Total Maximum Daily Load Document for *E. coli* Impairments at Myers Creek, Cedar Creek, Toms Creek, and Tributaries Within Hydrological Unit Codes 030501100310, 03050110305, 030501100306, 030501100307 and 030501100401

SCDES Bureau of Water

SC DEPARTMENT *of* ENVIRONMENTAL SERVICES

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Abstract

§303(d) of the Clean Water Act and EPA's *Water Quality Planning and Management Regulations* (40 CFR - Protection of Environment 2017) 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 (WQS) for the pollutant of concern. All TMDLs include a waste load allocation (WLA) for any National Pollutant Discharge Elimination System (NPDES)-permitted dischargers, a load allocation (LA) for all nonpoint sources, and an explicit and/or implicit margin of safety (MOS). This technical report describes the development of *Escherichia coli* (*E. coli)* recreational use TMDLs for impaired water quality monitoring (WQM) stations in the Myers Creek, Cedar Creek, Toms Creek and its tributaries. These stations are C-075, C-077, C-076, C-072, S-950, and are located in Richland County, South Carolina. All 5 stations have been included in South Carolina's draft 2024 303(d) list for exceeding the *E. coli* WQS for recreational use and have been prioritized for restoration.

Stations C-075, C-077, C-076, C-072 were designated as TMDL stations due to the availability of recent *E. coli* data at these stations. The data collected from these stations were used to calculate TMDLs for the Myers Creek, Cedar Creek and Toms Creek and their tributaries. The other legacy impaired station in the watershed with older fecal coliform data (S-950) will be associated with the appropriate TMDL stations and will receive their corresponding TMDL loads and percent reduction goals.

There are two NPDES-permitted Municipal Separate Storm Sewer (MS4) entities in this watershed: Richland County and the South Carolina Department of Transportation (SCDOT).

Table 1. TMDLs for Myers Creek, Cedar Creek, Toms Creek and tributaries. TMDLs are expressed as mpn/day.

Station	Existing Load (mpn/day)	TMDL (mpn/day)	MOS (mpn/day)	WLA			LA	
				Continuous source[1] (mpn/day)	Intermittent MS4[2, 3] (% reduction)	Intermittent MS4 SCDOT[3,4] (% reduction)	mpn/day	% Reduction[3]
C-075	4.55E+11	4.19E+11	2.04E+10	NA	12%	12%	3.99E+11	12%
C-077	9.96E+11	4.62E+11	2.25E+10	NA	54%	54%[6]	4.39E+11	54%
C-076	1.84E+12	7.40E+11	3.61E+10	NA	62%	62%	7.04E+11	62%
C-072	1.35E+11	9.74E+10	4.74E+09	NA	71%	71%	9.26E+10	71%
S-950[5]	1.35E+11	9.74E+10	4.74E+09	**NA**	71%	71%	9.26E+10	71%

Table Notes:

1. Not applicable at this time due to absence of dischargers. Future continuous dischargers will be required to meet the prescribed loading for pollutants of concern. Future loadings will be calculated based on permitted flow and *E. coli* concentration of 349 mpn/100 mL.
2. Percent reduction applies to all NPDES-permitted stormwater discharges, including current and future 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 the percentage reduction or the existing instream standard for pollutants of concern by their NPDES Permit.
3. The percent reductions apply to existing instream *E. coli*.
4. By implementing the BMPs that are prescribed in either the SCDOT annual SWMP or the SCDOT MS4 permit to address *E. coli*, the SCDOT will comply with these TMDLs and its applicable WLA to the MEP as required by its MS4 permit.
5. The TMDL loads from C-072 were assigned to S-950. S-950 only had data from 2003, which is not sufficient to establish a TMDL limit for this station.
6. The total developed area in this TMDL watershed is currently less than 5% and the Department deems the contributions from SCDOT negligible, and no reduction of bacteria is necessary at this time. If the total developed area in this TMDL watershed increases to 5% and above, SCDOT will comply with applicable WLA to the MEP as required by its NPDES MS4 permit.

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1.0 Introduction

1.1 Background

The federal *Clean Water Act (CWA)* requires each state to assess its waters, develop monitoring strategies, and establish water quality standards (WQS) for various types and uses of water bodies. Furthermore, the CWA mandates states to review the monitoring results every two years to ensure compliance with the established WQS. If monitoring indicates that the WQS are not being met or are under threat, the states are required to list the impaired bodies under §303(d) of the CWA. These listed stations are then assigned a priority ranking for restoration efforts, and the impairments are addressed through the implementation of Total Maximum Daily Loads (TMDLs), as outlined in *40 Code of Federal Regulations* (CFR) Part 130, based on their respective ranks (40 CFR - Protection of Environment 2017).

A Total Maximum Daily Load (TMDL) is one part of a regulatory framework used to manage and control pollutant levels in water bodies that are impaired by pollutants. It establishes the maximum amount of a specific pollutant that a water body can receive from all sources, continuous point sources, intermittent point sources, nonpoint sources, while still meeting WQS. The TMDL process includes estimating pollutant contributions from all sources, linking pollutant sources to their impacts on water quality, allocation of pollutant contributions to each source, and establishment of control mechanisms to achieve water quality standards.

A TMDL is comprised of the sum of individual waste load allocations (ΣWLAs) for continuous and intermittent point sources, and load allocations (ΣLAs) for nonpoint sources. In addition, the TMDLs include a margin of safety (MOS), either implicit or explicit, which is a buffer or safety factor included in the TMDL to account for uncertainties in the relationship between pollutant loads and water quality. Conceptually, this definition is represented by the equation:

$$TMDL = \Sigma WLA + \Sigma LA + MOS$$

Eq. 1

This TMDL document is a detailed analysis describing the development of *Escherichia coli* (*E. coli*) bacteria TMDLs for 5 water quality monitoring (WQM) stations that have exceeded the recreational WQS. These stations, located in Richand County within the Myers Creek, Cedar Creek, and Toms Creek watersheds, were identified in South Carolina's draft 2024 303(d) list of impaired waters by the South Carolina Department of Environmental Services (SCDES or the Department) as impaired due to *E. coli* bacteria exceedances (SCDES 2024).

The 5 impaired stations are C-075, C-077, C-076, C-072, and S-950. Figure 2 provides a visual representation of these bacteria-impaired WQM stations and details about their locations.

Testing for every potential pathogenic organism in surface water is not feasible, so bacteria like *E. coli* are used as the indicators for presence of human pathogens. Indicator bacteria are practical to measure, persist in surface waters for similar durations, and share common sources with the actual pathogens. *E. coli* bacteria belong to the fecal coliform group and naturally inhabit the gastrointestinal tract of warm-blooded animals. They serve important functions such as preventing the proliferation of harmful bacteria in the gut, producing vitamin K, aiding in lactose digestion, and facilitating fat metabolism. However, certain strains of *E. coli*, such as Shiga toxin-producing 0157:H7, can cause gastrointestinal illnesses, kidney failure, and even death. The presence of *E. coli* bacteria in surface waters may indicate recent contamination from human or animal waste, which can stem from various sources such as failing septic systems, agricultural runoff, and sewer leaks (Blount 2015), (Wolfson and Harrigan 2010).

1.2 Watershed Descriptions

The TMDL area is part of the Southeastern Plains ecoregion, which is characterized by woodland, cropland, and forest. The vegetation includes longleaf pine with oak-hickory-pine. The Southeastern Plains has four subcategories: “Sand Hills”, “Atlantic Southern Loam Plains”, “Rolling Coastal Plain”, and “Southeastern Floodplains and Low Terraces”. The northern portion of the TMDL area falls into the Sand Hills (65c). This ecoregion is characterized by rolling sandy hills with very poor moisture retention which are unsuitable for growing crops. The main vegetation consists of turkey oak, blackjack oak, longleaf pine, and wiregrass. Consistent streamflow is caused by the large capability for infiltration in the soil and high storage capacity in the sand aquifer. The middle portion of the TMDL area falls into the Atlantic Southern Loam Plains (65l). This ecoregion is characterized by fertile agricultural lands with well-drained soil. The southern portion of the TMDL area falls into the Southern Floodplains and Low Terraces (65p). The soil composition includes sand and clay with gravel. This region contains slow rivers, backwaters, swamps, and ponds. The vegetation consists of various oak species, bald cypress, and water tupelo (Griffith, G. E., et al. 2002) (Figure 1).

The Northern portion of the TMDL drains into the Congaree National Park. The Southern portion of the TMDL area is in the Congaree National Park. Cedar Creek inside the Congaree National Park is classified as ORW (Outstanding Resource Waters) and ONRW (Outstanding National Resource Waters). Dry Branch inside the Congaree National Park is classified as ORW. Waters located in the northern portion of the TMDL outside of the Congaree National are classified as FW (Freshwater) (SCDHEC 2023, R61-69). Delineation of the Congaree National Park portion of the TMDL was very challenging due to minimal elevation change (Figure 2).

Since February 28, 2013, South Carolina (SC) has been using *E. coli* as the freshwater fecal indicator bacteria, replacing fecal coliform (FC). In SC's draft 2024 303(d) list, 5 sites within the Myers Creek, Cedar Creek, and Toms Creek watershed were identified as impaired due to exceedances of the freshwater *E. coli* WQS. These 5 sites are C-075, C-077, C-076, C-072 and S-950 (see Table 5 for collection dates). The subwatersheds will be individually assessed in this TMDL document.

Impaired TMDL sites included in this document are prioritized for restoration in the draft 2024 Integrated Report.

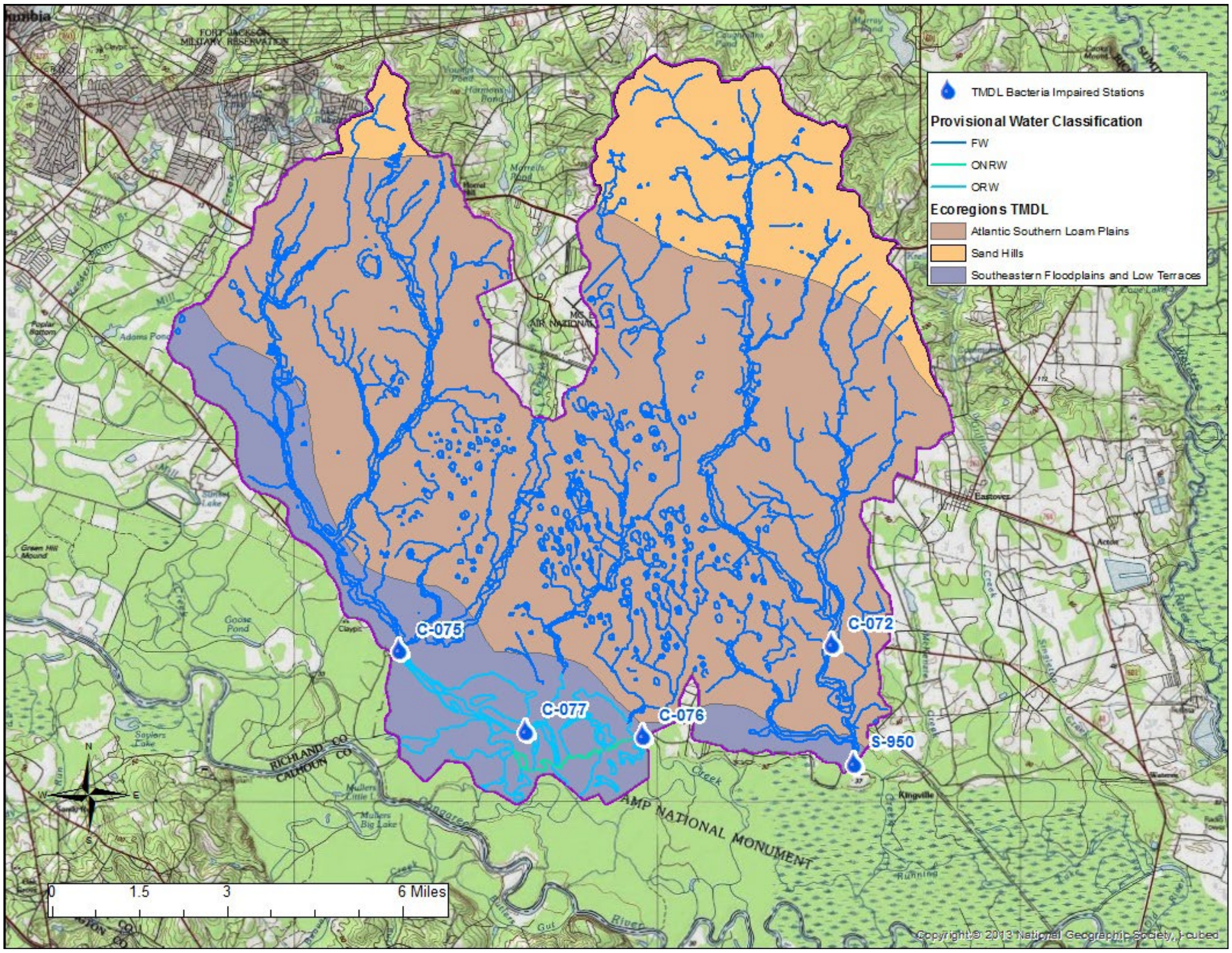

Figure 1.303(d) impaired WQM sites, Ecoregions, and Provisional Water Classifications in the Myers Creek, Cedar Creek, and Toms Creek TMDL.

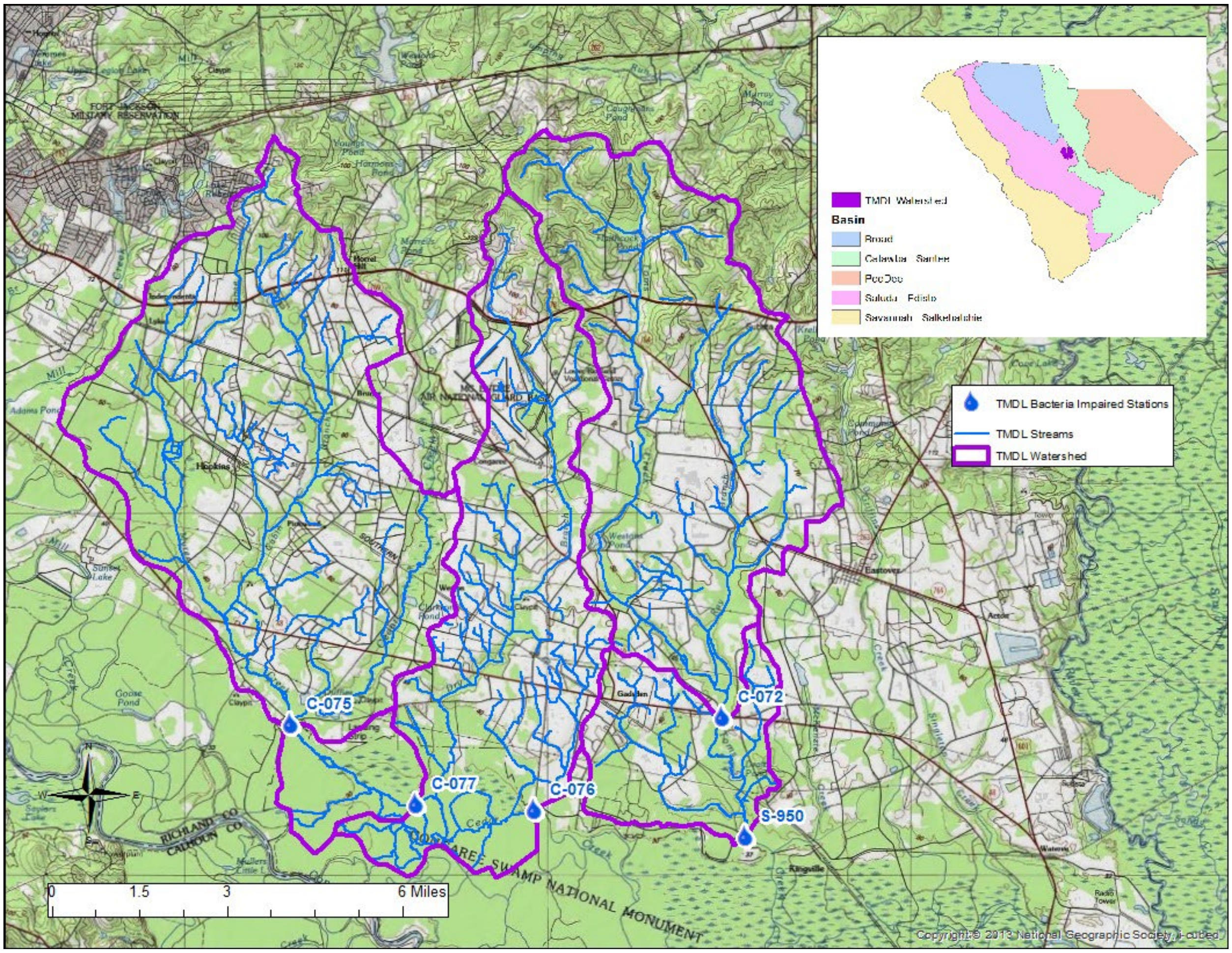

Figure 2. Myers Creek, Cedar Creek, and Toms Creek TMDL, 303(d) impaired WQM sites.

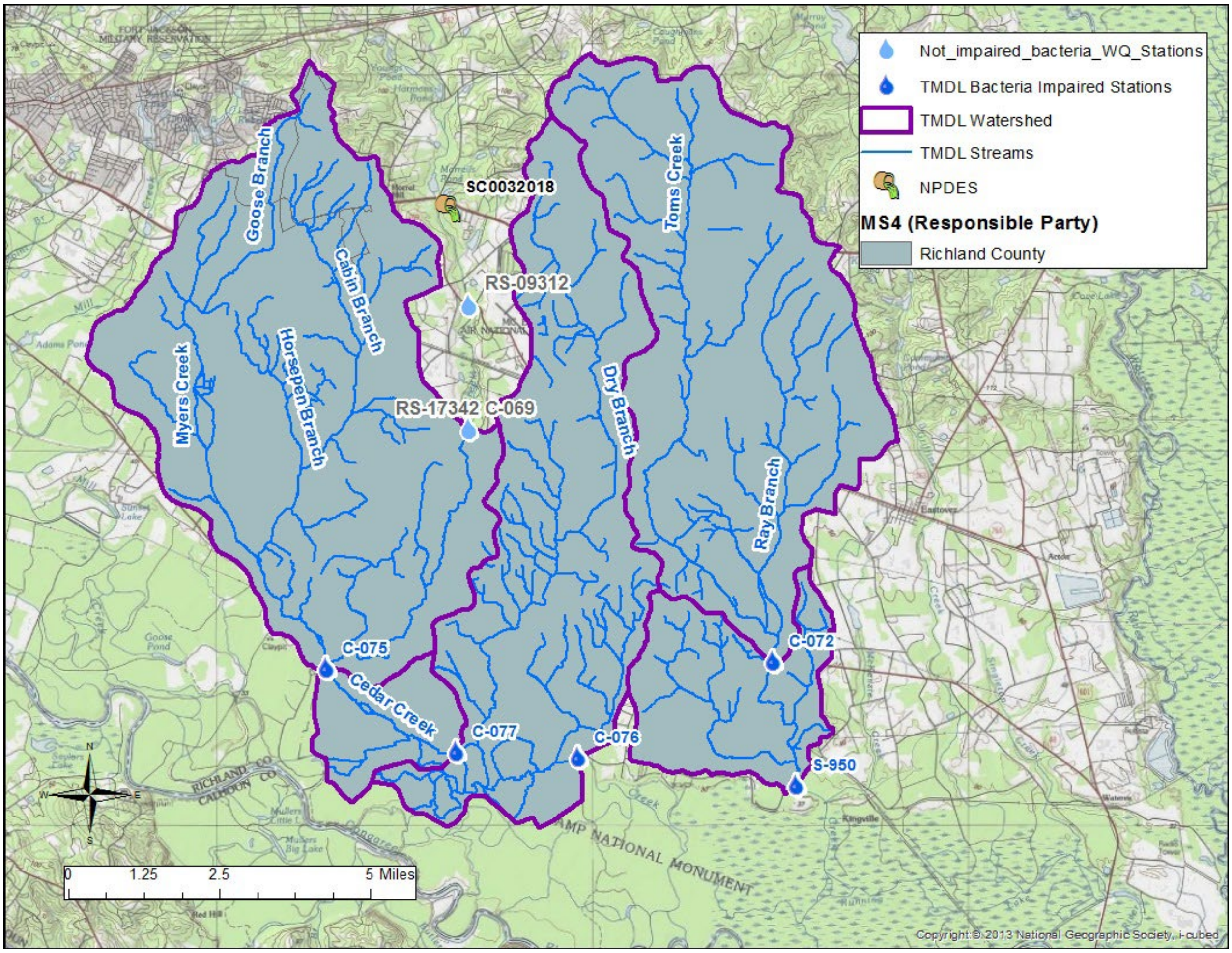

Figure 3. *E. coli*-impaired WQM sites, MS4, and NPDES-permitted discharger within the drainage area of Myers Creek, Cedar Creek, and Toms Creek watershed.

Table 2. Myers Creek, Cedar Creek, Toms Creek, and tributaries' bacteria-impaired stations and location descriptions.

Station	Description
C-075	CEDAR CK SOUTH OF S-40-734 OLD BLUFF ROAD; AT CANOE LAUNCH
C-077*	CEDAR CK - BRIDGE B LOCATED ALONG WESTON LAKE LOOP TRAIL
C-076*	CEDAR CK CANOE ACCESS OFF S-40-1288 (SO CEDAR CK RD)
C-072	TOMS CK AT SC 48
S-950*	TOMS CREEK AT RED BLUFF ROAD. PRIVATE ROAD RUNNING BETWEEN SSR1288 AND SSR489.D483

*** *Deactivated stations.***

The drainage areas for the TMDL WQM stations were delineated using USGS topographic maps and ArcGIS software.

Currently in the Myers Creek, Cedar Creek, and Toms Creek watershed TMDL area, there are no wastewater treatment plant (WWTP) NPDES permitted dischargers. There is one Domestic WWTP NPDES permitted discharger called Cedar Creek MHP (SC0032018) upstream of C-069 (Figure 3).

There are two NPDES-permitted Municipal Separate Storm Sewer (MS4) entities within the Myers Creek, Cedar Creek, and Toms Creek watershed: Richland County (SCS400001) and the South Carolina Department of Transportation (SCDOT) (SCS040001) (Figure 3).

Land uses and percent imperviousness of the TMDL stations were calculated using the 2021 National Land Cover Database (NLCD) and Esri ArcGIS software (Dewitz and US Geological Survey 2021). Land use characteristics for TMDL stations are summarized in Table 3 and primary and secondary dominant uses are bolded. A land use map of stations C-075, C-077, C-076, C-072, and S-950 can be found in Appendix B (Figure 15). Using the NLCD 2021 Percent Developed Imperviousness layer and the drainage area of TMDL stations, the percent imperviousness of the TMDL stations was calculated and is shown in Table 4.

Table 3. NLCD 2021 land uses of TMDL stations.

Landuse	C-075 Area (mi^2)	C-075 % of Area	C-077 Area (mi^2)	C-077 % of Area	C-076 Area (mi^2)	C-076 %of Area	C-072 (mi^2)	C-072 % of Area	S-950 (mi^2)	S-950 % of Area
Open Water	0.28	0.72	0.01	0.25	0.19	0.75	0.28	0.91	0.00	0.02
Developed Open Space	3.00	7.79	0.03	0.67	1.20	4.70	1.29	4.21	0.32	3.91
Developed Low Intensity	1.76	4.56	0.00	0.09	0.62	2.42	0.71	2.32	0.20	2.48
Developed Medium Intensity	0.35	0.90	0.00	0.01	0.26	1.03	0.10	0.32	0.03	0.31
Developed High Intensity	0.08	0.21	0.00	0.00	0.10	0.39	0.01	0.03	0.00	0.04
Barren	0.00	0.01	0.00	0.00	0.00	0.01	0.02	0.08	0.00	0.05
Deciduous Forest	0.63	1.65	0.00	0.08	0.33	1.30	0.89	2.91	0.06	0.73
Evergreen Forest	**6.86**	**17.81**	**0.40**	**10.24**	**5.49**	**21.44**	**7.58**	**24.65**	**2.28**	**27.97**
Mixed Forest	2.93	7.60	0.08	1.95	1.18	4.62	2.95	9.59	0.16	2.02
Shrub/Scrub	1.34	3.47	0.01	0.26	0.81	3.16	2.46	7.98	0.50	6.13
Grassland/Herbaceous	3.63	9.43	0.02	0.63	2.29	8.94	3.13	10.18	1.01	12.35
Pasture/Hay	2.32	6.02	0.01	0.26	1.62	6.33	0.97	3.15	0.21	2.52
Cultivated Crops	4.92	12.77	0.00	0.06	3.15	12.29	**5.67**	**18.43**	0.91	11.22
Woody Wetlands	**9.52**	**24.71**	**3.32**	**85.11**	**8.11**	**31.63**	4.37	14.19	**2.23**	**27.36**
Emergent Herbaceous Wetlands	0.91	2.36	0.02	0.40	0.25	0.98	0.32	1.05	0.23	2.87
Total	38.54	100	3.90	100	25.62	100	30.77	100	8.14	100

1.3 TMDL Stations

Subwatershed C-075

Myers Creek empties into Cedar Creek just upstream of C-075. Cedar Creek's headwaters originate in a residential area of the City of Columbia. The stream then flows through the small community of Hopkins before reaching the less developed area upstream of the park boundary. The water upstream of C-075 is classified as Freshwaters. The upper portion of this subwatershed is in the Sand Hills ecoregion. The middle portion of this subwatershed is in the Atlantic Southern Loam Plain ecoregion. A very small portion of the lower end of this subwatershed is in the Southeastern Floodplains and Low Terraces ecoregion (Figure 1). The drainage area of C-075 is 38.5 mi^2, and dominant land uses are evergreen forest (17.81%) and woody wetlands (24.71%) (Table 3, Figure 15).

In the drainage area of station C-075, there are 3 additional stations with bacteria monitoring data, RS-09312 (Status: Random), C-069 (Status: Inactive), and RS-17342 (Status: Random) (Figure 3). C-069 and RS-17342 are in the same location. Sampling data indicate these stations do not have *E. coli* impairments so TMDLs have not been calculated for them and the area draining to them has not been included in this TMDL analysis.

There is an active NPDES wastewater discharger (SC0032018) in the drainage area of C-075: Cedar Creek Mobile Home Park (SC0032018). This discharge is located outside of the TMDL area above C-069 RS-09312, and RS-17342 on Cedar Creek (Figure 3). This is the only active NPDES discharge in the entire TMDL area.

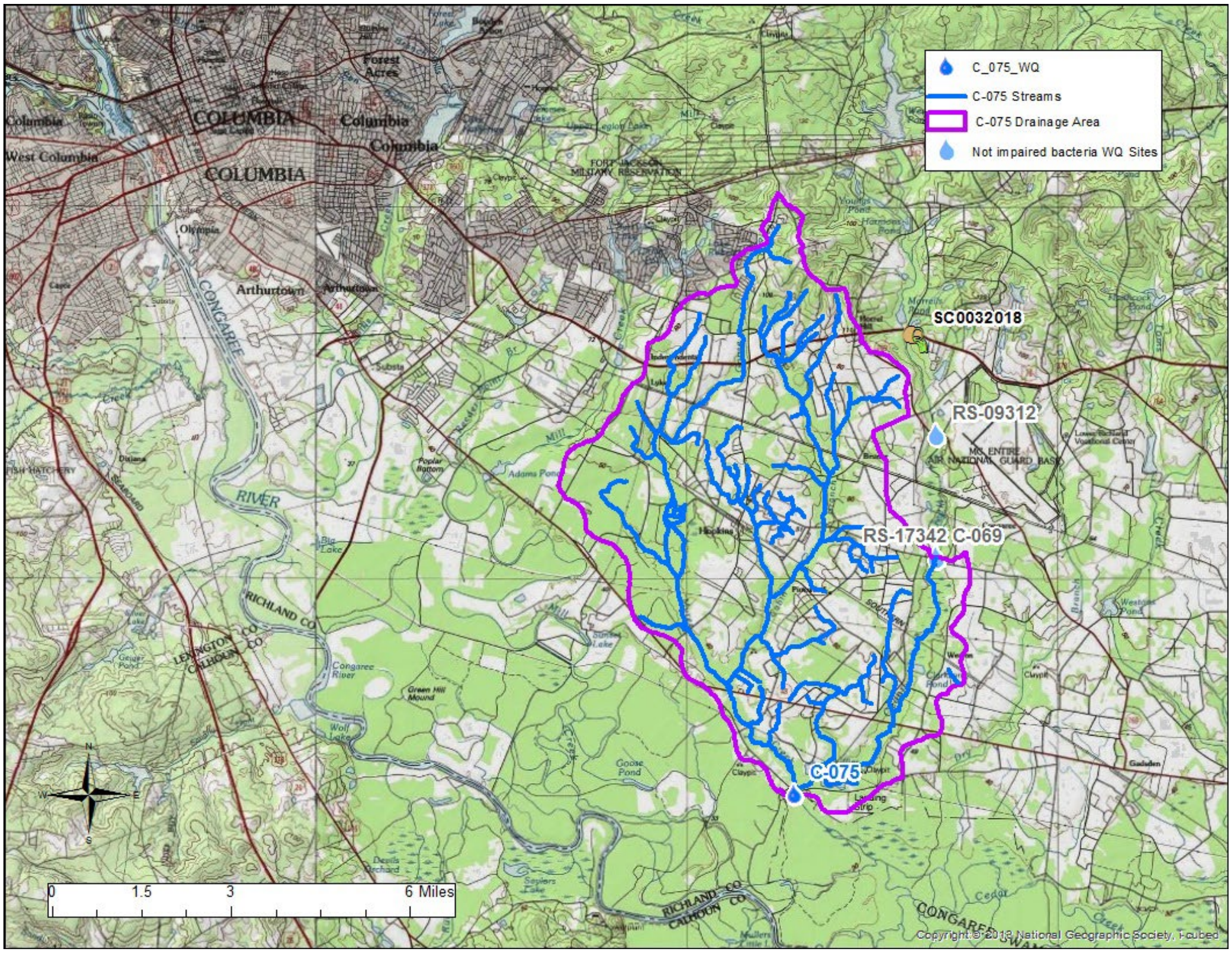

Figure 4. C-075 *E. coli*-impaired station, NPDES permitted discharger outside of the drainage area of Myers Creek, Cedar Creek and Toms Creek watershed.

Subwatershed C-077

The drainage area of C-077 includes the 030501100305 HUC12, about 25% of the 030501100306 HUC12, and a very small portion of the 030501100310 HUC12 and lies within the Congaree National Park.

This portion of the TMDL is in the Southeastern Floodplains and Low Terraces ecoregion. This part of Cedar Creek is classified as ORW (Figure 5). It is a large floodplain wetland with nearly zero slope. The drainage area of this site is 3.8 mi^2, not including the drainage area of C-075 upstream, and dominant land uses are evergreen forest (10.24%) and woody wetlands (85.11%) (Figure 15, Table 3).

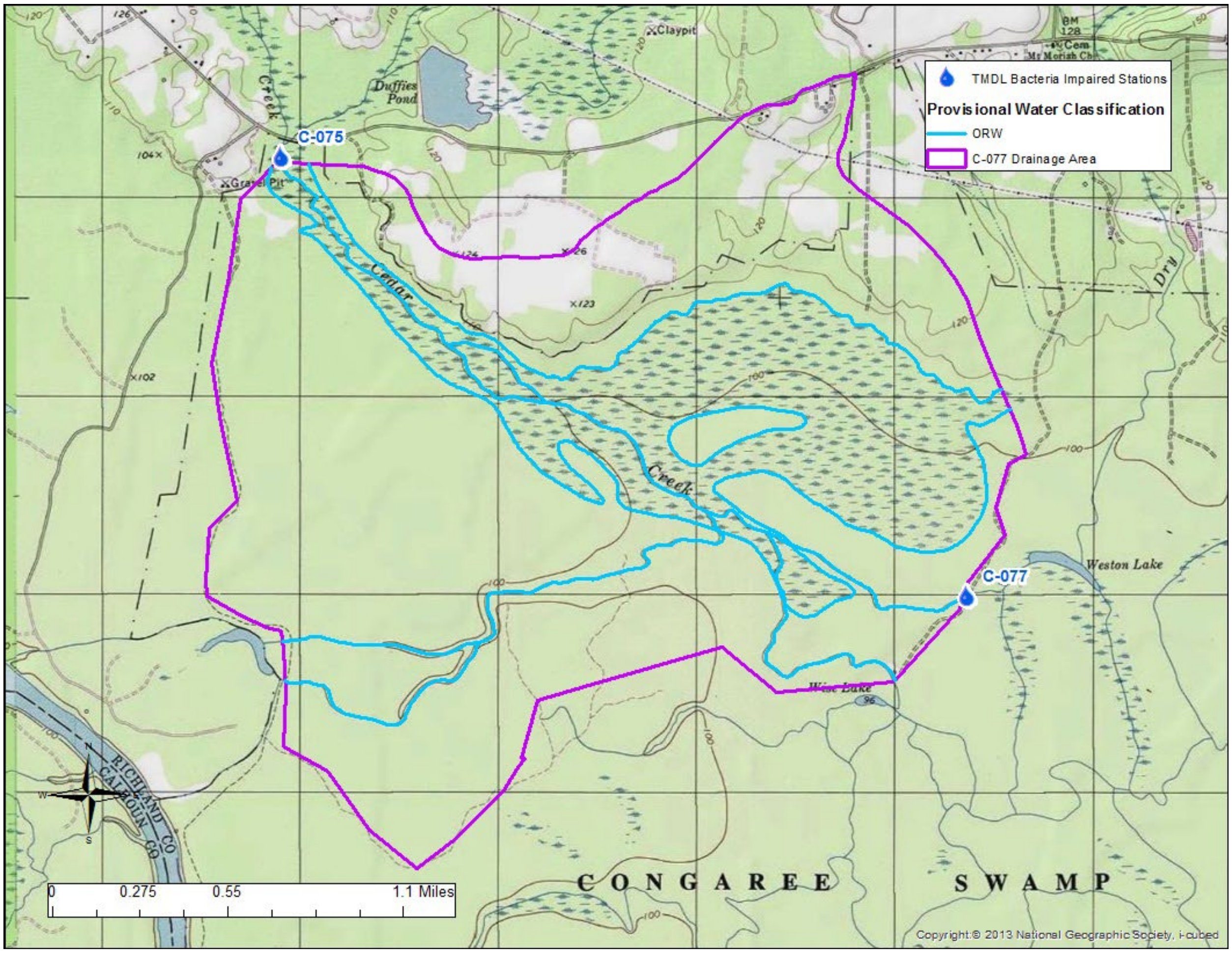

Figure 5. C-077 *E. coli*-impaired station drainage area.

Subwatershed C-076

The drainage area of C-076 includes the drainage areas of C-075, C-077, the entire 030501100307 HUC12, and a small portion of the 030501100310 HUC12. Dry Branch's headwaters originate upstream of the McEntire Joint National Guard Base. The stream then flows through the small community of Hopkins before reaching the less developed area upstream of the park boundary. The area outside of the Congaree National Park is classified as Freshwaters. The lower portion of C-076 lies within the Congaree National Park and is classified as ORW and ONRW. This portion of the subwatershed is a large floodplain wetland with nearly zero slope (Figure 6). This part of Cedar Creek accepts flow from Dry Branch before it leaves the TMDL boundary.

The headwater of this C-076 starts in the Sand Hills ecoregion. The middle portion of the subwatershed is in the Atlantic Southern Loam Plains, and the lower portion of the subwatershed is in the Southeastern Floodplains and Low Terraces ecoregion.

The drainage area of this site is 25.62 mi^2, not including the drainage area of C-075 and C-077 upstream, and dominant land uses are evergreen forest (21.44%) and woody wetlands (31.63%) (Figure 15, Table 3).

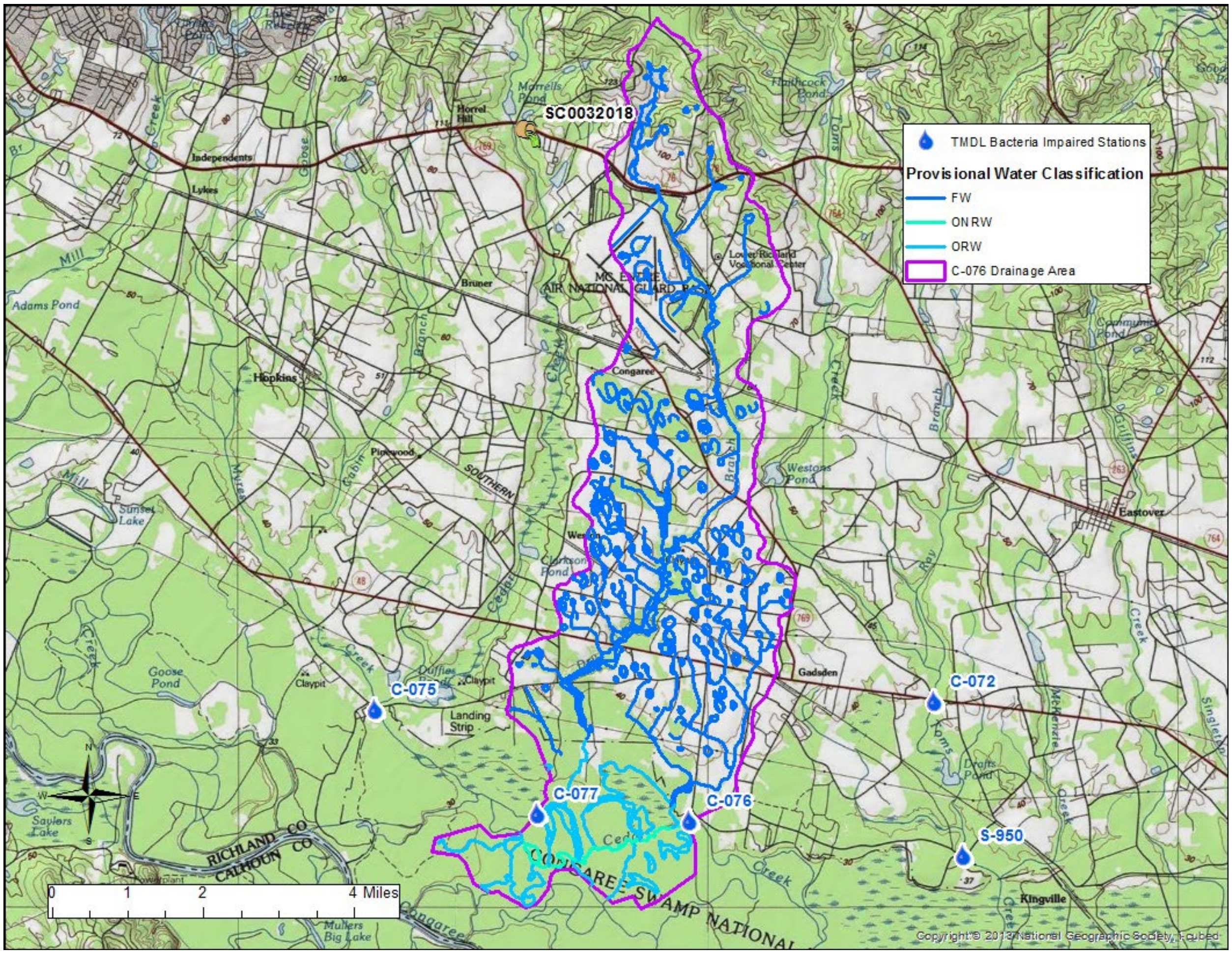

Figure 6. C-076 *E. coli*-impaired station drainage area.

Subwatershed C-072

Toms Creek originates from the headwater of the 030501100401 HUC12 in a less developed area. Just before Toms Creek reaches Site C-072, it joins with Ray Branch. The headwater of this subwatershed starts in the Sand Hills ecoregion. The middle portion of the subwatershed is in the Atlantic Southern Loam Plains. The lower portion of the subwatershed is in the Southeastern Floodplains and Low Terraces ecoregion. The water upstream of C-072 is classified as Freshwaters. The drainage area of this station is 30.77 mi^2 and dominant land uses are evergreen forest (24.65%) and cultivated crops (18.43%) (Figure 15, Table 3).

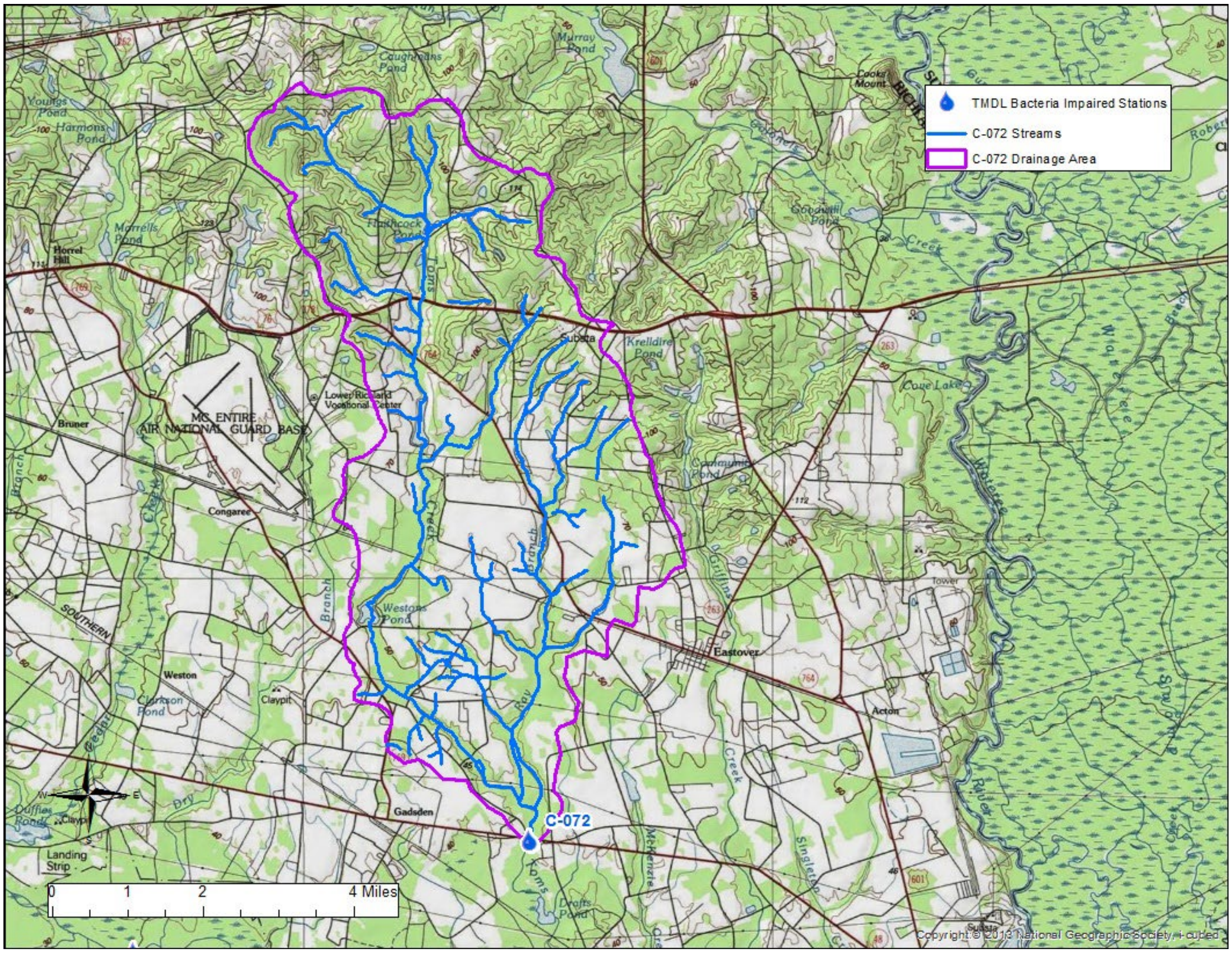

Figure 7. Drainage area of *E. coli*-impaired C-072 Water Quality Site.

Station S-950

Station S-950 is situated on Toms Creek in the southeastern portion of the TMDL watershed downstream of C-072. An unnamed tributary originating in Gadsden, SC, joins with Toms Creek just before the S-950 water quality site. The upper portion of this subwatershed is in the Atlantic Southern Loam Plain ecoregion. A very small portion of the lower end of this subwatershed is in the Southeastern Floodplains and Low Terraces ecoregion. The water upstream of S-950 is classified as Freshwaters. The drainage area of this station is 8.14 mi^2, not including the drainage area of C-072, and dominant land uses are evergreen forest (27.97%) and woody wetlands (27.36%) (Figure 15, Table 3).

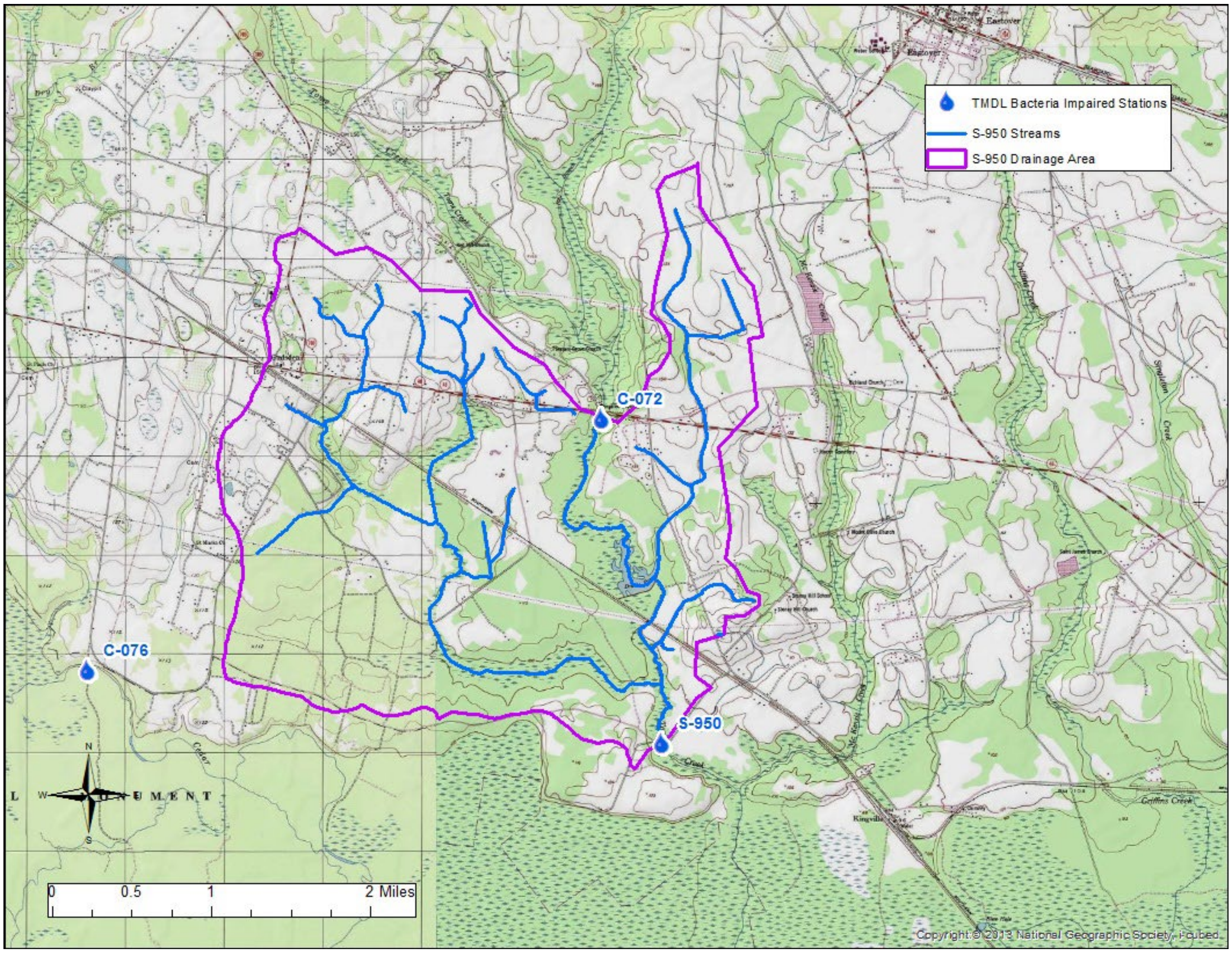

Figure 8. Drainage area of *E. coli*-impaired S-950 Water Quality Site.

Using the NLCD 2021 Percent Developed Imperviousness layer and the drainage area of TMDL stations, the percent imperviousness of the TMDL sites were calculated and is shown in Table 4.

Table 4. Percent imperviousness of the areas draining to the TMDL stations within the Myers Creek, Cedar Creek and Toms Creek watershed based on NLCD 2021 Impervious layer.

Station	% Imperviousness
C-075	2.72
C-077	0.06
C-076	2.11
C-072	1.24
S-950	1.30

1.4 Water Quality Standard

As defined in SC Regulation 61-68 (SCDHEC 2023), Freshwaters (FW) are suitable for primary and secondary contact recreation and as a source of 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 indigenous aquatic community of fauna and flora. Suitable also for industrial and agricultural uses. Outstanding National Resource Waters (ONRW) are freshwaters or saltwaters which constitute an outstanding national recreational or ecological resource. Outstanding Resource Waters (ORW) are freshwaters or saltwaters which constitute an outstanding recreational or ecological resource or those freshwaters suitable as a source for drinking water supply purposes with treatment levels specified by the Department.

The indicator bacteria for recreational uses in FW is *E. coli* and the water quality standards are: "*Escherichia coli* Not to exceed a geometric mean of 126/100 mL based on at least four (4) samples collected from a given sampling site over a 30-day period, nor shall more than ten percent (10%) of the total samples during any 30-day period exceed 349/100 mL." (SCDHEC 2023, R61-68)

2.0 Water Quality Assessment

Determination for §303(d) listing purposes is based on assessing five consecutive years of data collected from a WQM sites. For instance, for the draft 2024 303(D) list of impaired waters, data collected from 2018 through 2022 were used.

For recreational use, if more than 10% of the monthly geometric mean of available data collected during an assessment period exceeds the criterion, the station is listed on South Carolina's §303(d) list. If sufficient data are not available to calculate a monthly geometric mean, the available sample results are compared to the single sample maximum (SSM) criterion. If more than 10% of these samples exceed the criterion, the station is included on South Carolina's §303(d) list of impaired waters as not supporting recreational use. See Table 5 for a summary of the number of samples collected (n), the number of exceedances, and the percentage of samples exceeding the standard.

Table 5. Exceedance summary for bacteria impaired TMDL stations.

Station – US to DS	Number of Samples (n)	Number Exceeding WQS	Percent Exceeding WQS	TMDL Data Period
C-075	133	15	11.28	2009, 2013-2023
C-077	64	16	25	2009, 2015-2016
C-076	86	21	24.4	2009, 2015-2016, 2022-2023
C-072	111	27	24.3	2009, 2013-2023
S-950*	19	2	10.5	2003

**This station only had fecal coliform data. All others are E. coli.*

3.0 Source Assessment

Surface waters can be contaminated by various sources of pathogens, which can be categorized as continuous and intermittent point sources, and nonpoint sources. Efforts to control pollution from continuous point sources, such as WWTPs, have significantly reduced their impact through the implementation of technology-based controls. These point sources are regulated under the CWA and are required to obtain an NPDES permit. In South Carolina, NPDES permits mandate that dischargers with an *E. coli* limit meet the WQS at the discharge point (end of pipe). While dischargers, mostly domestic and municipal, can occasionally be sources of pathogens, if they are operating within their permit limits, they cannot be considered the cause of impairments. There are enforcement actions and mechanisms in place if these facilities fail to meet their permit requirements.

Regulated MS4, industrial, and construction site stormwater discharges are intermittent point sources. These intermittent sources are required to obtain discharge permits under the NPDES stormwater regulations. Each may be a source of pathogens. These sources are expected to meet the percentage reductions as prescribed in this TMDL document or the existing instream standard for the pollutant(s) of concern, to the maximum extent practicable (MEP), through compliance with the terms and conditions of their NPDES permit.

Nonpoint sources of bacteria in streams include various land-use practices such as agricultural activities, silviculture, urban and rural runoff, malfunctioning septic systems, sanitary sewer overflows, pet waste, wildlife, and poorly managed livestock operations. These activities can contribute to the presence of bacteria in surface water through runoff, leaching, and direct discharge.

3.1 Point Sources

Point sources refer to specific locations where NPDES-permitted effluent is discharged into the environment from identifiable sources such as pipes, outfalls, or conveyance channels. These sources can be traced to a single location such as industrial, municipal, domestic WWTPs, and NPDES-regulated stormwater discharges. Point sources are further divided into "continuous" and "intermittent".

3.1.1 Continuous Point Sources

Industrial, municipal, and domestic WWTPs have the potential to harbor pathogenic bacteria if their effluent fails to meet the WQS at the discharge point, as defined by their NPDES permit. If these facilities are discharging wastewater that meets their permit limits, they are not contributing to a bacteria impairment. If any of these facilities fail to comply with their permit limits, enforcement actions and mechanisms are in place to address the situation.

Within the TMDL area of the Myers Creek, Cedar Creek, and Toms Creek TMDL watersheds, there are no active NPDES dischargers. However, there is one domestic NPDES discharger located on Cedar Creek upstream of C-069, RS-09312, and RS-17342 outside the TMDL watershed. This discharger is called Cedar Creek Mobile Home Park (SC0032018) (Figure 3). Previously, there were several active dischargers (Table 6) that might have contributed to the *E. coli* problem in the past, but their NPDES permits have been terminated.

Cedar Creek Mobile Home Park (SC0032018) is a minor domestic discharger with a 0.0158 MGD flow. This discharger does not have any outstanding DMR (Discharge Monitoring Report) violations since 2019. There are no bacteria-impaired water quality sites downstream of the discharger. Because of this, SC0032018 was not included in the TMDL. If any of the WQ sites below the discharger (and outside of this TMDL) becomes impaired, a separate TMDL will be developed.

Table 6. Terminated NPDES dischargers within the TMDL area of Myers Creek, Cedar Creek and Toms Creek watershed.

Discharger	NPDES Permit Number	NPDES termination year
SC Air Force National Guard	SC0000701	2023
Hopkins Elementary School WWTP	SC0031496	2023
Hopkins Middle School WWTP	SC0031500	2023
Gadsen Middle School WWTP	SC0031526	2024

3.1.2 Intermittent Point Sources

Intermittent point sources include all NPDES-permitted stormwater discharges, including current and future MS4s, construction and industrial discharges covered under permit numbers beginning with SCS and SCR and regulated under SC *Water Pollution Control Permits* Regulation R61-9, §122.26(b)(4),(7),(14) - (21) (SCDHEC 2019). All regulated MS4 entities have the potential to contribute *E. coli* and other pathogen loadings in the Myers Creek, Cedar Creek and Toms Creek watershed and may be subject to the WLA for intermittent sources.

The presence of a substantial amount of developed and impervious land in a watershed leads to increased runoff from these areas following precipitation, which can contribute to pollution along with other sources. The "developed" land class, which encompasses open spaces, low, medium, and high-intensity areas, was determined for each TMDL station's drainage area using ArcGIS and the NLCD 2021 dataset, and the results are shown in Table 3. Additionally, the percentage of impervious areas in each TMDL station's drainage area was calculated using the NLCD imperviousness layer and is also summarized in Table 7.

Table 7. Aggregate developed land uses and impervious areas within the TMDL watersheds.

Station	Total Area (mi^2)	Developed Area (mi^2)	% Developed Area	% Impervious Area
C-075	38.54	5.19	13.5	2.72
C-077	3.90	0.03	0.77	0.06
C-076	25.62	2.19	8.5	2.11
C-072	30.77	0.12	6.88	1.24

S-950	8.14	0.55	6.74	1.30

Stormwater discharges from regulated MS4 entities operating within Myers Creek, Cedar Creek and Toms Creek watershed have the potential to contribute to *E. coli* and other pathogens and are subject to the WLA portion of the TMDL. There are two NPDES-permitted Municipal Separate Storm Sewer (MS4) entities within the Myers Creek, Cedar Creek, and Toms Creek watershed: Richland County (SCS400001) and the South Carolina Department of Transportation (SCDOT) (SCS040001).

The South Carolina Department of Transportation (SCDOT) is a designated MS4 within Myers Creek, Cedar Creek and Toms Creek watershed, operating under NPDES MS4 Permit SCS040001 (Figure 3). However, SCDOT is not a traditional MS4 as it lacks statutory taxing or enforcement powers, and does not regulate land use or zoning, or issue building or development permits.

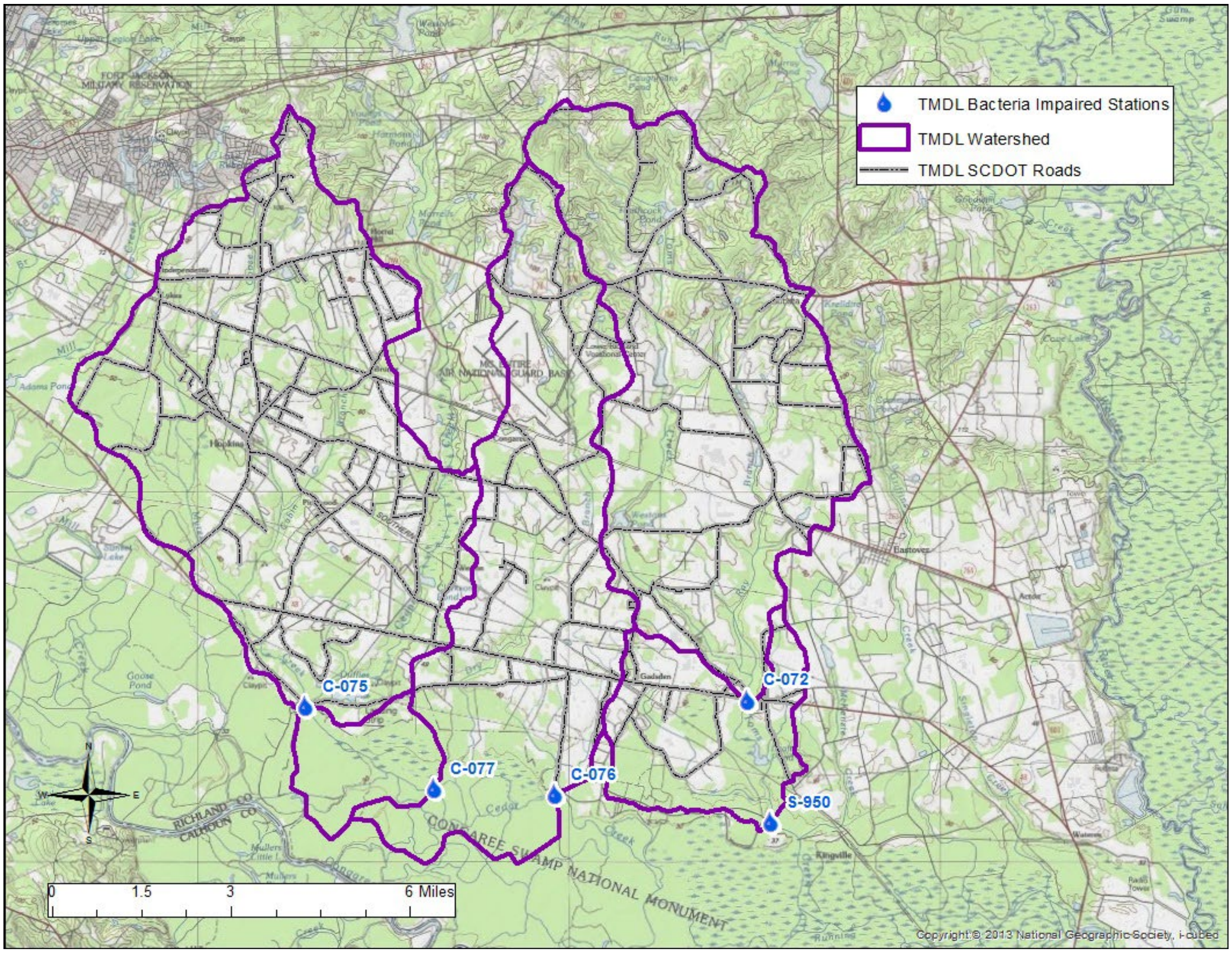

Figure 9. SCDOT owned and operated roads within Myers Creek, Cedar Creek and Toms Creek watershed.

The NPDES stormwater industrial general permit (SCR000000) regulates industrial facilities that could potentially cause or contribute to violations of WQS through stormwater discharges. Similarly, the NPDES stormwater construction general permit (SCR100000) applies to construction activities. If construction activities have the potential to impact a water body with a TMDL, the stormwater pollution prevention plan (SWPPP) must address pollutants of concern and comply with the WLAs specified in this TMDL document. It's important to note that some stormwater discharges in the watershed may not fall under the SCS and SCR permits, and therefore they are not subject to the WLA portion of the TMDL.

Sanitary sewer overflows (SSOs) are intermittent point sources that can have a significant impact on water quality when they release into surface waters. The responsibility for preventing SSOs lies with the NPDES wastewater discharger or the operator of the collection system for non-permitted systems that handle wastewater. However, it is important to note that SSOs are not always preventable or reported. There have been no reported sewer overflows in the last 10 years. Based on In the Myers Creek, Cedar Creek and Toms Creek TMDL area of the watershed, a small portion is serviced by municipal WWTPs and have sewer lines, which can increase the likelihood of SSO occurrences (Figure 10).

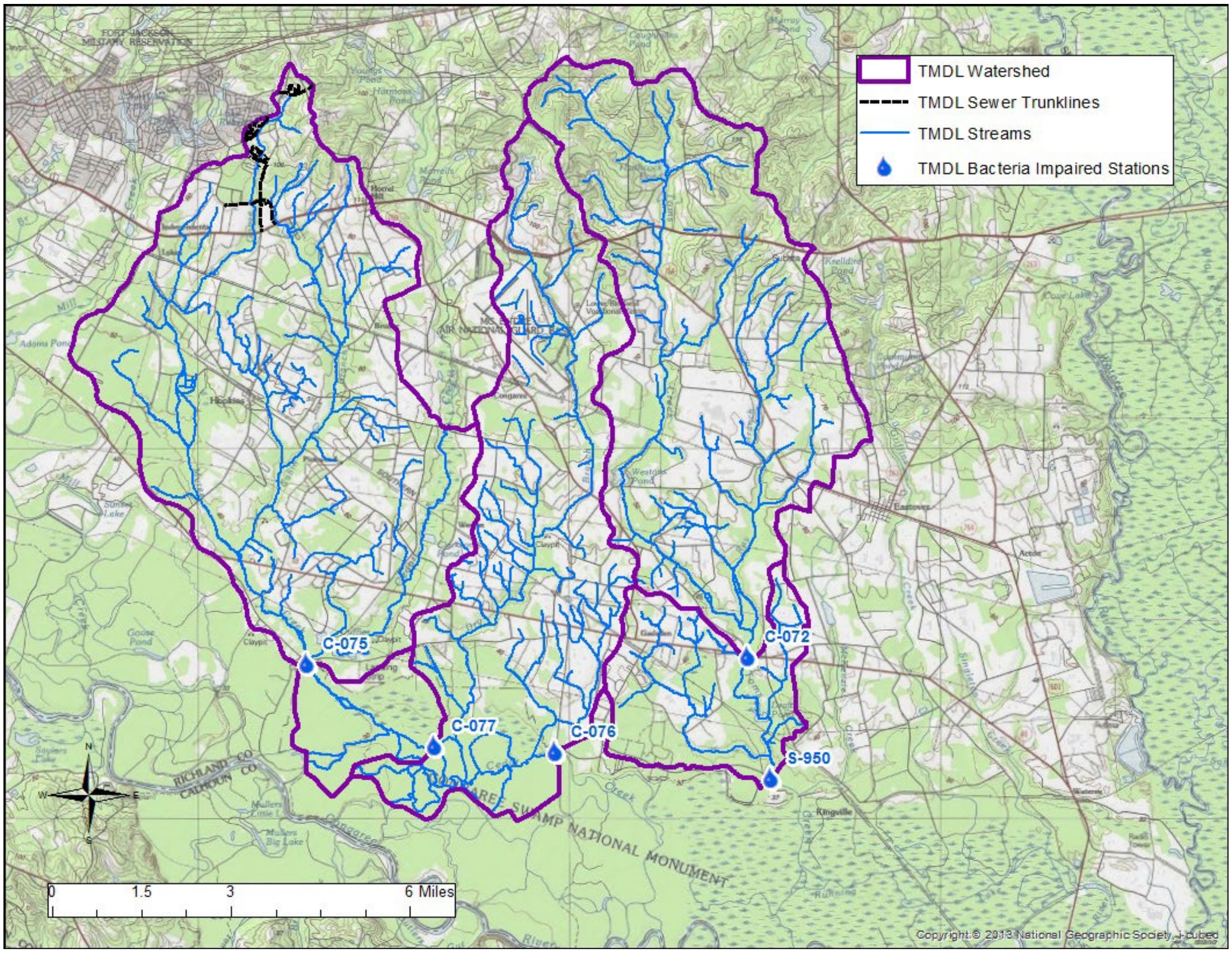

Figure 10. Areas served with sewer lines within Myers Creek, Cedar Creek, and Toms Creek watershed.

The Department acknowledges that MS4s may require multiple permit iterations to fully meet the assumptions and requirements of the TMDL. In order to comply with the MS4 permit, making progress towards achieving the WLA reduction for the TMDL through compliance with the stormwater management plan (SWMP) may be considered sufficient, as long as the criteria of Maximum Extent Practicable (MEP) are met. This allows for flexibility in the implementation process.

For SCDOT, existing and future NPDES MS4 permittees, compliance with the terms and conditions of their NPDES permit is an effective implementation of the WLA to the MEP and demonstrates consistency with the assumptions and requirements of the TMDL. For existing and future NPDES construction and industrial stormwater permittees, compliance with the terms and conditions of their permit is an effective implementation of the WLA. Required load reductions in the LA portion of this TMDL can be implemented through voluntary measures and may be eligible for the *Clean Water Act* (CWA) §319 grants (SCDHEC 2019, "Nonpoint Source Management Plan 2020-2024").

The Department recognizes that adaptive management/implementation of these TMDLs might be needed to achieve the water quality standard.

3.2 Nonpoint Sources

Nonpoint source pollution refers to pollution that originates from various sources across a large area, rather than being released through specific pipes. Nonpoint source pollution arises from a variety of land or water use activities, encompassing practices such as:

- Improper animal-keeping: Inadequate management of animal waste, runoff from livestock operations, and allowing livestock access to surface waters.
- Failing septic tanks: Malfunctioning or poorly maintained septic systems that release contaminants into groundwater or nearby water bodies.
- Agriculture: Runoff of fertilizers, pesticides, and sediment from agricultural lands.
- Forestry practices: Erosion and sedimentation resulting from logging activities and improper forest management.
- Wildlife: Animal waste and other natural sources contribute to water pollution.
- Urban and rural runoff: Surface runoff from developed areas (urban) and open spaces (rural), carrying pollutants like chemicals, oils, and litter into waterways.

These activities can lead to nonpoint source pollution, where pollutants are dispersed and do not have a single identifiable point of origin. These and other nonpoint source contributors located in unregulated areas can contribute to the presence of *E. coli* in the Myers Creek, Cedar Creek, Toms Creek and its tributaries. Nonpoint sources in unregulated areas are addressed through the LA portion of the TMDL, rather than the WLA portion. During precipitation events, nonpoint source contributions to in-stream *E. coli* are likely to increase as runoff carries pollutants from the land into waterways.

3.2.1 Wildlife

Wildlife, including deer, feral pigs, squirrels, raccoons, opossums, waterfowl, and other birds, can contribute to the presence of *E. coli* and other fecal-borne pathogens in waterways. Their feces may directly enter surface waters or be transported into streams through runoff after rainfall events. There is a large feral hog (*Sus scofa*) population within the Congaree National Park boundary. Feral hogs are a highly destructive invasive species in this area. They pose a risk to natural variegation and soil by uprooting acres of forest. Feral hogs are highly intelligent and adaptive (NPS 2024).

While visiting the TMDL area we saw deer, horses, donkeys, goats, birds, and turtles. The South Carolina Department of Natural Resources (SCDNR) releases deer harvest data by county (SCDNR, 2022). According to SCDNR, this data represents 30% of the existing population.

According to the 2022 deer harvest data released by SCDNR, there is an estimated deer population of 18.7 deer per square mile in the Myers Creek, Cedar Creek, and Toms Creek watershed.

Based on a study by Yagow (Yagow 2001), the bacteria production rate for deer was found to be 347 x 10^6 cfu/head-day, although only a portion of this bacteria will enter the water. As such, wildlife can be considered a potential source of *E. coli* in the Myers Creek, Cedar Creek, Toms Creek watershed.

3.2.2 Agriculture

Agricultural activities involving livestock or animal waste can contribute to pathogen contamination of surface waters. Animal feces can enter waterways through runoff or direct deposition. The large quantity of bacteria associated with animal waste makes agricultural activities a significant source of bacteria, including *E. coli*, which can affect water quality. Effective management of manure and animal waste is essential to prevent pathogen contamination in the Myers Creek, Cedar Creek, Toms Creek TMDL watershed.

3.2.2.1 Agricultural Animal Facilities

Under SC Regulation 61-43, owners/operators of most commercial animal growing operations are required to obtain permits for the proper handling, storage, treatment, and disposal of manure, litter, and deceased animals (SCDHEC 2021). These regulations aim to safeguard water quality, ensuring that compliant facilities do not contribute to water quality impairments. While South Carolina currently does not have concentrated animal feeding operations (CAFOs) under NPDES coverage, there are permitted animal feeding operations (AFOs) covered by R. 61-43. These permitted operations, operating under "no discharge" (ND) permits, are prohibited from releasing any discharges into the waters of the state. Any such discharges are illegal and subject to enforcement actions by SCDES.

In the Myers Creek, Cedar Creek and Toms Creek watershed, there is one active agricultural facility (Table 8 and Figure 11). Previously, there were several active agricultural facilities (Table 8) that might have contributed to the *E. coli* problem. These inactive facilities are no longer operational.

Table 8. Agricultural Facilities in the Myers Creek, Cedar Creek and Toms Creek TMDL area of the watershed.

Permit Number	Facility name	Animal Type	AFO Size	Status
ND0015415	Laurion Dairy	Dairy cows	Small	Inactive
ND0071862	Jones Rabbit Facility	Rabbit	N/A	Inactive
ND0072681	Bell Poultry	Poultry	Medium	Inactive
ND0086428	Hamilton Stables	Horse	Small	Active
ND0072401	Woods Poultry Facility	Poultry	Medium	Inactive
ND0072494*	Griffin Creek Farm	Poultry	Medium	Inactive
ND0071404	Unity Farms	Poultry	Small	Inactive

**The facility is located outside of the TMDL area. These Manure Utilization Sites are no longer operational.*

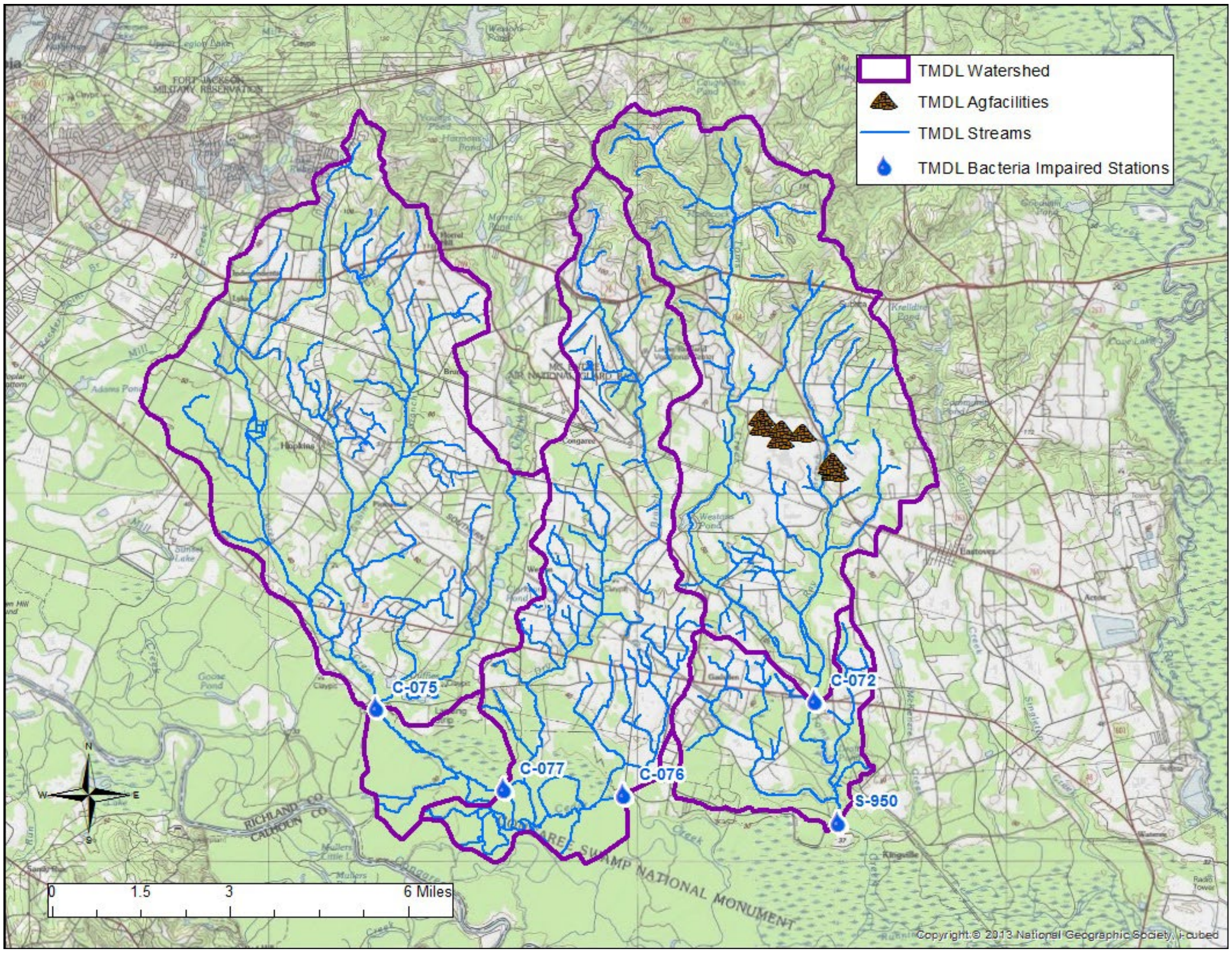

Figure 11. Active agricultural facilities within Myers Creek, Cedar Creek and Toms Creek TMDL area of the watershed.

3.2.2.2 Grazing Livestock

Livestock, especially cattle, are known contributors of *E. coli* and other fecal-borne pathogens in streams. On average, cattle produce approximately 1.0E+11 cfu/day per animal of FC bacteria. Grazing cattle and other livestock may indirectly contaminate streams with bacteria by runoff from pastures, or directly by defecating into streams and ponds. The grazing of livestock in pastures is not regulated by SCDES.

The United States Department of Agriculture's National Agricultural Statistics Service reported 1,400 cattle in Richland County in 2017 (USDA NASS, 2019). Based on the assumption of an even distribution of cattle across pasture/hay areas in Richland County, approximate estimates of the cattle population were calculated and are presented in (Table 9). It is estimated that these cattle could contribute up to 3.20E+13 colony-forming units (CFU) of fecal coliform bacteria per day to the entire watershed, with the possibility of some fraction entering the waterways (Table 10). The NLCD classification system, derived from the Anderson Land Cover Classification System, includes the "Pasture/Hay" category, which represents areas where grasses, legumes, or grass-legume mixtures are grown for livestock grazing or hay production on a perennial cycle. However, it should be noted that not all cattle included in the USDA census are grazed, as dairy cattle and feedlot cattle are often confined and not evenly distributed across Pasture/Hay areas. Therefore, the calculations provide an approximate estimation of the grazing cattle population. Nonetheless, the direct discharge of *E. coli* and other fecal coliform bacteria into surface waters by cattle and other livestock remains a potential contributing source within the TMDL watersheds.

Table 9. Grazing cattle per Acre of Pasture/Hay per county.

County	Number of Cattle	Pasture/Hay Acres	Cattle/Acre Pasture/Hay
Richland	1400	14363.59	0.097

Table 10. Estimated Bacteria Produced by Grazing Cattle in TMDL Stations' Drainage Area.

WQM Station	Pasture/Hay Acres	Cattle/Acre of Pasture/Hay	Number of Cattle Grazing in Station DA	Bacteria Produced in Station DA
C-075	1484	0.097	144	1.45E+13
C-077	6	0.097	1	5.85E+10
C-076	1039	0.097	101	1.01E+13
C-072	622	0.097	60	6.06E+12
S-950	131	0.097	13	1.28E+12

3.2.3 Land Application of Industrial, Domestic Sludge, or Treated Wastewater

Industrial and domestic wastewater treatment processes that are permitted under the NPDES may produce solid waste byproducts, known as sludge. Some facilities are authorized to apply this sludge to designated land areas under specific conditions. Similarly, there are NPDES-permitted facilities that can apply treated wastewater effluent to land at designated locations and under specific conditions. The regulations governing land application permits for these facilities can be found in SC Regulation 61-9, Sections 503, 504, or 505 (SCDHEC 2019).

Proper management of waste application is crucial to ensure that pollutants are effectively incorporated into the soil or taken up by plants, preventing their entry into streams or groundwater. If not managed correctly, land application sites can become a source of fecal pathogens and contribute to stream impairments. It's important to note that land application sites are not permitted to discharge directly into waterways. Any direct discharges from these sites to surface waters are illegal and can result in enforcement actions by SCDES.

In the TMDL watershed, one facility has a permit to apply sludge from treated wastewater to land. This facility is Manchester Farms, Inc./Hopkins Processing Plant (permit ND0068969). The facility is authorized to apply treated sludge from its WWTP to fields located within the TMDL watershed (Figure 12). The specific application rates of sludge vary depending on field conditions and the production rates of each facility. If not properly managed, land application sites can be a source contributing to *E. coli* exceedances in the TMDL watersheds.

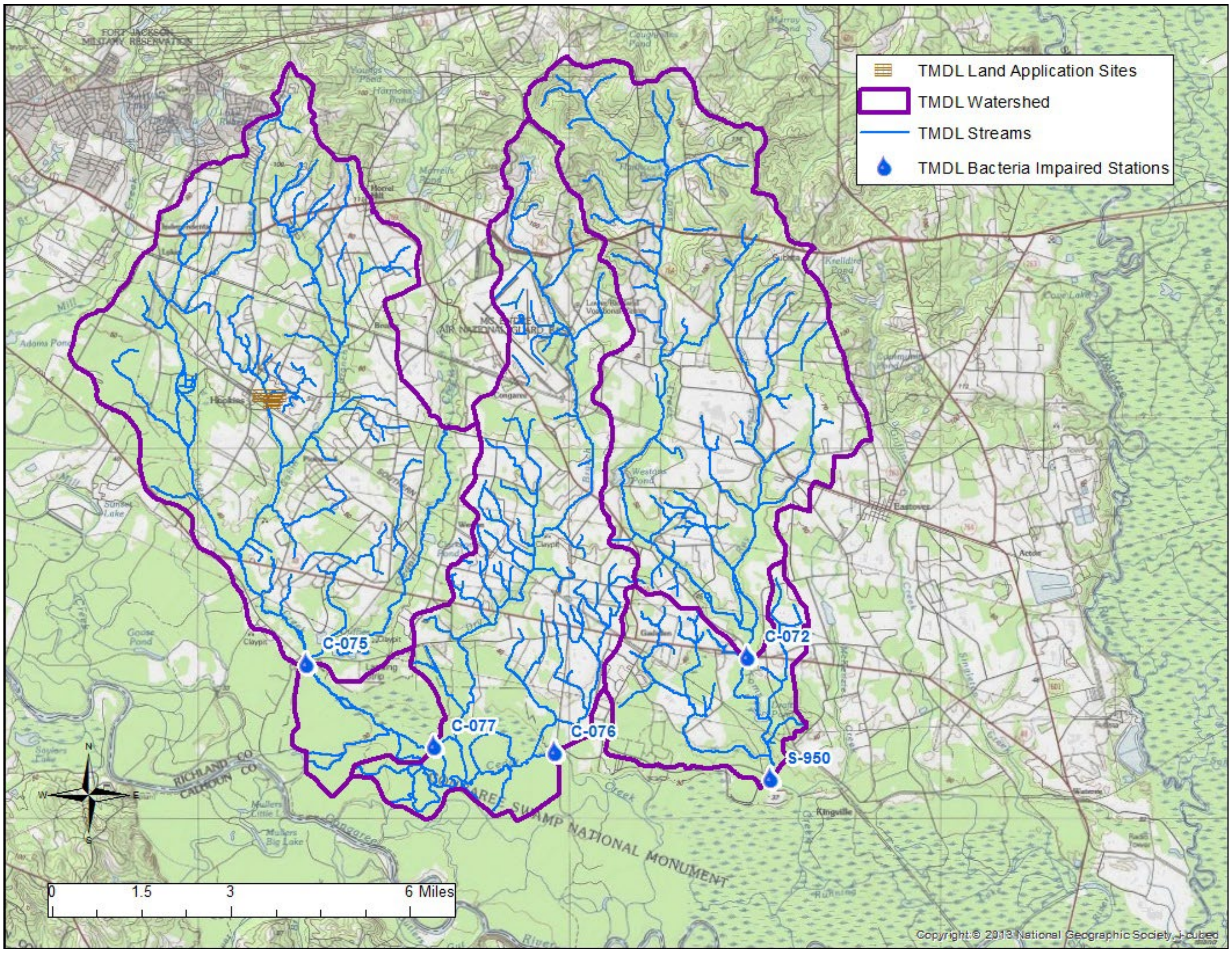

Figure 12. Land application sites within the Myers Creek, Cedar Creek and Toms Creek TMDL area of the watershed.

3.2.4 Leaking Sanitary Sewers and Illicit Discharges

Leaking sewer pipes and illicit sewer connections pose a significant public health risk by releasing partially treated or untreated human waste into the environment. Without direct monitoring, it is difficult to accurately quantify the extent of these sources, as their impact depends on factors such as volume and proximity to surface water. Untreated domestic wastewater typically contains bacteria levels ranging from 10^4 to 10^6 MPN per 100mL. GIS data indicates that some areas within the TMDL drainage area are serviced by a sanitary sewer system, suggesting the potential for leakage (Figure 10).

Illicit sewer connections that redirect sewage into storm drains result in the direct discharge of sewage through the outfalls of the storm drainage system. To evaluate this issue, it is crucial to conduct monitoring of the storm drain outfalls during periods of dry weather to determine the presence or absence of sewage in the drainage systems. This monitoring process is essential for identifying and documenting the extent of illicit sewer connections and their impact on the environment. Leaking sewer lines and illicit sewer connections can be one of the potential sources of *E. coli* exceedances in the Myers Creek, Cedar Creek, Toms Creek TMDL watershed.

3.2.5 Failing Septic Systems

According to the 2010 U.S. Census, the estimated population of the Myers Creek, Cedar Creek, and Toms Creek TMDL area of the watershed is 7,380 people in 3,036 housing units. Based on available data and analysis, approximately 6% of the population (446 people) and 5.7% of the housing units (173 units) are estimated to be connected to sewer lines (Figure 10). The remaining 94% of the population (6,934 people) and 94.3% of the housing units (2,863 units) are estimated to rely on onsite wastewater treatment systems (OWTS) such as septic tanks. It should be noted that the GIS layer for sewer lines may not include all newer or smaller branch lines, potentially underrepresenting the proportion of the population and housing units served by wastewater treatment plants. Consequently, this calculation of usage of septic tanks in this watershed may be overestimated.

When installed and maintained properly, septic systems are safe, long-term options for treating wastewater and preserving valuable water resources. Regulations stipulate that permits for new septic tanks will not be issued when a wastewater treatment facility/public sewer line is accessible for connection.

SCDES has an enforcement program that investigates complaints regarding the functioning of an onsite wastewater system and if an unpermitted discharge of sewage or other domestic wastewater is identified, prompt timelines for compliance are issued to the responsible party in order to minimize the risk of any discharge presenting significant harm to the environment and public health. At present, the state lacks sufficient regulatory authority for maintenance and upkeep of onsite wastewater systems.

Failing septic systems can be one of the potential sources of *E. coli* exceedances in the Myers Creek, Cedar Creek, Toms Creek TMDL watershed.

3.2.6 Urban and Suburban Runoff

Domesticated pets, such as dogs and cats, are contributors to *E. coli* and other bacteria in urban and suburban areas. Additionally, wildlife species like deer, squirrels, raccoons, opossums, and birds also contribute to the overall bacteria load. In the Myers Creek, Cedar Creek, and Toms Creek TMDL watershed area, urban runoff is not expected to be significant since it has a small percentage of developed area (Table 7). In the remaining parts of the TMDL watershed where there is limited development, urban runoff is considered to have a negligible impact.

Unregulated MS4 communities have the potential to contribute to *E. coli* and other bacteria through stormwater runoff. These unregulated entities are subject to the LA portion of the TMDL document.

4.0 Method

The TMDLs for the Myers Creek, Cedar Creek and Toms Creek Watershed were determined using the load-duration curve methodology. This method enables the calculation of TMDLs that account for different hydrologic conditions (Bonta and Cleland 2003). The process involves creating load-duration curves by analyzing the cumulative frequency distribution of stream flow and bacteria concentration data. By utilizing these curves, both the existing pollutant load and the total maximum daily load for a particular waterbody can be estimated. The development of flow-duration curves (FDC) and load-duration curves (LDC) is explained in depth in this section.

4.1 Flow-Duration Curve

The first step of the LDC methodology involves the development of FDC. FDCs are graphical representations that illustrate the cumulative frequency of historical flow data. Typically, these curves are constructed using data obtained from long-term, continuous-record flow-gaging stations maintained by the United States Geological Survey (USGS). These gages provide reliable and comprehensive information on stream flow over an extended period, enabling the creation of accurate flow-duration curves.

In the Myers Creek, Cedar Creek and Toms Creek TMDL watershed, there is no active USGS surface water flow gaging station. Therefore, USGS surface water flow gaging station 02169570 on Gills Creek was used. Daily mean discharge data from this gage for the period between January 1, 2003, and October 23, 2023, were obtained from the website https://waterdata.usgs.gov/sc/nwis/rt. These data were used to generate FDCs. To account for differences in drainage areas between the USGS station's drainage areas and the TMDL station's drainage areas, drainage area ratios were calculated. The daily mean streamflow from the USGS stations was adjusted for each

TMDL station by multiplying the instream flows by the ratio of the TMDL station's drainage.

To create the FDCs, estimated daily flows for each TMDL station were ranked from highest to lowest. The percentage of time that these flows were exceeded was then calculated. These data points were plotted on a semi-log plot, with flows represented on the y-axis and percent exceedance on the x-axis. In the FDC, higher flows correspond to lower percent exceedances, indicating that these flows are rarely exceeded. Conversely, lower flows correspond to higher percent exceedances, indicating that these flows are nearly always exceeded.

The flows in FDC are categorized into five hydrologic categories: High flows, moist conditions, mid-range flows, dry conditions, and low flows. Categorizing the flows into these categories and comparing bacteria exceedances can provide insights into the potential sources of pollution. A high number of exceedances during dry conditions may indicate NPDES permitted point sources not meeting their bacteria limits, illicit connections, or direct deposition while exceedances during wet conditions indicate runoff from developed areas, impervious surfaces, and nonpoint sources (Table 11). It is important to note that data within the high flow and low flow categories are typically not used in the development of a TMDL due to the infrequency of these flow conditions.

Table 11. Likelihood of contribution of various sources for flow duration categories.

Contributing Source Area	Duration Curve Zone				
	High Flow	**Moist**	**Mid-Range**	**Dry**	**Low Flow**
Point Source				*M*	*H*
On-site wastewater systems			*H*	*M*	
Riparian Areas		*H*	*H*	*H*	
Storm water: Impervious Areas		*H*	*H*	*H*	
Combined sewer overflows	*H*	*H*	*H*		
Storm water: Upland	*H*	*H*	*M*		
Bank erosion	*H*	*M*			
Note: Potential relative importance of source area to contribute loads under given hydrologic condition *(H: High; M: Medium)*					

USEPA 2007, 841-B-07-006 Table 4-1

There are no wastewater treatment plants (WWTPs) upstream of the USGS gage that needed to be accounted for. Flow duration curves for the TMDL stations are shown on Figure 13, Figure 21, Figure 23, Figure 25, and Figure 27.

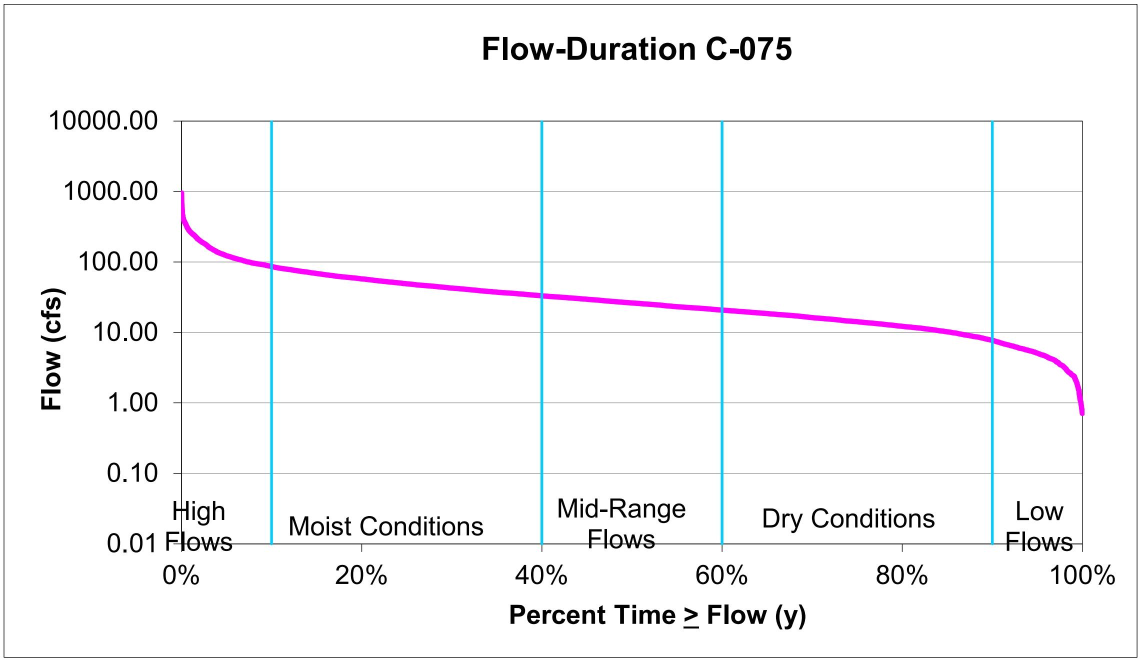

Figure 13. Flow duration curve for station C-075.

4.2 Load Duration Curve

After generating the FDCs, the next step in the analysis was to create LDCs by combining the adjusted flow duration data with *E. coli* data. The *E. coli* data were collected from four TMDL stations C-075 (2003, 2013-2023), C-077 (2009, 2015-2016), C-076 (2009, 2015-2015, 2022-2023), C-072 (2009, 2013-2023), and S-950 (2003).

The LDCs provide valuable insights into the relationship between specific flow conditions and the corresponding instream *E. coli* loads. By examining the variations in *E. coli* levels under different flow conditions, it becomes possible to assess the sources and transport mechanisms of *E. coli*, as well as the associated risks to water quality.

The utilization of *E. coli* data from multiple TMDL stations over an extended period enables a comprehensive assessment of *E. coli* loads in the monitored water bodies. This information facilitates the identification of patterns, trends, and potential sources of contamination, which can be helpful in the development of effective strategies and measures to address water quality impairments caused by *E. coli*.

The *E. coli* target loads for the TMDL stations were determined using the estimated daily instream flows and the water quality criterion (349 MPN/100mL) minus a 5% margin of safety (17 MPN/100 mL). By incorporating the MOS in the target load calculation, the TMDL takes into account the inherent complexities and uncertainties associated with water quality assessment. This approach enhances the effectiveness of the TMDL in protecting and improving water quality by providing a more realistic and protective framework for managing *E. coli* levels.

The Pearson correlation coefficient, also known as Pearson's r, is a statistical measure that quantifies the strength and direction of the linear relationship between two variables. It is denoted by the symbol "r" and takes values between -1 and +1. The interpretation of the coefficient depends on the context of the data and the specific variables being analyzed. It is important to note that the Pearson correlation coefficient measures only linear relationships and may not capture other types of relationships, such as non-linear associations.

Pearson’s r measures the strength and direction of the linear relationship between 24-hour total precipitation and the *E. coli* count for the same day *E. coli* samples. The Pearson’s r values for stations C-075, C-077, C-076, C-072, and S-950 were collected, and they are 0.37, 0.25, 0.18, 0.46, and 0.19, respectively (Table 12).

The correlation coefficient of 0.46 for station C-072 indicates a moderate positive relationship between precipitation and *E. coli* levels (Figure 19). This suggests that there is a tendency for *E. coli* levels to increase on Toms Creek with higher precipitation.

The correlation coefficient of 0.37, 0.25, 0.18, and 0.19 for stations C-075 (Figure 16), C-077 (Figure 17), C-076 (Figure 18), and S-950 (Figure 20), respectively suggests a moderate positive relationship between precipitation and *E. coli* levels, but the strength of the relationship is relatively weaker compared to the C-072.

These correlation coefficients provide insights into the association between precipitation and *E. coli* levels in the respective watersheds, helping to understand the influence of rainfall events on bacterial contamination in the Myers Creek, Cedar Creek and Toms Creek Watershed.

Table 12. Pearson correlation coefficients between precipitation and instream *E. coli* concentrations for the TMDL stations.

TMDL Station	Pearson's r
C-075	0.37
C-077	0.25
C-076	0.18
C-072	0.46
S-950	0.19

LDCs were generated for the five impaired stations using exclusively *E. coli* bacteria data. These curves provide a representation of the relationship between the duration of specific flow conditions and the corresponding *E. coli* loads in the water. By combining information on stream flow and *E. coli* concentrations, the target load for each station was determined.

An existing load was determined for each hydrologic category for the TMDL calculations. The 90th percentile of measured bacteria concentrations within each of the hydrologic categories was multiplied by the flow at each category midpoint (i.e., flow at the 25% duration interval for moist conditions, 50% interval for mid-range, and 75% for dry conditions). Existing loads were then plotted on the load-duration curve (pink line). These values were compared to the target load (green line) at each hydrologic category midpoint to determine the percent load reduction necessary to achieve compliance with the WQS. To calculate existing (pink line) and target loads (green line) for each of the flow ranges represented on the LDC graph, the following equations were used:

Existing Load (MPN/day) = Mid-Point Flow in Each Hydrologic Category (ft^3/s) x 90th %tile *E. coli* Concentration x Conversion Factor (24465758.4)

Eq. 2

WLA + LA to Meet Target Load (MPN/day) = Mid-Point Flow in Each Hydrologic Category (ft^3/s) x 332 (*E. coli* WQ criterion MPN/day – 5% MOS) x Conversion Factor (24465758.4)

Eq. 3

In an LDC, the independent variable (X-axis) represents the percentage of time that the estimated flow in the stream would be greater than the flows on the flow duration curve at that point. In this case, flows are represented by categories: high, moist, mid-range, dry, and low. The dependent variable (Y axis) represents the bacteria load

(MPN/day) at each flow. LDCs for TMDL stations are shown on Figure 14, Figure 22, Figure 24, Figure 26, and Figure 28.

There are no NPDES wastewater dischargers upstream of the TMDL stations, except for SC0032018 on Cedar Creek. This discharger with 0.0158 MGD flow is so small that it does not need to be taken into consideration.

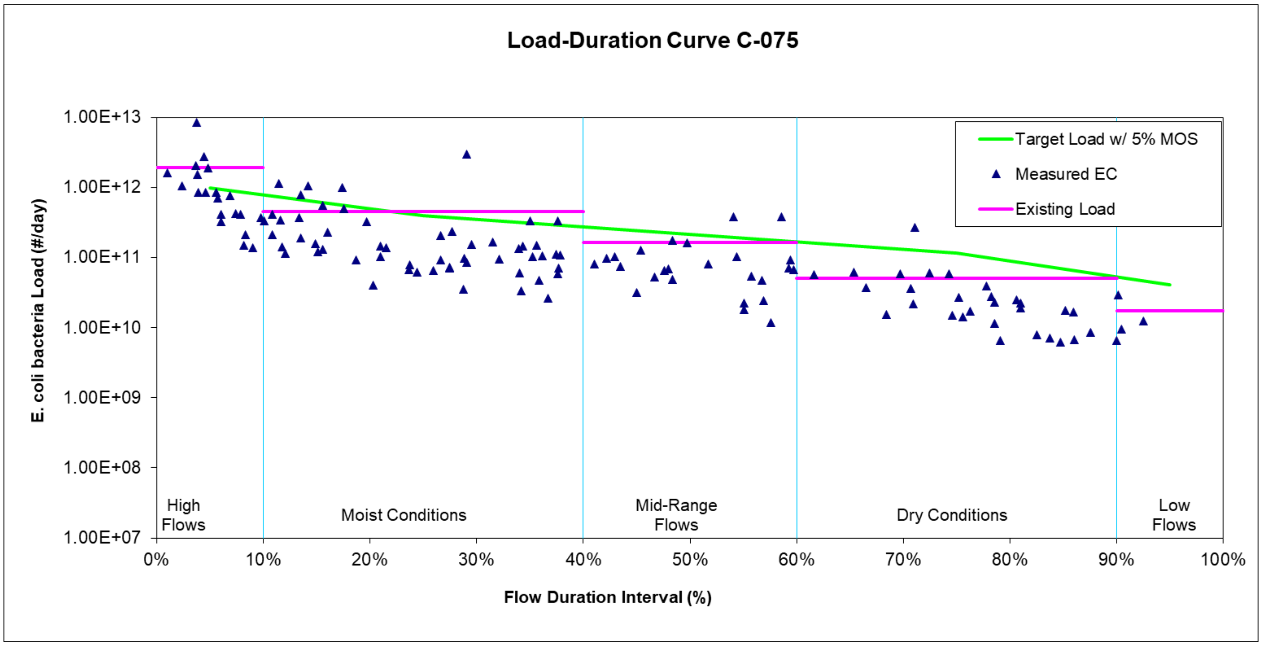

Figure 14. LDC of C-075.

5.0 Development of the TMDL

5.1 Critical Conditions

The critical condition for each monitoring station is identified as the flow condition requiring the largest percent reduction within the 10-90% flow duration intervals. 'Low' and 'High' flow categories were not included in the analysis. Critical conditions for the WQM stations are listed in Table 13, which also provides percent reductions in other flow categories for TMDL stations. These reductions are included for informational purposes and to encourage permitted entities and others implementing the TMDLs to investigate the causes of exceedances in these flow categories.

Table 11 provides a great insight to the likely bacteria sources at various flow duration categories. Based on this table, C-075, C077, C-076, and S-950 exhibit the highest exceedances in the 'Moist' category, which means the main contributors are "Riparian Areas', 'Storm water: Impervious Areas', 'Combined sewer overflows', and 'Storm water: Upland'.

Unlike the other WQ Sites, C-072 exhibits exceedances under all flow categories, suggesting that these exceedances are not solely attributable to precipitation-related runoff. Instead, they may be the result of various factors such as 'On-site wastewater systems', 'Riparian Areas', 'Storm water: Impervious Areas', 'Combined sewer overflows', and 'Storm water: Upland'.

By considering exceedances across different flow categories, the intention is to prompt permitted entities to delve deeper into understanding the sources and mechanisms contributing to water quality impairments at the TMDL station. This information can assist them in developing appropriate strategies and measures to address the issues effectively and achieve the necessary reductions in pollutant levels.

Table 13. Myers Creek, Cedar Creek and Toms Creek TMDL stations and required (**bolded**) reductions to meet the WQS. Percent reductions for remaining flow conditions are included for information purposes.

Station	Moist (10-40%)	Mid-Range (40-60%)	Dry (60-90%)
C-075	**12%**	NRN	NRN
C-077	**54%**	NRN	27%
C-076	**62%**	57%	NRN
C-072	27%	**71%**	31%
S-950	**63%**	NRN	NRN

NRN = No reduction needed for this flow range

5.2 Existing Load

In the TMDL calculations for each TMDL station, the existing loads were determined using the mid-point flow and 90th percentile *E. coli* concentration of each hydrologic category. This approach is described in Section 4.0 of the TMDL document. The existing load under the critical condition specified in Section 5.1 was utilized for the TMDL calculations.

The existing load considers loadings from all potential sources that contribute to water pollution at the TMDL stations. This includes various sources such as surface runoff, point source discharges exceeding permit limits, farm animals, pets, failing septic systems, and wildlife. By considering these different sources, a comprehensive assessment of the existing pollutant load at the TMDL station can be obtained, allowing for the development of appropriate load reduction targets and strategies to improve water quality.

5.3 Waste Load Allocation

The WLA is the portion of the TMDL allocated to NPDES-permitted point sources. These point sources typically include industrial facilities, wastewater treatment plants, and other regulated dischargers.

It is important to note that the WLA does not cover illicit dischargers, including SSOs or other illegal sources. Illicit discharges are considered unauthorized and are not granted any allocation under the TMDL. These sources are illegal because they introduce pollutants into the water without proper permits or compliance with regulatory requirements.

The WLA is specifically designed to address the allowable pollutant loadings from permitted point sources, while other mechanisms and enforcement actions are typically employed to address and reduce the impacts of illicit discharges and SSOs to protect water quality and public health.

5.3.1 Continuous Point Sources

There are no NPDES-permitted WWTPs that need to be considered in this TMDL.

5.3.1 Intermittent Point Sources

Intermittent point sources include all NPDES-permitted stormwater discharges, including current and future MS4s, construction and industrial stormwater discharges covered under permits numbered SCS000000 & SCR100000 regulated under SC *Water Pollution Control Permits* Regulation 122.26(b)(14) & (15). Illicit discharges, including SSOs, are not covered under any NPDES permit and are subject to enforcement mechanisms. Other non-urbanized areas may be required under the NPDES Phase II Stormwater Regulations to obtain a permit for the discharge of stormwater.

The South Carolina Department of Transportation (SCDOT) is one of the designated MS4s within Myers Creek, Cedar Creek and Toms Creek TMDL watershed TMDL watershed. SCDOT operates under NPDES MS4 Permit SCS040001 and owns and operates roads within the watershed. However, the Department recognizes that SCDOT is not a traditional MS4 in that it does not possess statutory taxing or enforcement powers. SCDOT does not regulate land use or zoning, or issue building or development permits.

Waste load allocations 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 regulated stormwater discharges are required to meet the percentage reduction or the existing instream standard for the pollutant of concern. The percentage reduction is based on the maximum percent reduction (critical condition) within any hydrologic category necessary to achieve target conditions. The reduction percentages in these TMDLs also apply to the *E. coli* waste load attributable to those areas of the watershed that are covered or will be covered under NPDES MS4 permits (Table 14).

5.4 Load Allocation

The LA applies to the nonpoint sources of *E. coli* and other FC bacteria and is expressed both as a load and as a percent reduction. The load allocations are calculated as the difference between the target load under the critical condition and the point source WLA. There may be other unregulated MS4s that are subject to the LA components of these TMDLs. At such time that the referenced entities or other future unregulated entities become regulated NPDES MS4 entities and are subject to applicable provisions of SC Regulation 61-68D, they will be required to meet load reductions prescribed in the WLA component of the TMDL. 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 2019).

5.5 Margin of Safety

A MOS allows for an accounting of the uncertainty in the relationship between pollutant loads and receiving waters. MOS can be incorporated either explicitly or implicitly by using conservative assumptions. An explicit 5%, 17 mpn/100 mL of the WQS (349 mpn/100 mL), is deducted in the TMDL calculations as MOS (Table 14).

5.6 Calculation of the TMDL

While TMDLs for most pollutants are expressed as a mass load (lbs/day), bacteria TMDLs for continuous dischargers are expressed as organism counts per day or concentration (mpn/100 mL, #/100 mL, cfu/100 mL), and as percent reduction for intermittent point sources. Myers Creek, Cedar Creek, and Toms Creek TMDL targets are based on a single sample maximum WQS for *E. coli* because there is not sufficient data to evaluate the 30-day geometric mean component of the WQS for *E. coli*. The TMDL load is the sum of the WLA for point sources and LA for non-point sources and a 5% explicit MOS, which is based on the mid-point of the critical flow zone or category.

5.7 Seasonal Variability

Federal regulations require that TMDLs consider seasonal variations in loading to the watershed, which accounts for environmental conditions such as precipitation, flow, temperature, etc. TMDLs for the Myers Creek, Cedar Creek and Toms Creek TMDL watershed include instream *E. coli* data collected from 2009, 2013 through 2023 under varying hydrological conditions, seasons, precipitation, and other factors.

5.8 Reasonable Assurance

When a TMDL is developed for a pollutant that originates from both point and nonpoint sources, or from nonpoint sources only, EPA guidance emphasizes the need to provide reasonable assurances that nonpoint source controls will effectively achieve their expected load reductions. For point sources, such as NPDES-permitted dischargers, the WLA provided in their permits already ensures this assurance.

However, for unregulated nonpoint sources of pollutants, achieving the necessary load reductions can be more challenging. To address this, various measures can be employed, including the implementation of Best Management Practices (BMPs), local ordinances, and outreach and educational efforts. CWA §319 grant funding may be available to interested parties for the purposes of implementing these measures.

Within the Myers Creek, Cedar Creek, and Toms Creek TMDL watershed, there are multiple non-profit, volunteer-based conservation groups actively engaged in environmental preservation. Among these organizations is Friends of the Congaree Swamp, which plays significant roles in safeguarding the river's water quality. Additional groups that may be interested in this TMDL: Gills Creek Watershed

Association, Midlands Sierra Club and the Lower Richland branch of the NAACP, and TCTAC (USC).

South Carolina Adopt-a-Stream (SC AAS) is a volunteer citizen science program which provides opportunities to engage interested parties in the protection and management of South Carolina's waterways. Groups are involved in monitoring and reporting of water quality parameters. In the Myers Creek, Cedar Creek, and Toms Creek TMDL watershed, there are multiple trained volunteer SC AAS groups. These groups are directly involved in monitoring and reporting of water quality data.

As evidenced by the presence and active engagement of volunteer non-profit organizations, consortiums, and advocacy groups described earlier, there is a collective and dedicated effort to improve water quality within the Myers Creek, Cedar Creek, and Toms Creek TMDL watershed. These entities are actively involved in conservation and restoration activities, which indicates a commitment to addressing the *E. coli* impairments. Given the demonstrated involvement and dedication of these groups, there is a reasonable assurance that the LA portion of the TMDLs will be effectively implemented.

Table 14. TMDLs for Myers Creek, Cedar Creek, Toms Creek and its tributaries. TMDLs, WLAs, and MOS are expressed as the mpn/day.

Station	Existing Load (mpn/day)	TMDL (mpn/day)	MOS (mpn/day)	WLA			LA	
				Continuous source[1] (mpn/day)	Intermittent MS4[2, 3] (% reduction)	Intermittent MS4 SCDOT[3,4] (% reduction)	mpn/day	% Reduction[3]
C-075	4.55E+11	4.19E+11	2.04E+10	NA	12%	12%	3.99E+11	12%
C-077	9.96E+11	4.62E+11	2.25E+10	NA	54%	54%[6]	4.39E+11	54%
C-076	1.84E+12	7.40E+11	3.61E+10	NA	62%	62%	7.04E+11	62%
C-072	1.35E+11	9.74E+10	4.74E+09	NA	71%	71%	9.26E+10	71%
S-950[5]	1.35E+11	9.74E+10	4.74E+09	**NA**	71%	71%	9.26E+10	71%

Table Notes:

1. Not applicable at this time due to absence of dischargers. Future continuous dischargers will be required to meet the prescribed loading for pollutants of concern. Future loadings will be calculated based on permitted flow and *E. coli* concentration of 349 mpn/100 mL.
2. Percent reduction applies to all NPDES-permitted stormwater discharges, including current and future 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 the percentage reduction or the existing instream standard for pollutants of concern by their NPDES Permit.
3. The percent reductions apply to existing instream *E. coli*.
4. By implementing the BMPs that are prescribed in either the SCDOT annual SWMP or the SCDOT MS4 permit to address *E. coli*, the SCDOT will comply with these TMDLs and its applicable WLA to the MEP as required by its MS4 permit.
5. The TMDL limits from C-072 were extended to S-950. S-950 only had data from 2003, which is not sufficient to establish a TMDL limit for this station.
6. The total developed area in this TMDL watershed is currently less than 5% and the Department deems the contributions from SCDOT negligible, and no reduction of bacteria is necessary at this time. If the total developed area in this TMDL watershed increases to 5% and above, SCDOT will comply with applicable WLA to the MEP as required by its NPDES MS4 permit.

6.0 Implementation

As implementation strategies progress, SCDES will continue to monitor the effectiveness of these measures and evaluate water quality where deemed appropriate. The Department recognizes that adaptive management might be necessary to achieve the water quality standard and we are committed to targeting the load reductions needed to improve water quality in the Myers Creek, Cedar Creek, Toms Creek watershed. As additional data and/or information become available, it may become necessary to revise and/or modify the TMDL target accordingly. The implementation strategies presented below are not inclusive and are only provided as guidance.

6.1 Continuous Point Sources

NPDES permitted continuous point sources are required to meet the instream WQS for *E. coli* at the end of pipe. Currently, there are no WWTP in the TMDL area of Myers Creek, Cedar Creek, Toms Creek. Following the EPA approval of this TMDL document, future facilities will be required to monitor for *E. coli* and meet the WQS at the end of pipe and other requirements stated in their permit. CWA §319 grants are not available for implementation of the WLA component of these TMDLs, however, there may be other sources of funding for capital improvements.

6.2 Intermittent Point Sources

NPDES MS4 entities are required to target and show progress towards implementing the calculated percent reductions to the MEP with each permit cycle by following their permit requirements. These entities are responsible for documenting and reporting their progress toward achieving the percent reductions allocated to the MS4s in the Myers Creek, Cedar Creek and Toms Creek watershed.

An iterative approach of water quality monitoring, illicit source detection, and elimination, deploying best management practices (BMPs) and evaluation of their effectiveness, outreach and education, optimization of other tools such as local ordinances, and revision of their stormwater management plan (SWMP) as needed in reducing *E. coli* loading to Myers Creek, Cedar Creek, Toms Creek and its tributaries is expected to show improvements in WQS.

For SCDOT, existing, and future NPDES MS4 permittees, compliance with the terms and conditions of the NPDES permit is effective implementation of the WLA to the MEP and demonstrates consistency with the assumptions and requirements of the TMDL. For existing and future NPDES construction and industrial stormwater permittees, compliance with terms and conditions of the permit is effective implementation of the WLA. Voluntary load reductions in the LA portion of these TMDLs can be implemented through voluntary measures and may be eligible for CWA §319 grants (SCDHEC 2019, "Nonpoint Source Management Plan 2020-2024").

NPDES-permitted continuous point source dischargers are required to meet the WQS for *E. coli* at the end of their discharge pipe. NPDES-permitted intermittent sources, MS4s, are required to target and show progress towards achieving the reductions shown in (Table 14) to the MEP by each permit cycle. There may be other regulated activities, such as land application of sludge and animal feeding operations, that require permits and are not allowed to contribute to bacteria loadings to streams.

Unregulated sources in these TMDL watersheds may include resident and transient wildlife, improper animal keeping practices, clear cutting, and surface runoff from unregulated areas. These sources may be reduced through local ordinances, education through outreach, partnerships with local NGOs and federal agencies, and CWA §319 funded opportunities.

While WLAs and percent reductions for continuous and intermittent NPDES permitted point source dischargers are based on the critical flow category (moist in this case) for the TMDL stations, conditions in other flow categories with *E. coli* exceedances should also be considered when implementing this TMDL. Because exceedances occurring during dryer conditions are likely from a different source than those occurring during wetter conditions (Table 14).

6.3 Nonpoint Sources

South Carolina has several tools available for implementing the nonpoint source component of this TMDL.

Interested parties (local stakeholder groups, universities, local governments, etc.) may be eligible to apply for CWA §319 grants to fund the installation of BMPs that will implement the LA portion of these TMDLs and reduce nonpoint source fecal coliform loadings to impaired areas. Congress amended the CWA in 1987 to establish the §319 Nonpoint Source Management Program. Under §319, States receive grant money to support a wide variety of activities including the restoration of impaired waters. TMDL implementation projects are given the highest priority for §319 funding (SCDHEC 2019, "Nonpoint Source Management Plan 2020-2024"). 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.

SCDES will work with the agencies in the area to provide nonpoint source education in this watershed and the surrounding watersheds.

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Appendix A – Data Used for Calculation of the TMDLs

C-075 date	EC	C-077 date	EC	C-076 date	EC	C-072 date	EC	S-950 date	FC
1/13/2009	64.4	1/5/2009	184.2	1/5/2009	68.3	1/13/2009	178.9	4/7/2003	2200
2/18/2009	73.8	1/12/2009	648.8	1/12/2009	1046.2	2/18/2009	1203.3	4/9/2003	20
3/17/2009	178.9	1/20/2009	135.4	1/20/2009	74.9	3/17/2009	275.5	4/10/2003	67
4/7/2009	44.3	1/26/2009	85.7	1/26/2009	33.6	4/7/2009	90.8	4/16/2003	24
5/19/2009	62.7	2/2/2009	85.5	2/2/2009	48.45	5/19/2009	141.4	4/17/2003	25
6/23/2009	80.4	2/9/2009	91	2/9/2009	37.3	6/23/2009	211.2	4/21/2003	87
7/29/2009	52.8	2/17/2009	52.5	2/17/2009	68.3	7/29/2009	264	4/22/2003	720
8/19/2009	70	2/23/2009	66.3	2/23/2009	55.4	8/19/2009	326.4	5/19/2003	40
9/22/2009	39.2	3/9/2009	59.4	3/2/2009	1251.5	9/22/2009	479.2	5/22/2003	20
12/15/2009	91.2	3/16/2009	201.4	3/9/2009	67.7	12/15/2009	214.8	6/11/2003	31
2/21/2013	68.85	3/23/2009	65.7	3/16/2009	88.6	2/21/2013	64.4	6/19/2003	310
4/30/2013	204.6	3/30/2009	1299.7	3/23/2009	50.4	4/30/2013	132.45	7/10/2003	100
6/27/2013	205.2	4/6/2009	63.7	3/30/2009	866.4	6/27/2013	166.4	7/24/2003	120
8/1/2013	122.3	4/13/2009	235.9	4/6/2009	65.7	8/1/2013	152.9	8/14/2003	33
10/3/2013	51.2	4/20/2009	186	4/13/2009	365.4	10/3/2013	86	8/21/2003	56
12/5/2013	387.3	4/27/2009	84.2	4/20/2009	237.8	12/5/2013	410.6	9/11/2003	110
2/18/2014	579.4	5/4/2009	151.5	4/27/2009	83.3	2/18/2014	167	9/25/2003	52
4/9/2014	79.4	5/12/2009	275.5	5/4/2009	37.9	4/9/2014	80.1	10/8/2003	77
6/19/2014	42.6	5/18/2009	579.4	5/12/2009	135.4	6/19/2014	178.5	10/14/2003	300
8/21/2014	21.3	5/26/2009	204.6	5/18/2009	387.3	8/21/2014	105		
10/9/2014	137.6	6/1/2009	167	5/26/2009	157.7	10/9/2014	166.4		
12/16/2014	36.9	6/8/2009	410.6	6/1/2009	79.4	12/16/2014	64.4		
1/20/2015	59.4	6/15/2009	219.2	6/8/2009	195.6	1/20/2015	72.7		
1/28/2015	71.7	6/22/2009	161.6	6/15/2009	43.6	3/24/2015	60.9		
2/18/2015	165.8	6/29/2009	147.6	6/22/2009	68.4	5/26/2015	133.4		
3/17/2015	77.1	7/6/2009	211.2	6/29/2009	97.2	7/21/2015	387.3		
3/24/2015	63.1	7/13/2009	149.2	7/6/2009	92.4	9/24/2015	387.3		
4/22/2015	29	7/20/2009	138	7/13/2009	79.6	1/13/2016	201.4		
5/19/2015	42	7/27/2009	342	7/20/2009	85.2	3/10/2016	57.3		
5/26/2015	70.3	8/3/2009	215	7/27/2009	91.2	5/24/2016	143		
6/16/2015	26.8	8/10/2009	326.4	8/3/2009	192	8/9/2016	67.7		
7/21/2015	39.9	8/17/2009	299.6	8/10/2009	102.4	9/15/2016	108.1		
7/21/2015	31.5	8/24/2009	494.4	8/17/2009	282.4	11/30/2016	206.4		
8/13/2015	145.4	8/31/2009	582	8/24/2009	79.6	1/24/2017	244.6		
9/10/2015	56.5	9/8/2009	201.6	8/31/2009	129.2	2/15/2017	167		
9/24/2015	248.9	9/14/2009	352.8	9/8/2009	149.6	3/15/2017	214.2		
11/12/2015	272.3	9/21/2009	526.8	9/14/2009	138	4/4/2017	185		
11/17/2015	104.6	9/28/2009	632	9/21/2009	225.2	5/3/2017	307.6		
12/10/2015	146.7	10/5/2009	7945.2	9/28/2009	314	6/15/2017	248.9		
1/13/2016	107.6	10/12/2009	471.2	10/5/2009	2317.6	7/6/2017	178.5		
1/14/2016	93.4	10/21/2009	103.6	10/12/2009	609.2	8/16/2017	86		

C-075 date	EC	C-077 date	EC	C-076 date	EC	C-072 date	EC		
2/11/2016	90.8	10/26/2009	145.6	10/21/2009	219.2	9/14/2017	387.3		
3/10/2016	106.7	11/2/2009	240.8	10/26/2009	174	10/23/2017	2419.6		
3/10/2016	75.9	11/9/2009	248	11/2/2009	145.6	11/13/2017	325.5		
4/14/2016	95.9	11/23/2009	690	11/9/2009	237.6	12/4/2017	117.8		
5/12/2016	135.4	11/30/2009	53.6	11/16/2009	192	1/4/2018	146.7		
5/24/2016	156.5	1/28/2015	88.4	11/23/2009	211.6	2/6/2018	172.2		
6/9/2016	35.9	2/18/2015	178.5	11/30/2009	91.2	3/5/2018	218.7		
7/14/2016	77.6	3/17/2015	137.4	12/7/2009	642.8	4/24/2018	755.6		
8/4/2016	248.1	5/19/2015	71.2	12/14/2009	103.6	5/24/2018	151.5		
8/9/2016	101.4	6/16/2015	124.8	12/21/2009	407.6	6/18/2018	137.4		
9/8/2016	75.4	7/21/2015	88	12/29/2009	663.2	8/13/2018	2419.6		
9/15/2016	117.8	8/13/2015	166.6	1/28/2015	128.1	9/26/2018	240		
11/30/2016	80.5	9/10/2015	248.9	2/18/2015	172.2	10/3/2018	275.5		
12/8/2016	648.8	12/10/2015	111.2	3/17/2015	150	11/27/2018	93.3		
1/24/2017	870.4	2/11/2016	166.4	4/22/2015	922.2	12/13/2018	178.9		
2/15/2017	117.8	3/10/2016	124.6	5/19/2015	33.1	1/2/2019	127.4		
3/15/2017	228.2	4/14/2016	141.4	6/16/2015	55	1/16/2019	195.6		
4/4/2017	63.7	5/12/2016	365.4	7/21/2015	101.4	2/12/2019	119.8		
5/3/2017	53	6/9/2016	410.6	8/13/2015	263.4	3/7/2019	67.7		
6/15/2017	129.6	7/14/2016	131.4	9/10/2015	155.3	4/1/2019	142.1		
7/6/2017	125.9	8/4/2016	435.2	11/12/2015	613.1	5/6/2019	613.1		
8/16/2017	178.5	9/8/2016	325.5	12/10/2015	107.6	6/12/2019	325.5		
9/14/2017	298.7	12/8/2016	816.4	1/14/2016	218.7	7/9/2019	1046.2		
10/23/2017	648.8			2/11/2016	137.9	8/6/2019	613.1		
12/4/2017	88.4			3/10/2016	53.8	9/11/2019	224.7		
1/4/2018	65			4/14/2016	98.7	10/8/2019	131.7		
2/6/2018	143.9			5/12/2016	307.6	11/18/2019	260.3		
3/5/2018	63.1			6/9/2016	71.7	12/3/2019	214.3		
4/24/2018	436			7/14/2016	44.8	1/27/2020	134		
5/24/2018	131.7			8/4/2016	488.4	2/5/2020	101.9		
6/18/2018	72.7			9/8/2016	129.6	3/23/2020	201.4		
7/19/2018	34.5			12/8/2016	648.8	4/6/2020	195.6		
8/13/2018	260.3			1/4/2022	2419.6	5/21/2020	387.3		
9/26/2018	98.8			2/8/2022	579.4	6/24/2020	648.8		
10/3/2018	102.2			3/14/2022	1299.7	7/7/2020	1844.4		
11/27/2018	214.3			4/14/2022	107.6	8/6/2020	449.4		
12/13/2018	156.5			5/24/2022	816.4	9/8/2020	185		

C-075 date	EC			C-076 date	EC	C-072 date	EC		
1/2/2019	73.8			6/6/2022	33.1	10/7/2020	275.5		
1/16/2019	51.2			7/7/2022	175.6	11/12/2020	2419.6		
2/12/2019	52.9			1/4/2023	1732.9	12/1/2020	344.8		
3/7/2019	61.3			2/15/2023	1413.6	1/20/2021	103.9		
4/1/2019	96			3/14/2023	248.9	2/23/2021	64.4		
5/6/2019	298.7			4/4/2023	167	3/16/2021	146.7		
6/11/2019	228.2			5/17/2023	72.7	4/19/2021	98.5		
7/9/2019	689.3			6/20/2023	1046.2	5/11/2021	579.4		
8/6/2019	93.3					6/1/2021	488.4		
9/11/2019	36.4					7/14/2021	133.3		
10/8/2019	21.6					8/2/2021	201.4		
11/18/2019	124.6					9/8/2021	129.6		
12/3/2019	86					10/12/2021	387.3		
1/27/2020	341					11/1/2021	344.8		
2/5/2020	178.5					12/1/2021	248.9		
3/23/2020	56.1					1/4/2022	727		
4/6/2020	29.5					2/8/2022	461.1		
5/21/2020	172.3					3/14/2022	298.7		
6/24/2020	2419.6					4/14/2022	224.7		
7/7/2020	2746.8					5/24/2022	2419.6		
8/6/2020	82.8					6/6/2022	152.9		
9/8/2020	159.7					7/7/2022	186		
10/7/2020	727					8/2/2022	275.5		
11/12/2020	613.1					9/12/2022	365.4		
12/1/2020	435.2					10/12/2022	248.9		
1/20/2021	79.8					11/7/2022	275.5		
2/23/2021	150					12/6/2022	816.4		
3/16/2021	32.3					1/4/2023	1986.3		
4/19/2021	44.1					2/15/2023	193.5		
5/11/2021	96					3/14/2023	201.4		
6/1/2021	24.3					4/4/2023	186		
7/14/2021	129.1					5/17/2023	178.5		
8/2/2021	167					6/20/2023	920.8		
9/8/2021	114.5								
10/12/2021	115.3								
11/1/2021	137.4								
12/1/2021	85.7								

C-075 date	EC								
1/4/2022	613.1								
2/8/2022	178.9								
3/14/2022	248.1								
4/14/2022	166.4								
5/24/2022	101.9								
6/6/2022	28.2								
7/7/2022	176.4								
8/2/2022	28.5								
9/12/2022	248.9								
10/12/2022	86								
11/7/2022	156.5								
12/6/2022	325.5								
1/4/2023	579.4								
2/15/2023	172.2								
3/14/2023	365.4								
4/4/2023	142.1								
5/17/2023	65								
6/20/2023	178.9								

The *E. coli* water quality criterion is 349 MPN/100mL.
The fecal coliform water quality criterion is 400 MPN/100mL.

Appendix B – Land Use Maps

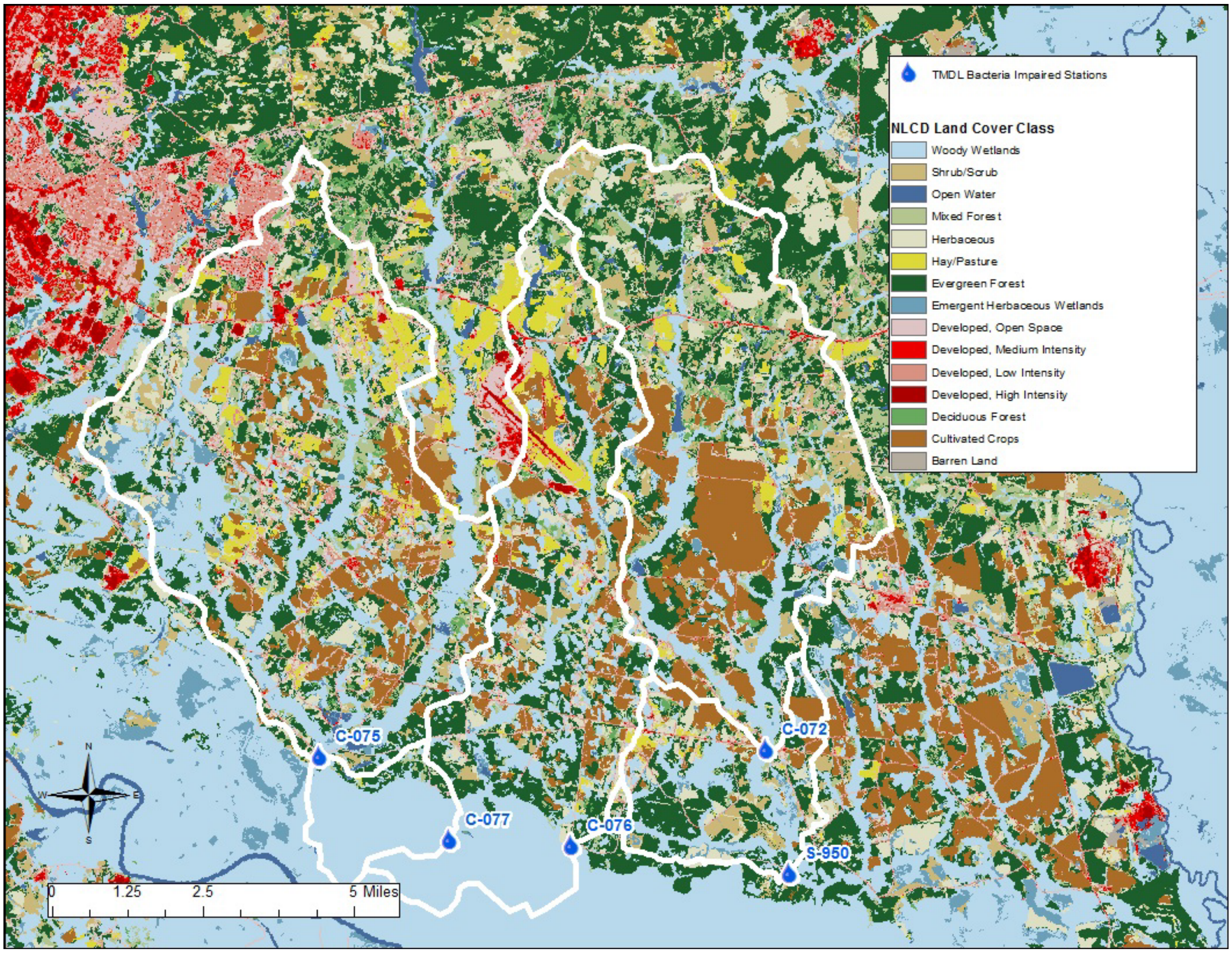


Figure 15. NLCD 2021 land uses of stations in Myers Creek, Cedar Creek, Toms Creek TMDL watershed.

Appendix C – Correlation between rainfall and *E. coli* at C-075, C-077, C-076, C-072, and S-950

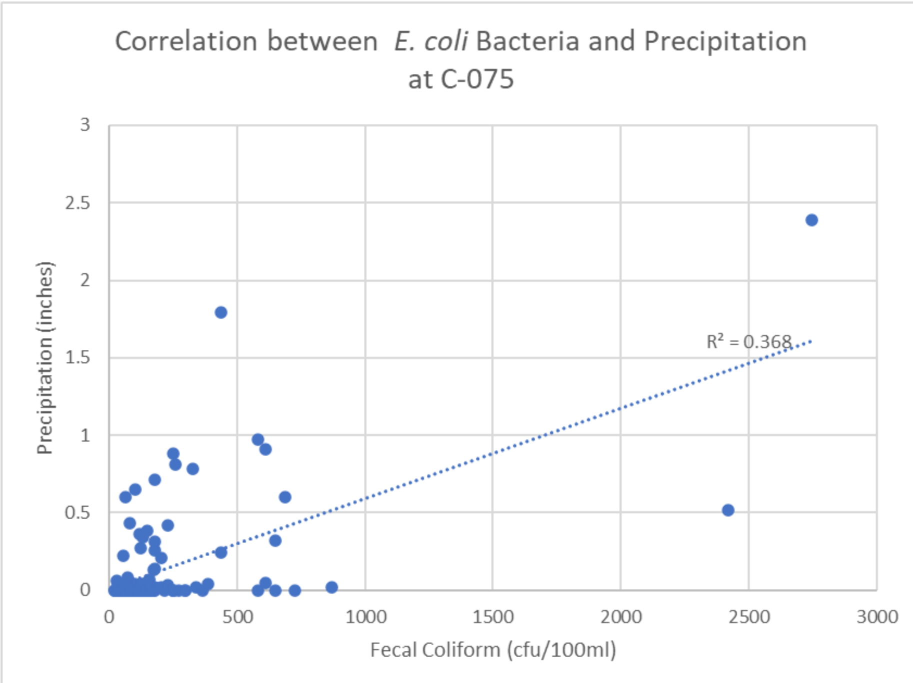


Figure 16. Correlation between rainfall and *E. coli* at C-075.

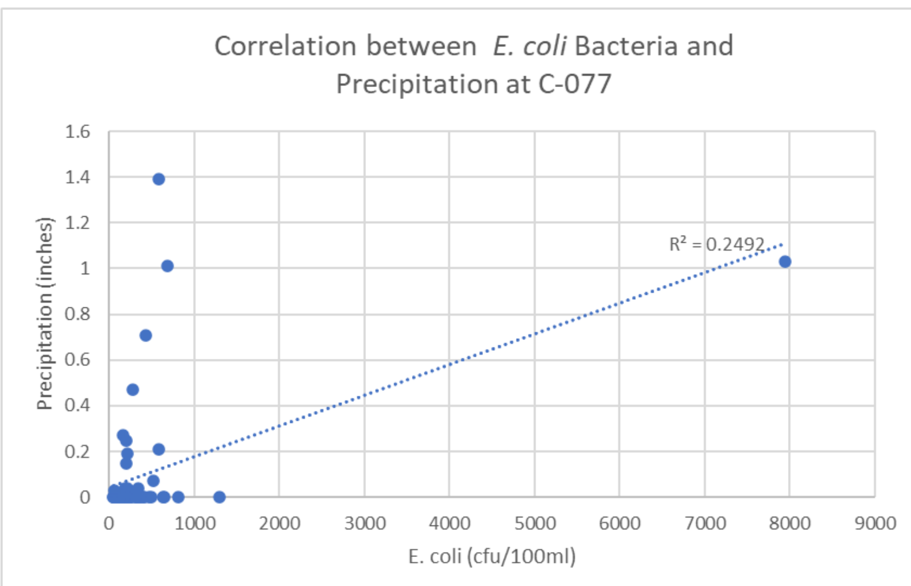


Figure 17. Correlation between rainfall and *E. coli* at C-077.

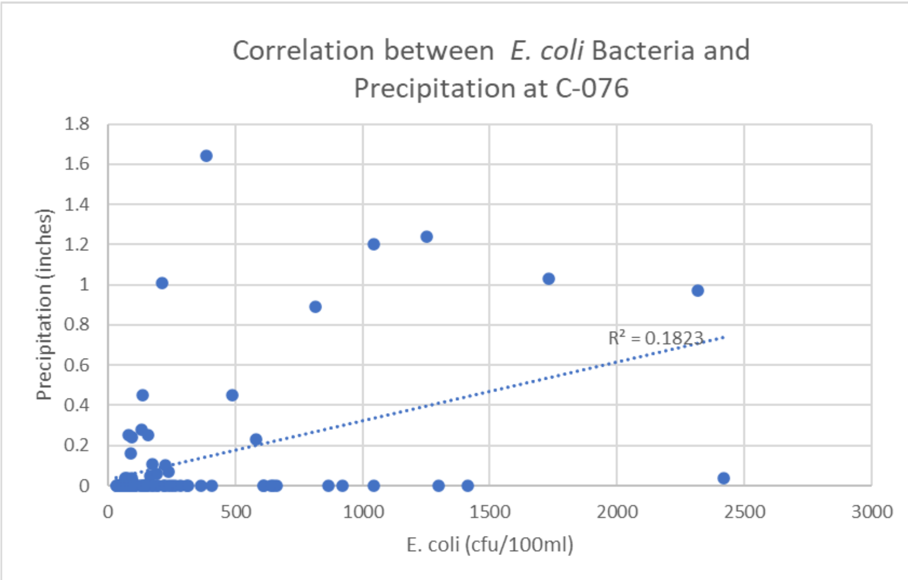


Figure 18. Correlation between rainfall and *E. coli* at C-076.

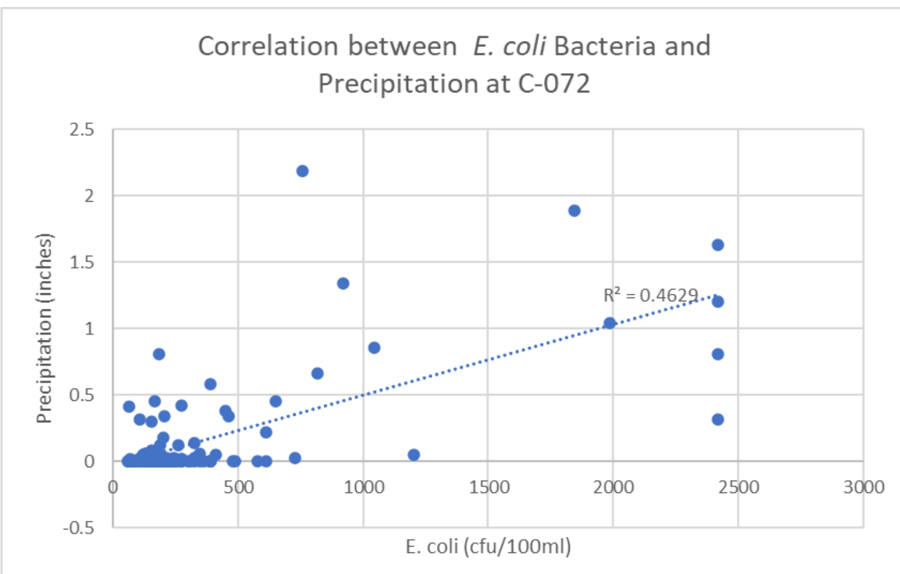


Figure 19. Correlation between rainfall and *E. coli* at C-072.

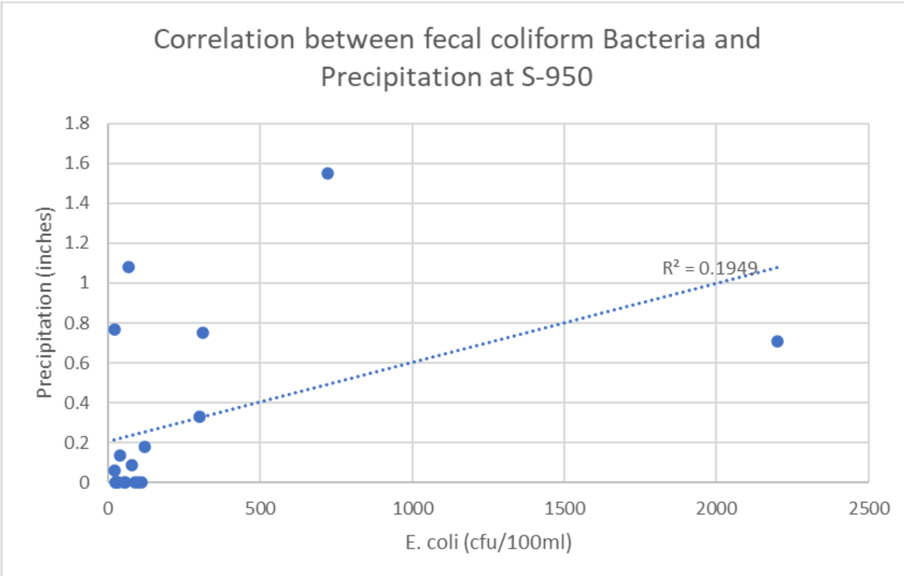


Figure 20. Correlation between rainfall and fecal coliform at S-950.

Appendix D – Flow Duration Curves and Load Duration Curves at C-077, C-076, C-072, and S-950

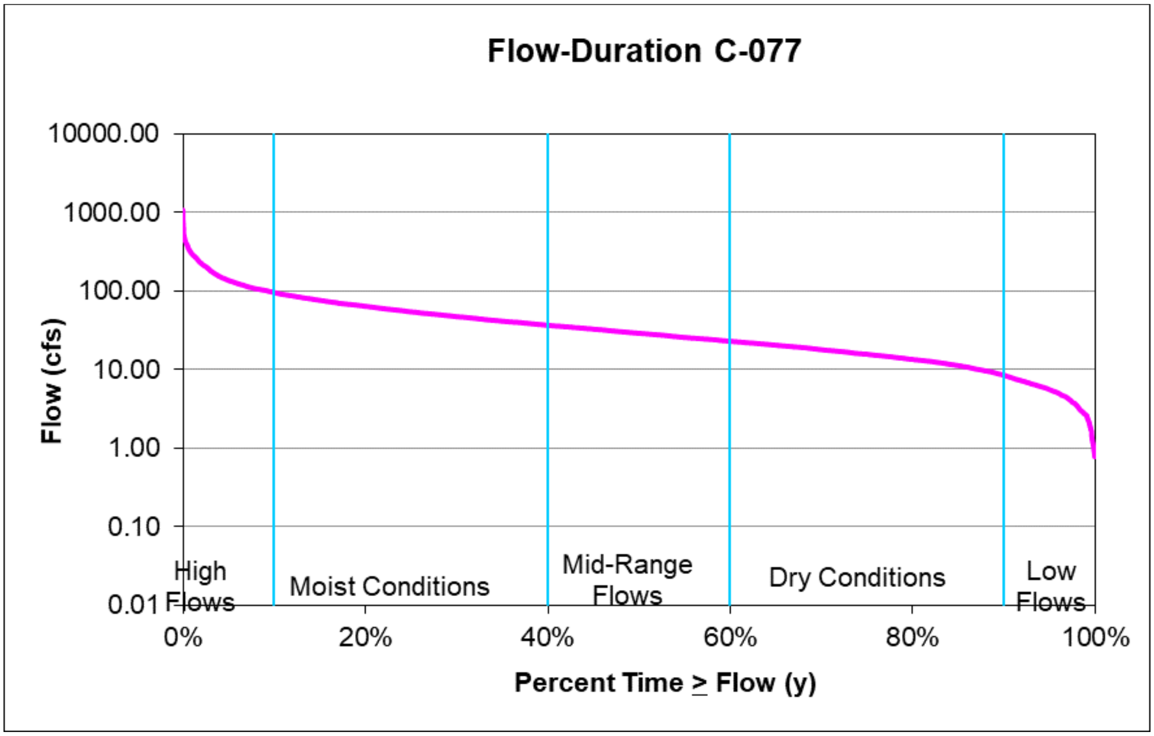


Figure 21. Flow Duration Curve of C-077.

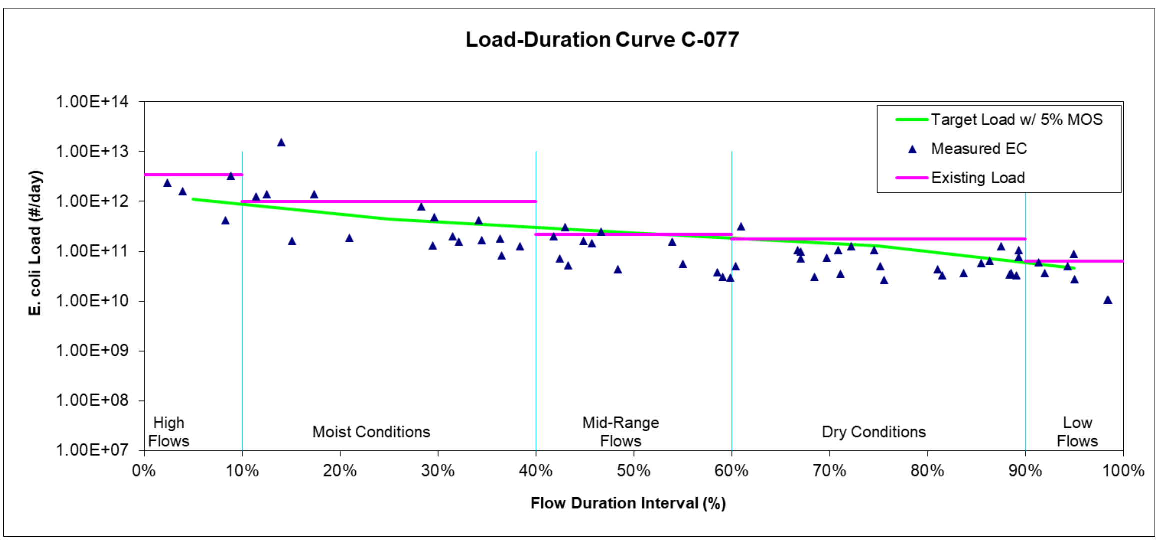


Figure 22. Load Duration Curve of C-077.

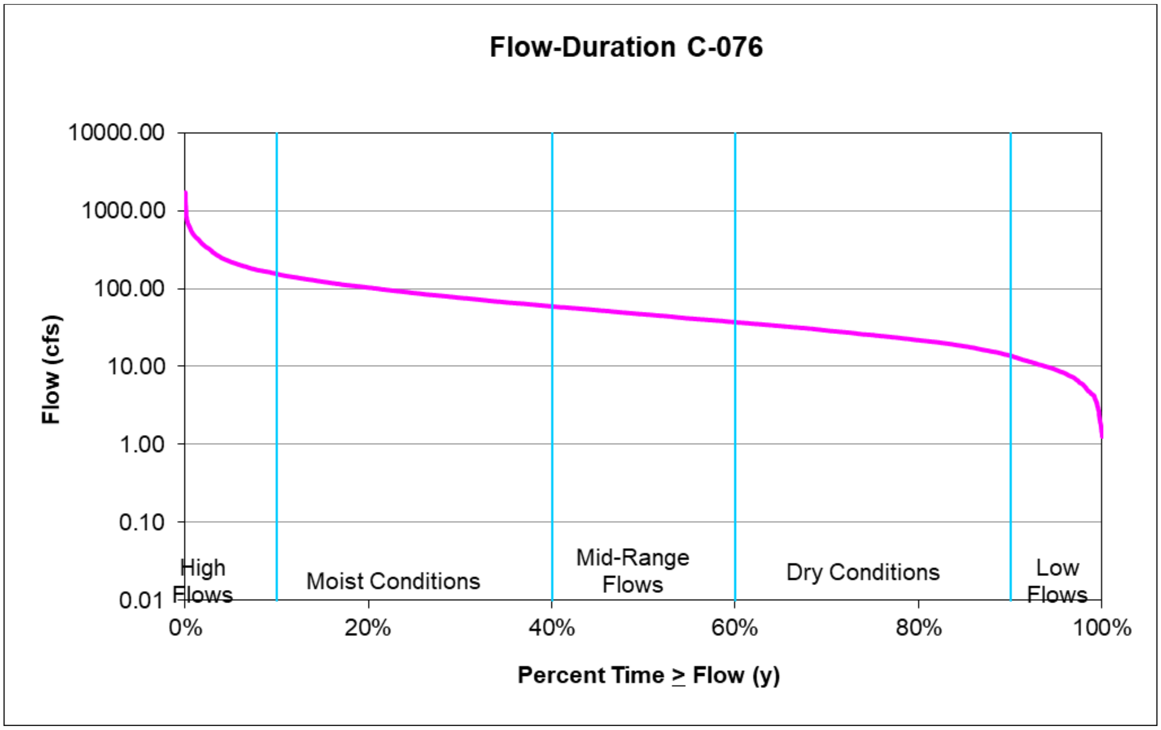


Figure 23. Flow Duration Curve of C-076.

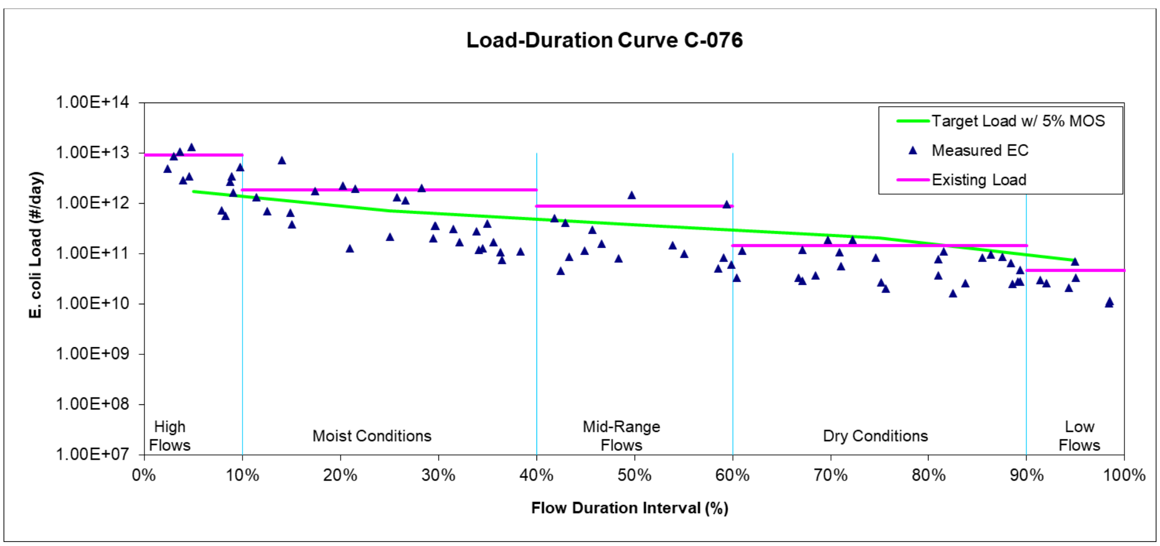


Figure 24. Load Duration Curve of C-076.

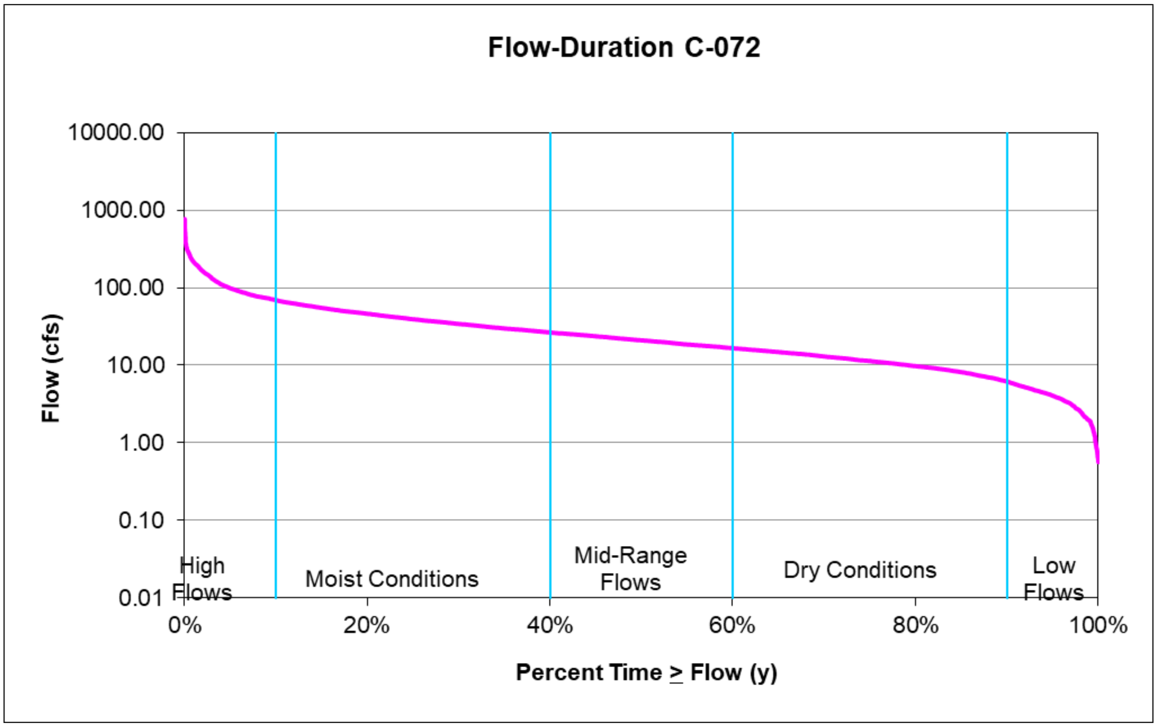


Figure 25. Flow Duration Curve of C-072.

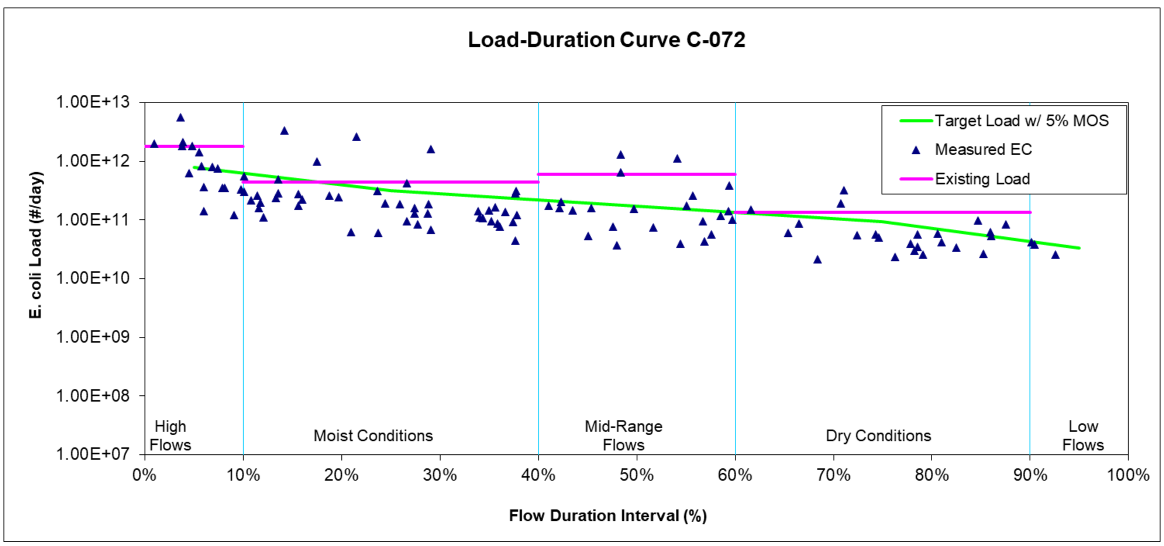


Figure 26. Load Duration Curve of C-072.

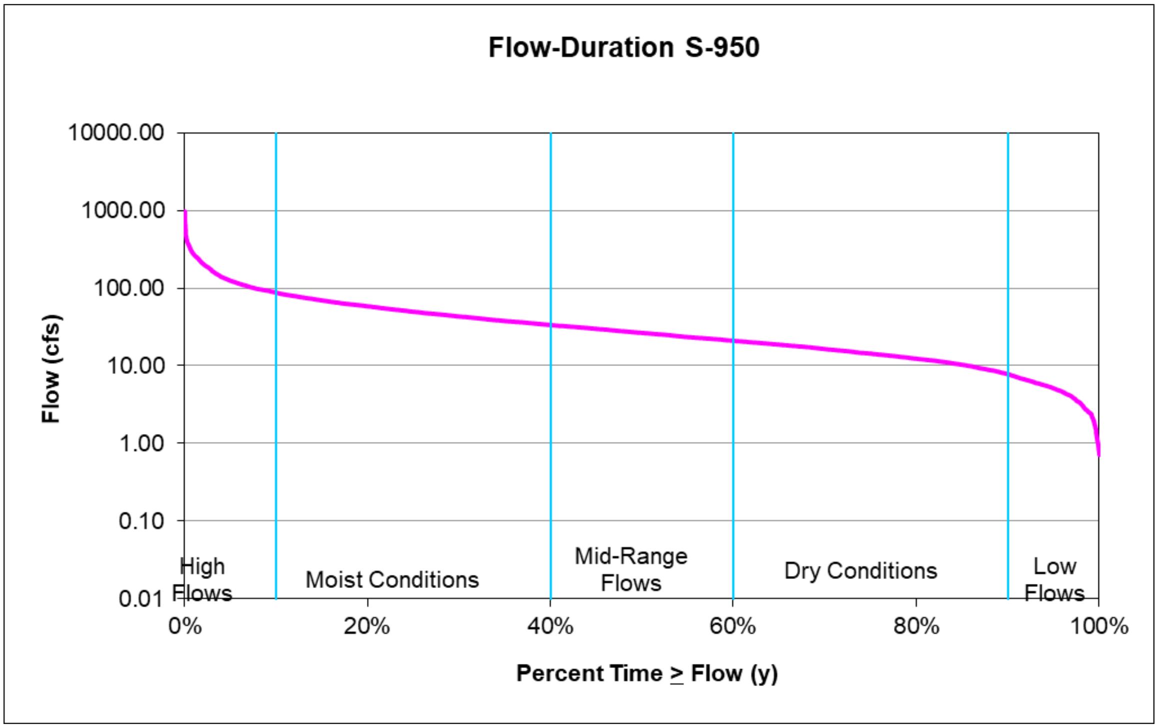


Figure 27. Flow Duration Curve of S-950.

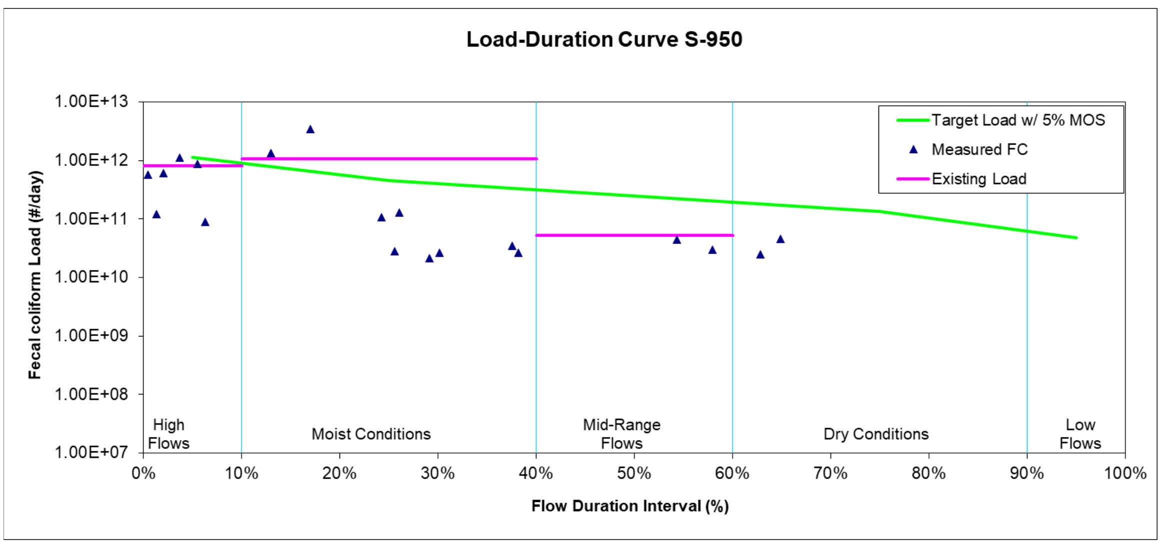


Figure 28. Load Duration Curve of S-950.

Appendix E – Source Assessment Pictures

Figure 29. Stream characteristics in the Myers Creek, Cedar Creek, Toms Creek TMDL watershed.

The TMDL area is part of the Southeastern Plains ecoregion, which is characterized by woodland, cropland, and forest. The vegetation includes longleaf pine with oak-hickory-pine. The northern portion of the TMDL area falls into the Sand Hills (65c). This ecoregion is characterized by rolling sandy hills with very poor moisture retention which are unsuitable for growing crops. The main vegetation consists of turkey oak, blackjack oak, longleaf pine, and wiregrass. Consistent streamflow is caused by the large capability for infiltration in the soil and high storage capacity in the sand aquifer. The middle portion of the TMDL area falls into the Atlantic Southern Loam Plains (65l). This ecoregion is characterized by fertile agricultural lands with well-drained soil. The southern portion of the TMDL area falls into the Southern Floodplains and Low Terraces (65p). The soil composition includes sand and clay with gravel. This region contains slow rivers, backwaters, swamps, and ponds. The vegetation consists of various oak species, bald cypress, and water tupelo (Griffith, G. E., 2002).

Figure 30. Developed areas in the watershed.

Even though Cedar Creek's headwaters originate in a residential area of the City of Columbia, only 9.4% percent of the TMDL area is developed. These pictures were taken in the C-075 subwatershed. Urban and rural runoff could contribute to the presence of *E. coli* in the waterways.

Figure 31. Silviculture

25.7% and 21% of the TMDL is Woody Wetlands and Evergreen Forest, respectively. Part of the TMDL lies in the Congaree National Park with giant hardwoods and pines.

Figure 32. Wildlife

The Congaree National Park is home to a large and biodiverse wildlife community. This includes several endangered species, which use Cedar Creek as their main water source. In the TMDL area outside of the Congaree National Park, birds, deer, turtles were observed near streams. All of these could contribute to the *E. coli* in the streams.

Figure 33. Livestock

During the assessment of the TMDL area, several livestock in fenced enclosures were observed near waterways. Horses, goats, and donkeys were seen. Poorly managed livestock operations could contribute to the presence of *E. coli* in the waterways.

Figure 34. Agricultural Lands

Several agricultural lands were observed in the TMDL area. Runoff of fertilizers, pesticides and sediment from agricultural lands could contribute to the presence of *E. coli* in the waterways.

Figure 35. Subwatershed C-075 Source Assessment

The upper portion of this subwatershed is in the Sand Hills ecoregion. The middle portion of this subwatershed is in the Atlantic Southern Loam Plain ecoregion. A very small portion of the lower end of this subwatershed is in the Southeastern Floodplains and Low Terraces ecoregion. Dominant land uses are evergreen forest (17.81%) and woody wetlands (24.71%). The highest percentages of developed area and imperviousness are in the C-075 subwatershed.

Figure 36. Subwatershed C-077 Source Assessment

This subwatershed is located almost entirely in Congaree National Park. A large portion of the lower end of this subwatershed is in the Southeastern Floodplains and Low Terraces ecoregion. Dominant land uses are evergreen forest (10.24%) and woody wetlands (85.11%) with very diverse wildlife.

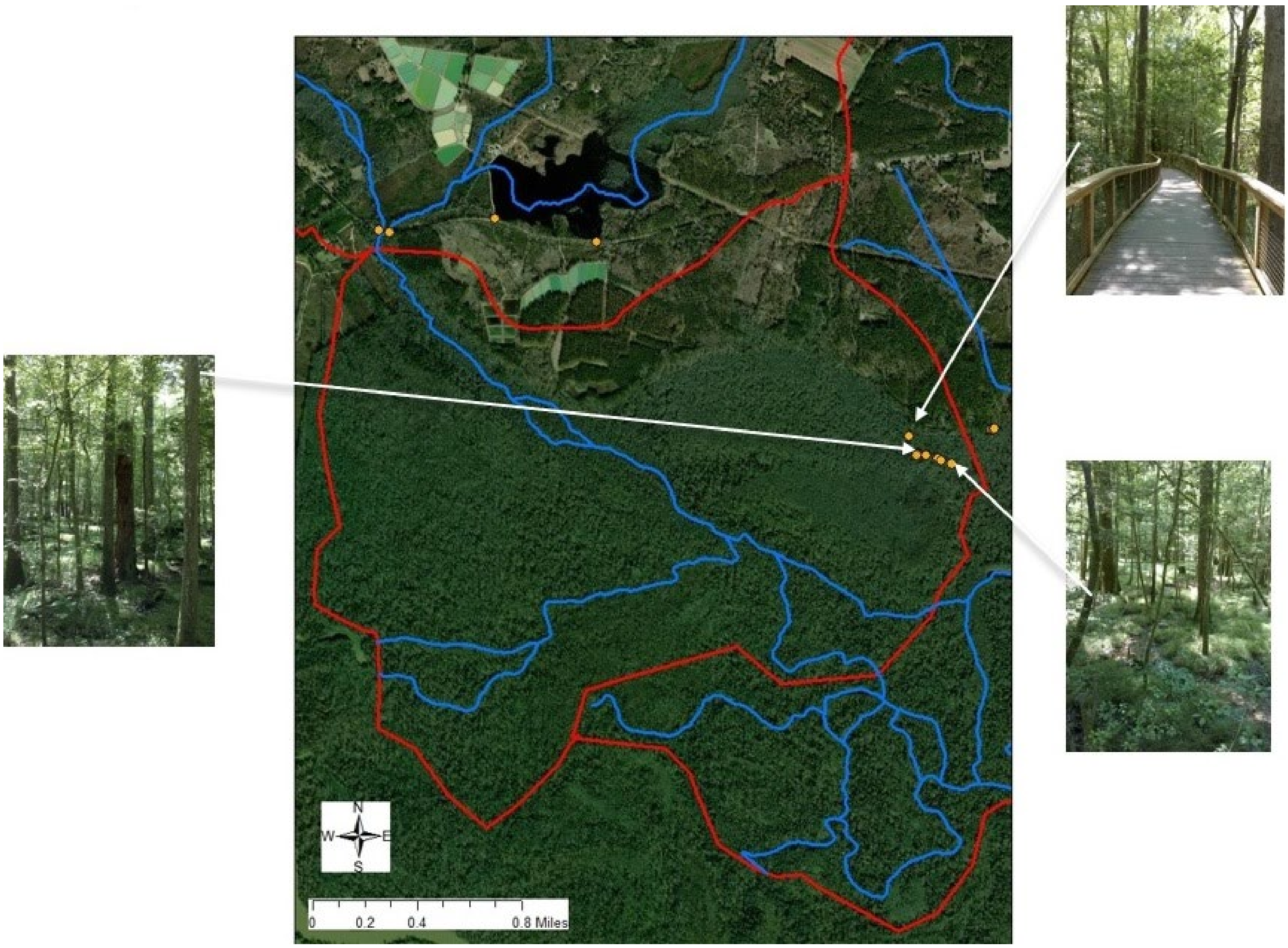


Figure 37. Subwatershed C-076 Source Assessment

The headwater of this subwatershed starts in the Sand Hills ecoregion. The middle portion of the subwatershed is in the Atlantic Southern Loam Plains. The lower portion of the subwatershed is in the Southeastern Floodplains and Low Terraces ecoregion. Dominant land uses are evergreen forest (21.44%) and woody wetlands (31.63%). There are many impoundments on Dry Branch before it flows into Cedar Creek. Several farms and row crop fields were seen in this area. Part of the McEntire Joint National Guard Base is in this subwatershed.

Figure 38. Subwatershed C-072 Source Assessment

The headwater of this subwatershed starts at the Sand Hills ecoregion. The middle portion of the subwatershed is in the Atlantic Southern Loam Plains. The lower portion of the subwatershed is in the Southeastern Floodplains and Low Terraces ecoregion. Dominant land uses are evergreen forest (24.65%) and cultivated crops (18.43%). Several livestock farms and row crop fields were seen in this area. Throughout Toms Creek and Ray Branch several impoundments were seen.

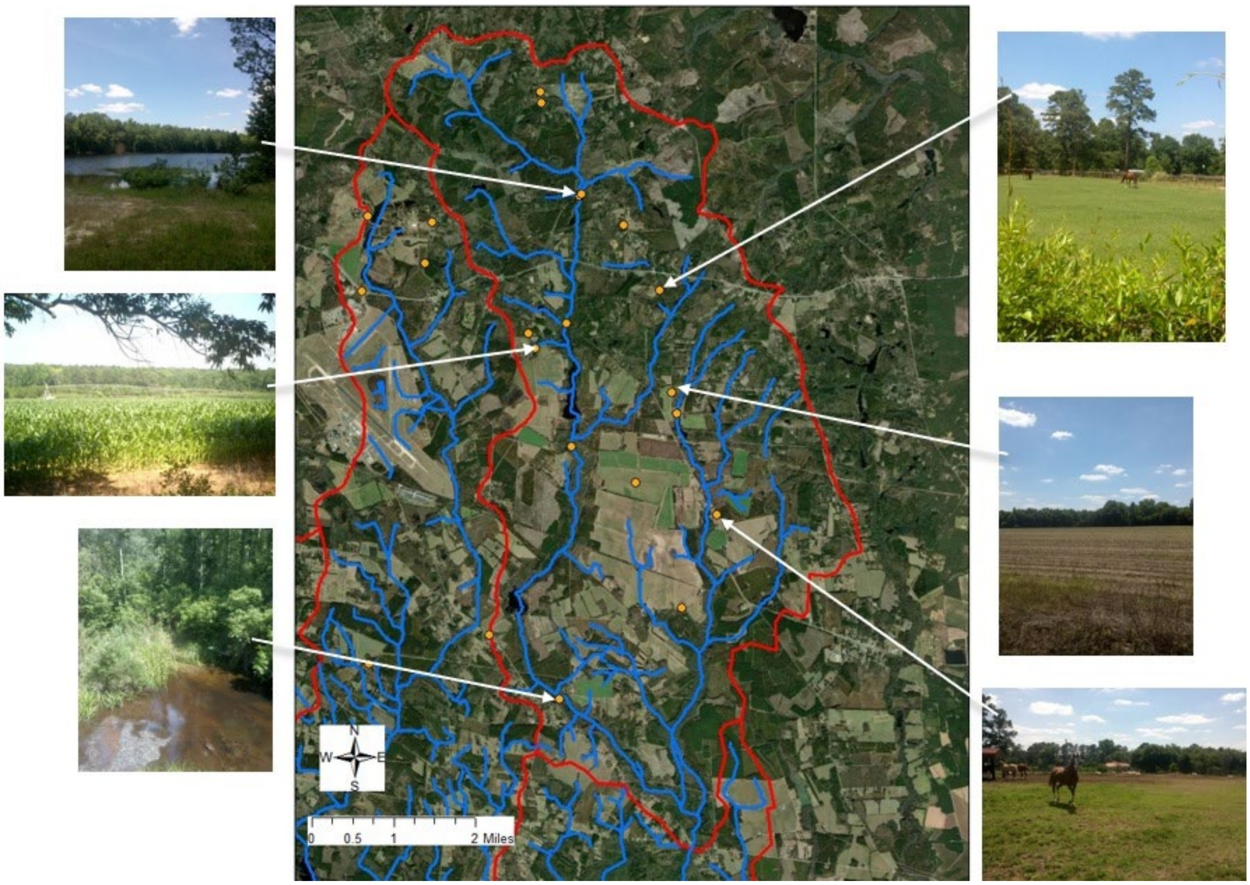
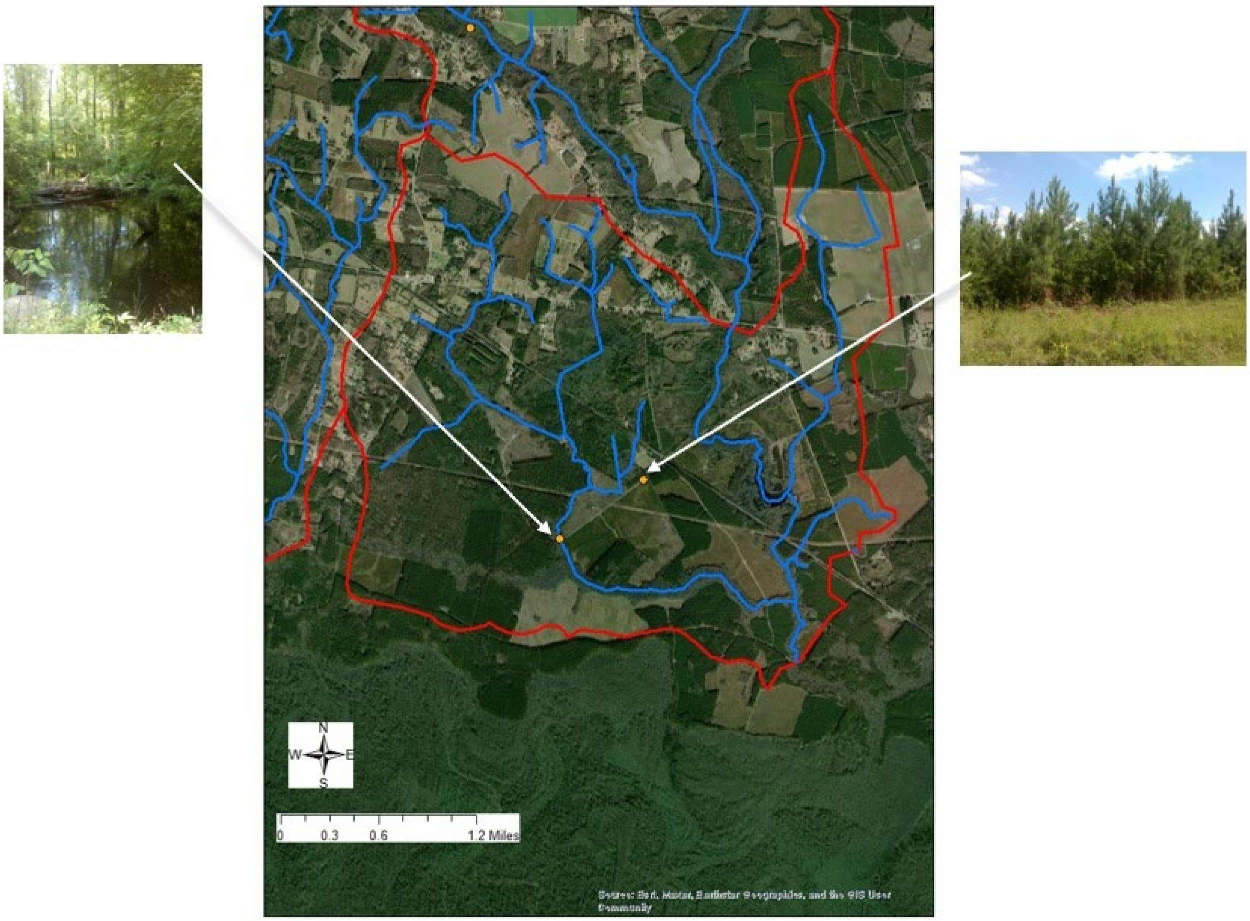


Figure 39. Subwatershed S-950 Source Assessment

The upper portion of this subwatershed is in the Atlantic Southern Loam Plain ecoregion. A very small portion of the lower end of this subwatershed is in the Southeastern Floodplains and Low Terraces ecoregion. Dominant land uses are evergreen forest (27.97 %) and woody wetlands (27.36 %).



Appendix F – Comments

PO Box 7746
Columbia, SC 29202-7746

Friends of Congaree Swamp

July 28, 2024
Erika Balogh
Bureau of Water, SC DES
2600 Bull Street
Columbia, SC 29201

Re: Draft TMDL Document for *E. Coli* Impairments at Myers Creek, Cedar Creek, Toms Creek and Tributaries

Dear Ms. Balogh,

Friends of Congaree Swamp has reviewed the draft TMDL document for *E. Coli* impairments at Myers Creek, Cedar Creek, Toms Creek and Tributaries. Given the long history of impairment for various stations in these watersheds, we strongly support the establishment of TMDL's (Total Maximum Daily Loads) for bacterial water quality contamination for the five subwatersheds included, each of which are listed as impaired for *E Coli* on SC DES's draft 2024 303(d) list of impaired waters. We do not feel SCDHEC's target recommendation of a 12% reduction in E. Coli at station C-075 is sufficient, though we do support reductions of 54% for C-077, 62% for C-076, 71% for C-072 and 71% for S-950.

In addition to the station history for C-075, C-076, C-077, C-072 and S-950 shared in the draft document, we relied upon Patel (2010), the master's thesis of Aashka Patel under the supervision of Buz Kloot, and observations from SC Adopt-a-Stream stations in Congaree National Park: MC-3466, (Myers Creek at Bannister Bridge), TC-1933 (Tom's Creek downstream from the confluence with McKenzie Creek) and MC-2584 (McKenzie Creek upstream of the confluence with Toms Creek) for our understanding of bacterial water quality in the study watersheds, with the familiar caveat that SC Adopt-a-Stream observations should not be used for regulatory purposes. Note too, that the SC Adopt-a-Stream program strongly discourages sampling within 24 hours of substantial precipitation events, during which bacterial water quality will be higher due to stormwater run-off, so that SC Adopt-a-Stream sampling results for bacterial water quality are inherently conservative.

Cedar Creek and Myers Creek

MC-3466, located at Myers Creek immediately upstream of the confluence with Cedar Creek at Bannister Bridge, has been sampled monthly since January 2023 under the SC Adopt-a-Stream program. Results at MC-3466 are particularly informative given the lack of SC DES sampling sites in the Myers Creek watershed. *E Coli* readings at MC-3466 were above 349 cfu/100 ml for 2 of 18 (22%) sampling events, compared to 11.28% on Cedar Creek below the confluence, as listed in the draft document. These results are suggestive of issues on Myers Creek, particularly since sampling results at MC-3466 have indicated issues with Dissolved Oxygen as well.

We were concerned that no mention was made in the draft document of the substantial aquaculture facilities managed by Southland Fisheries Corporation and Congaree Bluff Farms LLC in the Cedar Creek watershed. After the operations were expanded in 2021, over 50 aquaculture impoundments now lie within the Cedar Creek and Reeves Branch watershed immediately upstream from the park. Southland Fisheries does not have a discharge permit, though they do have a groundwater withdrawal registration (40AQ018G) and two surface water withdrawal registrations (40AQ018S01 and 40AQ018S02) with a combined allowance of up to 101.40 million gallons per year and up to 23.0 million gallons in any given month. We would request that further consideration be given to the impact of operations at these facilities when crafting the TMDL for the C-075 subwatershed.

The draft TMDL document discussed Manchester Farms Inc/Hopkins Processing Plant, which has a permit (ND0068969) to apply sludge to fields on either side of Horsepen Branch, which is in subwatershed C-075. When then-SC DHEC revised the permit in 2022 to ease Nitrogen monitoring, Friends of Congaree Swamp strongly objected to the relaxed reporting standards, especially given the documented history of groundwater contamination on-site. SC DHEC had the opportunity in 2015 to require Manchester Farms to connect to the then-proposed sewage line along Lower Richland Boulevard as part of the Lower Richland Sanitary Sewage Project, but failed to exercise its authority to do so. As part of the plan to meet TMDL reductions for subwatershed C-075, it would be useful for Manchester Farms to finally retire its sewage sludge application in the watershed and connect to the available sewage line adjacent to its property.

Despite Cedar Creek's designation as an ORW (Outstanding Resource Water) from Bannister Bridge to Wise Lake, and an Outstanding National Resource Water from

Wise Lake to Cedar Creek's confluence with the Congaree River, a variety of pollution problems on Cedar Creek has been well-documented. Bradley et al (2017) focused on pharmaceuticals, pesticides and other chemicals associated with wastewater, finding widespread evidence of contamination in each of the C-075, C-076 and C-077 subwatersheds. These documented issues add to those identified by SC DES in the draft TMDL document and confirm the need to address TMDL for pollutants in the watershed. Given the variety of problems in C-075's subwatershed, some of which were not adequately documented in the draft TMDL document, we feel that the reduction in TMDL for *E Coli* should be greater than 11.2%. Subwatersheds C-076 and C-077 are largely inside Congaree National Park. Congaree National Park and USDA-APHIS cooperate on feral hog management in the park and adjacent lands, with Friends of Congaree Swamp providing some financial support for these efforts. Reductions in TMDL for *E Coli* in will require increased resources for feral hog management in the C-076 and C-077 subwatersheds.

Tom's Creek

Patel noted the lowest bacterial counts in the Tom's Creek watershed immediately downstream of Weston's Pond, with steadily increasing bacterial counts downstream, peaking at site 13 on Bluff Road (near C-072), which Patel characterized as "chronically impaired"—consistent with SC DES's assessment. Patel felt that septic systems were the likely culprits for bacterial contamination at site 13, though attempts to confirm the hypothesis through a novel approach were inconclusive. Animal farms were another likely source.

Patel noted high bacterial counts in Tom's Creek inside Congaree National Park during high flows, but counts were generally attenuated downstream of Bluff Road for low to moderate flows. Patel speculated that buffering effects from Draft's Pond were the greatest contributor to the lower counts downstream at site 19 on Red Bluff Road (quite near S-950) and site 20 (downstream of the confluence with McKenzie Creek). Results from TC-1933, ¾-mile downstream of S-950, provide further evidence of attenuation—only 1 of 34 samples (2.9%) since August 2021 has exceed 349 cfu/100 ml, and that was the only sample taken after a substantial rainfall. This compares favorably with observations at S-950, which was impaired 10.5% of the time, though SC Adopt-a-Stream sampling, as noted above, generally takes place under conditions when stormwater runoff would not contribute to bacterial counts.

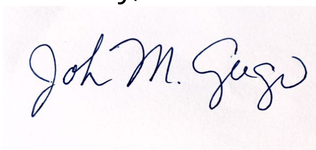
In addition to high counts during periods of high flow, Patel also noted high counts in the park sites at very low flows, and identified feral hogs as the likely source of bacterial contamination during low flows. Our observations during sampling trips to MC-2584 and TC-1933 confirm extensive year-round feral hog rooting, despite feral hog removal efforts by USDA-APHIS and Congaree National Park in the immediate sampling area of both sampling sites.

McKenzie Creek should be considered as a contributor to water quality problems on Tom's Creek. Patel sampled McKenzie Creek at site 17 (Griffins Creek Road bridge over McKenzie Creek) and found the site consistently impaired. Three of 17 monthly samples at SC Adopt-a-Stream site MC-2584 (17.6%) have exceeded 349 cfu/100 ml since sampling commenced in August 2021. Often water levels at the site are too low to sample due to beaver activity at the Griffins Creek Road bridge, which persists despite removal activities by SC DOT. Patel noted a lack of connectivity between site 17 and upstream sites, perhaps due to beaver activity as well.

Due to the bacterial water quality problems in Myers Creek documented by SC Adopt-a-Stream sampling, we request that the TMDL for *E. Coli* at C-075 be revisited. We also feel strongly that the source review is inadequate if it does not take into account the large aquaculture operation immediately upstream of C-075, which could result in further amendments to the TMDL.

The draft TMDL document identified various approaches to improving bacterial water quality. Richland County recently revised its Land Development Code, which left its water quality buffer ordinances unchanged, though the ordinances do require wider buffers for impaired waters for qualifying land development projects. The revised code does include a Water Resources Overlay (WR-O) district that could further protect water quality, but its provisions are weak and it is not yet widely applied. Patel et al (2010) built a convincing case that septic systems contribute to impairment in the Tom's Creek watershed. The draft TMDL document estimates that 94% of households in Lower Richland rely on septic systems; the draft TMDL's emphasis on education through outreach would be the logical initial approach to lowering TMDL's in the Tom's Creek watershed. Though Congaree National Park and USDA-APHIS have cooperated on feral hog control for several years with some financial assistance from Friends of Congaree Swamp, efforts have not resulted in a substantial reduction of feral hog activity and more intensive management would be needed to successfully impact bacterial water quality. Richland County has successfully applied for Clean Water Act Section 319 grants in the past, and a grant application for either the Cedar Creek watershed or Toms Creek watershed may provide a unifying approach to TMDL improvements.

Sincerely,



John Grego, President

References

Bradley, P.M, Battaglin, W.A., Clark, J.M., Henning, F.P., Hladik, M.L., Iwanowicz, L.R., Journey, C.A., Riley, J.W., Romanok, K.M. (2017). *Widespread occurrence and potential for biodegradation of bioactive contamininants in Congaree National Park, USA.* Environmental Toxicology and Chemistry, **36(11)**, 3045-3056

Patel, A. J.(2010). *Locating Sources of Bacterial Contamination In the Toms Creek Watershed.* (Master's thesis). Retrieved from https://scholarcommons.sc.edu/etd/235

Comment 1:

"MC-3466, located at Myers Creek immediately upstream of the confluence with Cedar Creek at Bannister Bridge, has been sampled monthly since January 2023 under the SC Adopt-a-Stream program. Results at MC-3466 are particularly informative given the lack of SC DES sampling sites in the Myers Creek watershed. E Coli readings at MC-3466 were above 349 cfu/100 ml for 2 of 18 (22%) sampling events, compared to 11.28% on Cedar Creek below the confluence, as listed in the draft document. These results are suggestive of issues on Myers Creek, particularly since sampling results at MC-3466 have indicated issues with Dissolved Oxygen as well."

Answer:

MC-3466 (Adopt-A-Stream) is located 250 ft upstream of C-075. We looked at all the available (2023-2024) data from MC-3466, and we concluded that only 2 samples out of 19 samples (10.52%) exceeded the standard of 349 cfu/100 ml for E. coli. We also looked at 10 years (2009, 2013-2023) of data from C-075, and we found 15 exceedances out of 133 samples (11.28%) for E. coli. The two datasets seem to be consistent and show the same pattern.

Comment 2:

"We were concerned that no mention was made in the draft document of the substantial aquaculture facilities managed by Southland Fisheries Corporation and Congaree Bluff Farms LLC in the Cedar Creek watershed. After the operations were expanded in 2021, over 50 aquaculture impoundments now lie within the Cedar Creek and Reeves Branch watershed immediately upstream from the park. Southland Fisheries does not have a discharge permit, though they do have a groundwater withdrawal registration (40AQ018G) and two surface water withdrawal registrations (40AQ018S01 and 40AQ018S02) with a combined allowance of up to 101.40 million gallons per year and up to 23.0 million gallons in any given month. We would request that further consideration be given to the impact of operations at these facilities when crafting the TMDL for the C-075 subwatershed."

Answer:

There was no mention of Southland Fisheries Corporation in the TMDL because it has no effect on the E. coli concentration in the stream. This operation does not have a discharge permit. Groundwater withdrawals have no effect on E. coli in surface water. Southland Fisheries Corporation has 2 registered withdrawals (40AQ018S01, 40AQ018S02); both are located on Duffies Pond 0.5 miles upstream of C-075. For

40AQ018S01 the highest ever reported withdrawal was 1.15 cfs between 2001 and 2023. For 40AQ018S02 the highest ever reported withdrawal was 0.38 cfs between 2014 and 2023. This amount of withdrawal should not have any effect on E. coli concentration in the stream.
The Department of Environmental Services has no recorded withdrawal from Congaree Bluff Farms LLC.

Comment 3:
"McKenzie Creek should be considered as a contributor to water quality problems on Tom's Creek. Patel sampled McKenzie Creek at site 17 (Griffins Creek Road bridge over McKenzie Creek) and found the site consistently impaired. Three of 17 monthly samples at SC Adopt-a-Stream site MC-2584 (17.6%) have exceeded 349 cfu/100 ml since sampling commenced in August 2021. Often water levels at the site are too low to sample due to beaver activity at the Griffins Creek Road bridge, which persists despite removal activities by SC DOT. Patel noted a lack of connectivity between site 17 and upstream sites, perhaps due to beaver activity as well."

Answer:
The confluence of McKenzie Creek and Tom's Creek is outside of and downstream of the TMDL area. McKenzie Creek was not included in the scope of the TMDL because the only data available for use in the analysis were from the Adopt-a-Stream program. The southern TMDL border is at the S-950 water quality site, which is located on Tom's Creek upstream of its confluence with McKenzie Creek.

The department appreciates this information about McKenzie Creek. The McKenzie Creek watershed may be eligible for a protection project using 319 Grant funding if a watershed based plan were to be developed and this TMDL were to be implemented. We won't use this information at this time since it is outside of the TMDL area; however we will keep it in mind for future studies.

Beaver dam control is difficult because unless the animals are removed along with the dam, it will be rebuilt in a matter of days. Trapping and shooting beavers is allowed in the state with a permit from SCDNR:
https://www.dnr.sc.gov/wildlife/publications/pdf/BeaverManagementControl.pdf.
Clemson University has developed plans for a device that allows water to bypass the dam without eliminating the beavers:
https://dnr.sc.gov/wildlife/publications/pdf/ClemsonBeaverPondLeveler.pdf.

This device moderates upstream flooding and restores flow downstream. It may be possible to install such a device in an active beaver dam and could perhaps be part of a watershed restoration plan.

Comment 4:

"Due to the bacterial water quality problems in Myers Creek documented by SC Adopt-a-Stream sampling, we request that the TMDL for E. Coli at C-075 be revisited. We also feel strongly that the source review is inadequate if it does not take into account the large aquaculture operation immediately upstream of C-075, which could result in further amendments to the TMDL."

Answer:

After thorough consideration of both water quality data sets (MC-3466 and C-075) and the additional information provided, we conclude that using the 12% reduction in the C-075 subwatershed is appropriate. This TMDL was determined using a lengthy record of quality-controlled site specific data and an accepted method for calculating existing conditions and load reductions. The load duration curve method includes considerations of loading at various flow conditions and the most protective percent reduction is chosen from among these. The Department of Environmental Services appreciates this extensive review provided, but at this time there are no reasons for a greater E. Coli reduction in the C-075 subwatershed.