Watershed Plan for the Waccamaw and Great Pee Dee Rivers

April 26, 2024, Rev 3

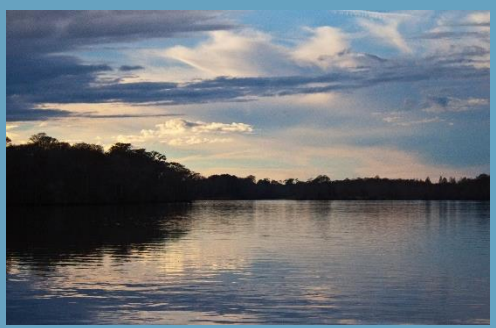


Table of Contents

List of Tables

List of Figures

Appendices

EXECUTIVE SUMMARY

The Waccamaw and Great Pee Dee Rivers Watershed includes approximately 210 square miles and drains to SCDHEC water quality monitoring station (WQMS) MD-278 in the Winyah Bay estuary. The Waccamaw and Great Pee Dee Rivers are vital resources as recreational areas and as the primary drinking water supply source for communities in Horry and Georgetown Counties, and portions of Garden City and Murrells Inlet. Grand Strand Water and Sewer Authority's (GSWSA) water treatment plant is in Bucksport, SC on Bull Creek and the Georgetown County Water and Sewer District's (GCWSD) water intake is on the Waccamaw River near Brookgreen Creek, with a second intake being added at the end of the canal. In addition to the benefits to the drinking water treatment process, pollutant load reductions in the Watershed will also have a direct impact on the local economy and the quality of life for citizens who live around and enjoy the rivers and their tributaries.

The Waccamaw and Great Pee Dee River Watershed is located within the Atlantic Intracoastal Water Way-Waccamaw River TMDL for DO. The TMDL is a result of high biological oxygen demand (BOD) possibly resulting from an increase in organic matter decomposition by bacteria and other microorganisms. In addition to bacteria, other pollutants may threaten the Waccamaw and Great Pee Dee Rivers and are a concern for the GSWSA and GCWSD water treatment plants, whose water source comes from the rivers. A variety of nonpoint sources (NPS) have the potential to cause bacteria, sediment, and nutrient loadings in the watershed. Agricultural NPS pollutants include a small number of grazing livestock depositing manure directly into waterways and runoff (manure, fertilizer, sediments, etc.) from livestock, crop, and horse farms entering the rivers and its tributaries. Septic tank usage is common for rural homes and businesses, with approximately 1,700 septic systems throughout the watershed. With an estimated septic system failure rate of 5 to 10% (Schueler 1999) the approximate number of failing septic systems is 85 to 170 systems. As well, sanitary sewer overflows (SSOs) are a potential pollutant source of bacteria in the Waccamaw and Great Pee Dee Watershed, often caused by fats, oils, wipes and grease (FOWG). In addition, urban runoff, such as domestic pet waste, fertilizers, litter, and sediment, contributes to pollutants in the Watershed.

To address the NPS issues in the Watershed, a Watershed-Based Plan (WBP) will be created to document the sources of water pollution and identify a course of action to protect and/or improve water quality within a watershed. To implement the WBP, the GSWSA and partners will install Best Management Practices (BMPs) and preventative measures, as funding is available, to reduce pollutants from nonpoint sources entering the Waccamaw and Great Pee Dee Rivers and their tributaries. BMPs will include septic system repairs/replacements, sewer tie-in, pet waste stations, urban stormwater retrofits, infiltration practices, water quality buffers, and agricultural BMPs such as critical area stabilization, fencing, stacking sheds, and manure composting. An outreach effort will accompany this project, educating farmers, residents, and businesses in the Waccamaw and Great Pee Dee Rivers Watershed about the causes and results of nonpoint source pollution and how they can prevent it.

1. INTRODUCTION

A watershed is the area of land where all the water that is under it or drains off it goes into a river, stream, or other body of water, and eventually drains to the same point. The purpose of a WBP is to document the sources of water pollution and present a course of action to protect and/or improve water quality within a watershed. The WBP provides an approach to manage and maintain or restore the waterbody to its designated use. Community stakeholders play a critical role in plan development, and the final WBP reflects the community's goals for their watershed.

The Waccamaw and Great Pee Dee Rivers Watershed (the Watershed) contains six subwatersheds: Great Pee Dee River (030402070205), Yauhannah Creek – Pee Dee River (030402070206), Cypress Creek – Great Pee Dee River (030402070207), Waccamaw River – Atlantic Intracoastal Waterway (030402061002), Collins Creek (030402061001), and Outlet Waccamaw River – Atlantic Intracoastal Waterway (030402061003) with a total area of 210 square miles (Figure 1). The Waccamaw and Great Pee Dee Rivers incorporate the Lower Coastal Plain and Coastal Zone regions of South Carolina and the greater Pee Dee Watershed (HUC 030402). The Waccamaw River watershed begins in southwestern Horry County and flows into northeastern Georgetown County, including portions of Garden City and Murrells Inlet. The Waccamaw River joins the Great Pee Dee River and drains to SCDHEC WQMS MD-278 in the Winyah Bay estuary.

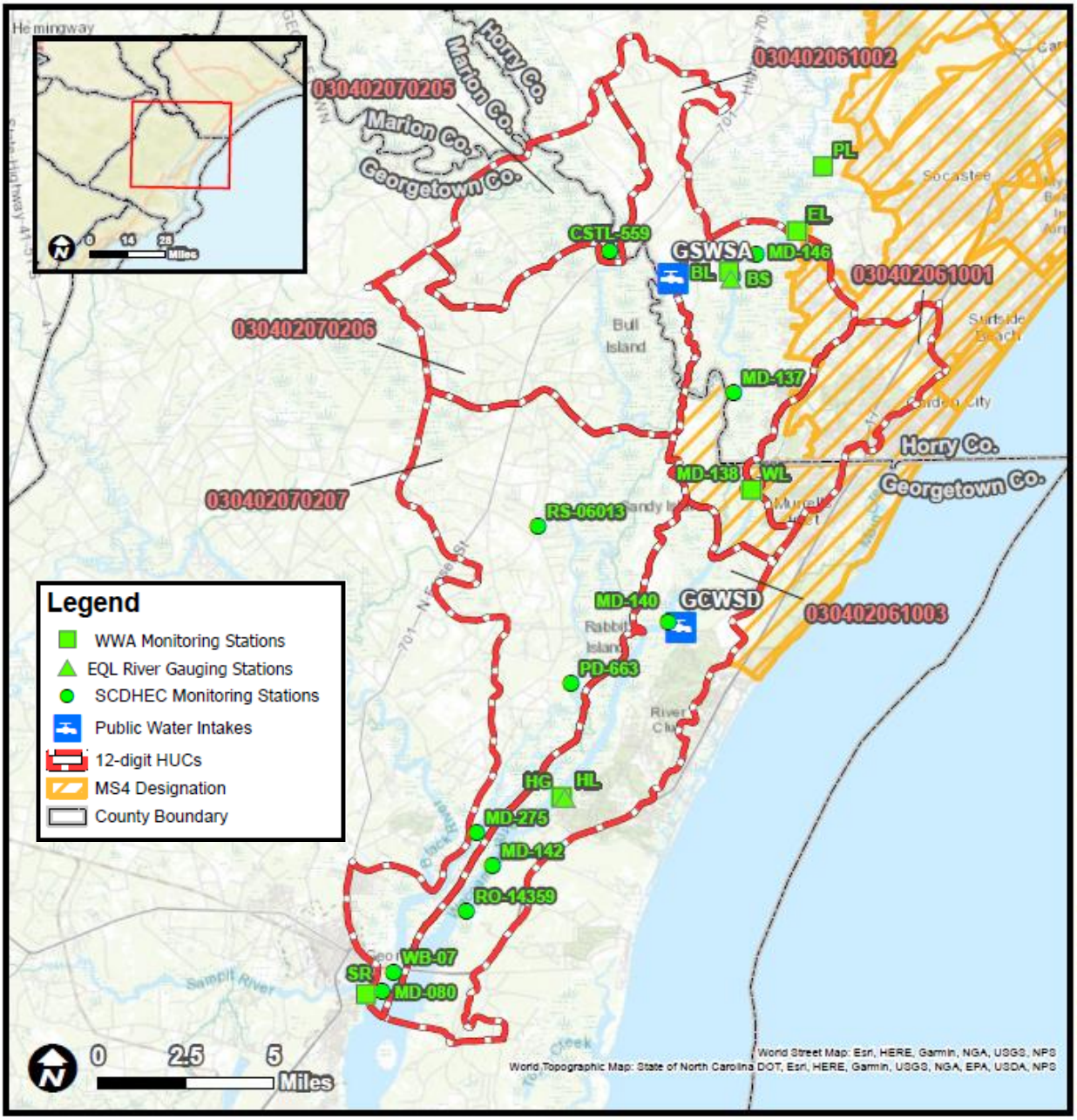


FIGURE 1. WACCAMAW AND GREAT PEE DEE RIVERS WATERSHED WATER QUALITY MONITORING SITES[1]

The rivers and tributaries of the Waccamaw and Great Pee Dee are recognized for their outstanding recreational, cultural, and economic resources for the local community. The rivers support several wastewater discharges and provide a critical source of drinking water for the residents of the community (Georgetown County Water and Sewer District (GCWSD) and Grand Strand Water Sewer Authority (GSWSA)). The GSWSA Bull Creek water intake point is located ~10 miles upstream of MD-138, while the

[1] See Appendix A for larger figure.

GCWSD intake is approximately five miles downstream of MD-138. The GSWSA supplies water to approximately 96,000 residents, and the GCWSD serves 25,000 residents, a total of 121,000 residents. In addition to drinking water, protection of and improvement in the water quality of the Waccamaw and Great Pee Dee Rivers will improve the quality of life and local economics in Georgetown and Horry Counties.

The United States Environmental Protection Agency (EPA) defines impaired waterbodies as any waterbody that does not meet water quality criteria that support its designated use (USEPA, 2012). Impaired waterbodies are placed on the South Carolina 303(d) List of Impaired Waters (303d List). Water quality impairments in the Watershed include dissolved oxygen (DO) and pH at WQMS MD-080 and an impairment for *E. coli* at WQMS RS-06013, both occurring within the Cypress Creek-Great Pee Dee River subwatershed. Additionally, Winyah Bay, the terminus of the Watershed, has suffered shellfish closures due to fecal impairments and is also not meeting state water quality standards for turbidity. A total of six WQMS within the study Watershed are not meeting state water quality standards for mercury levels (Table 1). Mercury is a naturally occurring element and can be released into the environment from many sources, including human activities. The mercury impairments in the Watershed are believed to be a result of atmospheric deposition and the resulting buildup of methylmercury in the food chain over a longer period of time. Because this is considered a result from point source pollution, mercury impairments will not be addressed in this WBP.

TABLE 1: IMPAIRED MONITORING STATIONS IN THE WACCAMAW AND GREAT PEE DEE RIVER WATERSHED

HUC-12	Subwatershed	Station	Station Type	Impairment
030402070207	Cypress Creek-Great Pee Dee River	PD-663	Fish Tissue	Mercury
030402070207	Cypress Creek-Great Pee Dee River	MD-080	AL	DO, pH
030402070207	Cypress Creek-Great Pee Dee River	MD-275	AL	DO
030402070207	Cypress Creek-Great Pee Dee River	RS-06013	REC	E. Coli
030402070207	Cypress Creek-Great Pee Dee River	WB-07	AL	Turbidity
030402070205	Great Pee Dee River	CSTL-559	Fish Tissue	Mercury
030402061002	Waccamaw River-Atlantic Intracoastal Waterway	MD-138	Fish Tissue	Mercury
030402061002	Waccamaw River-Atlantic Intracoastal Waterway	CSTL-557	Fish Tissue	Mercury
030402061003	Outlet Waccamaw River-Atlantic Intracoastal Waterway	MD-140	Fish Tissue	Mercury
030402061003	Outlet Waccamaw River-Atlantic Intracoastal Waterway	MD-141	Fish Tissue	Mercury
030402061003	Outlet Waccamaw River-Atlantic Intracoastal Waterway	MD-142	AL	pH

In addition, all six subwatersheds are found completely within or are partially within the Waccamaw River and Atlantic Intracoastal Waterway, for which an approved watershed-wide TMDL was written in 1998 for

biological oxygen demand (BOD).

During the development of this WBP, the stakeholders and their consultant evaluated pollutants of concern for the Waccamaw and Great Pee Dee Rivers' designated use as a freshwater stream and a source water. According to SCDHEC Water Classifications and Standards, waters classified as "Freshwaters" are freshwaters suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of SCDHEC. "Freshwaters" are suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora (SCDHEC, 2012). "Freshwaters" are also suitable for industrial and agricultural uses. The considerations in determining which pollutants are of concern for the Waccamaw River and Great Pee Dee included current water quality results, concerns for the water treatment plant and likely sources of pollutants in the watershed. It was determined that the key nonpoint source pollutants of concern are: nutrients (nitrogen and phosphorous), sediment (TSS), and bacteria (Fecal Coliform or *E. coli*). Each of these pollutants is detrimental to recreation, drinking water, fishing, and aquatic life, industrial, and agricultural uses. The Waccamaw River's low pH level is not considered a concern because the river is a blackwater system, characterized by naturally low pH conditions. Therefore, low pH was not addressed as a pollutant of concern in this WBP.

High levels of nutrients, sediment, and bacteria in streams are harmful to human health and to the health of the river; therefore, this WBP describes the sources of pollutants and identifies the recommendations needed to improve and protect the Waccamaw and Great Pee Dee Rivers' water quality. The WBP has considered the unique conditions within the Watershed and developed suitable approaches to minimize future impacts to the Waccamaw and Great Pee Dee Rivers. Altogether, the importance of developing this WBP to address the pollutants in the Waccamaw River Watershed is very clear. Efforts that will be taken to reduce pollutants in the Waccamaw and Great Pee Dee Rivers will be a tremendous benefit to the water treatment plants, the local economy, and the quality of life for citizens who live around and enjoy the rivers.

1.1.How was the WBP developed? Who was involved?

The WBP was developed using a collaborative approach. This approach aimed to actively involve local stakeholders in selecting management strategies that may be implemented over time to solve water quality problems within the Waccamaw River Watershed. The Georgetown County Water and Sewer District (GCWSD) was awarded $50,000 through the SCDHEC WBP Development Grant with the goal to protect water quality in the Waccamaw and Great Pee Dee River Watershed. This grant is funded by the Drinking Water State Revolving Fund set-aside. GCWSD managed and administered the overall project. Other cooperating organizations included Horry County Stormwater, Georgetown County Stormwater, Coastal Carolina University, Horry and Georgetown Soil and Water Conservation District, Horry and Georgetown NRCS, American Rivers, The Nature Conservancy, Hobcaw Barony, Waccamaw Riverkeeper, Winyah Rivers Alliance, Waccamaw Regional Council of Governments, Clemson Extension, Gullah Preservation Society, Gullah Geechee Chamber of Commerce, Grand Strand Water and Sewer Authority, watershed residents, Wood Environment & Infrastructure Solutions, Inc., and South Carolina Department of Health & Environmental Control (SCDHEC).

Over the span of a year, a kickoff meeting and a total of three focus groups were held with the above-mentioned local stakeholders and two public meetings to determine types and sources of pollutants within the Waccamaw and Great Pee Dee Rivers Watershed. Along with information obtained during these meetings, the following data were used to develop and refine management strategies: the TMDL developed in 1998 for Atlantic Intracoastal Water Way (AIWW), SCDHEC and Coastal Carolina University monitoring results, a windshield survey, and other items mentioned in Section 3.2

The WBP incorporates this work as well as SCDHEC requirements for a WBP to preserve and restore waterbodies. This alignment with SCDHEC guidance is intended to enable project partners to seek future Clean Water Act Section 319 grant funding to help implement the WBP.

1.2.Who should read this WBP?

This WBP was developed for any group that influences or is affected by water quality, habitat management, and land use decisions in the Waccamaw and Great Pee Dee Rivers Watershed. Local governments and local groups in and around the Waccamaw and Great Pee Dee Rivers Watershed should use this WBP as the foundation for local action. State and federal agencies can use this WBP to enhance their understanding of local watershed conditions and as a basis for coordinating, planning, permitting, and regulatory decisions.

2. WATERSHED CHARACTERISTICS

2.1.Location

The Waccamaw River is approximately 140 miles long and originates in southeastern North Carolina at Lake Waccamaw, in Columbus County, North Carolina. The river extends into South Carolina flowing southeast across Horry County. The Waccamaw joins with the Atlantic Intracoastal Waterway in South Carolina, then with the Great Pee Dee River before it empties into the Winyah Bay estuary in Georgetown, South Carolina. The Waccamaw River is considered one of the finest blackwater rivers in the Southeast USA. Its riverside forests provide clean drinking water, scenic landscapes, diverse fish and wildlife, outstanding recreation, cultural and historical treasures, flood protection, and is an economic driver that serves the region.

2.2.Climate

According to the National Centers for Environmental Information (NCEI), Georgetown County has an average mean temperature of 65.8 °F and an annual average precipitation of 65.17 inches per year. Horry County has an average mean temperature of 65.2 °F and an annual average precipitation of 66.08 inches per year.

Projected changes in both temperature and precipitation will have implications for watershed management. In Horry and Georgetown Counties, climate change has resulted in increasing average temperatures and changes in seasonal and daily temperature patterns. Extreme heat will also have a significant impact on watershed management. In the Georgetown and Horry County area, Coupled Model Intercomparison Project Phase 5 (CMIP5, Meehl et al. 2000) models suggest more than doubling in days per year above 100 °F, more than tripling in days above 95 °F, and a 2.4 °F increase in average summer temperature by the mid-century. Higher temperatures could impact the aquatic life in streams and the ability for BMP vegetation to survive.

As warmer temperatures cause more water to evaporate from the land and oceans, changes in the size and frequency of heavy precipitation events may in turn affect the size and frequency of river flooding. In Georgetown and Horry County area, CMIP5 models suggest a 21% increase in number of days with more than one inch of rain, an 18% increase in number of days with more than two inches of rain and a 4.5% increase in annual precipitation by the mid-century. These changes in size and frequency of heavy precipitation events could disrupt ecosystems by displacing aquatic life, increasing soil erosion, and impairing water quality.

BMPs included in Section 7.2 of this WBP take into consideration the impacts of more intense temperature and precipitation events and protective measures to proactively address how these events combined with future development may impact water quality. Such measures that may help a community adapt to climate change include:

1. Installing Low Impact Development practices
2. Modifying existing BMPs to handle larger storm events
3. Using plants which are more adaptable to extreme rainfall and flooding
4. Utilizing stormwater for non-potable uses such as irrigation
5. Preserving land, particularly riparian buffer areas
6. Green infrastructure to filter and allow rainwater to infiltrate on site

2.3.Soils

There is a diversity of soil types within this large watershed, however for the purpose of this WBP, Hydrologic Soil Groups within the watershed were examined to analyze areas with higher runoff potential. Hydrologic Soil Groups (HSG) are a designation developed by the National Resource Conservation Service (NRCS) which describes the infiltration capacity of soil. Soil associations are categorized in decreasing infiltration capacity from A to D and are described in greater detail below:

Group A is sand, loamy sand or sandy loam types of soils. These soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sand or gravel and have a high rate of water transmission (greater than 0.30 inches/hour).

Group B is silt loam or loam. These soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.30 inches/hour).

Group C soils are sandy clay loams. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission of (0.05-0.15 inches/hour).

Group D soils are clay loam, silty clay loam, sandy clay, silty clay, or clay. This HSG has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high-water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 inches/hour).

Groups A/D, B/D, or C/D are in the Dual Hydrologic Soil Groups. The first letter represents the drained areas and the second is for undrained areas. Only soils naturally in group D are assigned to dual classes.

Figure 2 below displays the Hydrologic Soils Groups throughout the Waccamaw and Great Pee Dee River Watershed. The floodplains of the Great Pee Dee River are predominantly HSG C/D soils, whereas the floodplains of the Waccamaw River are predominantly HSG A/D soils. Identifying areas of the watershed with higher runoff potential will help prioritize areas for BMPs and outreach efforts.

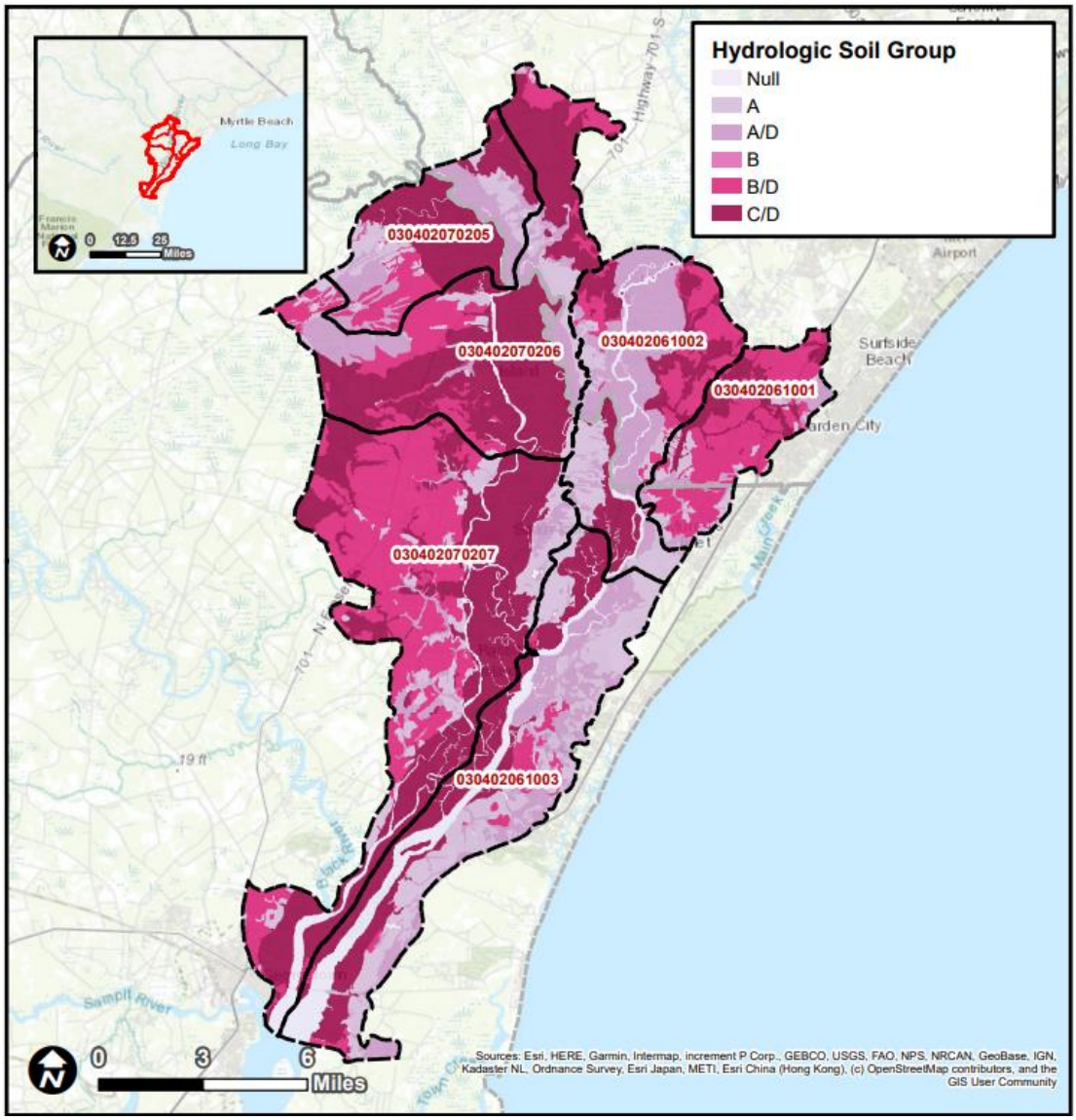


FIGURE 2. HYDROLOGIC SOIL GROUPS WITHIN THE WACCAMAW AND GREAT PEE DEE RIVERS WATERSHED[2]

Along with understanding the Watershed's areas of high runoff potential, Hydrologic Soil Groups (HSG) may shed some light on the soils' erodibility. Soil erodibility is an estimate of the ability of soils to resist erosion, based on the physical characteristics of each soil. Generally, soils with faster infiltration rates, higher levels of organic matter and improved soil structure have a greater resistance to erosion. Sand, sandy loam, and loam textured soils tend to be less erodible than silt, very fine sand, and certain clay textured soils. Soils that may erode more easily have the potential to increase the amounts of pollutants entering a waterway due to their adsorptive properties. Though HSG can only characterize infiltration rates and generalize certain soil textures, identifying the HSGs can aid in the decision process of narrowing down potential sources of pollution via increased sediment loads.

[2] See Appendix A for larger figure.

The T-Factor and K-Factor of soil can also help identify areas where best management practices may be most effective. The T-Factor is an estimate of the maximum average annual rate of soil loss in tons per acre that can occur before crop (or vegetative) growth is compromised. Values range from one ton/acre/year to five tons/acre/year. Areas closer to one ton/acre/year represent sensitive soils that are more quickly affected by soil loss. Those near five tons/acre/year represent soils that are least subject to damage by erosion. The K-Factor is an index to predict soil loss by way of erosion. The least erodible soils will have lower values and are generally high in clay or sand. Clay soils resist erosion and sandy soils have a low amount of runoff due to infiltration rate.

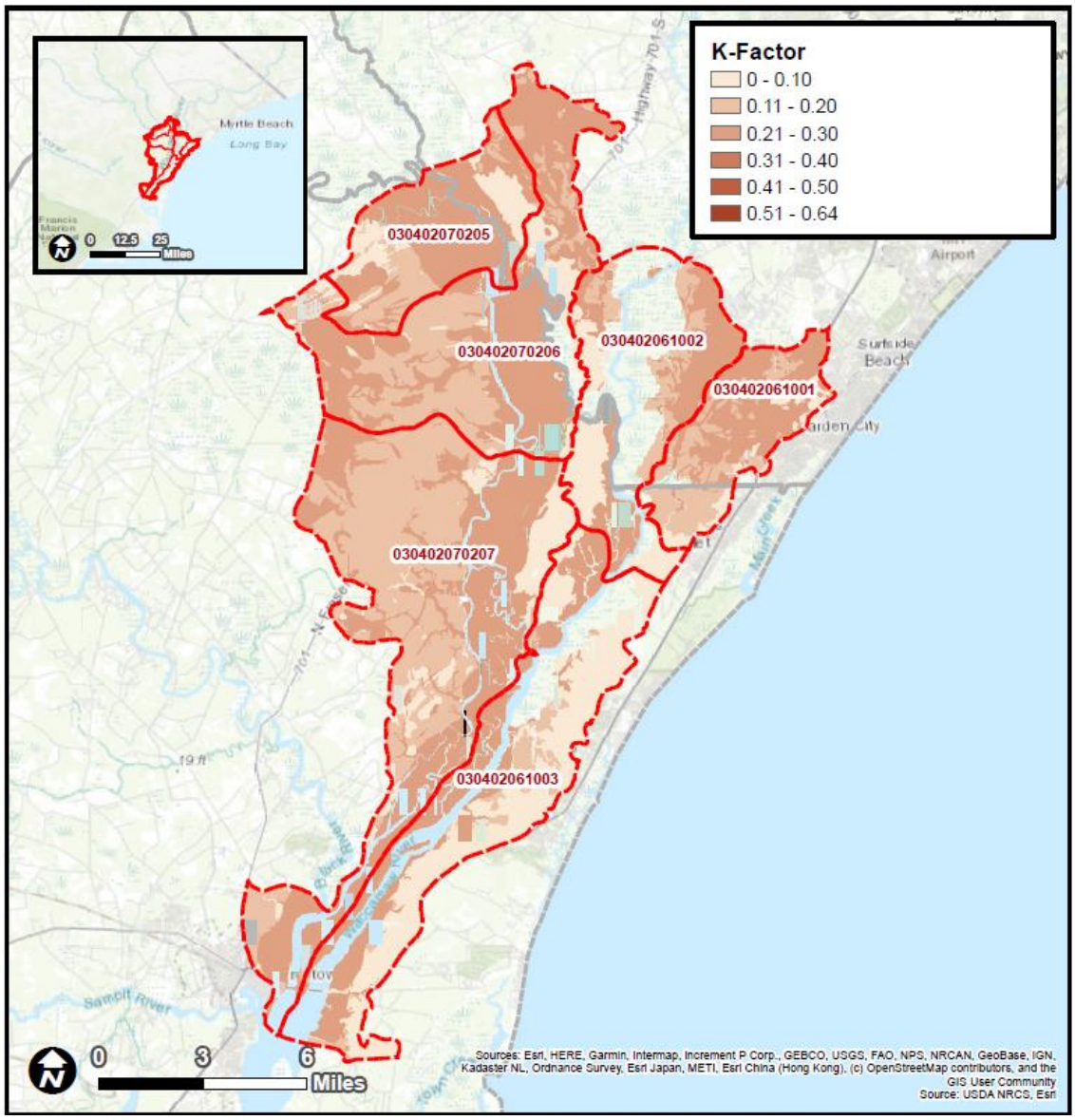


FIGURE 3. THE K-FACTOR OF SOILS IN THE WACCAMAW AND GREAT PEE DEE RIVERS WATERSHED[3]

[3] See Appendix A for larger figure.

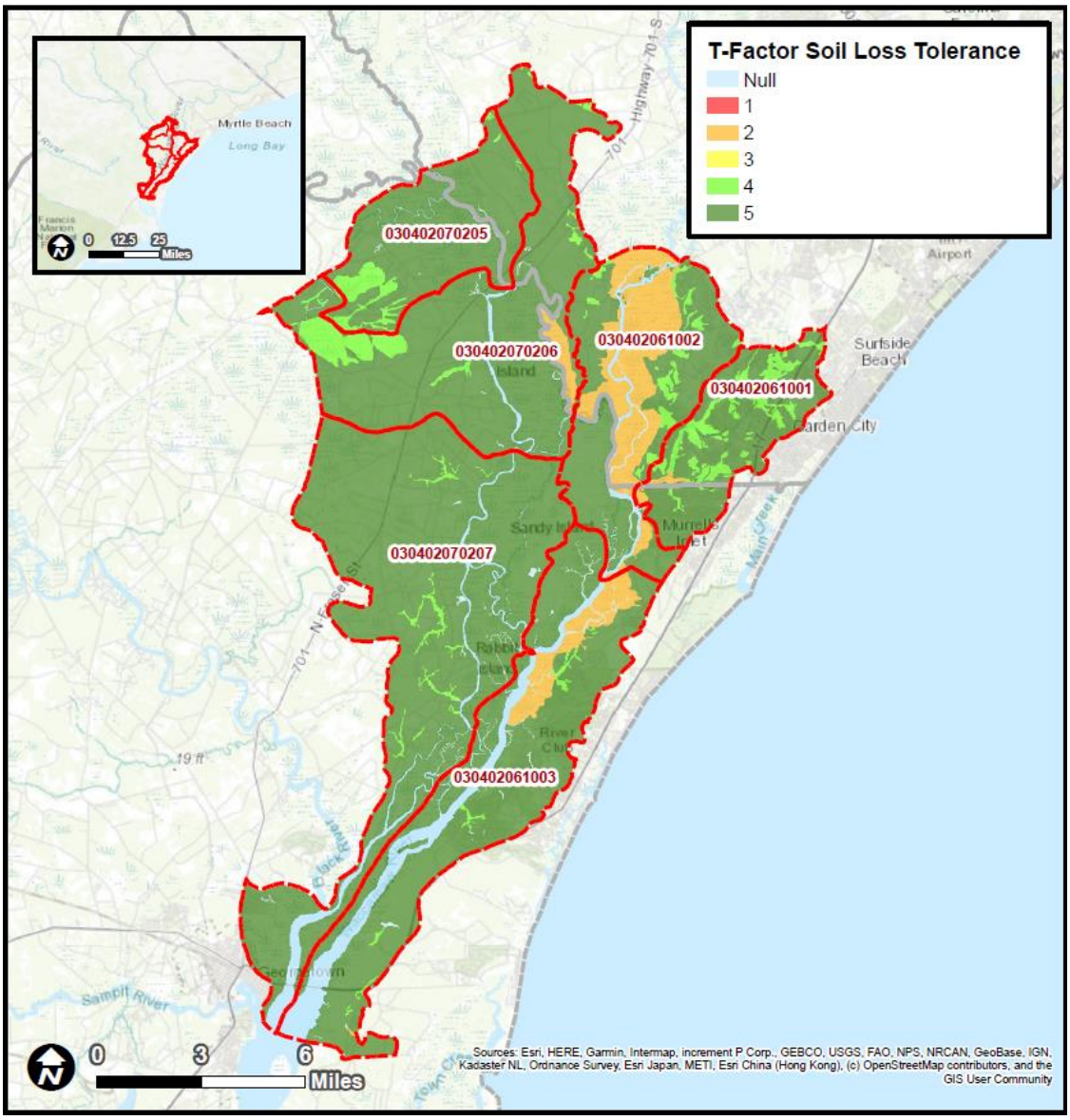


FIGURE 4. THE T-FACTOR OF SOIL IN THE WACCAMAW AND GREAT PEE DEE RIVERS WATERSHED[4]

The K-Factor of soils in the study area indicate lower potential of erosion in the southeastern portion of the Watershed, while more erodible soils are likely to be found on the eastern portion of the Great Pee Dee River and the area north of Murrell's Inlet in the Collins Creek subwatershed (Figure 3). Figure 4 indicates that most of the Watershed will be resistant to loss of vegetative growth due to soil erosion. However, the area bordering the Waccamaw River in the AIWW and northern portion of the Outlet to the AIWW may be more quickly affected by soil loss.

[4] See Appendix A for larger figure.

2.4.Natural Resources

The Waccamaw and Great Pee Dee Rivers Watershed have an abundance of natural resources available to the public and contribute to the state's economy each year. For example, exports of forest products from South Carolina in 2019 amounted to approximately $1.25 billion (Adams and Arias 2019). Silviculture activities are prominent in parts of the Watershed, including Cypress Creek – Great Pee Dee River and Great Pee Dee River subwatersheds (HUC 030402070207 and HUC 030402070205). In fact, Georgetown and Horry County ranked second and ninth, respectively, in South Carolina for harvested timber value in 2017. Shellfish harvesting is another natural resource available to the public. However, shellfish bed closures are not uncommon due to elevated fecal coliform levels.

Natural areas within the Watershed include South Carolina Department of Natural Resources (SCDNR) Samworth Wildlife Management Area (WMA), the Waccamaw National Wildlife Refuge, and land owned by The Nature Conservancy. Samworth WMA is found in Georgetown County along the Great Pee Dee River and includes 1,537 acres, with the majority comprised of land open to the public for recreation, hunting, wildlife forage, and conservation. The Waccamaw National Wildlife Refuge is approximately 9,000 acres in both Georgetown and Horry Counties. The area is managed to protect diverse habitat for coastal species and to provide recreational activities to the public, including hunting, fishing, and environmental education. Additional land is owned and protected by The Nature Conservancy. This includes Sandy Island, a 9,000 acre preserve at the confluence of the Great Pee Dee and Waccamaw Rivers. The island contains prehistoric sand dunes and is of cultural significance. Many residents of the island are descendants of a formerly enslaved man who purchased several hundred acres following the Civil War.

2.5.Land Use

Based on the 2016 USGS Multi-Resolution Land Characteristic (MRLC) land use data, the predominant land cover in the Watershed is water, including wetlands, (59.2%) and forestland (23.6%), as shown in Figure 5. The aerial view of the Watershed, as well as parcel data, show a large amount of forestland being used for timber production in the Cypress Creek-Great Pee Dee River and Great Pee Dee River subwatershed. Agriculture, consisting of crop farms, sod farms, hay, and pasture, is estimated to cover 3.2% of the Watershed. The remaining area is urban use (14%), which includes open space (e.g., golf courses) and is concentrated nearest the coast (Table 2). An estimated 1,000 acres within the urban area is represented by golf courses.

Although urban land use in the Watershed is not substantial, recent data show increases in population growth in both Horry and Georgetown Counties. It can be assumed that increases in population result in increases in urbanized land use with increased impervious surface. Specifically, Horry County saw an increase in population of 30.4% in the 2020 census, adding more than 80,000 residents over a decade. By 2040, an anticipated 275,000 more people are expected to move to the County (Horry County Planning and Zoning, Imagine 2040 Comprehensive Plan). Georgetown County held a steady growth rate of 6.25% between 2011 and 2021.

TABLE 2. LAND USE DISTRIBUTION IN ACRES IN THE WACCAMAW AND GREAT PEE DEE RIVERS WATERSHED

HUC-12	Subwatershed	Agricultural	Urban Land	Forestland	Wetland/Water
30402061001	Collins Creek	50	6665	1,057	2338
30402061002	Waccamaw River-Atlantic Intracoastal Waterway	886	2736	2,909	11710
30402061003	Outlet Waccamaw River-Atlantic Intracoastal Waterway	68	4642	5,083	16096
30402070205	Great Pee Dee River	578	499	2141	8755
30402070206	Yauhannah Creek-Great Pee Dee River	1,158	1342	7,210	15391
30402070207	Cypress Creek-Great Pee Dee River	1,328	2113	11834	21551
Total		**4068**	**17996**	**30233**	**75841**
% of Total		**3.2%**	**14%**	**23.6%**	**59.2%**

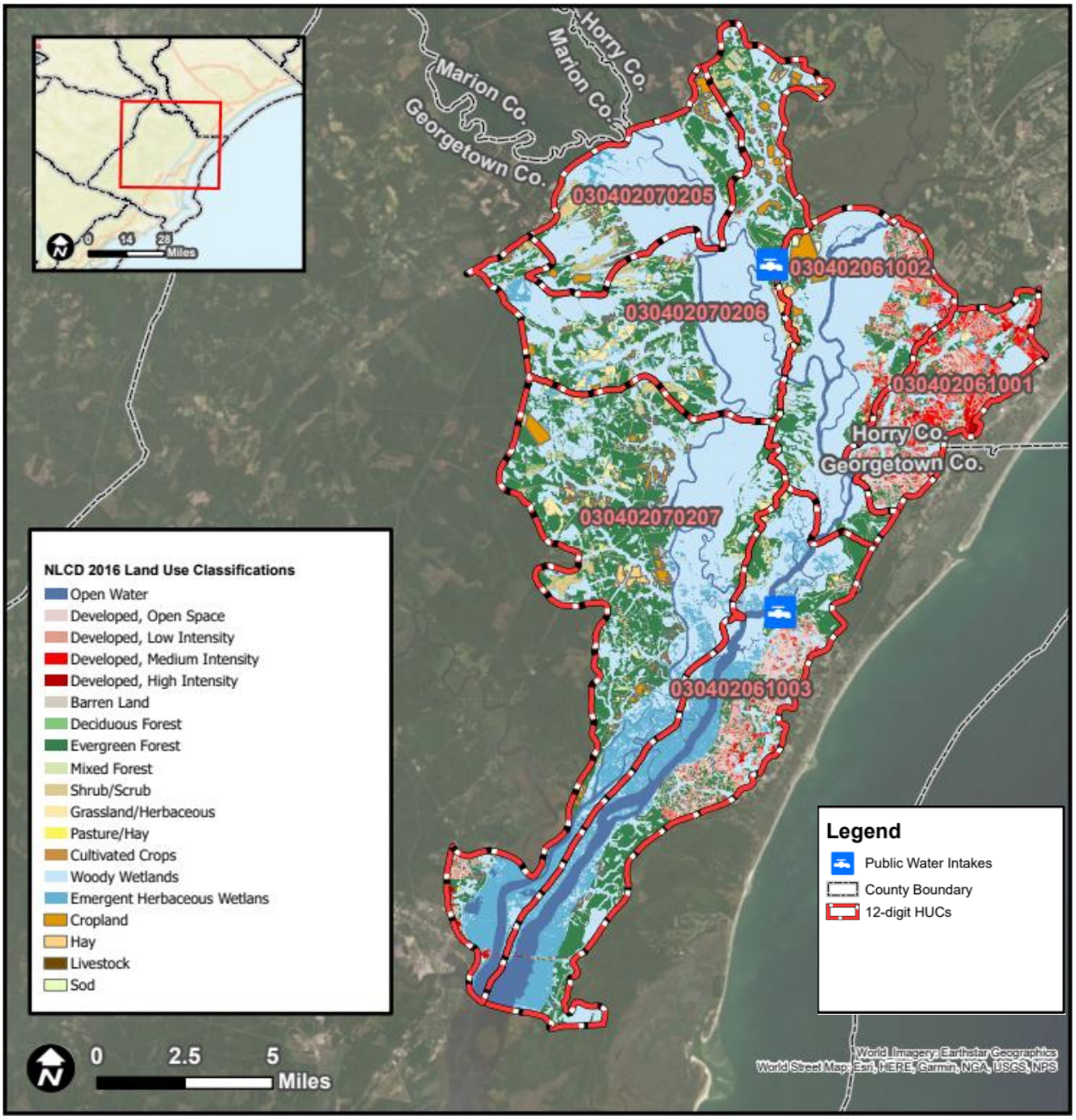


FIGURE 5. NLCD 2016 LAND USE CLASSIFICATIONS[5]

2.6. Land Use Effects on Waccamaw River

Based on the land classifications, urbanized runoff, septic, sanitary sewer systems, and other nonpoint sources affect water quality in the Waccamaw River. The 1998 TMDL established for the Atlantic Intracoastal

[5] See Appendix A for larger figure.

Water Way (AIWW) specifies four areas where nonpoint source TMDLs are established, two of which are found within the study area: the area of confluence of the AIWW and the Waccamaw River and the southern area of the Waccamaw River. The 1998 TMDL pollutant of concern is for biochemical oxygen demand (BOD). BOD is the amount of oxygen needed by bacteria and microorganisms to consume organic matter. Increases in organic matter from sewer or septic system failures can result in increases in BOD.

Nutrients from urbanized runoff in the form of pet waste or fertilizers applied to lawns and golf courses, as well as agricultural applications, can also be sources of excess nutrients in the Watershed. The increase and overabundance in nutrients, mainly nitrogen and phosphorus, can result in eutrophication and severe decreases of dissolved oxygen concentrations. Harmful algal blooms can produce dangerous toxins in fresh or marine water, but even nontoxic blooms hurt the environment and local economies by raising treatment costs for drinking water and hurting industries that depend on clean water. In the absence of BMPs, silvicultural operations have the potential to contribute pollutants to waterways. Sediment from unpaved roads, skid trails, and recently cleared land can travel during storm events and ultimately deposit in streams. However, a study by the South Carolina Forestry Commission in 2020 found that 96.1% of timber harvest operations properly installed and maintained BMPs.

These sources of pollution are addressed in greater detail in Section 4.

3. WATERSHED CONDITIONS

3.1 Stream Classification & Criteria

The South Carolina Legislature (S.C. Regulation 61-68) has established water quality classification standards for all surface waters in the State of South Carolina. This system provides water quality goals and criteria, and guides management efforts so that individual waterbodies can be protected and restored to meet these goals. The Waccamaw and Great Pee Dee Rivers are designated as Class Freshwater and the Waccamaw is also designated Tidal Saltwaters classification. Freshwaters are described as follows: "Freshwaters suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the Department. Suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora. Suitable also for industrial and agricultural uses." (R.61-68) Tidal Saltwaters are described as follows: "Saltwaters suitable for primary and secondary contact recreation, crabbing, and fishing, except harvesting of clams, mussels, or oysters for market purposes or human consumption and uses listed in Class SB. Also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora." (R.61-68)

3.2 Stream Assessments

SCDHEC and Coastal Carolina University both analyze the water quality of the Waccamaw and Great Pee Dee Rivers and their tributaries at various points and times. The following sections summarize the data collected that are pertinent to this WBP. DHEC and Coastal Carolina University sampling locations can be found in Figure 1.

Water Quality Monitoring Stations Data

SCDHEC has sampled and analyzed the Waccamaw and Great Pee Dee River basins at eleven WQMSs for various parameters periodically over the past 23 years. SCDHEC monitors at eight stations for estuarine sampling, and monitoring has been conducted periodically between 2000 and 2021. Additional locations include three stream sites along Cypress Creek, Black Creek, and an unnamed stream near Highway 17. There are three fixed WQMSs currently active; one upstream of the Great Pee Dee River (MD-275) and two in the Waccamaw River (MD-142 and MD-138). SCDHEC monitors two sites for aquatic macroinvertebrates: a fixed monitoring site, PD-715, is on Bull Creek, and a Special Study Site, PD-663, is on the Waccamaw River. WQMS PD-715 contained fewer than 100 individuals and was not scored. Special Study Site PD-663 was tidally influenced and also did not score. Fish tissue sampling estimates mercury concentrations in fish tissue and is used to guide fish consumption advisories. SCDHEC monitors six locations, all of which can be found in the Greet Pee Dee and Waccamaw Rivers.

There are 28 current and historic SCDHEC water quality monitoring stations within the Watershed. Of the 28 monitoring stations, only three stations have current data (MD-138, MD-142 and MD-275). The remaining stations are considered random or historic stations and have sampling dates that are more than a decade old. Because of this, only a select number of monitoring stations were included in further analysis.

The most recent data from SCDHEC Water Quality Monitoring Stations are presented in Tables 3 through 5 and Figures 7 through 14. Monitoring stations and parameters analyzed below were selected based on quantity of samples taken and most recent sample data available (MD-142, MD-138, MD-275, Figure 6). All other monitoring data were excluded due to age of sampling results. Orange horizontal lines indicate water quality standards for turbidity (50 Nephelometric Turbidity Unit (NTU)) and fecal coliform (400MPN/100 mL).

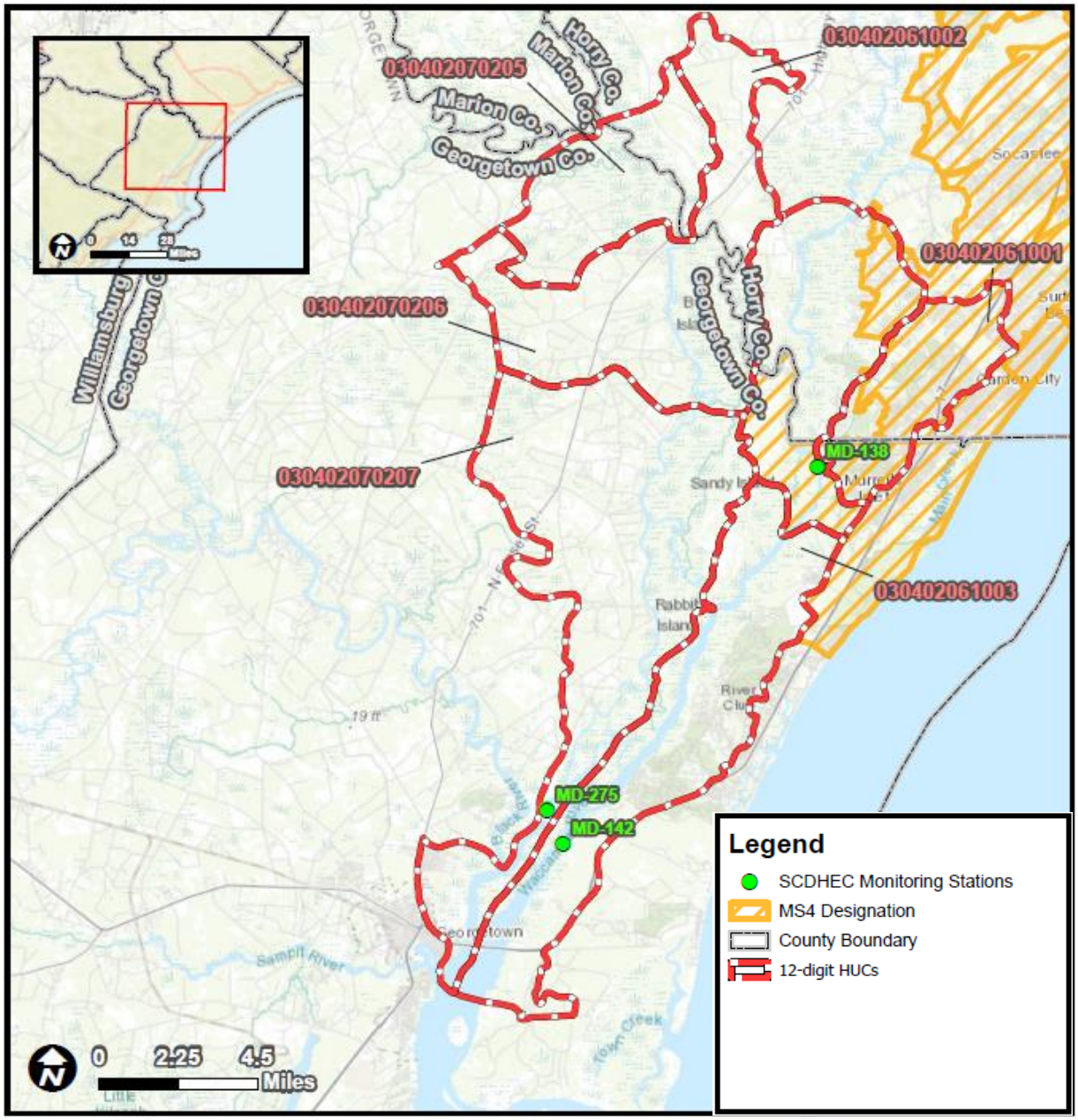


FIGURE 6. SCDHEC MONITORING LOCATIONS EXAMINED FOR THE WBP[6]

[6] See Appendix A for larger figure.

TABLE 3. SUMMARY OF ALL SCDHEC DATA AT MD-142

Parameter	Average	Max	Number of samples
Turbidity (NTU)	14	50	198
Total Phosphorus (mg/L)	0.06	0.18	186

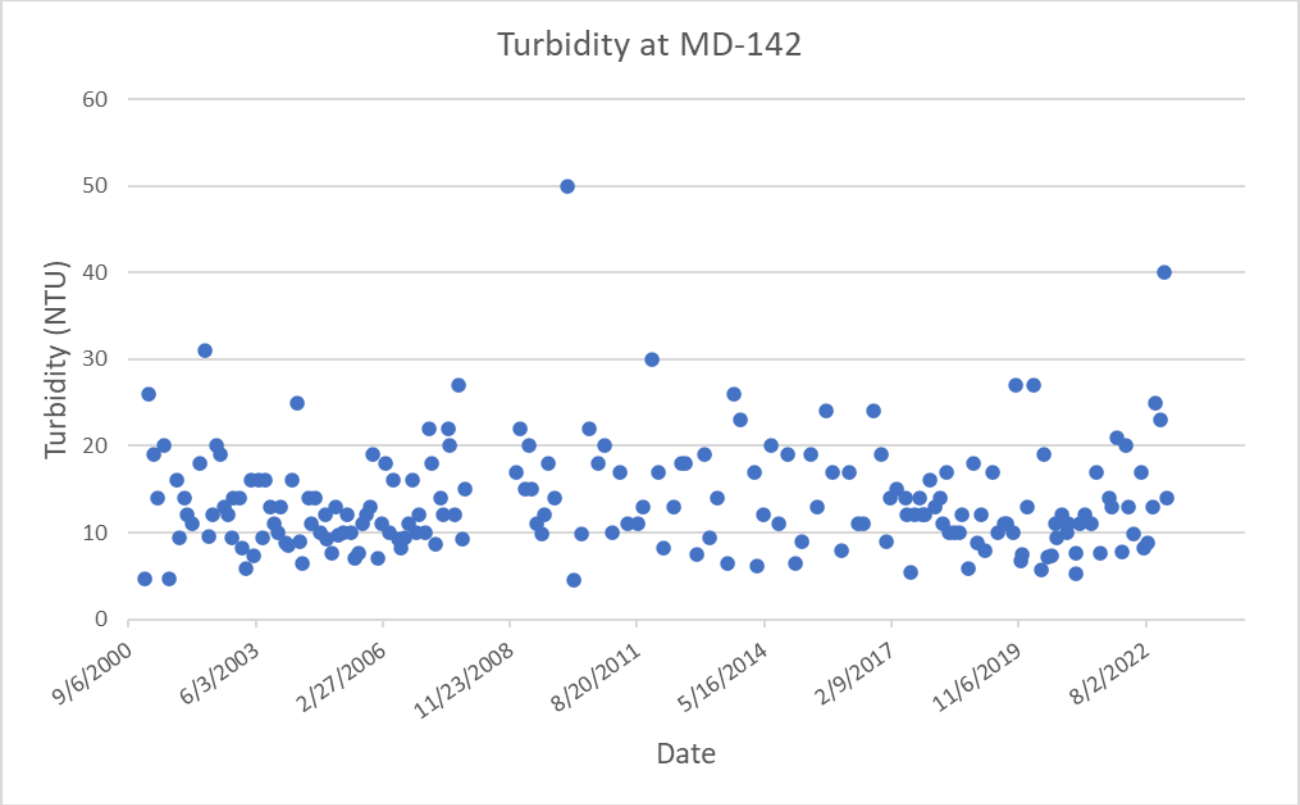


FIGURE 7: SCDHEC TURBIDITY DATA AT MD-142 (2001-2023)

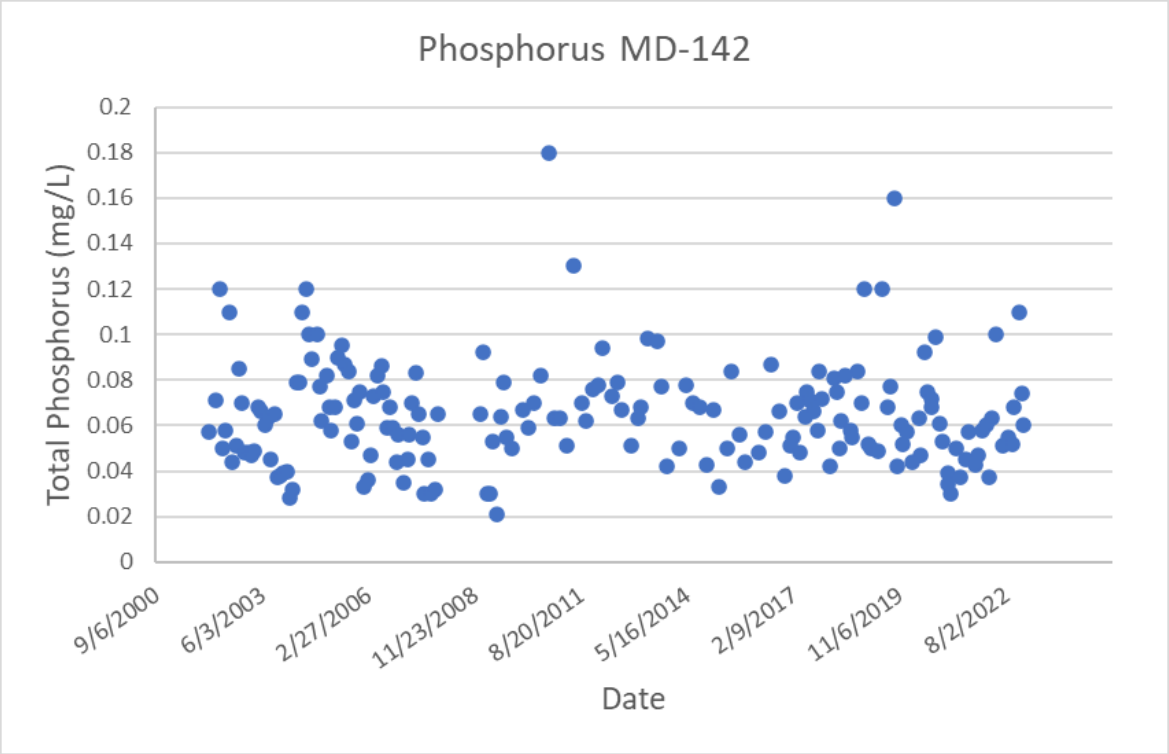


FIGURE 8. SCDHEC TOTAL PHOSPHORUS DATA AT MD-142 (2002-2023)

TABLE 4. SUMMARY OF ALL SCDHEC DATA AT MD-138

Parameter	Average	Max	Number of samples
Turbidity (NTU)	11	32	234
Total Phosphorus (mg/L)	0.07	0.34	203
Total Nitrogen (mg/L)	0.89	1.77	192

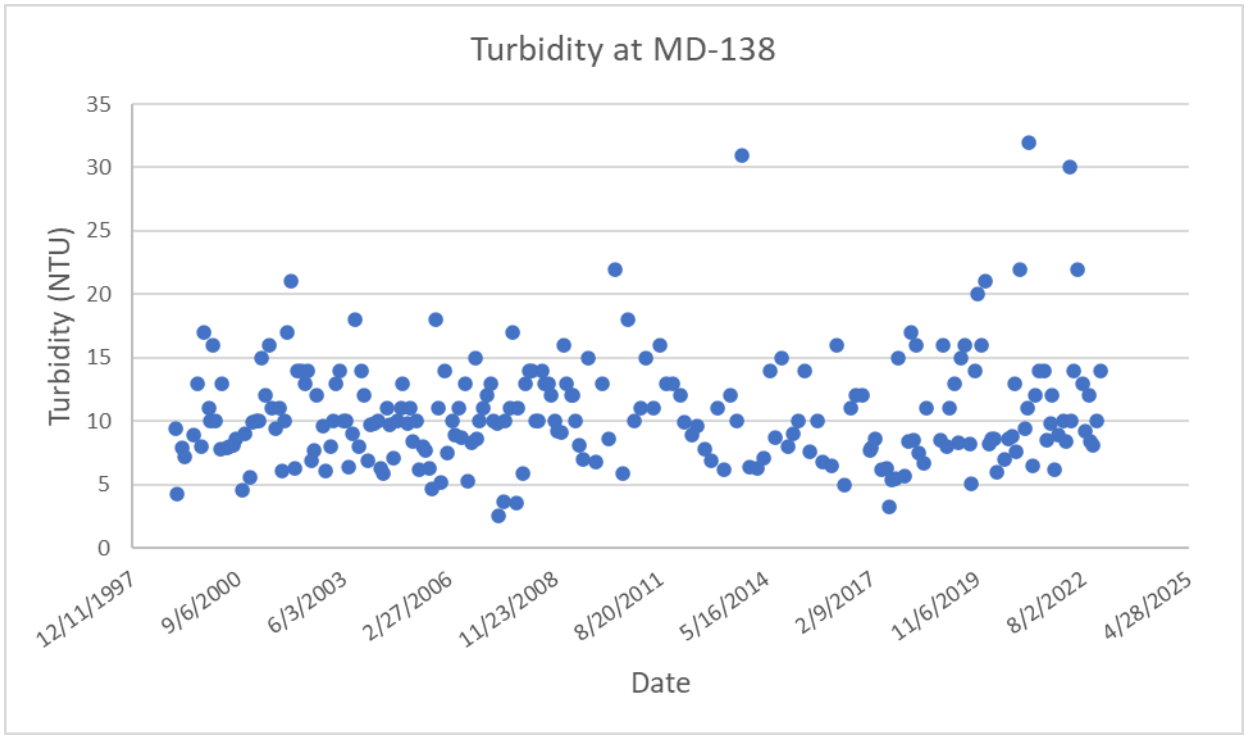


FIGURE 9: SCDHEC TURBIDITY DATA AT MD-138 (1999-2023)

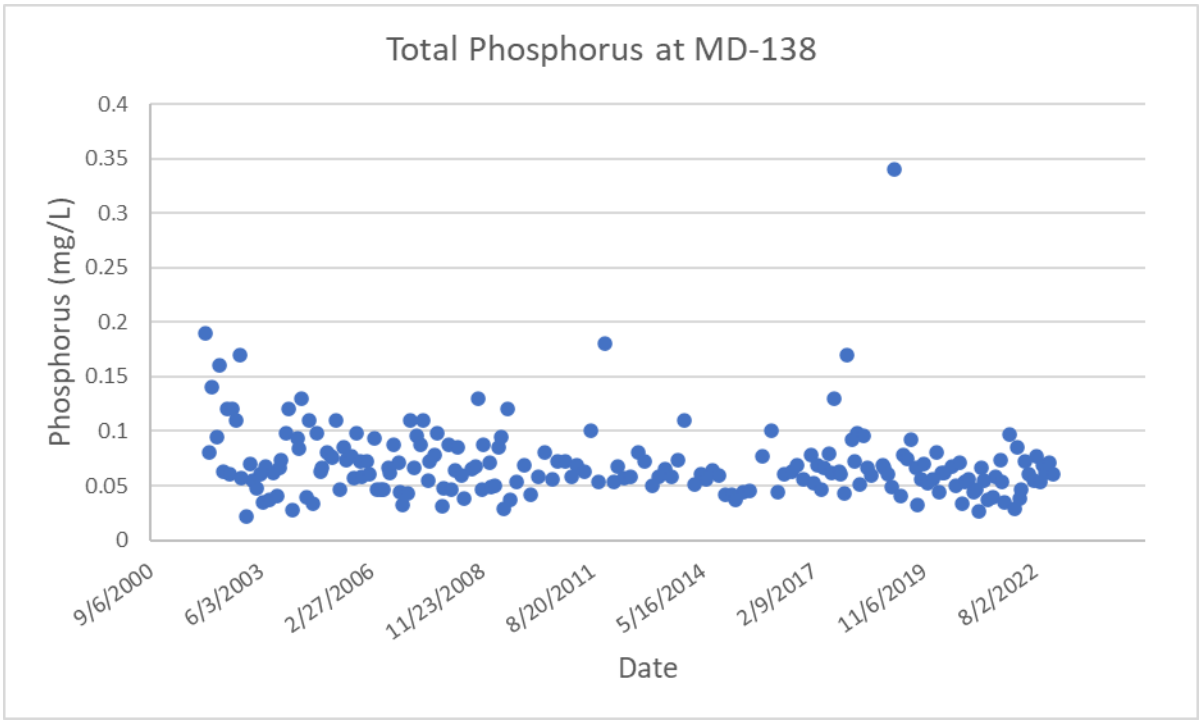


FIGURE 10. SCDHEC TOTAL PHOSPHORUS DATA AT MD-138 (2002-2023)

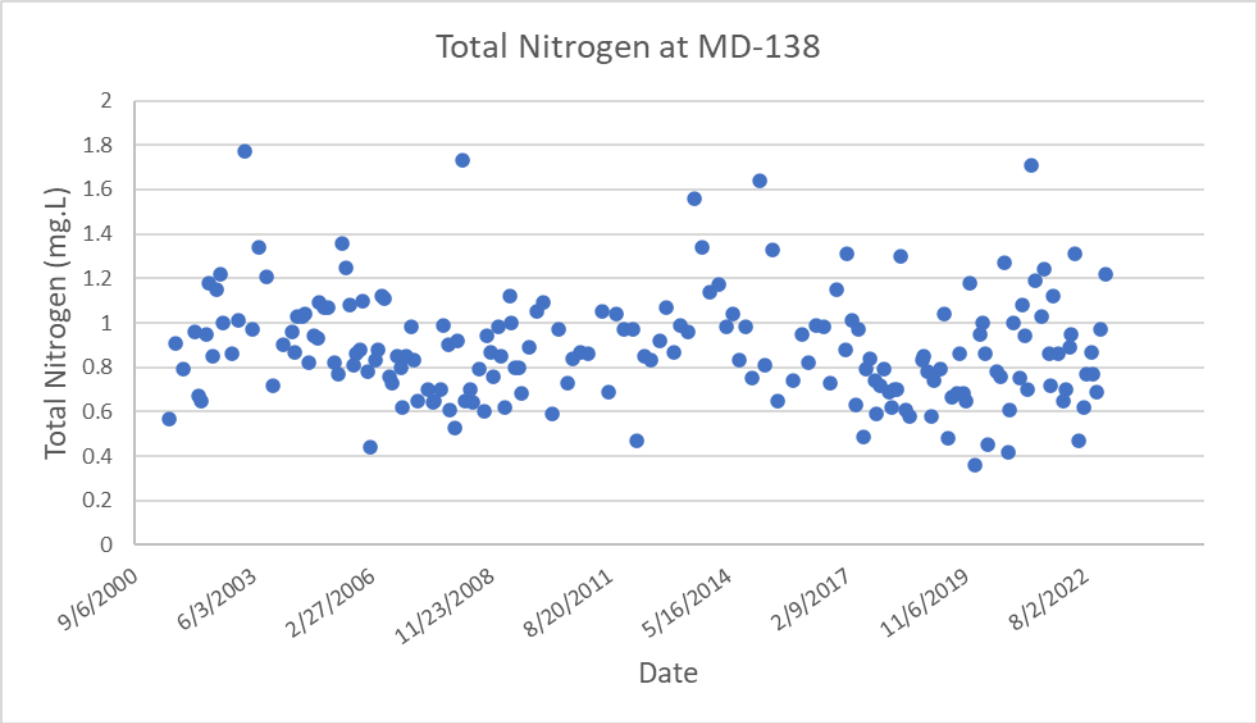


FIGURE 11. SCDHEC TOTAL NITROGEN DATA AT MD-138 (2001-2023)

TABLE 5. SUMMARY OF ALL SCDHEC DATA AT MD-275

Parameter	Average	Max	Number of samples
Turbidity (NTU)	14	50	196
Total Phosphorus (mg/L)	0.07	0.27	187
Total Nitrogen (mg/L)	0.8	2.15	170

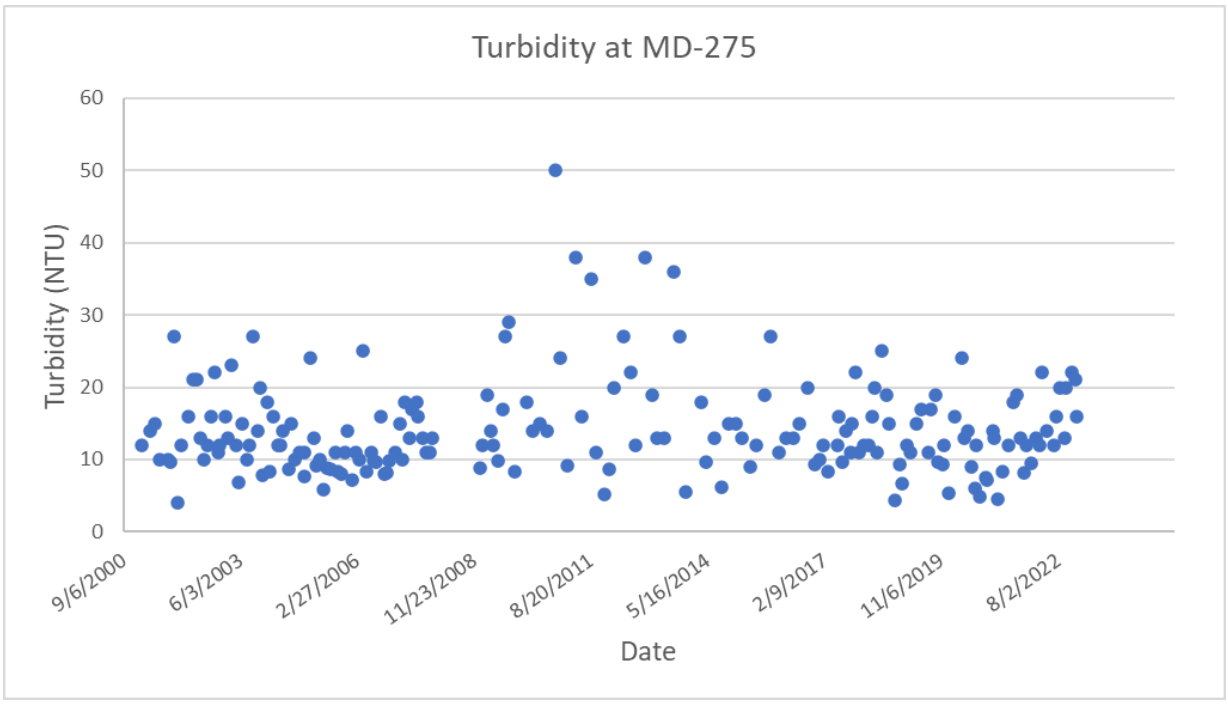


Figure 12. SCDHEC Turbidity Data at MD-275 (2001-2023)

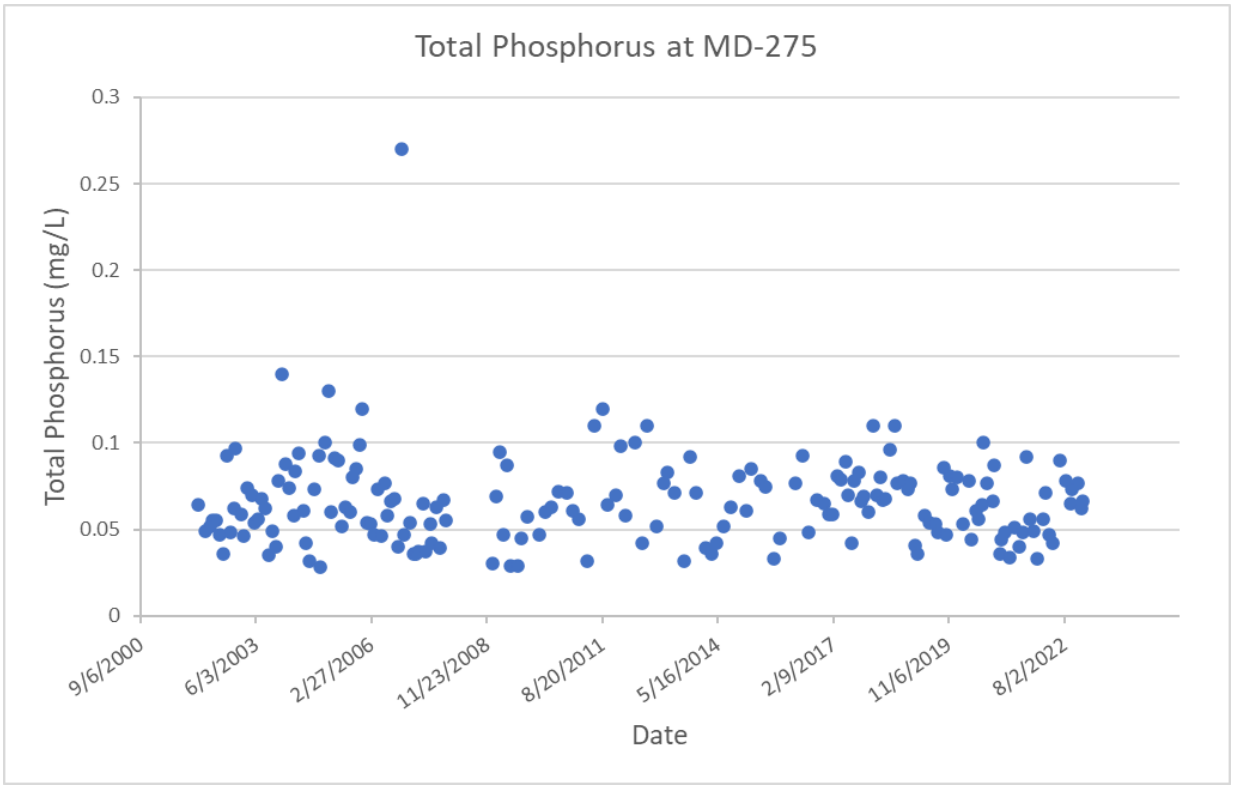


FIGURE 13. SCDHEC TOTAL PHOSPHORUS DATA AT MD-275 (2002-2023)

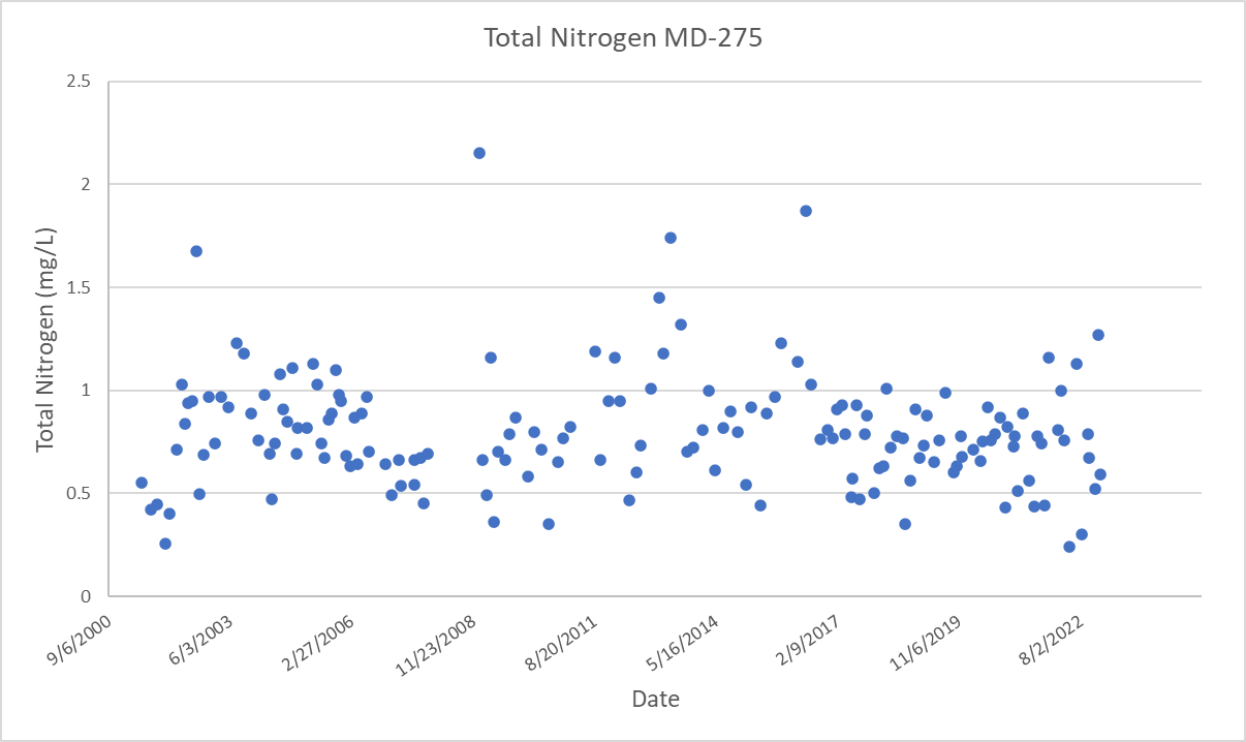
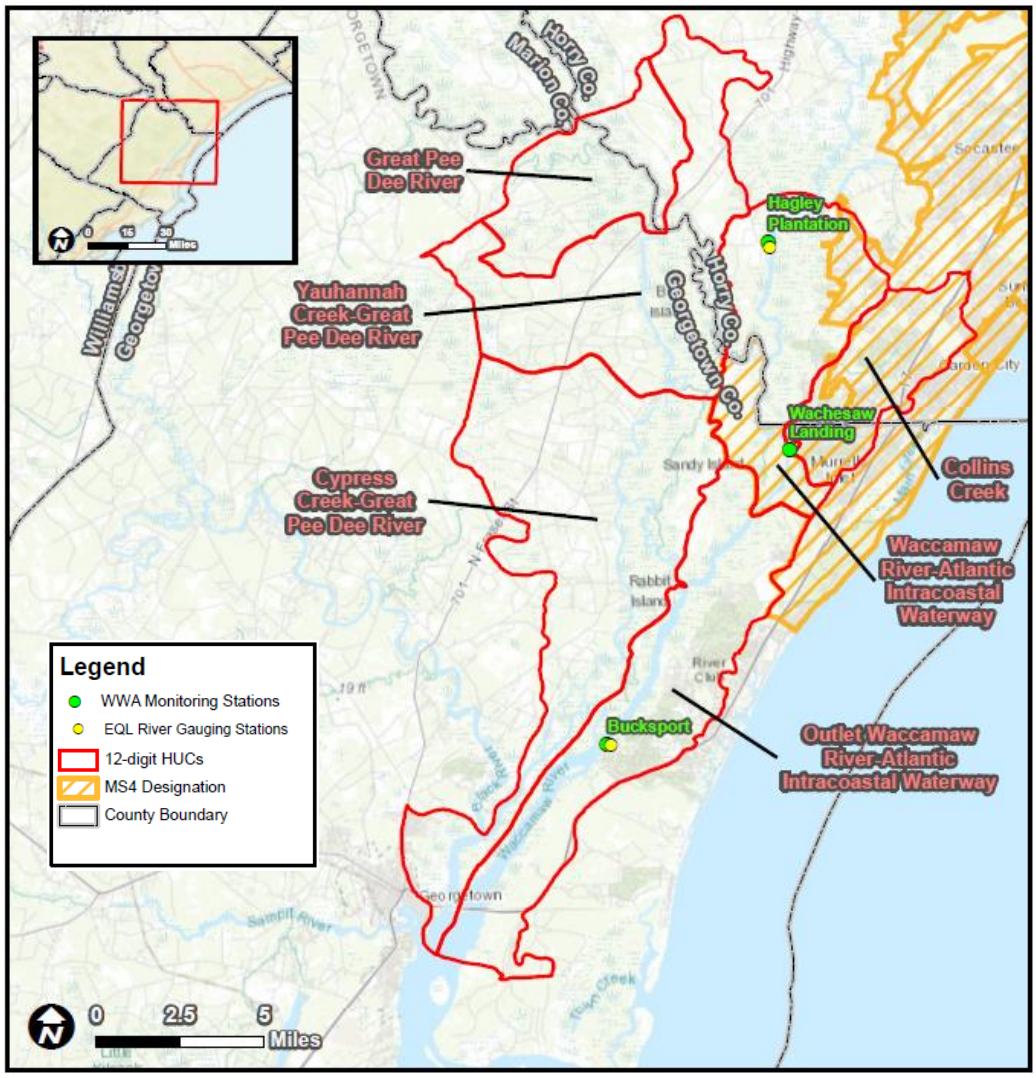


FIGURE 14. SCDHEC TOTAL NITROGEN DATA AT MD-275 (2001-2023)

Coastal Carolina University Monitoring Stations Data

Coastal Carolina University Environmental Quality Lab sampling data is presented in Tables 6 and 7 and Figures 15 through 22. Official sampling stations located within the Watershed include Hagley Landing and south of Bucksport Marina. Both are located on the Waccamaw River. Data from the Waccamaw River Volunteer Water Quality Monitoring Program are also presented in Table 8 and 9 and Figures 23 through 28. Data were taken at the Wachesaw Landing and Hagley

Plantation along the Waccamaw River. EPA water quality standards are calculated using the 25th percentile from median seasonal data.



15: Coastal Carolina University Monitoring Locations for the Environmental Quality Lab River Gauging and Volunteer Water Quality Monitoring Efforts[7]

Note the following explanation provided by Coastal Carolina University for the various *E. coli* water quality standards shown on Figures 19, 21, 23 and 26:

- EPA (2000) Water Quality Standard

[7] See Appendix A for larger figure.

There is no explanation on the EPA website. *Citation: Ambient Water Quality Criteria Recommendations Information Supporting the Development of State And Tribal Nutrient Criteria For Rivers And Streams In Nutrient Ecoregion XIV, EPA 822-B-00-022*

- EPA (2008) Water Quality Standard

  There is no explanation on the EPA website. *Citation: National Coastal Condition Report III, EPA/842-R-08-002 and Bricker, S., B. Longstaff, W. Dennison, A. Jones, K. Boicourt, C. Wicks, and J. Woerner. 2007. Effects of Nutrient Enrichment in the Nation's Estuaries: A Decade of Change. NOAA Coastal Ocean Program Decision Analysis Series No. 26. National Centers for Coastal Ocean Science, Silver Spring, MD. 328 pp.*

- EPA (2012) Water Quality Standard

  EPA (2012) has set a Beach Action Value of 190 to 235 CFU/100 mL *E. coli* for estimated gastrointestinal illness rates of 32 and 36 per 1000 primary contact recreators, respectively. Their recreational WQS is 100 to 126 CFU/100 mL for geometric mean values and 320 to 410 CFU/100 mL for its statistical threshold values. Both sets of WQS are for estimated GI illness rates of 32 and 36 per 1000 primary contact recreators, respectively. *Citation: US EPA (2012) Recreational Water Quality Criteria. Office of Water 820-F-12-058.*

- SCDHEC water quality standard

  The SCDHEC *E. coli* water quality standard is not to exceed a geometric mean of 126/100 ml based on at least four samples collected from a given sampling site over a 30-day period, nor shall a single sample maximum exceed 349/100 ml.

TABLE 6. MONITORING DATA FROM HAGLEY LANDING (2008-2022).

Hagley Landing	Average	Max	Sample Number
Nitrogen (mg/L)	0.86	1.5	269
Phosphorus (mg/L)	0.08	0.38	267
E. coli (CFU/100mL)	72	1,733	215
Turbidity (NTU)	14.5	112	389

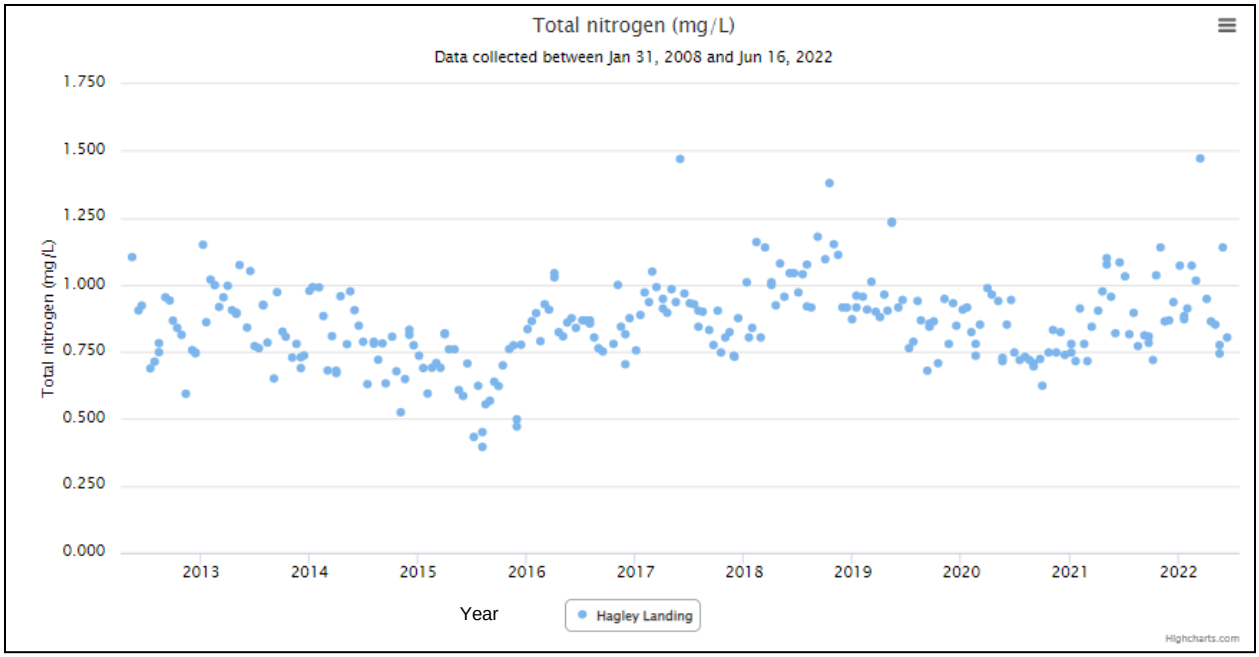


FIGURE 16. COASTAL CAROLINA UNIVERSITY TOTAL NITROGEN AT HAGLEY LANDING (2012-2022)

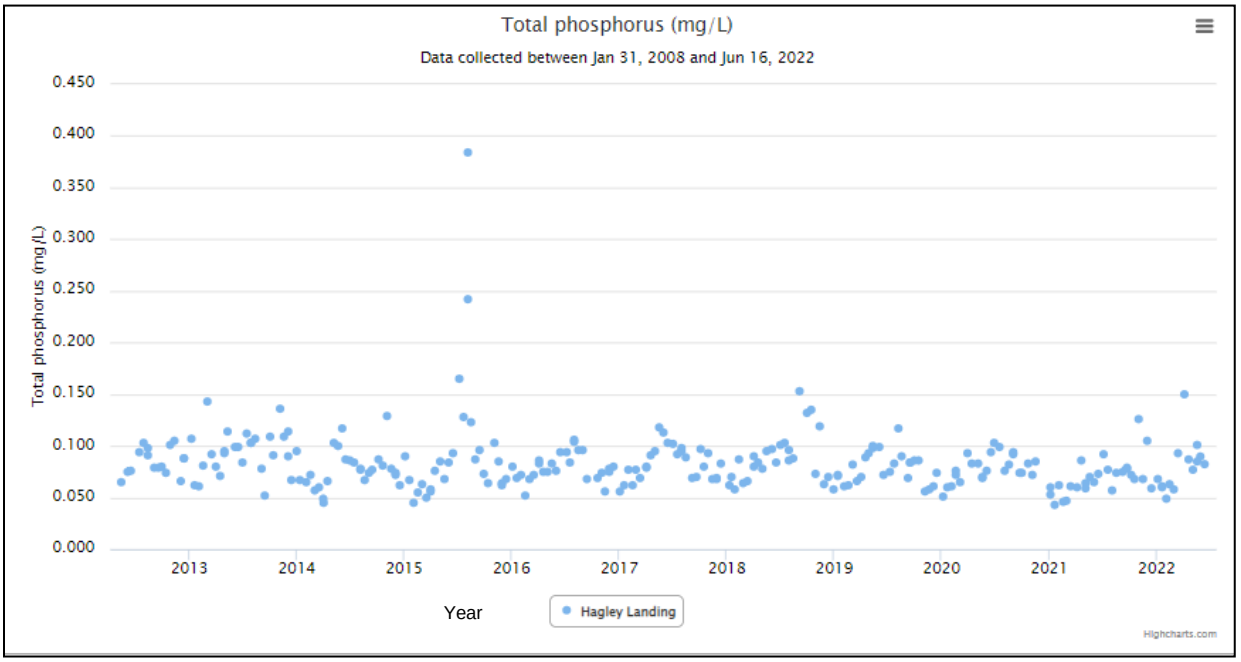


FIGURE 17. COASTAL CAROLINA UNIVERSITY TOTAL PHOSPHORUS AT HAGLEY LANDING (2008-2022)

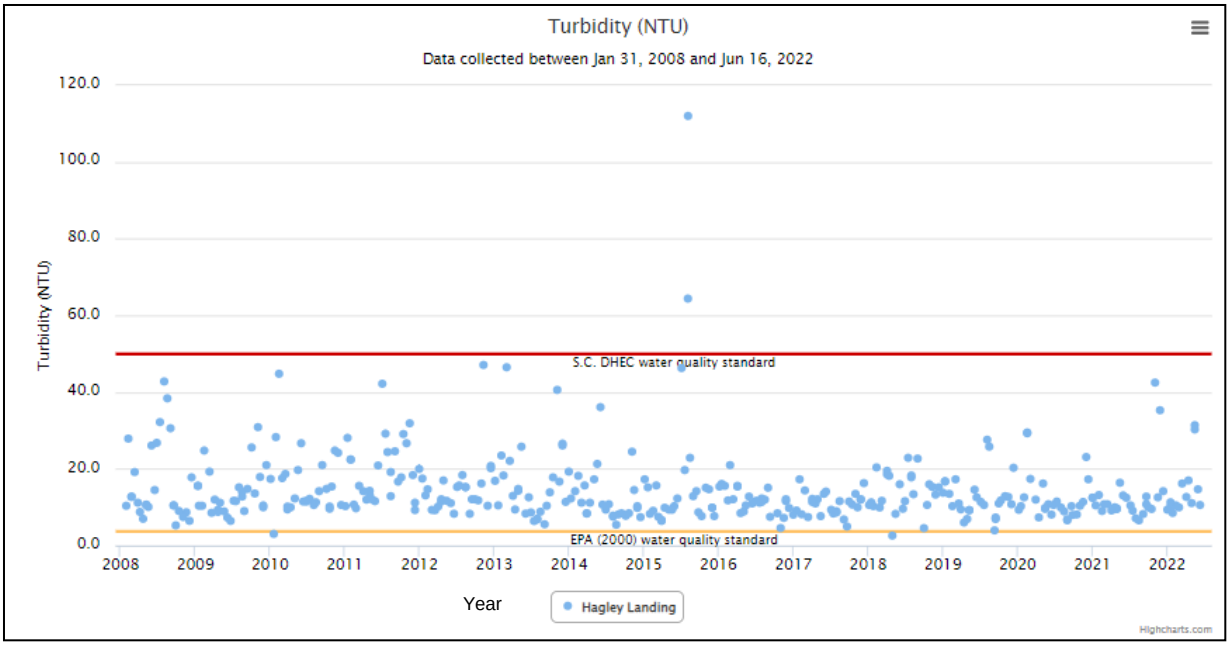


FIGURE 18. COASTAL CAROLINA UNIVERSITY TURBIDITY DATA AT HAGLEY LANDING (2008-2022)

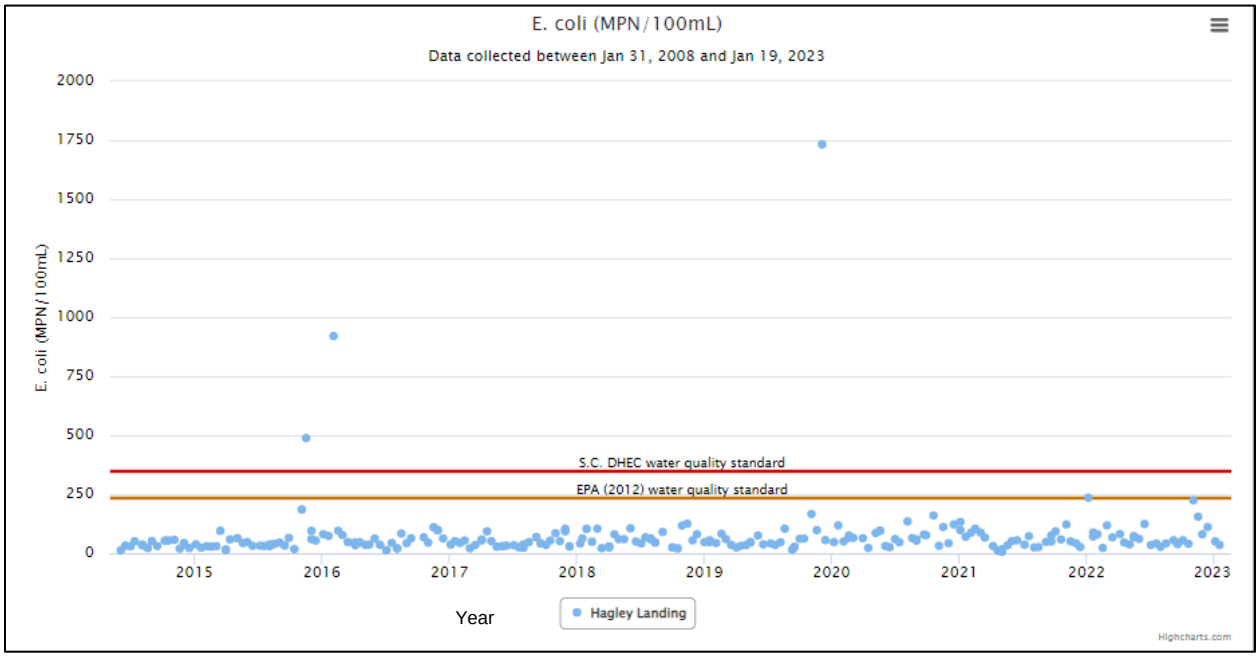


FIGURE 19. COASTAL CAROLINA UNIVERSITY E. COLI DATA AT HAGLEY LANDING (2008-2022)

TABLE 7. MONITORING DATA FROM THE BUCKSPORT SAMPLING LOCATION (2008-2022)

Bucksport	Average	Max	Sample Number
Nitrogen (mg/L)	0.85	1.58	270
Phosphorus (mg/L)	0.05	0.16	268
E. coli (MPN/100mL)	52	261	215
Turbidity (NTU)	6.5	26.9	389

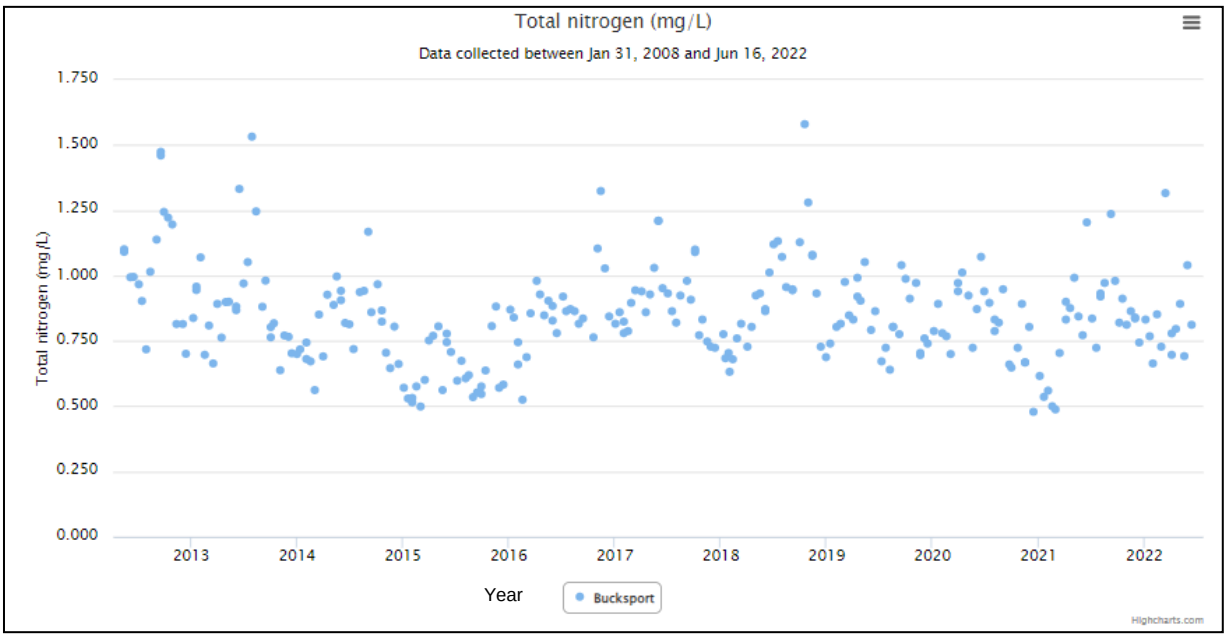


FIGURE 20. COASTAL CAROLINA UNIVERSITY TOTAL NITROGEN DATA AT THE BUCKSPORT SAMPLING LOCATION (2012-2022)

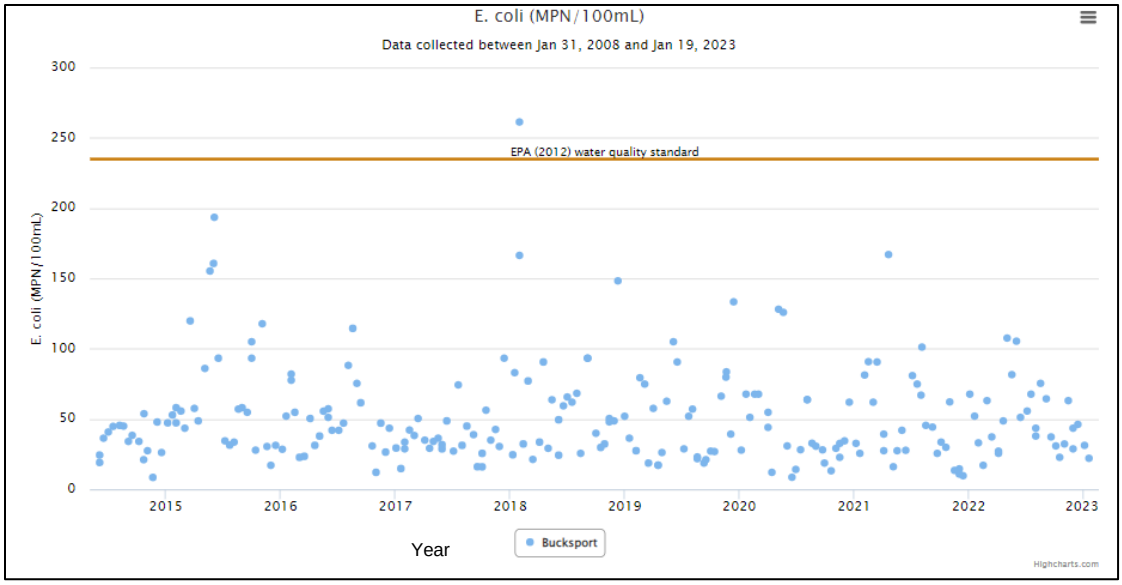


FIGURE 21. COASTAL CAROLINA UNIVERSITY *E. COLI* DATA AT THE BUCKSPORT SAMPLING LOCATION (2008-2015)

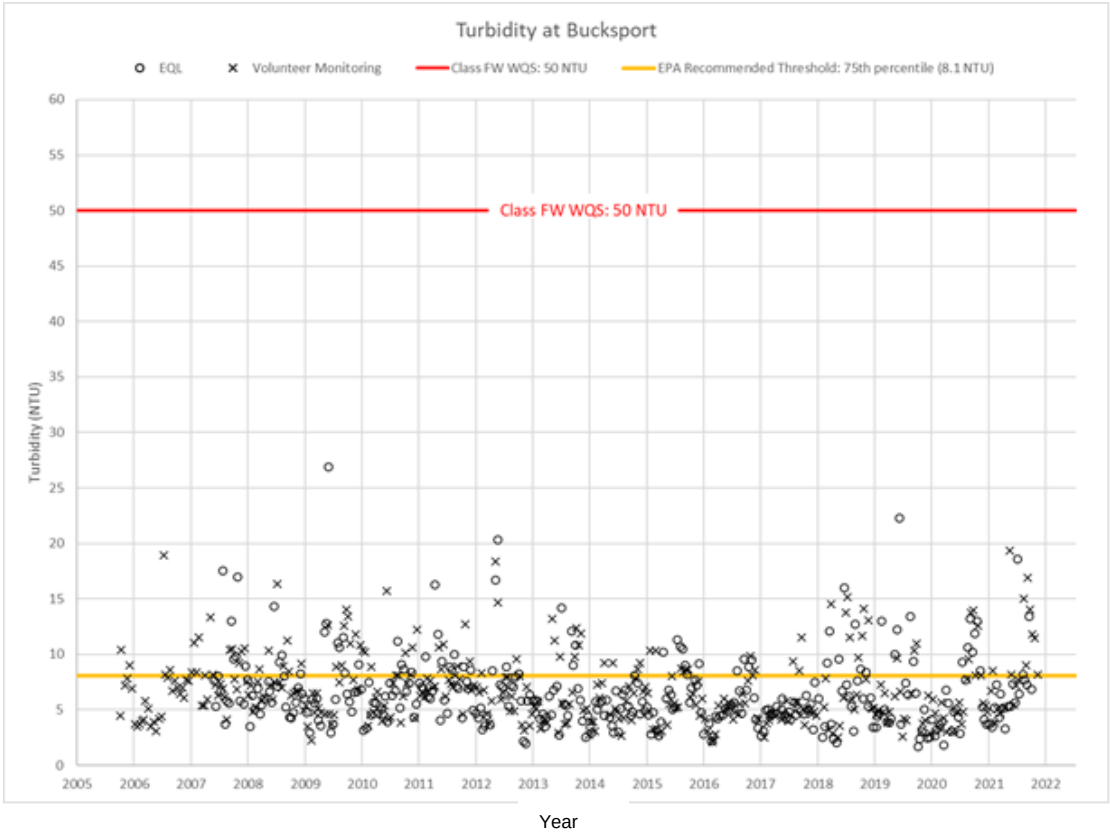


FIGURE 22. COASTAL CAROLINA UNIVERSITY AND VOLUNTEER MONITORING TURBIDITY DATA AT THE BUCKSPORT SAMPLING LOCATION (2008-2022)

TABLE 8. MONITORING DATA FROM WACHESAW LANDING (2006-2022).

Wachesaw Landing	Average	Max	Sample Number
E. coli (MPN/100mL)	31.0	933	327
Nitrate + Nitrite + Ammonia (mg/L)	0.19	2.00	362
Turbidity (NTU)	11.58	30.8	370

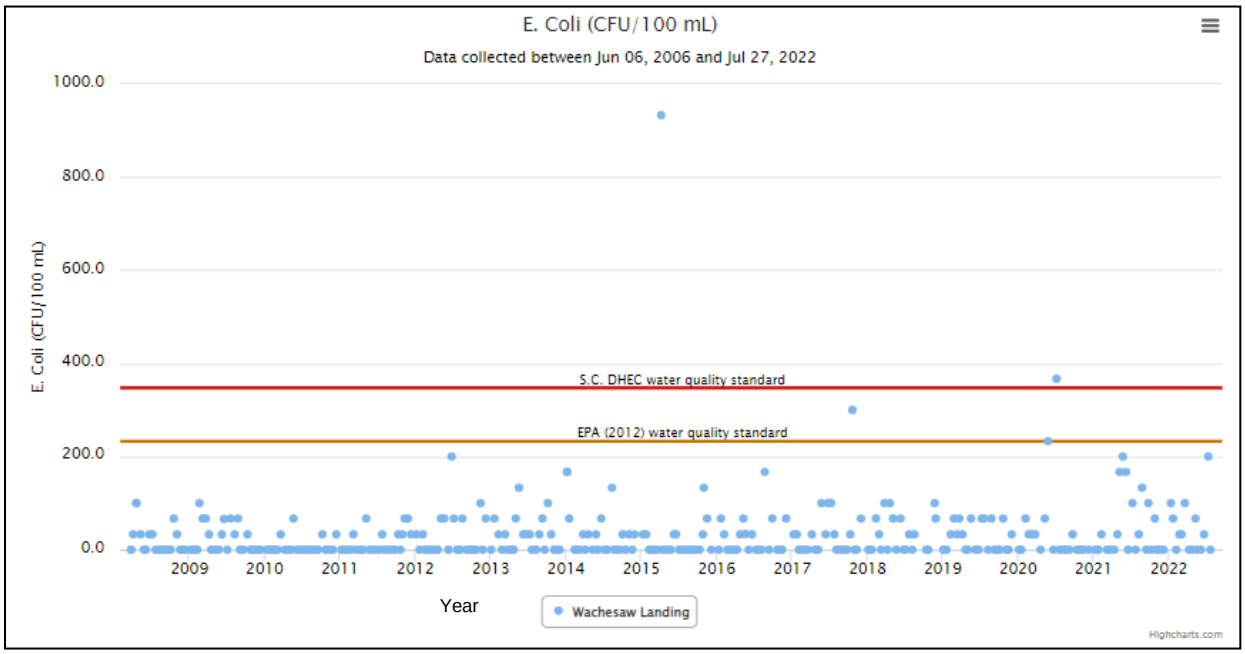


FIGURE 23. WACCAMAW WATERSHED ACADEMY WATER QUALITY E. COLI DATA AT WACHESAW LANDING (2006-2022)

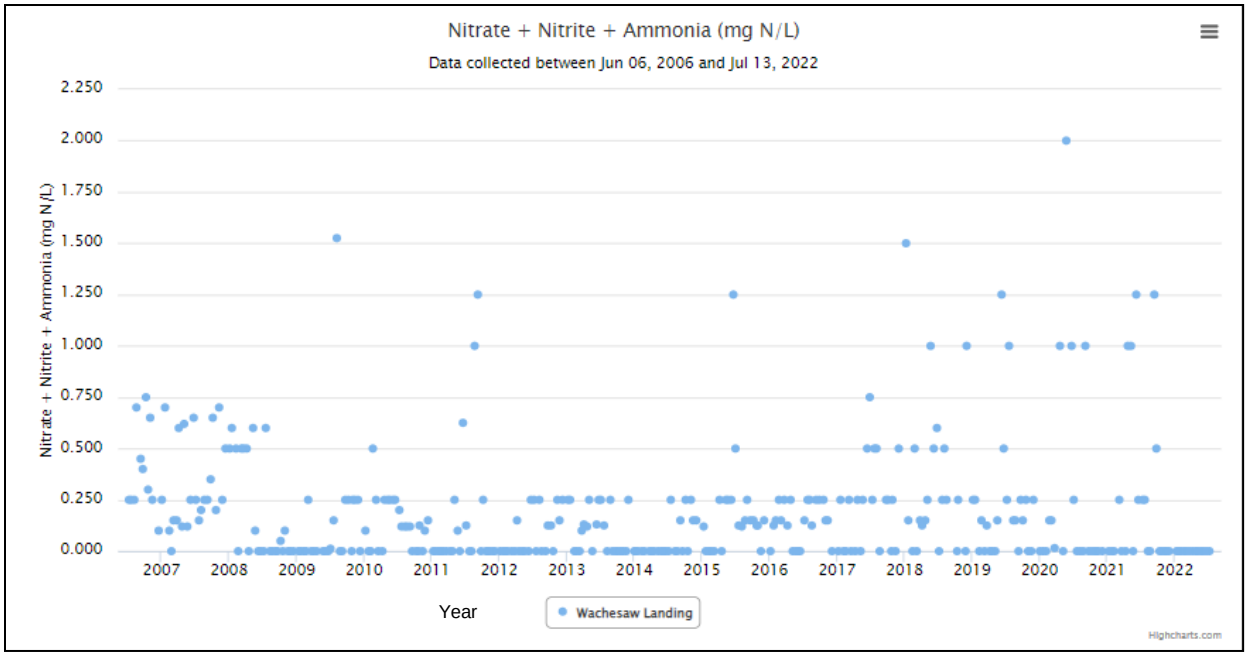


FIGURE 24. WACCAMAW WATERSHED ACADEMY WATER QUALITY NITRATE, NITRITE, AND AMMONIA DATA AT WACHESAW LANDING (2006-2022)

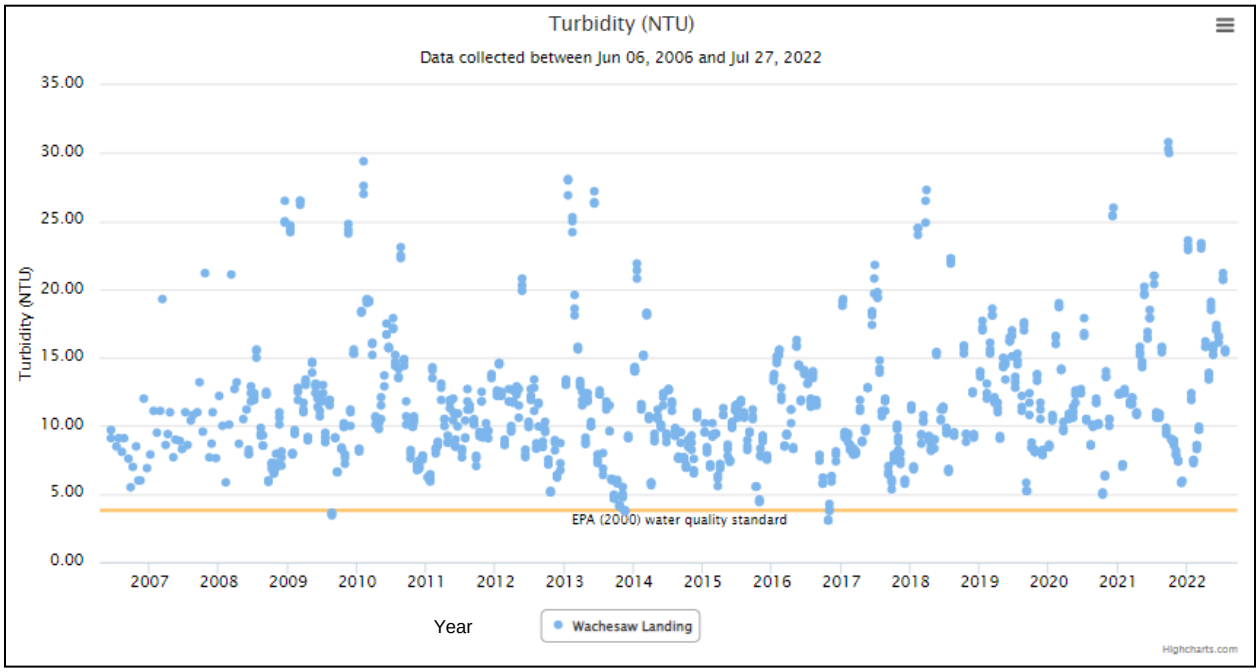


FIGURE 25. WACCAMAW WATERSHED ACADEMY WATER QUALITY TURBIDITY DATA AT WACHESAW LANDING (2006-2022)

TABLE 9. MONITORING DATA FROM HAGLEY PLANTATION (2006-2022)

Hagley Plantation	Average	Max	Sample Number
E. coli (MPN/100mL)	30	1,100	325
Nitrate + Nitrite + Ammonia (mg/L)	0.186	2.00	369
Turbidity (NTU)	0.19	3.0	370

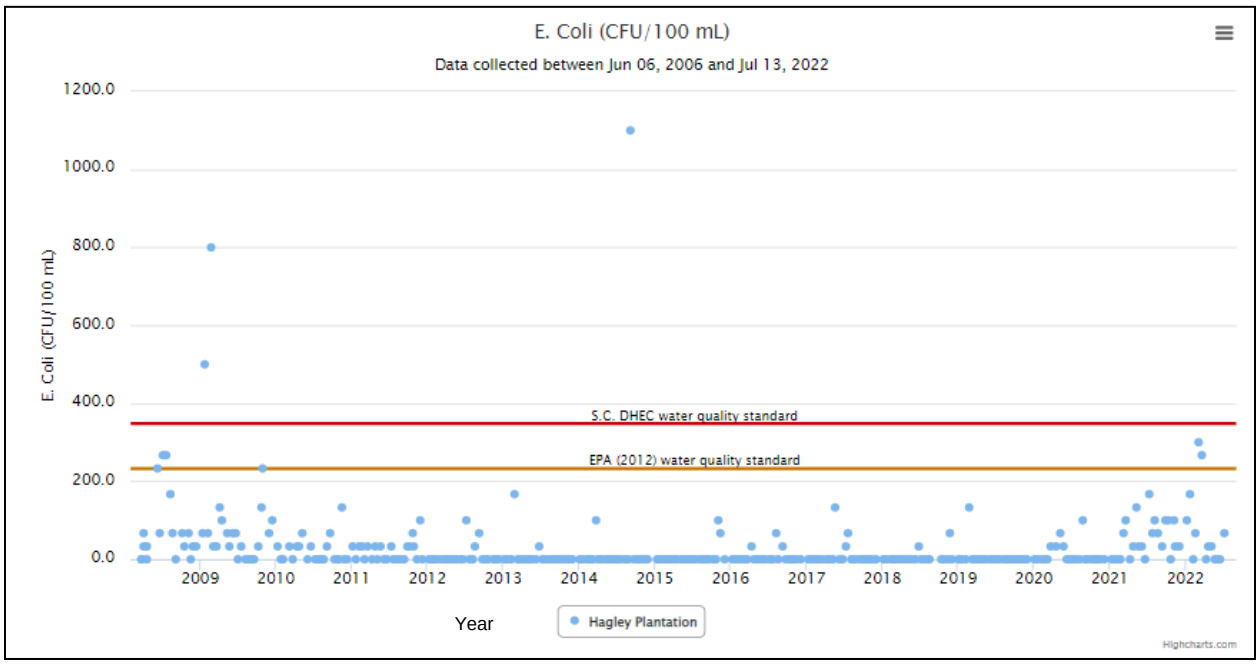


FIGURE 26. WACCAMAW WATERSHED ACADEMY WATER QUALITY E. COLI DATA AT HAGLEY PLANTATION (2006-2022)

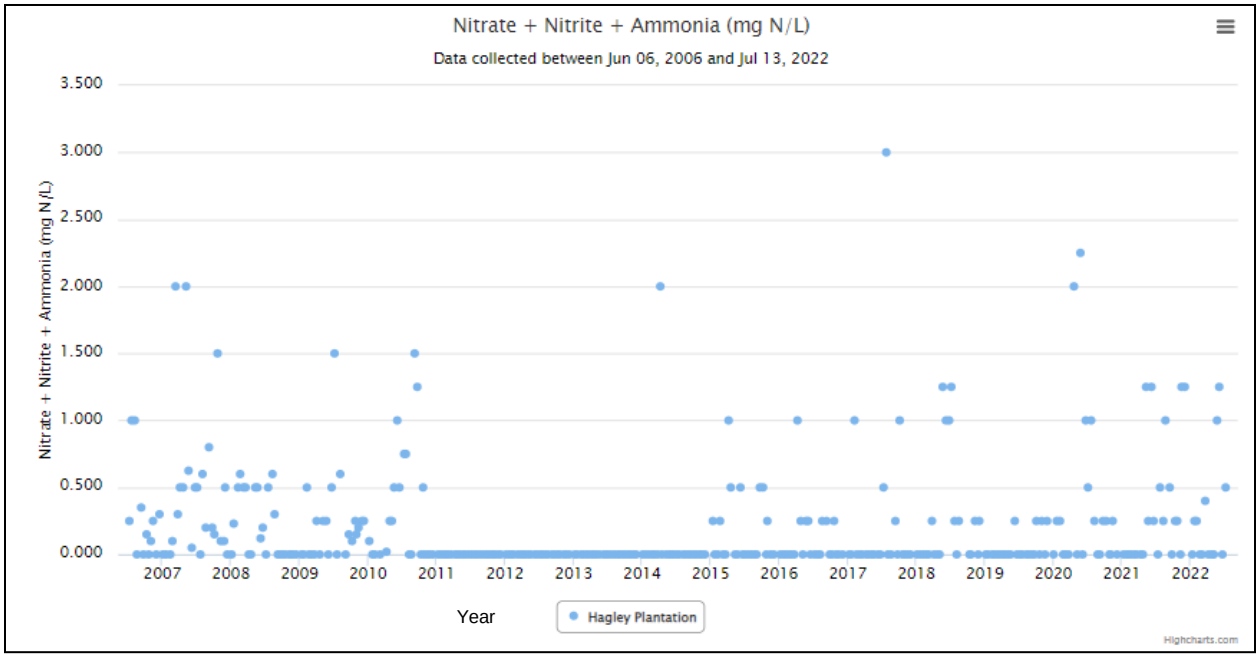


FIGURE 27 WACCAMAW WATERSHED ACADEMY WATER QUALITY NITRATE, NITRITE, AND AMMONIA DATA AT HAGLEY PLANTATION (2006-2022)

.

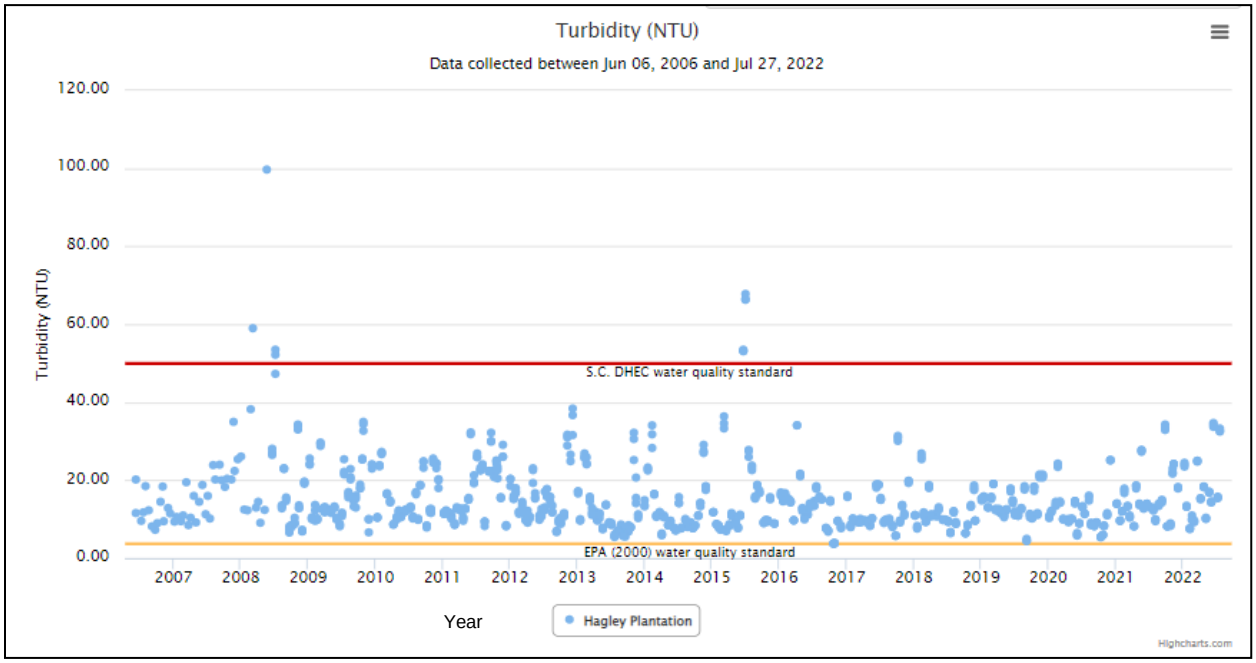


FIGURE 28. WACCAMAW WATERSHED ACADEMY WATER QUALITY TURBIDITY DATA AT HAGLEY PLANTATION (2006-2022)

Monitoring data for the Grand Strand Water Sewer Authority and Georgetown County Water Sewer District are presented in Tables 10 and 11 and Figures 29 and 30. Data presented were taken daily from January 2019 to July 2022.

TABLE 10. MONITORING DATA FROM THE GCWSD WACCAMAW NECK INTAKE (2019-2022)

Waccamaw Neck	Average	Max	Sample Number
Turbidity	13.8	41.4	1308

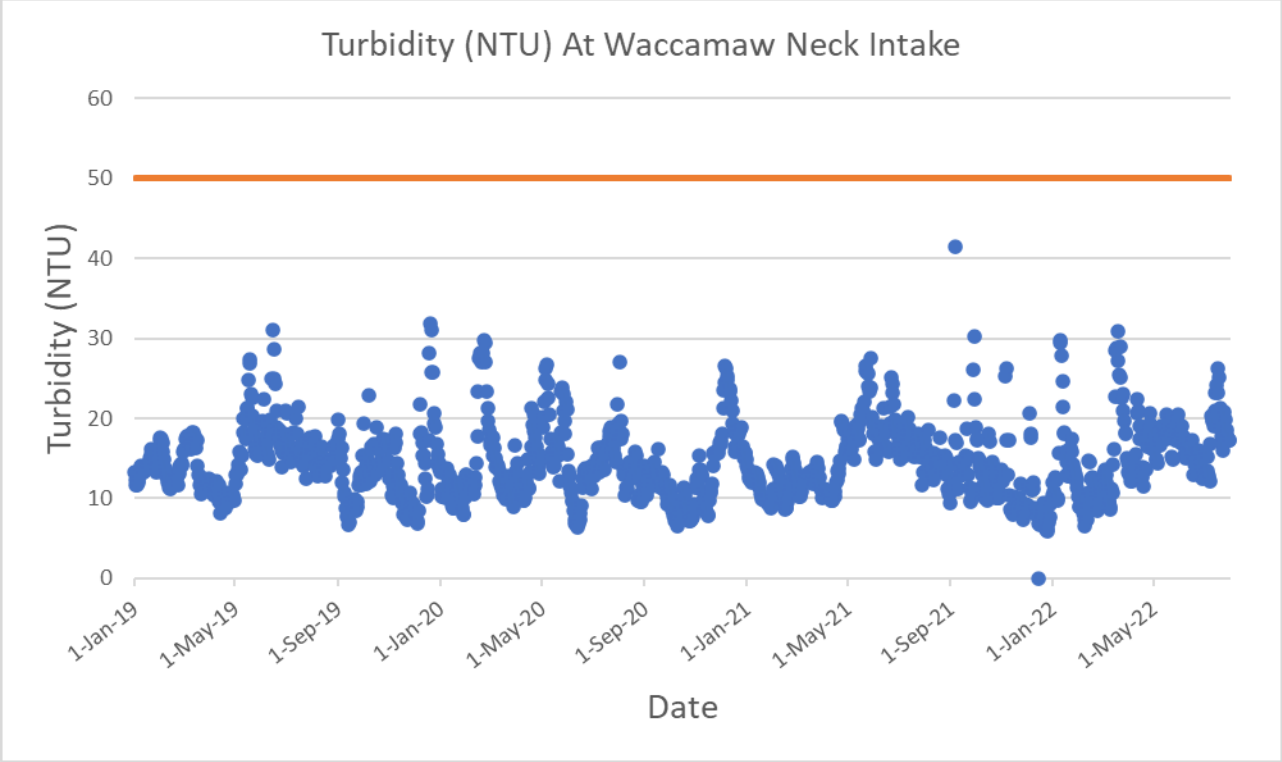


FIGURE 29: TURBIDITY LEVELS FROM THE GCWSD WACCAMAW DRINKING WATER INTAKE (2019-2022)

TABLE 11. MONITORING DATA FROM THE GSWSA BULL CREEK DRINKING WATER INTAKE (2019-2022)

Bull Creek	Average	Max	Sample Number
Turbidity	11.5	71.3	1307

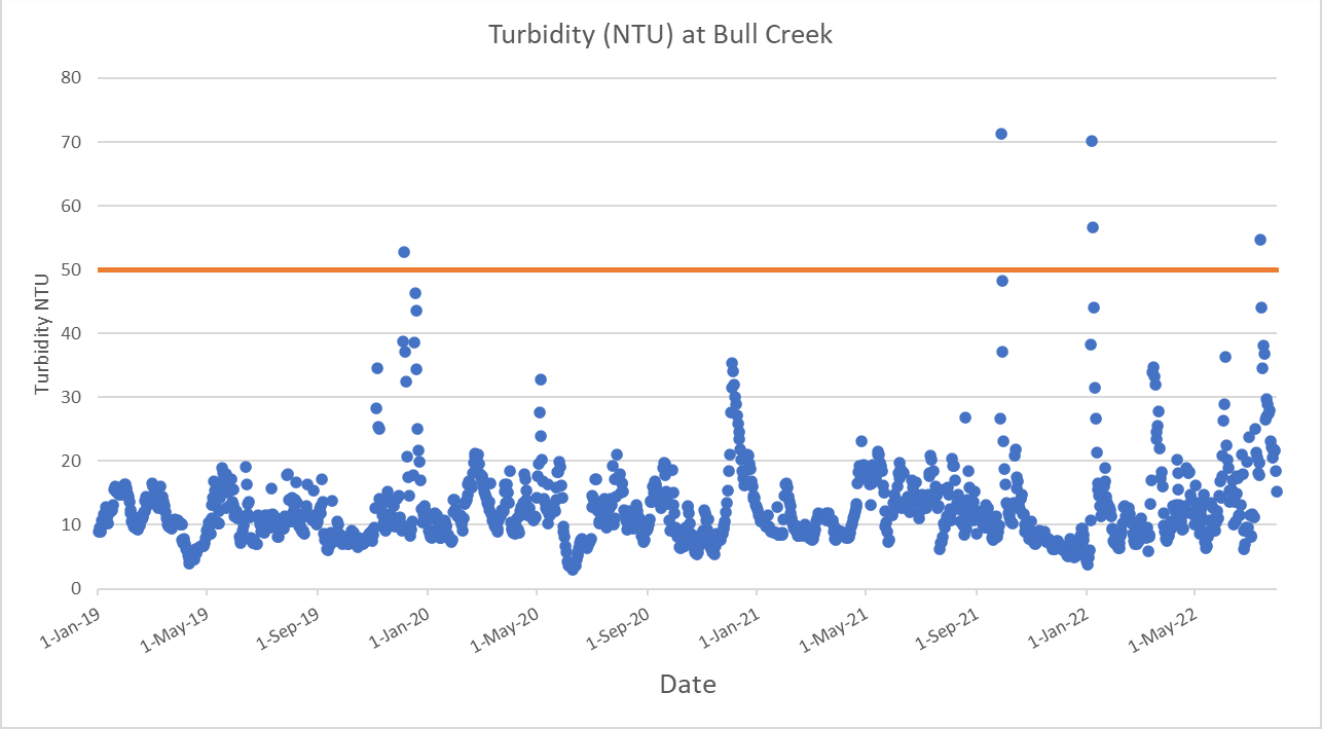


FIGURE 30: TURBIDITY LEVELS FROM THE GSWSA BULL CREEK DRINKING WATER INTAKE (2019-2022)

4. IDENTIFYING AND PRIORITIZING POLLUTANTS, SOURCES, CAUSES

Section 4 describes the possible sources and causes of the impacts from possible pollutant loadings. These were identified by reviewing the available assessment data, as previously discussed in Section 3.2 and conducting supplemental field investigations as further described in Sections 4.1 and 5.1 Technical advisors, stakeholders, and community members also provided input on the sources and causes of potential pollutants throughout the project. By identifying the cause of pollutant sources, implementation efforts can focus on protecting the Waccamaw and Great Pee Dee Rivers as drinking water sources and as recreational waters. This will ensure that implementation efforts will be completed efficiently and effectively.

Although point source pollution has not been ruled out, nonpoint source pollution has been identified as a likely cause of impairment during evaluation of Waccamaw and Great Pee Dee Rivers Watershed. The four primary sources of nonpoint source pollution in the Watershed are stormwater discharges from agricultural lands, urbanized areas, sanitary sewer overflows (SSOs), and failing septic systems. These sources are discussed in greater detail below.

4.1 Agricultural Sources

Livestock (Cattle/Horse)

Livestock such as cattle and horses grazing on pastureland can be a significant source of bacteria, nutrients, and sediment loadings. The main conveyance of this bacteria to the Watershed from livestock, including horses, is from stormwater runoff over pastureland containing manure.

In addition to bacteria, stormwater runoff from pastureland also contributes nutrients, as manure is a source of nitrogen and phosphorous. Fertilizer used during pasture maintenance is also a source of nitrogen and phosphorous. Lastly, sediment has the potential to become a pollution problem when livestock destabilize and erode pasturelands, allowing stormwater runoff to deposit sediment into nearby waterways.

Estimates from a windshield survey in 2021 and brainstorming sessions were used to determine the degree of livestock impacts within the Watershed. The windshield survey identified very few cattle operations and horse hobby farms located in the northern portion of the Watershed. Aerial review of land use found a total of 6 cattle farms, but only four individual cattle in the Pee Dee River subwatershed were identified. A total of two horse farms were found in the Outlet Waccamaw River-Atlantic Intracoastal Waterway and Collins Creek subwatersheds. A focus group held with agricultural stakeholders on January 6, 2022, also contributed information regarding livestock occurrence in the Watershed. Stakeholders that attended included Georgetown County Sewer and Water District, Clemson Extension, NRCS, Coastal Carolina University, The Nature Conservancy, Horry County, and the Waccamaw Regional Council of Governments. Although it was determined agricultural land use for livestock was not a significant contributor to water quality issues due to the small amount of acreage devoted to agriculture, outreach and funding sources will still provide a water quality benefit in the Watershed.

Crop Farms

Pollutant loadings from croplands are mostly attributed to runoff from fertilizer (including poultry manure) and poorly stabilized soils. Nutrient and bacteria loadings result from runoff of fertilizer containing bacteria and/or nitrogen and phosphorous. Sediment loadings occur from poorly stabilized soils entering the stream, potentially accompanied by bacteria and nutrients. USGS National Landcover Database and GIS analysis estimated 3.2% (4,100 acres) of land used in the Watershed is used for crops. However, data were not available to estimate the quantity of acreage using land application methods.

The windshield survey and attendees from the public meeting held May 10, 2022, in Bucksport, SC noted the presence of sod farms in the northern part of the Watershed. The GSWSA discharges treated wastewater effluent on fields used to grow sod in the Waccamaw River-Atlantic Intracoastal Waterway subwatershed, and sod is cut from the fields and sold to customers. The GSWSA has obtained land application permits from SCDHEC to use treated biosolids to provide water and nutrients for the sod, as well as for forestry products (Table 15, Section 4.6). This land application is an alternative waste disposal method, unlike traditional discharge of treated effluent into a surface water and is closely monitored and regulated by SCDHEC. The GSWSA uses best management practices to retain stormwater runoff on site, capturing any potential pollutants before they reach surface waters.

4.2 Urban Sources

The higher percentage of impervious surfaces, specifically those built prior to stormwater regulations requiring detention, and concentrations of pets (particularly dogs) that live in developed areas, especially in the northeastern portion of the Watershed closer to the coast, increase the pollutant loading from developed land. The increase in pollutant loadings (bacteria, sediment, and nutrients) from these areas is mostly due to the increase in connected impervious surfaces. Because stormwater flows over these hard surfaces directly into a water body or storm drain, there is no opportunity for soil and plants (or a water treatment facility) to filter out pollutants. This alteration in the natural landscape increases runoff volume and creates an efficient mechanism to convey available pollutants to the Waccamaw and Great Pee Dee Rivers and their tributaries. Stormwater pollutants originate from many different urban sources, ranging from fuel and oil on roads and parking lots to litter dropped on streets and in ditches, to sediment from construction sites. Common pollutants found in urban stormwater, their likely sources, and the effect of the pollutant on our waterways is outlined in Table 12 (EPA Victoria 2012). One pollutant of emerging concern associated with the urban environment is Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS). PFAS are a large group of manufactured chemicals occurring in everyday materials, such as packaging, cookware, clothing, carpet, etc. Although PFAS are of much concern due to their persistence in the environment, they are considered point source pollution and are therefore not being addressed in this WBP.

Pollutants in stormwater runoff will become of increasing concern as climate change continues to impact the southeast. Pollutant concentrations have been shown to increase with higher runoff events, even in low density development areas, such as the Bucksport, SC area in Horry County. Residents' reports of increased flooding bring to question whether water quality impacts are exacerbated by more frequent and higher magnitude rainfall. Additionally, climate models predict that heavy rain events will continue to increase in frequency and intensity. Records show that, in the past 50 years, the amount of rain received in the heaviest 1% of storm events increased by 20% (Karl et al 2009). Therefore, it is imperative that residents and local governments are aware of the need for stormwater education and on the ground practices to improve infiltration, reduce impervious surfaces, and remove pollutants from the landscape that would otherwise be captured in stormwater runoff.

TABLE 12. COMMON URBAN POLLUTANTS, THEIR LIKELY SOURCES, AND THE EFFECT ON WATERWAYS (EPA VICTORIA 2012)

Pollutant	Effect	Urban Source
Bacteria	High numbers of bacteria and viruses can cause illnesses, including hepatitis and gastroenteritis.	Animal Waste Sewer Overflows, Septic Tank Leaks Organic Matter Decay
Nutrients	An increase in nutrients stimulates growth of aquatic plants. This causes excessive growth of aquatic weeds and algae that may choke lakes and streams and lead to dramatic daily fluctuations in dissolved oxygen (DO) levels. Low DO levels can lead to fish kills.	Organic Matter Fertilizer Sewer Overflows, Septic Tank Leaks Animal Waste Detergents (Car Washing) Spillage, Illegal Discharges
Sediment	Reduces the amount of light in the water available for plant growth, decreasing the supply of food for other organisms. Can clog and damage sensitive tissues such as the gills of fish or aquatic macroinvertebrates. Can suffocate organisms that live on or in the bed of lakes and streams by forming thick deposits when the suspended material settles out. Can absorb sunlight and raise water temperatures	Land Surface Erosion Building and Construction Sites Unpaved roads Eroding stream banks
Oxygen Demanding Substances	Oxygen is used up more quickly than it can diffuse into the water from the atmosphere. The resulting drop in oxygen levels may then kill fish and other aquatic organisms. Reduced oxygen levels can cause unpleasant odors	Organic Matter Decay Atmospheric Deposition Sewer Overflows, Septic Tank Leaks Animal Waste Spillage, Illegal Discharges
pH (Acidity)	Increased acidity damages plants and animals	Atmospheric Deposition Spillage, Illegal Discharges Organic Matter Decay Erosion of Roofing Material
Toxic Organics	Poison living organisms or damage their life processes in some other way. Persist in the environment for a long time	Atmospheric Deposition Vehicle Wear Sewer Overflows, Septic Tank Leaks Weathering or Buildings/Structures Spillage, Illegal Discharges
Litter and Debris	Animals can eat and choke on this material. Can convey extra nutrients	Waste Collection Systems Lawn Clippings Spill and Accidents
Oils, Detergents, and Shampoos (Surfactants)	Highly toxic to fish and other aquatic life	Asphalt Pavements Spillage, Illegal Discharges Leaks from Vehicles Car Washing
Increased Water Temperature	High temperatures are lethal to fish and other aquatic organisms. Increased water temperatures stimulate the growth of nuisance plants and algae. This and other effects can lead to decreased levels of dissolved oxygen, which can threaten other aquatic life	Run-off from Impervious Surfaces Removal of Riparian Vegetation

The Murrells Inlet and Garden City portions of Georgetown and Horry Counties are small MS4s located in the Collins Creek and Waccamaw River – Atlantic Intercoastal Waterway subwatersheds. According to the 2011 NLCD data, developed areas account for 14% (17,996) of the subwatersheds. Developed areas are mainly in the eastern portion of the Watershed, along the coast, with Pawleys Island, Murrells Inlet, Garden City, developed near and around Highway 17 – Ocean Highway.

To better understand the impact that urbanization has on the Watershed, a kickoff session was held with stakeholders on June 24, 2021, two public meetings were held on May 10, 2022, and a focus group was held with Horry County, Georgetown County and GCWSD staff on January 7, 2022. Stakeholders that attended the meeting in June 2021 included GCWSD, Clemson Extension, NRCS, American Rivers, Coastal Carolina University, The Nature Conservancy, Horry County, and the Waccamaw Regional Council of Governments. Current and future urban sources of pollutants were identified as the major driving force behind water quality issues in the Watershed, though agricultural BMPs will also have a positive effect on water quality. The two public meetings held in May 2022 sought to identify problem areas and to discuss possible projects in the Watershed. Meetings were held in both counties to accommodate respective residents. An interactive map of the Watershed (https://arcg.is/0qLaOD) was also distributed by stakeholders and partners via social media and list serves to acquire additional information from residents regarding areas of concern and potential best management practice implementation locations. In June 2022, a survey was administered to county staff to further identify specific issues related to urban stormwater runoff and which land development practices and policies would be most beneficial and most accepted in the community (Appendix D).

Compiling information from the interactive map, public meetings, and survey, the following findings on potential urban sources of pollution are high amounts of impervious surface, construction BMPs and stormwater control structure maintenance, fertilizer runoff, land clearing for timber, and pet waste.

These urban sources primarily result in sediment and nutrient pollution, and bacteria to a lesser degree. Thus, sediment, nutrients, and bacteria were selected as the key pollutants to address in this WBP.

4.3 Sewer Sources

In urbanized areas, sewers may be another source of bacteria and nutrient contamination. Sanitary sewer overflows (SSOs) can result from anything obstructing the flow of wastewater, such as a build-up of solids and fats, oils, and greases and flushing of wipes (FOWG). Although there are different causes for sanitary sewer overflows, FOWG poured/thrown into sanitary sewer collection systems, either intentionally or unintentionally, have a significant effect on the size and frequency of sanitary sewer overflows. Fats, oils, and grease in a warm liquid form may appear to be harmless since they flow easily down the drain. However, as the liquid cools, the FOG solidifies and separates from other liquids in the sewer pipes. The layer of FOG sticks to the sewer pipes and, over time, the flow of wastewater becomes restricted and can cause a backup or overflow (HCSA 2012). When the gravity flow of sanitary sewer is blocked and backs up, it will eventually overflow into roads, storm drains, ditches, creeks, and rivers. Although sanitary sewer overflows are not a constant source of bacteria and nutrients to the Watershed, they can cause a significant impact to the Watershed when they occur. Sanitary sewer leaks also exist and can result in water quality issues in a stream.

FIGURE 31. SANITARY SEWER OVERFLOW

GSWSA reported four SSOs in the previous three years, for a total 44,000 gallons within the study Watershed. GCWSD has reported two SSOs in the past three years, discharging 5,000 gallons into waterways within the Watershed (Figure 32).

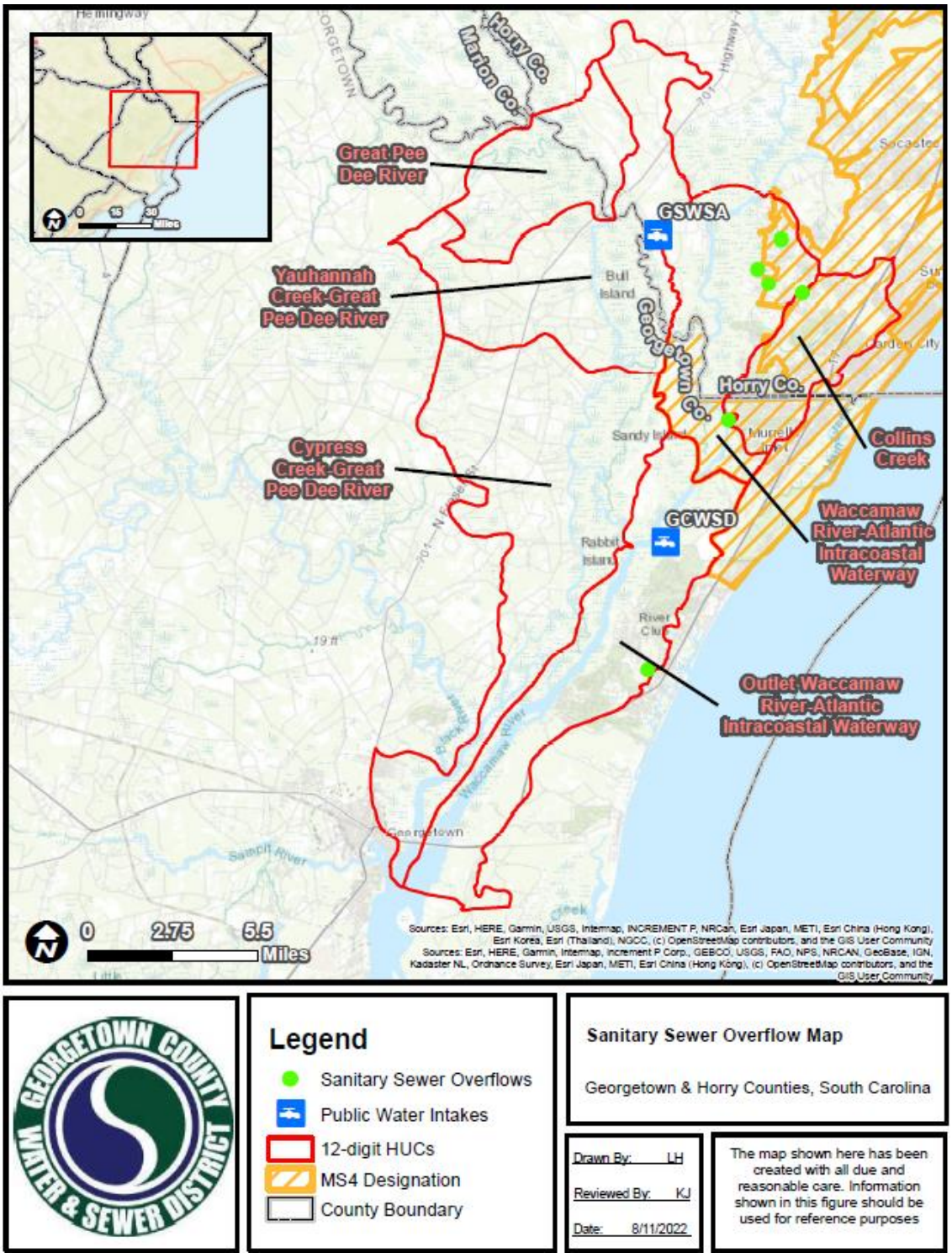


FIGURE 32: SANITARY SEWER OVERFLOW LOCATIONS FOR GSWSA AND GCWSD FROM 2019-2022[8]

[8] See Appendix A for larger figure.

4.4 Septic Sources

Failing septic systems represent a nonpoint source that can contribute bacteria and nutrients to receiving waterbodies through surface or subsurface malfunctions. Septic systems that do not function properly may leak septage which can reach nearby streams. Septic systems can fail due to improper design or construction, and systems may no longer function because of neglected maintenance. There is no accurate estimate of failure rate in this Watershed, but several studies have reported failure rates ranging from 5% to 39%, and a rule of thumb of 10% failure is generally used (Schueler 1999). Many residential property owners may be unaware of problems with their septic tanks or may be unable to afford repair of their septic tanks. Therefore, failing septic systems may be a significant source of bacteria and nutrients in the Watershed.

FIGURE 33. EXAMPLE FAILING SEPTIC SYSTEMS

The practice of not pouring FOG or wipes in septic systems prevents backups in septic systems as well. Results from the interactive Watershed map distributed to the public did show concern for aging septic tanks unable to properly function during heavy rain events.

A desktop analysis was conducted using sewer lines, building footprints, and parcel data to estimate the number of septic systems in the Watershed. This analysis estimated 1,724 septic systems in the Watershed, with the most septic tank concentration in the Cypress Creek – Great Pee Dee River and Outlet Waccamaw River – Atlantic Intracoastal Waterway subwatersheds (Figure 34). Thus, it is estimated that there are approximately 172 failing septic systems in the Watershed. The GIS analysis first assumed that all parcels with buildings greater than 500 square feet are either connected to sewer or have septic systems. To estimate the number of parcels connected to sewer, a 100-ft buffer was created from the sewer line or sewer lateral. If this buffer intersected with a parcel, that parcel was believed to be connected to the sewer system. The remaining number of parcels with buildings greater than 500 square feet were used to estimate total septic systems. Estimated bacteria and nutrient loadings from failing septic systems are detailed in Section 5.5. The estimated number of septic systems in each subwatershed and in each county are shown in 14 and 15.

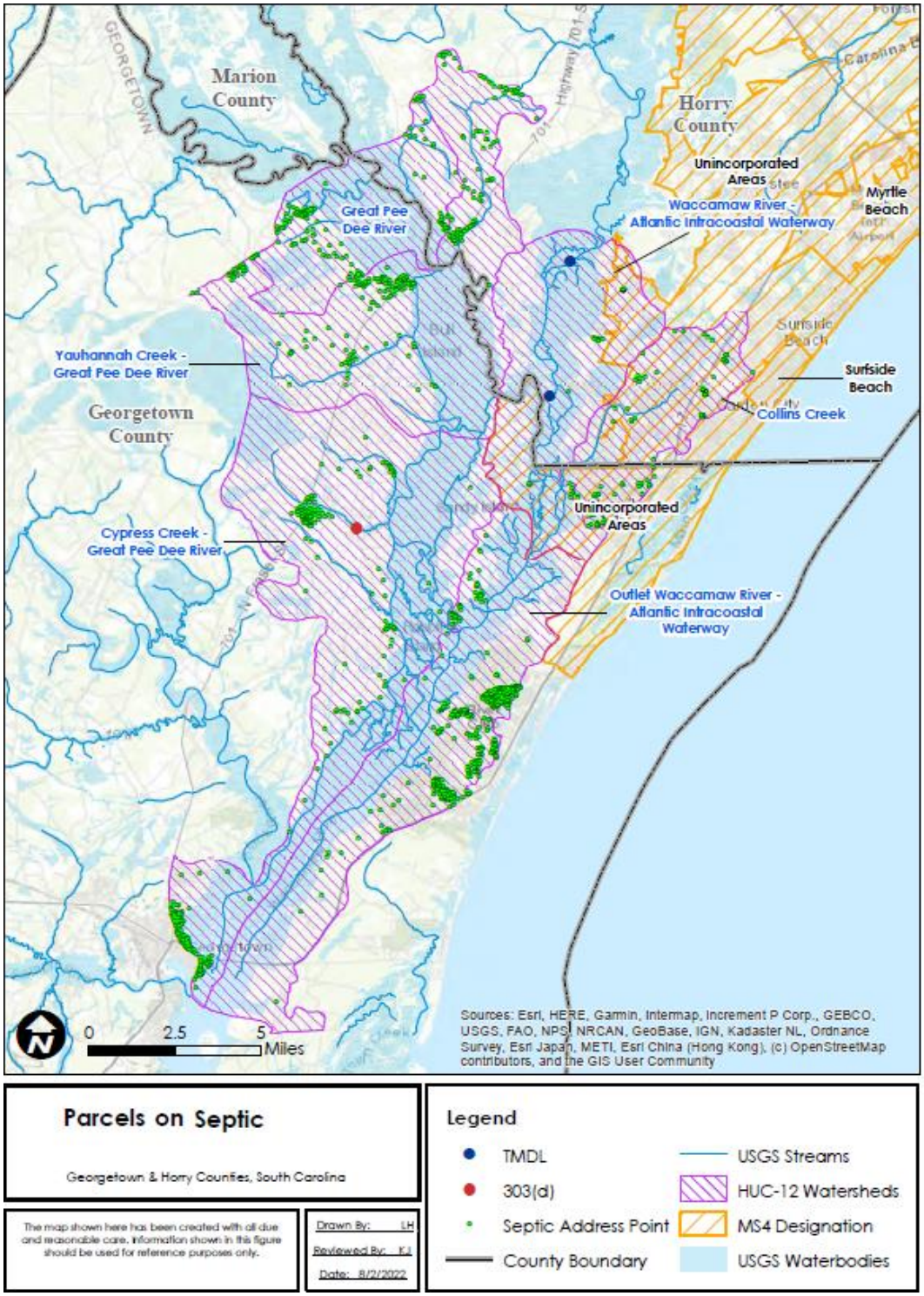


FIGURE 34: SEPTIC SYSTEM LOCATIONS IN THE WACCAMAW AND GREAT PEE DEE RIVERS WATERSHED[9]

[9] See Appendix A for larger figure.

TABLE 13. TOTAL ESTIMATED SEPTIC SYSTEMS BY SUBWATERSHED

HUC-12	Subwatershed Name	Approximate Number of Septic Systems
30402061001	Collins Creek	178
30402061002	Waccamaw River-Atlantic Intracoastal Waterway	35
30402061003	Outlet Waccamaw River-Atlantic Intracoastal Waterway	610
30402070205	Great Pee Dee River	143
30402070206	Yauhannah Creek-Great Pee Dee River	279
30402070207	Cypress Creek-Great Pee Dee River	479
Total		**1,724**

TABLE 14. ESTIMATED NUMBER OF SEPTIC TANKS IN WATERSHED BY COUNTY

County	Number of Septic Tanks
Georgetown County	1,434
Horry County	290
Total	**1,724**

4.5 Wildlife Sources

Wildlife (mammals, marsupials, and birds) are contributors of bacteria and nutrients to surface waters via wastes that are either carried into nearby streams by runoff following a rainfall or deposited directly in streams. This is especially true as urbanization expands and fewer natural areas are available for wildlife. This can result in concentrated wildlife populations reflected in increased bacteria loads in waterways.

Canada geese, both resident and migratory, can impact water quality by depositing undesirable amounts of fecal matter in and near waterbodies. SCDNR estimates 50,000 resident geese throughout the state, with most residing in the Upper Coastal Plain, Piedmont, and Foothills. In addition to excess feces, Canada geese are known to overgraze land, leaving it bare and susceptible to erosion from stormwater runoff.

Another known issue with wildlife in South Carolina is an increasing environmental impact from feral swine. They reproduce at an extremely rapid rate, have no natural enemies in South Carolina, and carry two diseases (swine brucellosis and pseudorabies) transmissible to humans or other wildlife. Their habit of "wallowing in the mud" and their preference for bottomlands (such as rivers, creeks, and other drainages)

(Figure 35) can have a direct effect on surface water quality, specifically sediment, bacteria, and nutrient loadings.

The SC State Wild Hog Task Force was established to coordinate education and management efforts to mitigate issues from wild hogs in South Carolina. SCDNR and legislation strongly encourage hunters to kill as many wild hogs as they can to control the population. There is no closed season or bag limit for wild hogs on private land. Environmental damages from wild boars include rooting, wallowing, and trampling activities compact soils, which in turn disrupts water infiltration and nutrient cycling and can lead to increased stormwater runoff (Hamrick, et. al. 2016). This runoff combined with wild pig activity in streams reduces water quality by increasing turbidity (excessive silt and particle suspension) and bacterial contamination. In time, turbidity and added contaminants affect a variety of native aquatic life, most notably fish, freshwater mussels, amphibians, and insect larvae. In some streams, feces from wild pigs have increased fecal coliform concentrations to levels exceeding human health standards. Additionally, destruction of vegetation in freshwater marshes not only reduces aquatic life and water quality but also affects ecosystem services, such as water filtration, flood control, and storm surge protection.

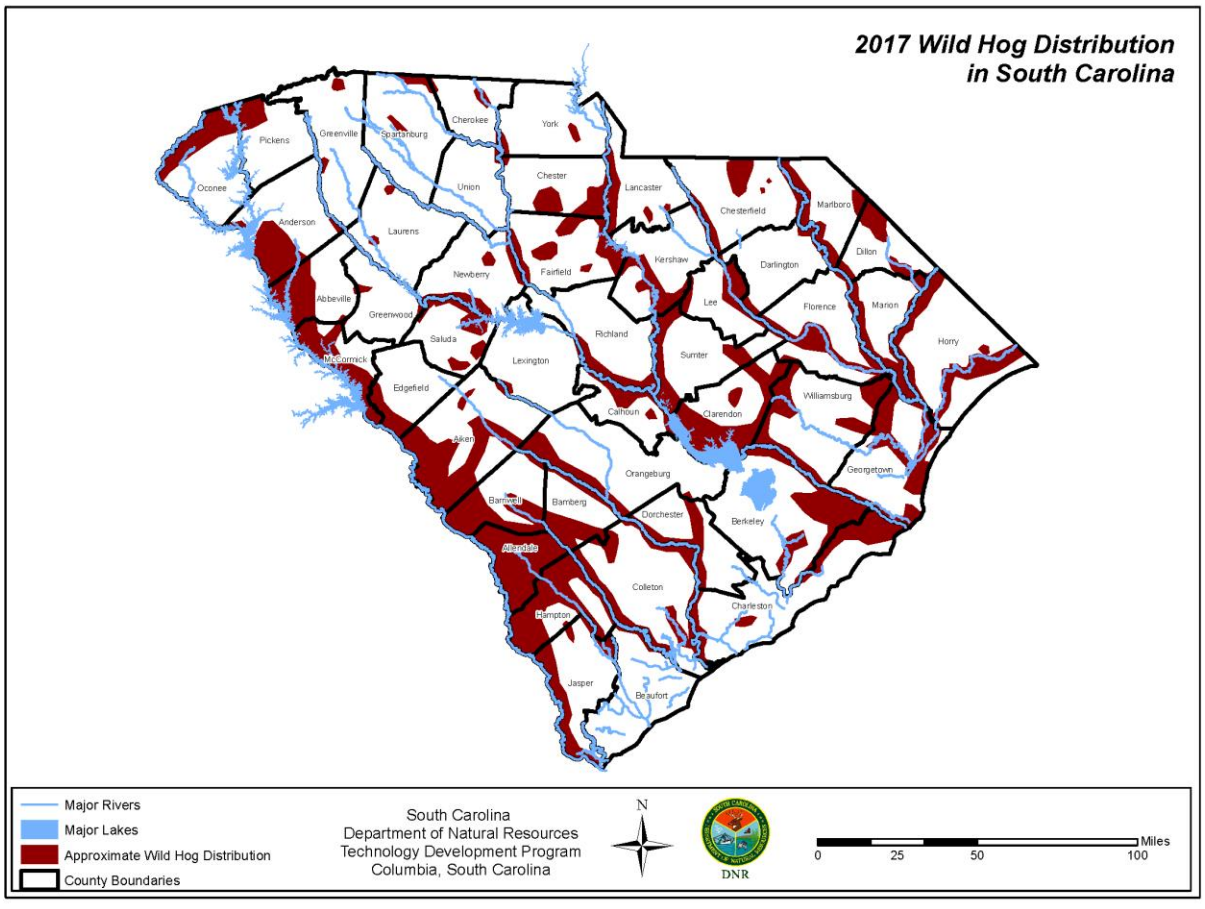


FIGURE 35. DISTRIBUTION OF FERAL HOGS IN SOUTH CAROLINA

4.6 Other Sources

Forestry

As mentioned in Section 2.5, there are several forestry operations in the Cypress Creek – Great Pee Dee River and Pee Dee River subwatersheds, and both Horry and Georgetown County rank in the top ten in harvested timber value. When there is a lack of best management practices during active timber operations, the potential environmental stresses stemming from sustained forestry practices can result in severe erosion, excessive sediment loadings, lack of sufficient woody debris, and stream channelization and channel/bank instability. These attributes and conditions could, in turn, induce water quality and aquatic/riparian habitat threats.

Possible sources of nonpoint source pollution associated with forestry activities include removal of streamside vegetation, road construction and road use, timber harvesting, and mechanical preparation for the planting of trees. Road construction and road use are the primary sources of NPS pollution on forested lands, contributing up to 90% of the total sediment from forestry operations. In addition to other water quality impacts, an excessive quantity of sediment in a waterbody can reduce the ability of aquatic organisms to successfully live, forage, and spawn (USEPA 2017).

Harvesting trees in the area beside a stream can affect water quality by reducing the streambank shading that regulates water temperature and by removing vegetation that stabilizes the streambanks. These changes can harm aquatic life by limiting sources of food, shade, and habitat, as well as decreasing areas suitable for species intolerant of warmer temperatures (USEPA 2017).

The South Carolina Forestry Commission (SCFC) is the lead agency in South Carolina in designing, interpreting, monitoring, and updating forestry BMPs. The guiding document for proper BMP selection and use is South Carolina's Best Management Practices for Forestry Manual (1994). Compliance with BMPs is required for forestry activities which involve discharge of dredge or fill materials into jurisdictional wetlands to qualify for the silvicultural exemption under Section 404(f) of the Clean Water Act. Compliance with BMPs is recommended on all sites on which there is a potential for violating water quality criteria as defined by the South Carolina Pollution Control Act.

The Sustainable Forestry Initiative Inc. (SFI) is an independent non-profit organization that also works to ensure the health and future of forests and natural resources intersecting with them. Sustainable Forestry Initiative (SFI) mills require loggers to initially take a two-day training (half a day on BMPs) with an annual video update training. In South Carolina, over one million acres are SFI certified. Mills who are SFI certified require loggers to be compliant with SFI and will reject lumber from loggers who do not meet requirements. SCFC provides half a day of BMP training to meet the SFI requirement. As well, SCFC conducts Courtesy Exams on active sites monthly and SCDHEC enforces issues the SCFC finds. SCFC's responses to issues found during Courtesy Exams vary depending on severity but range from requirement of the logger to go back through training, take the necessary remediation steps on the ground, or fines.

Additionally, SCFC provides annual reports to determine compliance with South Carolina's Best Management Practices for Forestry (BMPs). The 2019-2020 monitoring year evaluated 179 sites and found that overall BMP compliance was 96.1%. Specifically, there was 99.1% compliance to stream side management zone protection and 88.9% compliance with BMPs for stream crossings (www.scfc.gov/development/best-management-practices/best-management-practices-reports/).

Forestry activities are not believed to be a significant contribution to pollution in these subwatersheds and are not being addressed in this WBP, though one survey response expressed concern that BMPs are not

being installed and that there is little enforcement. Stakeholders plan to encourage landowners to put portions of their property (especially wider buffers along streams and wetlands) into conservation easements to maintain forests in these sensitive areas.

Point Sources

Point sources are defined as pollutant loads discharged at a specific location from pipes, outfalls, and conveyance channels from either municipal wastewater treatment plants, industrial waste treatment facilities, or regulated stormwater discharges (SCDHEC 2011). Individual NPDES permitted point sources identified within the Waccamaw and Pee Dee Rivers Watershed are listed below in Table 15.

TABLE 15. NPDES PERMITS IN THE WACCAMAW AND GREAT PEE DEE RIVERS WATERSHED

Facility	Permit #
GCWSD/Debordieu Colony WWTP	SC0048984
GCWSD/Pawleys Area WWTP	SC0039951
GCWSD/Waccamaw Neck WTP	SCG646021
GCWSD/Murrells Inlet WWTF	SC0040959
GSWSA/Schwartz Plant Pipe 01B	SC0037753
GSWSA/Schwartz Plant Pipe 001	SC0037753
GSWSA/Schwartz-Myrtle Beach-Bucksport Pipe 007	SC0037753
GSWSA/Schwartz Plant Pipe 006	SC0037753
GSWSA/Schwartz Plant Pipe 005	SC0037753
GSWSA/J L Bucksport WWTF	SC0040886
GSWSA/Bull Creek WTP	ND0069892
GSWSA/Bull Creek WTP	SCG646050
GSWSA/Yauhannah Tree Farm	SC0048461
GSWSA Land Application Effluent Reuse Site	38 locations

TABLE 16. PERMITTED MINES IN WACCAMAW AND GREAT PEE DEE RIVERS WATERSHED

Facility	Permit #	Material
AO Hardee & Son HWY 701 Mine	SCG731354	Non-metallic minerals
AO Hardee & Son HWY 707 May Mine	SCG731291	Non-metallic minerals

In addition to these facilities' NPDES permits for their process water outfall(s), compliance with the NPDES Industrial General Stormwater Permit is required. The permit, which was recently renewed, effective July 1, 2022, requires industrial permitted facilities with certain SIC codes to inspect their facilities, maintain BMPs and monitor their stormwater discharges for certain pollutants of concern (POC), either based on the type of manufacturing or based on stream impairments or both. A local government may request results of these sampling activities from industrial facilities to evaluate which, if any, of the industrial facilities may be point sources for bacteria, nutrient, sediment, or other pollutant(s).

However, because these industrial facilities have individual NPDES permits and some have additional industrial stormwater permits with their own pollution prevention requirements, they are not believed to be a significant contribution to pollution in these subwatersheds and are not being addressed in this WBP.

5. EXISTING LOADS

EPA's STEPL was used to calculate an estimated pollutant load for nitrogen (N), phosphorous (P), *E. coli*, and sediment (TSS), from livestock, cropland, and urban sources of pollution. Input data for STEPL can be found in Appendix E. Bacteria loading was estimated using the standard numbers per area per year from Shaver et al 2007 (Table 17). Methodology for STEPL can be found at www.epa.gov/nps/plet. Table 17 below summarizes the results for the existing pollutant loads estimated in the Watershed, followed by explanations on the estimated loads per source. *E. coli* estimates were converted to fecal coliform using EPA's recommended ration of 0.63. Fecal coliform data presented below allow comparison to monitoring data in Section 3.2.

TABLE 17. ESTIMATED EXISTING POLLUTANT LOADS FROM RUNOFF IN THE WACCAMAW AND GREAT PEE DEE RIVERS WATERSHED

Sources	N (lb/yr)	P (lb/yr)	TSS (ton/yr)	*E. coli* (CFU/yr)	Fecal Coliform (CFU/yr)
Livestock	119	9	4	1.05E+12	1.7E+12
Cropland	23,546	3,718	7,988		
Urban	126,514	19,904	3,242	9.06E+14	1.4E+15
Septic	5,362	2,103		4.17E+12	6.6E+12
Forest	8,531	4,265	609		
Golf Course	112	24	2,032		
Total Sources	**163,184**	**30,023**	**13,875**	**9.1E+14**	**1.4E+15**

Minor discrepancies between Table 17 and Total Loads in Appendix E are due to Table 17 including only load from runoff. Appendix E output from STEPL incorporates gully and stream bank erosion estimates. Additionally, STEPL bacteria loads reported in Appendix E do not include estimates from septic sources, which were calculated separately.

5.1 Agricultural - Livestock

Very few livestock operations were observed through the windshield survey and aerial review. Additionally, agricultural partners indicated livestock impacts are not likely to be substantial in the Watershed. Ultimately, only three of the six subwatersheds were estimated to contain livestock. Although livestock are unlikely to have a substantial impact in the Watershed, information on best management practices for livestock landowners will be disseminated throughout the study area.

TABLE 18. ESTIMATED NUTRIENT AND BACTERIA LOADS FROM LIVESTOCK IN THE WACCAMAW AND GREAT PEE DEE RIVERS WATERSHED

Subwatershed	N (lb/yr)	P (lb/yr)	TSS (ton/yr)	*E. coli* (CFU/yr)	Fecal Coliform (CFU/yr)
30402061001					
30402061002					
30402061003	10	1	1	9.0E+10	1.4E+11
30402070205	66	5	1.5	5.8E+11	9.2E+11
30402070206					
30402070207	43	3	1.52	3.8E+11	603E+11
Total Watershed	**119**	**9**	**4**	**1.1E+12**	**1.7E+12**

5.2 Agricultural – Cropland

Information on manure application for fertilization was not known; therefore, bacteria and nutrient loadings from crop farms were unable to be accurately estimated.

TABLE 19. ESTIMATED POLLUTANT LOADING FROM CROP FARMS IN THE WACCAMAW AND PEE DEE RIVERS WATERSHED

Subwatershed	N (lb/yr)	P (lb/yr)	TSS (ton/yr)
30402061001	248	39	98
30402061002	4,391	693	1,740
30402061003	214	34	134
30402070205	4,032	637	1,135
30402070206	8,079	1,276	2,274
30402070207	6,582	1,039	2,608
Total Watershed	**23,546**	**3,718**	**7,988**

5.3 Urban

Based on the NLCD 2016 land cover data and further GIS desktop analysis, the total acreage of urbanized areas within the Waccamaw and Great Pee Dee Rivers Watershed was 17,996 acres.

TABLE 20: ESTIMATED POLLUTANT LOADINGS FROM URBAN LAND IN THE WACCAMAW AND GREAT PEE DEE RIVERS WATERSHED

Subwatershed	N (lb/yr)	P (lb/yr)	TSS (ton/yr)	*E. coli* (CFU/yr)	Fecal Coliform (CFU/yr)
30402061001	41,852	6,624	1,093	3.41E+14	5.41E+14
30402061002	15,840	2,428	426	1.26E+14	1.99E+14
30402061003	21,985	3,371	543	1.54E+14	2.44E+14
30402070205	7,536	1,197	185	2.61E+13	4.14E+13
30402070206	22,234	3,607	592	1.13E+14	1.79E+14
30402070207	17,067	2,676	403	1.46E+14	2.32E+14
Total Watershed	**126,514**	**19,903**	**3,242**	**9.06E+14**	**1.44E+15**

Wildlife found in urban settings, specifically resident Canada geese, can contribute nutrients and bacteria to a waterway. An individual Canada goose can average two pounds of fecal matter each day, with a resulting 165 CFU/100 mL of *E. coli* per gram of feces (Kirschner 2004). Although Canada geese are found in the study Watershed, accurate estimates of the number of individuals throughout the year were unable to be made. Preventative measures and best management practices for Canada geese population control are discussed in Section 7.3.

5.4 Sewer

As outlined in Section 4.4, utilizing parcels with buildings and sewer line data, the estimated parcels with sewer service within the study Watershed is 23,462. Load estimates from sewer maintenance issues, such as sanitary sewer overflows (SSOs) and sewer line leaks, are extremely difficult to estimate and thus will not be estimated for this WBP. However, Capital Improvement Projects and preventative measures will be discussed in Section 7.2.

5.5 Septic

As outlined in Section 4.4, utilizing parcels with buildings and sewer line data, the estimated number of septic systems within the study Watershed is 1,724. For nutrient loadings, the method from Horsley and Whitten, 1999 was used to estimate the existing loads from septic systems, assuming 10% are failing. An estimated 5,362 lbs/yr of nitrogen and 2,103 lbs/yr of phosphorous reach the stream from each failing septic system.

Bacteria loads from failing septic tanks per household amount to 2.42E10 CFU/yr (SCDHEC 2017). As such, using the rule of thumb of a 10% failing rate for the estimated 1,724 septic systems within the study

Watershed, the approximated results are outlined in Table 21. It was estimated that the total existing Fecal Coliform load from failing septic systems in the Waccamaw and Great Pee Dee Rivers Creek Watershed is 4.17E12 CFU/yr.

TABLE 21: ESTIMATED POLLUTANT LOADINGS FROM FAILING SEPTIC SYSTEMS IN THE WACCAMAW AND GREAT PEE DEE RIVERS WATERSHED

Subwatershed	N (lb/yr)	P (lb/yr)	E. coli (CFU/yr)	Fecal Coliform (CFU/yr)
30402061001	554	217	2.71E+11	4.30E+11
30402061002	109	43	5.33E+10	8.46E+10
30402061003	1897	744	9.29E+11	1.47E+12
30402070205	445	174	2.18E+11	3.46E+11
30402070206	868	340	4.25E+11	6.75E+11
30402070207	1490	584	7.30E+11	1.16E+12
Total Watershed	**5363**	**2102**	**2.63E+12**	**4.17E+12**

TABLE 22. BACTERIA LOADINGS PER LAND USE (SHAVER, ET. AL 2007)

Table 3-13: Pollutant Loading (kg/ha-yr) Ranges for Various Land Uses								
Land-Use Category		TSS	TP	TN	Pb	In	Cu	FC
Road	Minimum	281	0.59	1.3	0.49	0.18	0.03	7.1 E+07
	Maximum	723	1.50	3.5	1.10	0.45	0.09	2.8E+08
	Median	502	1.10	2.4	0.78	0.31	0.06	1 .8E+08
Commercial	Minimum	242	0.69	1.6	1.60	1.70	1.10	I.7E+09
	Maximum	1,369	0.91	8.8	4.70	4.90	3.20	9.5E+09
	Median	805	0.80	5.2	3.10	3.30	2.10	5.6E+09
Single family Low density Residential	Minimum	60	0.46	3.3	0.03	0.07	0.09	2.8E+09
	Maximum	340	0.64	4.7	0.09	0.20	0.27	1.6E+10
	Median	200	0.55	4.0	0.06	0.13	0.18	9.3E+09
Single family High density Residential	Minimum	97	0.54	4.0	0.05	0.11	0.15	4.5E+09
	Maximum	547	0.76	5.6	0.15	0.33.	0.45	2.6E+10
	Median	322	0.65	5.8	0.10	0.22	0.30	1.5E+10
Multifamily Residential	Minimum	133	0.59	4.7	0.35	0.17	0.17	6.3E+09
	Maximum	755	0.81	6.6	1.05	0.51	0.34	3.6E+10
	Median	444	0.70	5.6	0.70	0.34	0.51	2.1E+10
Forest	Minimum	26	0.10	1.1	0.01	0.01	0.02	1 .2E+09
	Maximum	146	0.13	2.8	0.03	0.03	0.03	6.8E+09
	Median	86	0.11	2.0	0.02	0.02	0.03	4.0E+09
Grass	Minimum	80	0.01	1.2	0.03	0.02	0.02	4.8E+09
	Maximum	588	0.25	7.1	0.10	0.17	0.04	2.7E+10
	Median	346	0.13	4.2	0.07	0.10	0.03	1.6E+ 10
Pasture	Minimum	103	0.01	1.2	0.004	0.02	0.02	4.8E+09
	Maximum	583	0.25	7.1	0.015	0.17	0.04	2.7E+ 10
	Median	343	0.13	4.2	0.010	0.10	0.03	1.6E+ 10

6. WATERSHED PLANNING GOALS

The overarching goal for the WBP for the Waccamaw and Great Pee Dee Rivers is to protect and improve the water quality of the surface waters for sediment, nutrients, and bacteria. The following goals and objectives were established by the stakeholders at the kickoff Meeting in June 2021:

Goal #1 - Improve Surface Water Quality

- Ensure that waterbodies in the Waccamaw and Great Pee Dee Rivers Watershed meet or exceed water quality standards.
- Implement best management practices to improve sediment, nutrients, and bacteria water quality for drinking water, recreational, and aquatic life purposes.

Goal #2 - Protect and Maintain Water Quality

- Work with Horry and Georgetown Counties to improve land use regulations and enforcement to guide new development in a manner that protects waterbodies in the Waccamaw and Great Pee Dee River Watershed.
- Ensure that recreational use in the Waccamaw and Great Pee Dee Rivers is not diminished.
- Coordinate efforts from other groups in the Watershed focused on land conservation and protection strategies.

Goal #3 - Build Community Support for the Protection and Enhancement of Water Resources

- Develop and establish a Waccamaw and Great Pee Dee Rivers Workgroup to oversee WBP implementation, work towards long term health, and ensure that the WBP's goals are achieved.
- Develop an outreach program for citizens and businesses to promote and implement the WBP.

7. IMPLEMENTATION PLAN

The implementation plan for the Waccamaw and Great Pee Dee River Watershed includes BMPs and programmatic measures to reduce nutrients, sediment, and bacteria runoff, as well as protective measures to prevent a decrease in water quality.

BMPs and programmatic measures were identified and evaluated to address the pollutant sources and prioritized during the development of this WBP. A list of BMPs and programmatic measures selected for each source type in the Watershed is outlined in Table 23 and further described in the following sections.

Grant funding may be pursued to provide financial assistance for the installation of BMPs to reduce pollutant loading. Because participation in the implementation program is voluntary, effective outreach and community engagement will be crucial in reaching the appropriate participants. Table 23 and the following sections describe best management practices and programmatic measures and the anticipated level of participation for implementation, which was used to determine pollutant load reductions and costs.

TABLE 23. WACCAMAW AND GREAT PEE DEE RIVERS WATERSHEDS OVERALL ACTION PLAN

Sources	Pollutants			BMPs	Programmatic Measures
	Bacteria	Sediment	Nutrients		
Urban					
Eroding Stream Banks		X		Donated/purchased conservation easement of water quality buffer Purchase parcels with water quality buffer. Streambank stabilization	Water Quality Buffer regulation Workshops and Field Days for Residents and Landowners
Golf Course	X		X	Water Quality Buffer	Educational signs on the importance of water quality buffers Education on Canada geese as a bacteria source Soil test before fertilization Permanent Water Quality Buffers
Waterfowl	X		X	Water Quality Buffer	Ordinance to prevent feeding of wildlife
Pet Waste	X		X	Pet Waste Stations - at public parks, residential neighborhoods, and vet offices/pet stores/pet boarding facilities. Installation of signs in existing subdivisions requiring pet owners to pick up pet waste.	Pet Waste Ordinance Regulation requiring signs requiring picking up pet waste in new subdivisions Pet Owner Education
Fertilizers			X	Storm Drain Markers	Education and Outreach for Landowners and Land Care Companies
Stormwater Management Practices		X		Rain Barrels/Workshops Rain Gardens Storm Drain Markers Bioretention, Stormwater Control Structure Retrofits, Bioswales, Underground Detention, Stormwater Constructed Wetlands, Stormwater Ponds, Permeable Surfaces	Permanent Water Quality Buffers Land Development Regulations Land Conservation Easement Program Stormwater Pond Education Improve Land Development S&EC Inspection/Enforcement Procedures Improve construction inspection/enforcement
Sewer					
Leaking Sewer Lines	X		X		Recycle Used Cooking Oil
Sanitary Sewer Overflows (SSOs)	X		X		FOG Can Lids Educational Door Hangers Inspect/Enforce Commercial Grease Traps

Sources	Pollutants			BMPs	Programmatic Measures
	Bacteria	Sediment	Nutrients		
Septic					
Malfunctioning Septic System	X		X	Repair Septic System Replace Septic System Connect to Sewer	Confirm procedure for Permitting Additional Bedrooms in Georgetown County Education on recycling Used Cooking Oil FOG Can Lids
Agricultural					
Runoff from crop farms	X	X	X	Water Quality Buffer	Landowner lease conditions (buffers, stabilization requirements, etc.)
				Streambank stabilization	
				Cover Crops Conservation Tillage Nutrient Management Plans	Workshops and Field Days for Farmers Education and Outreach
Runoff from Pastures and Horse Hobby Farms	X	X	X	Alternative Water Source/Loafing Shed Cross fencing/Exclusion Fencing Stream Crossing Heavy Use Area Stabilization Manure Composting Manure Management Plans Water Quality Buffer	Landowner lease conditions (buffers, stabilization requirements, etc.) Workshops and Field Days for Farmers Education and Outreach

7.1 Education and Outreach

Community engagement is an essential component of a successful WBP and can be viewed as a non-structural best management practice. Fortunately, the Horry and Georgetown area have a history of educators engaging with the public to create awareness for issues related to stormwater pollution and water quality. Partnerships and collaboration with stakeholders will be key to provide effective community engagement.

A variety of methods will be used to disseminate information to the public, including:

Websites: Individual partner website will be used to promote workshops and other events for target audiences. Websites will also be used to share educational resources, such as factsheets, flyers, and videos.

Social Media: Many of the partners manage Facebook and/or Instagram accounts that can be used to quickly engage the public and promote events.

Mailings: Direct mailings will create a targeted approach to promote behavioral change. For instance, GIS analysis has identified residents on septic systems that could benefit from information relating to septic repair or replacement. Similarly, targeted mailings to homeowners in the vicinity of SSOs resulting from excess FOWG can be target for education.

Factsheets: A variety of water-related topics are covered by Clemson University's Home & Garden Center factsheet series. These factsheets provide information of topics such as rain gardens, bioswales, bioretention cells, riparian buffers, and more and can be accessed at hgic.clemson.edu/category/water/. Factsheets can be distributed at community events or promoted on websites or social media pages.

Workshops: In-person workshops not only promote the use of BMPs such as riparian buffers, rain gardens, and bioswales, they can also be used to install these practices on public property such as parks and recreational areas. Proper instruction during workshops is expected to lead to the installation of BMPs on the private properties of participants.

Individual Approach: Crop farm and livestock audiences may benefit from an individual approach rather than mailings, social media, or website information. Partnering organizations such as NRCS and Clemson Extension have the ability to engage one-on-one to promote agricultural BMPs.

Coastal Waccamaw Stormwater Education Consortium (CWSEC**)**: The CWSEC assists Horry and Georgetown with meeting the requirements for stormwater education and public involvement, detailed in the NPDES General Permit for Stormwater Discharges from Regulation Small MS4s. Many of the targeted pollutants of concern identified by CWSEC align with those of this WBP. Therefore, collaboration with CWSEC to build upon their work would be essential in this WBP.

Specific community engagement activities are identified for individual audiences beginning in the Implementation Plan section of this WBP (Section 7).

7.2 Best Management Practices

Agricultural Sources – Crop Farms

Many of the strategies and BMPs that are planned for croplands will be very similar to those planned for other agricultural sources. The main pollutant loading source addressed will also be pollutant runoff, but in the case of crops farms will be from application of fertilizers and pesticides as well as harvesting practices, as opposed to livestock. Based on past experience with 319 grants, it is anticipated that over a 15-year period, 30% of the 2,867 acres of cropland (880 acres) will participate in implementing BMPs to control for nutrients and sediments. Approximately 180 acres will participate every 3 years over the course of the 15-year implementation period.

Like livestock operations, agricultural stakeholders such as NRCS, SWCD, and Clemson Extension will be asked to assist in reviewing participants' farm operations, assessing their resource concerns, developing conservation plans, recommending and selecting appropriate BMPs, technical specifications, and practice standards, and helping to ensure that BMPs are installed correctly. Photos 36 through 38 are examples of BMPs for crop farms.

Water Quality Buffer & Vegetated Buffers

PHOTO CREDIT: HTTPS://WWW.CTC-N.ORG/PRODUCTS/RIPARIAN-BUFFER

FIGURE 36: WATER QUALITY BUFFER

Water quality or vegetated buffers along waterways have several water quality benefits. The native vegetation captures nutrients and bacteria from manure that would otherwise enter the stream system. Plants not only serve as a physical barrier, they also help remove nutrients via uptake and use nitrogen and phosphorus for growth. Additionally, the buffer will intercept upland erosion and pollutants, allowing them to settle out instead of entering the stream. The deep roots of these native plants will prevent erosion of stream banks and reduce the amount of sediment entering the stream. Riparian buffers also help provide flood control, wildlife habitat, and other valuable ecosystem benefits. Long term maintenance will include:

- Inspect the riparian buffer periodically and protect from adverse impacts such as excessive vehicular and pedestrian traffic, pest or invasive species infestations, concentrated flows, pesticides, livestock or wildlife damage and fire.
- Control concentrated flow, erosion, or mass soil movement in the up-gradient area to maintain riparian function.
- Remove invasive species to allow for native species to thrive.
- Repair and re-seed any areas where sheet, rill, or gully erosion is occurring.
- Replace dead trees or shrubs and control undesirable vegetative competition as needed until the buffer is, or will progress to, a fully functional condition.
- Control and exclude livestock and harmful wildlife.
- Pest management will be conducted in a manner that mitigates impacts to pollinators.
- Any use of fertilizers, pesticides and other chemicals to assure riparian area function shall not compromise the intended purpose nor impact water quality.
- Weed competition may be controlled using mowing and herbicides; however, great care should be taken to minimize negative impacts to pollinator species.

Conservation Tillage

PHOTO CREDIT: GREG LABARGE, OSU EXTENSION

FIGURE 37: RESIDUE COVER FOR CORN

Conservation tillage refers to the system that covers at least 30% of the soil surface with crop residue once planting is completed. This cover reduces soil loss by way of wind and water and promotes biological activity and holding capacity within the soil. Conservation tillage includes no-till, when the soil remains undisturbed, and strip-till, which only disturbs soil where the next crop will be planted. Maintenance will include:

- Terminate cover crops as late as practical to maximize plant growth by rolling (crimping), herbicide, or mowing.
- For best results when rolling/crimping winter cereal rye, terminate during the anthesis stage when

yellow pollen tubes are visible all over the seed heads.

- For best results when mow-killing cereal rye, wait until it has begun flowering. Alternatively, mow rye by late boot stage, before it heads or flowers.
- Do not burn cover crop residue.
- Maximize retention of cover crop residue on the soil surface, to the extent practicable, for soil conservation, including no-till planting through the cover crop or crimping, mowing, or spraying in tractor rows and tilling only in crop rows.
- Any use of pesticides and other chemicals shall be applied following manufacturer's recommendations and all label directions.

Nutrient Management Plans

Nutrient Management Plans are developed by a certified planner to identify and manage the application of nutrients for plant production. The plan details the quantity of nutrients, source, and timing of the application. Adherence to a Nutrient Management Plan will limit agricultural non-point source pollution into nearby waterways, while also improving crop yield.

Cover Crops

PHOTO CREDIT: ZEB WINSLOW, USDA

FIGURE 38: COVER CROP THAT INCLUDES RYE, OATS AND WOOLY POD VETCH

Cover crops can provide multiple benefits in a cropping system. They prevent erosion, improve soil's physical and biological properties, supply nutrients, suppress weeds, improve the availability of soil water, and break pest cycles along with providing various other benefits. See Conservation Tillage above for cover crop maintenance recommendations.

Agricultural Sources - Livestock

Due to the low number of livestock in the watershed, it is anticipated that overall, approximately 100% of

the livestock and horse hobby farms in the Waccamaw and Great Pee Dee Rivers Watershed will participate in projects implementing BMPs for sediment, nutrient, and bacteria reductions, with 20% of these few farms participating every 3 years.

Agricultural stakeholders, such as NRCS, SWCD, and Clemson Extension will be asked to assist in reviewing participants' farming operations, assessing resource concerns, developing conservation plans, technical specifications, and recommending and selecting appropriate BMPs for each participating farm. Grant funding, such as 319 grant and/or EQIP funding, can be pursued to provide cost share assistance for the installation of the appropriate BMPs listed in Table 23 to reduce nutrient, sediment, and bacteria loadings from livestock operations. Grant funding can also address some of the programmatic measures such as public education and a Land Conservation Easement Program.

Figures 39 through 47 are examples of BMPs for farms which as described below will address nutrient, sediment, and bacteria inputs for livestock farms. Table 27 shows the anticipated level of participation for implementation, which was used to determine pollutant load reductions.

Riparian Exclusion Fencing

PHOTO CREDIT: GEORGIA NRCS

FIGURE 39: FENCING INSTALLED TO LIMIT LIVESTOCK ACCESS TO THE STREAM

A livestock exclusion system uses permanent fencing to exclude livestock from streams and critical areas not intended for grazing to improve water quality and stream health. Benefits include reduced soil erosion, sedimentation, pathogen contamination and pollution from dissolved, particulate, and sediment-attached substances. The system includes an alternative water source (typically a well), which also improves livestock health by providing them with cleaner and more reliable water. See Conservation Tillage above for cover crop maintenance recommendations. Long term maintenance will include:

Inspect fence frequently for breaks, broken or dislodged fence posts and bracing. Repair or replace.

- Mow or trim weeds, grass and sprouts along and under the fence lines on a continual basis to minimize grounding of electric. Do not burn weeds or grasses under or around fences as this destroys post and the galvanized coating of the wire and accelerate rusting.

- Inspect signs posted on the fence at least once a year. Replace damaged and illegible signs.
- Check tension in the fence frequently. Repair sags in the fence.
- Inspect fence for loose and lost staples and broken tie wires. Repair or replace as soon as possible.
- Repair or replacement of loose or broken gates and appurtenances at all ingress/egress locations.
- Remove any trees or limbs that may be touching the fence.
- Repair or replacement any markers or other safety and control features as necessary.

Cross Fencing

PHOTO CREDIT: BLOUNT COUNTY

FIGURE 40: CROSS FENCING FOR ROTATIONAL GRAZING

Cross fencing can be used inside a larger fenced area for rotational grazing, to separate animals, or to prevent animals from disturbing wet areas within pastures, creating runoff issues. This type of fencing can portable or permanent and prevents overuse in pastures. See Riparian Exclusion Fending above for maintenance requirements for cross-fencing.

Streambank Stabilization

PHOTO CREDIT: CARMEN AGOURIDIS

FIGURE 41. RIPARIAN BUFFER ALONG A STREAM.

FIGURE 42: BEFORE AND AFTER PHOTOS FROM A STREAM STABILIZATION PROJECT

Streambank stabilization refers to vegetative and/or structural treatment(s) used to stabilize and protect banks of streams, lakes, or other waterbodies to prevent the loss of land and reduce the downstream effects of sediment resulting from bank erosion. Erosion from streambanks can be a significant source of sediment and TSS in surface waters. Long term maintenance includes:

- Inspect periodically—at least annually and immediately following significant rainfall events.
- Promptly repair or replace damaged components and/or erosion of banks.
- See Water Quality Buffer above for maintaining healthy vegetation and controlling undesirable vegetation.

Stream Crossings

PHOTO CREDIT: NRCS

FIGURE 43. STREAM CROSSING LIMITS CATTLE ACCESS TO A WATERWAY

Stream crossings provide a hard, stable area where livestock or equipment can cross streams without damaging the streambed or banks thereby maintaining a higher riparian area/stream quality. They help keep surface water cleaner which can also provide health benefits to animals and crops. Stream crossings with stream bank fencing are cost-effective BMPs that can help protect and improve water quality. Long term maintenance of a stream crossing includes:

- Inspect periodically—at least annually and immediately following significant rainfall events.
- Install and maintain fencing and gates to direct livestock through the crossing and not allow livestock to wander in the stream.
- Maintain riprap and surface material by replacing when necessary.
- Immediately repair any damage caused by vandalism, vehicle traffic or livestock movement.
- Remove debris that accumulates on or near the stream crossing.
- Inspect for barren or eroded areas on or around the stream crossing. Re-seed as necessary

Heavy Use Area Stabilization

FIGURE 44 HEAVY USE AREA STABILIZATION PREVENTS OVERUSE OF LAND

Heavy use area stabilization is the stabilization of areas frequently and intensively used by people, animals, or vehicles by establishing vegetative cover, surfacing with suitable materials, and/or installing needed structures to protect or improve water quality. Long term maintenance includes:

- Inspect periodically—at least annually and immediately following significant rainfall events.
- Promptly repair or replace damaged components, especially surfaces that are subjected to wear or erosion.
- Regularly remove and manage manure, as needed, for livestock heavy use areas.
- Restrict uses, as needed, to protect the stand and to allow vegetative recovery for vegetated heavy use areas.

Loafing Sheds

FIGURE 45: LOAFING SHEDS PROVIDE SHELTER AND SHADE TO LIVESTOCK

Providing alternative shade and shelter to livestock reduces the time spent near stream banks and in sensitive areas. It can also prevent heavy use areas from establishing, which can lead to erosion and impacts to nearby waterways. Long term maintenance includes:

- Inspect periodically—at least annually and immediately following significant rainfall events.
- Replace or repair maintenance coatings on structural steel components as necessary.
- For Shade Structures, maintain the structural and fabric components. Dispose of or recycle worn-out fabric or other nonstructural material as appropriate. Periodically tighten the shade cloth to minimize wind damage. Replace the fabric cover when it has deteriorated due to environmental conditions.
- For Portable Structures, move structures periodically to prevent destruction of vegetation in the immediate area. Re-anchor portable structures following relocation.

Manure Composting

PHOTO CREDIT: RICK MOONEY

FIGURE 46: MANURE COMPOSTING HAS SEVERAL BENEFITS FOR AGRICULTURAL PRODUCERS.

Manure composting has several advantages, including the reduction of manure volume by up to 65%, removal of pathogens from grazing land, and increasing the health and water-holding capacity of soil (M. A. Keena, 2022).

Manure Management Plans

Manure Management Plans guide ranchers and farmers in the application of manure to the land that benefits both the producer and the environment. Proper application reduces impacts to waterways by preventing nutrients and pathogens from leaving the site of application and entering surface and ground water.

Alternative Water Source

PHOTO CREDIT: BRYAN SMITH

FIGURE 47: FREEZE RESISTANT LIVESTOCK TROUGH

Providing alternative water sources can prevent livestock from entering streams and defecating and can also prevent erosion along stream banks as cattle enter and exit streams. Long term maintenance of a watering facility includes:

- Inspect periodically—at least annually and immediately following significant rainfall events. Check for leaks and condition of appurtenances associated with the watering facility.
- Repair or replace damaged components as needed.
- Check the performance of the automatic water level device, if present.
- Ensure that the outlet pipe, if present, is freely operating and is not causing erosion.
- Clean the facility as needed.
- Monitor and maintain the facility to ensure that there is adequate inflow and outflow.
- Repair the facility for winter as dictated by the climate. This may include draining supply pipes, emptying tanks, or ensuring that float valves will not be damaged by ice.
- For a portable facility, make a plan for moving the facility and for monitoring/repair of the areas around the facility.

Barriers to Participation

Because participation in the project is voluntary, and the landowners, particularly farmers, are traditionally somewhat skeptical of interference in their operations, effective outreach will be crucial in reaching the appropriate participants. In cooperation with stakeholders from NRCS, SWCD, and Clemson Extension in Horry and Georgetown Counties, these outreach efforts will strive to incorporate farms affected by improper livestock and/or farming practices into the project. Project partners, such as NRCS, SWCD, and Clemson Extension will assist with recruiting participants for the WBP, and also help to educate farmers on the benefits of BMPs.

Urban Sources

The Waccamaw and Great Pee Dee Rivers WBP targets residential, commercial, and industrial property owners and users to address urban runoff. Examples of the audience for urban runoff education and BMP installation include users of public properties (parks, schools, etc), animal vet/supply stores/boarding facilities, apartment complexes, and residential subdivisions (and their Homeowner Associations (HOAs)) within the Waccamaw and Great Pee Dee Rivers Watershed. A range of participation is anticipated, depending on the urban pollutant source and associated BMP, as is further detailed in Table 27. BMPs installed will only be successful with continued maintenance. All owners of BMPs will be made aware of BMP maintenance needs (e.g., replacement of plants in rain gardens, prohibited use of pesticide in water quality buffers, removal of sediment in bioretention cell drains, etc.). Maintenance agreements will be signed prior to their installation and BMP maintenance specifics will be disseminated to owners upon completion of projects. As stated in Section 2.2, for BMPs using native plants (e.g., bioretention cells, rain gardens, etc.), the use of climate adaptable plants should be considered during plant selection.

The WBP will include and supplement, as needed, programs already being implemented as part of MS4 permit compliance to address nonpoint source reduction from urban stormwater runoff in the urbanized portions of the Watershed. This includes programs and efforts by the Coastal Waccamaw Stormwater Education Consortium (CSWEC) to address nonpoint source pollution in Georgetown and Horry Counties. The following BMPs are recommended to address urban sources of pollution:

Pet Waste Stations & Signs

Pet waste stations with signs could be provided in green spaces located in residential subdivisions, many of which are located in the Collins Creek, Waccamaw River-Atlantic Intracoastal Waterway, and Outlet Waccamaw River-Atlantic Intracoastal Waterway subwatersheds. Other appropriate areas include businesses catering to dog owners, such as Palmetto Dog Wear, Benji's Bed and Breakfast, Shampooches Pet Grooming, and Bark Pet Resort. Approximately 5 miles of Waccamaw Neck Bikeway runs through the Watershed and could also benefit from pet waste station installation (Figure 48). Maintenance includes inspections for damage, refilling bags, and emptying trash.

FIGURE 48: PET WASTE STATIONS ENCOURAGE OWNERS TO CLEAN UP AFTER THEIR PETS

FIGURE 49: THE WACCAMAW NECK BIKEWAY (RED), RUNS FOR 5 MILES IN THE WATERSHED ALONG WAVERLY ROAD, KINGS RIVER ROAD, AND WILLBROOK BOULEVARD

Storm Drain Marking

This WBP includes installation of approximately 1,000 markers on storm drain markers on residential roads within the Watershed. Additional educational outreach will focus on reducing pet waste disposal in and around storm drains (outside of the MS4), will be provided. Several HOA communities would benefit from storm drain marking. For instance, Camden Creek at Allston Plantation lies just 0.5 mile west of the Waccamaw River and residents would benefit from understanding that their storm system drains to the river. Other communities near the river and tributaries include Seasons at Prince Creek, Creek Harbour POA, and International HOA

FIGURE 50. EXAMPLE OF A STORM DRAIN MARKER USED BY THE CWSEC

Permanent Water Quality Buffers

Educational resources can be shared with golf courses to promote water quality buffers around stormwater and recreational ponds and water courses. Golf courses nearest to the Waccamaw River or that contain tributaries to the Waccamaw River will be prioritized (e.g., Caledonia Golf and Fish Club, Litchfield Country Club, Willbrook Plantation, and Tradition Club). Vegetated buffers consisting of native grasses along water courses can mitigate the adverse effects of runoff containing nutrients on streams and rivers. Additionally, selecting a diversity of native species will be chosen to provide genetic diversity to mitigate the effects of climate change.

FIGURE 51: A RIPARIAN BUFFER CONSISTING OF NATIVE PLANTS SURROUNDS SMITH BRANCH IN THE MIDLANDS, SC

Rain Barrel Program/Downspout Disconnect

There are several opportunities to partner with schools to implement best management practices, particularly rain barrel installation and downspout disconnection. Many of the schools found in the Collins Creek and Outlet Waccamaw River-Atlantic Intracoastal Waterway subwatersheds have a large amount of rooftop available to collect rainwater. For instance, Waccamaw High School has more than 3-acres of rooftop (Figure 52). Several other schools in the area (e.g., Waccamaw Elementary and Palmetto Bay Elementary School) have at least two acres of rooftop. Involving schools in BMP implementation also offers educational opportunities to students, teachers, and parents.

Rain barrels can also be provided to residential audiences. This includes hosting a build your own rain barrel workshop, which is a cost-effective approach, or purchasing barrels at low cost through a program like Rain Water Solutions. Both options can also provide educational opportunities about the importance of stormwater BMPs. Additionally, the use of rain barrels to capture stormwater runoff for non-potable uses, such as irrigation, may become increasingly important with climate change. Maintenance of rain barrels includes inspections for leaks and damage and repairs, as needed.

FIGURE 52: WACCAMAW HIGH SCHOOL HAS A VAST AMOUNT OF ROOFTOP AVAILABLE FOR RAINWATER HARVESTING

FIGURE 53: RAIN BARREL PAINTING CONTESTS CAN BE USED TO ENGAGE STUDENTS

Rain Gardens

Rain gardens (on average, approximately 100 sq. ft. in size for ease of maintenance) could be provided at a cost share rate to residential homeowners with grant funding. Rain gardens are installed in low lying areas of the landscape and capture stormwater runoff before it enters the storm drain system or surface waters. They can be an attractive addition to a yard while also providing water quantity and quality benefits. As mentioned in Section 2.2, plant species adapted to extreme rainfall and flooding will be selected to ensure the rain garden continues to function as designed. Additional locations for rain gardens include the dozen or so schools found in the Outlet Waccamaw River-Atlantic Intracoastal Waterway and Collins Creek subwatersheds. For instance, many schools have unused open space that could benefit from rain garden installation that would provide pollution reduction as well as an educational component for schools. Speece Music School has areas of turf grass adjacent to the parking lot that could be used to install rain gardens to capture runoff (Figure 54). Public green spaces (e.g., East Bay and Morgan Park, Waccamaw Regional Recreation Center, and Brookgreen Gardens) could also serve as demonstration areas and allow for the distribution of educational materials to encourage property owners within the Watershed to incorporate rain gardens into their landscape. East Bay and Morgan Park combined have nearly 7 seven acres of open turf grass with few trees. Some areas with naturally low-lying depressions could be used for a community rain garden installation.

In addition to these installations, Clemson Extension offers the Master Rain Gardener program consisting of a multi-week hybrid course culminating in a rain garden and rainwater harvesting installation. Two course tracks are available, one of which is intended for contractors, landscape designers, and other professionals who will install residential-scale rain gardens. This training program is offered annually and can help to expand the knowledge required for rain garden installation.

PHOTO CREDIT: UNIVERSITY OF GEORGIA

FIGURE 54: A RAIN GARDEN INTERCEPTS WATER FROM A PARKING LOT

The Waccamaw Regional Recreation Center has an open area to the southeast that is roughly 0.60 acres of turf grass (Figure 55). A rain garden installation in this area would benefit water quality, wildlife, and

could continually serve as a demonstration site for visitors.

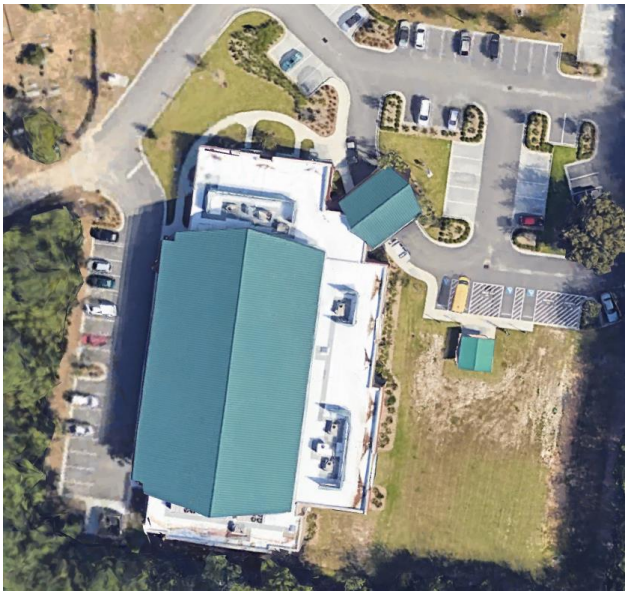


FIGURE 55: THE WACCAMAW REGIONAL RECREATION CENTER

Maintenance of a rain garden includes:

- Inspect periodically, including after significant storm events.
- Water 1 inch per week including rainfall for the first 3 years.
- Water new trees and shrubs weekly until soil at depth of roots is moist.
- Water established rain gardens during summer droughts and unseasonably hot and dry periods.
- Weed regularly, before seeds can spread.
- Mow lawn around rain garden and direct clippings away from the rain garden as they can cause clogging. Do not mow rain garden plants (unless garden is designed to be mowed).
- Clean up trash, organic debris, and pet waste from within and around garden.
- Inspect the rain garden bed for standing water lasting over 48 hours after a heavy rain. This indicates a clogged surface layer.
- Replace plants that are not thriving with approved native plants to maintain ground cover.
- Annuals may also be used to maintain ground cover.
- Remove sediment buildup from inflow structure and any flow channels (including gutters if they are directed toward garden) and from bed of rain garden when it accumulates 1 inch of sediment.
- Cut back perennials and mow tall grasses (removing clippings) in the fall, or early spring (to provide habitat for birds and other wildlife throughout winter).
- Prune trees and shrubs to encourage growth in the spring or fall.
- Repair gullies and any other problems caused by soil erosion in or near the rain garden.
- Stabilize soil if there is erosion on areas draining to the rain garden.

- Cover bare soil with mulch or reseed.
- Fill animal burrows and gently pack if there are any in or around rain gardens.
- Replenish mulch once per year to a depth of 2-3", using shredded non-dyed hardwood mulch.
- Never fertilize rain garden, apply pesticides, or add compost. Fertilizer and compost add nutrients that are not needed.

Bioretention Cells

Bioretention cells could be installed in public areas to temporarily capture and store stormwater runoff before it enters the stormwater system, providing both water quantity and water quality benefits. Before entering the stormwater system, the runoff is filtered through engineered soils that help to remove suspended solids, metals, and nutrients. Examples of areas for bioretention include East Bay and Morgan Park, which have approximately seven acres of land composed of turf grass. This area could be used to install a bioretention cell in low lying areas of the park, which would be functional and also serve as a demonstration site and public education for park visitors. Using not only native, but climate adaptable plants, should be considered during bioretention cell plant selection.

FIGURE 56. A BIORETENTION CELL IN THE CITY OF DURHAM FILTERS RUNOFF FROM THE ADJACENT PARKING LOT

As previously mentioned, several schools in the area have large amounts of impervious surfaces, whether rooftops or parking lots, and would benefit from bioretention cell installation. For example, St. James Elementary and Middle Schools (Figure 57) have more than five acres of roof top and more than seven acres of turf grass combined. Maintenance of bioretention cells includes:

- During the first year, adequate water is crucial to plant survival and temporary irrigation will be needed unless rainfall is adequate until plants mature.
- Prune and weed to maintain appearance.
- Stabilize or replace mulch when erosion is evident.
- Remove trash and debris.

- Mow filter strip.
- Renew mulch to replace that which has broken down into organic matter.
- Replace vegetation whenever percent cover of acceptable vegetation falls below 90 percent or project specific performance requirements are not met. If vegetation suffers for no apparent reason, consult with horticulturist and/or test soil as needed.
- Twice a year, inspect inflow points for clogging (off-line systems) and remove any sediment and inspect filter strip/grass channel for erosion or gullying and sod as necessary.
- Inspect herbaceous vegetation, trees and shrubs to evaluate their health and replanted as appropriate to meet project goals.
- Remove any dead or severely diseased vegetation.
- Inspect and remove any sediment and debris build-up in pre-treatment areas.
- Inspect inflow points and bioretention surface for buildup of road sand associated with spring melt period, remove as necessary and replant areas that have been impacted by sand/salt build up.
- Each spring, cut back and remove previous years plant material and remove accumulated leaves if needed (or controlled burn where appropriate).

FIGURE 57: ST. JAMES ELEMENTARY AND MIDDLE SCHOOLS HAVE AREAS THAT WOULD BENEFIT FROM BIORETENTION CELL INSTALLATION

Bioswales

Bioswales are stormwater conveyance systems that capture the "first flush" of stormwater. A bioswale works to slow down water before it enters a surface water or storm drain system, and also filters pollutants such as sediment and nutrients. East Bay and Morgan Park at the base of the Watershed have areas of erosion and stormwater runoff that could benefit from the installation of bioswales (Figure 58). An additional area to consider includes the Waccamaw Neck Bikeway, which covers 2.3 miles in the Watershed. Bioswales in areas could serve as educational opportunities for recreational users of the trail. One specific area of interest is along Kings River Drive east of the Litchfield Golf Course. At this point, the bikeway crosses drainage from the golf course that flows into the Waccamaw River. Additionally, educational resources in the form of posters or rack cards can be distributed to emphasize the importance of bioswales for stormwater management and water movement across the landscape. Similar to previous BMPs, climate change should be considered when selecting plant species for bioswales to mitigate the effects of climate change. Maintenance of bioswales includes:

- Inspect semi-annually (spring and fall) and after storm event of two inches of rain or more.
- Remove trash and debris on a regular basis.
- Stabilize applicable eroded areas with rolled erosion control products (RECP) or turf reinforcing mats (TRM), as required. If RCEP is applied, it is recommended to use truly biodegradable products to aid in mowing maintenance and deter wildlife entanglement. These products can be recognized as having "BN" for "B" for biodegradable.
- If turf cover is used mow regularly, weekly during summer. Mow lower than six inches to maintain desired design height.
- Remove material that accumulates on the upstream face of the check dams. Remove all vegetation that extends roots within the check dams manually and apply herbicides as necessary to eliminate herbaceous species with persistent roots.
- Where sediment forebays are provided, remove sediments accumulated in the forebay once that are half filled or to the designed depth. A depth marker should be provided in the forebay to guide the inspection requirements. If forebays are not provided, remove visible accumulations of sediment with rake and flat shovel.
- Hire a professional: if ponding is observed; if facility does not drain within 48 hours; replacement of deteriorating pipes or structural component; facility reconstruction; repair of severe erosion; aquatic vegetation control (chemical application) if licensing required by SCDHEC.

FIGURE 58: EAST BAY PARK, LOCATED IN THE CYPRESS CREEK-GREAT PEE DEE RIVER SUBWATERSHED, COULD BENEFIT FROM BIOSWALE INSTALLATION

FIGURE 59: THE WACCAMAW NECK BIKEWAY COULD SERVE AS A DEMONSTRATE SITE FOR BMPS LIKE BIOSWALES

Underground Detention

Underground detention systems consist of tanks and vaults used to reduce peak stormwater flow. Although relatively expensive, this practice can be used when space is limited, such as in highly urban environments.

Constructed Wetlands

PHOTO CREDIT: DRAGONFLY POND WORKS

FIGURE 60: A NEWLY INSTALLED CONSTRUCTED WETLAND IN NORTH CAROLINA

Constructed wetlands are similar to wet ponds. However, constructed wetlands mimic natural wetlands by varying depth and use of vegetation. Native plants are used to remove pollutants as stormwater flows through the post-construction BMP, and plant selection will incorporate future climate change scenarios.

Maintenance of constructed wetlands includes:

- Inspect periodically, including after significant storm events.
- Replant vegetation as needed.
- Mow embankments at least twice a year.
- Remove trash and debris.
- Repair eroded or bare soil areas.
- Check mosquitoes by controlling plant population and water flow into wetland.
- Remove invasive plants.
- Remove selected wetland plant material or replant vegetation (as needed)
- Repair broken mechanical components if needed.
- Complete forebay maintenance and sediment removal when needed.

Permeable Surfaces

PHOTO CREDIT: NORTH CAROLINA COASTAL FEDERATION

FIGURE 61: PERMEABLE PAVING INSTALLATION IN BEAUFORT, NC

Permeable surfaces include permeable pavement, porous concrete, permeable interlocking concrete pavement, and more. These permeable surfaces intercept stormwater and allow it to infiltrate on-site. This practice can be used in parking areas, sidewalks, and other traditionally impermeable surfaces. Low impact development strategies, like using permeable surfaces and other infiltration practices, may help mitigate effects of climate change, as mentioned in Section 2.2.

- Inspect periodically, including after significant storm events and keep maintenance records.
- Periodic vacuuming at least two times per year (end of winter and after autumn leaf-fall, more frequently if needed. Regenerative air vacuum sweepers are the suggested means for regular surface cleaning. For neglected surfaces (i.e., those with no surface cleaning over several years) true vacuum sweepers are more efficient than regenerative air or mechanical sweepers. If a true vacuum sweeper is used, the removed aggregate in the joints should be replaced with the same material.
- Minimize salt use or sand for de-icing and traction in the winter.
- Keep adjacent landscaping areas well maintained to prevent soil from being washed onto the pavement to increase its life.

Stormwater Control Structure Retrofits

Most of the commercial development is found in the Outlet Waccamaw River-Atlantic Intracoastal Waterway subwatershed northwest of Ocean Highway between County Road S-22-759 and Old Plantation Drive. Properties include hotels, car dealerships, and retail stores, some of which were developed prior to stormwater regulation requirements. For example, stormwater retrofits at 9013 Ocean Highway could include permeable pavement installation, bioswales, rain gardens, and shade trees that intercept much of the first inch of rainfall before leaving the property to the north. Other options may include replacing

traditional stormwater ponds with constructed wetlands at the Coastal Chevrolet, Cadillac, and Nissan Dealership. The current area dedicated to stormwater management is approximately 0.25 acres. Constructed wetlands increase flood storage area, improve water quality treatment and infiltration/groundwater recharge, and increase wetland habitat. The site, as well as others with large amounts of impervious surface, would provide benefits to water quality by reducing parking spaces and replacing with infiltration practices. This not only reduces pollutants carried in stormwater runoff; it also helps to maintain temperatures in nearby streams. These stormwater retrofits may increase in importance as coastal communities experience impacts from climate change, and existing BMPs are modified to manage larger storm events. For retrofits such as bioswales, rain gardens, and constructed wetlands, a diverse selection of climate adaptable species will be chosen to mitigate the effects of climate change.

Construction Erosion and Sediment Control

Horry and Georgetown Counties address many urban runoff issues with the construction and post-construction minimum control measures as part of MS4 permit compliance within the Myrtle Beach urbanized area. Much of the Georgetown County area of the Watershed is not urbanized, but strengthened inspections, enforcement of construction sites, and training for inspectors would hold contractors more accountable for meeting the requirements of their Stormwater Pollution Prevention Plans/Land Disturbance Permits. Stop Work Orders are also very effective at getting issues resolved quickly, and they do not cost a municipality anything except time.

Residential Stormwater Ponds

Survey results and public feedback indicate education on stormwater pond function, purpose, and maintenance is needed. It was also noted that preventing sediment buildup in a stormwater pond is a challenge for communities. Excess sediment could be a result of shoreline erosion, especially for communities with oversized fountains that create consistent wave action. Grant funding could provide a targeted outreach program for a public education campaign focusing on proper procedures for inspecting and maintaining residential stormwater ponds. Additional options are to host workshops to enhance shoreline buffers on ponds to protect water quality and prevent sedimentation by way of shoreline erosion. Several HOA communities have a substantial amount of stormwater pond shoreline. For example, The Lakes located in the Collins Creek subwatershed, has more than 5 miles of stormwater pond shoreline throughout the community, none of which has a vegetated buffer. Another priority community is Camden Creek at Allston Plantation, which contains 1.1 miles of unbuffered shoreline and is 0.5 miles east of the Waccamaw River (Figure 62).

Fortunately, programs currently exist to enhance public knowledge of stormwater ponds. For instance, the Healthy Pond Series and Stormwater Pond Conference offered by Clemson Extension and Sea Grant provide homeowners and professionals with the most recent and relevant information to ensure proper maintenance and care for stormwater ponds. Grant funded has the potential to support these programs. Maintenance of a detention pond includes:

- Inspect periodically, including after significant storm events, including outfall.

- Remove debris and litter.
- Manage vegetation to prevent erosion. Re-seed any barren or eroded areas which have developed.
- In the spring, remove decomposing vegetation if it is clogging pipe openings.
- Sediment removal to maintain design capacity of pond.
- Inspect for potential structural failure in the basin embankment or outlet structure. If any of the following conditions are observed, advice from a professional engineer should be obtained immediately: landslides on the embankment, cracks in the embankment or spillway, discharge of water through the downstream face of the embankment, or continuous ponding days after the end of a rainfall.

FIGURE 62: MANY HOA COMMUNITIES CONTAIN STORMWATER PONDS THAT HAVE NO WATER QUALITY BUFFER TO PREVENT SHORELINE EROSION

Septic Tank Sources

This WBP targets septic system owners with failing systems for septic tank maintenance, upgrade, or sewer connection. These repairs would be provided for the estimated 172 failing septic systems in the Watershed. Also, educational material on proper maintenance activities and frequency would be provided, as well as lids for proper FOG disposal. Figure 34 shows areas highly concentrated with septic systems.

7.3 Programmatic Measures

Along with implementing best management practices such as the ones outlined above, there are

programmatic measures which can help protect pollutant loadings entering the Waccamaw and Pee Dee Rivers and their tributaries from urban sources, such as focusing on future development regulations.

Regarding potential programmatic measures for future development, from the urban brainstorm session and survey, the following ideas were deemed most feasible to the municipalities within the subwatersheds:

Permanent Water Quality Buffers

Georgetown and Horry Counties could adopt permanent water quality buffers (riparian buffers) in their land development regulations. Currently, the only water quality buffers required in these municipalities are the 30-foot temporary buffers required by the NPDES General Permit for Storm Water Discharges from Construction Activities SCR100000 (Construction General Permit).

Without buffers, homes and residential neighborhoods can contribute sediment, bacteria, fertilizers, pesticides, metals, oil and other vehicle fluids, pet waste, and many other pollutants to nearby waters. In addition to stabilizing stream banks with their root systems the shade provided by buffers discourages algal growth and regulates water temperature while also providing leaf litter input and woody debris for aquatic habitat. This aquatic habitat benefits organisms such as dragonflies, which consume nuisance insects (e.g., mosquitoes).

As an example and reference, Lexington County, SC has implemented permanent water quality buffers around streams, shorelines and wetlands. Lexington County requires a 100-foot buffer on all perennial streams and 50-foot buffer on all intermittent streams. Stream buffers cannot be disturbed during project construction and must be left in existing conditions upon completion of the construction activities. The area associated with a stream buffer may be dedicated to the County, turned over to a Homeowners Association, or included as part of a conservation easement. For shorelines, Lexington County requires a 50-foot buffer along shorelines associated with ponds and lakes that are fed by springs or streams. Lastly, Lexington County requires a 50-foot buffer around wetlands associated with a stream and those not associated with a water body. The buffer is measured from the edge of the delineated wetland area. See Appendix C for Lexington County's buffer brochure.

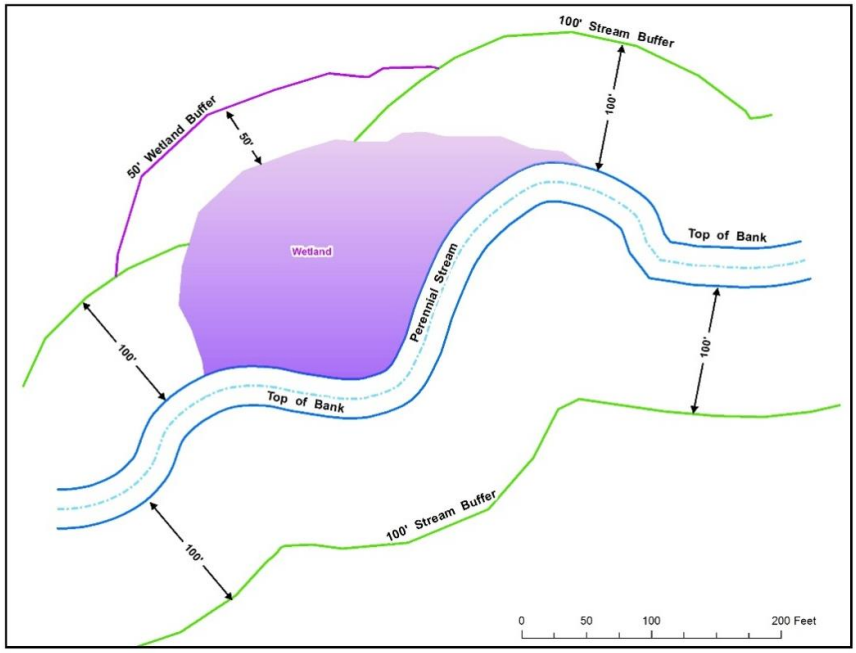


FIGURE 63. VISUAL EXAMPLE OF THE PERMANENT BUFFER REQUIREMENTS FOR LEXINGTON COUNTY

Water quality buffer requirements (and other regulations) could be adopted county-wide or in the Watershed only, such as an overlay district. Buffers will be most effective if all jurisdictions in the Watershed adopt the same requirements, but any stream and wetland protection in the subwatersheds will benefit water quality.

It is important to note that water quality buffers apply to development but do not typically address agricultural uses. See the following "Land Conservation" section regarding voluntary opportunities to preserve land such as aquatic buffers which may apply to agricultural land.

Land Conservation

Land conservation is a tool to help protect water quality by permanently protecting existing lands from future development and related environmental impacts. It can include both land acquisition and protection through conservation easements. Conservation easements are legal agreements between a landowner and a non-profit land trust or public agency (qualified to hold such interests) that limits uses of the land while offering private landowners flexibility in managing their land. By restricting development in key areas, easements provide a variety of ecosystem services that benefit people and nature such as cleaner water (resulting in less treatment costs), floodwater storage, recreation, and healthier habitats. Preserving land, particularly in riparian buffer areas, will also help mitigate the effects of climate change. The land trust is responsible for monitoring the easement and enforcing its terms, including annual monitoring visits. Landowners benefit from granting conservation easements to a qualified holder through cash payments or state and federal tax incentives associated with the easement value. Easements can be donated or sold at fair market value to another entity including land trusts, and local, state, and federal agencies. The WBP includes potential 319 grant funding to develop a land conservation easement program in the Watershed

in cooperation along with project partners. American Rivers, The Nature Conservancy, and Pee Dee Land Trust, developed a map of high value lands for protection of water quality in the Watershed. The map (Figure 65) was developed using a GIS model called the Watershed Management Priority Index (see Thrive Watershed Management Index and Article Watershed Forest Information System) which analyzes landscape characteristics (e.g., soil erodibility, land cover, slope etc.) that impact water quality. The model contains several sub-indexes that identify priority lands based on land cover classes to help decision-makers determine appropriate interventions to maintain or enhance clean water values. The Conservation Priority Index (CPI) is a sub-index that identifies high priority forested lands that can be protected through land conservation.

Figure 65 highlights areas in the Watershed identified as priority for protecting and enhancing water quality in the Waccamaw and Great Pee Dee Rivers Watershed. Lands that are currently protected are shown but are excluded from the CPI prioritization. This map can be used to identify priority parcels for land conservation within the designated source water protection area for Georgetown County Water and Sewer District. An estimated 39,815 acres of land are considered priority areas by The Nature Conservancy. Approximately 64% (25,469 acres) of land in the Watershed is ranked Priority 1 for conservation, 30% (12,057 acres) is Priority 2, and 6% (2,289 acres) is Priority 3. See Appendix G for details about a proposed establishment of a Clean Water Fund to help safeguard drinking water sources by protecting forests bordering rivers and streams, utilizing a State Revolving Fund loan. This Clean Water Fund could potentially be supplemented by a 319 grant to help develop the Land Conservation Program.

PHOTO CREDIT: GATES ROLL

FIGURE 64. PROTECTED PROPERTY ALONG BLACK RIVER

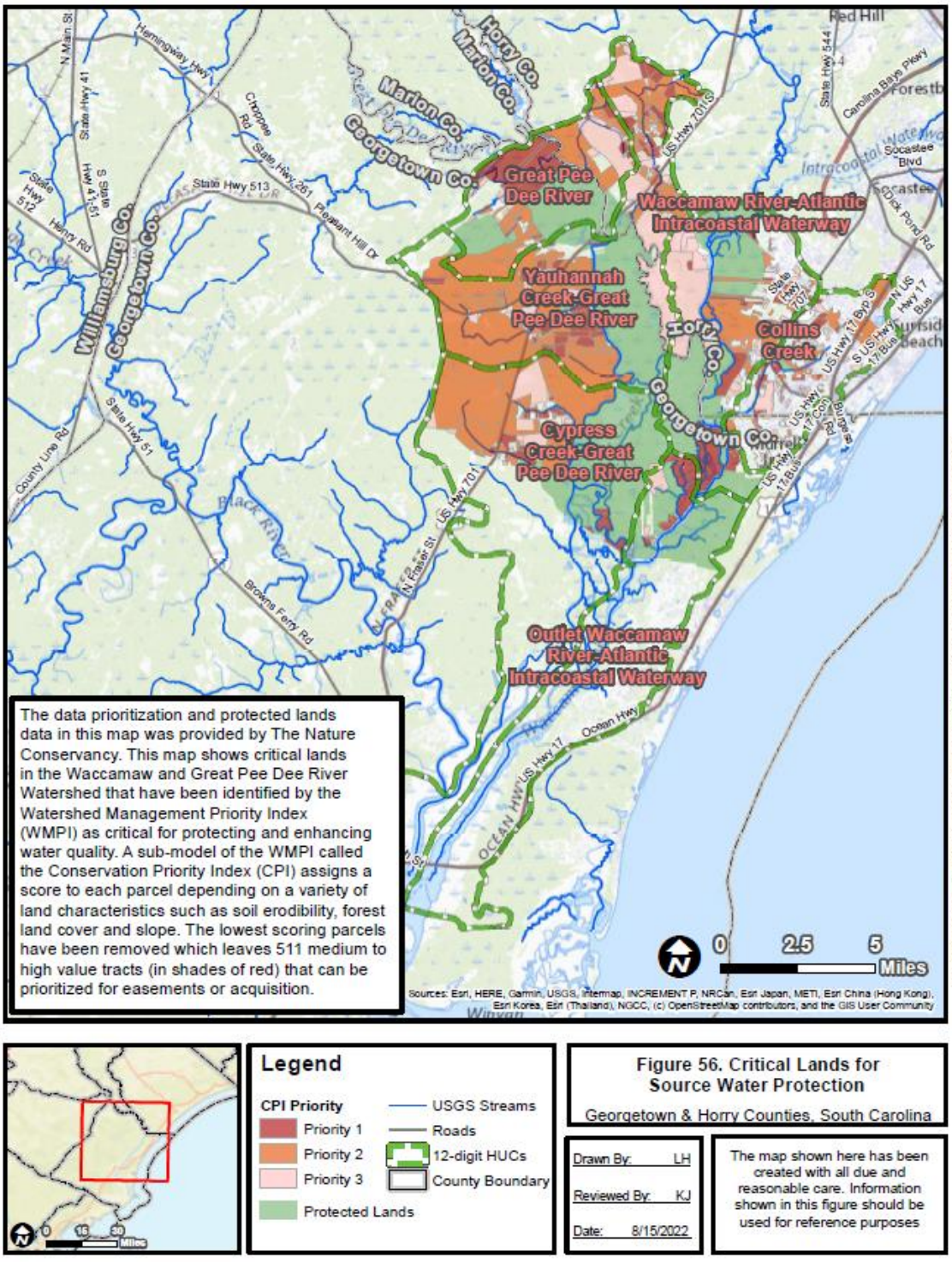


FIGURE 65: PRIORITY CONSERVATION AREAS RANKED BY THE NATURE CONSERVANCY[10]

[10] See Appendix A for larger figure.

Better Site Design

Better site design, or low impact development uses stormwater practices that are more similar to natural processes of the site and works with what is naturally available. This includes the preservation of natural areas such as riparian buffers, using low impact development, and enhancing existing drainage areas and patterns. Better site design will help mitigate effects of climate change as temperatures warm and precipitation patterns change. For instance, site design incorporating canopy cover will provide shade in open spaces as temperatures rise. Similarly, permeable paving may reduce runoff as the intensity of storms increases.

Pet Waste Ordinance

Horry County has a pet waste ordinance requiring owners to remove pet waste or risk fine or jailtime. Georgetown County has yet to adopt such an ordinance, though adoption of a Pet Waste Ordinance (see example in Appendix F) could help prevent pollutants from future pet waste as the Watershed becomes more urbanized.

Impervious Surface Limitations

Research shows that streams become adversely affected when impervious surface reaches 10% or more of land cover (New Hampshire, 2007). Streams in watersheds with 25% imperviousness are more likely to be unable to support aquatic life. Local jurisdictions could consider regulations to encourage limitations to impervious surfaces with new development.

Stormwater Control Structure (SCS) Inspections

Increasing inspection frequency of SCSs (e.g., detention ponds, stormwater retention ponds, swales, etc.) can help reduce the number of SCSs not functioning properly. If a SCS is not functioning properly, stormwater runoff is not being treated on site and can lead to water quality degradation downstream. The MS4 permit requires a County to inspect SCSs in the MS4 at least once each permit cycle, but the SCS owner is supposed to conduct an annual inspection and maintain as needed. Enforcement of the annual inspection throughout the Watershed (or throughout the County) would help improve water quality.

Sewer Sources

Similarly to septic homeowners, the residents and commercial customers of the GCWSD and GSWSA would be the target audience of a public education campaign to eliminate FOG in the sewer systems. Priority would go to properties upstream of most frequently occurring SSOs.

The current load from sewer sources in the Watershed are generally attributed to sanitary sewer overflows and/or potential leaks in sewer lines. These potential leaks are addressed by the GSWSA and GCWSD and are not being addressed by this WBP aside of the inclusion of the Capital Improvement Projects planned by GCWSD and GSWSA. SSOs are intermittent issues that will be addressed by this WBP through preventative actions (see Table 26).

As with the other components of this grant project, participation is voluntary and will be accomplished through social marketing and focused BMP strategy. The BMPs selected for this component include:

- Using outreach tools within the Watershed to advertise the project and recruit homeowners for participation.
- If grant funding is obtained, use educational door hangers similar to those used by wastewater treatment utilities.
- Create an educational public service announcement on how to properly dispose of FOG, similar to the one created for 12 Mile Creek Watershed in Lexington County, SC: https://www.youtube.com/watch?v=cBenOMxsz1g. Additionally, CWSEC created a video in 2020 through the Carolina Clear program to similarly address FOG:

  https://www.clemson.edu/extension/carolinaclear/what_you_can_do/restaurant_owners.html

- Parts of the Watershed, such as the Outlet Waccamaw River-Atlantic Intracoastal Waterway and Collins Creek subwatersheds, are highly urbanized and are likely to have the most restaurants benefiting from a FOG management program. This would include proper grease trap maintenance and proper disposal of used cooking oil to help to prevent SSOs. Both GSWSA and GCWSD have adopted a DHEC approved Sewer Use Ordinance (SUO). This SUO gives both entities the ability to require special customers (i.e. food establishments, schools, etc.) to use grease traps, require that grease traps are properly maintained, and inspect grease traps. Pumping stations are inspected for elevated levels of grease and, if necessary, allows GSWSA and GCWSD to take enforcement action if warranted.
- Grant funding could be used to distribute promotional FOG Can Lids (see photo below) to residents to encourage the practice of not pouring fats, oils, and grease down the drain. These FOG lids fit most food cans from 3 ounces to large family size cans. As well, promotional/educational FOG slogans and instructions can be printed on the lids.

FIGURE 66.PROMOTIONAL FOG CAN LID EXAMPLE

Septic Sources

All homeowners and businesses whose septic system is in need ofneeds repair and/or replacement within the Watershed area will be targeted for outreach efforts. Based on the available information, approximately 1,724 septic systems are located in the Watershed, with an estimated 172 septic systems that are failing. It is anticipated that with grant funding, 100% of the estimated 172 failing septic systems would be addressed. Approximately 34 septic tanks would be repaired, replaced, or connected to sewer every three years for a total of 15 years. The grantee would work with experienced SCDHEC personnel, local organizations, and septic tank contractors to target historic problem systems and problem areas. Based on sewer information gathered, areas to target will include septic systems on soils with poor infiltration (HGS C and D, see Figure 2) and parcels believed to be on septic within the floodplains of the Waccamaw and Great Pee Dee Rivers. Lexington County, SC has developed a process as part of the Congaree Creek 319 project, for recruiting, informing and approving participants, properly documenting costs and reimbursements, and screening and contracting with local septic tank contractors for a successful program, which will be useful for implementation of this WBP.

Wildlife Sources

It is estimated that with grant funding, ten wild hog traps would be distributed in the Watershed based on known densities that are nearest water sources. Every three years two traps would be distributed to volunteers willing to install traps on their property. Resident Canada geese are also of concern in the Watershed, though population estimates were unable to be made. This source of bacteria and nutrients will be addressed through the installation of water quality buffers because this riparian vegetation discourages the geese from entering the water along the shorelines and banks. It is anticipated that with grant funding, riparian buffers would be installed in the most urban watersheds (104 acres total), especially areas with golf courses as the primary land use. Educational signs would also be installed with grant funding at public parks to prohibit the feeding of Canada geese (Figure 67).

FIGURE 67. EDUCATIONAL SIGNS ENCOURAGING THE PUBLIC NOT TO FEED GEESE

FIGURE 68. WILD HOG TRAPS WILL BE SET IN AREAS MOST FREQUENTLY DISTURBED BY HOGS

7.4 Milestones

The goal of this WBP is to reduce pollutant inputs into the Waccamaw and Pee Dee Rivers and their tributaries so that drinking water quality and recreational opportunities are not adversely affected, ultimately preserving quality of life for residents of the Watershed. Suggested BMPs and educational programs will reduce the amount of nitrogen, phosphorus, sediment, and bacteria making its way into the Watershed. Table 24 shows the anticipated milestones for a 3-year grant. This will then be repeated five times for a total of 15 years of grant implementation. Table 26 provides details on estimated costs associated with each BMP and programmatic measure throughout each 3-year grant period.

Table 24: Milestones for the Waccamaw and Pee Dee River Watershed Based Plan IN 3-YEAR INCREMENTS

			Year		
Target Area		Action Item	1	2	3
Crop Farms		Send out targeted mailings to landowners	X		
		Host field days and workshops to futher promote installation of BMPs	X		
		Implement BMPs on ~570 acres (water quality buffer/streambank stabilization, intercropping, cover crops, conservation tillage, conservation/fertilizer & pesticide plans)		X	X
Livestock Farms		Send out targeted mailings to landowners	X		
		Host field days and works to futher promote installation of BMPs	X		
		Implement BMPs on one farm or 3 acres (havey use stabilization area, conservation/manure magement plans, water quality buffer, streambank stabilization, stream exclusion fencing, alternative water source, loafing shed, cross fencing, manure composting)		X	X
Septic		Send out targeted mailings to septic owners using GIS analysis	X		
		Distribute educational material and FOG can lids (130) at local events and County offices	X		
		Collect used cooking oil at local recycling centers	X	X	X
		Provide service to 34 septic tanks through repair, replace, or connecting to sewer		X	X
Sewer		Send out targeted education mailings to areas where FOG related SSO have occurred	X		
		Distribute educational material and FOG can lids (130) at local events and County offices	X		
		Collect used cooking oil at local recycling centers	X	X	X
Urban	Pet Waste	Revise the pet waste ordinance	X		
		Distribute education material at events and local veterinarian offices	X	X	X
		Install 3-4 pet waste stations	X	X	X
	Fertilizers	Host storm drain marking workshops with local groups (300 markers)	X	X	X
	Stream Banks	Promote the use of riparian buffers and streamside vegetation through distribution of education material	X	X	x
		Work with local partners to identify areas for streambank stabilization and resotration projects	X		
		Complete streambank stabilization/restoration projects (~600 LF)		X	X
		Acquired donated/purchased conservation easements of water quality buffers		X	X
	Development	Work with local government to implement permanent water quality buffer	X		
		Host training workshops for S&EC inspectors	X		
		Develop/refine enforcement procedures	X		
	Stormwater	Implement land conservation program	X	X	X
		Host rain garden workshop for homeowners	X		
		Install rain gardens at public parks and recreational areas		X	X
Wildlife	Wild Hogs	Install BMPs at at public parks and recreational areas (bioretention, stormwater control structure retrofits, bioswales, underground detention, stomwater		X	X
		Host workshops and distribute educational materials for hunters	X		
	Canada Geese	Provide wildlife traps (5)		X	X
		Install educational signs to discourage feeding Canada Geese	X		

TABLE 25: PROJECT COST FOR BMPS TO BE IMPLEMENTED IN THE WACCAMAW AND GREAT PEE DEE RIVERS WBP

Sources	BMPs		Years 1 - 3	Years 4 - 6	Years 7 - 9	Years 10 - 12	Years 13 - 15	Preventative Measures	Years 1 - 3	Years 4 - 6	Years 7 - 9	Years 10 - 12	Years 13 - 15
Agricultural													
Livestock Farms (Total of 15 acres))	Examples: Heavy Use Area Stabilization, Conservation/Manure Management Plans, Water Quality Buffer, Streambank Stabilization, Stream Exclusion Fencing, Alt. Water Source, Loafing Shed	Livestock Farms 1 - 15	$ 171,618					Workshops/Education/Materials	$5,000	$5,000	$5,000	$5,000	$5,000
		Livestock Farms 16 - 24		$ 171,618									
		Livestock Farms 25 - 33			$ 171,618								
		Livestock Farms 34 - 41				$ 171,618							
		Livestock Farms 41 - 49					$171,618						
Crop Farms (Total 2,867 acres)	Examples: Water Quality Buffer, Streambank Stabilization, Vegetated Cover Between Rows, Cover Crops, Conservation Tillage, Conservation/Fertilizer & Pesticide Plans	Crop Farms 1 - 5	$ 171,618					Landowner lease conditions (buffers, stabilization requirements, etc)	X				
		Crop Farms 6 - 17		$ 171,618									
		Crop Farms 18 - 28			$ 171,618			Workshops/Education/Materials	$5,000	$5,000	$5,000	$5,000	$5,000
		Crop Farms 29 - 39				$ 171,618							
		Crop Farms 40 - 50					$171,618						
Septic													
Malfunctioning septic system (Total 172 failing systems)	Examples: Repair septic system, replace septic system, connect to sewer	Septic Systems 1 - 34	119,000					Procedure for Adding Bedrooms	X				
		Septic Systems 35 - 69		$119,000				Acceptable septic system letter		X			
		Septic Systems 70 - 104			$119,000			Education/Materials		$5,000	$5,000	$5,000	$5,000
		Septic Systems 105 - 139				$119,000		Recycle Used Cooking Oil		$1,000			
		Septic Systems 140 - 172					$119,000	FOG Can Lids (2000 lids)	$400	$400	$400	$400	$400
Sewer													
Leaking sewer lines								Recycle Used Cooking Oil		$1,000			
Sanitary Sewer Overflows (SSOs)								FOG Can Lids (500 lids)		$100	$100	$100	$100
								Education/Materials		$5,000	$5,000	$5,000	$5,000
								Inspect/Enforce Commercial Grease Traps in Georgetown County	X	X	X	X	X
Urban													
Dirt Roads and Eroded Embankments	Examples: Straw Waddles, Check Dams, Sediment Traps	Miles of Dirt Roads 1 - 17		$ 9,979				Education/Workshops/Materials	$10,000	$10,000	$10,000	$10,000	$10,000
		Miles of Dirt Roads 18 - 36			$ 9,979			Pet Waste Ordinance Revision		X			
		Miles of Dirt Roads 37 - 54				$ 9,979		Permanent Water Quality Buffers		X			
		Miles of Dirt Roads 55 - 71					$ 9,979	Post Construction BMP Design Manual, per municipality		$100,000	$100,000	$100,000	
Pet Waste	Pet waste stations	Pet Waste Stations 1 - 10		$ 1,200				Set Up Land Conservation Program	$ 30,000				
Fertilizers	Storm Drain Tagging	Storm Drain Markers 1 - 1000		$ 2,000				Implement Land Conservation Program	$1,056,482	$1,056,482	$1,056,482	$1,056,482	$1,056,482
Development	Rain Barrel Workshops	Rain Barrels 1 - 60	$4,500					Improve S&EC inspection/enforcement procedures, Training Workshops	$10,000				
		Rain Barrels 61 - 120		$4,500									
		Rain Barrels 121 - 180			$4,500								
		Rain Barrels 181 - 240				$4,500							
		Rain Barrel 241 - 300					$4,500						
	Rain Gardens	Rain Gardens 1-5	$300	$300	$300	$300	$300						
	Bioretention Cells	Bioretention Cells 1-5	$300	$300	$300	$300	$300						
Wildlife													
Wild Hogs	Wild Animal Traps	Traps 1 - 10		$ 4,300				Education/Workshops/Materials	$10,000	$10,000	$10,000	$10,000	$10,000
TOTALS:			**$ 467,336**	**$ 484,815**	**$ 477,315**	**$ 477,315**	**$477,315**		**$1,126,882**	**$1,198,982**	**$1,196,982**	**$1,196,982**	**$1,096,982**

*This budget is an estimate for a 15-year plan, which is dependent upon funding availability. Grant funding will be an integral part of the stakeholder's ability to implement this WBP.
*Note that this 15-year plan does not include implementation of conservation BMPs for all farms. Implementation of BMPs on agricultural properties is voluntary and therefore may not reach 100% participation.

TABLE 26. ESTIMATED PROJECT COSTS DURING YEARS 1-15 BY 3-YEAR PERIODS

Budgeted Year	Cost
Years 1-3	$3,217,116
Years 4-6	$3,296,716
Years 7-9	$3,287,216
Years 10-12	$3,277,216
Years 13-15	$3,177,216
TOTAL Years 1-15	$16,255,481

Reference Table 25 for the cost of individual projects and BMPs.
Note that the BMPs driving the cost are the stream restoration and land conservation program.

8. MEASURES OF SUCCESS

8.1 Monitoring Plan

Monitoring in the Watershed is carried out by SCDHEC, Coastal Carolina University's River Gauging Monitoring Program, and Coastal Carolina University's Volunteer Water Quality Monitoring Program.

SCDHEC

SCDHEC monitoring station RS-06013 is listed as impaired for not meeting water quality standards for *E. coli*. However, because this site is an Ambient Surface (Random) monitoring station, data were taken monthly in for one year in 2006. The WBP recommends establishing a fixed monitoring location at this site to track any progress made through BMPs and programmatic measures within the WBP. Current fixed monitoring stations for 2022 include MD-138, MD-142, and MD-275.

Coastal Carolina University

Many of the River Gauging and Volunteer Water Quality Monitoring Program stations are located along the eastern portion of the Watershed. It is recommended that monitoring locations be established in the Cypress Creek-Great Pee Dee River and Yauhannah Creek-Great Pee Dee River subwatersheds to capture elevated levels resulting from more rural land use, such as livestock operations, crop farms, and forestry activities. Monitoring downstream of BMP installations could also be used to estimate water quality improvements from reduced impervious surface, retrofits, water quality buffers, and other BMPs. Monitoring can be targeted to the pollutant of interest.

Drinking Water Monitoring

Both GCWSD and GSWSA monitor multiple parameters, including turbidity, as water enters their respective treatment facilities along the Waccamaw River and Bull Creek. Additional parameters monitored by GCWSD and GSWSA can be viewed at www.gcwsd.com/water-quality-report and www.gswsa.com/water-quality-reports.cfm, respectively.

Microbial Source Tracking

In addition to bacteria monitoring, Microbial Source Tracking (MST) can identify the source of elevated bacterial levels. Private and public laboratories offer this tool, and markers can identify a multitude of bacterial sources, including beaver, geese, humans, and domesticated animals. Identifying the source of bacteria can not only allow for proper selection of BMP, but it can also help educators select the audience that would benefit most from the education. For instance, identification of *E. coli* from dogs would result in outreach efforts geared toward pet owners.

8.2 Loading Sources

Evaluation Method

In addition to evaluation of monitoring data proposed above, the success of this WBP, per source, will be evaluated based on the following criteria as defined for each source:

Agricultural Sources

1. Crop Farms
    - The quantity of crop farmers within the Watershed who participate in outreach initiatives
    - The quantity of crop farm owners who develop conservation plans
    - The quantity of BMPs that are implemented at crop farms
    - The quantity of landowners that update their lease conditions
2. Livestock Farms
    - the quantity of livestock/horse farmers within the Watershed who participate in outreach initiatives
    - the quantity of livestock/horse farms who develop conservation plans
    - the quantity of BMPs implemented at livestock/horse farms

Follow-up surveys may be conducted to determine if there has been a change in attitudes, knowledge, and future conservation efforts regarding agricultural practices.

Urban Sources

- the quantity of illicit discharges reported to the counties and DOT
- The acres of land within land conservation easements
- Improvements in post-construction stormwater regulations
- The quantity of watershed/stream signs installed
- The quantity of citizens who participate in outreach activities
- the quantity of pet waste stations installed
- the quantity of marked storm drains
- the quantity of urban stormwater controls installed

- the quantity of rain barrels distributed/voluntarily installed
- the quantity of rain gardens incorporated in the Watershed
- the quantity of counties that adopt permanent water quality buffers
- the length in linear feet of water quality buffer installed
- the quantity of municipalities that participate in revising their post-construction stormwater design methodologies

Follow-up surveys may be conducted to determine if there has been a change in attitude, knowledge, and future conservation efforts regarding practices.

Sewer Sources

The quantity of participants within the Watershed that receive Promotional FOG Can Lids
The quantity of used cooking oil collected at the County recycling facilities
The measured reduction in the number of reported SSOs
the number of private commercial properties that participate in outreach initiatives

Follow up surveys may be conducted to determine if there has been a change in attitudes, knowledge, and disposal methods for FOG.

Septic Sources

The quantity of failing septic systems that are repaired, replaced, or connected to sewer
The quantity of used cooking oil collected at the County recycling facilities
The quantity of participants within the Watershed that receive Promotional FOG Can Lids
the quantity of municipalities that adopt an Acceptable Septic System Letter
the number of counties properly enforcing septic permits for bedroom additions

Follow up surveys may be conducted to determine if there has been a change in attitudes, knowledge, and maintenance requirements for septic systems.

Anticipated Load Reductions

It is important to note that implementation of BMPs on private properties, particularly agricultural, is voluntary.

Agricultural – Livestock and Horse Hobby Farm Sources

Based on calculations using the anticipated participation in the WBP and estimated nitrogen, phosphorous, sediment and bacteria loadings from livestock, the load reductions for nutrients (nitrogren and phosphorous), sediment and bacteria were estimated. Note that this 15 year WBP does not include implementation of conservation BMPs for all farms. Implementation of BMPs on agricultural properties is voluntary and therefore may not reach 100% participation. It was assumed two out of three farms would participate after 15 years of implementation and the BMPs would reduce the load on average at participating farms by 40%. The following load reductions are expected with a combination of several livestock BMPs, including stream exclusion fencing, streambank stabilization, and manure management plans: 32 lb/yr of nitrogen, 2.4 lb/yr of phosphorus, 0.1 tons/yr of sediment, and 2.8 E+11 CFU/yr of *E. coli*. Table 27 provides details of the estimated load reduction calculations to the Waccamaw and Great Pee Dee Rivers Watershed from proposed BMPs during years 1 through 15.

Agricultural – Cropland Sources

Based on calculations using the anticipated participation in the WBP and estimated nitrogen, phosphorous, sediment and bacteria loadings from crop farms, the load reductions for nutrients (nitrogen and phosphorous), sediment and bacteria were estimated. As mentioned above, this 15-year WBP does not include implementation of conservation BMPs for all farms, as participation is voluntary. It was assumed 30% participation. From cropland BMPs installed, including cover crops, water quality buffers, streambank stabilization and conservation tillage, it is estimated that 3,532 lbs of nitrogen/yr, 558 lbs of phosphorous/yr, and 125 tons of TSS/yr will be reduced in the Waccamaw and Great Pee Dee Rivers Watershed by this WBP. Table 27 provides details of the estimated load reduction calculations to Waccamaw and Great Pee Dee Rivers Watershed from proposed BMPs during years 1 through 15.

Urban Sources

Reduction of sediment, nutrient and bacteria loadings from urban runoff is anticipated to be achieved from installation of several different BMPs including bioretention cells and water quality buffers. See Table 27 for the full list of BMPs and associated pollutant load reductions.

Bioretention

For load reductions from bioretention, the following assumptions were made in order to estimate load reduction:

Bioretentions installed will be an average of 4,800 square feet
Bioretention cells will be sized as 4% of the area draining to the BMP
On average, the bioretention cell will drain 1 acre.

It is estimated that that 361 lbs of nitrogen/yr and 107 lbs of phosphorous/yr will be reduced in the Waccamaw and Great Pee Dee Rivers Watershed through the installation of five bioretention cells predominantly in the three most urban watersheds. STEPL assumes a runoff capture depth of 0.5 inches.

Water Quality Buffers

For this WBP, water quality buffers are installed to filter pollutants from runoff while also detering nuisance Canada geese. Calculations from STEPL show 336 lbs of nitrogen/yr, 59 lbs of phosphorus/yr, and 15.8 tons of sediment/yr removed by water quality buffers, assuming they are added to 1% of the urbanized land.

Golf course land use accounts for approximately 1,000 acres in the watershed. Research estimates an average of 60 lb/acre of nitrogen and 18 lbs/acre of phosphorus are found in golf course runoff (Payton et al 2006). Although pollutant load estimates and reductions were not included for stormwater runoff from golf courses, research shows that inputs of nutrients into surrounding waterbodies can be mitigated by moderate increases in buffer height. For instance, a graduated buffer as short as 2 inches was able to limit nitrogen and phosphorus by 17% and 11%, respectively (Payton et al. 2006). Outreach and education on the importance of buffers will be disseminated to golf course management.

Table 27 provides details of the estimated load reduction calculations to Waccamaw and Great Pee Dee Rivers Watershed from proposed BMPs during years 1 through 15.

Sewer Sources

Since the proposed BMPs addressing sewer leaks and sanitary sewer overflows for this WBP are all preventative measures, no load reductions were calculated.

Septic Sources

For this WBP, it is anticipated that participation from all of all the estimated 172 failing systems will be accomplished with septic repairs/replacements or connecting to sewer. Based on a calculation using the anticipated participation for septic repairs/replacements (100%) and estimated loading from failing septic systems, it is estimated that 5,362 lbs of nitrogen/yr, 2,103 lbs of phosphorous/yr, and 4.17 E+12 CFU/yr will be reduced in the Waccamaw and Great Pee Dee Rivers Watershed by this WBP. These estimates anticipate that septic repairs/replacements will treat pollutants completely (100%). See Table 27 for more details of the estimated load reductions to the Watershed from proposed BMPs during years 1 through 6.

TABLE 27. ESTIMATED LOAD REDUCTIONS TO THE WACCAMAW AND GREAT PEE DEE RIVERS WATERSHED FROM PROPOSED BMPS DURING YEARS 1-15

Loading Source	BMPs	Existing N Loading (lbs/yr)	Existing p Loading (lbs/yr)	Existing TSS Loading (lbs/yr)	Existing Loading (cfu/yr)	Comments	Estimated % of participants	Estimated % Reduction	N Load Removed by BMPs (lbs/yr)	P Load Removed by BMPs (lbs/yr)	TSS Load Removed by BMPs (tons/yr)	Bacteria Load Removed by BMPs (CFU/yr)	Quantity	Single Cost	Cost
				Urban											
	TOTAL URBAN LOADING	126,210	19,848	6,453,898	9.06E+14										
Urban Pollutant Runoff and Eroding Stream Banks	Purchase parcels with water quality buffer					American Rivers, Natureland Trust, and Pee Dee Land Trust estimated the acreage of priority critical lands adjacent to GCWSD's Source Water Protection Area and the cost to purchase at $333/acre. With the assistance of the SC Conservation Bank match, the cost could decrease to $167/acre. Donated or purchased conservation easement of water quality buffer may decrease the cost. Assume 50% of priority 1 critical lands are acquired.	50%						12,735	$ 333	$ 4,240,589
	Streambank stabilization/Restoration					USGS analysis estimates 998,674 linear feet of streams. Assuming 1% (9,987 LF) of streams undergo a stream restoration.	1%						9,987	$ 800	$ 7,989,392
Urban	Water Quality Buffer					Vegetated filter strips in 1% of acreage in most urbanized watersheds 1, 2, and 3 (104 acres of urbanized drainage area)	1%		336	59	16		104	$ 461	$ 47,977
Pet Waste	Pet Waste Stations - at public parks, residential neighborhoods and vet/pet offices/stores.					10 Pet Waste Stations in the most urbanized watersheds.							25	$ 120	$ 3,000
Stormwater Management Practices	Rain Barrels/Workshops												300	$ 75	$ 22,500
	Rain Gardens					10x10 ($100ft^2$) rain gardens							15	$ 300	$ 4,500
	Bioretention, stormwater control structure retrofits, bioswales, underground detention, stormwater wetlands, dry detention, wet ponds, filtration practices, permeable surfaces					BMPs applied to most urbanized Watersheds 1, 2, and 3 and assume 1% of land with BMPs added (84 acres of urbanized drainage area)			361	107			15	$ 1,920	$ 28,800
				Septic											
Septic Failures	TOTAL SEPTIC LOADING	5,362	2,103		4.17E+12										
	Septic Repairs, Replacements or Connect to Sewer					Approximately 1,724 septic systems in watershed; Estimated 10% of septic systems failing = 172 systems and 100% of failing septic systems will be treated	100%	100%	5,362	2,103		4.17E+12	172	$ 3,500	$ 602,000
				Crop Farms											
	TOTAL CROP FARM LOADING	23,546	3,718	1,663,523			30%	50%	3,532	557.7	125		860.1	$ 1,800	$ 1,548,180
Runoff from crop farms	Water Quality Buffer					A total of 2,867 acres of cropland with 30% participation (860 acres) and . An estimated $1,800 per acre for all BMPs.									
	Streambank stabilization														
	Vegetated Cover Between Rows														
	Cover Crops														
	Conservation Tillage														
	Conservation/Fertilizer & Pesticide Management														
				Livestock											
	TOTAL LIVESTOCK LOADING	119	9	839	1.05E+12		67%	40%	32	2.4	0.1	2.8E+11	2	$ 56,000	$ 112,000
Run off from pastures and hobby horse farms	Stream exclusion fencing/water source/loafing shed					A total of 3 farms are used for livestock with assumed 2/3 participation and 75% reduction at participating farms. An estimated $56,000 per farm for all BMPs.									
	Cross fencing/Pasture Planting														
	Heavy Use Area Stabilization														
	Waste Management/Manure Composting														
	Conservation/Manure Management Plans														
	Water Quality Buffer														
	Streambank stabilization														
	TOTAL LOADS	155,237	21,960	8,118,260	9.11E+14	TOTAL COST			9,591	2,829	141	4.45E+12			$ 14,598,938

9. FUNDING OPPORTUNITIES

Several types of grant and self-supporting funding may be available to implement watershed restoration and protection practices and land conservation measures outlined in this WBP.

9.1 Grant Opportunities

Clean Water Act Section 319 Grant Program

Each year, SCDHEC receives an annual grant allocation from EPA to implement NPS abatement strategies as described in the state's NPS Management Plan. A portion of these funds are passed on through a competitive grant process to stakeholder groups, government entities, or other agencies to fund eligible projects that reduce or prevent NPS pollution through the implementation of an approved WBP which includes EPA's nine elements. Pollutant load reduction must lead to measurable water quality improvements in the target area. These funds are known as Section 319 grants and pay up to 60% of eligible project costs, with the applicant providing a 40% non-federal match.

NRCS Programs.

The USDA NRCS has several programs for watershed protection:

The Environmental Quality Incentives Program (EQIP) is a voluntary program administered by the USDA NRCS that provides financial and technical assistance to farmers to help plan and implement conservation practices that improve soil, water, plant, animal, air and related resources on agricultural land and non-industrial private forestland.

In South Carolina, EQIP will pay 75% of the costs of eligible conservation practices under the general sign-up. Eligible landowners who are historically underserved, of limited resources, socially disadvantaged, and beginning farmers are eligible for 90 percent cost share. A ranking tool is used to prioritize applications based on the resource concerns that each county selected. Farms within an approved TMDL watershed and farms that are part of a 319 implementation grant are typically ranked high to receive EQIP funds. Therefore, landowners may apply for EQIP funds to potentially maximize the effect of 319 grant funds.

The Agricultural Conservation Easement Program (ACEP) provides financial and technical assistance to landowners, land trusts, and other entities to help protect, restore, and enhance wetlands, grasslands, and working farms and ranches through conservation easements.

The Regional Conservation Partnership Program (RCPP) promotes coordination of NRCS conservation activities with partners to provide assistance to producers and landowners through partnership agreements and through program contracts or easement agreements.

The Conservation Stewardship Program (CSP) helps agricultural producers maintain and improve their existing conservation systems.

The National Water Quality Initiative (NWQI) is a partnership among NRCS, state water quality agencies, and the U.S. Environmental Protection Agency to identify and address impaired waterbodies through voluntary conservation. NRCS provides targeted funding for financial and technical assistance in small priority watersheds. In FY19, NRCS expanded the scope of NWQI to include source water protection. New provisions of the 2019 Farm Bill require that ten percent of NRCS conservation funding be allocated for source water protection in collaboration with local water utilities in priority watersheds.

US EPA/ National Fish and Wildlife Foundation: 5 Star Grants

Description: Open to any public or private entity engaging in community-based restoration. Request for Proposals are expected in October with proposals due in January. Grant amounts are $10,000 to $40,000 (typically in $20,000 to $25,000 range in South Carolina). Partnerships are required with at least 5 organizations. No matching is required but is strongly encouraged to have at least a 1:1 match, and competitive projects often have 2:1 match (including in-kind match). Five Star grants provide modest financial assistance on a competitive basis to support community-based wetland, riparian, and coastal habitat restoration projects that build diverse partnerships and foster local natural resource stewardship through education, outreach, and training activities. Since 2010, there is a new emphasis on urban projects.

Other Grant Sources

Other grant sources may be available to help with funding needs. These include private grants from foundations, corporations, businesses, and individuals, and additional financial and in-kind support from cooperating partner organizations.

National Coastal Resilience Fund (NCRF)

Administered through the National Fish and Wildlife Foundation (NFWF), these funds provide for the planning, design, and restoration of natural and nature-based solutions to help protect coastal communities from the impacts of storms, floods, and other natural hazards and enable them to recover more quickly and enhance habitats for fish and wildlife. Eligible projects must encompass the four criteria below:

- Community Planning and Capacity Building
- Site Assessment and Preliminary Design
- Final Design and Permitting
- Restoration Implementation

Community Development Block Grant (CDBG)

The South Carolina Community Development Block Grant (CDBG) Program is designed to help units of general local government in improving economic opportunities and meeting community revitalization needs, particularly for persons of low and moderate income. The CDBG program has

been funded through the State since 1982 by the U.S. Department of Housing and Urban Development (HUD) under the Housing and Community Development Act of 1974, as amended (Title I). The three overarching goals of the CDBG program are to provide decent housing, economic opportunities, and a suitable living environment. Within the context of these goals, each project must also meet one of three outcomes identified by HUD: affordability, accessibility, or sustainability.

Horry County is a CDBG entitlement communities. Georgetown County is not a CDBG entitlement community but can participant in the State CDBG plan. The City of Georgetown is currently a participating city within the Williamson County Community Development Block Grant Consolidated Plan. The city encompasses a very small portion of the Cypress Creek-Great Pee Dee River subwatershed.

9.2 Self-Supporting Funding

Stormwater Utility Fee

Both Georgetown and Horry County have stormwater utility fees which could help fund portions of this WBP.

Landowner Support

If grant opportunities are made available for implementation of this WBP, landowners will be required to provide a match (up to 40%) for installation of certain BMPs (such as agricultural, septic, and rain gardens). To meet this match, some landowners may be able to perform in-kind labor.

10. TECHNICAL ASSISTANCE

This WBP is written so that any stakeholder may elect to implement any of the applicable BMPs and/or preventative measures in the WBP to protect or improve water quality in the Watershed. A stakeholder who may choose to implement agricultural BMPs may require assistance from NRCS, one of many valuable partners in this project, to assist in recruiting agricultural landowners, developing conservation plans and/or providing technical advice for agricultural BMPs. NRCS also administers the EQIP cost share program. Landowners may apply for EQIP funds, instead of or in addition to 319 funds in order maximize results. Technical Service Providers and SWCDs may also assist NRCS with conservation plans and BMP inspections.

Assistance from many supporting organizations including the following will be needed to implement this WBP: Georgetown and Horry NRCS and SWCDs, Georgetown County Stormwater, Horry County Stormwater, SC Forestry Commission, SCDHEC Public Health, Georgetown County Water Sewer District, Grand Strand Water Sewer Authority, SCDNR, Coastal Carolina University, Waccamaw Riverkeeper. The participation of these groups will have a large impact on the ability to implement this WBP and to conduct an effective and efficient social marketing campaign.

A stakeholder may also choose to utilize a consultant to assist with implementation of the WBP. Such tasks may include project oversight, reporting, social marketing, permitting and BMP design.

11. REFERENCES

Adams, T and E. Arias. 2019. SC Forest Products: Industry Export Report, 2019. South Carolina Forestry Commission. https://www.scfc.gov/wp-content/uploads/2021/06/bmpmonitoringreport2019-20.pdf:

Benefield, L. 2002. Residential Flow Rates. Washington State Department of Health - Wastewater Management Program. Technical Issue #7b, dated May 31, 2002. http://www.doh.wa.gov/Portals/1/Documents/Pubs/337-103.pdf

Bock, E.M. and Z.M. Easton, 2020. Export of Nitrogen and Phosphorus from Golf Courses: A Review. Journal of Environmental Management 225.

Caraco, D., R. Claytor, P. Hinkel, H. Kwon, T. Schueler, C. Swann, S. Vysotsky, and J. Zielinksi. 1988. Center for Watershed Protection, 1998. Rapid Watershed Planning Handbook: a comprehensive guide for managing urbanizing watersheds.

Climate and Hazard Mitigation Planning (CHaMP) Tool, see https://champ.rcc-acis.org/

Environment Protection Authority Victoria (EPA Victoria), 2012. Types and Causes of Urban Stormwater Pollution. http://www.epa.vic.gov.au/your-environment/water/stormwater/types-and-causes-of-urban-stormwater-pollution

Halifax County Service Authority (HCSA), Virginia. 2012. "FOG Control Program" dated 2012. http://www.hcsa.us/files/HCSA-What-is-FOG.pdf

Hamrick, B., C. Jaworowski, and B. Strickland, 2016. A Landowner's Guide for Wild Pig Management: Practical Methods for Wild Pig Control. Mississippi State University Extension Service. http://extension.msstate.edu/publications/publications/landowners-guide-for-wild-pig-management-practical-methods-for-wild-pig

Henze, M.2008. Biological Waste Treatment: Principles, Modelling and Design. IWA Publishing, London, UK.

Horry County Planning and Zoning. Imagine 2040 Comprehensive Plan. December 10, 2019. https://www.horrycounty.org/portals/0/docs/PlanningandZoning/Imagine2040/ADOPTED%20IMAGINE%202040%20with%2012-08-2020%20Amendment-compressed.pdf

Larsen, R1995. Manure Loading into Streams from Direct Fecal Deposits. University of California Extension. Fact Sheet No 25. http://ucanr.edu/sites/UCCE_LR/files/180584.pdf

Libes, S.M. (2008 – present) Waccamaw River Quality Monitoring Project [Online]. Coastal Carolina University, Burroughs & Chapin Center for Marine and Wetland Studies [Producer and Distributor], URL: https://www.coastal.edu/wwa/datasets/rivergauging/

Libes, S.M. (1995 – present) Waccamaw River Volunteer Water Quality Monitoring Program [Online]. Coastal Carolina University, Burroughs & Chapin Center for Marine and Wetland Studies [Producer and Distributor], URL: https://www.coastal.edu/wwa/vm/programs/waccamawriver/

Karl, T.R., Melillo J.M., Peterson T.C. (eds). 2009. Global climate change impacts in the United States. Cambridge University Press: New York. http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf, (accessed 2010).

Keena, M.A. (2022). Composting Animal Manures: A guide to the process and management of animal manure compost. NDSU Extension. NM1478.

Kirschner, A., T. Zechmeister, G. Kavka, C. Beiwl, A. Herzig, R. Mach, and A. Farnleitner. 2004. Integral strategy for evaluation of fecal indicator performance in bird-influenced saline inland waters. Appl. Environ. Microbiol. 70(12):7396-7403.

Klein, R., 1979, Urbanization and stream quality impairment: Water Resources Bulletin, v. 15, p. 948-963

Mallin, M.A., Johnson V.L., Ensign S.H. 2009. Comparative impacts of stormwater runoff on water quality of anurban, a suburban, and a rural stream. Environmental Modeling and Assessment 159: 475–491. DOI: 10.1007/s10661-008-0644-4.

Meehl, G.A., G.J. Boer, C. Covey, M. Latif, and R. J. Stouffer, 2000. The Coupled Model Intercomparison Project (CMIP). Bull. Amer. Meteor. Soc., 81, 313-318.

Myers, N., 2017. State Director with USDA APHIS WS, Personal Email, May 3, 2017

New Hampshire Estuaries Project, "The Impacts of Impervious Surfaces on Water Resources, NHEP" (2007). PREP Reports & Publications. 236. https://scholars.unh.edu/prep/236

Payton, M.E., Z. Hailin, D.L. Martin, 2006. Reducing Nutrient Runoff from Golf Course Fairways Using Grass Buffers of Multiple Heights. Crop Science 46:72-80.

Schnelle, M., 2013. Water Quality Handbook for Nurseries. Oklahoma Cooperative Extension Service. Circular E-951. http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2222/e-951.pdf

Shaver, E. R Horner, J Skupien, C May, G Ridley. 2007. "Fundamentals of Urban Runoff Management - Technical and Institutional Issues: 2nd edition".

https://yosemite.epa.gov/oa/eab_web_docket.nsf/Attachments%20By%20ParentFilingId/77FFADF0D8FEB2E485257C62005376F2/$FILE/Att%2013%20%20Fundamentals%20of%20Urban%20Runoff.pdf

Simpson T. and S. Weammert. 2009. Developing Best Management Practices Definitions and Effectiveness estimates for Nitrogen, Phosphorus and Sediment in the Chesapeake Bay Watershed. http://archive.chesapeakebay.net/pubs/BMP_ASSESSMENT_REPORT.pdf

Speir, A. and S. Wells. 2010. Environmental Checklist for Nurseries, Greenhouses, and Turfgrass Producers. University of Georgia Cooperative Extension. Bulletin 1366. http://athenaeum.libs.uga.edu/bitstream/handle/10724/12137/B1366.pdf?sequence=1

SCDHEC 2002. Standards for the Permitting of Agricultural Animal Facilities (Regulation 61-43). Bureau of Water. Columbia, SC.

SCDHEC 2011. "Total Maximum Daily Load Document E-013 and E-113 South Fork Edisto River for Fecal Coliform Bacteria" dated July 2011, http://www.scdhec.gov/HomeAndEnvironment/Docs/tmdl_mlEdisto.pdf

SCDHEC 2017. SCDHEC Load Estimation and Reduction Spreadsheet

South Carolina Forestry Commission (SCFC). 1994. South Carolina's Best Management Practices for Forestry. https://www.state.sc.us/forest/bmpmanual.pdf

Schueler, T. 1994. The Importance of Imperviousness. Watershed Protection Techniques 1(3): 100-111.

Schueler, T. 1999. "Microbes and Urban Watersheds: Concentrations, Sources, and Pathways" Watershed Protection Techniques. 3(1): 551-596.

USACE 2022. USACE Hydrologic Engineering Center. CN Tables. https://www.hec.usace.army.mil/confluence/hmsdocs/hmstrm/cn-tables.

USEPA. 1991. Guidance for Water Quality-Based Decisions: The TMDL Process. Office of Water, EPA 440/4-91-001

USEPA. 2012. Water Quality Standards Handbook: Second Edition. http://water.epa.gov/scitech/swguidance/standards/handbook/index.cfm

USEPA. 2017. Nonpoint Source: Forestry. Accessed May 9, 2017. https://www.epa.gov/nps/nonpoint-source-forestry

USEPA STORET data, https://www.epa.gov/waterdata/storage-and-retrieval-and-water-quality-exchange

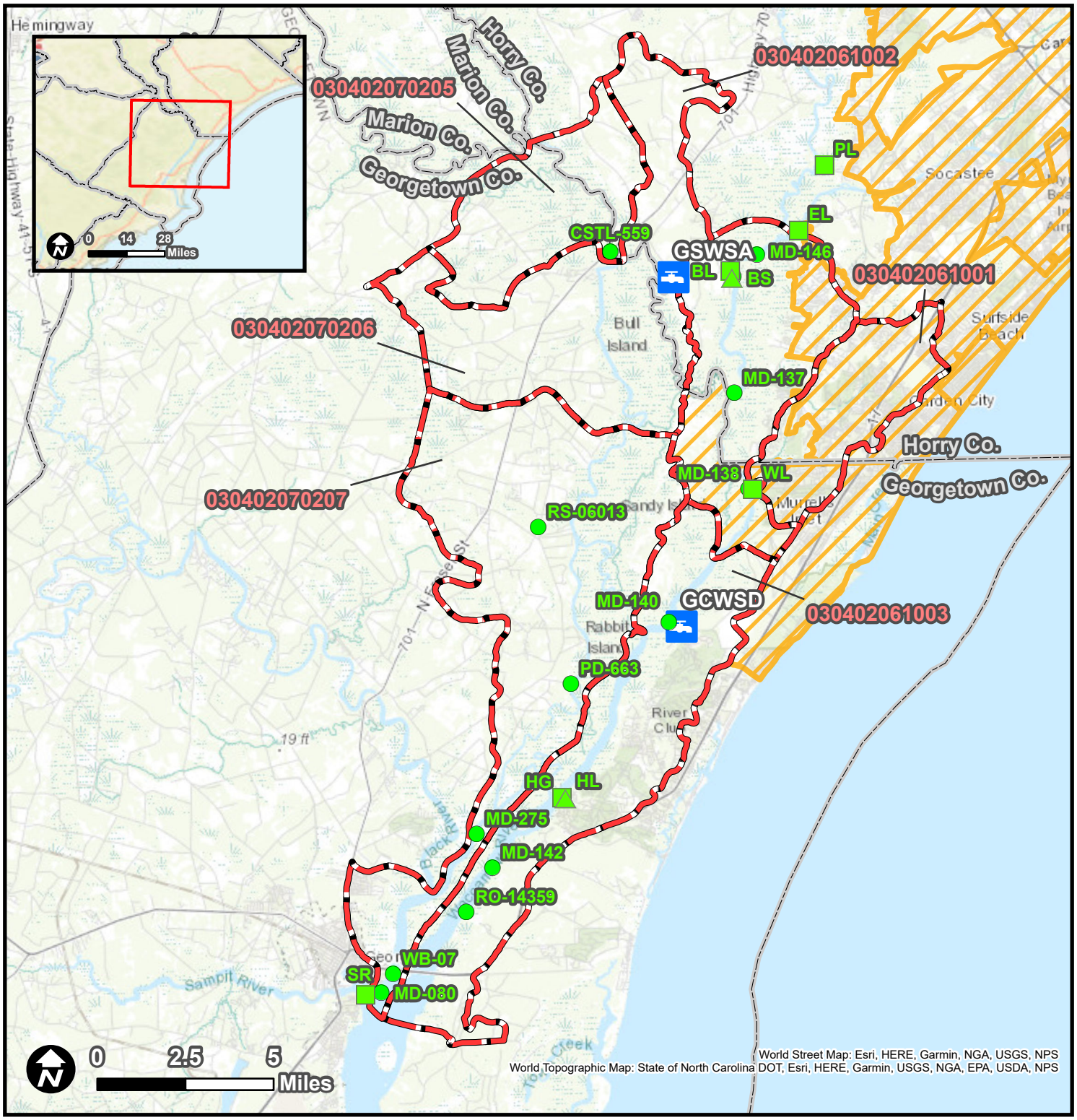
Welch, H. 2020. Forestry BMPs in South Carolina: Compliance and Implementation Monitoring Report, 2019-2020. https://www.scfc.gov/wp-content/uploads/2021/06/bmpmonitoringreport2019-20.pdf

APPENDICES

APPENDICES

Appendix A

Figures



A:\Environmental\2020 + Projects\Org 6480\0109 - Waccamaw and Great Pee Dee River Watershed\GIS\Monitoring_Station_Map_Update_011223\Map_update_010324.aprx

GEORGETOWN COUNTY WATER & SEWER DISTRICT

Legend

- WWA Monitoring Stations
- EQL River Gauging Stations
- SCDHEC Monitoring Stations
- Public Water Intakes
- 12-digit HUCs
- MS4 Designation
- County Boundary

Figure 1. Watershed Features Map

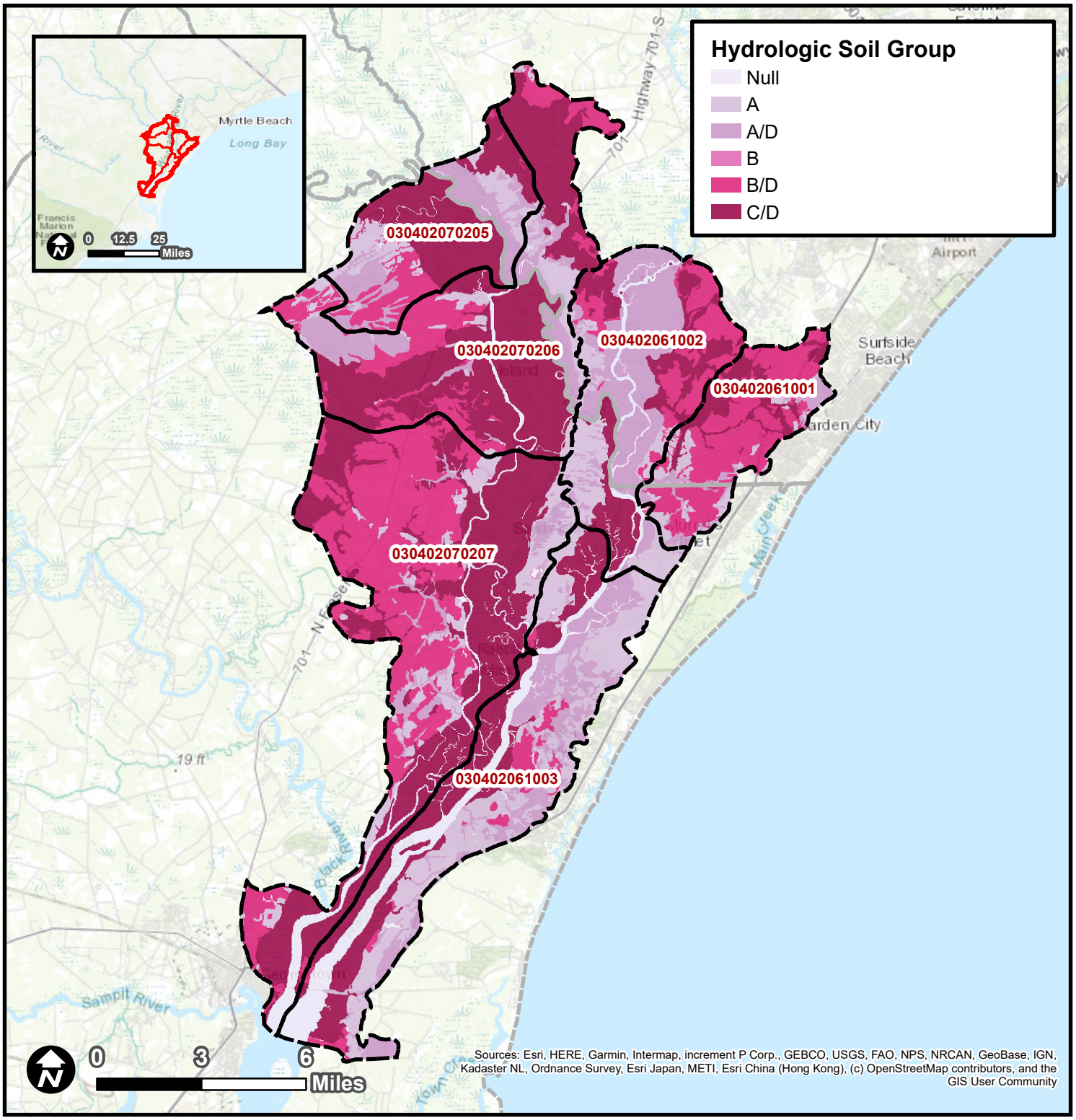
Georgetown & Horry Counties, South Carolina

Drawn By: MC

Reviewed By: AV

Date: 1/3/2024

The map shown here has been created with all due and reasonable care. Information shown in this figure should be used for reference purposes only.



C:\Users\cory.pennington\Desktop\Columbia Soils\Figure 5. Hydrologic Soils Group.mxd

GEORGETOWN COUNTY WATER & SEWER DISTRICT

Legend

HUC-12

County Boundaries

Hydrologic Soils Group

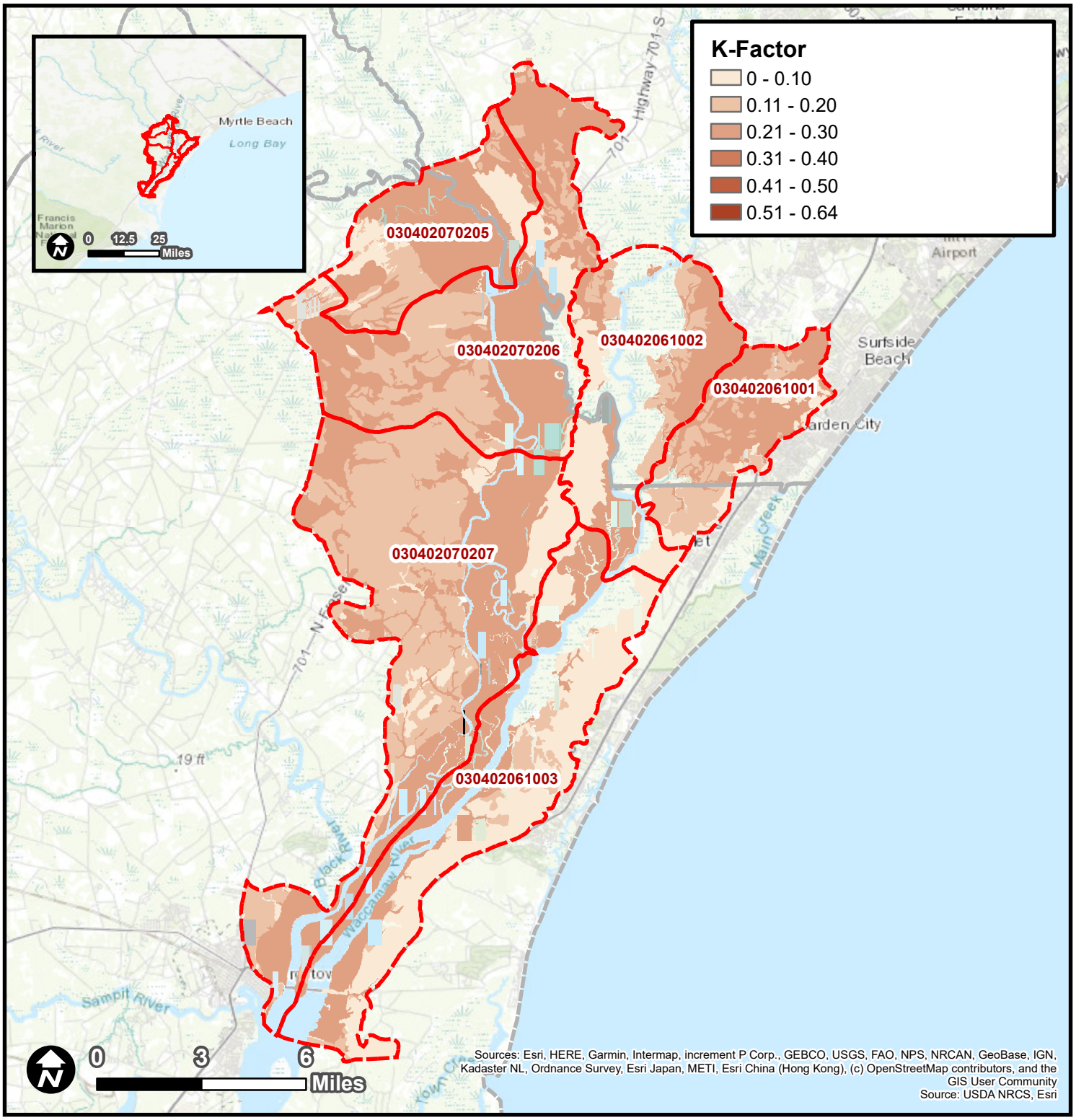
Georgetown & Horry Counties, South Carolina

Drawn By: CSP

Reviewed By: AV

Date: 1/5/2022

The map shown here has been created with all due and reasonable care. Information shown in this figure should be used for reference purposes



C:\Users\cory.pennington\Desktop\Figure 4. Soils K Factor.mxd

GEORGETOWN COUNTY WATER & SEWER DISTRICT

Legend

HUC-12

County Boundaries

Soils K-Factor

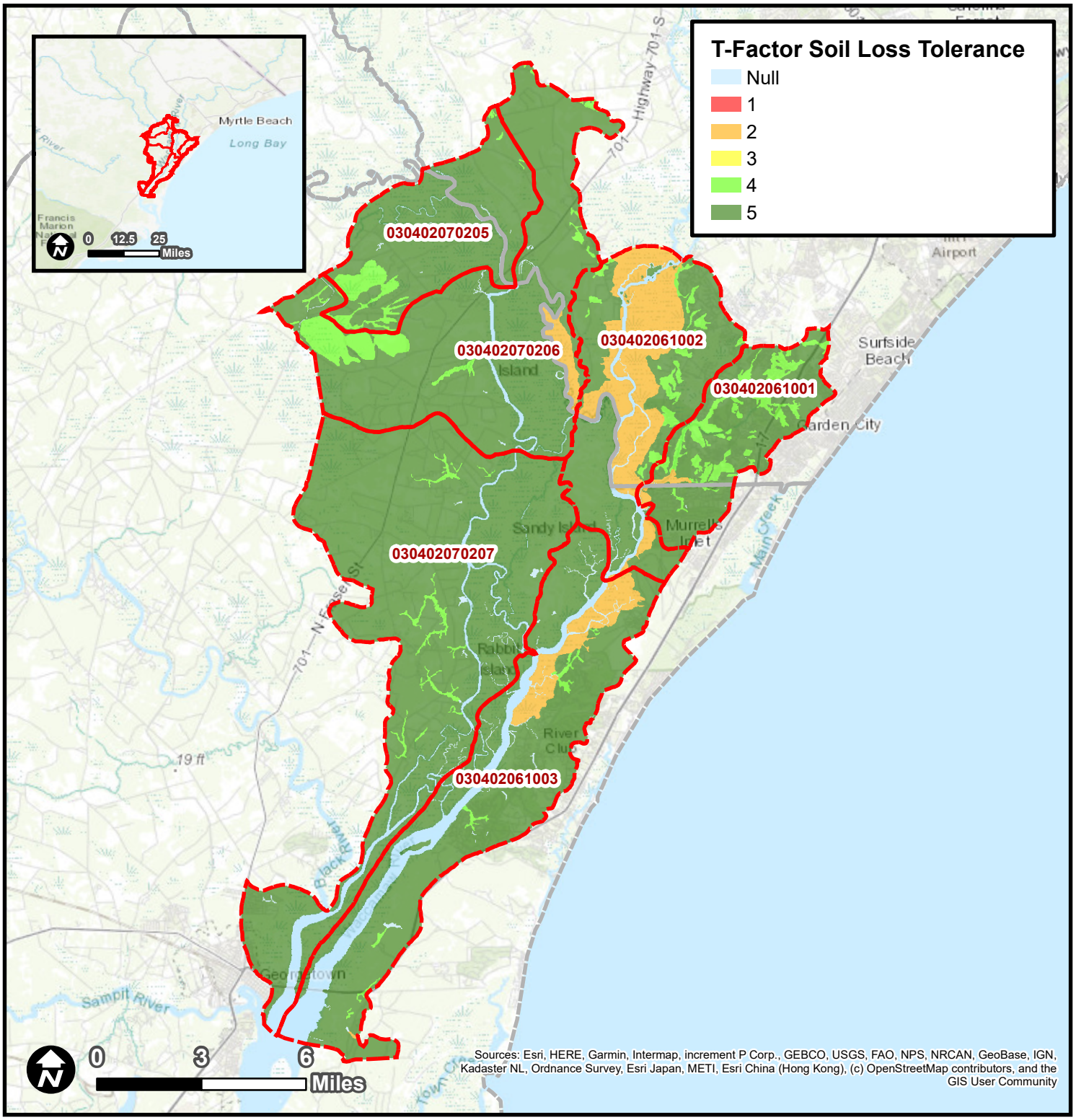
Georgetown & Horry Counties, South Carolina

Drawn By: CSP

Reviewed By: AV

Date: 1/5/2022

The map shown here has been created with all due and reasonable care. Information shown in this figure should be used for reference purposes



C:\Users\cory.pennington\Desktop\Columbia Soils\Figure 3. Soils T Factor.mxd

GEORGETOWN COUNTY WATER & SEWER DISTRICT

Legend

HUC-12

County Boundaries

Soils T-Factor

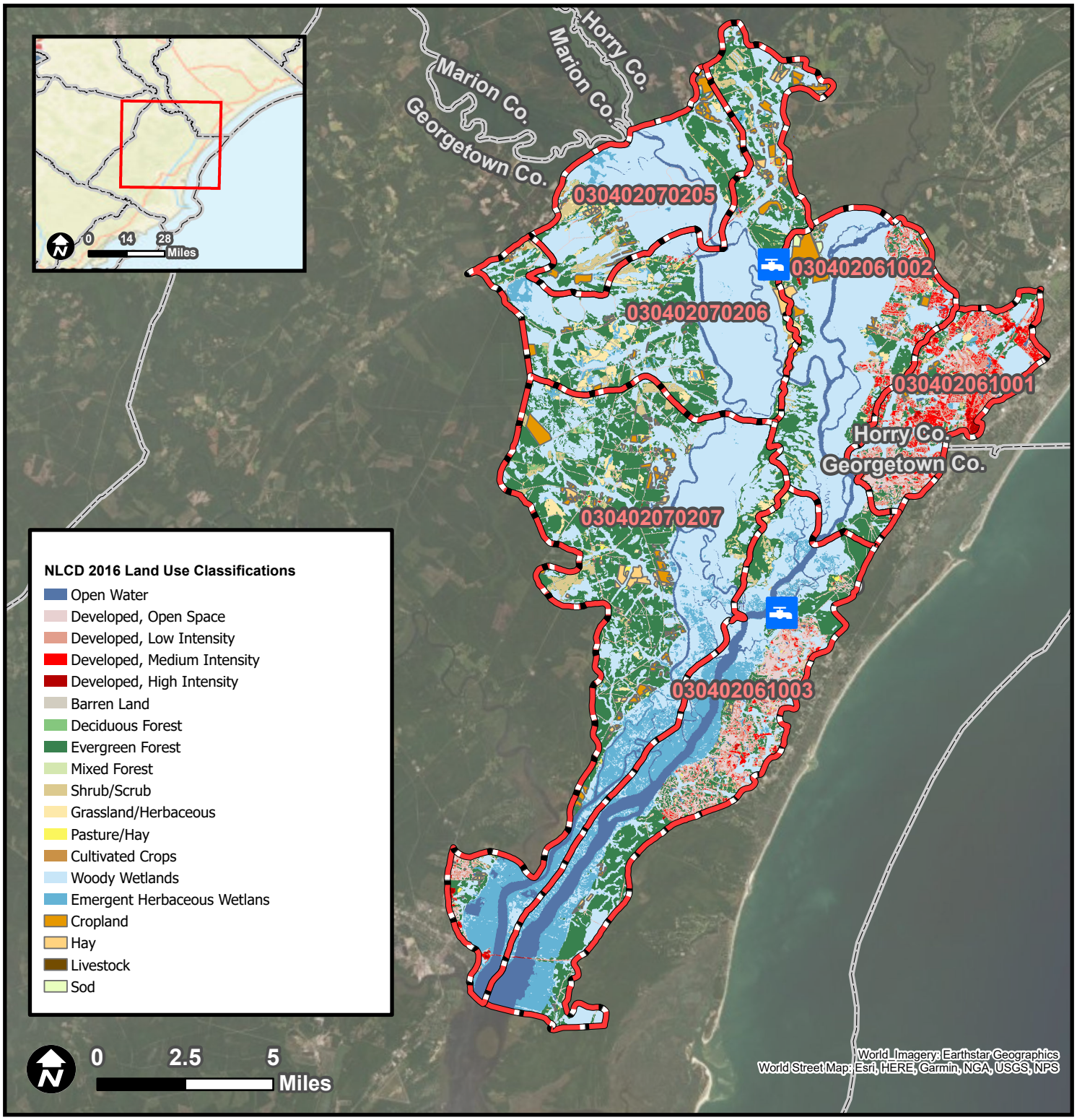
Georgetown & Horry Counties, South Carolina

Drawn By: CSP

Reviewed By: AV

Date: 1/5/2022

The map shown here has been created with all due and reasonable care. Information shown in this figure should be used for reference purposes



V:\Environmental\2020 + Projects\Org 6480\0109 - Waccamaw and Great Pee Dee River Watershed\GIS\GIS.aprx

GEORGETOWN COUNTY WATER & SEWER DISTRICT

Legend

- Public Water Intakes
- County Boundary
- 12-digit HUCs

Modified Land Use Map

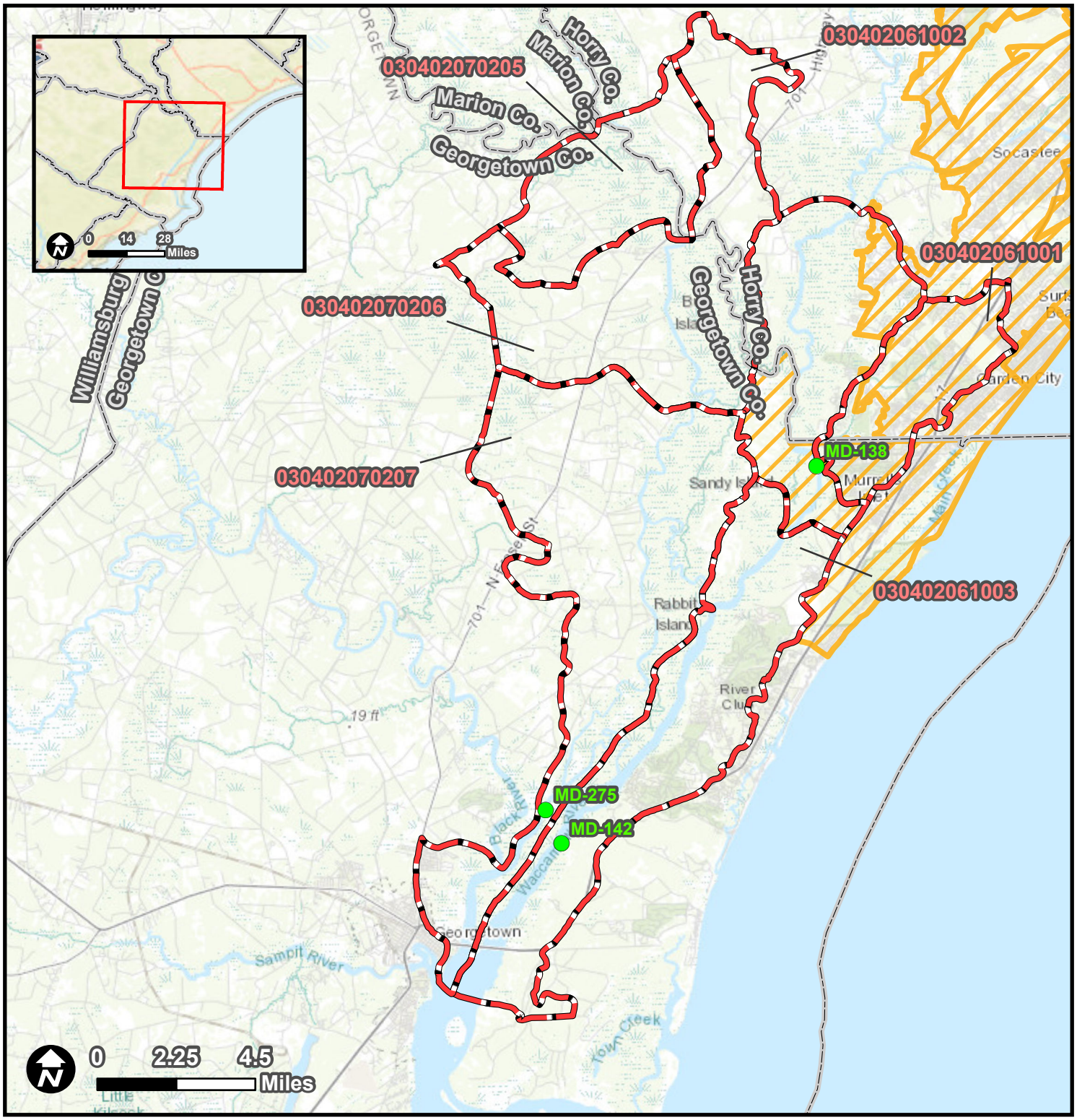
Georgetown & Horry Counties, South Carolina

Drawn By: LW

Reviewed By: AV

Date: 1/6/2022

The map shown here has been created with all due and reasonable care. Information shown in this figure should be used for reference purposes only.



A:\Environmental\2020 + Projects\Org 6480\0109 - Waccamaw and Great Pee Dee River Watershed\GIS\Monitoring_Station_Map_Update_011223\Map_update_010324.aprx

GEORGETOWN COUNTY WATER & SEWER DISTRICT

Legend

- SCDHEC Monitoring Stations
- MS4 Designation
- County Boundary
- 12-digit HUCs

Figure 6. Monitoring Stations Map

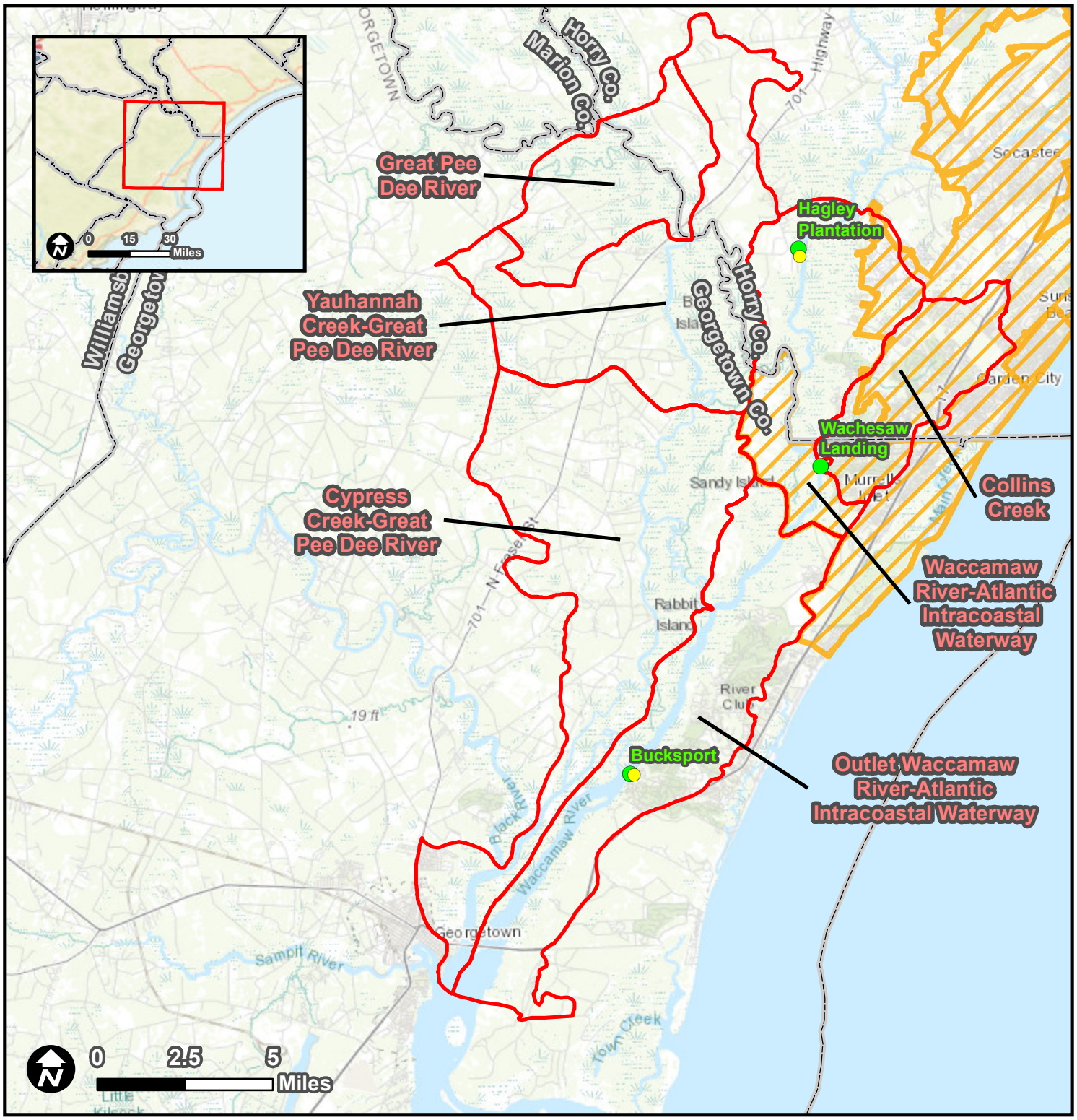
Georgetown & Horry Counties, South Carolina

Drawn By: MC

Reviewed By: KJ

Date: 1/3/2024

The map shown here has been created with all due and reasonable care. Information shown in this figure should be used for reference purposes only.



Z:\Environmental\2020 + Projects\Org 6480\0109 - Waccamaw and Great Pee Dee River Watershed\GIS\Monitoring_Station_Map_Update_011223\Waccamaw Watershed Academy WQ Monitoring Stations.mxd

GEORGETOWN COUNTY WATER & SEWER DISTRICT

Legend

- WWA Monitoring Stations
- EQL River Gauging Stations
- 12-digit HUCs
- MS4 Designation
- County Boundary

Waccamaw Watershed Academy WQ Monitoring Stations

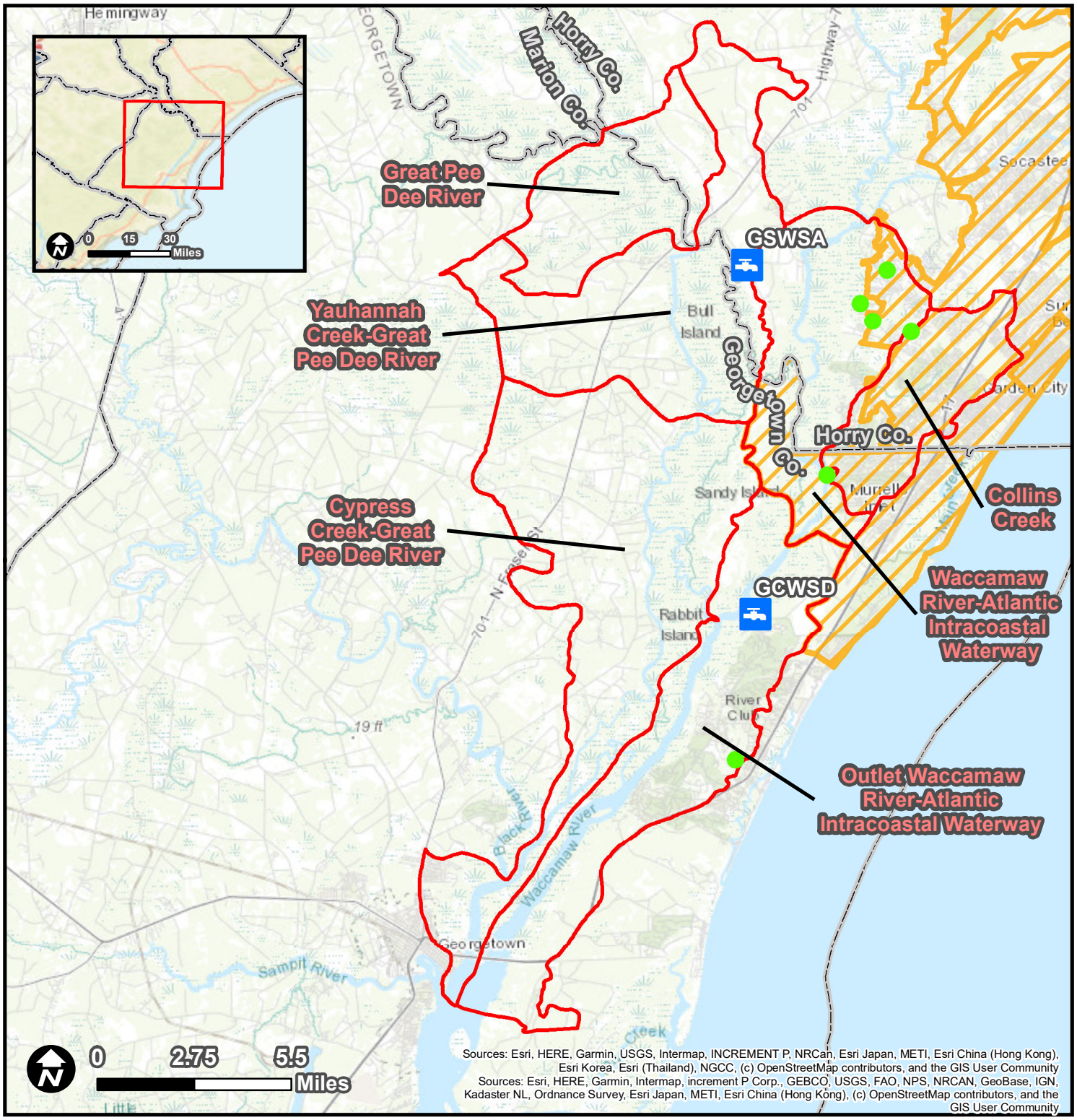
Georgetown & Horry Counties, South Carolina

Drawn By: MC

Reviewed By: KJ

Date: 1/25/2023

The map shown here has been created with all due and reasonable care. Information shown in this figure should be used for reference purposes



\\cba-fs1\projects\Environmental\2020 + Projects\Org 6480\0109 - Waccamaw and Great Pee Dee River Watershed\GIS\SSOMap.mxd

GEORGETOWN COUNTY WATER & SEWER DISTRICT

Legend

- Sanitary Sewer Overflows
- Public Water Intakes
- 12-digit HUCs
- MS4 Designation
- County Boundary

Sanitary Sewer Overflow Map

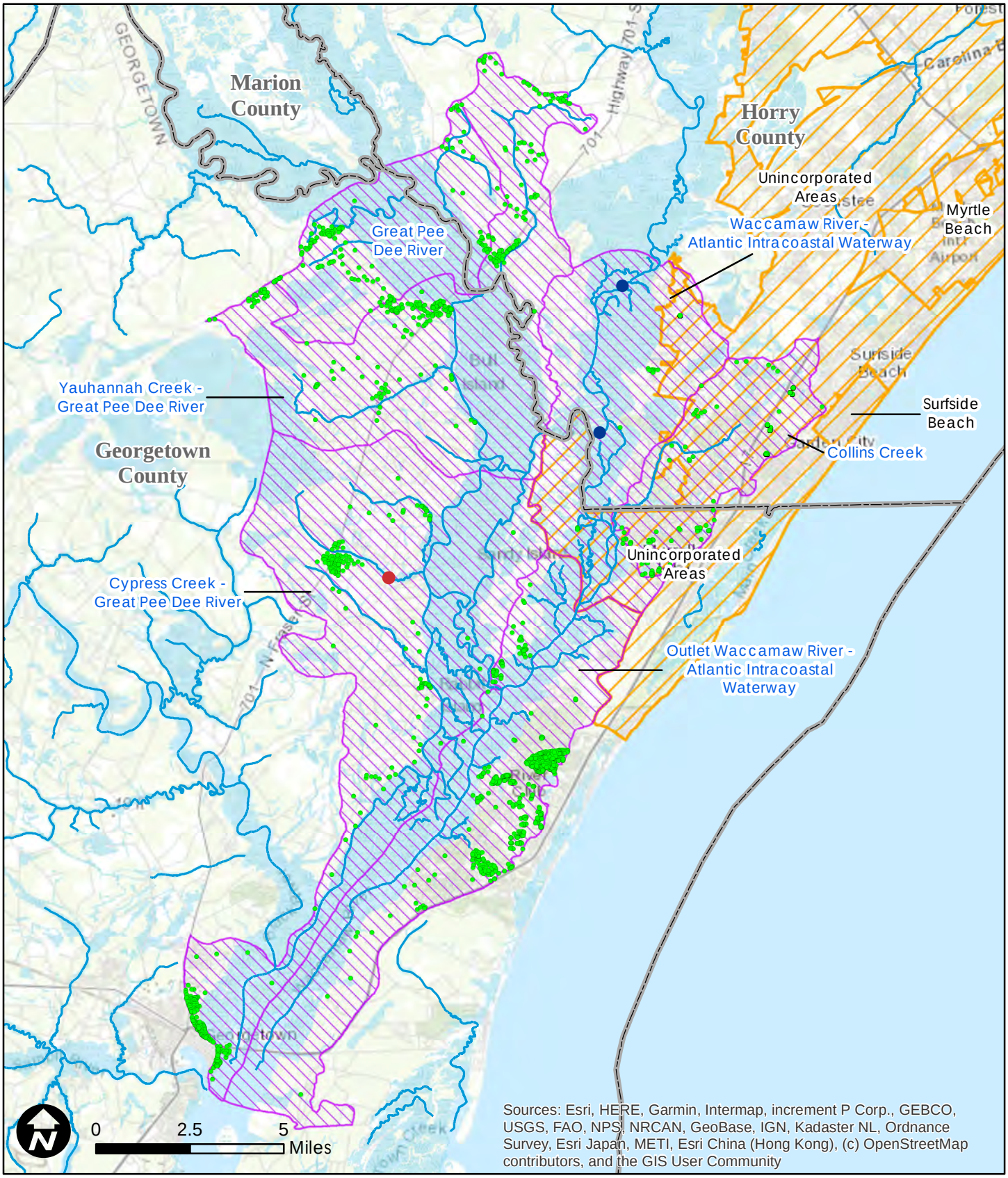
Georgetown & Horry Counties, South Carolina

Drawn By: LH

Reviewed By: KJ

Date: 8/11/2022

The map shown here has been created with all due and reasonable care. Information shown in this figure should be used for reference purposes



Parcels on Septic

Georgetown & Horry Counties, South Carolina

The map shown here has been created with all due and reasonable care. Information shown in this figure should be used for reference purposes only.

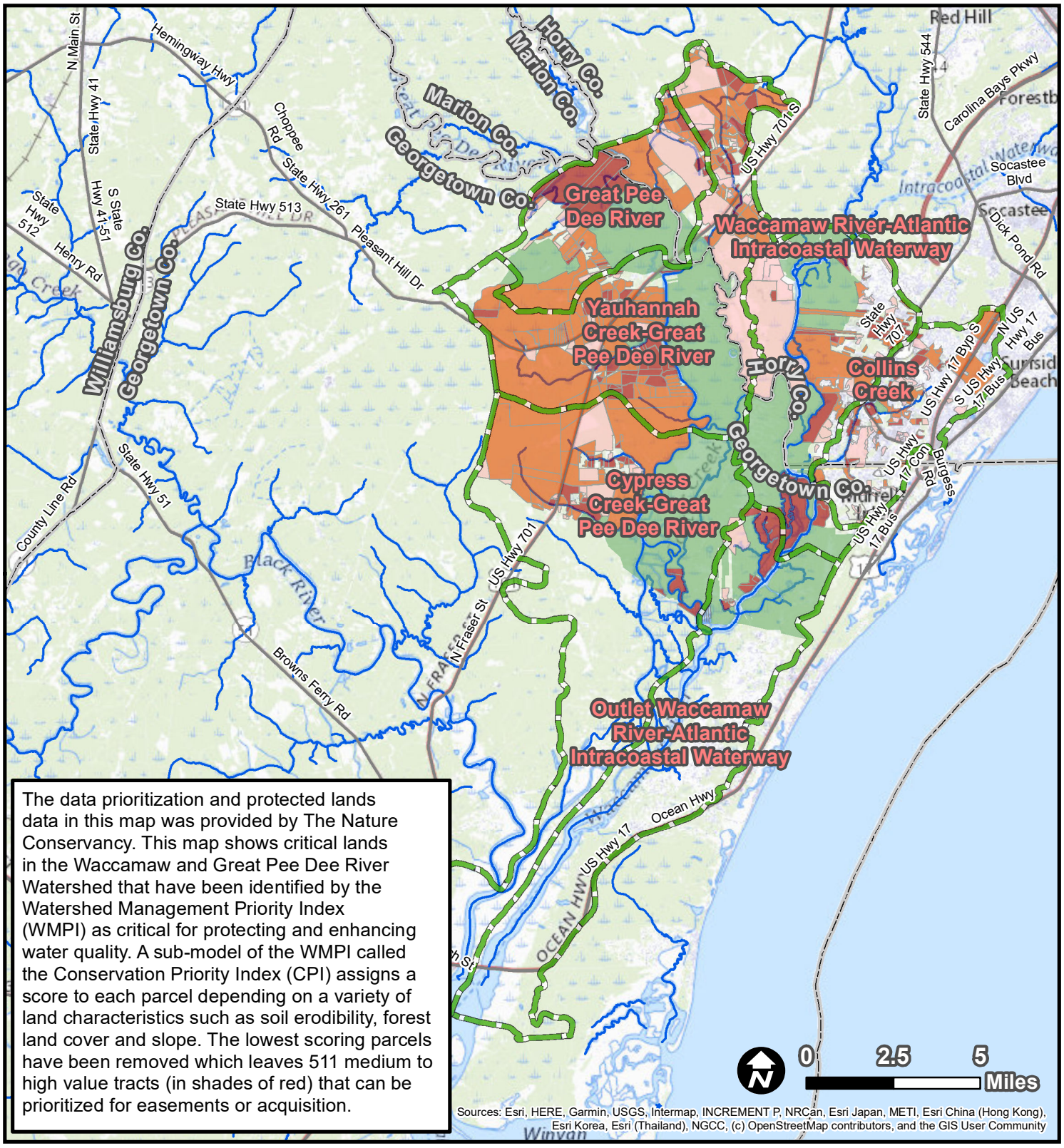
Drawn By: LH

Reviewed By: KJ

Date: 8/2/2022

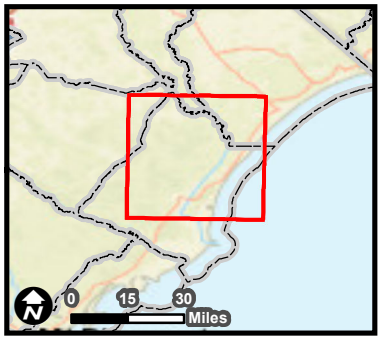
Legend

- TMDL
- 303(d)
- Septic Address Point
- County Boundary
- USGS Streams
- HUC-12 Watersheds
- MS4 Designation
- USGS Waterbodies



The data prioritization and protected lands data in this map was provided by The Nature Conservancy. This map shows critical lands in the Waccamaw and Great Pee Dee River Watershed that have been identified by the Watershed Management Priority Index (WMPI) as critical for protecting and enhancing water quality. A sub-model of the WMPI called the Conservation Priority Index (CPI) assigns a score to each parcel depending on a variety of land characteristics such as soil erodibility, forest land cover and slope. The lowest scoring parcels have been removed which leaves 511 medium to high value tracts (in shades of red) that can be prioritized for easements or acquisition.

\\cba-fs1\projects\Environmental\2020 + Projects\Org 6480\0109 - Waccamaw and Great Pee Dee River Watershed\GIS\FigureXCriticalLands.mxd



Legend

CPI Priority

- Priority 1
- Priority 2
- Priority 3
- Protected Lands

- USGS Streams
- Roads
- 12-digit HUCs
- County Boundary

Figure 55. Critical Lands for Source Water Protection

Georgetown & Horry Counties, South Carolina

Drawn By: LH

Reviewed By: KJ

Date: 8/15/2022

The map shown here has been created with all due and reasonable care. Information shown in this figure should be used for reference purposes

Appendix B

Public Meeting Summaries

Horry County Public Meeting
Waccamaw and Great Pee Dee River Watershed WBP
James R. Frazier Community Center
May 10, 2022, 5 PM – 6 PM

A. Welcome
    a. Angela Vandelay and Karen Jackson welcomed attendees to the public meeting.

B. Presentation
    a. A brief presentation was given by A. Vandelay and K. Jackson:
        i. Discussion of Watershed Based Plans
        ii. South Carolina Watershed Based Plan success stories and pollutant reductions
            1. Shaws Creek
            2. Twenty-Five Mile Creek
        iii. Water Quality Impairments in Waccamaw and Great Pee Dee River Watershed
        iv. Project Goals
        v. Best Management Practices
        vi. Programmatic Measures
        vii. Accomplishments to Date
        viii. Interactive Watershed Map

C. Questions and Concerns from attendees and residents of the Watershed.
    a. Many questions and comments were concerned with flooding.
    b. In addition to flooding, standing water in wetland areas were of concern due to algal growth and mosquitoes.
        i. It is possible algal growth is due to an increase in nutrients in urbanized stormwater runoff.
        ii. Wetlands are ecosystem services that can help filter water. Possible educational opportunity.
    c. Turbidity issues from upstream developments.
    d. Several questions focused on monitoring efforts by SCDHEC.
        i. How can data be accessed?
        ii. Which waterbodies are being monitored?
    e. Many residents are on septic and may benefit from septic repairs and servicing.

Georgetown County Public Meeting
Waccamaw and Great Pee Dee River Watershed WBP
Waccamaw Regional Recreational Center
May 10, 2022, 7 PM –8 PM

A. Welcome
    a. Angela Vandelay and Karen Jackson welcomed attendees to the public meeting.

B. Presentation
    a. A brief presentation was given by A. Vandelay and K. Jackson:
        i. Discussion of Watershed Based Plans
        ii. South Carolina Watershed Based Plan success stories and pollutant reductions
            1. Shaws Creek
            2. Twenty-Five Mile Creek
        iii. Water Quality Impairments in Waccamaw and Great Pee Dee River Watershed
        iv. Project Goals
        v. Best Management Practices
        vi. Programmatic Measures
        vii. Accomplishments to Date
        viii. Interactive Watershed Map

C. Questions and Concerns from attendees and residents of the Watershed.
    a. A question was asked about the fish consumption advisory based on mercury levels.
    b. Several questions focused on monitoring efforts by SCDHEC.
        i. How can data be accessed?
        ii. Which waterbodies are being monitored?
    c. Isolated wetlands are numerous in the Georgetown/Horry area and are unprotected and have no buffers.
    d. The most frequently used BMP is detention ponds.
        i. Can we advise other BMPs?
    e. HOA's need more education on detention basin and stormwater pond maintenance needs.
        i. Stormwater control structures are filling in too quickly with sediment and it is costly to dredge.
    f. Drainage ditches fill quickly with sediment.
    g. Forests are declining due to saltwater intrusion.
    h. Urban development is an issue and results in loss of pervious surface.
    i. The filling in and loss of Carolina Bays is of concern.

Appendix C

Lexington County Permanent Water Quality Buffer Requirements

Appendix C

Lexington County's Permanent Water Quality Buffers Requirements

Buffers are a natural way to protect water courses.

Stream Buffers are 100 ft along perennial streams and 50 ft along intermittent streams. Stream buffers protect stream banks from erosion and improve water quality.

Shoreline buffers are 50 ft from the shoreline of ponds and lakes. Shoreline buffers protect shores from erosion and enhance the integrity of the lake or pond.

Water Quality Buffer Quick Facts

- Floodway areas greater than and equal to 100 or 50 ft may be used as the water quality buffer area.
- Utilities are allowed in water quality buffers, but must remain 25ft from the stream or shoreline.
- The buffer area can be increased based on neighboring land use or slope.
- Single family lots not associated with a larger common development are exempt from the buffer requirement.
- Properties less than 5 acres are exempt from the water quality buffer requirements.

More information on stream and shoreline buffers can be found in Chapter 3 of the Lexington County Land Development Manual located at www.lex-co.com/departments/publicwoks/stormwater.html.

The Natural Way to Protect Waterways

Stormwater Division
440 Ball Park Road
Lexington, SC 29072

Phone: 803-785-8201
Fax: 803-785-8593

Water Quality Buffers

The Natural Way to Protect Waterways

Public Works Stormwater Division

803-785-8201

Water Quality Buffers

Water quality buffers (a.k.a. riparian buffers) are areas of natural vegetation along a water-body such as lakes, streams, rivers, and wetlands. Water quality buffers aid waterways by stabilizing stream banks, filtering pollutants, and slowing stormwater runoff entering the waterway.

There are three main types of water quality buffers:

- Grass buffers- lowest pollutant removal potential
- Shrub buffers- higher pollutant removal efficiency and limited flood control
- Forest buffers: highest pollutant removal efficiency and flood control

Lexington County requires water quality buffers in an effort to protect riparian and aquatic ecosystems, improve water quality, and provide for the environmentally sound use of the County's land resources.

Lexington County Stream Buffer Requirements

Lexington County requires a 100 ft buffer on all perennial streams and a 50 ft buffer on all intermittent streams as identified on a 7.5 USGS quad map, US Army Corp of Engineers of the Public Works Stormwater Division.

Stream buffers cannot be disturbed during project construction and must be left in the existing conditions upon completion of construction activities. The area associated with a stream buffer may be dedicated to the County, turned over to a Homeowners Association, or included as part of a conservation easement. Stream buffers shall be maintained in accordance with Lexington County's maintenance and inspection requirements for permanent stormwater management structures.

Stream buffers must be marked with permanent signage to inform the public that water quality buffers may not be disturbed.

Lexington County Shoreline Buffer Requirements

Lexington County requires a 50 ft buffer along shorelines associated with ponds and lakes that are fed by springs or streams. For ponds and lakes, the shoreline is considered the 100-yr high water elevation. For Lake Murray the shoreline is considered the 360 elevation.

Shoreline buffers are considered areas of managed vegetation. Limited clearing of understory trees and shrubs are allowed to provide access to the shoreline and view corridors.

Permanent signage is not required, but is recommended, on shoreline buffers. Management and maintenance requirements of shoreline buffers are the same as those for stream buffers.

Lexington County Wetland Buffer Requirements

Lexington County requires a 50 ft buffer around wetlands associated with a stream and those not associated with a water body. The buffer should be measured from the edge of the delineated wetland area. The management, maintenance, and signage requirements listed under stream buffers also apply to wetland buffers.

Appendix D

Urban Focus Group Survey

Urban Sources of Pollutants

Urban runoff is one of the categories of pollution sources being addressed in the Watershed Based Plan (WBP) for the Waccamaw and Great Pee Dee Rivers Watershed. Urban runoff is arguably one of the greatest threats to water quality in our inland and coastal areas. Local governments, such as Georgetown County and Horry County, have the opportunity to mitigate these effects by adopting land development practices such as preserving aquatic buffers, requiring better site design, and conserving land, and other policies and enforcement measures. We would appreciate your time to complete the following brief survey regarding what you know as a County employee to help us better understand current, as well as future, land development regulations, policies and enforcement measures that may be of interest to your staff and Council. Note that, as stakeholders in this WBP, we will only include language that you support and approve related to your County's policies and regulations. Note that only stormwater best management practices (BMPs) included in the WBP would qualify for 319 funding, and this plan may be used by any qualified entity to apply for 319 funding. So, it's important for us to understand how the Counties currently operate in order to determine BMPs for the future. Thank you for completing this survey as soon as possible, and by June 22nd at the latest.

Please provide your (1) Name, (2) County Name, and (3) County Department.

1. **Has the County's stream monitoring and/or public complaints about stormwater, pollution, or litter identified specific hot spots of pollution (areas where pollution is common/likely)? If so, are there any BMPs that you would recommend be installed to address these hot spots? Please identify on the following map: https://arcg.is/0qLaOD!**

2. **Are pet waste stations located at all parks (that allow dogs), veterinarian offices, and pet stores in the Waccamaw and Great Pee Dee River watersheds? If not, which ones do not have them?**

3. **Are septic overflows a problem in your County? Does your County have a program to identify and enforce and/or help fund septic repairs? Does your County's planning department require proof that a septic system be approved by DHEC when obtaining a building permit for an additional bedroom(s) on an existing house ?**

4. **Do you believe County staff are able to effectively inspect and enforce erosion & sediment control requirements on construction sites? If not, what are the challenges and possible solutions?**

5. **Do you believe timber harvesting is an issue for water quality? Is it clear when land is being cleared for timber harvesting vs. land development? What are the challenges and possible solutions to address water quality associated with silviculture?**

6. **How many miles of dirt roads are your County responsible for maintaining? Are these roads mapped in GIS by the responsible entity and by dirt/paved? Do you believe there are water quality challenges associated with dirt roads? If so, is there a plan to pave them? Or other solutions?**

7. **Is streambank erosion a problem in your County? If yes, please identify areas where you know erosion is problematic on this interactive map: https://arcg.is/0qLaOD! How does the County address these issues when they become a nuisance or potentially damaging to public or private property?**

8. **Are both public and private post-construction stormwater control structures (ex: stormwater pond, detention pond) required to be maintained annually? Is this being enforced? If not, what are the challenges with ensuring that they are properly maintained?**

9. **Does the County include design/construction of stormwater quality control structures for public building projects (e.g., schools, County offices, police, etc.)? If not, why not? If yes, how?**

10. **Does the County include design/construction of stormwater quality controls for public roadway projects (e.g., County road widening or new road construction)? If not, why not? If yes, how?**

11. **Does the County include design/construction of stormwater quality controls for capital improvement projects? If no, why? If yes, how?**

12. **Do County "field" staff understand what an illicit (non-stormwater) discharge is and how to report it? Do current staff and new employees receive training on illicit discharges? Do you believe citizens and businesses in your County understand this? Are there barriers to reporting, investigation and/or enforcement related to illicit discharges?**

13. **Land Conservation is a technique that places strict, permanent limits on, or eliminates, development of certain properties, if agreed to by its owner. Land conservation is ideally a permanent condition that, when done in large areas or across several connected properties, protects critical habitats, aquatic corridors, and hydrologic reserve areas. Does the County encourage land conservation?**

14. **Provide an explanation if any current local water quality land development regulations that are above and beyond the SCDHEC regulations for water quality (Construction General Permit, SC Reg. 72-307 and the S.C. Coastal Council Stormwater Management Guidelines). Ex: Buffer requirements for aquatic corridors and water quality protection.**

15. From the following, please choose the top three land development practices/policies you believe would have the GREATEST POSITIVE EFFECT ON WATER QUALITY. In answering these questions, don't worry about whether or not these practices/policies would be supported by your County. We will address that in the next question. Permanent Water Quality Buffers are undisturbed vegetated (ideally with trees) corridors along a stream that can prevent stream erosion, intercept unwanted pollutants, provide habitat, and regulate water temperature. To be effective for water quality, a buffer needs to be at least 25 feet wide, but 50 feet or greater is ideal. A permanent water quality buffer is more restrictive than the temporary buffer required during construction in the Construction General Permit.

- ☐ Better Site Design (also called Low Impact Development) is a land development approach that focuses on the layout of buildings, pavement, and green areas on a land development. The goal of better site design is to preserve (or restore) natural areas within a site and minimize the amount of clearing, grading, pavement and rooftop to reduce the amount of stormwater that discharges from a land development. In turn, this prevents stormwater pollution from developed land.
- ☐ Stormwater Management Practices (often called BMPs) are facilities constructed on land developments that provide pollution removal or reduction from the stormwater generated on the development. Examples include stormwater ponds, engineered wetlands, grassy swales, and bioretention.
- ☐ Green Infrastructure is a group of stormwater management practices that rely specifically on getting a small volume of stormwater to soak into the ground (or being captured and reused) to reduce pollution.
- ☐ Impervious Surface Limitations are land development policies that limit impervious cover to a specific maximum. Stream quality typically becomes "degraded" when impervious area is greater than11% and "non-supporting" when impervious area is greater than25%).
- ☐ Overlay Zoning places special restrictions, criteria, or performance standards on specific zones or area(s).
- ☐ Performance Zoning (also called Impact Zoning) is an alternative to traditional land use zoning. Whereas traditional land use zoning specifies what uses land can be put to within specified districts, performance zoning specifies the intensity of land use that is acceptable. In other words, it deals not with the use of the parcel, but the performance of a parcel and how it impacts surrounding areas.
- ☐ Urban Growth Boundaries - establishes a dividing line between areas appropriate for urban and suburban development, and areas appropriate for agriculture, rural and resource protection.
- ☐ Large Lot Zoning - zoning development at very low densities to disperse impervious cover over very large areas. Densities of 1 lot per 2, 5, or even 10 acres are not uncommon.

- Infill/Community Redevelopment - encourages new or re-development in unused or underutilized land in existing urban areas. Although the objectives behind promoting infill/redevelopment may be primarily tied to economic growth or area revitalization, these approaches tend to be good from a stormwater quality perspective because they use land and/or stormwater systems that are already developed. Thus, green space is inadvertently preserved.
- Incentives for Better Site Design and Green Infrastructure are ways to promote stormwater-friendly site designs. Stormwater utility credits, design volume reductions, landscape credits, plan review acceleration, and other planning/zoning credits are all ways local governments can promote these types of development.

16. From the following, please rank the top three land development practices/policies that would be most supported by the COMMUNITY. Permanent Water Quality Buffers are undisturbed vegetated (ideally with trees) corridors along a stream that can prevent stream erosion, intercept unwanted pollutants, provide habitat, and regulate water temperature. To be effective for water quality, a buffer needs to be at least 25 feet wide, but 50 feet or greater is ideal. A permanent water quality buffer is more restrictive than the temporary buffer required during construction in the Construction General Permit.

- Better Site Design (also called Low Impact Development) is a land development approach that focuses on the layout of buildings, pavement, and green areas on a land development. The goal of better site design is to preserve (or restore) natural areas within a site and minimize the amount of clearing, grading, pavement and rooftop to reduce the amount of stormwater that discharges from a land development. In turn, this prevents stormwater pollution from developed land.
- Stormwater Management Practices (often called BMPs) are facilities constructed on land developments that provide pollution removal or reduction from the stormwater generated on the development. Examples include stormwater ponds, engineered wetlands, grassy swales, and bioretention.
- Green Infrastructure is a group of stormwater management practices that rely specifically on getting a small volume of stormwater to soak into the ground (or being captured and reused) to reduce pollution.
- Impervious Surface Limitations are land development policies that limit impervious cover to a specific maximum. Stream quality typically becomes “degraded” when impervious area is greater than11% and “non-supporting” when impervious area is greater than25%).
- Overlay Zoning places special restrictions, criteria, or performance standards on specific zones or area(s).
- Performance Zoning (also called Impact Zoning) is an alternative to traditional land use zoning. Whereas traditional land use zoning specifies what uses land can be put to within specified districts, performance zoning specifies the intensity of land use

that is acceptable. In other words, it deals not with the use of the parcel, but the performance of a parcel and how it impacts surrounding areas.

- Urban Growth Boundaries - establishes a dividing line between areas appropriate for urban and suburban development, and areas appropriate for agriculture, rural and resource protection.
- Large Lot Zoning - zoning development at very low densities to disperse impervious cover over very large areas. Densities of 1 lot per 2, 5, or even 10 acres are not uncommon.
- Infill/Community Redevelopment - encourages new or re-development in unused or underutilized land in existing urban areas. Although the objectives behind promoting infill/redevelopment may be primarily tied to economic growth or area revitalization, these approaches tend to be good from a stormwater quality perspective because they use land and/or stormwater systems that are already developed. Thus, green space is inadvertently preserved.
- Incentives for Better Site Design and Green Infrastructure are ways to promote stormwater-friendly site designs. Stormwater utility credits, design volume reductions, landscape credits, plan review acceleration, and other planning/zoning credits are all ways local governments can promote these types of development.

17. From the following, please rank the top three land development practices/policies you believe COUNTY STAFF WOULD BE MOST LIKELY TO PURSUE. Permanent Water Quality Buffers are undisturbed vegetated (ideally with trees) corridors along a stream that can prevent stream erosion, intercept unwanted pollutants, provide habitat, and regulate water temperature. To be effective for water quality, a buffer needs to be at least 25 feet wide, but 50 feet or greater is ideal. A permanent water quality buffer is more restrictive than the temporary buffer required during construction in the Construction General Permit.

- Better Site Design (also called Low Impact Development) is a land development approach that focuses on the layout of buildings, pavement, and green areas on a land development. The goal of better site design is to preserve (or restore) natural areas within a site and minimize the amount of clearing, grading, pavement and rooftop to reduce the amount of stormwater that discharges from a land development. In turn, this prevents stormwater pollution from developed land.
- Stormwater Management Practices (often called BMPs) are facilities constructed on land developments that provide pollution removal or reduction from the stormwater generated on the development. Examples include stormwater ponds, engineered wetlands, grassy swales, and bioretention.
- Green Infrastructure is a group of stormwater management practices that rely specifically on getting a small volume of stormwater to soak into the ground (or being captured and reused) to reduce pollution.
- Impervious Surface Limitations are land development policies that limit impervious cover to a specific maximum. Stream quality typically becomes “degraded” when

impervious area is greater than11% and “non-supporting” when impervious area is greater than25%).

- Overlay Zoning places special restrictions, criteria, or performance standards on specific zones or area(s).
- Performance Zoning (also called Impact Zoning) is an alternative to traditional land use zoning. Whereas traditional land use zoning specifies what uses land can be put to within specified districts, performance zoning specifies the intensity of land use that is acceptable. In other words, it deals not with the use of the parcel, but the performance of a parcel and how it impacts surrounding areas.
- Urban Growth Boundaries - establishes a dividing line between areas appropriate for urban and suburban development, and areas appropriate for agriculture, rural and resource protection.
- Large Lot Zoning - zoning development at very low densities to disperse impervious cover over very large areas. Densities of 1 lot per 2, 5, or even 10 acres are not uncommon.
- Infill/Community Redevelopment - encourages new or re-development in unused or underutilized land in existing urban areas. Although the objectives behind promoting infill/redevelopment may be primarily tied to economic growth or area revitalization, these approaches tend to be good from a stormwater quality perspective because they use land and/or stormwater systems that are already developed. Thus, green space is inadvertently preserved.
- Incentives for Better Site Design and Green Infrastructure are ways to promote stormwater-friendly site designs. Stormwater utility credits, design volume reductions, landscape credits, plan review acceleration, and other planning/zoning credits are all ways local governments can promote these types of development.

18. From the following, please rank the top three practices your COUNTY COUNCIL WOULD MOST LIKELY HAVE AN INTEREST IN PURSUING. Permanent Water Quality Buffers are undisturbed vegetated (ideally with trees) corridors along a stream that can prevent stream erosion, intercept unwanted pollutants, provide habitat, and regulate water temperature. To be effective for water quality, a buffer needs to be at least 25 feet wide, but 50 feet or greater is ideal. A permanent water quality buffer is more restrictive than the temporary buffer required during construction in the Construction General Permit.

- Better Site Design (also called Low Impact Development) is a land development approach that focuses on the layout of buildings, pavement, and green areas on a land development. The goal of better site design is to preserve (or restore) natural areas within a site and minimize the amount of clearing, grading, pavement and rooftop to reduce the amount of stormwater that discharges from a land development. In turn, this prevents stormwater pollution from developed land.
- Stormwater Management Practices (often called BMPs) are facilities constructed on land developments that provide pollution removal or reduction from the stormwater

generated on the development. Examples include stormwater ponds, engineered wetlands, grassy swales, and bioretention.

- Green Infrastructure is a group of stormwater management practices that rely specifically on getting a small volume of stormwater to soak into the ground (or being captured and reused) to reduce pollution.
- Impervious Surface Limitations are land development policies that limit impervious cover to a specific maximum. Stream quality typically becomes “degraded” when impervious area is greater than11% and “non-supporting” when impervious area is greater than25%).
- Overlay Zoning places special restrictions, criteria, or performance standards on specific zones or area(s).
- Performance Zoning (also called Impact Zoning) is an alternative to traditional land use zoning. Whereas traditional land use zoning specifies what uses land can be put to within specified districts, performance zoning specifies the intensity of land use that is acceptable. In other words, it deals not with the use of the parcel, but the performance of a parcel and how it impacts surrounding areas.
- Urban Growth Boundaries - establishes a dividing line between areas appropriate for urban and suburban development, and areas appropriate for agriculture, rural and resource protection.
- Large Lot Zoning - zoning development at very low densities to disperse impervious cover over very large areas. Densities of 1 lot per 2, 5, or even 10 acres are not uncommon.
- Infill/Community Redevelopment - encourages new or re-development in unused or underutilized land in existing urban areas. Although the objectives behind promoting infill/redevelopment may be primarily tied to economic growth or area revitalization, these approaches tend to be good from a stormwater quality perspective because they use land and/or stormwater systems that are already developed. Thus, green space is inadvertently preserved.
- Incentives for Better Site Design and Green Infrastructure are ways to promote stormwater-friendly site designs. Stormwater utility credits, design volume reductions, landscape credits, plan review acceleration, and other planning/zoning credits are all ways local governments can promote these types of development.

19. Are there other programmatic practices you/your County would be interested in pursuing that will benefit water quality?

20. Would you/the County be interested in pursuing a 319 grant once this WBP is completed? If so, what type(s) of project(s) would you be interested in applying for?

Appendix E

STEPL Input

										Rain correction factors		
1. Input watershed land use area (ac) and precipitation (in)										0.930	0.554	
Watershed	Urban	Cropland	Pasturelan d	Forest	User Defined (Golf Course)	Feedlots	Feedlot Percent Paved	Total		Annual Rainfall	Rain Days	Avg. Rain/Even t
W1	6509	50	0	1057	156	0	0-24%	7772		55	111	0.826
W2	2615	886	0	2909	120	0	0-24%	6530		55	111	0.826
W3	3883	68	0	5083	759	0	0-24%	9793		55	111	0.826
W4	498.6	578	5	2141	0	0	0-24%	3222.6		55	111	0.826
W5	1342	1158	5	7210	0	0	0-24%	9715		55	111	0.826
W6	2113.2	1328	5	11834	0	0	0-24%	15280.2		55	111	0.826

2. Input agricultural animals											
Watershed	Beef Cattle	Dairy Cattle	Swine (Hog)	Sheep	Horse	Chicken	Turkey	Duck	# of months manure applied on Cropland	# of months manure applied on Pasturelan d
W1	0	0	0	0	0	0	0	0	0	0	0
W2	0	0	0	0	0	0	0	0	0	0	0
W3	0	0	0	0	3	0	0	0	0	0	0
W4	4	0	0	0	0	0	0	0	0	0	0
W5	0	0	0	0	0	0	0	0	0	0	0
W6	0	0	0	0	0	0	0	0	0	0	0
Total	4	0	0	0	3	0	0	0			

3. Input septic system and illegal direct wastewater discharge data

Watershed	No. of Septic Systems	Population per Septic System	Septic Failure Rate, %	r Direct Discharge, # of	Discharge Reduction, %
W1	0	2.43	10	0	0
W2	0	2.43	10	0	0
W3	0	2.43	10	0	0
W4	0	2.43	10	0	0
W5	0	2.43	10	0	0
W6	0	2.43	10	0	0

Optional Data Input:

5. Select average soil hydrologic group (SHG), SHG A = highest infiltration and SHG D = lowest infiltration									
Watershed	SHG A	SHG B	SHG C	SHG D	SHG Selected	Soil N conc.%	Soil P conc.%	Soil BOD conc.%	Soil E. coli conc. (#/100mg)
W1	○	◉	○	○	B	0.080	0.031	0.160	0.000
W2	○	◉	○	○	B	0.080	0.031	0.160	0.000
W3	◉	○	○	○	A	0.080	0.031	0.160	0.000
W4	○	○	◉	○	C	0.080	0.031	0.160	0.000
W5	○	○	◉	○	C	0.080	0.031	0.160	0.000
W6	○	◉	○	○	B	0.080	0.031	0.160	0.000

6. Reference runoff curve number (may be modified)

SHG	A	B	C	D
Urban	83	89	92	93
Cropland	67	78	85	89
Pastureland	49	69	79	84
Forest	39	60	73	79
User Defined	39	61	74	80

7. Nutrient concentration in runoff (mg/l) and E. coli (MPN/100ml)

Land use	N	P	BOD	E. coli
1. L-Cropland	**1.9**	**0.3**	**4**	0
1a. w/ manure	8.1	2	12.3	0
2. M-Cropland	**2.9**	**0.4**	**6.1**	0
2a. w/ manure	12.2	3	18.5	0
3. H-Cropland	**4.4**	**0.5**	**9.2**	0
3a. w/ manure	18.3	4	24.6	0
4. Pastureland (see Table 10 for default values with manure)				
5. Forest	**0.2**	**0.1**	**0.5**	0
6. User Defined	**0.14**	**0.03**	**0**	0

8. Input or modify urban land use distribution

Watershed	Urban Area (ac.)	Commercial %	Industrial %	Institutional %	Transportation %	Multi-Family %	Single-Family %	Urban-Cultivated	Vacant (develope	Open Space %	Total % Area
W1	6509	5	0	10	10	10	30	25	0	10	100
W2	2615	5	0	0	10	10	30	25	5	15	100
W3	3983	10	0	10	10	10	30	20	5	5	100
W4	498.6	0	0	5	45	0	5	0	0	45	100
W5	1342	5	0	5	45	0	5	35	0	5	100
W6	2113.2	10	0	10	10	10	35	10	5	10	100
W7	0	15	10	10	10	10	30	5	5	5	100
W8	0	15	10	10	10	10	30	5	5	5	100
W9	0	15	10	10	10	10	30	5	5	5	100
W10	0	15	10	10	10	10	30	5	5	5	100

10. Pastureland Nutrient concentration in runoff (mg/l) and E. coli (MPN/100ml)

Land use	N	P	BOD	E. coli
1. L-Pastureland	**4**	**0.3**	**13**	7800
1a. w/ manure	4	0.3	13	0
2. M-Pastureland	**4**	**0.3**	**13**	8200
2a. w/ manure	4	0.3	13	0
3. H-Pastureland	**4**	**0.3**	**13**	8600
3a. w/ manure	4	0.3	13	0

***E. coli numbers from Bacterial Transport from Agricultural Lands Fertilized with Animal Manure 2008 Mishra et al**

Input Ends Here.

Estimated Existing Pollutant Loads in the Waccamaw and Great Pee Dee Rivers Watershed

	N (lb/yr)	P (lb/yr)	TSS (ton/yr)	E. coli (CFU/yr)
Livestock	119	9	4	1.05E+12
Cropland	23,546	3,718	7,988	
Urban	126,196	19,848	3,242	9.06E+14
Septic	5,362	2,103		4.17E+12
Forest	8,531	4,265	609	
Golf Course	112	24	2,032	
Total Sources	**163,866**	**29,967**	**13,875**	**9.11E+14**

Appendix F

Pet Waste Ordinance Example

Appendix F

Pet Waste Ordinance Example

Model Ordinance - Pet Waste

Ordinance # [ ] - Pet Waste

SECTION I. Purpose:

An ordinance to establish requirements for the proper disposal of pet solid waste in **[insert name of municipality]**, so as to protect public health, safety and welfare, and to prescribe penalties for failure to comply.

SECTION II. Definitions:

For the purpose of this ordinance, the following terms, phrases, words and their derivations shall have the meanings stated herein unless their use in the text of this Chapter clearly demonstrates a different meaning. When not inconsistent with the context, words used in the present tense include the future, words used in the plural number include the singular number, and words used in the singular number include the plural number. The word "shall" is always mandatory and not merely directory.

a. Immediate – shall mean that the pet solid waste is removed at once, without delay.

b. Owner/Keeper – any person who shall possess, maintain, house or harbor any pet or otherwise have custody of any pet, whether or not the owner of such pet.

c. Person – any individual, corporation, company, partnership, firm, association, or political subdivision of this State subject to municipal jurisdiction.

d. Pet - a domesticated animal (other than a disability assistance animal) kept for amusement or companionship.

e. Pet solid waste – waste matter expelled from the bowels of the pet; excrement

f. Proper disposal – placement in a designated waste receptacle, or other suitable container, and discarded in a refuse container which is regularly emptied by the municipality or some other refuse collector; or disposal into a system designed to convey domestic sewage for proper treatment and disposal. [Disposal into a stormdrain or stormwater system is strictly prohibited. From Morris, NJ ordinance, full reference below]

SECTION III. Requirement for Disposal:

All pet owners and keepers are required to immediately and properly dispose of their pet's solid waste deposited on any property, public or private, not owned or possessed by that person.

SECTION IV. Exemptions:

Any owner or keeper who requires the use of a disability assistance animal shall be exempt from the provisions of this section while such animal is being used for that purpose.

SECTION V. Enforcement:

The provisions of this Article shall be enforced by the **[Police Department and the Local Board of Health]** of **[insert name of municipality]**.

SECTION VI. Violations and Penalty:

Any person(s) who is found to be in violation of the provisions of this ordinance shall be subject to a fine not to exceed **[insert amount]**.

SECTION VII. Severability:

Each section, subsection, sentence, clause and phrase of this Ordinance is declared to be an independent section, subsection, sentence, clause and phrase, and the finding or holding of any such portion of this Ordinance to be unconstitutional, void, or ineffective for any cause, or reason, shall not affect any other portion of this Ordinance.

SECTION VIII. Effective date:

This Ordinance shall be in full force and effect from and after its adoption and any publication as may be required by law.

ALL OF WHICH IS ADOPTED this _____ day of ____, 200_, by the _____.

Model ordinance based on NJ Model Pet Waste Ordinance:

http://nj.gov/dep/stormwater/tier_A/pdf/pet%20waste%20ordinance.pdf accessed February 5, 2006

Annotations:

Operation and Maintenance Program for the Prevention and Reduction of Pollution in Storm Water Runoff From Municipal Operations within the city of {Municipality Name}, St. Louis County, Missouri, February 2005, Adopted {date} Appendix 2-F6: Model – Animal Waste Ordinance

6.06.030 Possession of Removal Equipment. It is unlawful for the owner or handler of any animal to fail to have in their possession the equipment necessary to remove their animals' fecal matter when accompanied by said animal on public property or public easement, or private property of another.

6.06.040 Set Aside Areas. The above prohibitions shall not extend to areas set aside and designated by the city as areas where animals can be off-lease for exercise or training.

Ordinance #1-05, Chapter 99A Pet Waste, Township of Morris NJ – http://www.morristwp.com/ord-petwaste.asp accessed January 31, 2007

Section III. Requirements for Disposal:
"…On any property owned or possessed by that person, all pet owners and keepers are required to properly dispose of their pet's solid waste at a frequency of at least weekly or more frequently if necessary to prevent a public health nuisance."

Section VI. Violations and Penalty:
"….for each offense, together with the costs of prosecution. A separate offense shall be deemed committed on each day or part of each day during which a violation occurs or continues."

North Kingstown code of ordinances, Chapter 3 ANIMALS, http://www.municode.com/ accessed 1/21/07

Sec. 3-23. Removal of dog feces.
(a) *Required.* It shall be the duty of each person who owns, possesses or controls a dog to remove and dispose of any feces left by such person's dog on any sidewalk, street or other public area. It shall, further, be the duty of each person who owns, possesses or controls a dog to remove and dispose of any feces left by such person's dog on any private property neither owned nor occupied by the person.
(b) *Duty to possess means of removal.* No person who owns, possesses or controls a dog shall appear with such dog on any sidewalk, street, park or other public area without the means of removal of any feces left by such dog. Furthermore, no person who owns, possesses, or controls such dog shall appear on any private property neither owned nor occupied by such person without the means of removal of any feces left by the dog.

(c) *Method of removal and disposal.* For the purpose of this section, the means of removal shall be any tool, implement or other device carried for the purpose of picking up and containing such feces, unexposed to such person or the public. Disposal shall be accomplished by transporting the feces to a place suitable and regularly reserved for the disposal of human feces, to a place specifically reserved for the disposal of dog feces, or to a place so designated as appropriate by the department of public works.
(d) *Fines for violation.* Violation of this section shall be punishable by a fine not exceeding:
(1) $10.00 for the first offense;
(2) $25.00 for the second offense within a year of the first offense; and
(3) $50.00 for the third and any subsequent offenses within a year of the first offense.
Fines to be recovered by action of debt or by complaint or warrant, to use as the town council may prescribe.
(e) *Exemption.* This section shall not apply to a licensed dog accompanying any handicapped person who, because of such person's handicap, is physically unable to comply with the requirements of this section.
(Ord. No. 96-13, § 1, 7-8-1996; Ord. No. 03-06, § 3, 5-12-2003)

The Codified Ordinances of the City of Newport, Rhode Island, Chapter 6.08. ANIMAL CONTROL REGULATIONS, 6.08.050. Restraint of animals.

F. No person having control of an animal shall knowingly permit the same to defecate in or upon any sidewalk, public place, park or building, or in or upon any part of a building used by or open to the public, or upon the property of a person other than the owner of such animal. Any person having control of an animal which defecates in or upon any sidewalk, public place, park or building, or in or upon any part of a building used by or open to the public, or upon the property of a person other than the owner of such animal, shall forthwith remove the feces.

2. Any person who brings into an off-leash site shall:
a. Carry materials and implements for removing and disposing of *dog* excreta and remove all excreta deposited by the *dog* in the off-leash site, in compliance with Section 6.08.050;

Appendix G

Georgetown Clean Water Fund Proposal

Safeguarding Clean Drinking Water for Georgetown County

Why Investing in Source Water Protection Makes Good Business Sense

Protecting the sources of our drinking water is good for our economy, quality of life *and* our environment. Investing in forest and watershed protection:

- **Safeguards clean drinking water**
- **Is less expensive than conventional water treatment**
- **Lowers maintenance costs**
- **Maximizes investment because forest values appreciate over time**
- **Reduces flooding of homes, roads and businesses**
- **Lowers county flood insurance costs by utilizing open space credits earned though the National Flood Insurance Program**
- **Delivers financial benefits to property owners who protect their land**

A Costly Problem with an Effective Solution

Community water supplies across the United States are threatened by polluted stormwater, flooding and rising sea levels. As our population grows and forests are converted to residential developments and urban landscapes, providing communities with clean, affordable drinking water becomes a growing challenge. These problems are compounded in coastal communities where sea level rise and worsening drought events threaten to contaminate drinking water supplies with saltwater. How can we protect our water supplies and ensure our communities stay vibrant and do it all in the most economical way possible?

Source water protection is a natural, cost-saving approach to protecting community water supplies. It safeguards clean drinking water by removing potential pollutants at the source -- our rivers and riverside lands. These forested landscapes also play a significant role in reducing the movement of saltwater upstream. Georgetown County Water and Sewer District has an opportunity to apply these natural solutions to secure long-term, affordable drinking water protection and provide a variety of additional benefits to local communities that build resiliency, support quality of life and foster economic growth.

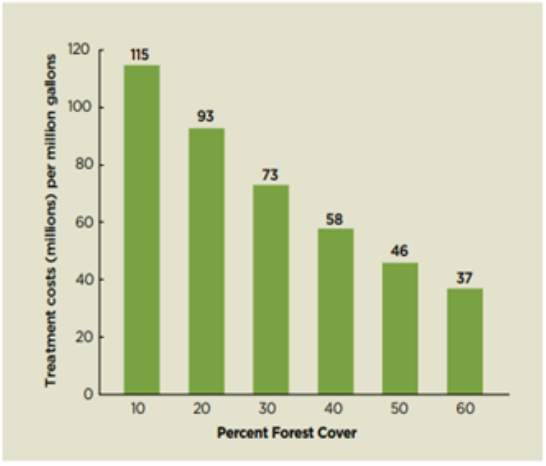


Figure 1: Water treatment costs decrease as forest cover increases.

Forests effectively deliver the nation's largest source of water. For every dollar invested in forest protection, utilities save up to $200 in treatment and filtration costs.[1] Utilities are investing in watershed protection to save on infrastructure. In a study of 27 U.S. water supply systems, watersheds with 60 percent forest cover required on average $37 per million gallons for treatment costs compared to $115 per million gallons for watersheds with only 10 percent forest cover (see Figure 1 at right).[2]

[1] Edmonds, K., DeBonis, M., & Sunderland, P. (2013). *Forests to faucets: Protecting upstream forests for clean water downstream* (p. 16). Washington D.C.: American Rivers.
[2] Ernst, C., Hopper, K., & Summers, D. (2004). *Protecting the source: Land conservation and the future of America's drinking water* (p.22). Trust for Public Land.

Traditional engineered approaches to protecting water quality are costly to build and maintain. It can also be difficult or expensive to alter their capacity or function to adapt to changing conditions. In addition, pipelines depreciate from the moment they are built, while the value of forests increases as they mature. Healthy forests are also able to adapt to a wide range of climatic conditions and weather events such flooding, intense storms and droughts, which are projected to become increasingly common and extreme.

One of the greatest threats to clean water is the conversion of forests to developed landscapes such as residential developments, shopping centers and roadways. These structures increase the amount of stormwater runoff and pollution in rivers and streams. The American Water Works Association recently found that when a forested watershed undergoes development, chemical treatment costs increase by 8.7 percent — an annual increase of over $65,000 for the typical water treatment plant.[3]

Benefits to Georgetown County

Today, communities in Georgetown County enjoy the environmental and economic benefits of the vast forested landscape along the Waccamaw and Pee Dee Rivers. These riverside lands filter pollutants from stormwater runoff before contaminants have a chance to enter the rivers, saving Georgetown County Water and Sewer District substantial water treatment costs.

An analysis of water quality done by the Pee Dee Clean Water Study Group — which includes Georgetown County Water and Sewer District, other water users, state agencies and conservation organizations — showed high levels of turbidity in reaches of the Pee Dee that flow through agricultural and urban areas upstream from Georgetown County Water and Sewer District's intake. Turbidity decreased significantly as the river flows through forested areas in Horry and Georgetown counties.

These counties, however, are among the fastest growing regions in South Carolina. Between 2000 and 2018, the combined populations of Horry and Georgetown counties increased 62 percent — and this growth is expected to continue.[4] [5] These population and development pressures are compounded by growing flood risks in many areas along the Waccamaw and Pee Dee Rivers. Between 2015 and 2018, Grand Strand communities experienced three major flood events. More frequent flooding and the conversion of forests to developed areas will likely increase stormwater runoff and treatment costs.

In addition, urbanized land produces peak flows more than twice that of natural land[6]. Not only does this increase flood risk, these peak flows represent water which under natural conditions would be retained and released slowly back to the river. This reduces flood peaks but raises normal daily river flows. A relatively small area of natural floodplain upstream of Conway, for example, can hold and release enough water to completely push back upstream tidal flow for 30 days or more[7]. This represents a significant natural buffer against the upstream movement of tidal saltwater.

---

[3] Warziniack, T., Sham, C., Morgan, R., & Ferferholtz, Y. (2017). *Effect of forest cover on water treatment costs*. Water Economics and Policy. (3(4)

[4] Evans, D., Bodman, S., Cooper, K. and Kincannon, C., 2003. *Population and Housing Unit Counts*. PHC-3-42, South Carolina. [online] Washington, D.C.: U.S. Census Bureau, p.2. Available at: <https://www.census.gov/prod/cen2000/phc-3-42.pdf>

[5] Census Bureau QuickFacts. 2020. *U.S. Census Bureau Quickfacts: Georgetown County, South Carolina; Horry County, South Carolina*. [online] Available at: <https://www.census.gov/quickfacts/fact/table/georgetowncountysouthcarolina,horrycountysouthcarolina/PST045219>

[6] Konrad, C.P., 2003. *Effects of urban development on floods.* USGS Fact Sheet 076-03; 4pp. Available at https://pubs.usgs.gov/fs/fs07603/pdf/fs07603.pdf

[7] Schmid, K., 2020. *Pilot Report: Measurement of Floodplain Value for Downstream Flood Reduction*. The Nature Conservancy, South Carolina; 25 pp.

We need a proactive solution that protects Georgetown County's water supply, allows for continued growth, accounts for future flooding and secures the integrity of riverside forests.

A Path Forward for Georgetown County Water and Sewer District

American Rivers, Pee Dee Land Trust and The Nature Conservancy propose a partnership agreement with Georgetown County Water and Sewer District to establish a clean water fund that will help safeguard drinking water sources by protecting riverside forests.

Our GIS model has identified and ranked 236 properties, comprising 52,877 acres, along the Waccamaw and Pee Dee Rivers that are within and adjacent to Georgetown County Water and Sewer District's source water protection area (see Figure 2). Since they are close to rapidly expanding urban areas, these properties may be at risk of being converted from forest to built landscapes — which, as we have shown, could negatively impact water quality. Protecting these lands today will secure clean, affordable drinking water for the future.

With an investment from Georgetown County Water and Sewer District, we will work with willing landowners to protect their property through conservation easements or voluntary purchase agreements. We will also leverage the water district's contribution many times over with outside funding sources such as private donations, Clean Water State Revolving Funds and South Carolina Conservation Bank grants. Our experience shows that matching funds can multiply Georgetown County Water and Sewer District's contributions by six-fold or more.

Understanding the Georgetown Clean Water Fund

The goal of the Georgetown Clean Water Fund is to invest in the protection of critical riverside lands through conservation easements or acquisitions. Conservation easements are voluntary legal agreements that permanently limit the use of land to protect water quality and other natural values while allowing private landowners to retain their properties. Conservation easements are highly discounted transactions that cost a fraction of the price of land purchases. Following initial approval, a detailed funding agreement would be developed by Georgetown County Water and Sewer District, American Rivers, Pee Dee Land Trust and The Nature Conservancy that explains the decision-making process for how the funds would be used.

How much will it cost?

- There are 52,877 acres of priority tracts.
- The average easement value for rural land is from $750 to $1000 per acre.
- The landowner typically donates 2/3 of the easement value making the cash value for an easement 1/3 of the easement value. Assuming a $1000 easement value, the cash needed would be $333/acre.
- We expect to be able to match the Georgetown Clean Water Fund money at a 1:1 rate with SC Conservation Bank or other grants. This brings the cost for the water fund to $167 per acre.

How long will it take?

- The length of time to achieve land conservation goals depends upon:
    1. The amount of funding available per year
    2. The willingness of landowners

3. The capacity of the land trust(s)

We recommend having a targeted completion date of 10 years.

How much land can be protected?

- The amount of funding available is a key driver for how much land can be protected. The different conservation goals come with different costs. The source water protection benefits achieved would be proportional to the amount of land protected.
- Goal 1: Protect 35,251 acres or 2/3 of priority conservation properties
    - Total cash required at $333/acre is $11,738,694.
    - Georgetown Clean Water Fund investment $5,869,347 or $586,935 per year
- Goal 2: Protect 26,439 acres or 1/2 of priority conservation properties
    - Total cash required at $333/acre is $8,804,021.
    - Georgetown Clean Water Fund investment $4,402,010 or $440,201 per year
- Goal 3: Protect 17,626 acres or 1/3 of priority conservation properties
    - Total cash required at $333/acre is $5,869,347.
    - Georgetown Clean Water Fund investment $2,934,673 or $239,467 per year

Funding Options

- The Georgetown Clean Water Fund investments listed above are for annual contributions over 10 years
- Providing lump sum funding through a 30-year loan from the State Revolving Fund lowers annual costs, speeds up land protection, and delivers water quality benefits sooner.
- If Georgetown County Water and Sewer District provided funding through a State Revolving Fund loan at the current rate of 1.7% interest compounded annually for 30 years, the annual payments would be:
    - Goal 1: $251,380 if paid annually
    - Goal 2: $188,535 if paid annually
    - Goal 3: $125,690 if paid annually

Additional Community Benefits

In addition to safeguarding clean, affordable drinking water for the residents, visitors and businesses in Georgetown County, investing in forest and watershed protection will enhance the region's economy and environment, and local quality of life. Protecting freshwater sources ensures proper function of the natural system. Its benefits include floodwater storage in riverside lands that reduce flooding in homes and businesses; lower county flood insurance costs by utilizing open space credits earned through the National Flood Insurance Program; affordable, family-friendly recreation; financial incentives to property owners who protect their land; job creation through ecotourism; and attraction and retention of sought-after companies. It also shows water customers that the utility is doing all it can to protect drinking water sources and keep costs down.

Public water providers like Georgetown County Water and Sewer District need to embrace a long-term view of their water supplies and tap into opportunities that will pay dividends far into the future. Investing in healthy forests and watershed protection makes good business sense as a cost-effective solution for preserving clean, affordable water for generations to come.

Critical Lands for Source Water Protection

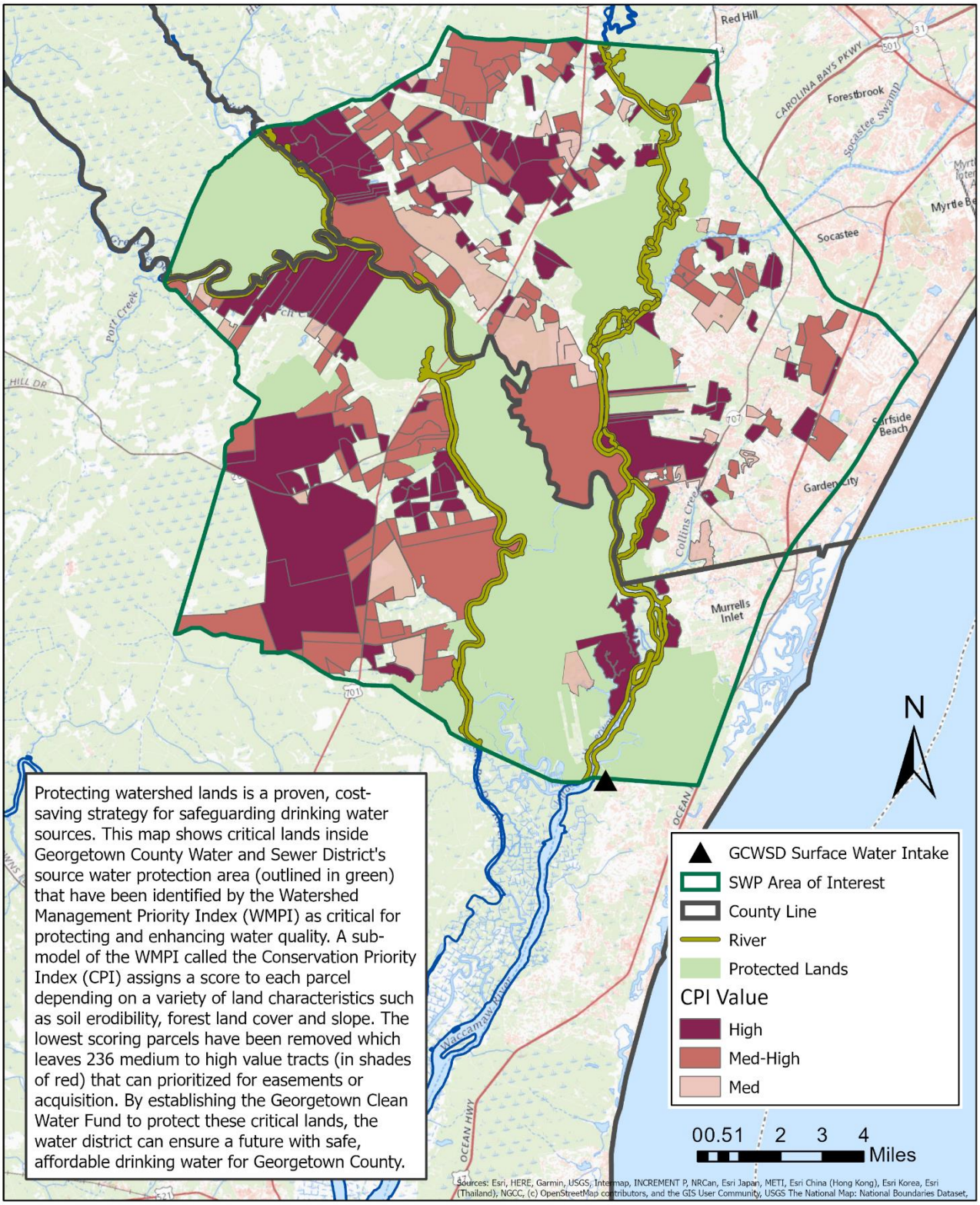


Figure 2: This map shows parcels within and adjacent to Georgetown County Water and Sewer District's source water protection area that were identified by the Conservation Priority Index as lands that are vital to the region's clean water supply.

American Rivers
RIVERS CONNECT US®

Pee Dee Land Trust
Protecting the past. Ensuring the future.

The Nature Conservancy

For more information, contact Janae Davis at jdavis@americanrivers.org or (843) 999-0182.