Fecal Coliform and *Enterococci* Bacteria Total Maximum Daily Loads for Monitoring Stations in the Dawho River within Shellfish Management Area 12B HUC 030502060405

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Abstract

§303(d) of the Clean Water Act (CWA) and EPA's *Water Quality Planning and Management Regulations* 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 fecal coliform (FC) TMDL for impaired shellfish station 12B-53, and *Enterococci* TMDLs for impaired recreational stations MD-120, RT-07055, and RT-20236 in Dawho River in Charleston County, South Carolina. These stations have been included in South Carolina's 2020 and 2022 303(d) list of impaired waters for exceeding FC and *Enterococci* WQS for shellfish harvesting and recreational uses.

South Carolina Department of Transportation (SCDOT) is a national pollutant discharge elimination system (NPDES) permitted transportation separate storm sewer system (TS4). For SCDOT, compliance with terms and conditions of its NPDES TS4 permit is effective implementation of the WLA to the maximum extent practicable (MEP). Charleston County is an NPDES permitted municipal separate storm sewer system (MS4) in this watershed and has been allocated a WLA.

Table Ab1. TMDLs for Dawho River. TMDLs are expressed as the mpn/100 mL and mpn per day, and allocations are expressed as % reductions.

Station	Existing Conc. (mpn/ 100ml)	TMDL Conc.[1] (mpn/ 100ml)	TMDL Load[2] (WLA+LA+ MOS) (mpn/day)	WLA + LA (mpn/day)	MOS (mpn/day)	Implementation Targets[6]			
						Continuous Sources[3] (mpn/100ml)	Intermittent MS4[5] (%)	Intermittent TS4 SCDOT (%)	Non-Point Source LA (%)
12B-53	90.7	43	3.10E+12	2.94E+12	1.55E+11	See Note Below	54.9%	54.9%[4]	54.9%
MD-120	164.3	104	1.18E+13	1.12E+13	5.93E+11	See Note Below	39.9%	39.9%[4]	39.9%
RT-07055	140.2	104	1.64E+13	1.56E+13	8.23E+11	See Note Below	29.6%	29.6%[4]	29.6%
RT-20236	260.4	104	1.45E+13	1.38E+13	7.25E+11	See Note Below	62.1%	62.1%[4]	62.1%

Table Notes:

1. TMDL = SFH waters WQS for single sample maximum not to exceed 43 mpn/100 mL FC, and TMDL = Recreational salt waters WQS for single sample maximum not to exceed 104 mpn/100 mL *Enterococci.*
2. TMDL at average flow conditions calculated using estimated average tidal flow at the WQM station. See Appendix B for example calculation.
3. WLAs are expressed as a daily maximum of 43 mpn/100 mL FC and 104 mpn/100 mL *Enterococci*. There are no continuous dischargers at this time. Future continuous discharges are required to meet the WQS for the pollutant of concern. Loadings to meet the WQS are developed based on the permitted flow and an allowable permitted maximum concentration of 43 mpn/100mL (FC) and 104 mpn/100 mL *Enterococci.*
4. By implementing the best management practices (BMPs) that are prescribed in either the SCDOT annual storm water management plan or the SCDOT NPDES TS4 permit to address bacteria, the SCDOT will comply with this TMDL and its applicable WLA to the maximum extent practicable (MEP) as required by its NPDES TS4 permit.

5. Percent reduction applies to all NPDES-permitted stormwater discharges, including current and future MS4s, construction, and industrial discharges covered under permits numbered SCS & SCR. Stormwater discharges are expressed as a percentage reduction due to the uncertain nature of stormwater discharge volumes and recurrence intervals. Stormwater discharges are required to meet percentage reduction or the existing instream standard for the pollutant of concern in accordance with their NPDES Permit.
6. Refer to section 6.0 for the derivation of implementation targets.

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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, the states are required to list the impaired bodies under §303(d) of the CWA. These listed sites 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 WQS.

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:

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

This TMDL document is a detailed analysis describing the development of one fecal coliform (FC) and three *Enterococci* bacteria TMDLs for four stations located in Dawho River in shellfish management area (SFMA) 12B, Charleston County, South Carolina. Shellfish monitoring station 12B-53 has exceeded the shellfish harvesting WQS for "approved" classification, and three ambient water quality monitoring stations (WQMS), MD-120, RT-07055, and RT-20236, have exceeded the recreational WQS. All four stations have been included in South Carolina's combined 2020 and 2022 303(d) list of impaired waters (SCDHEC 2023). Shellfish station 12B-53 has been prioritized and accepted by United States Environmental Protection Agency (EPA) as a metric in the CWA §303(d) program performance measures.

In South Carolina, oysters and clams are the two species of bivalve molluscan shellfish that are harvested commercially, recreationally, and utilized for aquaculture. These two species are the Eastern or American oyster, *Crassostrea virginica*, and hard clam or Northern quahog, *Mercenaria mercenaria*. Both species are native to the North American Atlantic and Gulf coasts and have economic importance. Oysters in South Carolina cluster together to form oyster beds and oyster reefs. These formations stabilize shorelines from erosion, provide nursery grounds as well as protection for other marine species. In South Carolina, 95% of oyster reefs are intertidal, meaning they are exposed during low tide and submerged during high tide.

Both oysters and clams are filter feeders, meaning they filter water for algae as a nutrient source. In brackish and saltwaters, there are naturally occurring bacteria and viruses. Also, there are other sources for bacteria and viruses to enter these waters as a result of human activities, some examples are agricultural runoff, malfunctioning septic systems, pet waste, sanitary sewer overflows, and stormwater runoff. An adult oyster can filter approximately 50 gallons of water a day, while an adult clam can filter approximately 24 gallons a day. These filter feeders can concentrate naturally occurring bacteria, such as pathogenic bacteria *Vibrio vulnificus* and *Vibrio parahaemolyticus*, and viruses that are in the water as well as those resulting from human-related activities.

The National Shellfish Sanitation Program (NSSP) is the federal and state cooperative program recognized by both the United States Food and Drug Administration (FDA) and the Interstate Shellfish Sanitation Conference (ISSC). States have agreed, through participation in NSSP and membership in the ISSC, to enforce the Model Ordinance (USFDA 2021). The Model Ordinance supplies states with standards as well as administrative practices required for the sanitary control of shellfish produced and sold for human consumption.

The FC group of bacteria is usually not pathogenic, and they are used as indicator organisms. As an indicator, they may indicate the presence of other pathogenic bacteria. In the NSSP Model Ordinance (USFDA 2021) and in South Carolina Shellfish Regulation 61-47 (SCDHEC 2017), the WQS for shellfish harvesting waters with an "approved" classification is "…the geometric mean fecal coliform most probable number (MPN) shall not exceed fourteen per one hundred milliliters, nor shall the estimated ninetieth percentile exceed an MPN of forty three per one hundred milliliters (per five tube decimal dilution)". Shellfish Regulation 61-47 was promulgated by the statutory authority under S.C. Code Section 44-1-140. This regulation adopted the shellfish FC WQS as set forth in the NSSP Model Ordinance.

Genus *Enterococci* are Gram-positive cocci common in the feces of warm-blooded animals which includes humans. Starting in 1986, EPA has recommended using *Enterococci* as the indicator organism for fecal contamination and health risk in marine waters (USEPA 1986).

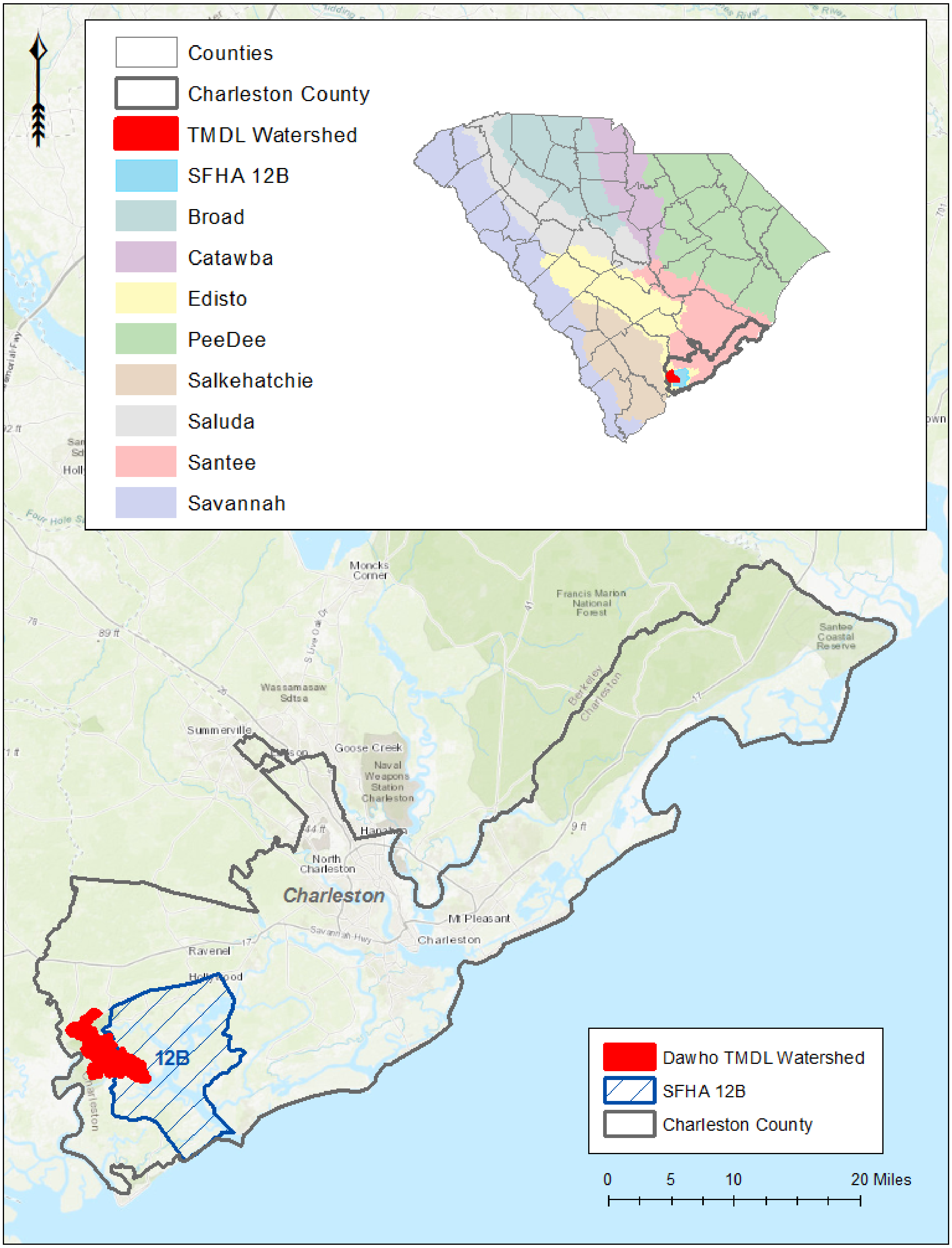


Figure 1. Locations of shellfish management area 12B and Dawho River TMDL watershed in Charleston County, SC.

1.2 Watershed Description

Dawho River is a tidal estuary tributary to North Edisto River and under certain tidal conditions may receive flows from South Edisto River. The River is located among Whooping Island to the south, Stann Island to the north, and Jehossee Island to the west, and is situated to the southwest of the City of Charleston in Charleston County, South Carolina. To the west of the McKinley Washington Jr bridge towards Jehossee Island, Dawho River splits into two. The Dawho River continues to the north of Jehossee Island, and to the south of the Island becomes Watts Cut and both merge with the South Edisto River to the west.

The river is encompassed within shellfish management area (SFMA) 12B and 12-digit hydrologic unit code (HUC) 030502060405. The drainage areas for the TMDL WQMS were delineated using USGS topographic maps and ArcGIS software. Dawho River TMDL area has an approximate drainage area of 14.24 mi^2 (Figure 1).

Dawho River is located within the Sea Islands/Coastal Marsh ecoregion, characterized by the state's lowest elevations. This dynamic environment is shaped by elements such as wind, ocean waves, and river flows. Dominant forest types in this ecoregion include slash pine, cabbage palmetto, red cedar, and live oaks. Marshes play a significant role and are primarily populated by plant species like saltgrass, rushes, and various cordgrasses. Notably, these marshes serve as essential nursery grounds for a wide range of aquatic species, including shrimp, fish, crabs, and various other organisms (Griffith, et al. 2002).

South Carolina Department of Environmental Services (SCDES or the Department) formerly known as, South Carolina Department of Health and Environmental Control (SCDHEC or DHEC), currently has two active shellfish stations within the TMDL watershed, 12B-09 and 12B-53. Station 12B-53 does not meet the FC WQS for shellfish harvesting (SFH) waters and is classified as “restricted” for shellfish harvesting (SCDHEC 2023). Per U.S. Food and Drug Administration (FDA) rules and regulations (USFDA 2021), station 12B-09 is the downstream boundary of the area restricted for shellfish harvesting use (Figure 3). Station MD-120 is an active ambient WQMS within the TMDL watershed that has exceeded the *Enterococci* WQS for saltwater recreational uses in shellfish harvesting and recreational salt waters. Additionally, there were three random statistical WQMS that were sampled during 2001 (RT-01665), 2007 (RT-07055), and 2020 (RT-20236). WQMS RT-07055 and RT-20236 exceed the *Enterococci* recreational WQS for shellfish harvesting and recreational salt waters (Figure 2). Stations 12B-53, MD-120, RT-07055, and RT20236 have been included in 2020 and

2022 303(d) list of impaired waters (SCDHEC 2023). Station 12B-53 has been prioritized and accepted by United States Environmental Protection Agency (EPA) as a metric in the CWA §303(d) program performance measures (Table 1).

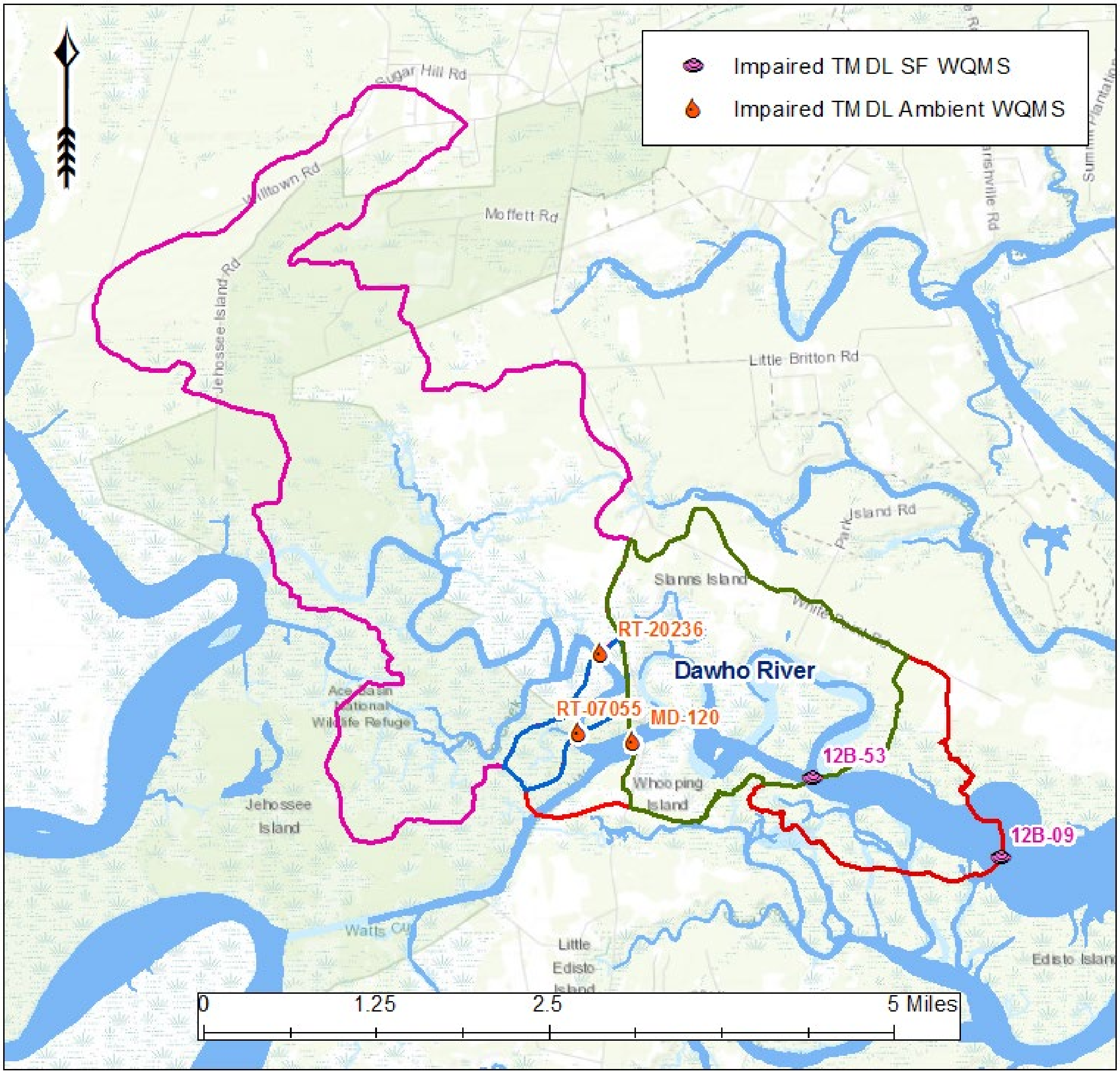


Figure 2. Dawho River TMDL stations and their drainage areas.

Outside the TMDL watershed boundaries, in North Edisto, South Edisto, and Wadmalaw rivers, no WQMS are impaired for bacteria. However, there are FC impairments at SFH stations in the smaller tributaries of these larger tidal estuaries, which indicates that the bacteria impairments documented in the TMDL stations are due to non-point sources within the TMDL watershed (Figure 4).

Table 1. Dawho River shellfish and ambient water quality monitoring stations and their location descriptions.

Station	Location Description
12B-09	Dawho River, AIWW Marker #119
12B-53	Dawho River, AIWW Marker #126
MD-120	Dawho River at SC 174 9 mi N of Edisto Beach State Park
RT-07055	Dawho River 0.2 mi US of Confluence with North Creek/ICWW
RT-20236	Dawho River 0.5 mi Following River Curves NE of Mouth of Fishing Creek

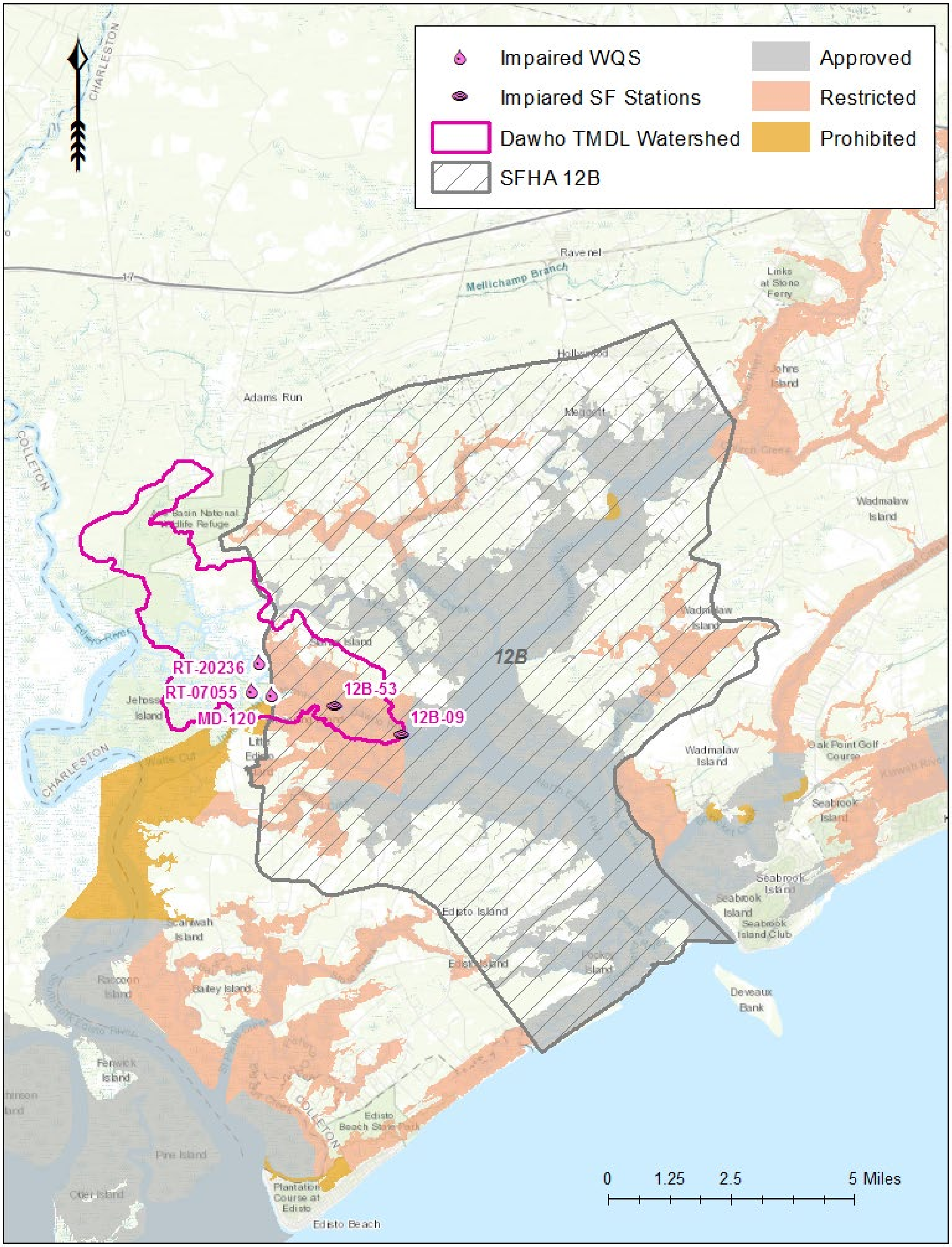


Figure 3. Dawho River located in SFMA 12B, impaired TMDL stations, and the current shellfish harvesting classifications.

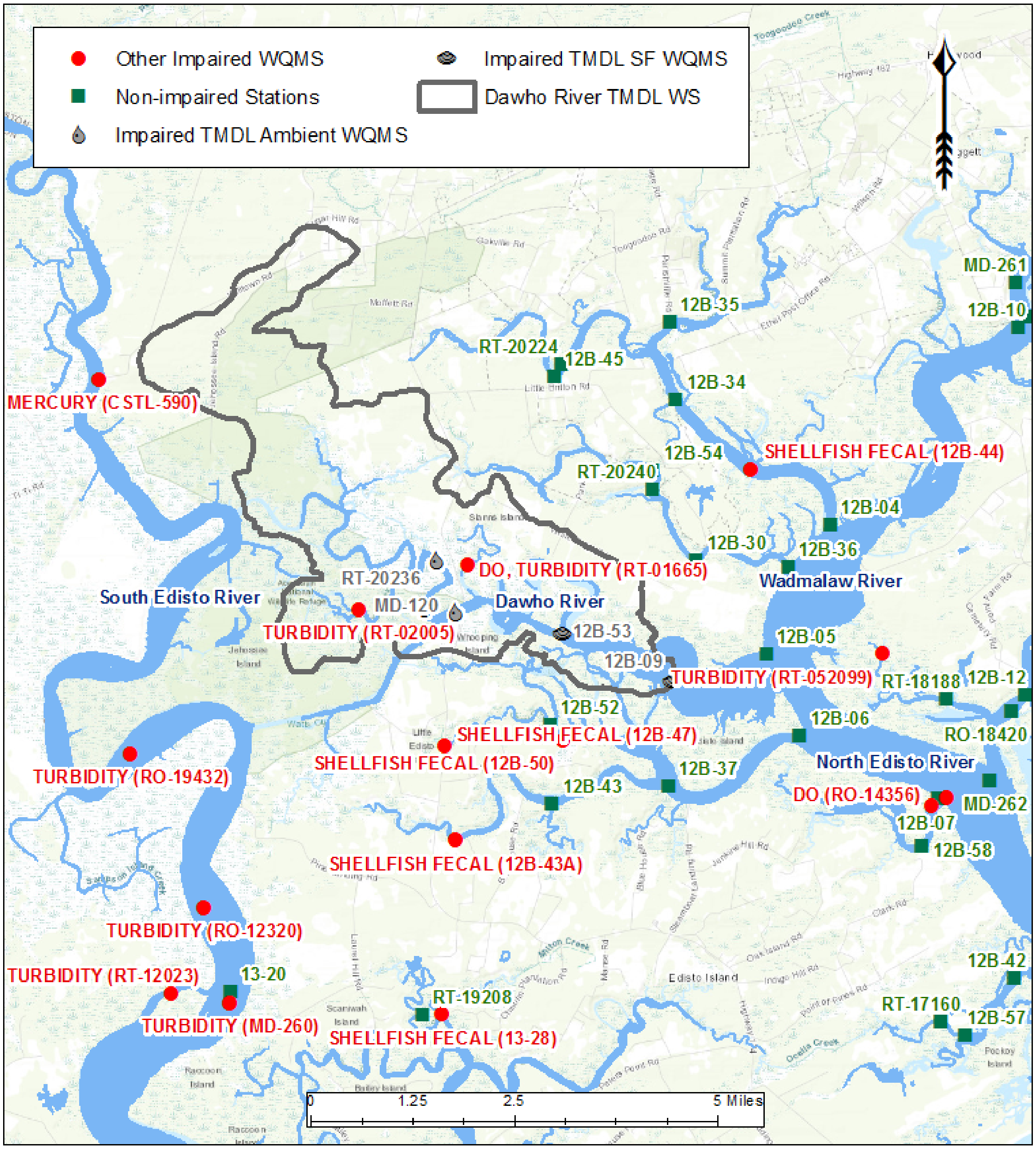


Figure 4. Other impaired and non-impaired stations not included in this TMDL document.

1.3 Land use

Land uses of stations of TMDL stations were calculated using the National Land Cover Database (NLCD) 2021 (Dewitz 2023) (Figure 5). Land use characteristics of station 12B-53 is summarized in Table 2, and primary and secondary dominant uses are

bolded for the station's drainage area. Remaining TMDL stations' land use summaries can be found in Appendix D – Land Uses.

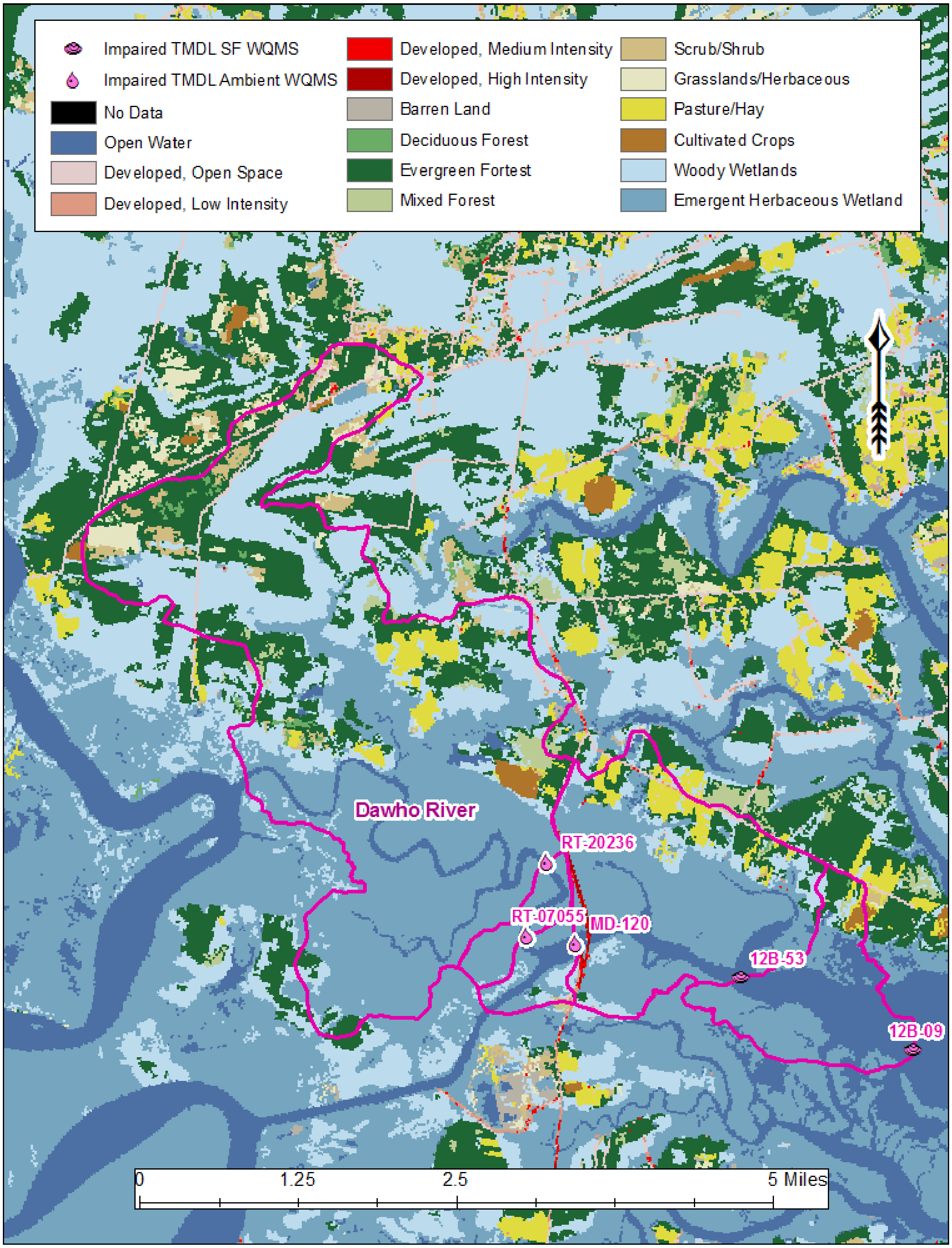


Figure 5. 2021 NLCD land uses of the TMDL stations.

Table 2. NLCD 2021 land uses of station 12B-53.

12B-53	Area (ac)	% of Area
Open Water	208.8	10.9
Developed	66.9	3.5
Barren Land	1.3	0.1
Forest	168.6	8.8
Pasture/Hay	124.5	6.5
Forested Wetlands	**227.5**	**11.8**
Non-forested Wetlands	**1126.0**	**58.5**
Total	1923.7	100.0

1.4 Water Quality Standard

Dawho River is classified as shellfish harvesting waters (SFH) and outstanding resource waters (ORW) in SC Regulation 61-69 (SCDHEC 2012).

SFH waters are defined in SC Regulation 61-68 (SCDHEC 2023) as:

> "Shellfish harvesting waters (SFH) are tidal saltwaters protected for shellfish harvesting and uses listed in Class SA and Class SB. Suitable for primary and secondary contact recreation, crabbing, and fishing. Also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora."

ORW waters are defined in SC Regulation 61-68 (SCDHEC 2023) as:

> "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".

FC WQS for SFH waters is defined in SC Regulation 61-68 as (SCDHEC 2023):

> "Not to exceed an MPN fecal coliform geometric mean of 14/100 ml; nor shall more than ten percent (10%) of the samples exceed an MPN of 43/100 ml."

Enterococci WQS for SFH, Class SA, and Class SB waters is defined in SC Regulation 61-68 as (SCDHEC 2023):

> "Not to exceed a geometric mean of 35/100 mL based on at least four (4) samples collected from a given sampling site over a 30-day period; nor shall more than 10 percent (10%) of the samples exceed a single sample maximum of 104/100 mL during any 30-day period"

2.0 Water Quality Assessment

In 1986, the USEPA documented that *Enterococci* bacteria is a better indicator in predicting the presence of human gastroenteritis (upset stomach, nausea, diarrhea, and vomiting) causing pathogenic bacteria in marine waters. In cases of water-borne illnesses, pathogens sources are inadequately treated human waste and feces originating from other warm-blooded animals. In South Carolina, *Enterococci* is the indicator bacteria for assessing the presence and recreational uses in salt waters (SCDHEC 2023).

Ambient monitoring station MD-120 and statistical random monitoring stations RT-07055 and RT-20236 have exceeded the WQS for *Enterococci* in recreational salt waters. The 303(d) listing determination for ambient monitoring stations is based on an assessment of five consecutive years of data. Statistical random sampling stations are monitored for one year, and data collected during that period is used for the 303(d) listing determination. These three stations have been included in the 2020 and 2022 303(d) lists of impaired waters. Data summaries for these stations and shellfish station 12B-53 are presented in Table 3.

The National Shellfish Sanitation Program (NSSP) allows shellfish growing areas to be classified using either total or FC, and application of either standard to different water bodies within the state. There are also two sampling strategies for the application of the standards:

a) Adverse pollution control,
b) Systematic random sampling (SRS).

The SCDES Shellfish Program currently utilizes the SRS strategy within SFMA 12B instead of sampling under adverse pollution control conditions. To ensure random sampling, sampling dates are computer-generated before the beginning of each quarterly period. Due to shipping requirements and manpower constraints, samples are collected on Mondays, Tuesdays, or Wednesdays (SCDHEC 2023).

To comply with NSSP guidelines, a minimum of 30 samples are required to be collected and analyzed from each station during the three-year review period. For harvest classifications, samples are collected according to the SRS strategy outlined in NSSP Guidance document for 12 months between January 1st and December 31st, for three years. This allows for a maximum of 36 samples per station for three years yet provides a six-sample "cushion" (above the NSSP required 30 minimum) for broken samples, lab error, breakdowns, etc. This also allows each annual report to meet the NSSP Triennial Review sampling criteria (USFDA 2021).

The determination for 303(d) listing purposes is based on assessing three consecutive years of data from a shellfish station. For instance, for 2022 303(d) list, shellfish data collected from 2018 through 2020 were used. Note that station 12B-09 meets the WQS and is the downstream boundary for the impaired station 12B-53 in accordance with NSSP (USFDA 2021) and R. 61-47 (SCDHEC 2017). Data are included for informational purposes only.

In addition to bacteriological samples, surface water temperatures are measured using a hand-held, laboratory-quality calibrated thermometer. Salinities are measured in the laboratory using an automatic temperature compensated refractometer. Additional field data collected during samplings are ambient air temperature, wind direction, tidal stage, date, and time of sampling (SCDHEC 2023).

Table 3. Bacteria data summaries of TMDL stations.

Station	# of samples (n)	SSM WQS mpn/100mL	n Exceeding SSM WQS	% Exceeding SSM WQS	TMDL Data Period
12B-53	71	43	20	28.2	2017-2022
12B-09*	71	43	6	8.5	2017-2022
MD-120	92	104	20	21.7	2012-2022
RT-07055	13	104	2	15.4	2007
RT-20236	13	104	4	30.8	2020

** 12B-09 is the downstream boundary for the area restricted for shellfish harvesting and is not impaired. Data included for informational purposes.*

3.0 Source Assessment

Surface waters can be contaminated by various sources of pathogens, which can be categorized as point sources, and nonpoint sources. Efforts to control pollution from continuous point sources, such as wastewater treatment plants (WWTP), 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 a bacteria limits 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 TS4, 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 tidal stream 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 surface waters 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.

Currently, there are no continuous point sources within the TMDL watersheds. Future NPDES dischargers to these waters are required to comply with their permit limit for FC and *Enterococci* which will limit them to the WQS at the point of discharge.

3.1.2 Intermittent Point Sources - TS4 and MS4s

Intermittent point sources include all NPDES-permitted stormwater discharges, including current and future TS4s, MS4s, construction, and industrial discharges covered under permits numbered SCS and SCR and regulated under *SC Water Pollution Control Permits*: R.61-9 (SCDHEC 2023). All regulated TS4 and MS4 entities have the potential to contribute bacteria and other pathogen loadings to the TMDL watersheds and are subject to the WLA for intermittent point sources.

The presence of developed 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 (Dewitz 2023) dataset, and the results for station 12B-53 are shown in Table 2. Land use summaries for the remaining TMDL stations is in Appendix D.

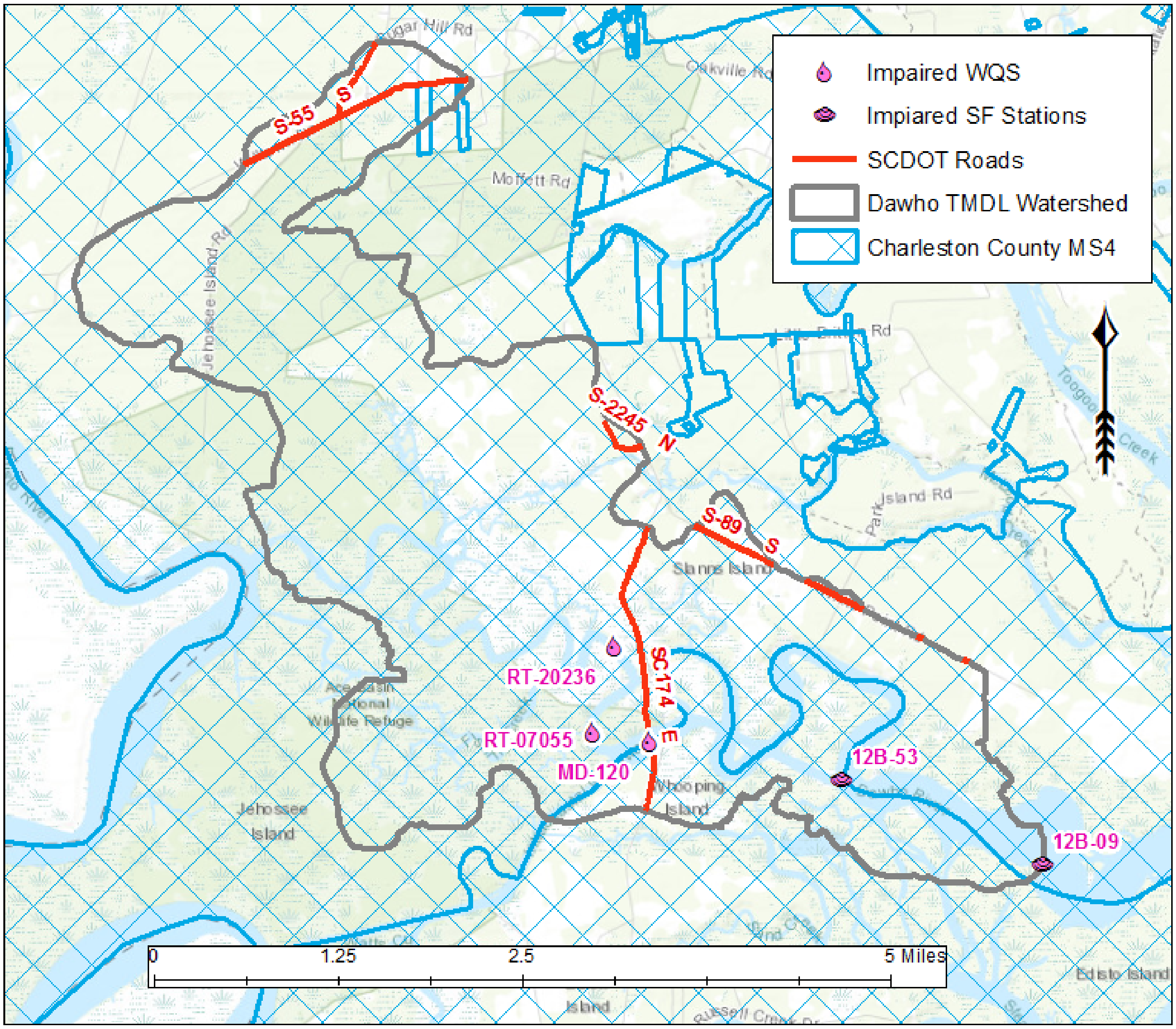


Figure 6. SCDOT and Charleston County are the TS4 and MS4 within the TMDL watershed.

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.

Stormwater discharges from all regulated TS4 and MS4 entities operating within the TMDL watersheds have the potential to contribute to bacteria and other pathogens and are subject to the WLA portion of the TMDL. The South Carolina Department of Transportation (SCDOT) is a designated TS4 within these TMDL watersheds, operating under NPDES TS4 Permit SCS040001 (Figure 6). 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.

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 is no sewer service in the TMDL watershed, therefore SSOs are not considered as a source in this TMDL watershed.

The Department acknowledges that TS4 and MS4s may require multiple permit iterations to fully meet the assumptions and requirements of the TMDL. In order to comply with the TS4 and MS4 permits, 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 MEP met. This allows for flexibility in the implementation process.

For SCDOT NPDES permitted TS4, 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 are eligible for the *Clean Water Act* (CWA) §319 grants. The Department recognizes that adaptive management/implementation of these TMDLs might be needed to achieve the WQS.

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 bacteria and other pathogens in this TMDL watershed. 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 of pathogens to tidal streams 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 bacteria and pathogens in waterways. Their feces may directly enter surface waters or be transported into streams through runoff after rainfall events. According to a study conducted in 2013, the South Carolina Department of Natural Resources (SCDNR) estimated deer density based on suitable habitats such as forests, croplands, and pastures. Based on this study, there is an estimated deer population of 30 to 45 per square mile in these TMDL watersheds (SCDNR 2013). 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 FC and other pathogens in these watersheds.

The Ernest F. Hollings ACE Basin National Wildlife Refuge, overseen by the U.S. Fish and Wildlife Service, lies to the west of Dawho River. Spanning 350,000 acres, this wetland ecosystem comprises upland and bottomland forests, as well as fresh and saltwater marshes, alongside managed impoundments. The refuge is home to a diverse range of wildlife, including waterfowl, resident and migratory birds, white-tailed deer, reptiles, amphibians, river otters, gray foxes, rabbits, and bobcats are observable throughout the year.

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 which can affect water quality. Effective management of manure and animal waste is essential to prevent pathogen contamination in the TMDL watersheds.

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. South Carolina currently does not have concentrated animal feeding operations (CAFOs) under NPDES coverage. Currently, there are no regulated agricultural operations within Dawho River watershed.

3.2.2.2 Grazing Livestock

Livestock, particularly cattle, are recognized contributors of bacteria and other fecal-borne pathogens in waters. On average, cattle and horses typically produce approximately 1.0E+11 cfu/day and 4.20E+08 cfu/day per animal of FC bacteria, respectively. The presence of grazing cattle and other livestock can introduce bacteria into streams via runoff from pastures or through direct defecation into waters. The grazing of livestock in pastures is not regulated by SCDES.

The United States Department of Agriculture's National Agricultural Statistics Service's 2022 agricultural census reported 1,438 cattle and calves, and 503 horses and ponies in Charleston County (USDA 2024). Based on the assumption of an even distribution of cattle and horses across pasture/hay areas in Charleston County, approximate estimates of the cattle population within the TMDL watershed were calculated. It is estimated that cattle could contribute 2.15E+12 (Table 4) and horses could contribute 3.10E+09 (Table 5) bacteria per day to TMDL watersheds, with the possibility of some fraction entering the waterways.

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 cattle population. Nonetheless, the direct discharge of fecal indicator bacteria and other pathogens into surface waters by cattle and other livestock remains a potential contributing source within the TMDL watersheds.

Table 4. Estimated bacteria contributions from cattle and calves in the TMDL watershed.

WQM Station	Pasture/Hay Acres	Number of Cattle and Calves in Station DA	Bacteria Produced in Station DA per day
12B-53	124.5	8.0	7.97E+11
12B-09	12.5	0.8	8.00E+10
MD-120	0	0	0
RT-07055	0	0	0
RT-20236	199	12.7	1.27E+12

Table 5. Estimated bacteria contributions from horses and ponies in the TMDL watershed.

WQM Station	Pasture/Hay Acres	Number of Horses and Ponies in Station DA	Bacteria Produced in Station DA per day
12B-53	124.5	2.7	1.15E+09
12B-09	12.5	0.3	1.16E+08
MD-120	0	0	0
RT-07055	0	0	0
RT-20236	199	4.4	1.84E+09

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 (SCDHEC 2021).

Proper management of the 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.

It is recognized that there may be operating regulated land application sites located in this watershed. If properly managed, waste is applied at a rate that ensures pollutants will be incorporated into the soil or plants and pollutants will not enter streams. Land application sites can be a source of bacteria and other pathogens and contribute to stream impairment if not properly managed. The NPDES permitted land application sites are not allowed to directly discharge to surface waters in TMDL watersheds. Direct discharges from land application sites to surface waters of the State are illegal and are subject to enforcement actions by the Department. Currently, there are no

NPDES permitted facilities with a land application permit for applying treated wastewater within these TMDL watersheds.

3.2.4 Leaking Sanitary Sewer and Illicit Discharges

Leaking sewer pipes and unauthorized sewer connections pose substantial risks to public health by releasing partially treated or untreated human waste into the environment. However, quantifying the full extent of these sources without direct monitoring is challenging, as their impact is contingent on variables like volume and proximity to surface water. Untreated domestic wastewater typically contains bacteria levels within the range of 10^4 to 10^6 MPN per 100mL.

Illicit sewer connections reroute sewage into storm drains, causing direct sewage discharge through the storm drainage system's outfalls. To assess this issue, monitoring the storm drain outfalls during dry weather periods is crucial to determine the presence or absence of sewage within the drainage systems. This monitoring process is essential for identifying and documenting the extent of unauthorized sewer connections and their environmental impact.

Currently, there is no sewer service or sewer lines within the Dawho River TMDL watershed (SCDHEC 2023). Therefore, these are not considered as sources of bacteria impairments.

3.2.5 Failing Septic Systems

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.

The Department 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.

Based on the 2020 U.S. Census, there are approximately 235 housing units accommodating a population of 467 individuals within the TMDL watershed. According to the SFMA 12B annual update, sewer services are not present within the TMDL watershed, with waste management primarily reliant on septic systems. Failing septic systems are identified as one of the potential sources contributing to bacteria exceedances in this TMDL watershed.

3.2.6 Stormwater Runoff

Domesticated pets, such as dogs and cats, are contributors of fecal indicator bacteria and other pathogens in urban and suburban areas. Wildlife species like deer, squirrels, raccoons, opossums, and birds also contribute to the overall bacteria load in these areas. Calculations based on the national pet statistics data from the American Veterinary Medical Association (AVMA) suggest an estimated count of 375 dogs and 457 cats within the TMDL watersheds (AVMA 2016). These pets can contribute to the overall bacterial load in these specific areas.

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

3.2.7 Marinas, Boating Activities, and Structures

Currently, there are no marinas or pump out stations within the TMDL watershed. There is one public boat ramp located near the Highway 174 bridge. Additionally, a few private docks exist within the watershed area.

There are 3 main types of marine sanitation devices (MSD) that are suitable for different kinds of marine vessels with varying effluent treatment levels. Every vessel with an MSD installed as of January 30, 1980, must be equipped with one of the three types of MSDs (The United States Code 2012). Properly maintained MSDs should not be causing or contributing to bacteria exceedances in impaired waters. It is prohibited under Federal law to discharge untreated sewage from vessels within navigable waters as stated in the Clean Vessel Act.

Illegal discharges of untreated sewage from boats and other watercraft can contribute to bacteria exceedances in the Dawho River TMDL watershed.

4.0 Cumulative Probability Method

Cumulative probability distributions were used to calculate existing conditions and percent reductions necessary to meet SFH and recreational salt waters WQS for FC and *Enterococci* in Dawho River.

For the calculation of the cumulative probability distributions, data collected from each bacteria impaired monitoring station were used to calculate the percent reductions necessary to meet WQS. Data from these impaired stations are summarized in Table 3. For example, data collected from 2017 through 2022 were used to calculate the percent reductions for shellfish monitoring station 12B-53 (Appendix A). Cumulative probability graphs were created using Cumulative Probability Plot 3.0 (Boeing 2003) and log base 10 of bacteria data. If the data follow a log-normal distribution, the data points on the plot will approximate a straight line (the normal distribution). This straight line is then compared to the WQS at the appropriate percentile. For SFH waters in South Carolina, the TMDL target equates to 43 mpn/100ml FC bacteria minus a 5% MOS (40.85 mpn/100mL, log10 1.61). Evaluating the data at the 90th percentile allows for the 10% exceedance as referenced in R. 61-68 (SCDHEC 2023), R. 61-47 (SCDHEC 2017), and NSSP (USFDA 2021). Figure 7 shows the cumulative probability plot for station 12B-53. Remaining cumulative probability plots are shown in Appendix C – Cumulative Probability Graphs.

This evaluation is consistent with the NSSP approach under the SRS scheme. According to the NSSP approach under an SRS scheme, if the data do not meet the SSM WQS, a line is drawn parallel to the original normal distribution line that intersects the standard at the 90th percentile. Drawing the line parallel to the original distribution assumes that the coefficient of variation remains the same for the original data and the desired water quality data (Novotny 2004). The necessary percent reduction is calculated as the difference between the distributions at the 90th percentile:

$$\frac{\text{Existing 90th \%tile concentration} - (\text{WQS} - \text{MOS})}{\text{Existing 90th \%tile concentration}} \times 100$$

To determine whether TMDLs would be based on SSM or geometric mean WQS, bacteria data collected from TMDL stations were analyzed and percent reductions based on SSM and geometric mean were calculated and summarized in Table 6. As shown on the table, SSM percent reductions are greater than geometric mean percent reductions. Therefore, SSM WQS criterion will be targeted for the calculation of TMDLs for the impaired stations. Targeting SSM percent reductions will also be protective of the geometric mean standard. Note that, SSM percent reductions shown on Table 6 are based on 43 mpn/100 mL for SFH waters and 104 mpn/100 mL for recreational salt waters. Percent reductions shown on the TMDL Table 7 are based on SSM minus 5% MOS, and therefore are higher than those on Table 6.

Table 6. Single sample maximum and geometric mean percent reduction comparisons.

Station	# of Samples	SSM % Reduction	Geomean % Reduction	TMDL Data Period
12B-53	71	52.6	14.1	2017-2022
MD-120	92	36.7	19.1	2012-2022
RT-07055	13	25.8	NRN (Geomean < 35)	2007
RT-20236	13	60.1	43.6	2020

NRN = No reduction needed.

Total maximum daily loadings of bacteria for the impaired stations listed in this document were calculated by estimating the cross-sectional area of the channel at the impaired station and estimating average tidal flow. TMDL loads were based on the SSM WQS. Detailed description of the methodology along with an example calculation can be found in Appendix B.

This method provides an estimate of the target daily load based on average tidal flow. Actual tidal flows and loads are highly variable at these locations. The estimated daily loading calculations are based on multiple assumptions such as dated NOAA station data, channel geometry, cross sectional area of the channel, flow velocities, channel depth, and the dynamic nature of the environment. Therefore, the resulting loadings are only provided as an example.

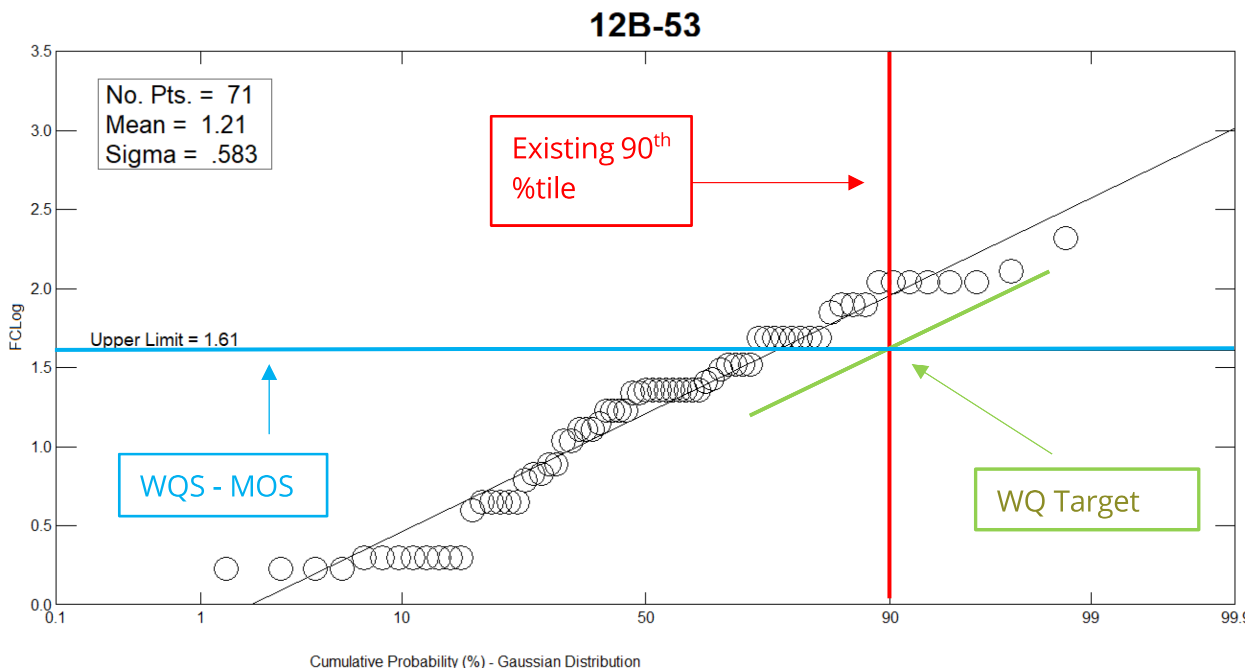


Figure 7. Cumulative probability plot for station 12B-53.

5.0 Development of the TMDL

5.1 Critical Conditions

Critical conditions are factors that either in combination or individually cause violations of WQS. In these TMDL watersheds, characterized by their tidal and complex hydrologic nature, determining a singular critical flow remains ambiguous. The implicit inclusion of critical conditions is achieved by considering data collected across all seasons over multiple years, diverse tidal states, and varying weather conditions during which the water samples were collected. This approach inherently addresses the range of potential critical conditions within the system.

5.2 Wasteload 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.

5.2.1 Continuous Point Sources

Dawho River is classified as ORW, SFH, and recreational salt waters and dischargers to these waters are allowable if the Department deems appropriate. Currently, there are no continuous NPDES-permitted discharges to the affected TMDL watersheds with a bacteria effluent limit on their NPDES permit. Future continuous dischargers are required to meet the prescribed loading for the pollutant of concern based on permitted flow and assuming an allowable permitted SSM FC of 43mpn/100 mL for the SFH waters and SSM *Enterococci* of 104 mpn/100 mL for recreational salt waters. Continuous point source permit limits for bacteria are equivalent to the WQS.

5.2.2 Intermittent Point Sources

Intermittent point sources include all NPDES-permitted stormwater discharges, including current and future MS4s, TS4, construction and industrial stormwater discharges covered under permits numbered SCS000000 & SCR100000 regulated under SC *Water Pollution Control Permits* Regulation R61-9 (SCDHEC 2023). 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.

SCDOT TS4 and Charleston County MS4 are the regulated NPDES transportation and municipal MS4s located in the TMDL watersheds. SCDOT operates under NPDES TS4 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 percent reduction instead of a numeric concentration 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. Table 7 presents the reductions needed for the impaired segments. The percent reduction identified for the impaired stations in this document also applies to the bacteria waste loads attributable to those areas of the watershed which are covered or will be covered under NPDES TS4 and MS4 permits.

5.3 Load Allocation

The LA applies to the nonpoint sources of bacteria, which include unregulated processes/entities and is expressed as a percent reduction. The LA for TMDL stations are expressed in Table 7 as percent reductions. At such time that the referenced entities or other future unregulated entities become regulated NPDES TS4 or MS4 entities and are subject to applicable provisions of SC Regulation 61-68, 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 (SCDHEC 2023).

5.4 Existing Load

Due to the tidal nature of the system, it is difficult to calculate an existing load for this system. For this reason, existing conditions are given as a concentration. The existing concentration is calculated as the concentration of bacteria at the 90^{th} percentile based on the normal line fit to the monitoring data. The 90^{th} percentile of the existing data is used to allow for the 10% exceedance outlined in the R. 61-68 and R. 61-47. The existing concentrations for impaired stations are shown in Table 7.

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. These TMDLs have an explicit 5% MOS. Water quality data collected from shellfish monitoring station was compared to 40.85 mpn/100mL which is the SSM WQS minus 5% for FC in SFH waters, and 98.8 mpn/100 mL which is the SSM WQS minus 5% for *Enterococci* in recreational salt waters.

5.6 Calculation of the TMDLs

Bacteria data summarized in Table 3 and shown in Appendix A were used to calculate the TMDLs for the impaired stations. Station 12B-09, although not impaired, serves as the downstream station delineating the boundary for the area restricting shellfish harvesting. Consequently, no reductions were computed for station 12B-09.

5.7 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.

Based on the information available at this time, the portions of the watersheds that drain directly to a regulated TS4 and MS4 and that which drain through the non-regulated MS4 have not been clearly defined. Loading from both types of sources (regulated and non-regulated) typically occurs in response to rainfall events, discharge volumes and recurrence intervals are largely unknown. Therefore, where applicable, the regulated MS4 is assigned the same percent reduction as the non-regulated sources in the watershed. Compliance with the TS4 and MS4 permit regarding this TMDL document is determined at the point of discharge to the waters of the state. The regulated TS4 or MS4 entity is only responsible for implementing the TMDL WLA by following their TS4 and MS4 permit requirements and is not responsible for reducing loads prescribed as LA in this TMDL document.

Table 7. TMDLs for Dawho River. TMDLs are expressed as the mpn/100 mL and mpn per day, and allocations are expressed as % reductions.

Station	Existing Conc. (mpn/ 100ml)	TMDL Conc.[1] (mpn/ 100ml)	TMDL Load[2] (WLA+LA+ MOS) (mpn/day)	WLA + LA (mpn/day)	MOS (mpn/day)	Implementation Targets[6]			
						Continuous Sources[3] (mpn/100ml)	Intermittent MS4[5] (%)	Intermittent TS4 SCDOT (%)	Non-Point Source LA (%)
12B-53	90.7	43	3.10E+12	2.94E+12	1.55E+11	See Note Below	54.9%	54.9%[4]	54.9%
MD-120	164.3	104	1.18E+13	1.12E+13	5.93E+11	See Note Below	39.9%	39.9%[4]	39.9%
RT-07055	140.2	104	1.64E+13	1.56E+13	8.23E+11	See Note Below	29.6%	29.6%[4]	29.6%
RT-20236	260.4	104	1.45E+13	1.38E+13	7.25E+11	See Note Below	62.1%	62.1%[4]	62.1%

Table Notes:

1. TMDL = SFH waters WQS for single sample maximum not to exceed 43 mpn/100 mL FC, and TMDL = Recreational salt waters WQS for single sample maximum not to exceed 104 mpn/100 mL *Enterococci.*
2. TMDL at average flow conditions calculated using estimated average tidal flow at the WQ station.
3. WLA is expressed as a daily maximum of 43 mpn/100 mL FC and 104 mpn/100 mL *Enterococci*. There are no continuous dischargers at this time. Future continuous discharges are required to meet the WQS for the pollutant of concern. Loadings to meet the WQS are developed based on the permitted flow and an allowable permitted maximum concentration of 43 mpn/100mL (FC).
4. By implementing the best management practices (BMPs) that are prescribed in either the SCDOT annual storm water management plan or the SCDOT NPDES TS4 permit to address bacteria, the SCDOT will comply with this TMDL and its applicable WLA to the maximum extent practicable (MEP) as required by its NPDES TS4 permit.

5. Percent reduction applies to all NPDES-permitted stormwater discharges, including current and future MS4s, construction, and industrial discharges covered under permits numbered SCS & SCR. Stormwater discharges are expressed as a percentage reduction due to the uncertain nature of stormwater discharge volumes and recurrence intervals. Stormwater discharges are required to meet percentage reduction or the existing instream standard for the pollutant of concern in accordance with their NPDES Permit.
6. Refer to section 6.0 for the derivation of implementation targets.

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 WQS and we are committed to targeting the load reductions needed to improve water quality in these TMDL watersheds. 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 Sources

NPDES permitted continuous point sources are required to meet the instream WQS for bacteria at the discharge point (end of pipe). Currently, there are no direct discharges to TMDL watersheds described in this document.

6.1 Intermittent Point Sources – TS4 and MS4s

NPDES permitted TS4 and 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 these TMDL watersheds.

An iterative approach of water quality monitoring, illicit source detection and elimination, deploying 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 bacteria loading to these TMDL watersheds is expected to show improvements in water quality.

For SCDOT TS4, Charleston County MS4, and future NPDES MS4 permittees, compliance with terms and conditions of its NPDES permit is effective implementation of the WLA to the MEP. For existing and future NPDES construction and industrial stormwater permittees, compliance with the terms and conditions of its permit is an effective implementation of the WLA.

6.2 Nonpoint Sources

South Carolina has several tools available for implementing the nonpoint source component of this TMDL. The Nonpoint Source Management Plan document is one example (SCDHEC 2019).

Required load reductions in the LA portion of this TMDL can be implemented through voluntary measures and are eligible for CWA §319 grants. Interested parties, such as local stakeholder groups, universities, local governments, etc., may be eligible to apply for CWA §319 grants to install BMPs that will implement the LA portion of these TMDLs and reduce nonpoint source bacteria and other pathogen loadings to impaired waters. 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. CWA §319 grants are not available for implementation of the WLA component of these TMDLs but may be available for the LA component within permitted TS4 and MS4 jurisdictional boundaries.

7.0 References

2017. "40 CFR - Protection of Environment." *Subchapter D Water Programs Part 130 Water Quality Planning and Management.* July 1.

AVMA. 2016. *https://www.avma.org/KB/Resources/Statistics/Pages/US-pet-ownership-calculator.aspx.*

Boeing. 2003. "Cumulative Probability Plot 3.0."

Dewitz, J. 2023. "National Land Cover Database (NLCD) 2021 Products." https://www.usgs.gov/data/national-land-cover-database-nlcd-2021-products.

Griffith, G. E., J. M. Omernik, J. A. Comstock, M. P. Schafale, W. H. McNab, D. R. Lenat, T. F. MacPherson, J. B. Glover, and V. B. Shelburne. 2002. "Ecoregions of North Carolina and South Carolina, (color poster with map, descriptive text, summary tables, and photographs)." Reston , Virginia: U.S. Geological Survey (map scale 1:1,500,00).

Novotny, Vladimir. 2004. "Simplified Data Based Total Maximum Daily Loads, or the World is Log-Normal." *Journal of Environmental Engineering* 130 (6): 674-683.

SCDHEC. 2012. "Classified Waters (R. 61-69)." Columbia, SC: Bureau of Water.

SCDHEC. 2019. *Nonpoint Source Management Plan 2020-2024.* SCDHEC Bureau of Water. https://scdhec.gov/environment/your-water-coast/watersheds-program/section-319-nonpoint-source-program.

SCDHEC. 2021. *R. 61-43 Standards for the Permitting of Agricultural Animal Facilities.* Effective June 28, 2002. Columbia, SC. Accessed March 19, 2018. http://www.scdhec.gov/Agency/docs/water-regs/r61-43.pdf.

SCDHEC. 2017. "R. 61-47 Shellfish." https://scdhec.gov/BOW/water-regulations-standards/water-regulations-standards-shellfish.

—. 2023. "R. 61-68 Water Classifications and Standards."

—. 2005. "Regulation 61-110 Total Maximum Daily Loads for Pollutants in the Water."

SCDHEC. 2023. "Shellfish Management Area 12B 2023 Annual Update." https://des.sc.gov/programs/bureau-water/shellfish-monitoring-program-overview/shellfish-monitoring-station-reports.

SCDHEC. 2023. "The State of South Carolina's 2020 and 2022 Integrated Report (IR) Part I: Section 303(d) Listing of Impaired Waters."

SCDHEC. 2023. *Water Pollution Control Permits: R. 61-9.*

SCDNR. 2013. *South Carolina Deer Density Map.* https://www.dnr.sc.gov/wildlife/deer/deermap.html.

The United States Code. 2012. "33 U.S.C. 1322 - Marine Sanitation Devices." *United States Code, 2006 Edition, Supplement 5, Title 33 -Navigation and Navigable Waters.* January 3.

USDA. 2024. *2022 Census of Agriculture .* National Agricultural Statistics Service, United States Department of Agriculture, 604. https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1,_Chapter_2_County_Level/South_Carolina/.

USEPA. 1986. "Ambient Water Quality Criteria for Bacteria." Vols. EPA 440/5-84-002. Washington DC: Office of Water Regulations Standards and Criteria Division, January.

USFDA. 2019. "National Shellfish Sanitation Program (NSSP). Guide for the Control of Molluscan Shellfish." https://www.fda.gov/media/143238/download.

USGS. 2019. "The StreamStats program." https://streamstats.usgs.gov/ss/.

Yagow, G. 2001. "Fecal Coliform TMDL Mountain Run Watershed Culpeper County, Virginia." April.

Appendix A – Data Used for Calculation of the TMDLs

12B-53 Date	FC MPN/100 mL
1/11/2017	110
2/14/2017	2
3/21/2017	8
4/4/2017	7
5/23/2017	110
6/14/2017	2
7/19/2017	110
8/29/2017	2
9/6/2017	33
10/3/2017	17
11/7/2017	7
12/6/2017	5
1/17/2018	2
2/14/2018	49
3/28/2018	79
4/3/2018	2
5/22/2018	5
6/13/2018	49
7/18/2018	11
8/13/2018	49
9/5/2018	4
10/2/2018	2
11/7/2018	26
12/5/2018	210
1/16/2019	49
2/13/2019	5
3/5/2019	110
4/22/2019	23
5/28/2019	13
6/25/2019	5
7/17/2019	23
8/14/2019	17
9/30/2019	2
10/30/2019	23

12B-53 Date	FC MPN/100 mL
12/11/2019	110
1/15/2020	27
2/12/2020	79
3/30/2020	2
4/22/2020	23
5/19/2020	23
6/15/2020	23
7/20/2020	49
8/12/2020	17
9/2/2020	31
10/19/2020	17
11/16/2020	130
12/21/2020	6
1/13/2021	49
2/10/2021	33
3/2/2021	110
4/19/2021	14
5/19/2021	2
6/21/2021	23
7/19/2021	33
8/11/2021	5
9/13/2021	23
10/12/2021	2
11/15/2021	22
12/14/2021	33
1/19/2022	22
2/14/2022	13
3/2/2022	49
4/13/2022	79
5/23/2022	2
6/15/2022	11
7/20/2022	8
8/22/2022	70
9/12/2022	23

12B-53 Date	FC MPN/100 mL
10/25/2022	13
11/13/2022	49
12/14/2022	2

Date MD-120	Entero #/100 mL
2/21/2012	20
4/26/2012	10
6/21/2012	41
8/16/2012	75
10/25/2012	110
12/11/2012	75
2/14/2013	86
4/11/2013	10
6/13/2013	10
8/22/2013	156
10/17/2013	41
12/17/2013	41
2/20/2014	10
6/19/2014	10
8/21/2014	131
10/16/2014	119
12/17/2014	20
4/29/2015	75
8/25/2015	108
10/29/2015	10
12/17/2015	108
3/21/2016	41
9/22/2016	62
1/3/2017	30
2/2/2017	10
3/1/2017	10
4/11/2017	10
5/3/2017	31
6/15/2017	10
7/18/2017	85
8/10/2017	85
9/18/2017	121
10/9/2017	63
11/6/2017	31

Date MD-120	Entero #/100 mL
1/16/2018	10
2/27/2018	31
3/12/2018	10
4/18/2018	20
5/7/2018	10
6/25/2018	30
7/30/2018	20
8/23/2018	84
10/18/2018	75
11/8/2018	63
12/3/2018	839
1/9/2019	20
2/19/2019	52
3/7/2019	10
4/17/2019	20
5/13/2019	173
6/13/2019	393
7/11/2019	120
8/13/2019	110
9/30/2019	10
10/29/2019	52
11/18/2019	74
12/2/2019	31
1/8/2020	20
2/27/2020	41
3/12/2020	10
4/20/2020	201
5/28/2020	63
6/8/2020	10
7/9/2020	41
8/27/2020	450
9/10/2020	187
10/28/2020	52
11/2/2020	63

Date MD-120	Entero #/100 mL
1/28/2021	109
2/11/2021	52
3/10/2021	10
4/8/2021	31
5/27/2021	86
6/17/2021	20
7/22/2021	63
8/5/2021	238
9/16/2021	211
10/26/2021	52
11/4/2021	20
1/6/2022	41
2/22/2022	10
3/1/2022	20
4/18/2022	131
5/16/2022	74
6/6/2022	31
7/25/2022	73
9/26/2022	52
10/25/2022	121
11/28/2022	74
12/6/2022	31

Date MD-120	Entero #/100 mL
12/11/2017	75

Date MD-120	Entero #/100 mL
12/15/2020	41

Date RT-07055	Entero #/100 mL	Date RT-20236	Entero #/100 mL
1/18/2007	110	1/8/2020	41
2/26/2007	10	2/27/2020	10
3/8/2007	10	3/12/2020	10
4/19/2007	84	4/20/2020	226
5/17/2007	30	5/28/2020	98
6/27/2007	20	6/8/2020	61
7/17/2007	1	7/9/2020	63
7/31/2007	41	7/28/2020	20
8/30/2007	10	8/27/2020	355
9/20/2007	63	9/10/2020	231
10/11/2007	31	10/28/2020	110
11/1/2007	52	11/2/2020	63
12/6/2007	108	12/15/2020	52

Appendix B – The Method Used to Calculate the Daily Load

Calculating a target load begins with the determination of average tidal flow. First, the average cross-sectional area of the waterway at the sampling station is estimated using the mean tidal range, average depth at low tide, the average width of the channel, and channel geometry (rectangular vs triangular). Lacking site-specific data, average depth at low tide and average widths may be obtained from navigation charts, satellite imagery, topo maps, etc. Mean tidal range is determined as the difference between mean high and mean low water levels and is retrieved from NOAA's Tides and Currents web page using the NOAA station most appropriate for the sampling location. Though infrequently, mean tidal range may also be readily available for some stations. Where available, tidal velocity is determined from the time of travel or flow study data. Usually, these data are not available and default ranges are used (Table 8).

Table 8. Default velocities to be used in the absence of site-specific data.

Velocity (ft/sec)	Waterbody Characteristic
0.5 – 1.0	Relatively slow, constricted estuaries
1.0 – 2.0	Moderate, free-flowing estuaries
2.0 – 3.0	Rapid, highly tidal estuaries

Average tidal flow is calculated by multiplying velocity by the cross-sectional area of the waterbody at the sampling station.

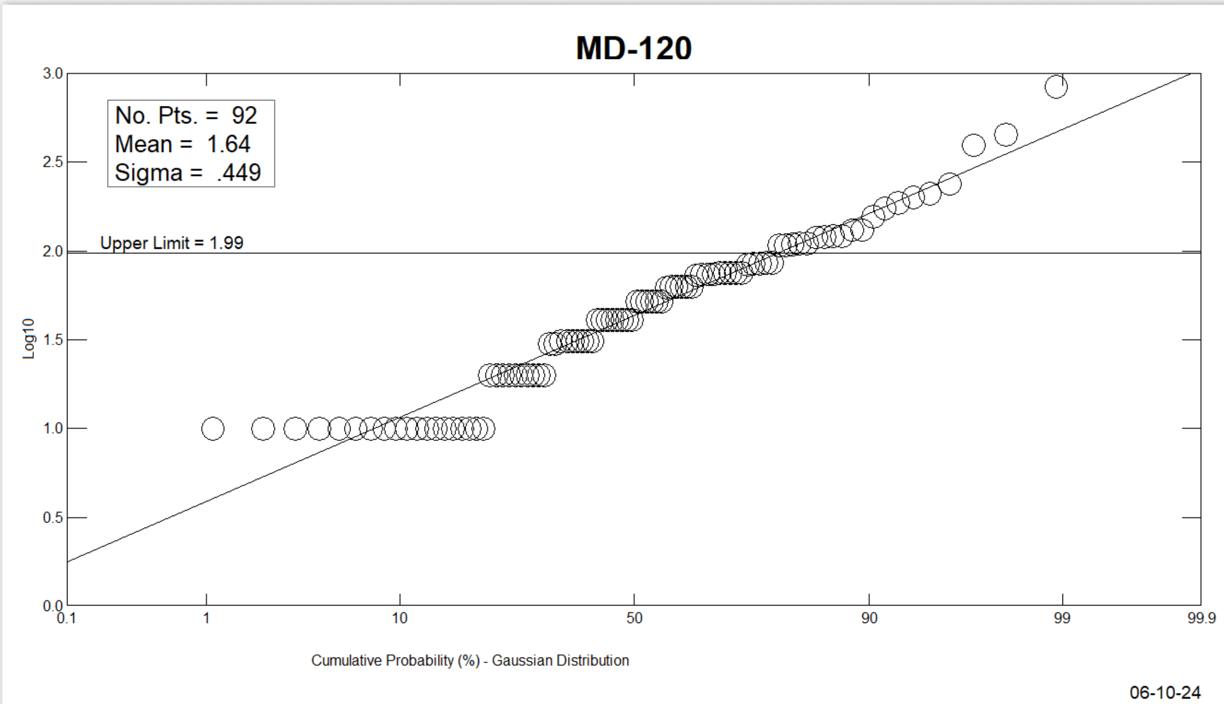
The TMDL loads are then calculated by subtracting the 5% MOS from the WQS and multiplying the resulting concentration by average tidal flow and a conversion factor (24,465,758.4 sec*ml / ft^3*day) as demonstrated below.

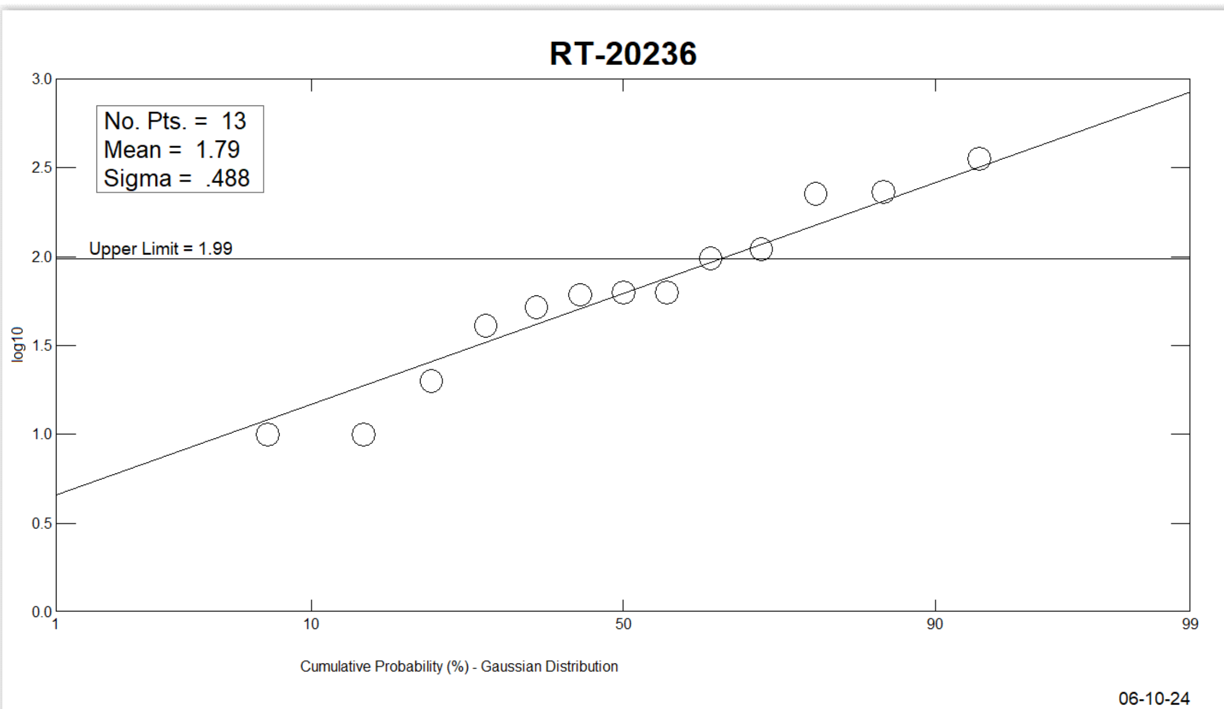
This method provides an estimate of the target daily load based on average tidal flow. Actual tidal flows and loads are highly variable at this location. Therefore, the TMDL expression includes concentration and percent reduction targets for implementation.

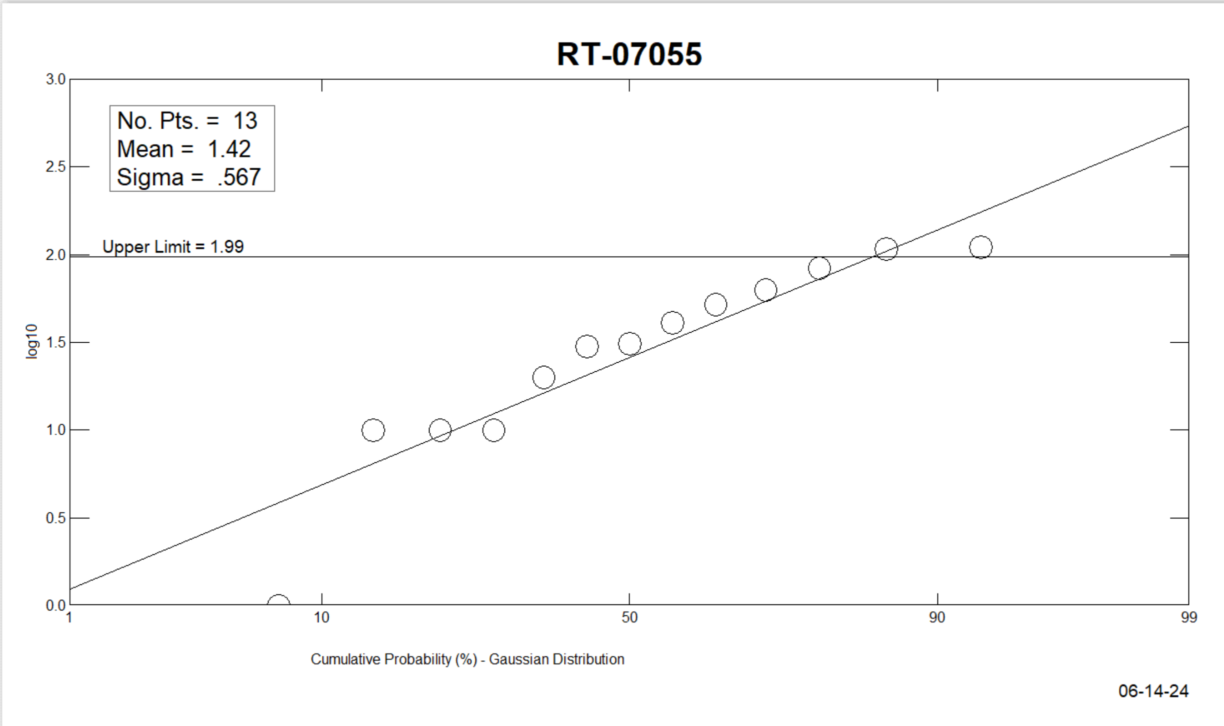
Calculation for 12B-53
Average depth at low tide: 8 ft
Average width: 265.7 ft
Mean tidal range: 6.16 ft
Channel shape: triangular
Channel area = 2{(265.7/2) * (0.5 (8 + 6.16/2))} = 1472 ft^2
Average tidal flow = 1472 ft2 * 2 ft/s = 2944 cfs

WLA + LA = 40.85 mpn/100 mL
WLA + LA load = 40.85 mpn/100 ml * 2944 ft^3/sec * 24,465,758.4 sec*ml/ft^3*day = 2.94×10^{12} mpn/day
MOS Load = 2.15 mpn/100 ml * 2944 ft^3/sec * 24,465,758.4 sec*ml/ft^3*day = 1.5×10^{11} mpn/day
TMDL = 3.10×10^{12}

Appendix C – Cumulative Probability Graphs






RT-07055
No. Pts. = 13
Mean = 1.42
Sigma = .567
Upper Limit = 1.99
log10
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
10
50
90
99
Cumulative Probability (%) - Gaussian Distribution
06-14-24

Appendix D – Land Uses

12B-09	Area (ac)	% of Area
Open Water	**421.4**	**49.5**
Developed	1.6	0.2
Forest	50.9	6.0
Pasture/Hay	12.5	1.5
Cultivated Crops	12.7	1.5
Forested Wetlands	24.2	2.8
Non-forested Wetlands	**328.9**	**38.6**
Total	852.2	100.0

MD-120	Area (ac)	% of Area
Open Water	**64.3**	**28.7**
Developed	2.4	1.1
Forest	5.1	2.3
Forested Wetlands	41.6	18.6
Non-forested Wetlands	**110.5**	**49.4**
Total	224.0	100.0

RT-07055	Area (ac)	% of Area
Open Water	**30.9**	**14.1**
Developed	0.4	0.2
Forested Wetlands	2.0	0.9
Non-forested Wetlands	**186.1**	**84.8**
Total	219.5	100.0

RT-20236	Area (ac)	% of Area
Open Water	212.4	3.6
Developed	115.0	1.9
Barren Land	3.8	0.1
Forest	**1560.8**	**26.5**
Pasture/Hay	199.0	3.4
Cultivated Crops	50.0	0.8
Forested Wetlands	1460.5	24.8
Non-forested Wetlands	**2298.0**	**39.0**
Total	5899.4	100.0

Addendum

Implementation targets have been added to the TS4 column in Tables Ab1 and 7 to provide percent reduction goals for stormwater management planning.

Dawho Responsiveness Summary

Comments were received from the following entities:
Charleston County
EPA Region 4
SCDOT

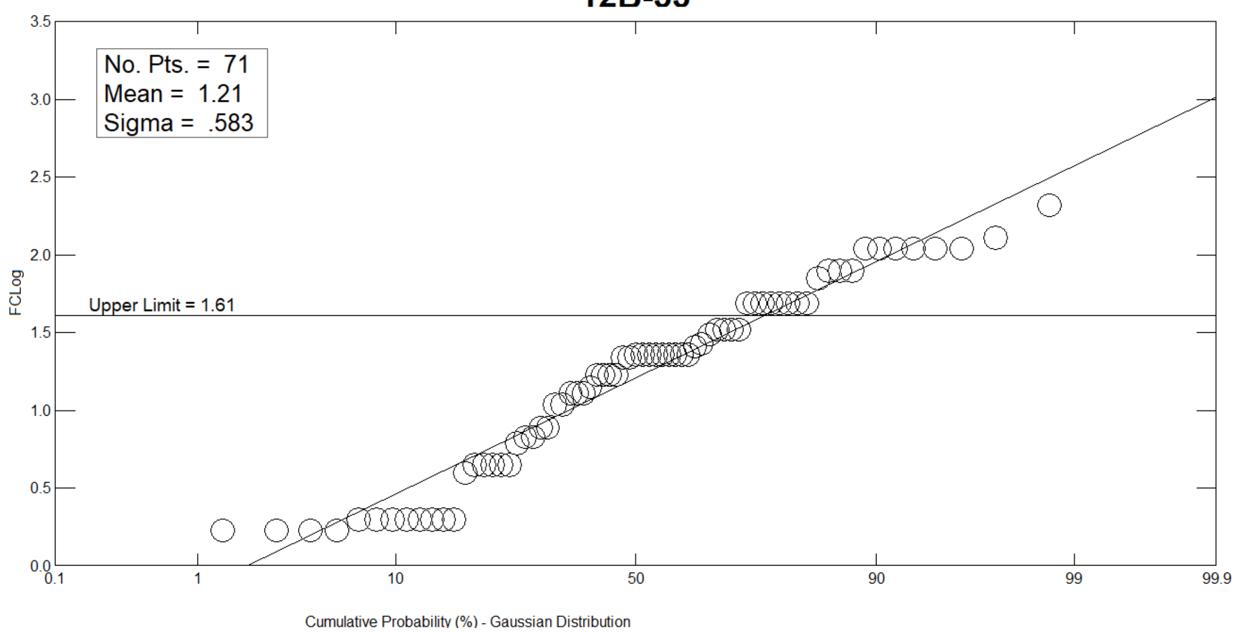
Charleston County:

Comment 1: Calculations of geometric mean are not provided for any stations. Implementation targets should be included for both single sample maximum and geometric mean in Table Ab1.
Response 1: Percent reductions based on both the single sample maximum (SSM) and geometric mean water quality standards (WQS) for the TMDL stations are provided in Table 6 of the draft document. As shown in Table 6, percent reductions based on SSM are greater than those based on the geometric mean.

To ensure protection of water quality standards, the TMDLs for the impaired stations will target the SSM WQS criterion. By targeting SSM percent reductions will also be protective of the geometric mean standard.

Comment 2: Figure 6 only contains 35 data points while Appendix A has 71 data points for 12B-53. Why were some points excluded? Which were included?
Response 2: Incorrect graph for station 12B-53 has been replaced with the correct one shown below. The analysis included all 71 data points, and no data was excluded.

12B-53



Comment 3: Percent reductions are all about 5-10% lower than expected. Check accuracy of these values. Sample calculations would be useful to verify percent reductions.

Response 3:

The harvest classification of shellfish stations within each harvest area is determined following the NSSP Guidance Document (USFDA 2021), which specifies the method for estimating the 90th percentile. This calculation involves:

1. Calculating the arithmetic mean and standard deviation of the sample result logarithms (base 10).
2. Multiplying the standard deviation by 1.28.
3. Adding the result to the arithmetic mean.
4. Taking the antilog (base 10) of the final result to determine the estimated 90th percentile.

The cumulative probability plot provided earlier contains the statistics necessary to calculate the estimated 90th percentile. Using the NSSP formula, along with the mean and standard deviation of the data, the estimated 90th percentile for station 12B-53 for the analysis period is 90.658 MPN/100 mL.

Percent reductions are calculated using the single sample maximum WQS of 43 mpn/100 mL minus a 5% margin of safety (40.85 mpn/100 mL). For station 12B-53, this results in a 54.9% reduction.

Commentor's calculated percent reductions for station 12B-53 were based on incorrect assumptions and methodologies, leading to discrepancies. Specifically:

- The percent reduction was incorrectly calculated using 43 MPN/100 mL, rather than 40.85 MPN/100 mL, which accounts for the 5% margin of safety.
- Rounded data in the appendix were used, which led to inaccurate calculations of mean and standard deviation.
- The trendline equation was used to estimate the 90th percentile instead of the NSSP method, resulting in higher values and, consequently, a larger percent reduction.

Note that, the data in the appendix of the draft document were rounded to whole numbers for visual clarity and ease of interpretation because FC MPN method results can include fractions with up to 14 significant digits. This distinction is crucial for verifying accuracy in percent reduction calculations.

The percent reductions for the remaining TMDL stations were calculated following the NSSP methodology and SSM WQS minus the 5% margin of safety.

Comment 4: The respective areas for each monitoring station (listed on pg. 43) should be graphically delineated on the watershed map.
Response 4:
A new map was added (Figure 2) showing the drainage areas of the TMDL stations.

EPA Region 4:
Comment 1: EPA believes that the most defensible approach is for SC DES to return to the TMDL expression language that was developed in 2009 through collaboration between SC DEQ, SC DOT, and EPA R4. This consensus language resolved SC DOT's objection to the 69 Creek TMDL, and therefore is the best language to use for the Dawho River pathogen TMDL, and future SC pathogen TMDLs.
Response 1: The TMDL table notes have been updated to reflect the consensus language agreed upon in 2009 by SCDES, SCDOT, and EPA R4. This language was reinstated to ensure consistency with previous agreements and to address the concerns raised by SCDOT.

Comment 2: Abstract (page ii) paragraph 2. Remove the last sentence "Charleston County has been allocated a WLA".
Response 2: The sentence will remain in the abstract, as Charleston County is a designated MS4 and has been allocated a Wasteload Allocation (WLA) in accordance with regulatory requirements.

Comment 3: Page 6, paragraph 2. In the sentence "However, there are FC impairments at SFH stations in the smaller tributaries of these larger tidal estuaries, which indicates that the bacteria impairments documented in the TMDL stations are due to non-point sources within the TMDL watershed (Figure 3)", replace "non-point" with "pollutants".
Response 3: Due to the addition of another figure, Figure 3 has been renumbered to Figure 4. The sentence in question references bacteria impairments within the Dawho TMDL watershed. Since "non-point sources" accurately describes the origin of these bacteria impairments, no changes to the terminology have been made.

Comment 4: Table 4 (page 19) and Table 5 (page 20). Add units to the header of the "Bacteria Produced in Station DA" column.
Response 4: The unit "per day" has been added to the header of the "Bacteria Produced in Station DA" column in Tables 4 and 5 for clarity and consistency.

Comment 5: Page 19 paragraph 1. Add unit after "2.15E+12" and "3.10E+09".
Response 5: The sentence in question already specifies the units as "bacteria per day," as seen in the text:
"It is estimated that cattle could contribute 2.15E+12 (Table 4) and horses could contribute 3.10E+09 (Table 5) bacteria per day to TMDL watersheds, with the possibility of some fraction entering the waterways."
Therefore, no additional edits are necessary.

Comment 6: Appendix A. In the title "Shellfish Data Used for Calculation of the TMDL", remove "Shellfish".
Response 6: The word "Shellfish" has been removed from the title of Appendix A, which now reads "Data Used for Calculation of the TMDL."

SCDOT:
Comment 1: Abstract, Page ii. SCDOT Requested Language: For SCDOT, compliance with terms and conditions of its NPDES TS4 permit is effective implementation of the WLA to the Maximum Extent Practicable (MEP).

> **SCDOT Justification 1:** 1. SCDOT requests that the proposed language be incorporated as a third paragraph to the abstract to align with the settlement wording of the Ninety-Six Creek TMDL.

Response 2: The requested language has been added to the Abstract to reflect that compliance with the terms and conditions of SCDOT's NPDES TS4 permit constitutes effective implementation of the WLA to the Maximum Extent Practicable (MEP).

Comment 2: Table Ab1, table notes #4, Page ii & Table 7, table notes #4, Page 29. Replace SCDES Public Notice Language "As long as the conditions within the SCDOT MS4 area remain the same the Department deems the current contributions from SCDOT negligible, and no reduction of bacteria is necessary. SCDOT must continue to comply with the provisions of its approved NPDES stormwater permit." with "By implementing the best management practices (BMP's) that are prescribed in either the SCDOT annual SWMP or the SCDOT TS4 Permit to address bacteria, the SCDOT will comply with this TMDL and its applicable WLA to the maximum extent practicable (MEP) as required by its TS4 permit."

> **SCDOT Justification 2:** SCDOT petitions that SCDES revert the proposed language of the Dawho TMDL to the language adopted as a condition of the SCDHEC Board's resolution of matters formalized in the Consent Order dated March 11, 2010. Specifically, SCDOT relies on the longstanding precedent established in the language of the Ninety-Six Creek Watershed Fecal Coliform

TMDL, which has been consistently incorporated into subsequent TMDLs issued after 2010.

SCDOT Justification 3: The TMDL is designed to address conditions present at the time of the study. Therefore, the inclusion of the phrase, “As long as the conditions within the SCDOT MS4 remain the same,” is problematic, unnecessary, and impractical given the continuous changes watersheds undergo due to environmental development driven by human needs and activities.

SCDOT Justification 4: SCDOT regularly modifies current conditions through ongoing maintenance and construction projects. Including the phrase, “As long as the conditions within the SCDOT MS4 area remain the same,” would impose significant financial burdens on SCDOT’s operating budget, thereby hindering its ability to fulfill its core mission of constructing, maintaining, and operating the state highway system.

SCDOT Justification 5: SCDES just issued the TMDL for Leadenwah Creek on November 7th, 2024. This TMDL for Fecal Coliform and within Shellfish Management Area 12B was issued with footnote (#5) which has the language SCDOT is requesting herewith.

Response 2: The requested language has been incorporated into footnotes #4 for both Table Ab1 (Page ii) and Table 7 (Page 30). The revised text now states:

"By implementing the best management practices (BMPs) that are prescribed in either the SCDOT annual SWMP or the SCDOT TS4 Permit to address bacteria, the SCDOT will comply with this TMDL and its applicable WLA to the maximum extent practicable (MEP) as required by its TS4 permit."