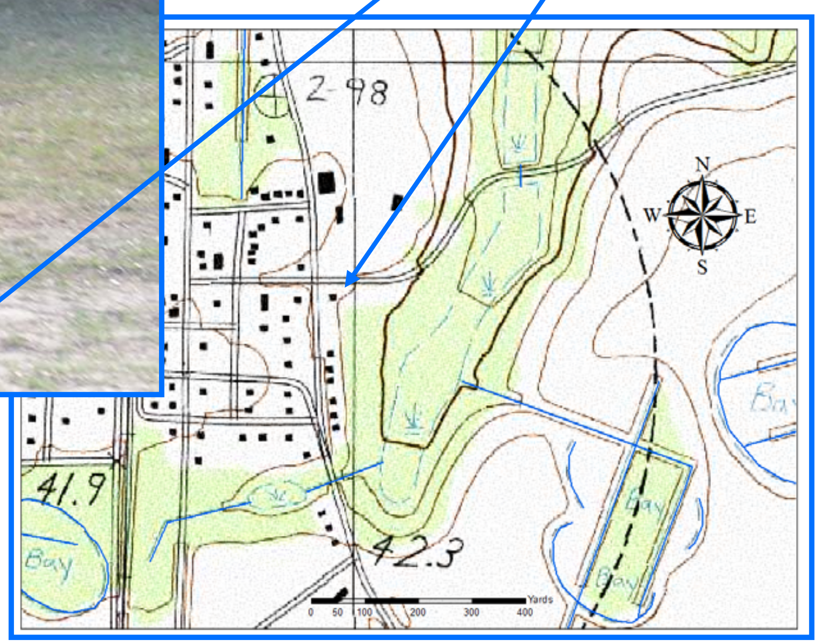


Figure F-15

Unattended cats in street in Allendale (location: 33.00751 N, -81.29995 W) on Cohen Street in Allendale County. Found in Reach 3 of the CRT Watershed (Date of photography: November 21, 2017).

Figure F-16

Unattended cat in yard in Brunson (location: 32.92567 N, -81.18721 W) on Manker Street in Hampton County. Found in Reach 3 of the CRT Watershed (Date of photography: November 30, 2017).

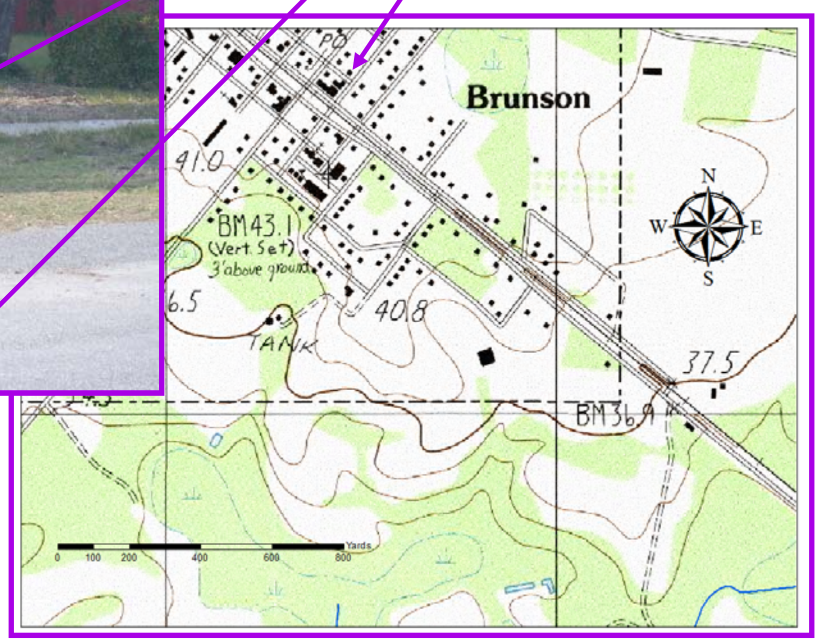


Figure F-17

Unattended cat in yard (location: 32.92111 N, -81.28891 W) on Road Cr-78 in Allendale County. Found in Reach 3 of the CRT Watershed (Date of photography: November 28, 2017).

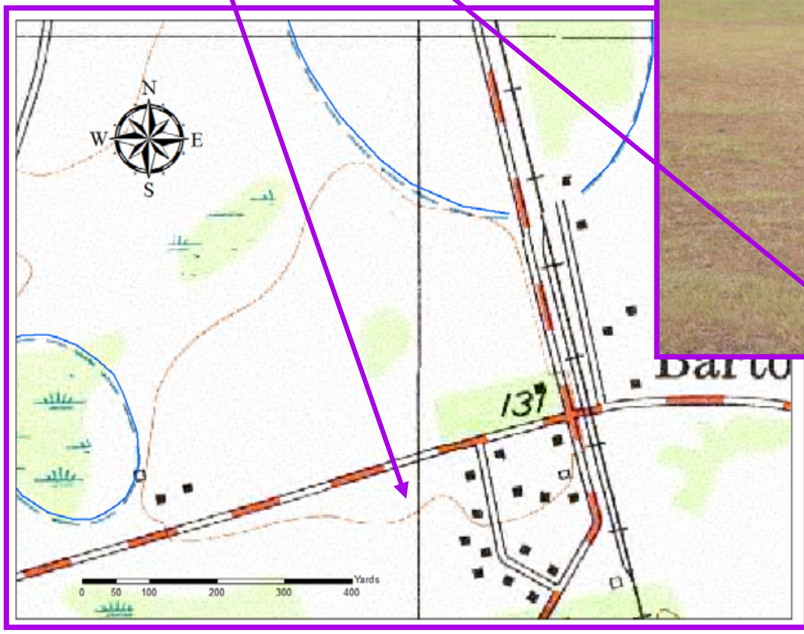


Figure F-18

Unattended dog in road in Allendale (location: 33.00278 N, -81.31168 W) on South Mill Street in Allendale County. Found in Reach 1 of the CRT Watershed (Date of photography: November 21, 2017).

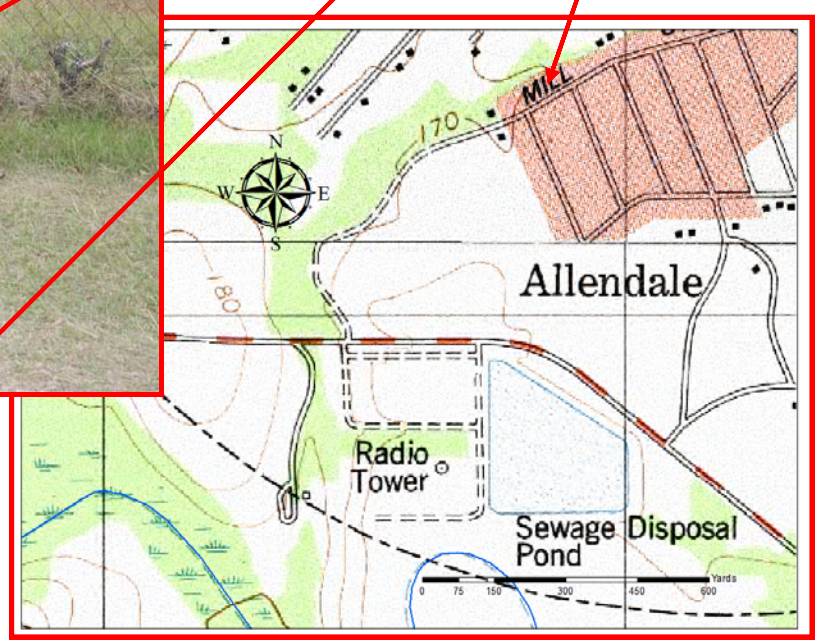


Figure F-19

Unattended dog in yard in Gifford near Blood Hill Street (location: 32.86595 N, -81.24464 W) on Sumpter Street in Hampton County. Found in Reach 2 of the CRT Watershed (Date of photography: November 30, 2017).

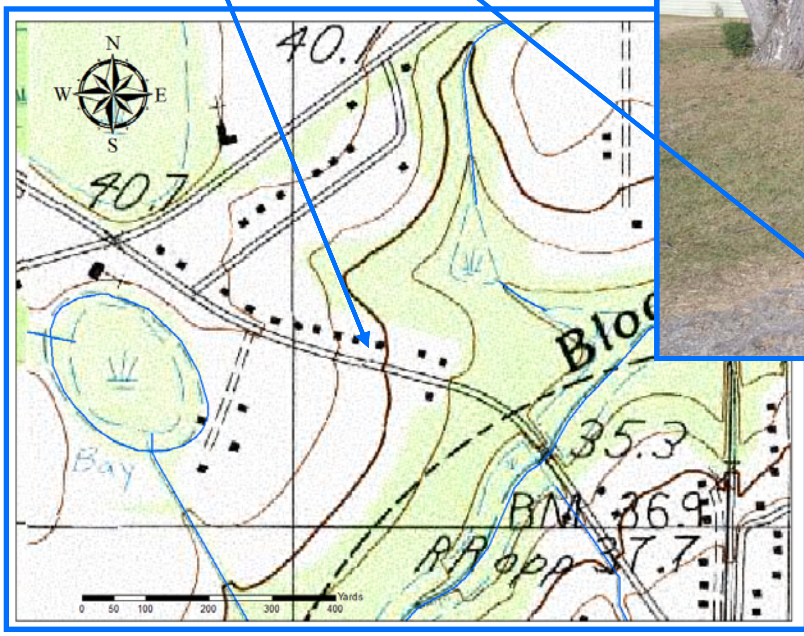


Figure F-20

Unattended dog in yard in Fairfax near Duck Branch (location: 32.95618 N, -81.24985 W) on South Old Orangeburg Road in Allendale County. Found in Reach 3 of the CRT Watershed (Date of photography: November 28, 2017).

Figure F-21

Unattended dog in yard (location: 32.86873 N, -81.19920 W) on Hadwin Circle in Hampton County. Found in Reach 3 of the CRT Watershed (Date of photography: November 30, 2017).