Total Maximum Daily Load Document
Pudding Swamp and Tributaries
Stations: RS-11027, RS-05557, RS-12091 and PD-203
(Hydrologic Unit Codes: 030402050501, 030402050502, 030402050503, 030402050504, and 030402050505)
Escherichia coli Bacteria,
Indicator for Pathogens

October 2018

Prepared for: Bureau of Water

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Healthy People. Healthy Communities.

Prepared by:

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Photographs on Title Page

Photographs, counterclockwise, beginning with the center-left photograph: **a)** proximity of the South Carolina Department of Health and Environmental Control's (SCDHEC) Water Quality Monitoring (WQM) Station PD-203 in Pudding Swamp at SC Route 527 (Sumter Highway) in Williamsburg County, SC (date of photography: June 22, 2018); **b)** proximity of the SCDHEC's WQM Station RS-12091 in Pudding Swamp at County Route S-45-287 (Burgess Crossing Road) in Williamsburg County, SC (date of photography: June 22, 2018); **c)** proximity of the SCDHEC's WQM Station RS-05557 in Horse Branch at County Route S-14-106 (Horse Branch Road) southeast of the Town of Turbeville in Clarendon County, SC (date of photography: June 22, 2018); and, **d)** proximity of the SCDHEC's WQM RS-11027 in Douglas Swamp at County Route S-43-150 (Norwood Road) northeast of the Town of Turbeville in Sumter County, SC (date of photography: June 15, 2018).

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 four (4) impaired water quality monitoring (WQM) stations in Pudding Swamp and its tributaries are listed on the 2016 §303(d) list for *E. coli* bacteria: **a)** station RS-11027 in Douglas Swamp in Sumter County; **b)** station RS-05557 in Horse Branch in Clarendon County; **c)** station RS-12091 in Pudding Swamp in Williamsburg County; and, **d)** station PD-203 in Pudding Swamp in Williamsburg County. Fecal coliform (FC) bacteria TMDLs were developed for the aforementioned four (4) WQM stations using FC bacteria data collected between May 1999 and December 2012. These four (4) 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 four (4) 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 Pudding Swamp and its tributaries, the following reductions in the existing loads at the respective WQM stations will be necessary: **a)** up to 51% at RS-11027; **b)** up to 78% at RS-05557; **c)** up to 50% at RS-12091; and, **d)** up to 39% at PD-203. 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 Pudding Swamp 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 Pudding Swamp and Tributaries Watershed (Loads are expressed as FC bacteria or *E. coli* bacteria count/day)

Station	Existing FC Load (count/day)	TMDL (count/day)		Margin of Safety (MOS) (count/day)		Waste Load Allocation (WLA)				Load Allocation (LA)		
						Continuous Source[1] (count/day)		Non-Continuous Sources[2,3] (% Reduction)	Non-Continuous SCDOT[3] (% Reduction)	Load Allocation (count/day)		% Reduction to Meet LA[3]
	FC (CFU/day)	FC (CFU/day)	*E. coli* (MPN/day)[6]	FC (CFU/day)	*E. coli* (MPN/day)[6]	FC (CFU/day)	*E. coli* (MPN/day)[6]	(Percent)	(Percent)	FC (CFU/day)	*E. coli* (MPN/day)[6]	(Percent)
RS-11027	3.86E+11	1.99E+11	*1.74E+11*	9.95E+09	*8.68E+09*	See Note Below	See Note Below	51	0[4]	1.89E+11	*1.65E+11*	51
RS-05557	3.34E+11	7.84E+10	*6.84E+10*	3.92E+09	*3.42E+09*	See Note Below	See Note Below	78	78[5]	7.45E+10	*6.50E+10*	78
RS-12091	3.78E+11	1.15E+11	*1.00E+11*	5.73E+09	*5.00E+09*	6.06E+08	*5.28E+08*	71	71[5]	1.09E+11	*9.50E+10*	71
PD-203	1.95E+11	1.25E+11	*1.09E+11*	6.25E+09	*5.45E+09*	See Note Below	See Note Below	39	0[4]	1.19E+11	*1.04E+11*	39

Table Notes:

1. 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.
2. 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.
3. Percent reduction applies to existing instream FC bacteria or *E. coli.*
4. As long as the conditions within the SCDOT MS4 area remain the same the Department deems the current contributions from SCDOT negligible and no reduction of FC bacteria or *E. coli* is necessary. SCDOT must continue to comply with the provisions of its approved NPDES stormwater permit.
5. 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.
6. 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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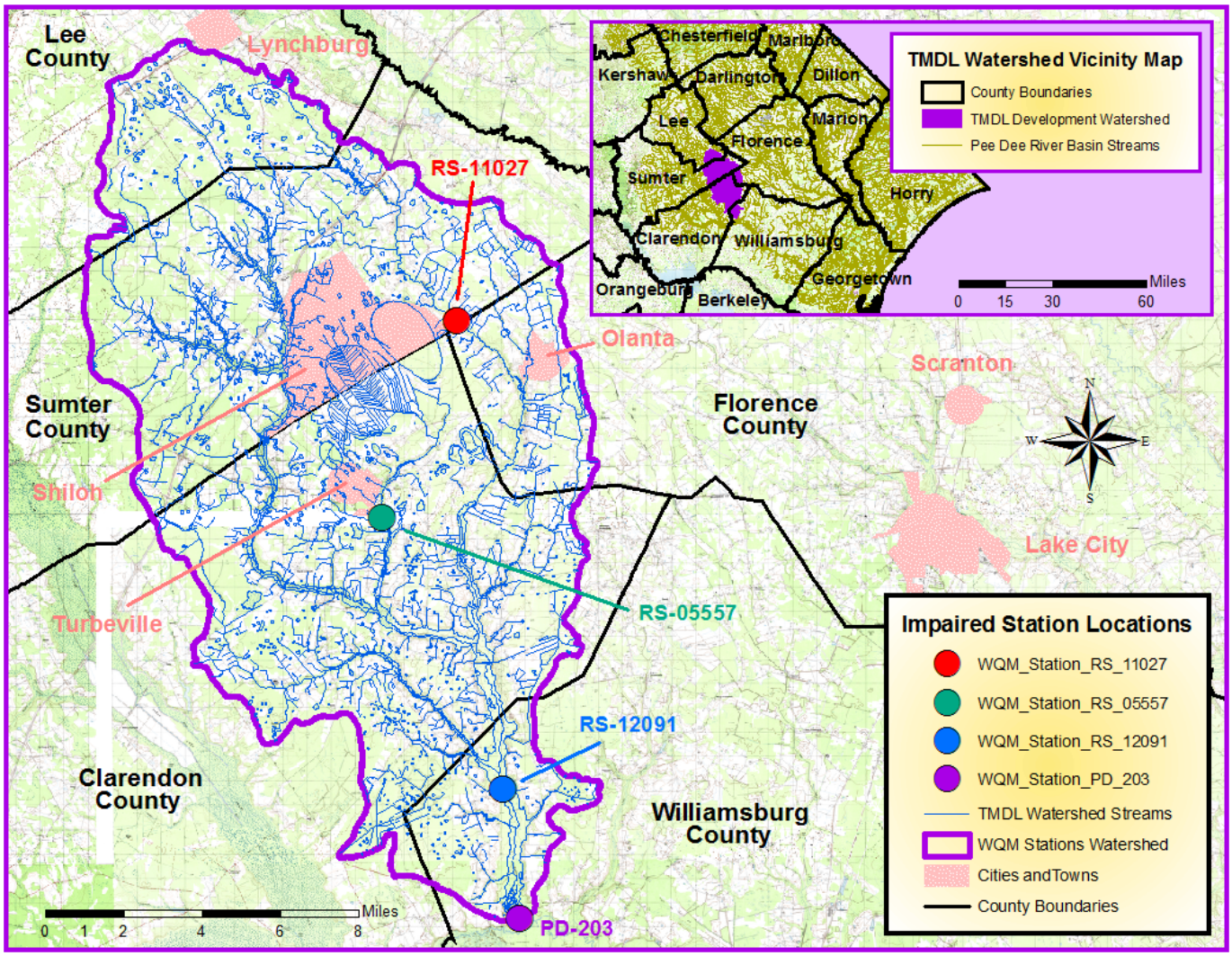
1.0 Introduction

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 four (4) impaired water quality monitoring (WQM) stations in South Carolina on the 2016 §303(d) list for *E. coli* bacteria: **a)** station RS-11027 in Douglas Swamp in Sumter County; **b)** station RS-05557 in Horse Branch in Clarendon County; **c)** station RS-12091 in Pudding Swamp in Williamsburg County; and, **d)** station PD-203 in Pudding Swamp in Williamsburg County. These four (4) WQM stations are identified in Figure 1 and Table 1.

Figure 1. Location of Water Quality Monitoring Stations RS-11027, RS-05557, RS-12091, and PD-203 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. Pudding Swamp and Tributaries Watershed Recreational Use Impaired Waters

Waterbody	Station Number	Description
Douglas Swamp	RS-11027	Doutlas Swamp at County Route S-43-150, 5 miles northeast of the Town of Tubeville in Sumter County
Horse Branch	RS-05557	Horse Branch at County Route S-14-106, 1.2 miles southeast of the Town of Turbeville in Clarendon County
Pudding Swamp	RS-12091	Bridge over Pudding Swamp at County Route S-45-287 in Williamsburg County
Pudding Swamp	PD-203	Pudding Swamp at SC 527, 8.1 miles northwest of the Town of Kingstree in Williamsburg 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 FC bacteria TMDLs for: **a)** WQMS Station RS-11027 in Douglas Swamp in Sumter County; **b)** WQM Station RS-05557 in Horse Branch in Clarendon County; **c)** WQM Station RS-12091 in Pudding Swamp in Williamsburg County; and, **d)** WQM Station PD-203 in Pudding Swamp in Williamsburg County. These FC bacteria TMDLs were developed using FC bacteria data collected between May 1999 and December 2012. The FC bacteria TMDLs for these four (4) WQM stations were converted to *E. coli* bacteria TMDLs for the purposes of implementation of the current *E. coli* bacteria WQS.

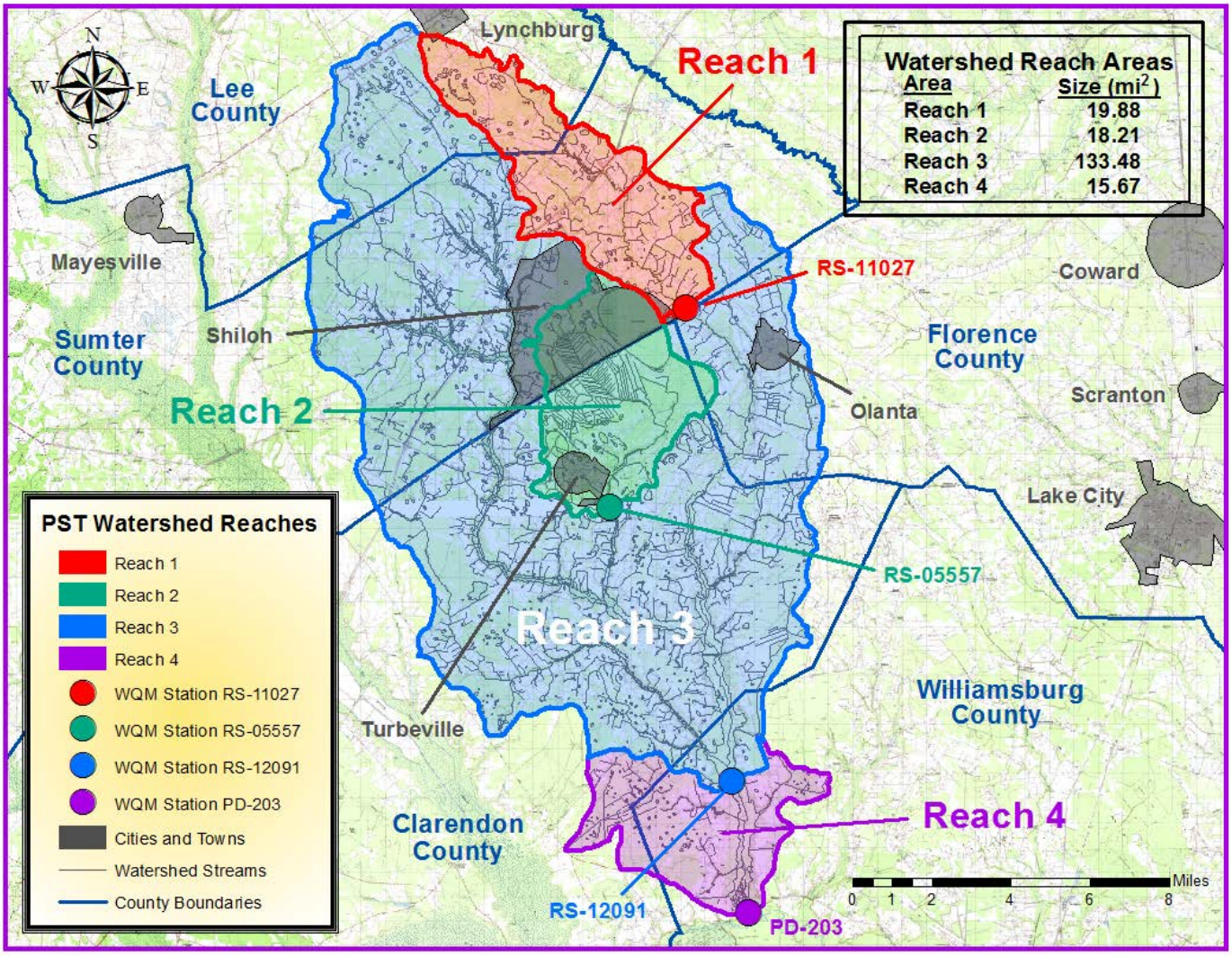
1.2 Watershed Descriptions

The watersheds for the four (4) 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 four watersheds ultimately flows through WQM Station PD-203. Collectively, the four watersheds are referred to as the Pudding Swamp and Tributaries (PST) Watershed in this TMDL development document.

The PST Watershed is 187.24 mi^2 (119,867.23 acres) in size, is located in Clarendon, Florence, Lee, Sumter, and Williamsburg Counties in South Carolina, and lies in the Middle Atlantic Coastal Plains ecoregion of the State. The general stream flow direction in the PST Watershed is in the south-southeastern direction. The upper northern part of the watershed is located at the Town of Lynchburg in Lee County, and the lower southern part of the PST Watershed is located in Williamsburg County approximately eight (8) miles northwest of the Town of Kingstree. According to the 2011 National Land Cover Database (NLCD), land use in the watershed is predominately Woody Wetlands (30.12%), and Cultivated Crops (26.91%).

As mentioned above, collectively, the aforementioned four (4) contiguous, hydrologically connected watersheds are referred to as the PST Watershed. However, these four (4) watersheds under TMDL development in this document will be referred to individually as reaches of the PST Watershed. These four (4) reaches are: **a)** Reach 1 - the reach draining through WQM Station RS-11027; **b)** Reach 2 - the reach draining through WQM Station RS-05557; **c)** Reach 3 - the reach draining through WQM Station RS-12091; and, **d)** Reach 4 - the reach draining through WQM Station PD-203. The reaches of the PST Watershed are shown in Figure 2.

Figure 2. Location of the Pudding Swamp and Tributaries Watershed Reaches



1.2.1 Reach 1 of the PST Watershed; Terminal WQM Station RS-11027

Reach 1 of the PST Watershed covers a drainage area of 19.88 mi^2 (12,728.50 acres) in size that drains into Douglas Swamp and its tributaries from an area at the Town of Lynchburg in Lee County, in a general southeastern fashion to impaired station RS-11027 in Douglas Swamp at County Route S-43-150, at the Town of Shiloh in Sumter County (Figure 2). The reach lies in the Middle Atlantic Coastal Plains ecoregion of the State.

Land use within Reach 1 of the PST Watershed is predominately Woody Wetlands (32.94%), and Cultivated Crops (31.99%) (Figure 3a, Table 2a). Developed lands (residential, commercial, industrial, or open urban space) comprise 4.11% 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 eighty-five (85) miles of streams within Reach 1 of the PST Watershed. The streams are all classified as freshwater (FW or FW-SP). From WQM Station RS-11027, Douglas Swamp flows for approximately ten (10) stream miles to Pudding Swamp in Clarendon County approximately 5 miles southeast of Town of Turbeville.

Figure 3a. Land Use Diagram for Reach 1 of the Pudding Swamp and Tributaries Watershed

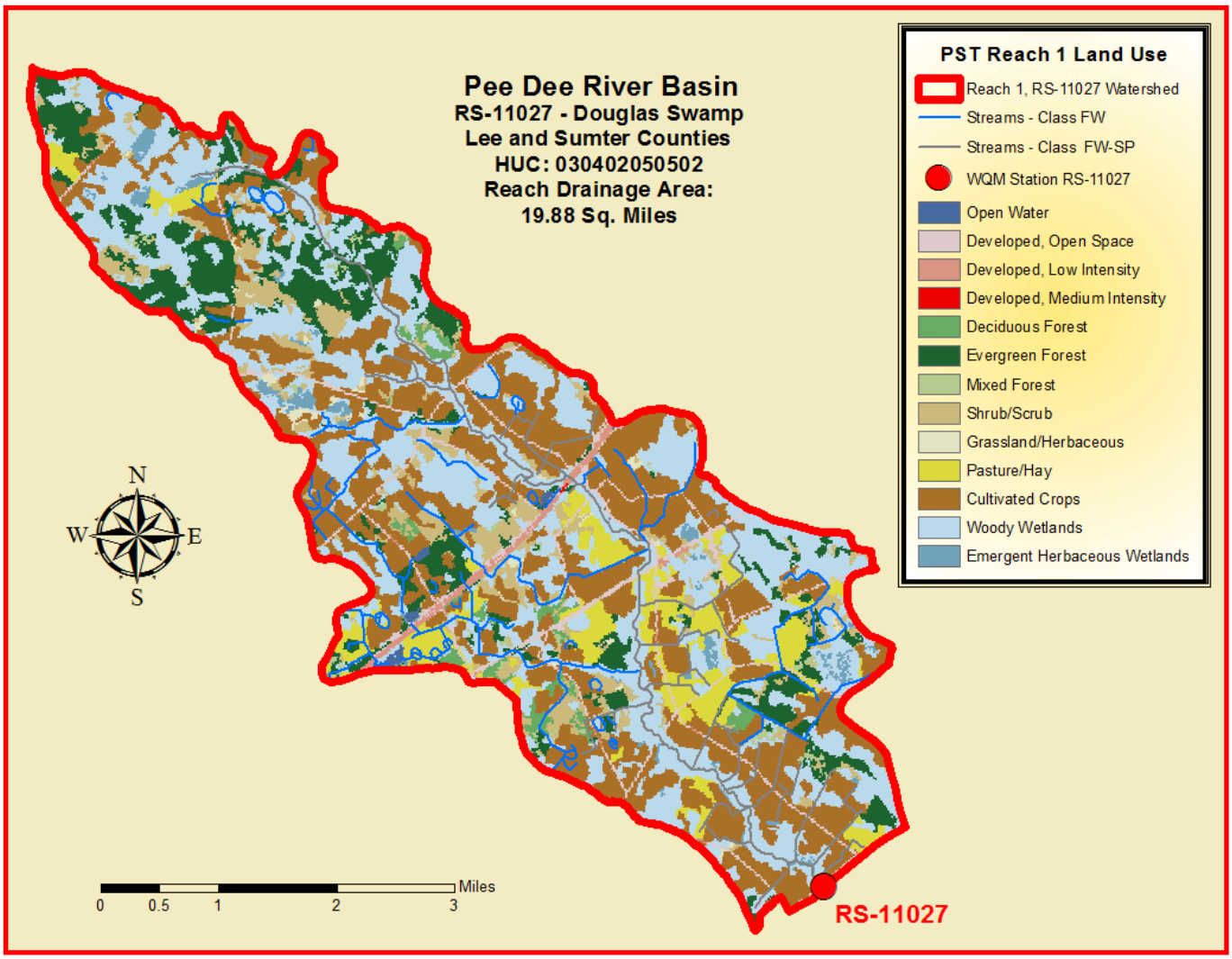


Table 2a. Pudding Swamp and Tributaries Watershed: Land Use in Reach 1 (WQM Station RS-11027) (Derived from National Land Cover Database (NLCD) 2011)

Description	Area (Acres)	Area (Mile^2)	Percent
Woody Wetlands	4192.79	6.55	32.94%
Cultivated Crops	4072.26	6.36	31.99%
Evergreen Forest	1516.06	2.37	11.91%
Shrub/Scrub	928.94	1.45	7.30%
Pasture/Hay	916.71	1.43	7.20%
Developed, Open Space	410.76	0.64	3.23%
Emergent Herbaceous Wetlands	194.59	0.30	1.53%
Deciduous Forest	193.71	0.30	1.52%
Developed, Low Intensity	111.42	0.17	0.88%
Mixed Forest	81.62	0.13	0.64%
Grassland/Herbaceous	77.39	0.12	0.61%
Open Water	31.14	0.05	0.24%
Developed, Medium Intensity	1.11	0.00	0.01%
Totals	**12,728.50**	**19.88**	**100.00%**

Table 3. Developed Areas in the Pudding Swamp and Tributaries Watershed Reaches

Reach	Reach Description	Reach Area (mi^2)	Developed Area (mi^2)	Percent Developed
Reach 1 of the PST Watershed	From an area at the Town of Lynchburg in Lee County to impaired station RS-11027 in Douglas Swamp at County Route S-43-150, at the Town of Shiloh in Sumter County.	19.88	0.82	4.11%
Reach 2 of the PST Watershed	From an area in Sumter County at the northeastern border of the Town of Shiloh to impaired station RS-05557 in Horse Branch at County Route S-14-106, at the southern border of the Town of Turbeville in Clarendon County.	18.21	1.34	7.36%
Reach 3 of the PST Watershed	From an area in Lee County at the Town of Lynchburg to impaired station RS-05557 in Pudding Swamp at County Route S-45-287 in Williamsburg County, approximately nine (9) mile northwest of the Town of Kingstree.	133.48	7.19	5.39%
Reach 4 of the PST Watershed	From an area in Clarendon County approximately seven (7) miles south of the Town of Turbeville to impaired station PD-203 in Pudding Swamp at SC 527 in Williamsburg County, approximately six (6) miles northwest of the Town of Kingstree.	15.67	0.52	3.31%
Total Area in the Pudding Swamp and Tributaries Reaches		187.24	9.87	5.27%

1.2.2 Reach 2 of the PST Watershed; Terminal WQM Station RS-05557

Reach 2 of the PST Watershed covers a drainage area of 18.21 mi^2 (11,656.11 acres) in size that drains into Horse Branch and its tributaries from an area in Sumter County at the northeastern border of the Town of Town of Shiloh, in a general south-southeastern fashion to impaired station RS-05557 in Horse Branch at County Route S-14-106, at the southern border of the Town of Turbeville in Clarendon County (Figure 2). The reach lies in the Middle Atlantic Coastal Plains ecoregion of the State.

Land use within Reach 2 of the PST Watershed is predominately Woody Wetlands (34.02%), and Cultivated Crops (32.61%) (Figure 3b, Table 2b). Developed lands (residential, commercial, industrial, or open urban space) comprise 7.36% 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 120 miles of streams within Reach 2 of the PST Watershed. The streams are all classified as freshwater (FW). From WQM Station RS-05557, Horse Branch flows for approximately two (2) stream mile to Pudding Swamp in Clarendon County approximately 2.4 miles south of the Town of Turbeville.

1.2.3 Reach 3 of the PST Watershed; Terminal WQM Station RS-12091

Reach 3 of the PST Watershed covers a drainage area of 133.48 mi^2 (85,448.43 acres) in size that drains into Pudding Swamp and its tributaries from an area in Lee County at the Town of Lynchburg, in a general south-southeastern fashion to impaired station RS-12091 in Pudding Swamp at County Route S-45-287 in Williamsburg County, approximately nine (9) miles northwest of the Town of Kingstree (Figure 2). The reach lies in the Middle Atlantic Coastal Plains ecoregion of the State.

Land use within Reach 3 of the PST Watershed is predominately Woody Wetlands (28.82%), and Cultivated Crops (26.47%) (Figure 3c, Table 2c). Developed lands (residential, commercial, industrial, or open urban space) comprise 5.39% of the reach (Table 3). At the time of the development of this TMDL, there were three (3) active animal feeding operation in the reach (Figure 3c).

According to GIS information, there are approximately 665 miles of streams within Reach 3 of the PST Watershed. The streams are all classified as freshwater (FW or FW-SP). From WQM Station RS-12091, Pudding Swamp flows for approximately four (4) stream miles to the Black River in Williamsburg County approximately six (6) miles northwest of Town of Kingstree.

Figure 3b. Land Use Diagram for Reach 2 of the Pudding Swamp and Tributaries Watershed

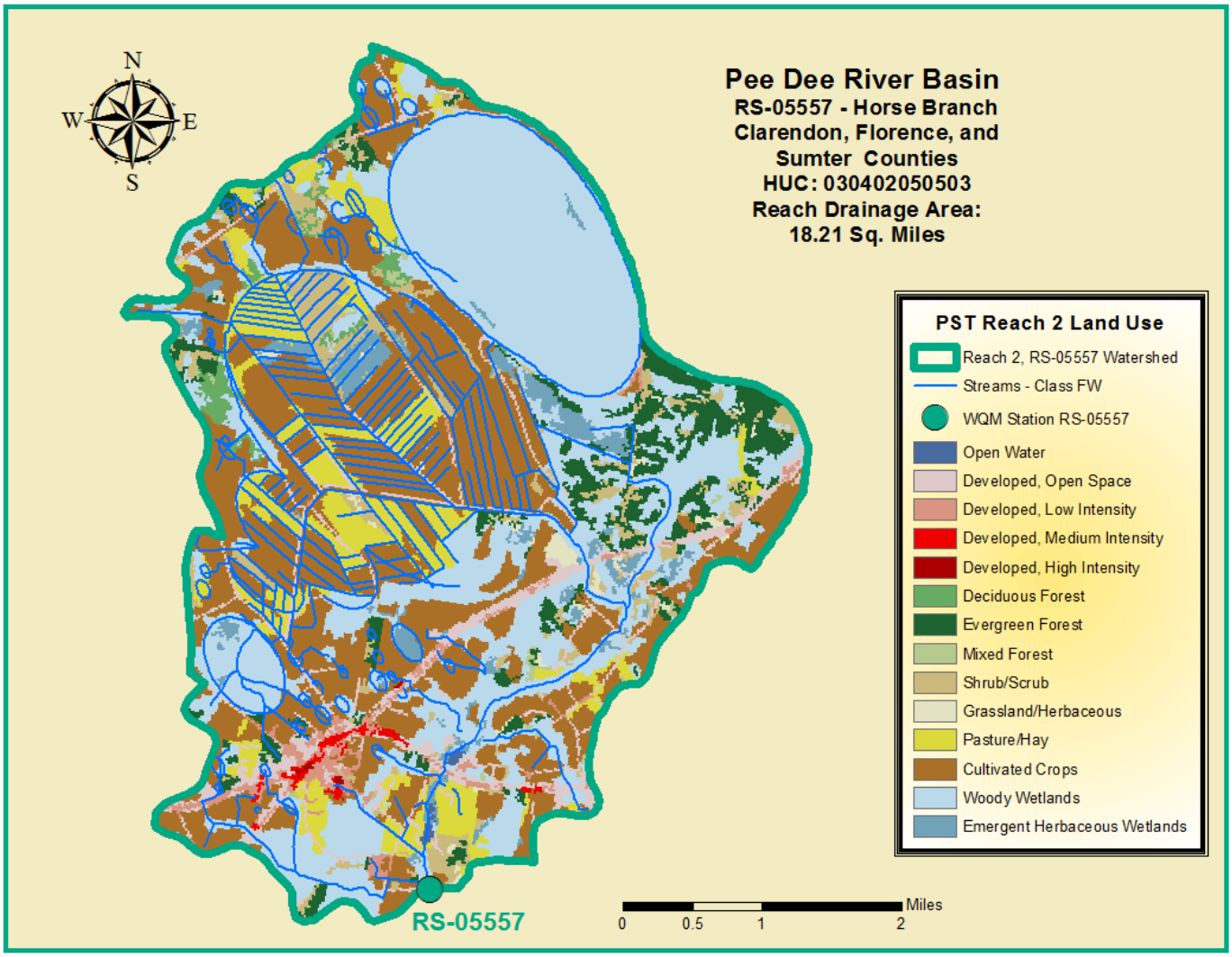


Table 2b. Pudding Swamp and Tributaries Watershed: Land Use in Reach 2 (WQM Station RS-05557) (Derived from National Land Cover Database (NLCD) 2011)

Description	Area (Acres)	Area (Mile^2)	Percent
Woody Wetlands	3965.28	6.19	34.02%
Cultivated Crops	3800.94	5.94	32.61%
Pasture/Hay	1051.92	1.64	9.02%
Evergreen Forest	717.67	1.12	6.16%
Developed, Open Space	611.81	0.96	5.25%
Shrub/Scrub	608.91	0.95	5.22%
Emergent Herbaceous Wetlands	373.62	0.58	3.21%
Developed, Low Intensity	195.48	0.31	1.68%
Deciduous Forest	124.54	0.19	1.07%
Grassland/Herbaceous	87.62	0.14	0.75%
Mixed Forest	50.48	0.08	0.43%
Developed, Medium Intensity	44.03	0.07	0.38%
Open Water	16.90	0.03	0.15%
Developed, High Intensity	6.89	0.01	0.06%
Totals	**11,656.11**	**18.21**	**100.00%**

Figure 3c. Land Use Diagram for Reach 3 of the Pudding Swamp and Tributaries Watershed

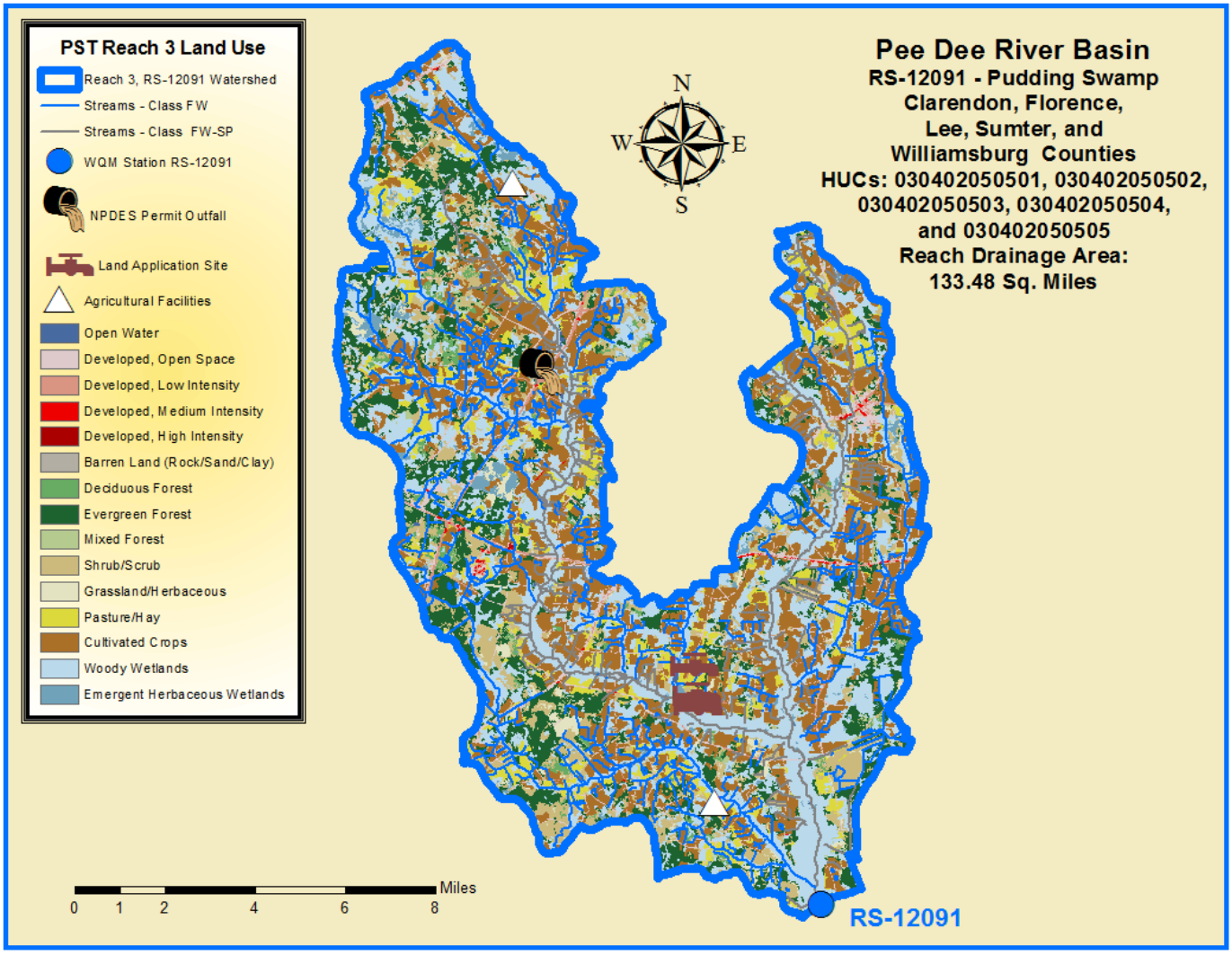


Table 2c. Pudding Swamp and Tributaries Watershed: Land Use in Reach 3 (WQM Station RS-12091)

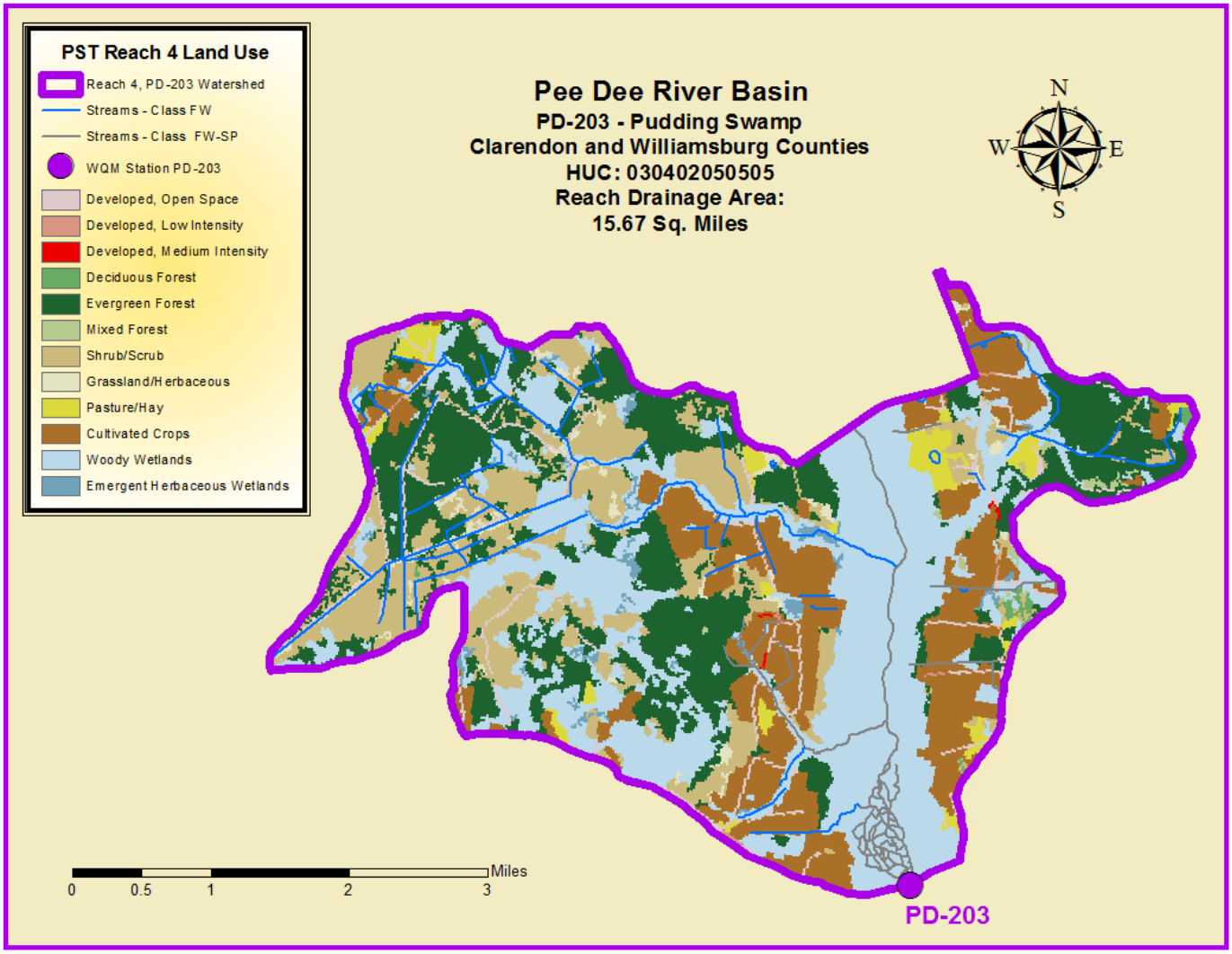
Description	Area (Acres)	Area (Mile^2)	Percent
Woody Wetlands	24,622.79	36.46	28.82%
Cultivated Crops	22,618.80	35.33	26.47%
Evergreen Forest	12,945.11	20.22	15.15%
Shrub/Scrub	8782.56	13.72	10.28%
Pasture/Hay	6264.62	9.79	7.33%
Developed, Open Space	3626.80	5.67	4.24%
Emergent Herbaceous Wetlands	1885.01	2.94	2.21%
Grassland/Herbaceous	1495.82	2.34	1.75%
Deciduous Forest	1050.59	1.64	1.23%
Mixed Forest	1027.68	1.61	1.20%
Developed, Low Intensity	823.52	1.29	0.96%
Developed, Medium Intensity	142.11	0.22	0.17%
Open Water	127.65	0.20	0.15%
Barren Land (Rock/Sand/Clay)	24.46	0.04	0.03%
Developed, High Intensity	10.90	0.02	0.01%
Totals	**85,448.43**	**133.48**	**100.00%**

1.2.4 Reach 4 of the PST Watershed; Terminal WQM Station PD-203

Reach 4 of the PST Watershed covers a drainage area of 15.67 mi^2 (10,034.19 acres) in size that drains into Pudding Swamp and its tributaries from an area in Clarendon County approximately seven (7) miles south of the Town of Turbeville, in a general southern fashion to impaired station PD-203 in Pudding Swamp at SC 527 in Williamsburg County, approximately six (6) miles northwest of the Town of Kingstree (Figure 2). The reach lies in the Middle Atlantic Coastal Plains ecoregion of the State.

Land use within Reach 4 of the PST Watershed is predominately Woody Wetlands (33.15%), and Evergreen Forest (23.39%) (Figure 3d, Table 2d). Developed lands (residential, commercial, industrial, or open urban space) comprise 3.31% of the reach (Table 3). At the time of the development of this TMDL, there were no animal feeding operations in the reach.

Figure 3d. Land Use Diagram for Reach 4 of the Pudding Swamp and Tributaries Watershed



According to GIS information, there are approximately seventy (70) miles of streams within Reach 4 of the PST Watershed. The streams are all classified as freshwater (FW or FW-SP). From WQM Station PD-203, Pudding Swamp flows for approximately three-tenths (0.3) stream miles to the Black River in Williamsburg County approximately six (6) miles northwest of Town of Kingstree.

Table 2d. Pudding Swamp and Tributaries Watershed: Land Use in Reach 4 (WQM Station PD-203)

Description	Area (Acres)	Area (Mile^2)	Percent
Woody Wetlands	3326.57	5.20	33.15%
Evergreen Forest	2346.92	3.67	23.39%
Cultivated Crops	1761.14	2.75	17.55%
Shrub/Scrub	1655.72	2.59	16.50%
Developed, Open Space	311.13	0.49	3.10%
Pasture/Hay	268.21	0.42	2.67%
Grassland/Herbaceous	160.57	0.25	1.60%
Emergent Herbaceous Wetlands	113.64	0.18	1.13%
Mixed Forest	38.70	0.06	0.39%
Deciduous Forest	30.25	0.05	0.30%
Developed, Low Intensity	16.23	0.03	0.16%
Developed, Medium Intensity	5.12	0.01	0.05%
Totals	**10,034.19**	**15.67**	**100.00%**

1.3 Water Quality Standard

The impaired stream segments of the PST 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 four (4) monitoring locations within the PST Watershed described earlier in this TMDL development document. These four (4) WQM stations in Pudding Swamp and its tributaries in Clarendon, Sumter, and Williamsburg 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 RS-11027 in Douglas Swamp in Sumter County; **b)** station RS-05557 in Horse Branch in Clarendon County; **c)** station RS-12091 in Pudding Swamp in Williamsburg County; and, **d)** station PD-203 in Pudding Swamp in Williamsburg 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 FC bacteria TMDLs for WQM Station RS-11027, RS-05557, RS-12091, and WQM Station PD-203 in the PST Watershed listed on the 2016 §303(d) list as impaired for recreational use, using FC bacteria data collected between May 1999 and December 2012. These 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 WQS Exceedence Summary for Impaired Stations (1999-2012)

Station	Waterbody	Number of Samples	Number of Samples >400/100mL	% Samples Exceed WQS
RS-11027	Douglas Swamp	11	3	27%
RS-05557	Horse Branch	7	3	43%
RS-12091	Pudding Swamp	11	2	27%
PD-203	Pudding Swamp	92	10	11%

Figure 4 illustrates precipitation precipitation and *E. coli* bacteria by data and date for WQM Station PD-203. The graph and Table 5 show that there is a moderate positive correlation between the amount of precipitation and the temporal FC bacteria exceedences of WQSs (r = 0.379). The graphs for precipitation and FC bacteria by data and date for the other three (3) WQM stations in the PST Watershed are shown in Appendix A. Those graphs in Appendix A and Table 5 show the following relationships between the amount of precipitation and the temporal FC bacteria exceedences of WQSs: **a)** for WQM Station RS-11027, a weak negative correlation; **b)** for WQM Station RS-05557, a strong positive correlation; and, **c)** for WQM Station RS-12091, little or no correlation.

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 FC Bacteria Data by Date for Water Quality Monitoring Station PD-203

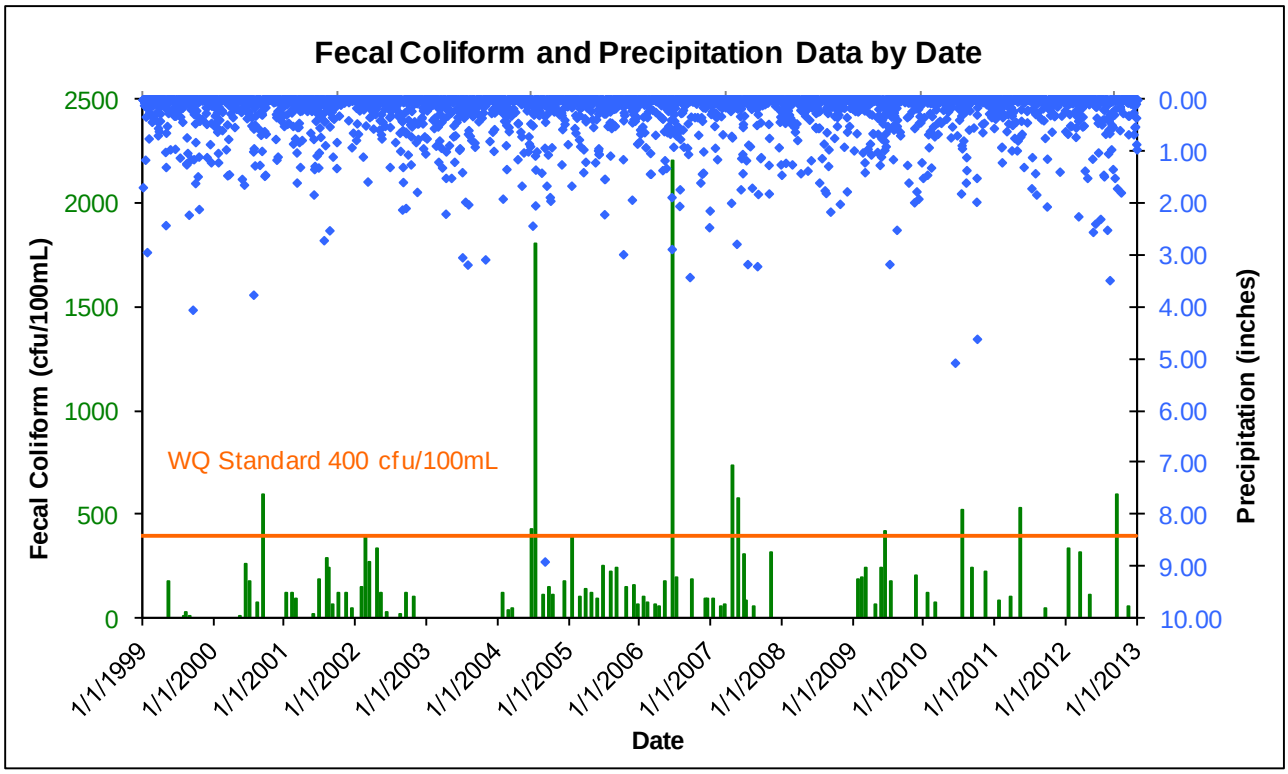


Table 5. Correlations Between Rainfall and FC Bacteria in the Pudding Swamp and Tributaries Watershed

Station	Waterbody	Correlation Coefficient (r)	Coefficient of Determination (r^2)
RS-11027	Douglas Swamp	-0.273	0.075
RS-05557	Horse Branch	0.625	0.316
RS-12091	Pudding Swamp	0.016	0.000
PD-203	Pudding Swamp	0.379	0.144

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 PST Watershed authorized under an NPDES permit issued by the SCDHEC. Sumter County, SC has a domestic WWTF located at the Interstate 95 Rest Area at mile marker 139 on I-95, approximately 1.75 miles south of the intersection of I-95 and SC 53 in Sumter County. The facility is authorized under the SCDHEC's NPDES Permit No. SCG570018 to discharge to Pudding Swamp at the I-95 bridge (near mile marker 140) in Reach 3 of the PST 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 December 11, 2013, and will expire on December 31, 2018. 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 PST Watershed.

Future NPDES discharges of *E.coli* and other FC bacteria in the referenced watershed are required to implement the WLA and demonstrate consistency with the assumptions and requirements of the TMDL.

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 PST Watershed. The SCDOT operates under the SCDHEC's NPDES MS4 Permit SCS040001, and owns and operates roads within all of the reaches in the PST 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.

Current developed land use for the PST Watershed range from 3.31% to 7.36% (Table 3). Based on GIS information, there are no SCDOT facilities located in the PST Watershed. And, based on information provided on the SCDOT website, the I-95 rest area at mile marker 139 in Sumter County is the only highway rest area 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. However, at the time of the development of these TMDLS, there were no urbanized areas in the PST 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 PST Watershed.

Figure 5. NPDES Permitted *E. coli* Bacteria Discharge in the Pudding Swamp and Tributaries Watershed

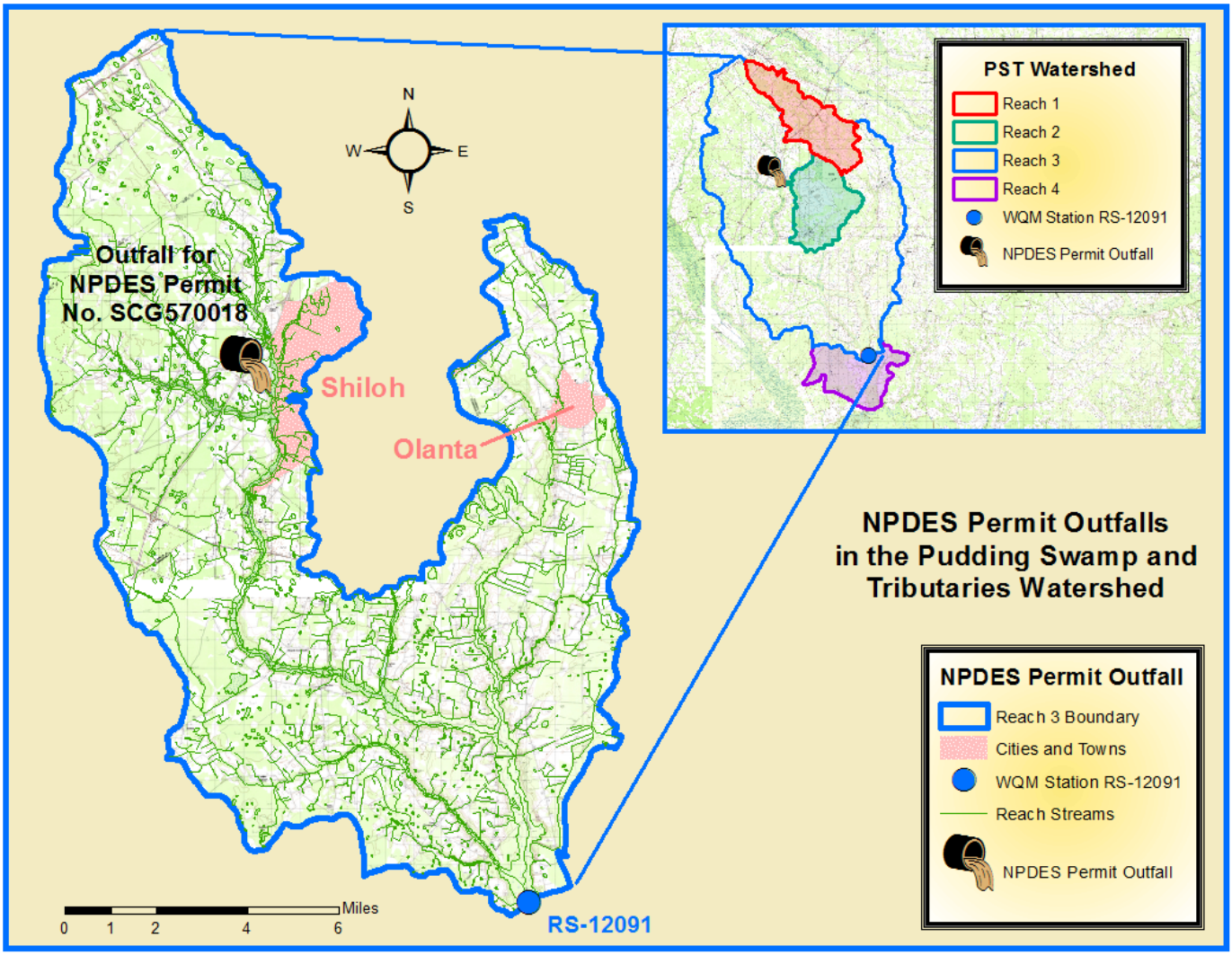


Table 6. NPDES Permitted *E. coli* Bacteia Discharge in the Pudding Swamp and Tributaries Watershed

Impaired Station Watershed	Permitted Facility	NPDES Permit Number	Permit Type	Permit Limitation (*E. coli* x Unit/Volume)	Permitted Flow (MGD)	Outfall Stream
RS-12091	Sumter County, SC	SCG570018	Minor	349 MPN/100 mL	0.04	Pudding Swamp

Other than the abovementioned MS4 owned and/or operated stormwater sewer system, there are currently no permitted stormwater systems that discharge into the PST 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

Figure 6. SCDOT Owned and Maintained Roads in the Pudding Swamp and Tributaries Watershed Reaches

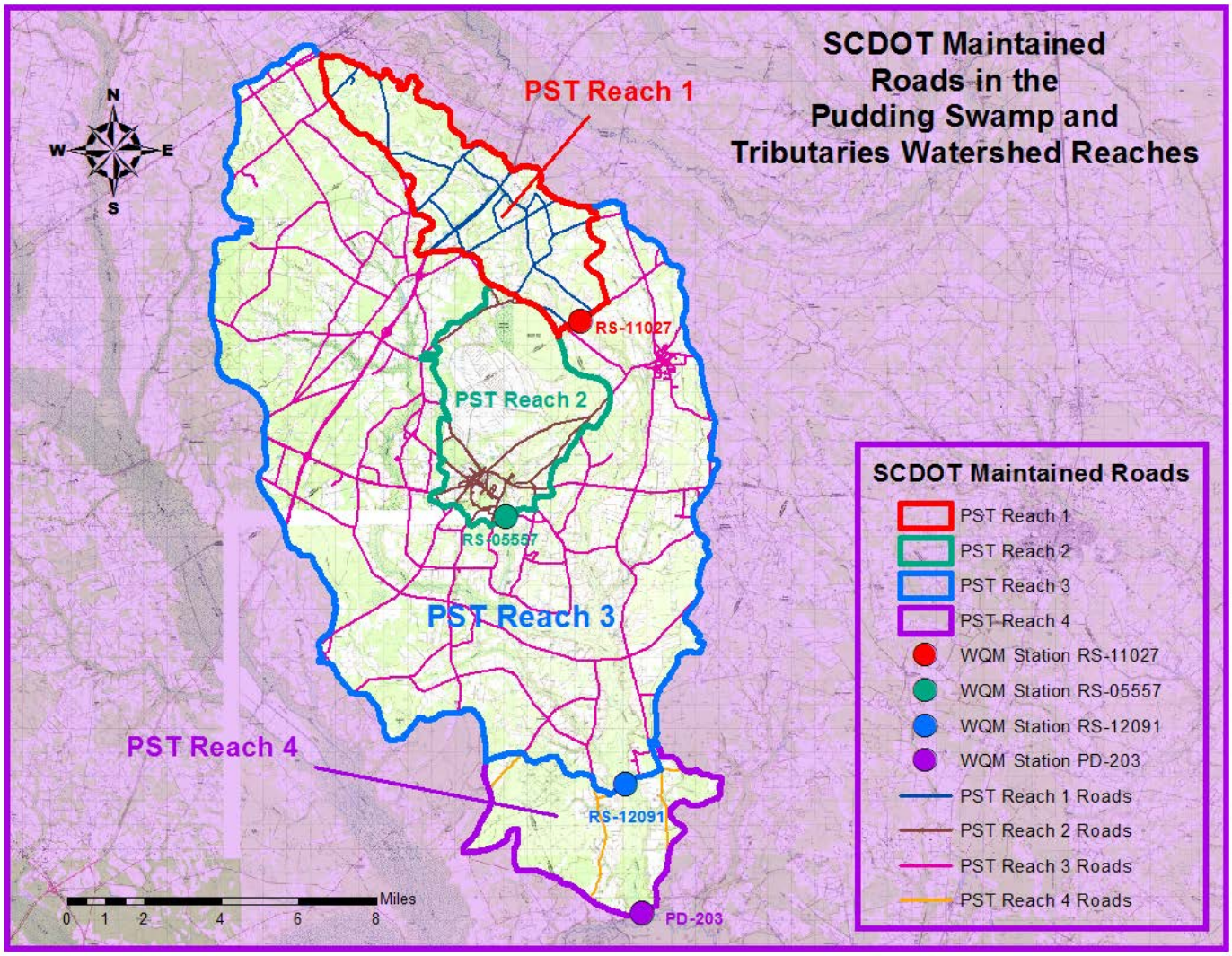


Table 7. SCDOT Maintained Road Miles in the Pudding Swamp and Tributaries Watershed Reaches

Watershed Reach	Station	Road Miles
Watershed Reach 1	RS-11027	33.2
Watershed Reach 2	RS-05557	28.6
Watershed Reach 3	RS-12091	213.0
Watershed Reach 4	PD-203	13.2
Total Miles in the PST Watershed Reaches:		288.0

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 2 and Reach 3 in the PST Watershed. The Town of Turbeville's sewer collection

system serves an area in the southern portion of Reach 2 of the watershed (terminal WQM Station RS-11027). The area served is 2.01 mi^2 (1287.78 acres). This represents approximately 11% of the 18.21 mi^2 reach being served by a sewer collection system (Table 8).

Table 8. Areas Served by Community Sewer Collection Systems in the Pudding Swamp 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
RS-05557	Reach 2	18.21	2.01	11%
RS-12091	Reach 3	133.48	4.48	3%

Also, according to GIS information, the Town of Olanta's sewer collection system serves an area in the northeastern portion of Reach 3 of the PST Watershed (terminal WQM Station RS-12091). The area served by the Town of Olanta is 1.35 mi^2 (865.77 acres). And, the Town of Turbeville's sewer collection system serves areas in the central and western portions of the reach. The area served by the Town of Turbeville is 3.13 mi^2 (2000.85 acres). The total areas served by the Towns of Olanta and Turbeville, 4.48 mi^2, represents only approximately 3% of the 133.48 mi^2 reach being served by a sewer collection system (Table 8). There are no community sewer collection systems in Reach 1 and Reach 4 of the PST 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 PST 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

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.

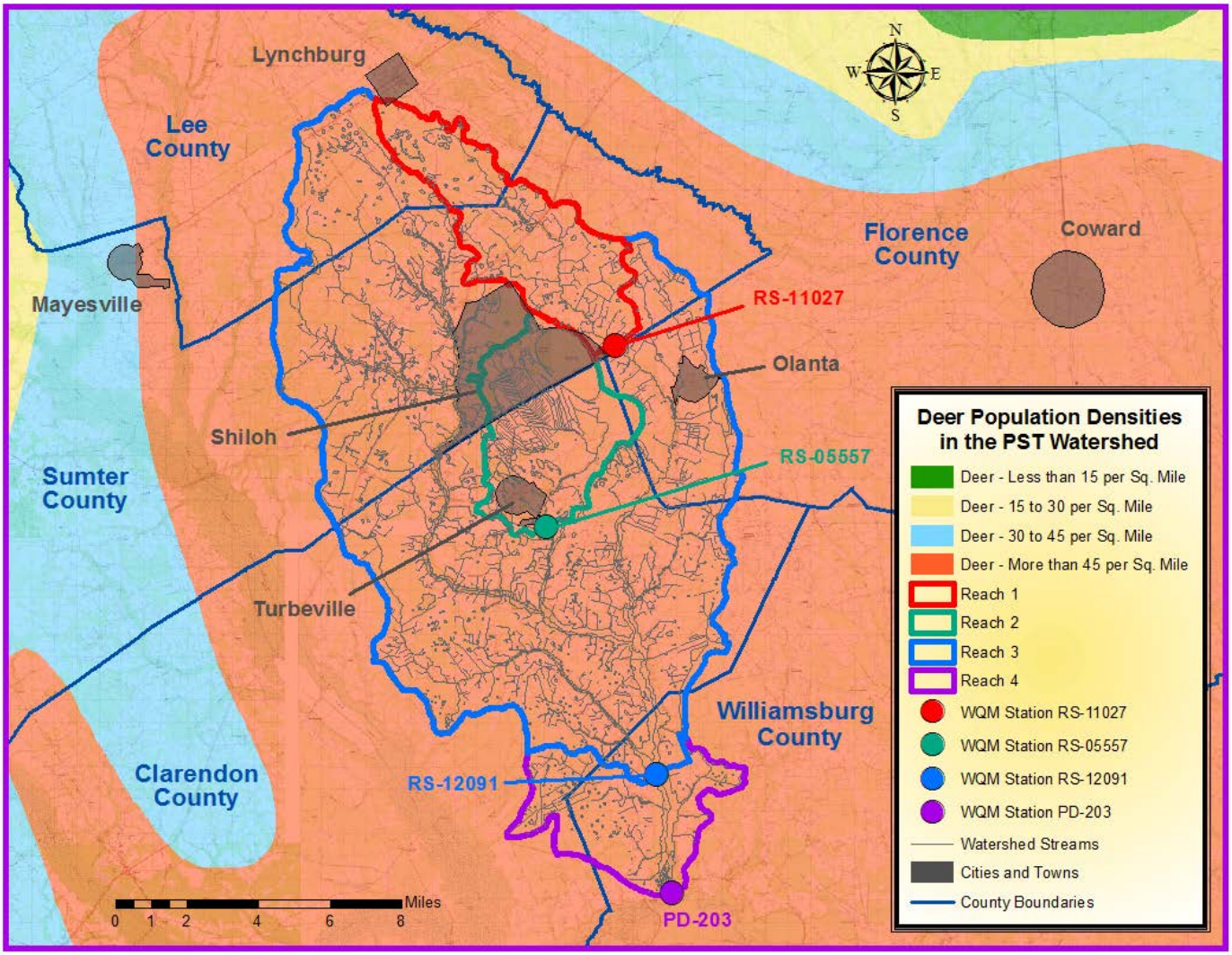
The Department recognizes that there may be wildlife, agricultural activities, grazing animals, septic tanks, and/or other nonpoint source contributors located within unregulated areas (outside of NPDES permitted area) of the PST Watershed. Nonpoint sources located in unregulated areas are subject to 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 more than 45 deer/mi^2 in all four reaches of the PST Watershed (SCDNR, 2015) (Figure 7). 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

Figure 7. Deer Population Densities in the Pudding Swamp and Tributaries Watershed Reaches (Based on the 2013 SCDNR South Carolina Deer Population Density Map)



347 x 10^6 cfu/head-day in a study conducted by Yagow (1999), of which only a portion will enter the PST 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 PST 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.

At the time of the development of these TMDLs, there were two (2) active AFOs with regulated structures or activities in the PST Watershed (Figure 3c, and Table 9). These facilities consist of two (2) poultry facilities. Both facilities are located in Reach 3 of the PST Watershed (terminal WQM station RS-12091) (Figures 3c. The poultry operations are regulated according to Section 122.23 of SC Regulation 61-9, *Water Pollution Control Permits*. There may also be land application sites associated with these 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.

Table 9. Active Animal Feeding Operations with Regulated Structures or Activities Within the Pudding Swamp and Tributaries Watershed

Downstream Impaired Station	AFO Permit	Facility	Type of Livestock	Number of Permitted Animals
RS-12091	ND0085677	Tomlinson Farms	Turkey (Grow-out)	48,000
RS-12091	ND0085723	Ucann Farm	Poultry (Broilers)	232,000

3.2.2.2 Grazing Animals

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 PST 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 3694, 2812, 1874, 5701 and 2900 cattle and calves in Clarendon, Florence, Lee, Sumter, and Williamsburg Counties, respectively, in 2012 (USDA 2014). According to the 2011 National Land Cover Database (NLCD), there are 37,075.96, 15,476.62, 8309.53, 40,313.91 and 35,543.23 acres of pastureland in Clarendon, Florence, Lee, Sumter, and Williamsburg Counties, respectively. This relates to 0.10, 0.18, 0.23, 0.14 and 0.08 cattle per acre of pastureland in Clarendon, Florence, Lee, Sumter, and Williamsburg Counties, respectively, assuming an even distribution of cattle across pastureland in the counties. Table 10 shows the number of acres of pastureland in the reaches of the PST 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 PST Watershed: **a)** 1.38E+13 cfu/day by an estimated one hundred and thirty-eight (138) cattle and calves in Reach 1 (terminal WQM Station RS-11027); **b)** 1.19E+13 cfu/day by an estimated one hundred and nineteen (119) cattle and calves in Reach 2 (terminal WQM Station RS-05557); **c)** 8.24E+13 cfu/day by an estimated eight hundred and twenty-four (824) cattle and calves in Reach 3 (terminal WQM Station RS-12091); and, **d)** 2.29E+12 cfu/day by an estimated twenty-three (23) cattle and calves in Reach 4 (terminal WQM Station PD-203).

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

Table 10. Cattle FC Bacteria per Day in the Pudding Swamp and Tributaries Watershed Reaches

Downstream Impaired Station	County	Pasture Area (Acre) per Reach	Cattle per Reach	Cattle Fecal Coliform, cfu/day/County/Reach	Cattle Fecal Coliform, cfu/day/Reach
	Lee	92.51	21	2.09E+12	
RS-11027	Sumter	827.04	117	1.17E+13	1.38E+13
	Clarendon	715.23	71	7.13E+12	
	Florence	6.90	1	1.25E+11	
RS-05557	Sumter	329.03	47	4.65E+12	1.19E+13
	Clarendon	2713.54	270	2.70E+13	
	Florence	608.94	111	1.11E+13	
	Lee	399.44	90	9.01E+12	
	Sumter	2446.88	346	3.46E+13	
RS-12091	Williamsburg	86.07	7	7.02E+11	8.24E+13
	Clarendon	64.05	6	6.38E+11	
PD-203	Williamsburg	202.83	17	1.65E+12	2.29E+12

61-9, Sections 503, 504, or 505. According to GIS information (available at time of TMDL development), there were three (3) active land application sites in the PST Watershed. The Town of Turbeville is authorized under the SCDHEC's NPDES Permit No. ND0085014 to land apply treated effluent from its domestic WWTF. Under the permit, the town is allowed to land apply to a 178-acre spray field (location: 33.854736 N, 79.998386 W), a 27-acre drip field (location: 33.845763 N, 79.998869 W), and a 49-acre drip field (location: 33.842154 N, 79.997356 W). The three land application sites are all located approximately three (3) miles south-southeast of the town in Reach 3 of the PST Watershed (Figure 3c). The permit was issued on September 18, 2012, and will expire on December 31, 2022. 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 PST 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 PST 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 PST 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 failing septic systems because of the wash-off effect from runoff and the increased rate of groundwater recharge.

3.2.5.1. Septic Systems in Reach 1 of the PST Watershed (WQM Station RS-11027)

According to GIS information, there are no community sewer systems serving Reach 1 of the PST Watershed. Based on current GIS information, 2015 USDA aerial photography of the reach, and based on

the 2010 U.S. population census, there are 309 households within the 12,728.50-acre reach. Therefore, assuming one (1) septic tank per household, it is estimated that there are approximately 309 septic tanks within the reach. This translates into 0.024 septic1 tanks per reach acre. At the time of the development of these TMDLs, their status in relation to function was unknown.

3.2.5.2. Septic Systems in Reach 2 of the PST Watershed (WQM Station RS-05557)

According to GIS information, sewer lines for the Town of Turbeville extend into the southern portion of the 11,656.11-acre Reach 2 of the PST Watershed. However, the vast majority of Reach 2 (approximately 89%) is not served by the Town of Turbeville sewer system, 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 233 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 233 septic tanks within the reach. This translates into 0.020 septic tanks per watershed acre. At the time of the development of these TMDLs, their status in relation to function was unknown.

3.2.5.3. Septic Systems in Reach 3 of the PST Watershed (WQM Station RS-12091)

According to GIS information, sewer lines for the Town of Olanta extend into the northeastern portion of the 85,448.43-acre Reach 3 of the PST Watershed. And, sewer lines for the Town of Turbeville extend into the central and western portions of the reach. However, the vast majority of Reach 3 (approximately 97%) is not served by the sewer systems for the Town of Olanta or Town of Turbeville, 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 1836 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 1836 septic tanks within the reach. This translates into 0.021 septic tanks per watershed acre. At the time of the development of these TMDLs, their status in relation to function was unknown.

3.2.5.4. Septic Systems in Reach 4 of the PST Watershed (WQM Station PD-203)

And, according to GIS information, there are no community sewer systems serving Reach 4 of the PST Watershed. Based on current GIS information, 2015 USDA aerial photography of the reach, and based on the 2010 U.S. population census, there are 93 households within the 10,034.19-acre reach. Therefore, assuming one (1) septic tank per household, it is estimated that there are approximately 93 septic tanks within the reach. This translates into 0.009 septic1 tanks per reach 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 PST Watershed. Based on GIS information, some portion of four (4) incorporated areas lie within Reaches 1, 2, and 3 of the PST Watershed (Figure 2).

According to GIS information, 2.08% of the incorporated area of the Town of Lynchburg (i.e., 15.12 acres of 726.73 acres) lie within in the northern portion of the 12,728.50-acre Reach 1 of the PST Watershed (Figure 2). Also, according to GIS information, 1.73% of the incorporated area of the Town of Shiloh (i.e., 108.05 acres of 6252.73 acres) lie within in the southwestern portion of the reach. Therefore, 123.17 acres is the total incorporated areas within the reach. However, this translates to only 0.97% of the reach being incorporated areas.

According to GIS information, 51.94% of the incorporated area of the Town of Shiloh (i.e., 3245.41 acres of 6252.73 acres) lie within in the northern portion of the 11,656.11-acre Reach 2 of the PST Watershed (Figure 2). Also, according to GIS information, the entire incorporated area of the Town of Turbeville (i.e., 788.96 acres) lie within in the southern portion of the reach. Therefore, 4034.37 acres is the total incorporated areas within the reach. This translates to 34.61% of the reach being incorporated areas.

And, according to GIS information, 46.37% of the incorporated area of the Town of Shiloh (i.e., 2899.27 acres of 6252.73 acres) lie within in the north-central portion of the 85,448.43-acre Reach 3 of the PST Watershed (Figure 2). Also, according to GIS information, the entire incorporated area of the Town of

Olanta (i.e., 633.65 acres) lie within in the southern portion of the reach. Therefore, 3532.92 acres is the total incorporated areas within the reach. However, this translates to only 4.13% 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 PST Watershed may have the potential to contribute pollutant loadings in stormwater runoff. According to GIS information, only 5.27% of the PST Watershed is developed. Therefore, there is potential for growth in the PST 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. Two (2) United States Geological Survey (USGS) gages were used for collecting "real-time" flow data for the PST 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 and Reach of the PST Watershed (WQM Stations RS-11027 and RS-05557) was the Chicod Creek gage near Simpson, NC (Gage Number: 02084160). This gage has a drainage area of 45 square miles, began recording daily flows in 1975 and provides the flow data required to establish the flow duration curve for these impaired stations.

And, The USGS gage used for collecting flow data for Reach 3 and Reach 4 of the PST Watershed (WQM Station PD-203) 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 these impaired stations.

For example, flow data for a 14-year period (January 1, 1999 to December 31, 2012) from the USGS Springfield, GA gage was used to establish the flow duration curve for Reach 4 of the PST Watershed (WQM Station PD-203). 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 4 of the PST Watershed at WQM Station PD-203 (in Pudding Swamp at SC 527 in Williamsburg County) is 187.24 sq mi, or 115.58% of the area drained at the Springfield, GA gage. Therefore, mean daily flow for the PD-203 monitoring location was assumed to be 115.58% of the daily flow at the Springfield, GA gage.

However, additional adjustments were necessary in order to more accurately estimate stream flow at WQM Stations RS-12091 and PD-203. Sumter County, SC's WWTF (NPDES Permit No. SCG570018) at the Interstate 95 Rest Area at mile marker 139 on I-95 in Sumter County (Figure 5 and Table 6) is a minor domestic WWTP located upstream of these WQM stations. 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 permit SCG570018 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.

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 PD-203, where the target load-duration curve was created using existing FC bacteria data, the curve was 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 curve for station PD-203 is presented in Figure 8 as an example. The load-duration curves for stations RS-11027, RS-05557, and RS-12091 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 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 RS-11027, RS-05557, RS-12091, and PD-203 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 four (4) TMDLs, FC bacteria percent reductions should also be representative of reductions necessary to meet the *E. coli* bacteria WQS.

For all curves, including Figure 8, the independent variable (X-Axis) represents the percentage of estimated flows greater than value x. The dependent variable (Y-Axis) represents the FC bacteria loading at each estimated flow expressed in terms of colony forming units per day (cfu/day). In each of the defined flow intervals for WQM Stations RS-11017 and RS-05557, existing loads and LAs to achieve target loads 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

In each of the defined flow intervals for WQM Station RS-12091, 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, including long term average DMR flow for NPDES Permit SCG570018 (ft^3/s)) x 90^{th} Percentile FC Bacteria Concentration (cfu/100 ml) x Conversion Factor (24465758.4)

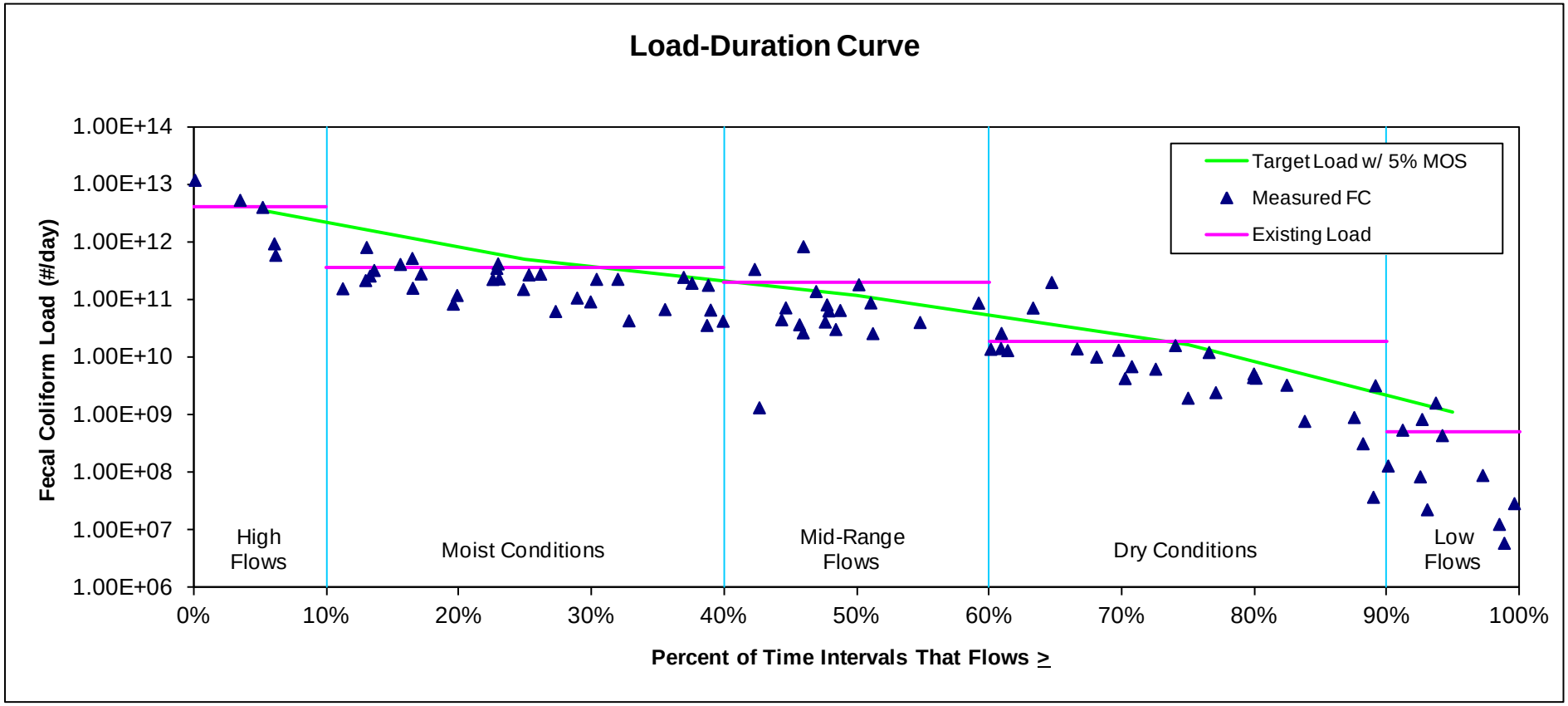
LA to Achieve Target Load (cfu/day) = (Mid-Point Flow in Each Hydrologic Category, including NPDES Permit SCG570018 Facility Design Flow (ft^3/s)) x 380 (FC Bacteria WQ criterion minus a 5% MOS (cfu/100 ml)) x Conversion Factor (24465758.4)) - (NPDES Permit SCG570018 Facility Design Flow (0.04 MGD = 0.06 ft^3/s) x 400 (FC Bacteria WQ criterion (cfu/100 ml)) x Conversion Factor (24465758.4))

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

In each of the defined flow intervals for WQM Station PD-203, 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, including long term average DMR flow for NPDES Permit SCG570018 (ft^3/s)) x 90^{th} Percentile FC Bacteria Concentration (cfu/100 ml) x Conversion Factor (24465758.4)

Figure 8. Load Duration Curve for Reach 4 of the Pudding Swamp and Tributaries Watershed, Water Quality Monitoring Station PD-203



LA to Achieve Target Load (cfu/day) = Mid-Point Flow in Each Hydrologic Category, including NPDES Permit SCG570018 Facility Design Flow (ft^3/s)) x 380 (FC Bacteria WQ criterion minus a 5% MOS (cfu/100 ml)) x Conversion Factor (24465758.4)

Note: *the WLA for NPDES Permit SCG570018 was not considered in the calculation of LA to Achieve Target Load (cfu/day) for WQM Station PD-203 since that WLA was considered in the calculation of LA to Achieve Target Load (cfu/day) for WQM Station RS-12091, the terminal WQM station Reach 3 of the PST Watershed, the reach in which the NPDES permitted facility discharges.*

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

Instantaneous loads for each of the impaired stations were calculated. Measured FC bacteria concentrations from 1999 through 2012 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 8, 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 four (4) WQM stations in the PST Watershed, the 90th percentile of measured 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 PD-203 in Figure 8. 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 four (4) WQM stations in the PST Watershed were based on the flow recurrence interval between 10% and 90% and excludes extreme high and low flow conditions, i.e., flows that are characterized as 'Low' or 'High.' The critical conditions for the PST Watershed pathogen impaired segments are listed in Table 11. This data indicates that for WQM Station PD-203, mid-range flow conditions result in larger bacteria loads and is therefore the critical condition for that station. The following flow conditions result in larger bacteria loads,

Table 11. Percent Reduction Necessary to Achieve Target Load by Hydrologic Category

WQM Station	Waterbody	Moist Conditions	Mid-Range Flow	Dry Conditions
RS-11027	Douglas Swamp	51	NRN	NRN
RS-05557	Horse Branch	5	78	NM
RS-12091	Pudding Swamp	NRN	71	NRN
PD-203	Pudding Swamp	NRN	39	11

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

and are therefore the critical conditions, for the other three (3) WQM stations in the PST Watershed: **a)** moist conditions for RS-11027; **b)** mid-range flow conditions for RS-11027; and, **c)** mid-range flow conditions for RS-05557.

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 four (4) WQM stations in the PST 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 PST Watershed. The facility is Sumter County, SC's WWTF, which is discharging in Reach 3 of the watershed (Figure 5) (see Section 3.1.1 of this TMDL development document). The County is permitted under the SCDHEC's NPDES Permit No. SCG570018 to discharge *E. coli* bacteria from its WWTF to Pudding Swamp. 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 12. The WLA for the WWTF is 528.4 million counts per day (5.28E+08 MPN/day) based on a permitted average design flow of 0.04 MGD.

Table 12. Average Permitted Flow and *E. coli* Bacteria WLA for the NPDES Wastewater Discharge in the Pudding Swamp and Tributaries Watershed

Impaired Station Watershed	Permitted Facility	Permit Number	Permitted Flow (MGD)	WLA *E. coli* (MPN/day)
RS-12091	Sumter County, SC's WWTF	SCG570018	0.04	5.28E+08

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. However, at the time of the development of these TMDLS, there were no urbanized areas in the PST 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 PST 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 13 presents the reduction needed for each impaired segment in the PST 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 13. Percent Reduction Necessary to Achieve Target Load

WQM Station	Waterbody	% Reduction
RS-11027	Douglas Swamp	51
RS-05557	Horse Branch	78
RS-12091	Pudding Swamp	71
PD-203	Pudding Swamp	39

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 14. There may be other unregulated MS4s located in the PST Watershed that are subject to the LA

Table 14. Total Maximum Daily Loads for the Pudding Swamp and Tributaries Watershed (Loads are expressed as FC bacteria or *E. coli* bacteria count/day)

Station	Existing FC Load (count/day)	TMDL (count/day)		Margin of Safety (MOS) (count/day)		Waste Load Allocation (WLA)				Load Allocation (LA)		
						Continuous Source[1] (count/day)		Non-Continuous Sources[2,3] (% Reduction)	Non-Continuous SCDOT[3] (% Reduction)	Load Allocation (count/day)		% Reduction to Meet LA[3]
	FC (CFU/day)	FC (CFU/day)	*E. coli* (MPN/day)[6]	FC (CFU/day)	*E. coli* (MPN/day)[6]	FC (CFU/day)	*E. coli* (MPN/day)[6]	(Percent)	(Percent)	FC (CFU/day)	*E. coli* (MPN/day)[6]	(Percent)
RS-11027	3.86E+11	1.99E+11	*1.74E+11*	9.95E+09	*8.68E+09*	See Note Below	See Note Below	51	0[4]	1.89E+11	*1.65E+11*	51
RS-05557	3.34E+11	7.84E+10	*6.84E+10*	3.92E+09	*3.42E+09*	See Note Below	See Note Below	78	78[5]	7.45E+10	*6.50E+10*	78
RS-12091	3.78E+11	1.15E+11	*1.00E+11*	5.73E+09	*5.00E+09*	6.06E+08	*5.28E+08*	71	71[5]	1.09E+11	*9.50E+10*	71
PD-203	1.95E+11	1.25E+11	*1.09E+11*	6.25E+09	*5.45E+09*	See Note Below	See Note Below	39	0[4]	1.19E+11	*1.04E+11*	39

Table Notes:

1. 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.
2. 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.
3. Percent reduction applies to existing instream FC bacteria or *E. coli.*
4. As long as the conditions within the SCDOT MS4 area remain the same the Department deems the current contributions from SCDOT negligible and no reduction of FC bacteria or *E. coli* is necessary. SCDOT must continue to comply with the provisions of its approved NPDES stormwater permit.
5. 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.
6. 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.

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 12-year and 14-year hydrological and water quality sampling data sets.

5.6 Margin of Safety

The MOS may be explicit and/or implicit. The explicit MOS in the PST 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 PST 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 PST Watershed TMDLs is 95% of the assimilative capacity (or, 95% of the TMDL) of the waterbody. The Target Load values for the PST 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 PST 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 14 indicates the percentage reduction or WQS required for each watershed (or reach) in the PST 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 PST 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 PST 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 silvicultural 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 the PST 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 Pudding Swamp and its 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 PST 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 PST 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 Pudding Swamp and its 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 PST Watershed. Local sources of nonpoint source education and assistance include the Natural Resource Conservation Service (NRCS), the Clarendon, Florence, Lee, Sumter, and Williamsburg 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 PST 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.

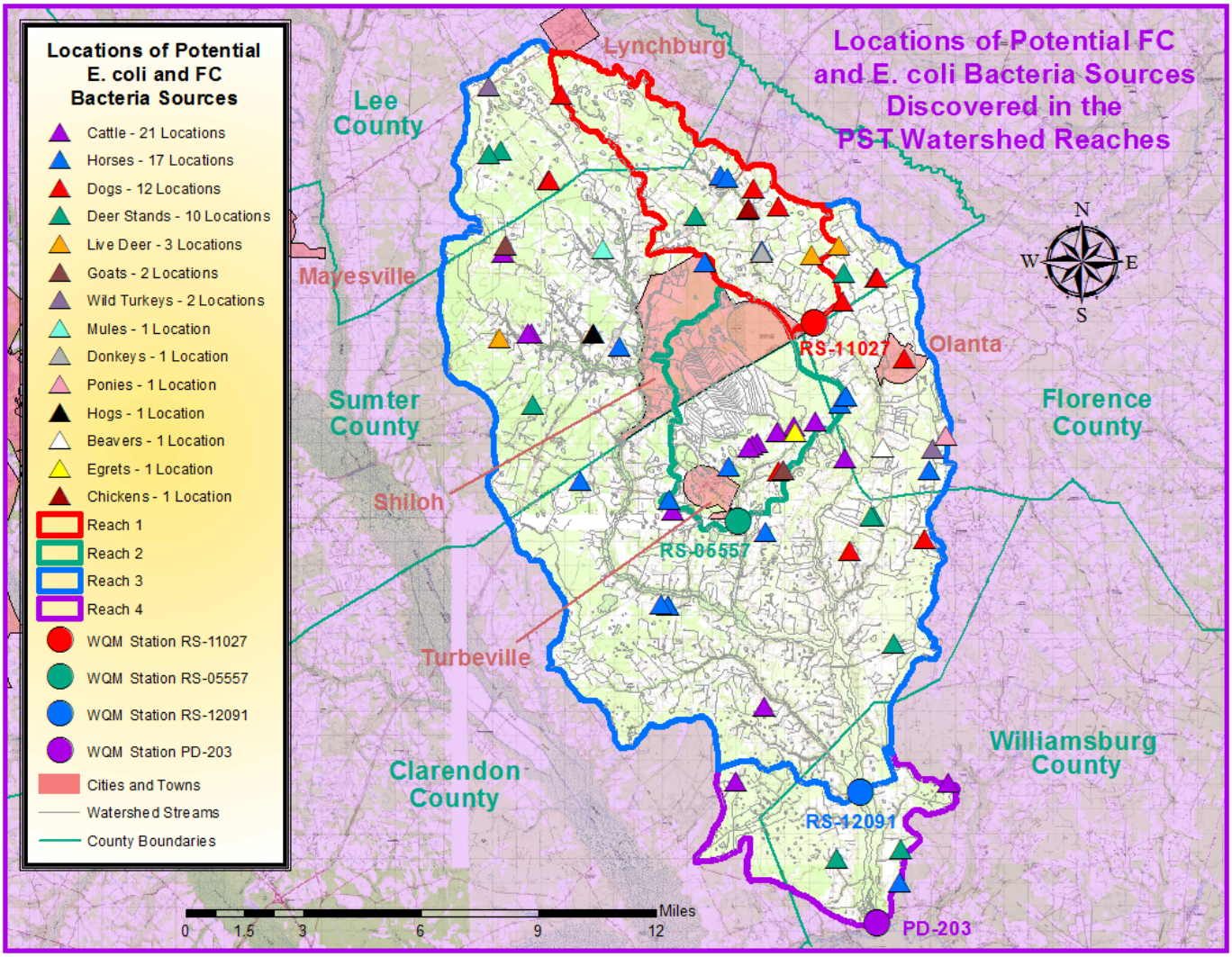
6.1.3 Wildlife

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 PST Watershed is 60.56 percent forest or otherwise vegetated (non-cultivated). On June 8th, 15th, and 22nd in 2018, the SCDHEC conducted site visits in the PST Watershed to assess pollutant sources potentially contributing to water quality impairment in the watershed. Potential pollutant sources found in the watershed during the June 2018 site visits are identified in Figure 9 and Tables Ap-1 through Ap-4 in Appendix E[1]. During the potential pollutant source assessment visits, the department found wild game and/or wildlife, or evidence of such in the PST Watershed. The Department found wild turkeys in Reach 3 of the watershed (Figures F-1 and F2 in Appendix F). The Department also found evidence of beaver in a beaver trap sign in Reach 3 of the watershed (Figure F-3).

According to the SCDNR 2013 deer population density map and GIS information, the estimated population of deer in Clarendon, Florence, Lee, Sumter, and Williamsburg Counties in the areas of the PST Watershed is more than forty-five (45) deer per square mile (see Section 3.2.1 and Figure 7 in this TMDL development document) (SCDNR 2015). During the June 2018 potential pollutant source assessment visits in the PST Watershed, the SCDHEC actually found live deer in Reaches 1 and 3 of the watershed (e.g., Figures F-4 and F-5). Evidence of their presence in the form of deer stands were found in Reaches 1, 3, and 4 of the watershed (e.g., Figures F-6, F-7, and F-8).

[1] Figure 9 and the tables in Appendix E depict only the locations of those potential sources discovered during the SCDHEC's June 2018 site visits, and are not to imply the totality of locations of such sources.

Figure 9. Locations of Potential E. coli and FC Bacteria Sources in the PST Watershed (Depicts only sources discovered during the SCDHEC's June 2018 watershed survey)



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. During the SCDHEC's potential pollutant source assessment visits in June 2016, the department found an egret in a field near a stream in Reach 2 of the PST Watershed (Figure F-9) 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).

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 June 2018 potential pollutant source assessment visits in the PST Watershed, the SCDHEC found cattle pastures in Reaches 2, 3, and 4 of the PST Watershed (e.g., Figures F-10, F-11, F-12, and F-13).

During the potential pollutant source assessment visits in June 2018, the SCDHEC also found hobby farms within the PST Watershed. Horses were found in all four (4) reaches of the watershed (e.g., Figures F-14, F-15, F-16, and F-17). A mule was found in Reach 3 (Figure F-18); a donkey was found in Reach 1 (Figure F-19); and, a pony was found in Reach 3 (Figure F-20) of the watershed. Goats were found in Reaches 2 and 3 of the watershed (Figures F-21 and F-22). Hogs were found in Reach 3 of the watershed (Figure F-23). And, chickens were found in Reach 1 of the watershed (Figures F-24).

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 PST 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 PST 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 June 2018, dogs were found in Reaches 1, 2, and 3 of the PST Watershed (e.g., Figures F-25, F-26, F-27, and F-28).

Although the PST 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
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- USEPA's Stormwater website: https://www.epa.gov/npdes/npdes-stormwater-program

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- 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

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7.4 Wildlife

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7.6 Field Application of Manure

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- 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

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- 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
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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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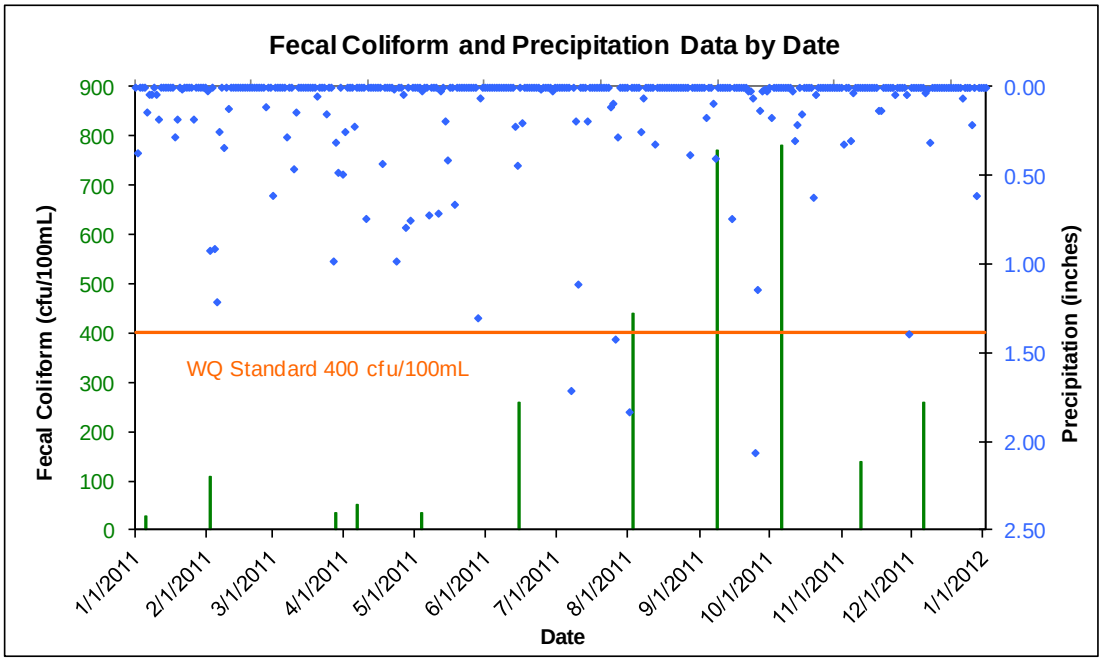
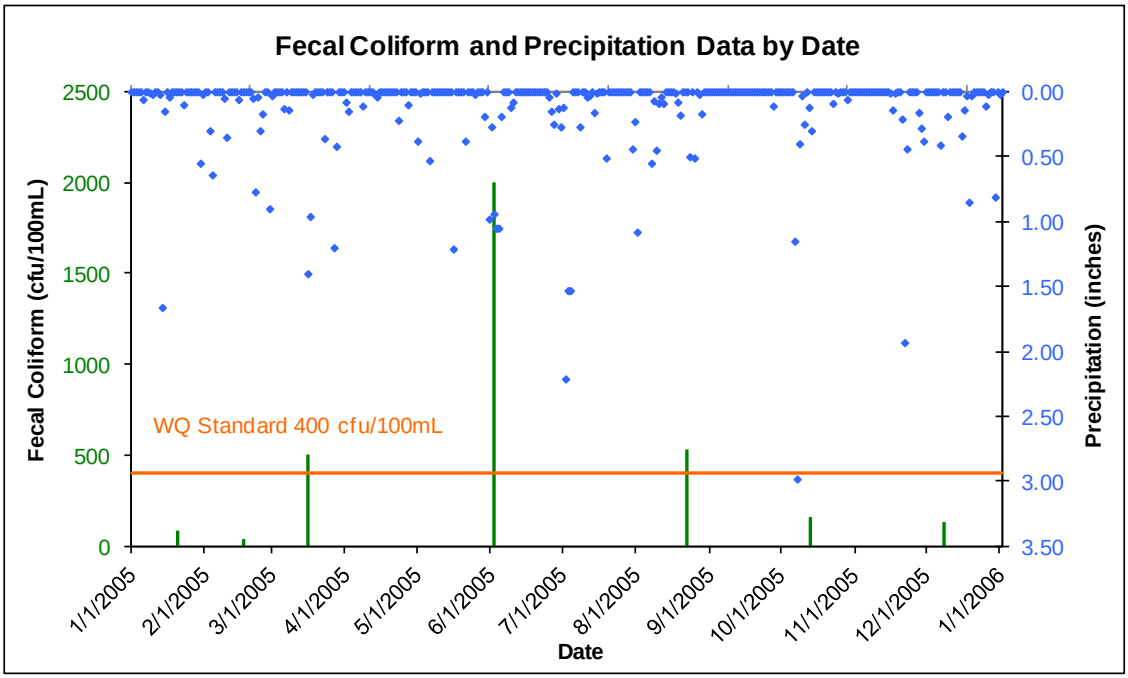
APPENDIX A
ADDITIONAL RAIN CHARTS BY STATION

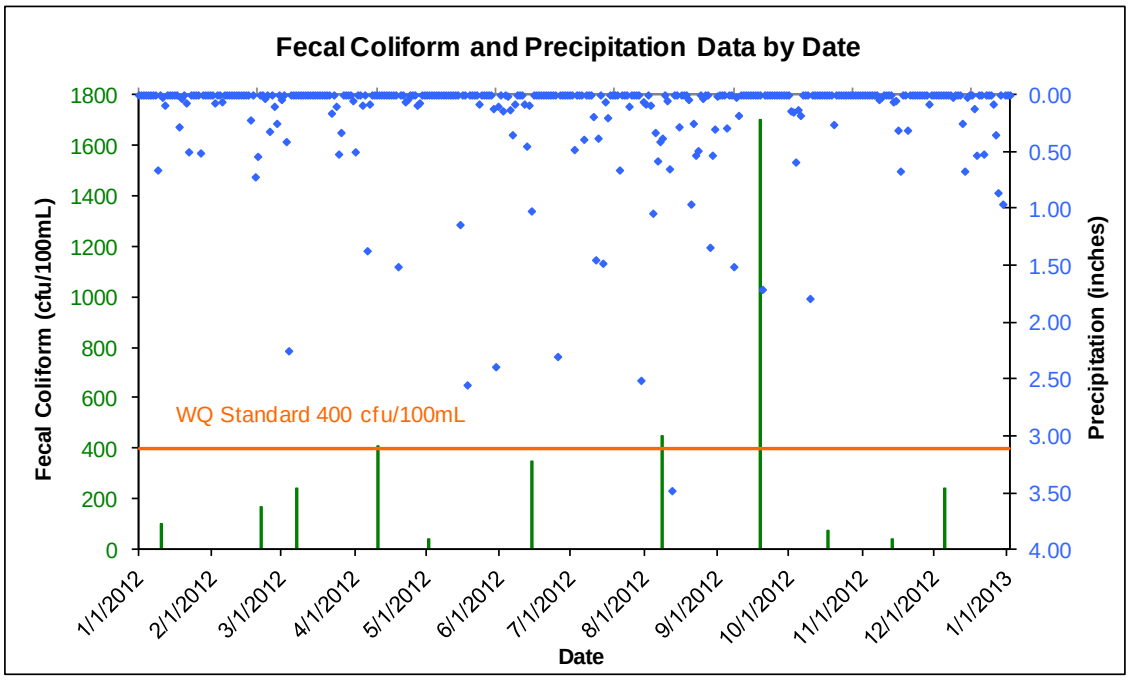
Precipitation and FC Data by Date for Monitoring Station RS-11027



Precipitation and FC Data by Date for Monitoring Station RS-05557

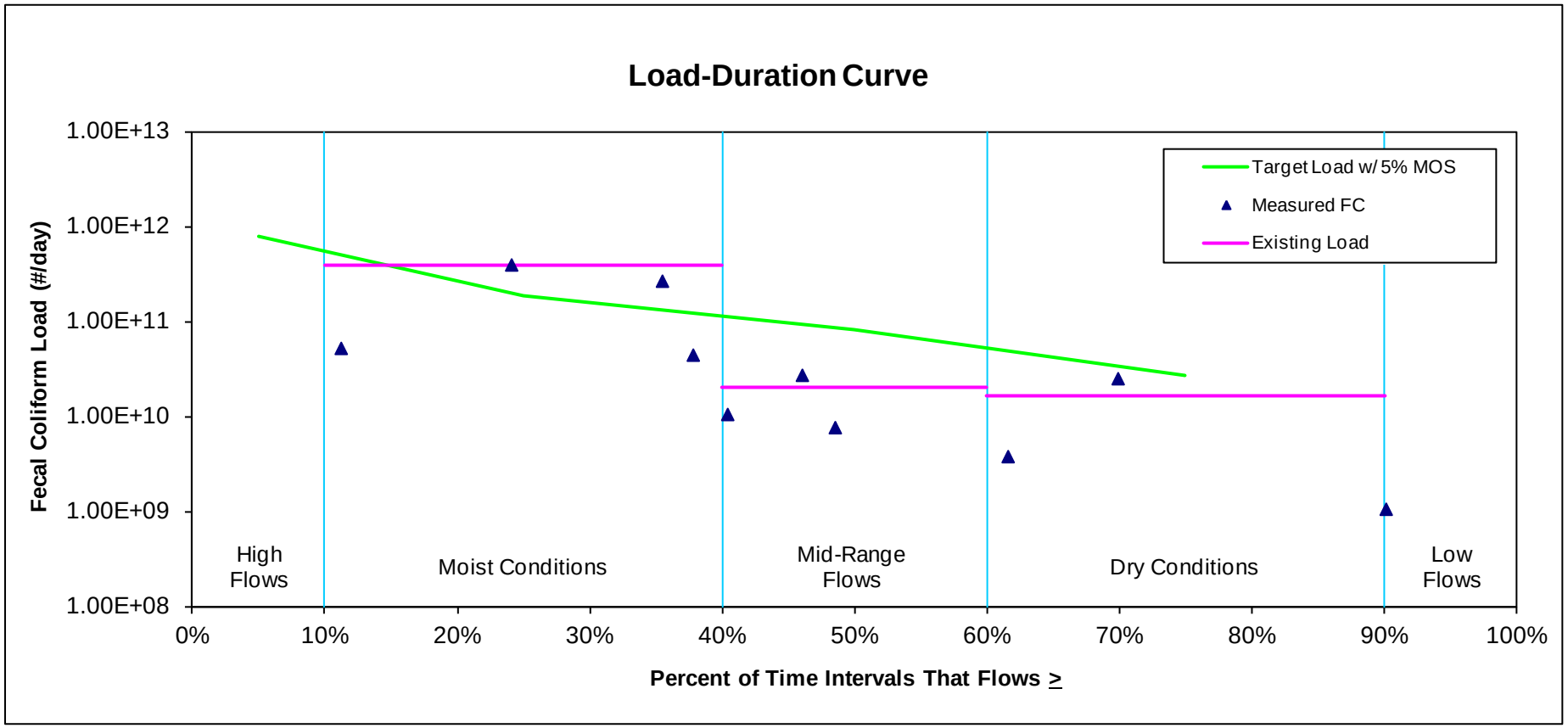


Precipitation and FC Data by Date for Monitoring Station RS-12091

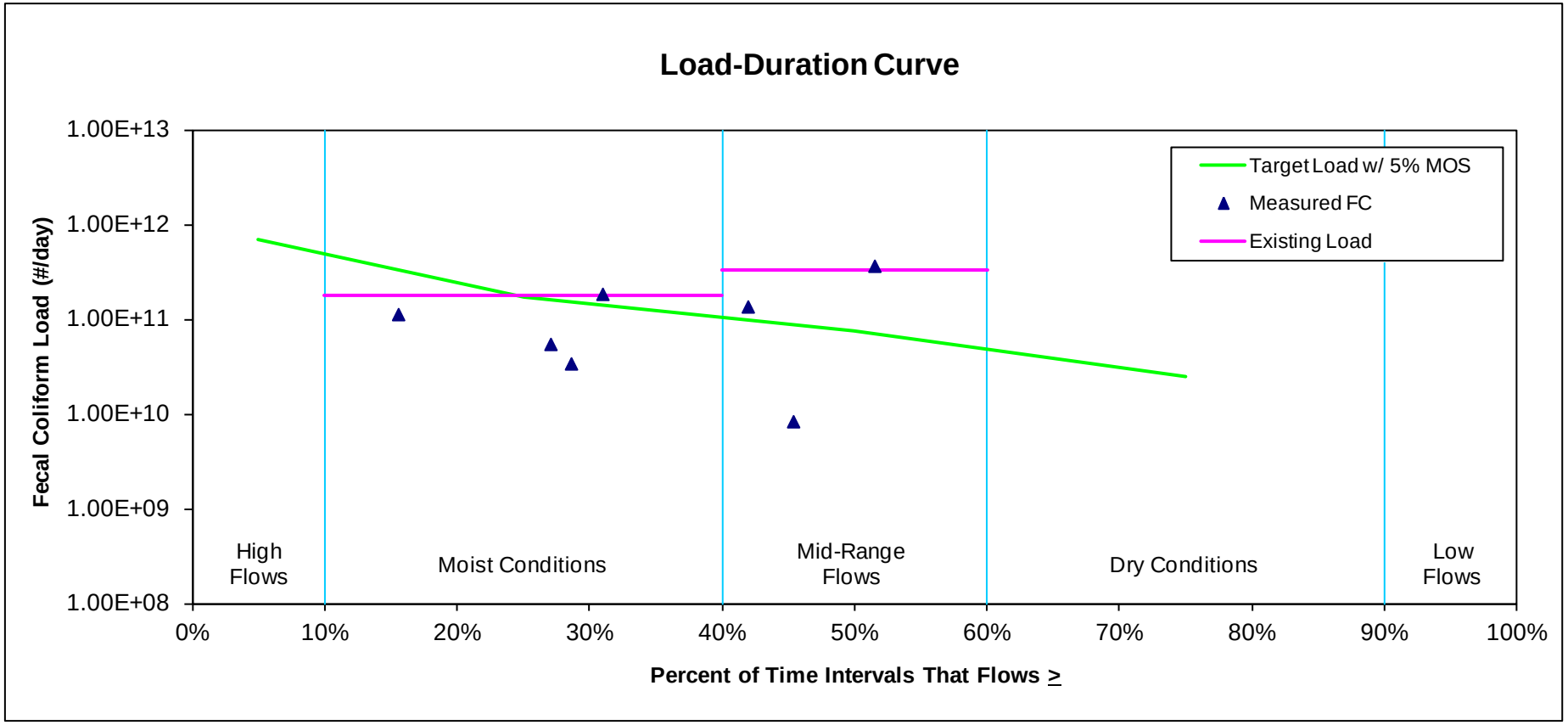


APPENDIX B
ADDITIONAL LOAD-DURATION CURVES BY STATION

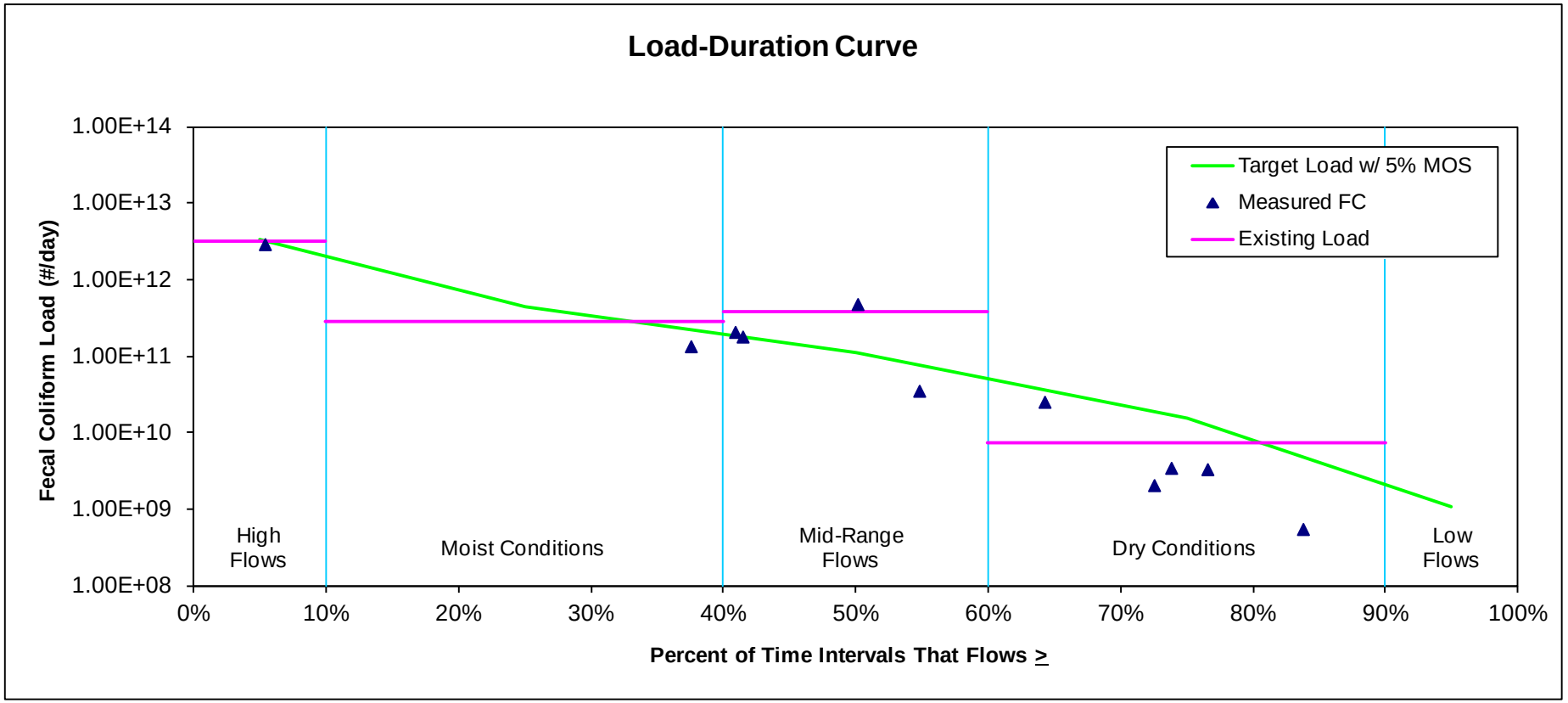
Load Duration Curve for Reach 1 of the Pudding Swamp and Tributaries Watershed, WQM Station RS-11027



Load Duration Curve for Reach 2 of the Pudding Swamp and Tributaries Watershed, WQM Station RS-05557



Load Duration Curve for Reach 3 of the Pudding Swamp and Tributaries Watershed, WQM Station RS-12091



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 RS-11027 by Date

Date	FC (cfu/100 mL)
1/5/2011	27
2/2/2011	110
3/28/2011	36
4/6/2011	51

Date	FC (cfu/100 mL)
5/4/2011	34
6/15/2011	260
8/3/2011	**440**
9/8/2011	**770**

Date	FC (cfu/100 mL)
10/6/2011	**780**
11/9/2011	140
12/6/2011	260

____ **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-11027	NS	777	95	237	422	11

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-11027	82.63	20.32	8.75	2.85	0.00

Existing Load (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
RS-11027	NM	3.86E+11	2.04E+10	1.65E+10	0.00E+00

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-11027	7.68E+11	1.89E+11	8.13E+10	2.65E+10	0.00E+00

Load Reduction Necessary (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
RS-11027	N/A	1.97E+11	NRN	NRN	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)
RS-11027	N/A	51	NRN	NRN	N/A

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

Fecal Coliform WQS Exceedence Summary for Impaired Station RS-05557 by Date

Date	FC (cfu/100 mL)
1/20/2005	86
2/17/2005	36
3/16/2005	**500**
6/2/2005	**2000**
8/22/2005	**530**
10/13/2005	160
12/8/2005	130

____ **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-05557	NS	398	1706	NS	NS	7

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-05557	75.66	18.61	18.01	2.61	0.00

Existing Load (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
RS-05557	NM	1.81E+11	3.34E+111	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-05557	7.03E+11	1.73E+11	7.45E+10	2.43E+10	0.00E+00

Load Reduction Necessary (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
RS-05557	N/A	8.20E+09	2.60E+11	NM	N/A

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-05557	N/A	5	78	NM	N/A

NM = Not measured

Fecal Coliform WQS Exceedence Summary for Impaired Station RS-12091 by Date

Date	FC (cfu/100 mL)
1/10/2012	100
2/21/2012	170
3/7/2012	240
4/10/2012	**410**

Date	FC (cfu/100 mL)
5/2/2012	39
6/14/2012	350
8/8/2012	**450**
9/18/2012	**1700**

Date	FC (cfu/100 mL)
10/17/2012	77
11/13/2012	44
12/5/2012	240

____ 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-12091	350	240	1325	184	NS	11

NS = No samples

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)
RS-12091	360.48	47.47	11.65	1.62	0.07

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)
RS-12091	360.52	47.51	11.71	1.65	0.11

Existing Load (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
RS-12091	3.09E+12	2.79E+11	3.78E+11	7.28E+09	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-12091	3.35E+12	4.41E+11	1.08E+11	1.48E+10	4.62E+08

Load Reduction Necessary (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
RS-12091	N/A	NRN	2.70E+11	NRN	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)
RS-12091	N/A	NRN	71	NRN	N/A

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

Fecal Coliform WQS Exceedence Summary for Impaired Station PD-203 by Date

Date	FC (cfu/100 mL)	Date	FC (cfu/100 mL)	Date	FC (cfu/100 mL)
5/12/1999	180	8/10/2000	73	7/30/2001	290
7/27/1999	3	**9/13/2000**	**600**	8/16/2001	240
8/4/1999	32	1/4/2001	120	9/5/2001	70
9/2/1999	7	2/8/2001	120	10/4/2001	120
10/12/1999	0	3/1/2001	96	11/14/2001	120
5/17/2000	6	4/24/2001	0	12/12/2001	46
6/14/2000	260	5/24/2001	24	1/28/2002	150
7/6/2000	180	6/20/2001	190	2/19/2002	390

____ **WQS Exceeded**

Fecal Coliform WQS Exceedence Summary for Impaired Station PD-203 by Date (continued)

Date	FC (cfu/100 mL)
3/5/2002	270
4/15/2002	340
5/8/2002	120
6/3/2002	34
8/19/2002	24
9/17/2002	120
10/24/2002	100
1/28/2004	120
2/25/2004	38
3/16/2004	44
6/17/2004	**430**
7/14/2004	**1800**
8/18/2004	110
9/15/2004	150
10/12/2004	110
12/9/2004	180
1/13/2005	390
2/22/2005	100
3/28/2005	140
4/28/2005	120
5/26/2005	92
6/20/2005	250
7/28/2005	220

Date	FC (cfu/100 mL)
8/31/2005	240
10/17/2005	150
11/28/2005	160
12/24/2005	64
1/19/2006	100
2/9/2006	77
3/23/2006	64
4/3/2006	54
5/4/2006	180
6/13/2006	**2200**
7/6/2006	200
9/19/2006	190
11/28/2006	98
12/7/2006	94
1/11/2007	92
2/15/2007	58
3/12/2007	64
4/17/2007	**740**
5/17/2007	**580**
6/14/2007	310
7/3/2007	89
8/2/2007	60
11/1/2007	320

Date	FC (cfu/100 mL)
1/26/2009	190
2/18/2009	200
3/5/2009	240
4/21/2009	64
5/19/2009	240
6/9/2009	**420**
7/13/2009	180
11/17/2009	210
1/13/2010	120
3/2/2010	78
7/14/2010	**520**
9/1/2010	240
11/9/2010	220
1/18/2011	82
3/16/2011	100
5/11/2011	**530**
9/13/2011	46
1/10/2012	340
3/7/2012	320
5/2/2012	110
9/18/2012	**600**
11/13/2012	58

___ 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
PD-203	426	290	628	435	260	92

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)
PD-203	393.41	51.80	12.72	1.76	0.08

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)
PD-203	393.45	51.84	12.78	1.80	0.12

Existing Load (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
PD-203	4.10E+12	3.68E+11	1.95E+11	1.88E+10	5.05E+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)
PD-203	3.66E+12	4.82E+11	1.19E+11	1.67E+10	1.11E+09

Load Reduction Necessary (#/day)

Hydro Categ (Mid-Point)	High Flow (5)	Moist Cond. (25)	Mid Range (50)	Dry (75)	Low Flow (95)
PD-203	N/A	NRN	7.66E+10	2.04E+09	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)
PD-203	N/A	NRN	39	11	N/A

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

Appendix E

POTENTIAL POLLUTANT SOURCE IDENTIFICATION

Table Ap-1. Potential FC and *E. coli* Pollutant Sources in Reach 1 of the Pudding Swamp and Tributaries Watershed (WQM Station RS-11027)

Reach Station	Source	Vicinity of Road/Street	County	Location in Watershed	Latitude	Longitude	Date Observed	Source Notes
RS-11027	Chickens	Hewitt Street	Sumter	Central	33.99336	-79.99815	6/8/2018	Chickens in yard near Douglas Swamp
RS-11027	Deer	Rush Street	Sumter	Central	33.99075	-80.02198	6/8/2018	Deer stand in field
RS-11027	Deer	Farm Road	Sumter	Southeast	33.97591	-79.97043	6/15/2018	Two deer in woods
RS-11027	Dogs	McKnight Road	Lee	Northwest	34.03613	-80.08091	6/8/2018	Unattended dog in road
RS-11027	Dogs	Nero Circle	Sumter	Central	34.00072	-79.99584	6/8/2018	Unattended dog in yard near Douglas Swamp
RS-11027	Dogs	SC 53	Sumter	Central	33.99413	-79.98498	6/8/2018	Tethered dog in yard
RS-11027	Dogs	Hewitt Street	Sumter	Central	33.99276	-79.99844	6/8/2018	Unattended dog in road
RS-11027	Dogs	Douglas Swamp Road	Sumter	Southeast	33.98303	-79.99313	6/8/2018	Unattended dog in yard near Douglas Swamp
RS-11027	Donkeys	Douglas Swamp Road	Sumter	Southeast	33.97688	-79.99213	6/8/2018	Donkeys in pasture near Douglas Swamp
RS-11027	Horses	Douglas Swamp Road	Sumter	Central	34.00554	-80.01064	6/8/2018	Horse in pasture near Douglas Swamp
RS-11027	Horses	Douglas Swamp Road	Sumter	Central	34.00473	-80.00750	6/8/2018	Pastured horses near Douglas Swamp
RS-11027	Horses	Douglas Swamp Road	Sumter	Southeast	33.97809	-79.99258	6/8/2018	Pastured horses near Douglas Swamp

Table Ap-2. Potential FC and *E. coli* Pollutant Sources in Reach 2 of the Pudding Swamp and Tributaries Watershed (WQM Station RS-05557)

Reach Station	Source	Vicinity of Road/Street	County	Location in Watershed	Latitude	Longitude	Date Observed	Source Notes
RS-05557	Cattle	US 301	Clarendon	South	33.91443	-79.96944	6/15/2018	Pastured cattle near Horse Branch
RS-05557	Cattle	US 301	Clarendon	South	33.91287	-79.97891	6/15/2018	Pastured cattle near Horse Branch
RS-05557	Cattle	US 301	Clarendon	South	33.91053	-79.98626	6/15/2018	Pastured cattle near Horse Branch
RS-05557	Cattle	US 301	Clarendon	South	33.91054	-79.98626	6/15/2018	Pastured cattle near Horse Branch
RS-05557	Cattle	US 301	Clarendon	South	33.90657	-79.99554	6/15/2018	Pastured cattle near Horse Branch
RS-05557	Cattle	US 301	Clarendon	South	33.90573	-79.99754	6/15/2018	Pastured cattle near Horse Branch
RS-05557	Cattle	US 301	Clarendon	South	33.90513	-79.99874	6/15/2018	Pastured cattle near Horse Branch
RS-05557	Cattle	Woods Bay Road	Clarendon	South	33.91038	-79.97842	6/15/2018	Pastured cattle near Horse Branch
RS-05557	Cattle	Watts Road	Clarendon	South	33.88581	-80.03463	6/22/2018	Cattle in pasture with horses
RS-05557	Dogs	Horse Branch Road	Clarendon	South	33.89628	-79.98581	6/15/2018	Unattended dog in yard near Horse Branch
RS-05557	Egrets	Woods Bay Road	Clarendon	South	33.91036	-79.97843	6/15/2018	Egret in field near Horse Branch
RS-05557	Goats	John M Road	Clarendon	South	33.89656	-79.98381	6/15/2018	Goats in a pen near Horse Branch
RS-05557	Horses	US 301	Florence	North	33.92094	-79.95844	6/15/2018	Horses in a pen
RS-05557	Horses	US 301	Clarendon	South	33.89817	-80.00786	6/15/2018	Horses in pen near Horse Branch
RS-05557	Horses	Watts Road	Clarendon	South	33.88581	-80.03463	6/22/2018	Horses in pasture with cattle

Table Ap-3. Potential FC and *E. coli* Pollutant Sources in Reach 3 of the Pudding Swamp and Tributaries Watershed (WQM Station RS-12091)

Reach Station	Source	Vicinity of Road/Street	County	Location in Watershed	Latitude	Longitude	Date Observed	Source Notes
RS-12091	Beaver	Park Avenue	Florence	Central	33.90447	-79.93953	6/15/2018	Beaver trap sign at pond near Douglas Swamp
RS-12091	Cattle	Jip McDowell Road	Florence	Northeast	33.92359	-79.95543	6/15/2018	Cattle in pasture with horses
RS-12091	Cattle	Central Road	Florence	Northeast	33.90865	-79.91153	6/15/2018	Pastured cattle near Burnt Branch
RS-12091	Cattle	Atkins Avenue	Lee	Northwest	34.00434	-80.08685	6/8/2018	Pastured cattle
RS-12091	Cattle	Old C C Road	Sumter	Northwest	33.97807	-80.10713	6/8/2018	Pastured cattle near Threemile Branch
RS-12091	Cattle	Mt. Sinai Church Road	Sumter	Northwest	33.94778	-80.09479	6/8/2018	Pastured cattle near Hope Swamp
RS-12091	Cattle	Mt. Sinai Church Road	Sumter	Northwest	33.94791	-80.09633	6/8/2018	Pastured cattle near Hope Swamp
RS-12091	Cattle	SC S-14-621	Clarendon	Central	33.90062	-79.95621	6/15/2018	Pastured cattle near Douglas Swamp
RS-12091	Cattle	Watts Road	Clarendon	Central	33.88214	-80.03274	6/22/2018	Pastured cattle
RS-12091	Cattle	Newmans Branch Road	Clarendon	South	33.80918	-79.99343	6/22/2018	Pastured cattle near Newman Branch
RS-12091	Cattle	Salem Road	Clarendon	South	33.84684	-80.03551	6/22/2018	Cow in pasture with horses near Pudding Swamp
RS-12091	Deer	Farm Road	Sumter	Northeast	33.96908	-79.95579	6/15/2018	Deer stand in woods near Bushy Branch
RS-12091	Deer	SC 341	Sumter	Northeast	33.97936	-79.95794	6/15/2018	Deer in woods near Cypress Branch
RS-12091	Deer	McKnight Road	Lee	Northwest	34.01587	-80.10806	6/8/2018	Deer stand in field
RS-12091	Deer	McKnight Road	Lee	Northwest	34.01425	-80.11349	6/8/2018	Deer stand in woods
RS-12091	Deer	Mt. Sinai Church Road	Sumter	Northwest	33.94624	-80.10911	6/8/2018	Two deer in woods near Hope Swamp
RS-12091	Deer	Oak Grove Road	Clarendon	Central	33.87888	-79.94394	6/15/2018	Deer stand beside road
RS-12091	Deer	Oak Grove Road	Clarendon	Central	33.87900	-79.94484	6/15/2018	Deer stand beside road
RS-12091	Deer	Fullard Street	Sumter	Central	33.92145	-80.09488	6/8/2018	Deer stand in field
RS-12091	Deer	Salem Road	Clarendon	South	33.83194	-79.93553	6/22/2018	Deer stand in field
RS-12091	Dogs	Liberty Street	Florence	Northeast	33.93756	-79.92928	6/15/2018	Unattended dog in yard in Olanta
RS-12091	Dogs	Norwood Road	Sumter	Northeast	33.95847	-79.95694	6/15/2018	Unattended dog in yard near Bushy Branch
RS-12091	Dogs	Norwood Road	Sumter	Northeast	33.96738	-79.94126	6/15/2018	Unattended dog in yard near Cypress Branch
RS-12091	Dogs	Atkins Avenue	Lee	Northwest	34.00440	-80.08672	6/8/2018	Unattended dogs in yard
RS-12091	Dogs	Burnt Branch Road	Clarendon	Central	33.86630	-79.95492	6/22/2018	Unattended dog in road
RS-12091	Dogs	St James Road	Clarendon	Central	33.87029	-79.92169	6/22/2018	Unattended dog in yard
RS-12091	Goats	Old C C Road	Sumter	Northwest	33.98029	-80.10648	6/8/2018	Goats in a pen near Threemile Branch
RS-12091	Hogs	Mt. Sinai Church Road	Sumter	Northwest	33.94760	-80.06751	6/8/2018	Hogs in pen near Threemile Branch
RS-12091	Horses	US 378	Clarendon	Central	33.89341	-80.07374	6/22/2018	Horses in pen

Table Ap-3 (Continued). Potential FC and *E. coli* Pollutant Sources in Reach 3 of the Pudding Swamp and Tributaries Watershed (WQM Station RS-12091)

Reach Station	Source	Vicinity of Road/Street	County	Location in Watershed	Latitude	Longitude	Date Observed	Source Notes
RS-12091	Horses	Jip McDowell Road	Florence	Northeast	33.92359	-79.95543	6/15/2018	Horses in pasture with cattle
RS-12091	Horses	Norwood Road	Sumter	Northeast	33.96713	-79.94166	6/15/2018	Pastured horses near Cypress Branch
RS-12091	Horses	Mt. Sinai Church Road	Sumter	Northwest	33.94260	-80.05597	6/8/2018	Pastured horses near Pudding Swamp
RS-12091	Horses	Rush Street	Sumter	Northwest	33.97373	-80.01765	6/15/2018	Pastured horses in Shiloh
RS-12091	Horses	Sandhill Road	Clarendon	Central	33.87351	-79.99216	6/22/2018	Horse in pasture near Horse Branch
RS-12091	Horses	Windright Road	Florence	Central	33.89578	-79.91891	6/15/2018	Horses in pen near Burnt Branch
RS-12091	Horses	Salem Road	Clarendon	South	33.84684	-80.03551	6/22/2018	Horses in pasture with a cow near Pudding Swamp
RS-12091	Horses	Salem Road	Clarendon	South	33.84683	-80.03536	6/22/2018	Horse in pasture near Pudding Swamp
RS-12091	Horses	Salem Road	Clarendon	South	33.84727	-80.03879	6/22/2018	Horses in pen near Pudding Swamp
RS-12091	Mules	Trinity Road	Sumter	Northwest	33.97884	-80.06285	6/8/2018	Mule in pasture near Pudding Swamp
RS-12091	Ponies	Central Road	Florence	Northeast	33.90873	-79.91146	6/15/2018	Shetland pony in pasture with cattle near Burnt Branch
RS-12091	Turkeys	US 76	Lee	Northwest	34.03924	-80.11292	6/8/2018	Wild turkeys in woods
RS-12091	Turkeys	Central Road	Florence	Central	33.90402	-79.91755	6/15/2018	Wild turkeys in field near Burnt Branch

Table Ap-4. Potential FC and *E. coli* Pollutant Sources in Reach 4 of the Pudding Swamp and Tributaries Watershed (WQM Station PD-203)

Reach Station	Source	Vicinity of Road/Street	County	Location in Watershed	Latitude	Longitude	Date Observed	Source Notes
PD-203	Cattle	Burgess Crossing Road	Williamsburg	East	33.78048	-79.91223	6/22/2018	Pastured cattle
PD-203	Cattle	Fire Tower Road	Clarendon	West	33.78163	-80.00608	6/22/2018	Pastured cattle
PD-203	Deer	Lynchburg Road	Williamsburg	East	33.75585	-79.93353	6/22/2018	Deer stand at edge of field
PD-203	Deer	McIntosh Road	Williamsburg	East	33.75266	-79.96181	6/22/2018	Deer stand at edge of field
PD-203	Horses	Violet Avenue	Williamsburg	East	33.74356	-79.93431	6/22/2018	Horse in pen near Pudding Swamp

Appendix F

SOURCE ASSESSMENT PICTURES

Figure F-1

Wild turkeys in field near Burnt Branch (location: 33.90402 N, -79.91755 W) on Central Road in Florence County. Found in Reach 3 of the PST Watershed (Date of photography: June 15, 2018).

Figure F-2

Wild turkeys in woods (location: 34.03924 N, -80.11292 W) on US 76 in Lee County. Found in Reach 3 of the PST Watershed (Date of photography: June 8, 2018).

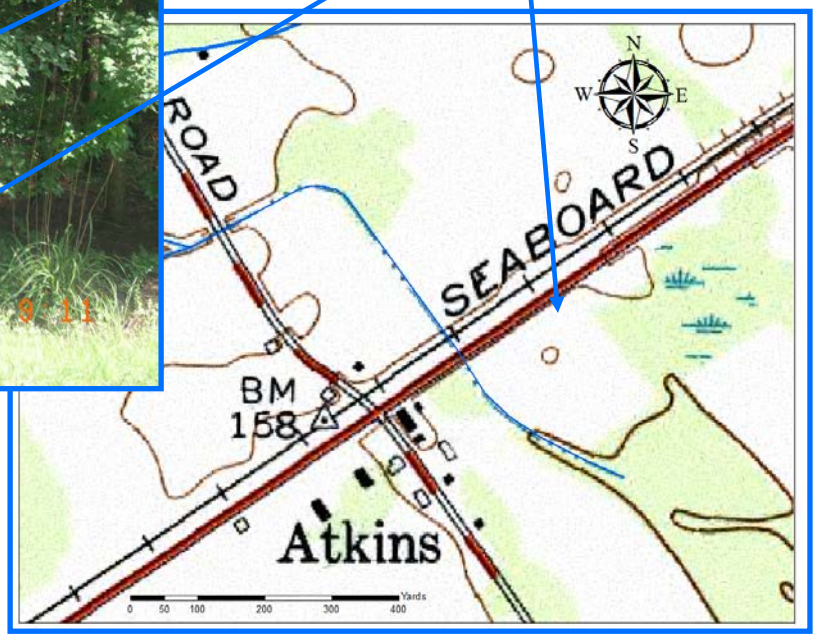


Figure F-3

Beaver trap sign at pond near Douglas Swamp (location: 33.90447 N, -79.93953 W) on Park Avenue in Florence County. Found in Reach 3 of the PST Watershed (Date of photography: June 15, 2018).

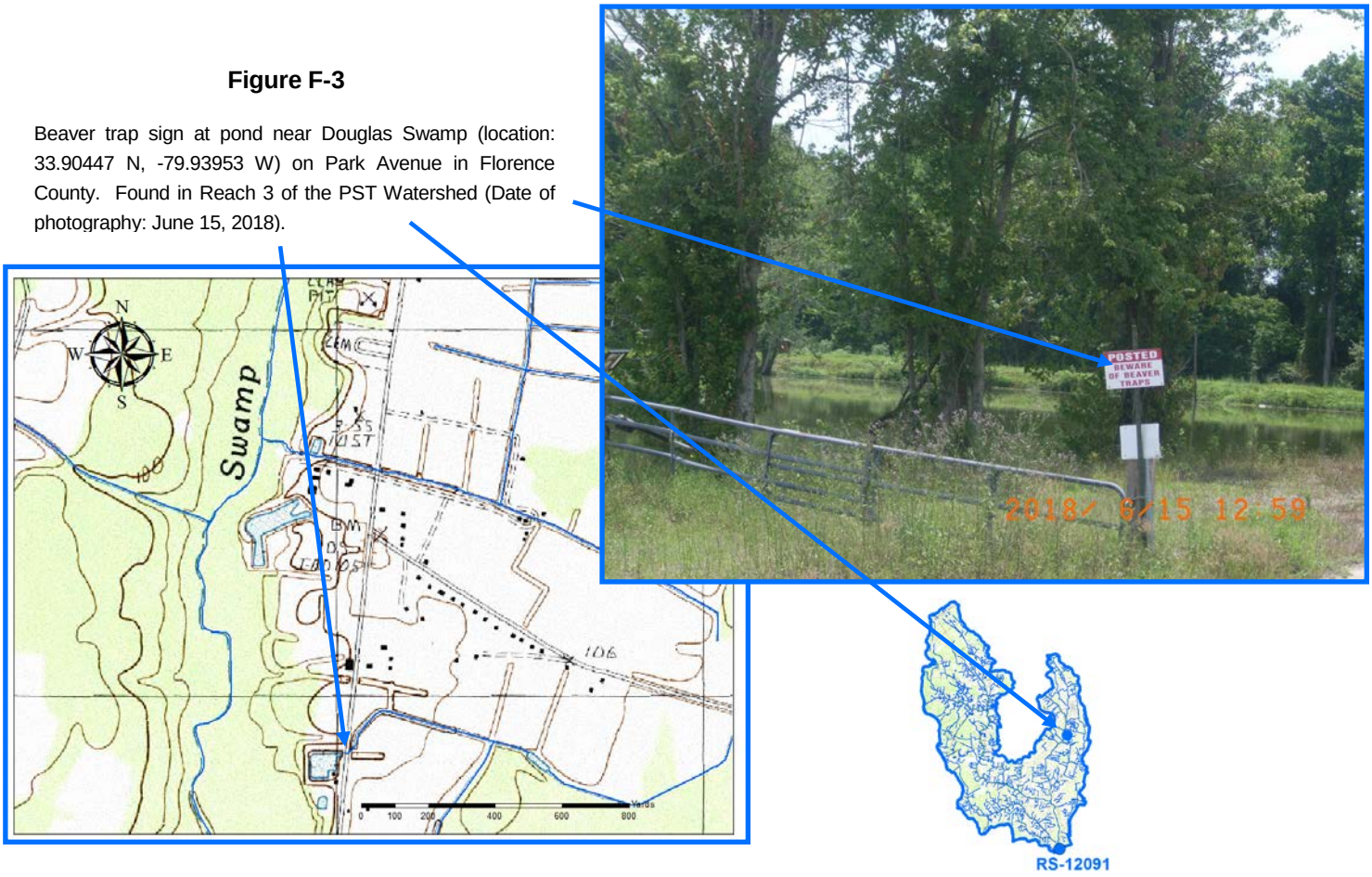


Figure F-4

Two deer in woods (location: 33.97591 N, -79.97043 W) on Farm Road in Sumter County. Found in Reach 1 of the PST Watershed (Date of photography: June 15, 2018).

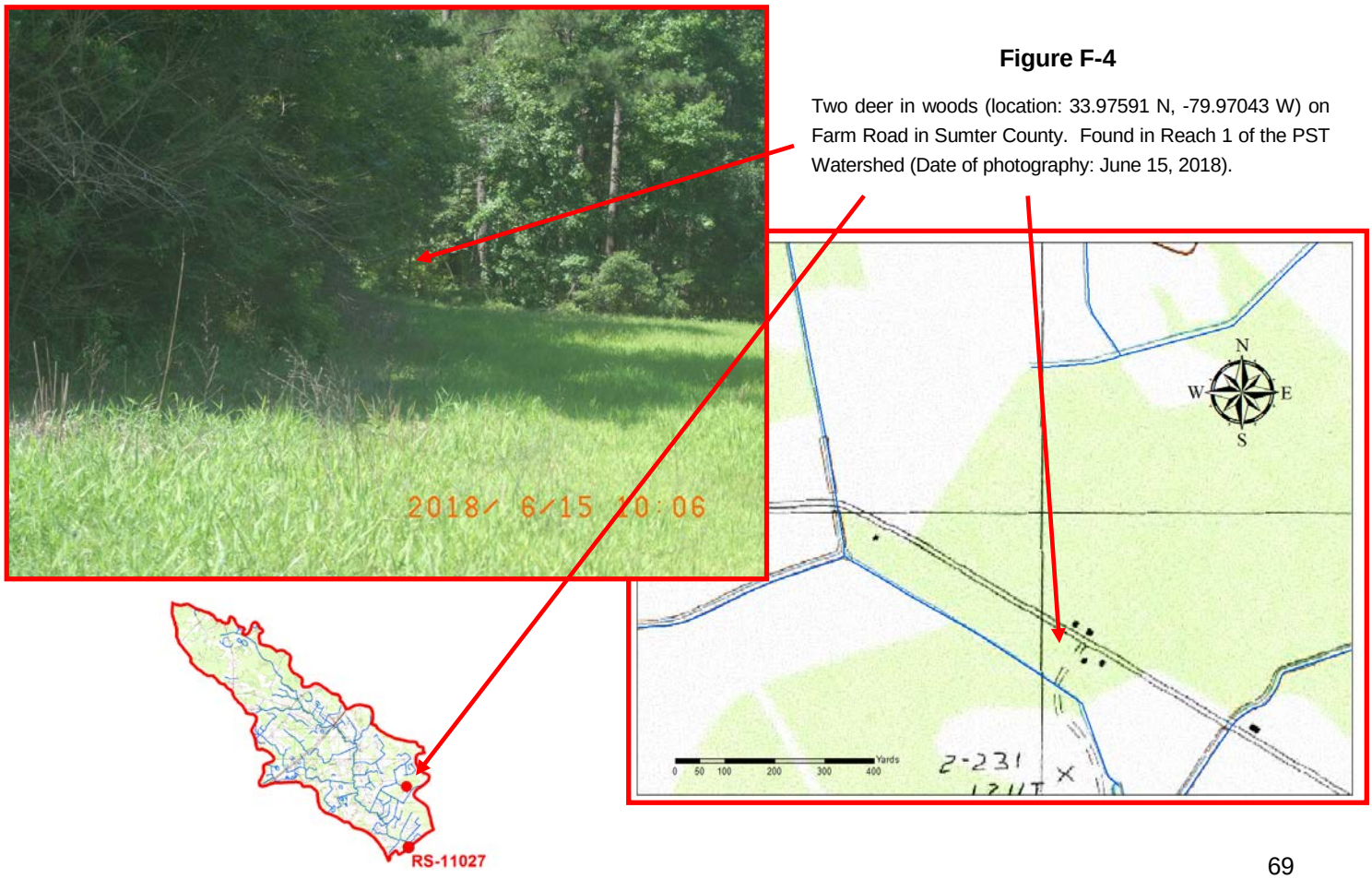


Figure F-5

Deer in woods near Cypress branch (location: 33.97936 N, -79.95794 W) on SC 341 in Sumter County. Found in Reach 3 of the PST Watershed (Date of photography: June 15, 2018).

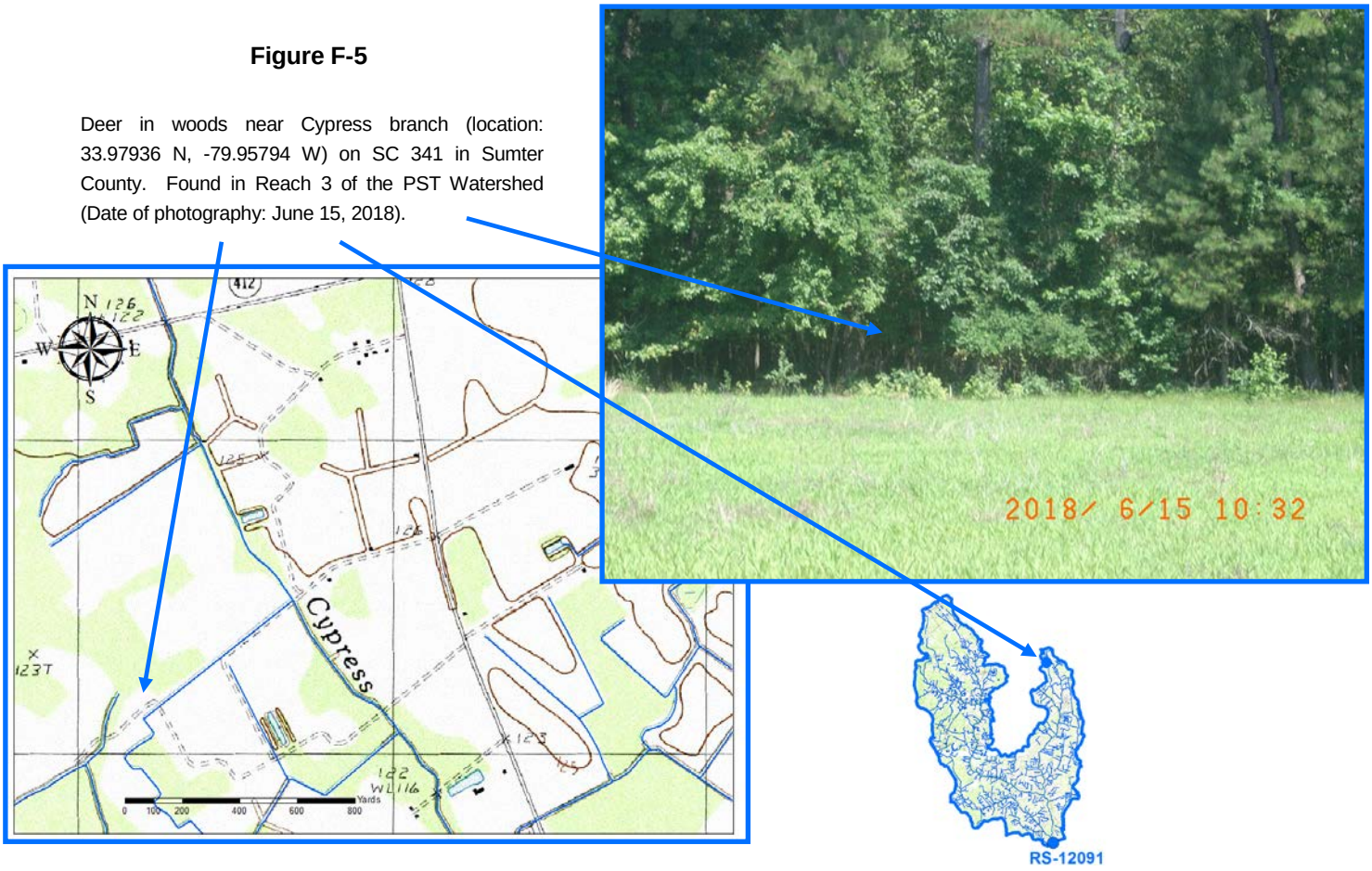


Figure F-6

Deer stand in field (location: 33.99075 N, -80.02198 W) on Rush Street in Sumter County. Found in Reach 1 of the PST Watershed (Date of photography: June 8, 2018).

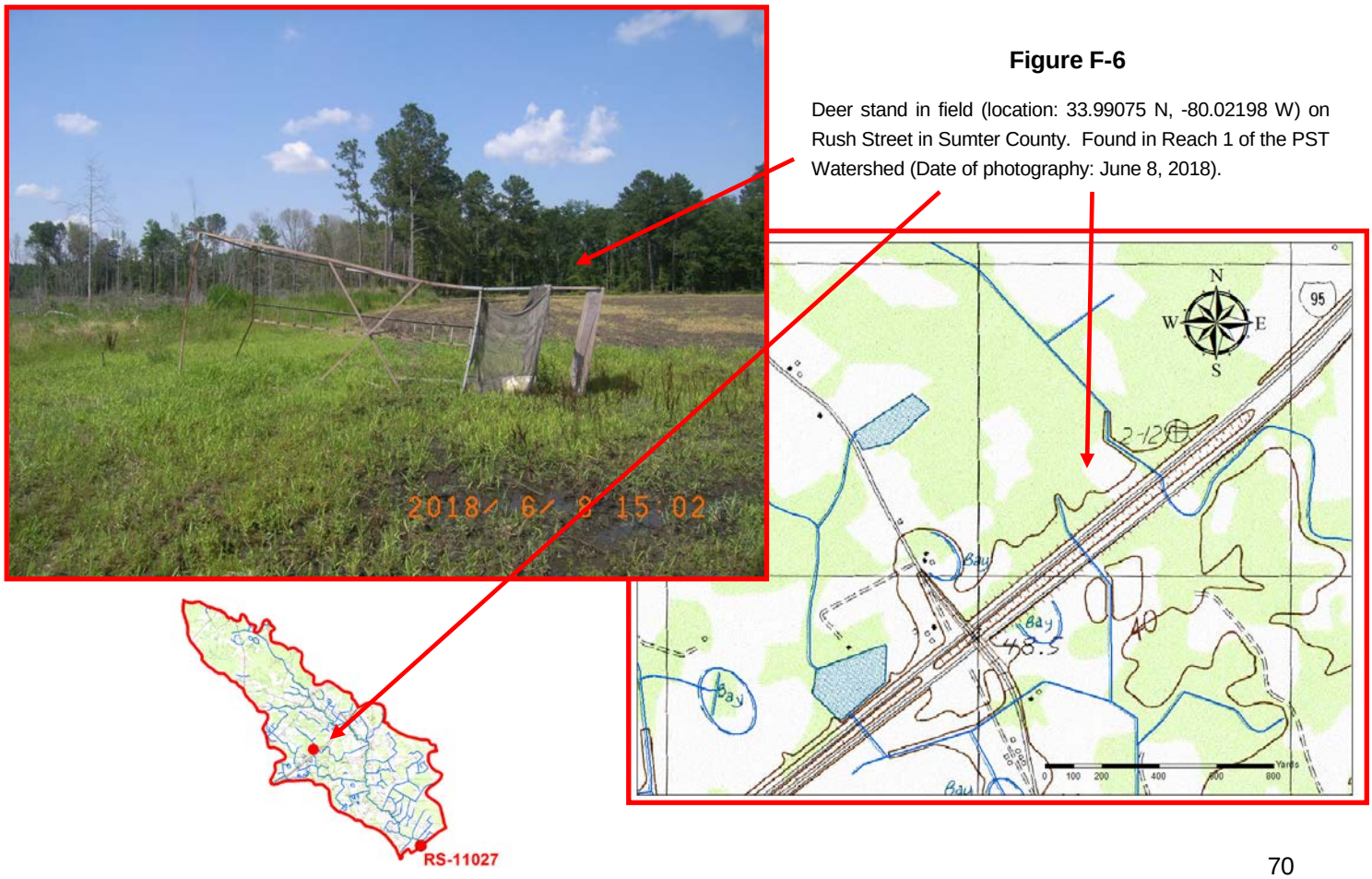


Figure F-7

Deer stand beside road (location: 33.87888 N, -79.94394 W) on Oak Grove Road in Clarendon County. Found in Reach 3 of the PST Watershed (Date of photography: June 15, 2018).

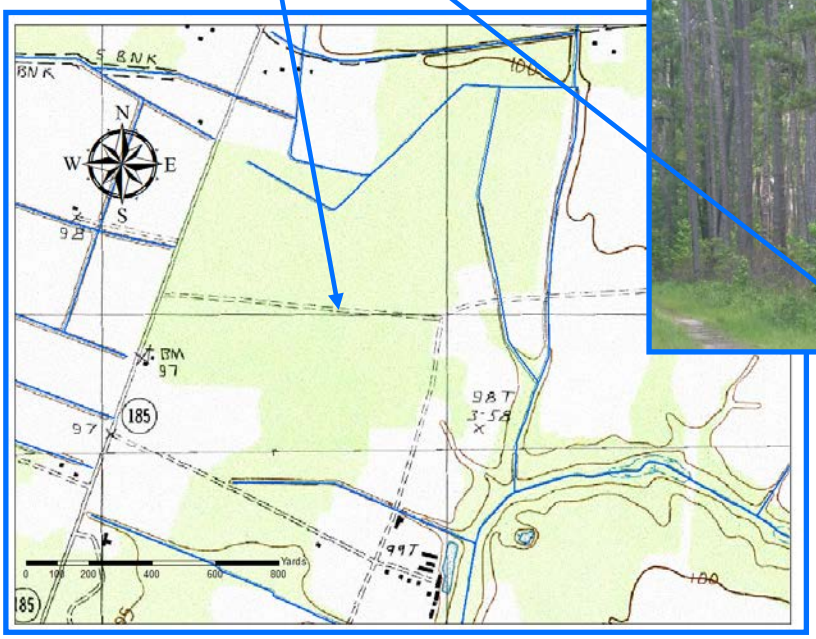


Figure F-8

Deer stand at edge of field (location: 33.75585 N, -79.93353 W) on Lynchburg Road in Williamsburg County. Found in Reach 4 of the PST Watershed (Date of photography: June 22, 2018).

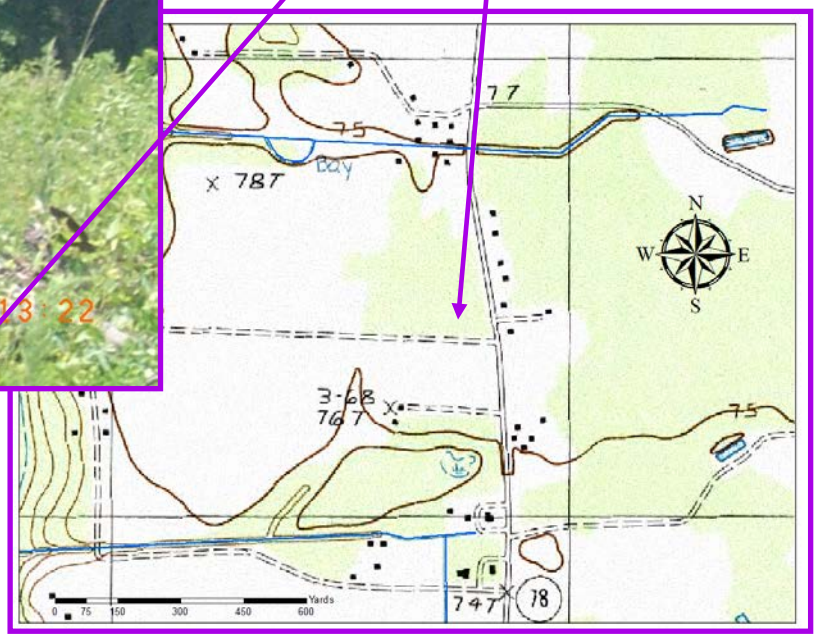
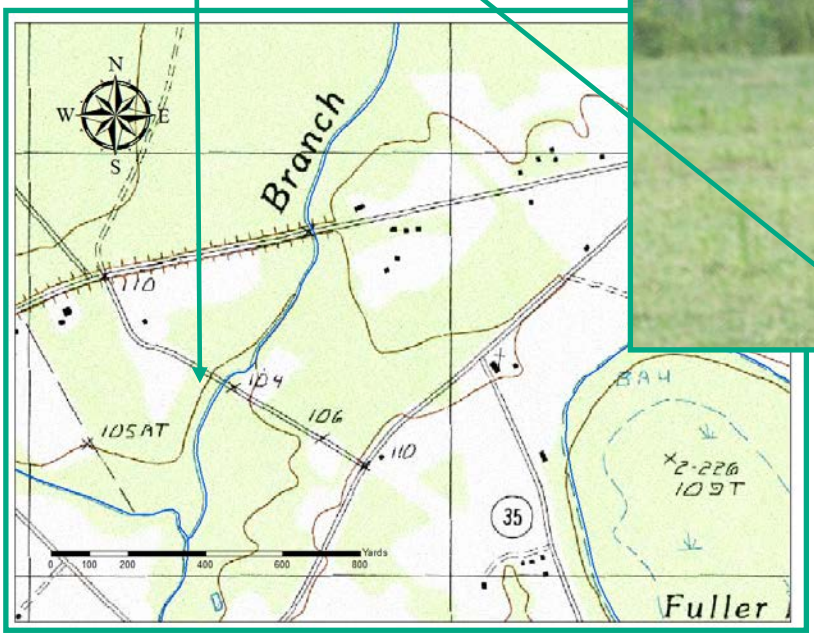


Figure F-9

Egret in field near Horse Branch (location: 33.91036 N, -79.97843 W) on Woods Bay Road in Clarendon County. Found in Reach 2 of the PST Watershed (Date of photography: June 15, 2018).



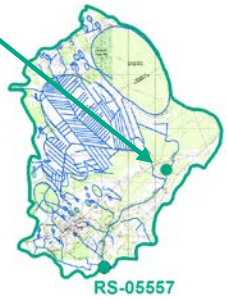


Figure F-10

Pastured cattle near Horse Branch (location: 33.91054 N, -79.98626 W) on US 301 in Clarendon County. Found in Reach 3 of the PST Watershed (Date of photography: June 15, 2018).

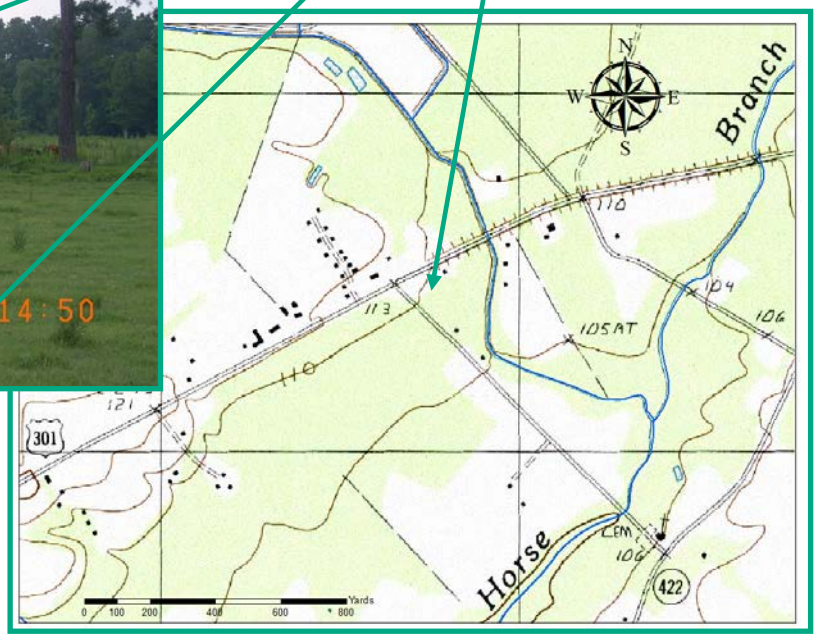


Figure F-11

Pastured cattle near Burnt Branch (location: 33.90865 N, -79.91153 W) on Central Road in Florence County. Found in Reach 3 of the PST Watershed (Date of photography: June 15, 2018).

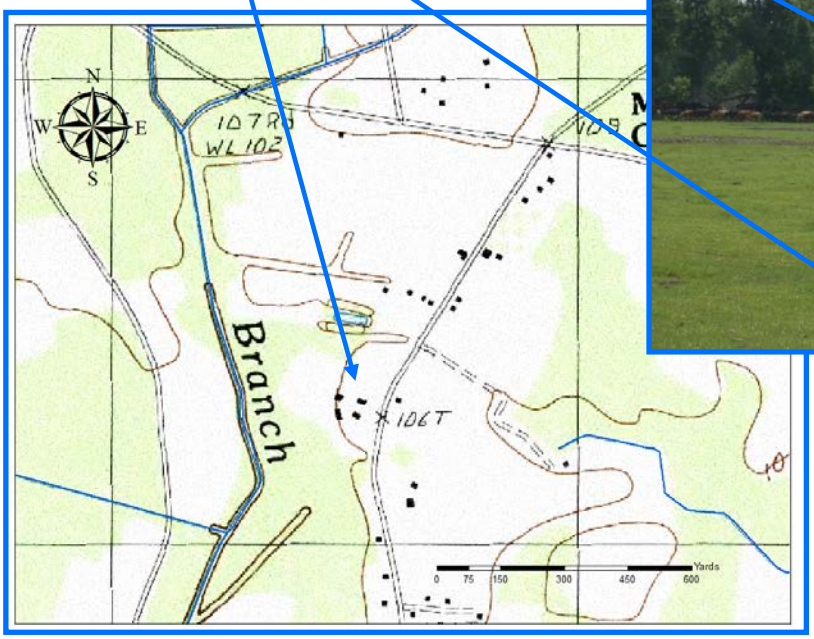


Figure F-12

Pastured cattle near Newman Branch (location: 33.80918 N, -79.99343 W) on Newmans Branch Road in Clarendon County. Found in Reach 3 of the PST Watershed (Date of photography: June 22, 2018).

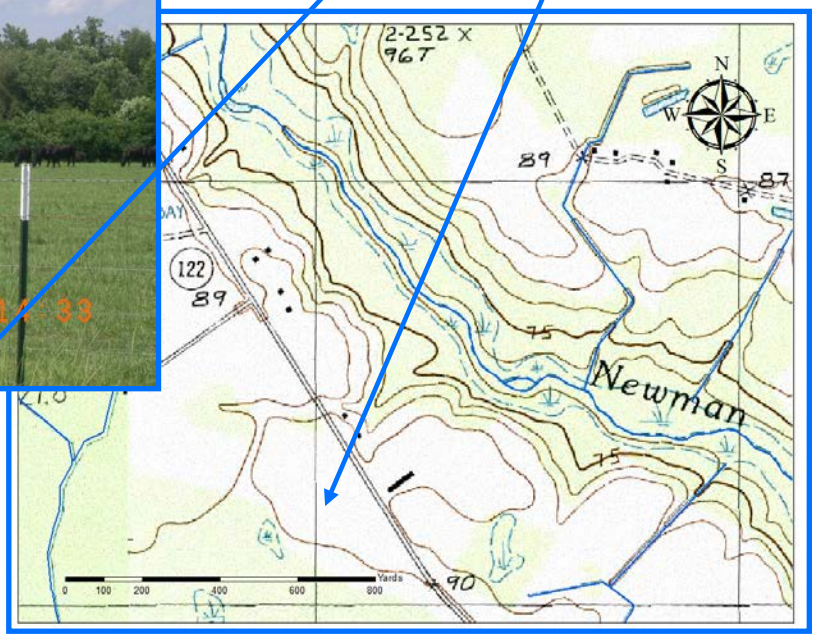


Figure F-13

Pastured cattle (location: 33.78163 N, -80.00608 W) on Fire Tower Road in Clarendon County. Found in Reach 4 of the PST Watershed (Date of photography: June 22, 2018).

Figure F-14

Pastured horses near Douglas Swamp (location: 34.00473 N, -80.00750 W) on Douglas Swamp Road in Sumter County. Found in Reach 1 of the PST Watershed (Date of photography: June 8, 2018).

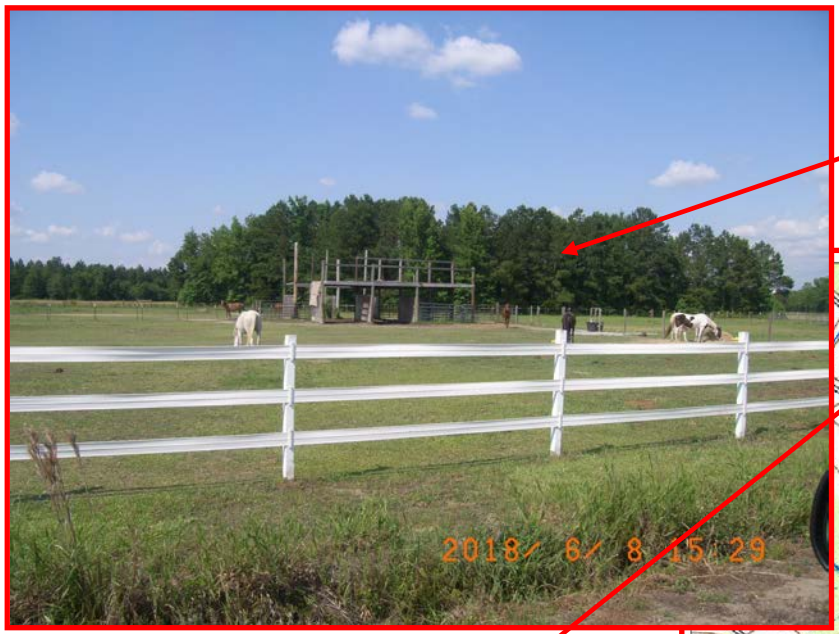


Figure F-15

Horses in pen near Horse Branch (location: 33.89817 N, -80.00786 W) on US 301 in Clarendon County. Found in Reach 2 of the PST Watershed (Date of photography: June 15, 2018).

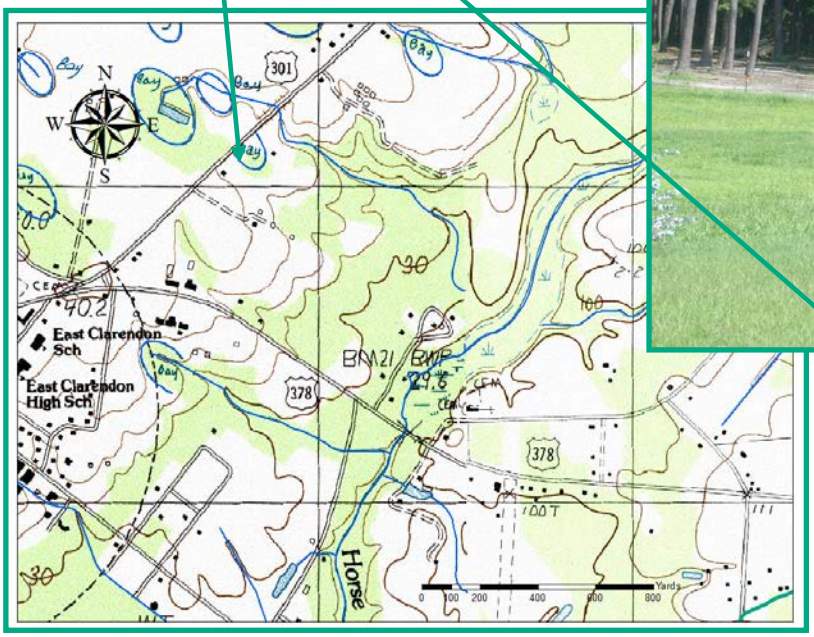


Figure F-16

Pastured horses near Pudding Swamp (location: 33.94260 N, -80.05597 W) on Mt. Sinai Church Road in Sumter County. Found in Reach 3 of the PST Watershed (Date of photography: June 8, 2018).

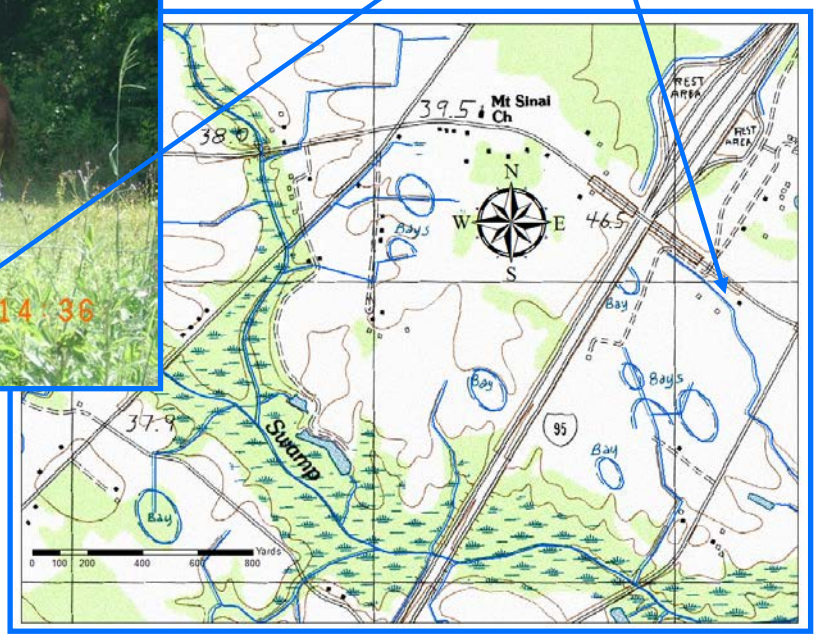


Figure F-17

Horse in pen near Pudding Swamp (location: 33.74356 N, -79.93431 W) on Violet Avenue in Williamsburg County. Found in Reach 4 of the PST Watershed (Date of photography: June 22, 2018).

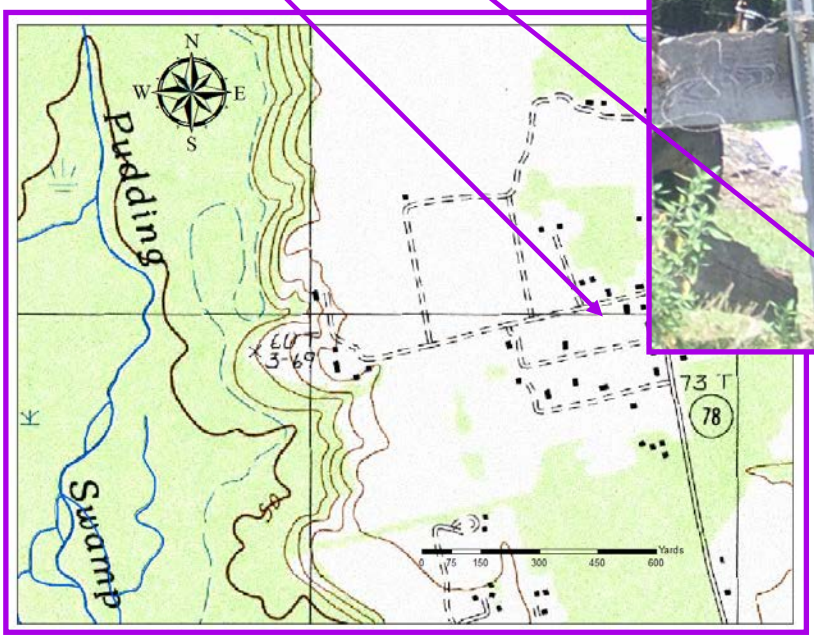


Figure F-18

Mule in pasture near Pudding Swamp (location: 33.97884 N, -80.06285 W) on Trinity Road in Sumter County. Found in Reach 3 of the PST Watershed (Date of photography: June 8, 2018).

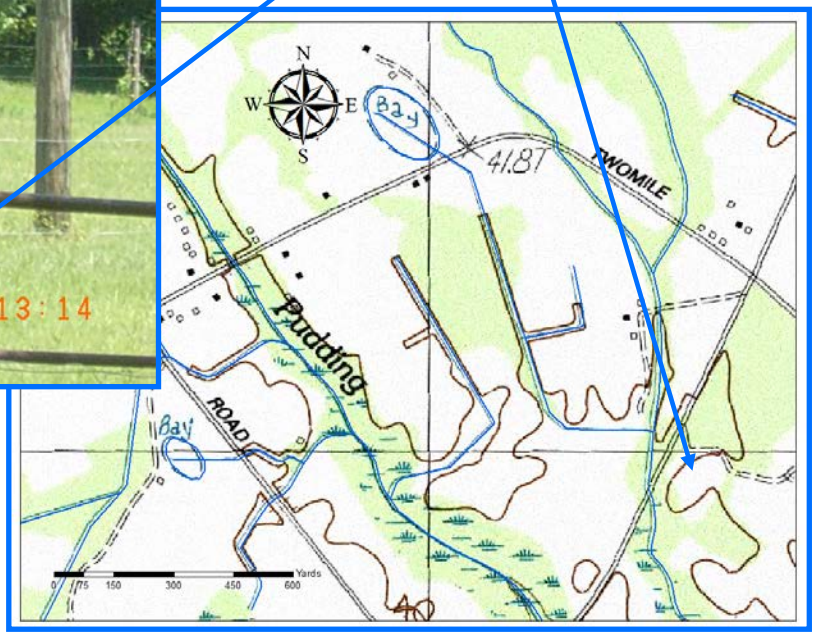


Figure F-19

Donkeys in pasture near Douglas Swamp (location: 33.97688 N, -79.99213 W) on Douglas Swamp Road in Clarendon County. Found in Reach 1 of the PST Watershed (Date of photography: June 15, 2018).

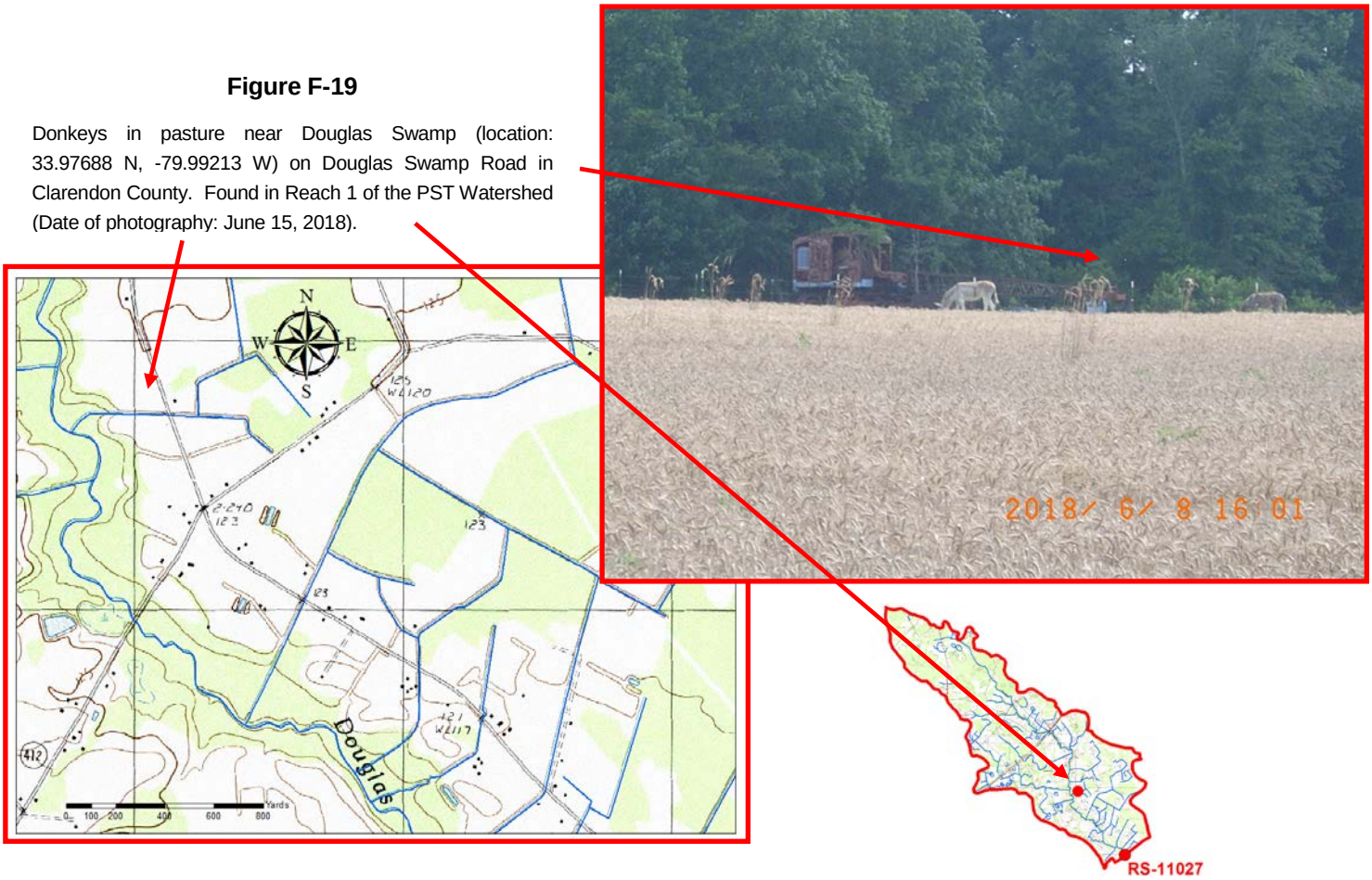


Figure F-20

Shetland pony in pasture with cattle near Burnt Branch (location: 33.90873 N, -79.91146 W) on Central Road in Sumter County. Found in Reach 3 of the PST Watershed (Date of photography: June 15, 2018).

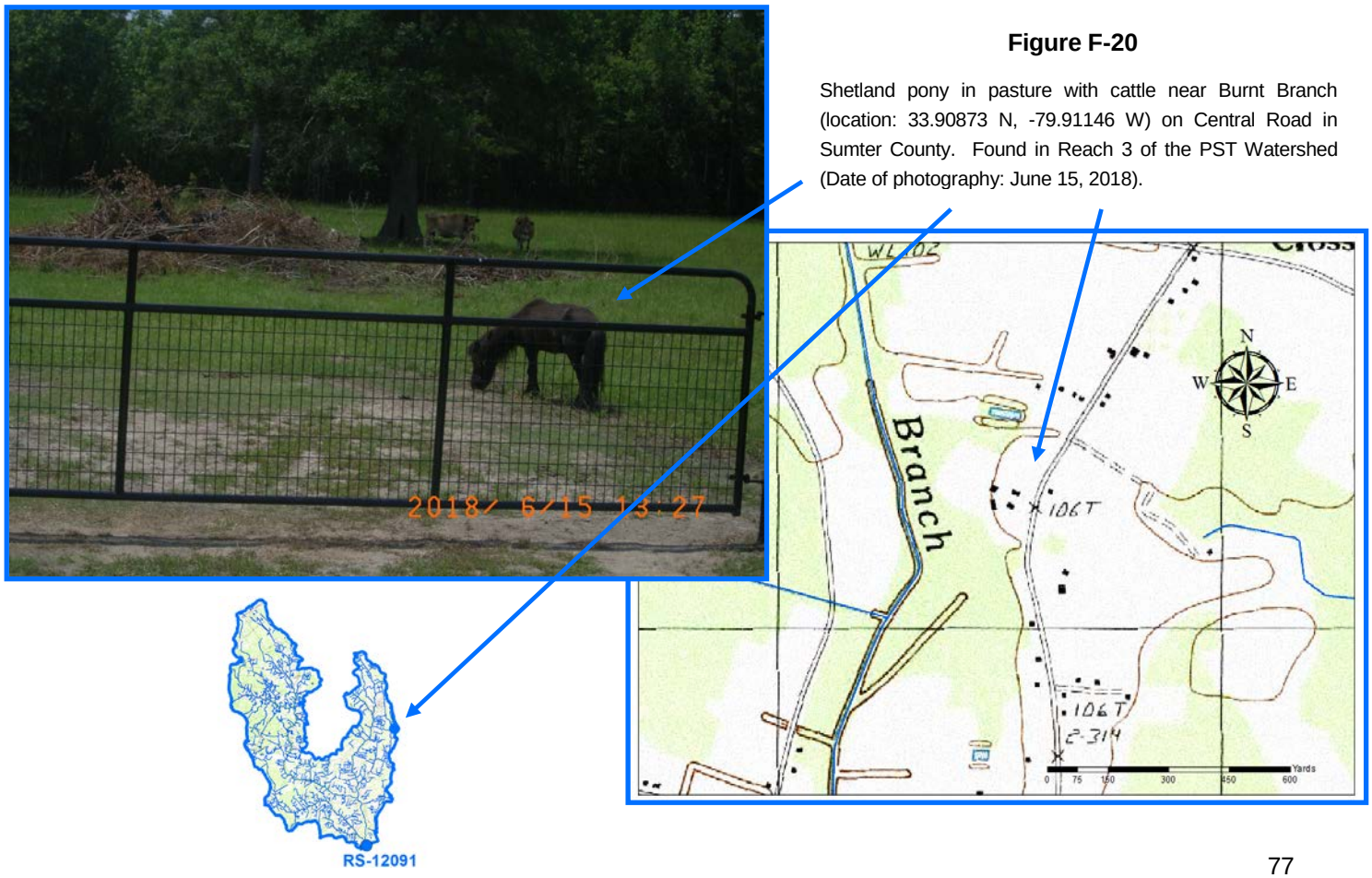


Figure F-21

Goats in a pen near Horse Branch (location: 33.89656 N, -79.98381 W) on John M Road in Clarendon County. Found in Reach 2 of the PST Watershed (Date of photography: June 15, 2018).

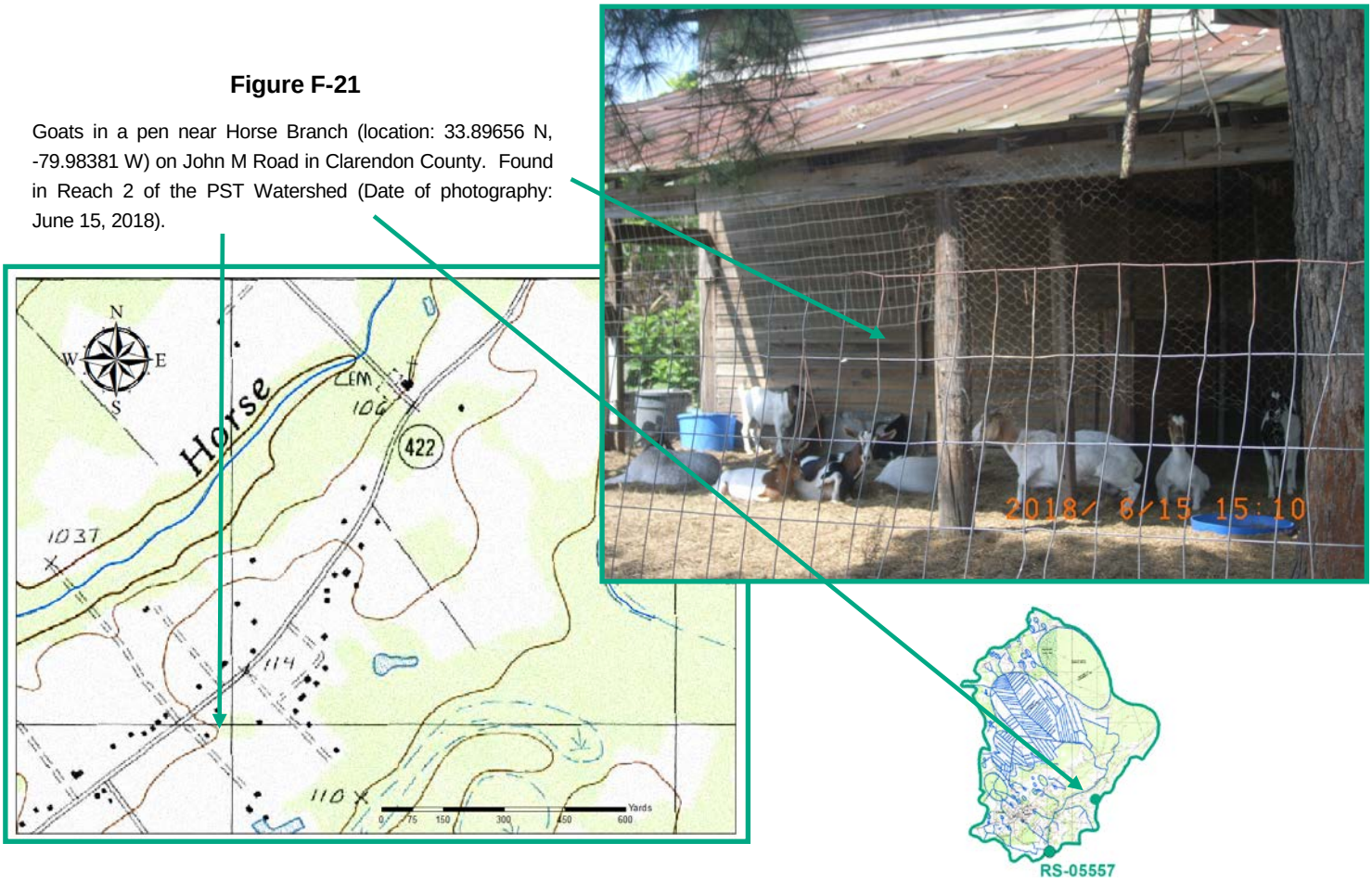


Figure F-22

Goats in a pen near Threemile Branch (location: 33.98029 N, -80.10648 W) on Old C C Road in Sumter County. Found in Reach 3 of the PST Watershed (Date of photography: June 8, 2018).

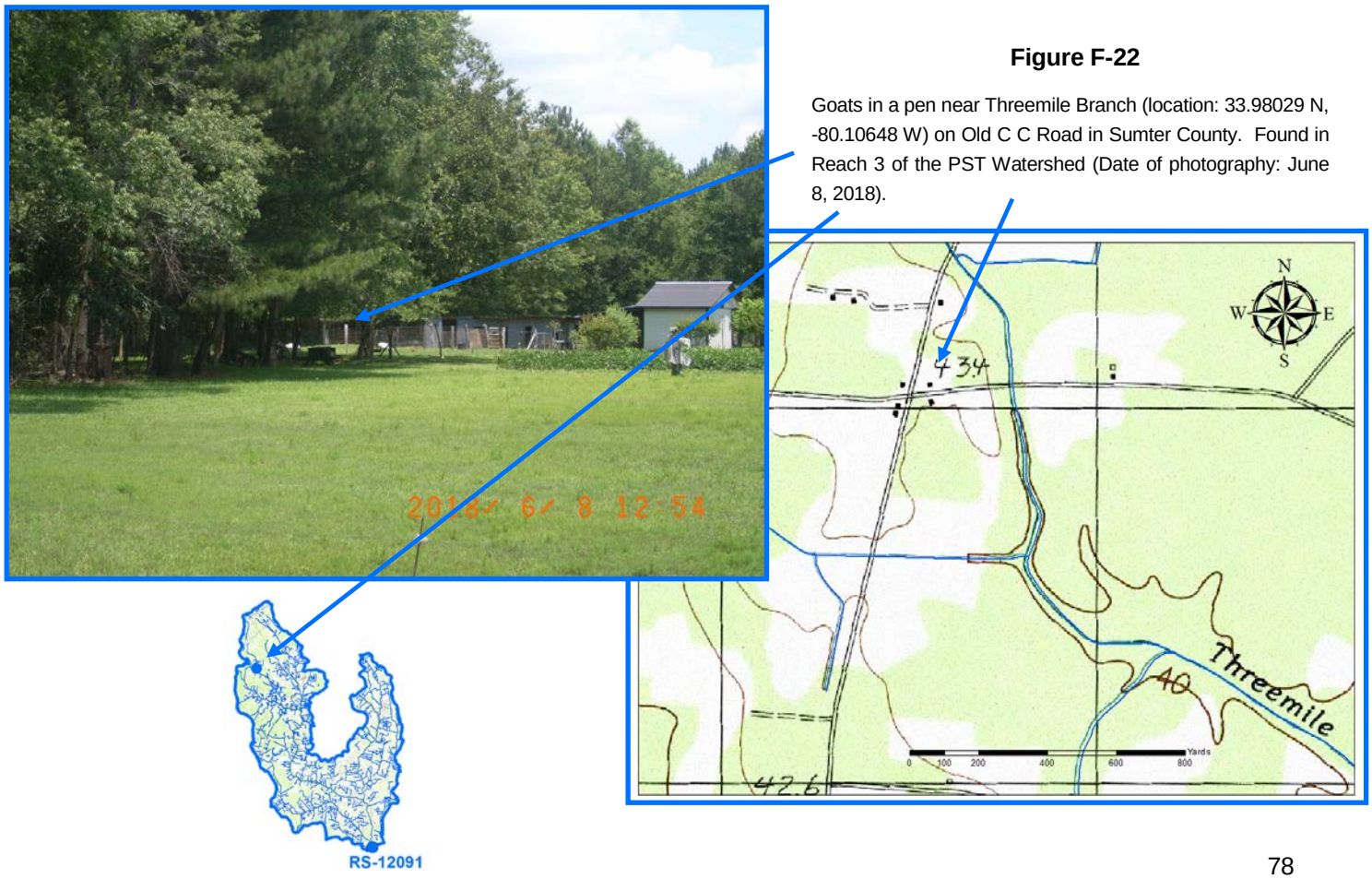


Figure F-23

Hogs in pen near Threemile Branch (location: 33.94760 N, -80.06751 W) on Mt. Sinai Church Road in Sumter County. Found in Reach 3 of the PST Watershed (Date of photography: June 8, 2018).

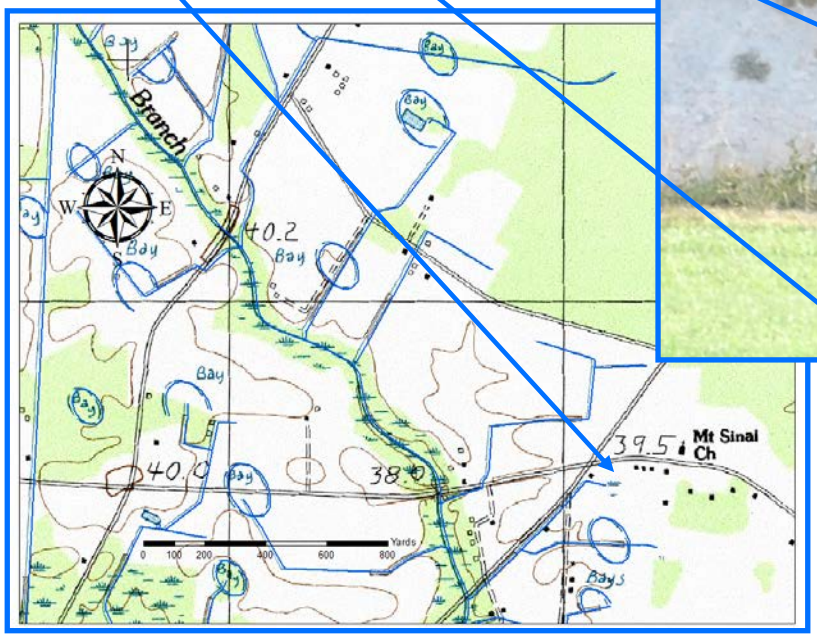


Figure F-24

Chickens in yard near Douglas Swamp (location: 33.99336 N, -79.99815 W) on Hewitt Street in Sumter County. Found in Reach 1 of the PST Watershed (Date of photography: June 8, 2018).

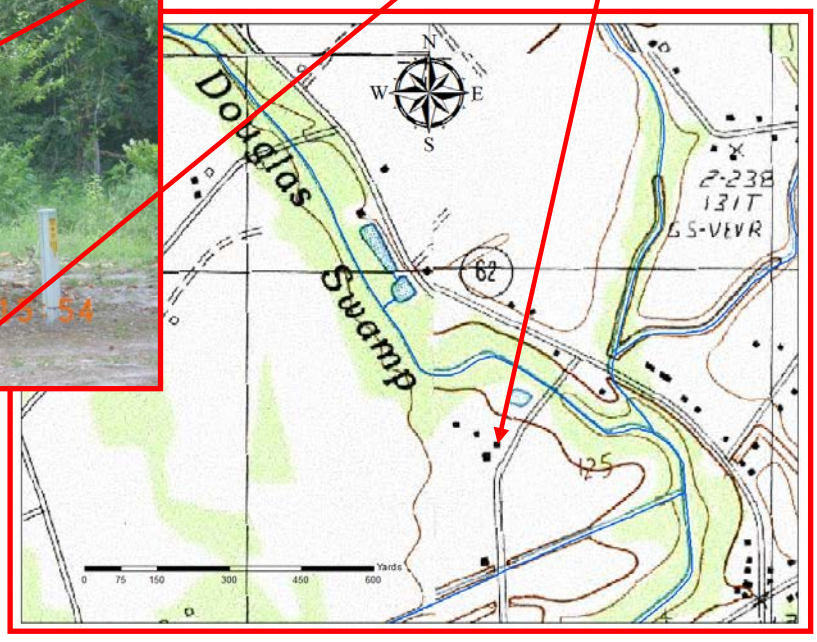


Figure F-25

Unattended dog in road (location: 33.99276 N, -79.99844 W) on Hewitt Street in Sumter County. Found in Reach 1 of the PST Watershed (Date of photography: June 8, 2018).

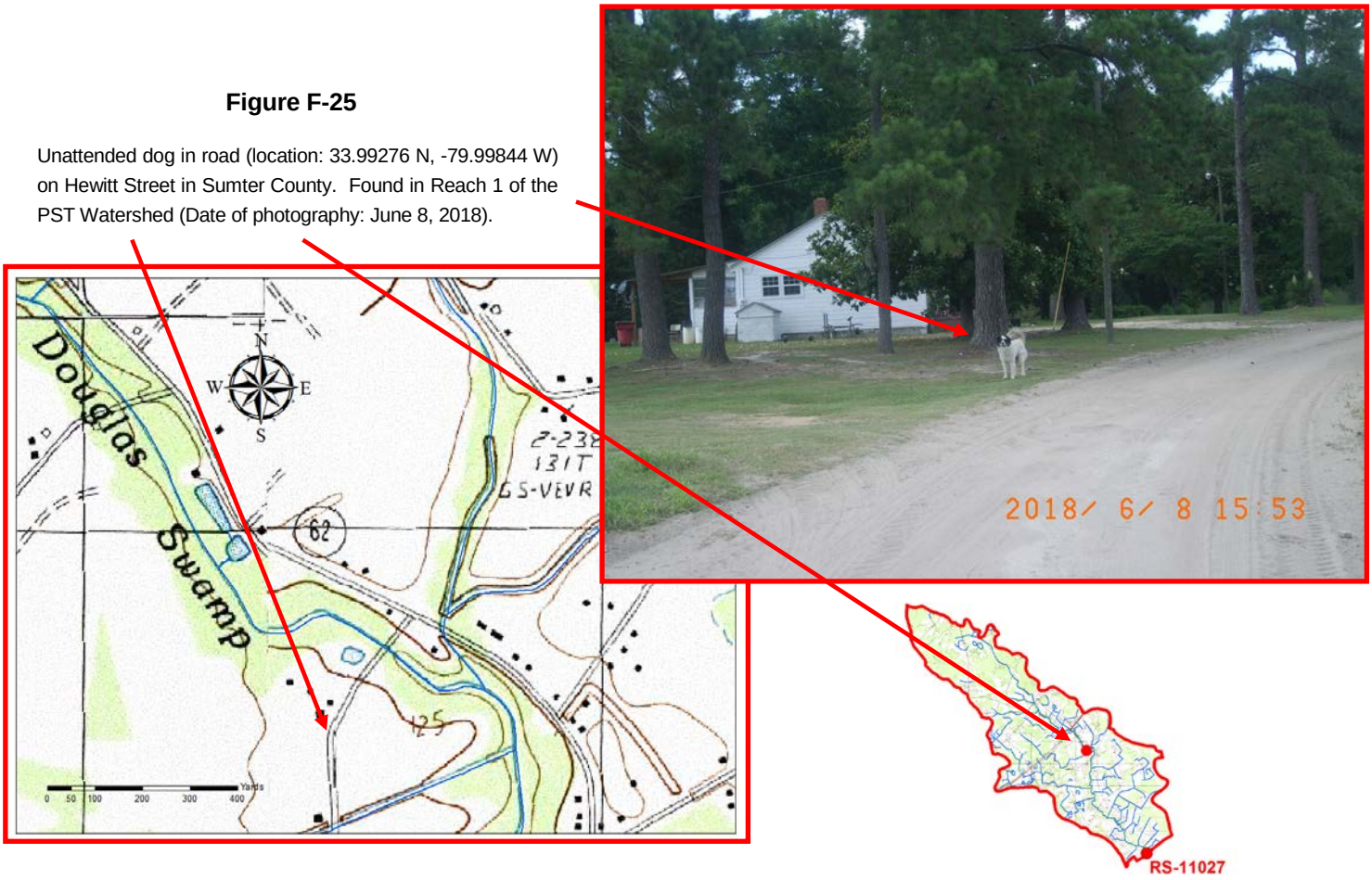


Figure F-26

Unattended dog in yard near Horse Branch (location: 33.89628 N, -79.98581 W) on Horse Branch Road in Clarendon County. Found in Reach 2 of the PST Watershed (Date of photography: June 15, 2018).

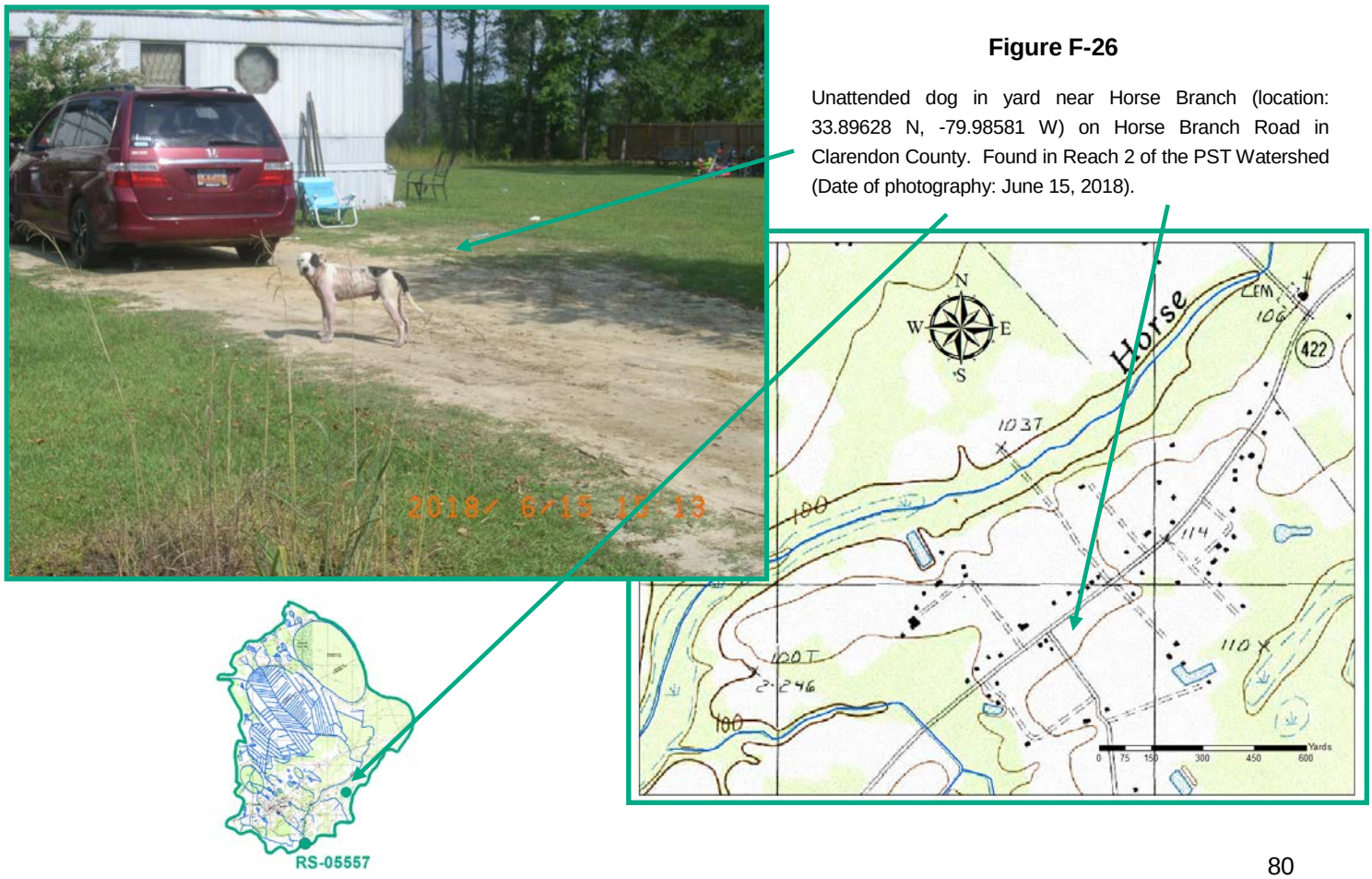


Figure F-27

Unattended dog in yard near Cypress Branch (location: 33.96738 N, -79.94126 W) on Norwood Road in Sumter County. Found in Reach 3 of the PST Watershed (Date of photography: June 15, 2018).

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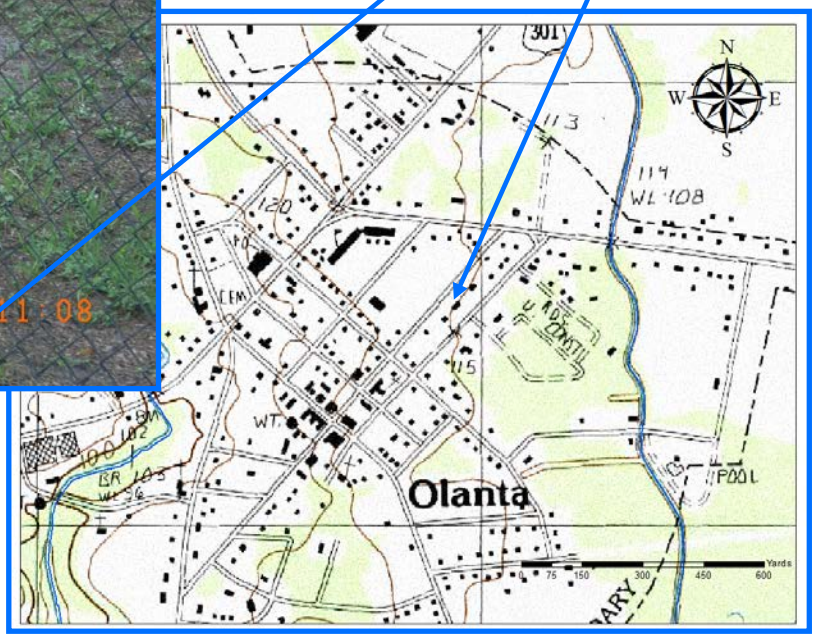
Figure F-28

Unattended dog in yard in Olanta (location: 33.93756 N, -79.92928 W) on Liberty Street in Florence County. Found in Reach 3 of the PST Watershed (Date of photography: June 15, 2018).



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