WATERSHED PLAN FOR THE FISHING CREEK RESERVOIR-CATAWBA RIVER, SIXMILE CREEK-CATAWBA RIVER, AND WAXHAW CREEK WATERSHEDS

South Carolina Rural Water Association
for
South Carolina Department of Environmental Services

2025

ACKNOWLEDGEMENTS

The Watershed Plan (WP) for Fishing Creek Reservoir-Catawba River, Sixmile Creek-Catawba River, and Waxhaw Creek watersheds was developed by the South Carolina Rural Water Association (SCRWA) with contributions from many state and local organizations. We would like to thank the Stakeholder Team listed below for providing their assistance in the development of this plan. Their past contributions and future efforts will lead to water quality improvement throughout the project area. SCRWA would like to thank the South Carolina Department of Environmental Services (SCDES) for their support and guidance provided throughout the planning process. The development of the WP was funded by the South Carolina Drinking Water State Revolving Fund, which is administered by SCDES.

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EXECUTIVE SUMMARY

This WP's project area includes the Fishing Creek Reservoir-Catawba River (030501030606), Sixmile Creek-Catawba River (030501030604), and Waxhaw Creek (030501030603) watersheds. These watersheds are a total of 118 square miles and located in the Lower Catawba River Basin in portions of Chester, Fairfield, Lancaster, and York counties.

The region's climate is characterized as humid subtropical, consisting of relatively high temperatures and evenly distributed precipitation throughout the year. The project area is made up of a diverse range of geological formations, including crystalline rocks and well-drained soils. The primary land cover consists of 64% forested land, 11% developed, and 9% agricultural land.

The Fishing Creek Reservoir is a manmade impoundment fed by the Catawba River. The headwaters of the Catawba River begin in North Carolina's McDowell County and flow east, then south into South Carolina. There are two municipal drinking water intakes in the project area – Chester Metropolitan District (CMD) (1220002) and the Catawba River Water Supply Project (WSP) (2920002). CMD is the primary drinking water utility, providing drinking water to approximately 16,500 customers. The Catawba River WSP treats water for wholesale to Lancaster County Water and Sewer District in South Carolina and Union County in North Carolina.

The waterbodies in the project area, including the Fishing Creek Reservoir, are classified as freshwaters with designated uses including contact recreation, fish consumption, and aquatic life by SCDES. Water quality in the project area is impaired due to numerous water quality standards not being met. There are 37 SCDES Water Quality Monitoring Stations (WQMSs) currently included on the Clean Water Act Section 303(d) List of Impaired Waters. The listed impairments include biological, copper, dissolved oxygen (DO), *E. coli*, nitrogen, phosphorus, pH, polychlorinated biphenyl (PCB), and turbidity. Stakeholder input and field surveys indicate that the primary sources of pollution in the project area are failing septic systems, agricultural runoff, stormwater runoff, flooding, and upstream urban influence. The calculated estimated annual load from bacterial nonpoint pollution sources in the project area is 1.83E+09 Colony Forming Units (CFUs)/year. This is a combined calculation from specific sources including septic systems, agricultural (pastureland and cropland), and urban. The total estimated annual load from sediment pollution is 5,967 tons/year. The Environmental Protection Agency's (EPA) Pollutant Load Estimation Tool (PLET) was used to calculate the combined sediment pollutant load through the analysis of data relating to land cover, agriculture, soil, and precipitation. The total estimated annual load from nutrient pollution is approximately 120,339 lbs./year of nitrogen and 22,486 lbs./year of Phosphorus. PLET was used in the same manner to determine the combined nutrient loads.

This WP addresses the bacteria, sediment, and nutrient pollutants through mitigation strategies that will efficiently reduce and/or prevent nonpoint source pollutants from contaminating the waterbodies in the project area. The recommended actions are intended to improve water quality and reduce the potential burden of increased water treatment costs to the local water utilities. The proposed mitigation strategies include installing a suite of Best Management Practices (BMPs) over a 15-year timeline that consists of three five-year phases. Over the 15-year project timeline, the proposed BMPs could reduce bacteria, sediment, and nutrient loads by approximately 1.83E+16 CFUs, 5,100 tons, and 60,015 lbs. respectively. The calculated reductions from the proposed BMPs are sufficient in addressing the current pollutant issues in the project area with the potential to mitigate future impacts from continued upstream development.

Installing the proposed BMPs over the recommended 15-year timeline will cost approximately $20 million, which equates to approximately $6.7 million for each five-year phase. Sections 10 through 12 provide more details regarding the proposed BMP installation timeline, their costs, definitions and maintenance plans for each, and recommendations for BMP installation locations. If implemented, these BMPs over time will greatly reduce the bacteria, sediment, and nutrient nonpoint source pollution causing the current water quality impairments in the project area. Though these BMPs are specifically prescriptive to the identified sources of pollution in the project area, supplemental BMPs should be considered as funding opportunities allow. Continued engagement with partners and stakeholders will increase the likelihood of the successful implementation of the recommendations proposed in this WP.

KEY TERMS

1. **Anthropogenic**. Environmental change that is caused or influenced by people, either directly or indirectly (USGS, 2015).
2. **Best Management Practice (BMP)**. Methods, measures or practices selected by an agency to meet its nonpoint source control needs. BMPs include but are not limited to structural and nonstructural controls and operation and maintenance procedures. BMPs can be applied before, during and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters (National Archives, 1989).
3. **Designated Uses**. Designations used to establish water quality goals for a waterbody, while criteria define the minimum conditions necessary to achieve those water quality goals. By Federal mandate, states and authorized Tribes are required to specify appropriate water uses to be achieved and protected (EPA, 2024).
4. **Freshwaters (FW)**. 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 (SCDHEC, 2023).
5. **Hydrologic Unit Code (HUC)**. Watersheds are delineated by USGS using a nationwide system based on surface hydrological features. This system divides the country into 22 regions (2-digit), 245 subregions (4-digit), 405 basins (6-digit), roughly 2,400 subbasins (8-digit), roughly 19,000 watersheds (10-digit), and roughly 105,000 subwatersheds (12-digit). A hierarchical HUC consisting of 2 additional digits for each level in the hydrologic unit system is used to identify any hydrologic area (USGS, n.d.).
6. **Load Allocation (LA)**. The LA is the fraction of the total pollutant load apportioned to nonpoint sources (SCDHEC, 2005).
7. **Margin of Safety (MOS)**. The MOS is a percentage of the TMDL that accounts for the uncertainty associated with model assumptions and data limitations (SCDHEC, 2005).
8. **Nonpoint Source (NPS) Pollution**. This is caused by rainfall (or snowmelt) moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, depositing them into lakes, rivers, wetlands, coastal waters, and ground waters. (EPA, 2024)
9. **Primacy Agency**. Primacy agencies are entities that regulate drinking water systems (EPA, 2024).
10. **Total Maximum Daily Load (TMDL)**. A TMDL is the calculation of the maximum amount of a pollutant allowed to enter a waterbody so that the waterbody will meet and continue to meet water quality standards for that pollutant. A TMDL determines a pollutant reduction target and allocates load reductions necessary to the source(s) of the pollutant (EPA, 2024).
11. **Waste Load Allocation (WLA)**. The WLA is the fraction of the total pollutant load apportioned to point sources, including stormwater discharges regulated under the National Pollutant Discharge Elimination System (NPDES) as point sources (SCDHEC, 2005).
12. **Wastewater Treatment Plant/Wastewater Treatment Facility (WWTP/WWTF)**. A WWTP is an industrial facility where a combination of mechanical, physical, chemical and biological processes is used to achieve pollutants removal from the incoming wastewater (Rainier, 2015).

13. **Water Quality Monitoring Station (WQMS).** A location where the quality of a body of water is measured. SCDES monitors water quality at these stations to ensure that water meets standards and to identify areas that need attention (SCDES, 2025).

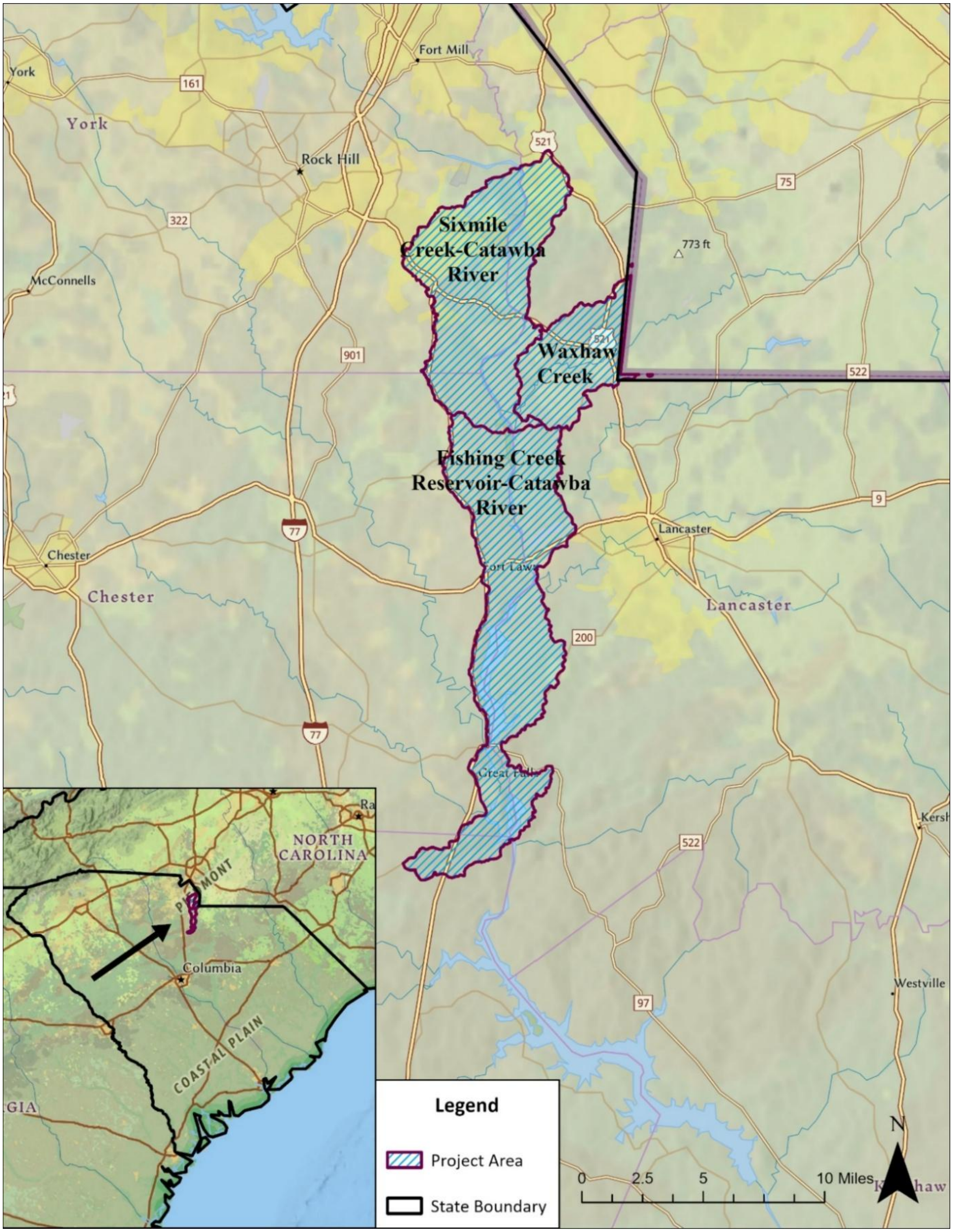
1. INTRODUCTION

According to the EPA, a watershed is defined as “the land area that drains to a stream, lake or river – affects the water quality in the water body that it surrounds” (EPA, 2024). Healthy watersheds collect, filter, and supply water to ecosystems, making them an integral part of the water cycle and of thriving ecosystems. Watershed planning is an important part of maintaining and improving watershed health because planning provides site specific recommendations to address water quality pollutants.

The purpose for developing a WP for the Fishing Creek Reservoir is to identify, assess, and develop strategies that address the known impairments in the defined project area. The project area consists of three 12-digit Hydrologic Unit Code (HUC) watersheds in the upper portion of the Southern Catawba-Wateree Basin: Fishing Creek Reservoir-Catawba River (HUC-030501030606), Sixmile Creek-Catawba River (HUC-030501030604), and Waxhaw Creek (HUC-030501030603) (see Map 1). The WP ultimately provides a clear roadmap that specifically addresses the identified impairments in the watersheds. That is, the roadmap is used to manage and maintain or restore the project area to its designated use(s). Specifically, the roadmap for the WP is made up of proposed BMPs and/or other strategies, that if implemented, will help control or mitigate the effects to water quality impairments caused by nutrients, sediment, and bacteria in the watersheds. Incorporating stakeholder input into the WP is a critical component of creating an effective roadmap. SCRWA requested, received, and incorporated (where necessary) stakeholder feedback. The stakeholder team will continue to incorporate stakeholder feedback, especially regarding funding for BMP implementation. An approved WP is a prerequisite for application to EPA Section 319 implementation funding. The 319 implementation funding is distributed by the EPA to state primacy agencies for allocation to qualifying WP projects. The monies are utilized to support implementation goals such as public education, technical training, and BMPs. Other funding sources are also available for assisting in BMP implementation. For example, the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) manages many funding/cost share programs that may be used by agricultural producers and forest landowners. These programs provide technical and financial assistance to agricultural producers and forest landowners to address natural resource concerns (USDA, n.d.).

The project area is in parts of four counties in South Carolina: Fairfield, Chester, Lancaster, and York. The Waxhaw Creek watershed extends into North Carolina. For this project, SCRWA does not include the North Carolina portion of the Waxhaw Creek watershed. Map 1 defines the project area and the watersheds that are included.

In 2005 a Fecal Coliform Bacteria Total Maximum Daily Load (TMDL) for Fishing Creek and Tributaries was approved by the EPA. SCDES WQMS CW-145 is an approved TMDL site within the project area. According to the published TMDL report, the suspected sources of bacteria in the project area include point source discharges and nonpoint sources. The point source discharges can be characterized by those originating from wastewater treatment plants (WWTPs) and stormwater runoff into Municipal Separate Storm Sewer Systems (MS4s). The nonpoint sources identified in this report include wildlife, agricultural activities, domesticated animals, onsite wastewater disposal systems, and domestic pets (SCDHEC Technical Report, 2005).



Map 1: Project Area

1.1. The Nine Required Elements

All approved WPs must meet the EPA's required nine elements for watershed planning. These elements explain/identify impairment concerns within the watershed, create a strategy to address those concerns, and develop a plan to monitor progress. The nine required elements are as follows:

1. Identify causes of impairment and pollution sources
2. Estimate load reductions expected from management measures
3. Describe management measures to be implemented
4. Estimate technical and financial assistance needed
5. Include information and educational components
6. Create a schedule for implementation of management measures
7. Describe the interim measurable milestones
8. Determine criteria to measure success
9. Create a monitoring plan

1.2. The Watershed Planning Process

An integral part of watershed planning is identifying and inviting local/statewide stakeholders to assist with and support the plan's development. Several organizations are active and engaged within the project area, and without their guidance, feedback, and support, this plan would not have been possible. The Stakeholder Team offers support in the planning process in a variety of ways including:

- Assisting in goal creation and schedule development
- Sharing concerns on water quality impairments in the project area
- Offering feedback and guidance on each stage of the planning process
- Sharing data that was needed to successfully complete the assessment

The Stakeholder Team includes members from each of the following organizations

- South Carolina Forestry Commission
- South Carolina Department of Natural Resources
- Catawba Riverkeeper Foundation
- Chester Metropolitan District
- Duke Energy
- Chester County Wastewater Recovery
- AECOM
- Research Technical Institute
- Catawba Wateree Water Management Group
- Lancaster County
- City of Rock Hill
- Catawba Valley Land Trust
- South Carolina Forestry Association

Contributions from these members accounted for many professional and local perspectives including public water utilities, state forestry, county administration, academia, water basin planners, and local citizens.

Public input was sought and considered during the planning process. Over the planning process, the Stakeholder Team met, conducted many windshield surveys on and around the Fishing Creek Reservoir, published a pollutant locator mapping tool, and held public-facing meetings. Figure 1 below shows a pollutant locater mapping tool developed by SCRWA to help identify local nonpoint sources of pollution. The tool was built using ArcGIS Survey 123 and ArcGIS Experience Builder software. SCRWA also recorded a training video utilizing YouTube that provided step-by-step instructions for completing the dashboard*. Digital links to the training video and dashboard were then distributed to the Stakeholder Team. The dashboard allowed stakeholders to perform several functions including filling in written detail for identified pollution, pinpointing pollution locations on a map, and attaching pictures showing the pollution as observed by the stakeholder. SCRWA included on the dashboard a list of either observable pollution or observable results from pollutants such as *Erosion/Sedimentation*, *Failing Septic System*, *Presence of Algae*, *Excess Fertilizers, Livestock in Streams/Rivers*, *Foam*, *Trash*, *Illicit Discharge/Effluent*, *Land Disturbance (Construction-Related)*, *Land Disturbance (Forestry-Related)*, and *Other*.

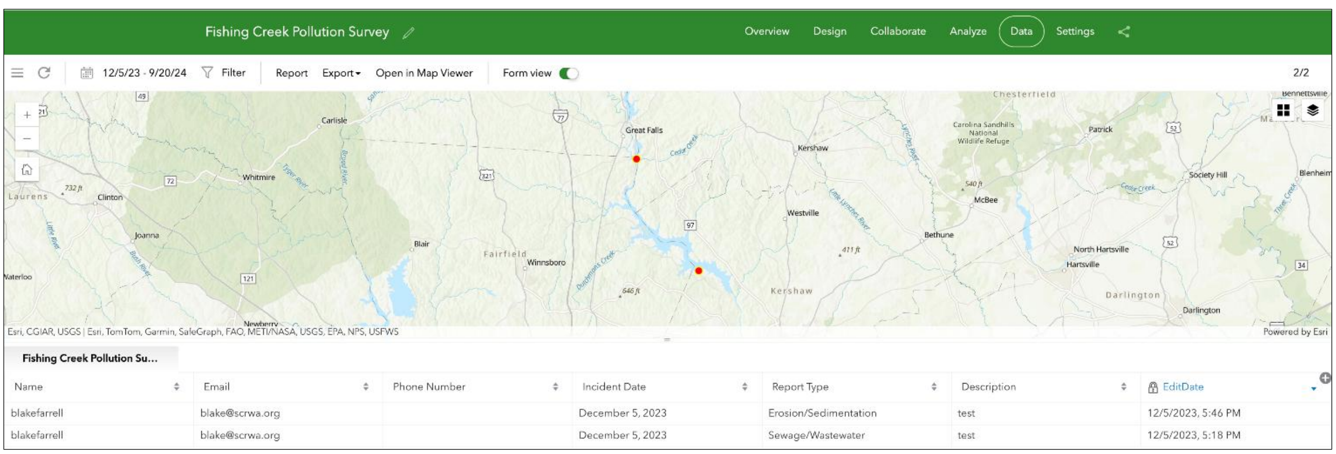


Figure 1: Pollutant Locator Mapping Tool
*(web access: https://arcg.is/15b4zm)

2. GENERAL WATERSHED OVERVIEW

2.1. Project Area Summary

The WP focuses on three contiguous HUC-12 watersheds upstream from Lake Wateree in the Piedmont geographic region of South Carolina.

1. **Fishing Creek Reservoir-Catawba River (030501030606)**
2. **Sixmile Creek-Catawba River (030501030604)**
3. **Waxhaw Creek (030501030603)**

Together, the watersheds total approximately 75,592 acres or 118 square miles of land in parts of Fairfield, Chester, York, and Lancaster counties (see Map 1 in Section 1). A portion of the Waxhaw Creek watershed extends into North Carolina but is not treated as a part of the project area. The primary land cover classifications analyzed in this plan include forest, agricultural, and developed.

Forested land cover totals roughly 64%, developed 11%, and agricultural use 9%. A complete land cover evaluation of the project area can be found in Section 2.5.

2.2. Location and Hydrology

The Fishing Creek Reservoir is a manmade impoundment that is fed by the Catawba River. The headwaters begin in North Carolina's McDowell County as the Catawba River, flow east, then southward into South Carolina, and into the Fishing Creek Reservoir.

The Reservoir is an 8.5 mile long and 3,112-acre impoundment in Lancaster County. The Fishing Creek Reservoir is a multifunctional lake, serving as a source for drinking water, recreation and tourism, power generation, and a desirable community for many residents. It was built at the start of the twentieth century to provide hydroelectric power to the Duke Energy Hydroelectric Station. It has 78 miles of shoreline and includes landmarks like the Landsford Canal State Park (Figure 2) and Edgewater Golf Club. The reservoir is owned by Duke Energy and was dammed in 1916 (Duke Energy, 2018). Protecting this resource is vital to the long-term economic success and environmental sustainability of the region.

Metropolitan centers upstream from the project area are likely to experience continued population growth. For example, the city of Charlotte, which is approximately 35 miles north from the CMD's intake, is currently the third fastest-growing major city in the United States. If population growth continues at the current rate, Charlotte's population is set to surge by 47% from 2010 to 2030, growing from 1.87 million to about 2.74 million in just twenty years (World Population Review, 2022). Nutrient, sediment, and bacteria related impairments, coupled with the growth potential of upstream metropolitan areas, present an ideal opportunity for watershed planning focused on mitigating current and future impairments.

Figure 2: Landsford Canal State Park

2.3. Climate

The Lower Catawba River Basin in South Carolina has a humid subtropical climate, characterized by hot summers, mild winters, and abundant rainfall throughout the year. The climate is influenced by its proximity to the Atlantic Ocean and the Gulf of Mexico, as well as by its location in the southeastern United States (Trewartha, 1981).

During the summer months, temperatures typically range from the mid-70s to the mid-90s Fahrenheit, with high humidity levels. Thunderstorms are common during the summer months, and the region can experience occasional tropical storms or hurricanes.

In the winter months, temperatures typically range from the mid-30s to the mid-50s Fahrenheit, with occasional cold snaps, snowstorms, or ice storms. Frost can occur in the region, particularly in the northern part of the basin, which is where the project area is located.

Annual precipitation averages around 46 inches, with most of the rainfall occurring during the summer months. However, the region does experience rainfall throughout the year and is known for its frequent thunderstorms and occasional tropical weather systems (SCDNR, 2022).

2.4. Geology and Soils

The Lower Catawba River Basin in South Carolina is characterized by a diverse range of geological formations and soil types. The region is underlain by crystalline rocks, including gneiss, schist, and granite, which are among the oldest rocks in North America. These rocks were formed during the Precambrian era and have been subjected to intense pressure and heat over millions of years.

The soils in the Lower Catawba River Basin are generally derived from these underlying rocks and are predominantly sandy loam and clayey soils. The region's soils are further classified into various types based on their physical and chemical properties, including Ultisols, Inceptisols, and Entisols. The dominant soil in the area is the Cecil series, a well-drained, moderately deep, and moderately permeable soil formed on loamy and clayey residuum derived from granite, gneiss, and schist.

According to the USDA's soil survey data for the project area, the watersheds contain predominantly well drained soils. The USDA characterizes soils by "drainage class," which refers to the frequency and duration of wet periods under conditions like those under which the soil formed. Seven classes of natural soil drainage are recognized: *excessively drained*, *somewhat excessively drained*, *well drained*, *moderately well drained*, *somewhat poorly drained*, *poorly drained*, and *very poorly drained*. Well drained soils are defined as "water is removed from the soil readily but not rapidly. Internal free water occurrence commonly is deep or very deep; annual duration is not specified. Water is available to plants throughout most of the growing season in humid regions. Wetness does not inhibit root growth for significant periods during most growing seasons" (USDA, 2017). Table 1 details the drainage classifications for soils in the project area. It should be noted that water accounts for approximately 5,569 acres in the project area.

Drainage Class	Acres	Percent
Well Drained	58,378	76.2%
Moderately Well Drained	6,960	8.8%
Other (water)	5,569	7.5%
Somewhat Poorly Drained	4,067	5.3%
Poorly Drained	535	1.4%
Somewhat Excessively Drained	49	0.7%
Excessively Drained	34	0.1%
Total	**75,592**	**100**

Table 1: Soils/Drainage Class - Project Area

2.5. Land Cover

SCRWA completed a watershed assessment for the project area utilizing desktop and field surveys. This section details current land cover conditions for the project area and for each of the three watersheds individually. The National Land Cover Dataset (NLCD) is organized by land cover characterizations based on existing land uses. The term *land cover* is used instead of *land use* in instances where NLCD data was utilized.

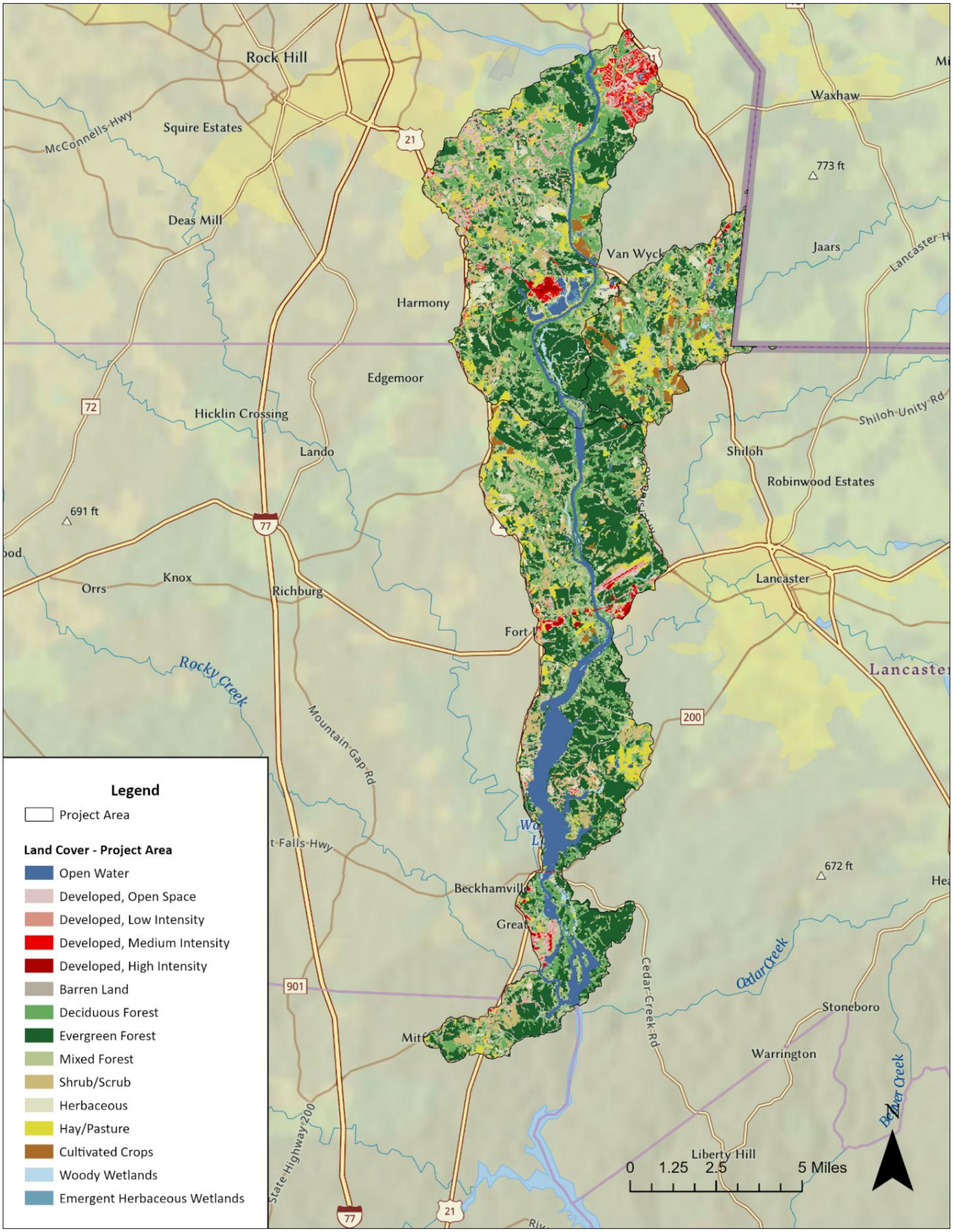
The 2020 National Land Cover Dataset (NLCD) was used as the most current data for determining current land cover in the project area. Table 2 and Map 2 provide details regarding land cover in the project area. Tables 3 through 5 and Maps 3 through 5 show the land cover for each individual watershed. Table 6 shows a side-by-side comparison of land cover designations across all three watersheds in the project area. In Tables 2 through 6, *Forests* represent the following as one combined calculated percentage: Evergreen Forest, Deciduous Forest, and Mixed Forests. *Developed* represents the following as one combined calculated percentage: Developed, Open Space; Developed, Medium Intensity; and Developed, Low Intensity. *Agriculture* represents the following as one combined calculated percentage: Hay/Pasture and Cultivated Crop. Detailed below is a snapshot of select land cover designations for the project area as a whole and each individual watershed. The select land cover designations (*forests*, *developed*, and *agriculture*) are highlighted because of their existing or potential contribution to nonpoint source pollution.

Project Area. Of roughly 75,592 acres in the project area, 64% are forested, 11% developed, and 9% agriculture.

Fishing Creek Reservoir-Catawba River (030501030606). This is the largest watershed in the project area, covering roughly 36,170 acres in Chester, Lancaster, and Fairfield counties. The watershed is roughly 64% forested, 8% developed, and 6% agriculture.

Sixmile Creek-Catawba River (030501030604). This watershed covers approximately 28,522 acres in Chester, York, and Lancaster counties. The watershed is roughly 63% forested, 15% developed, and 8% agricultural. Sixmile Creek flows southeasterly from North Carolina into the Catawba River, north of South Carolina Highway 5.

Waxhaw Creek (030501030603). This watershed is roughly 10,972 acres in Lancaster County. Approximately 66% are forested, 21% agricultural, and 7% developed. Waxhaw Creek flows southwesterly from the North/South Carolina border into the Catawba River near Landsford Canal State Park.

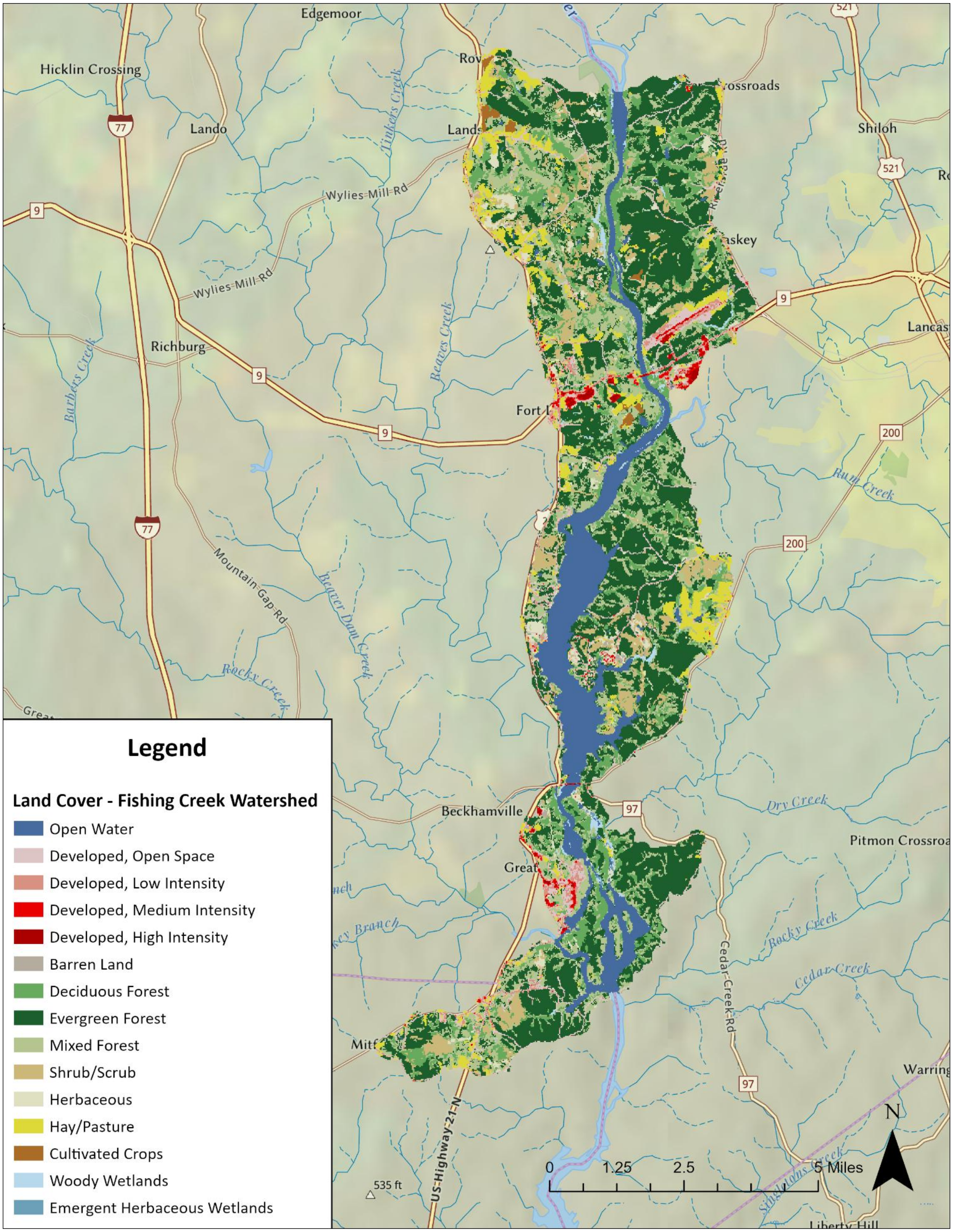


Map 2: Land Cover - Project Area

Land Cover	Acres	Percent
Forests	48,326	63.9
Developed	8,001	10.6
Agriculture	6,916	9.1
Open Water	5,633	7.5
Shrub/Scrub	3,373	4.5
Herbaceous	2,460	3.3
Woody Wetlands	582	< 1
Barren Land	167	< 1
Emergent Herbaceous Wetlands	134	< 1
Total	**75,592**	**100**

Table 2: Land Cover - Project Area

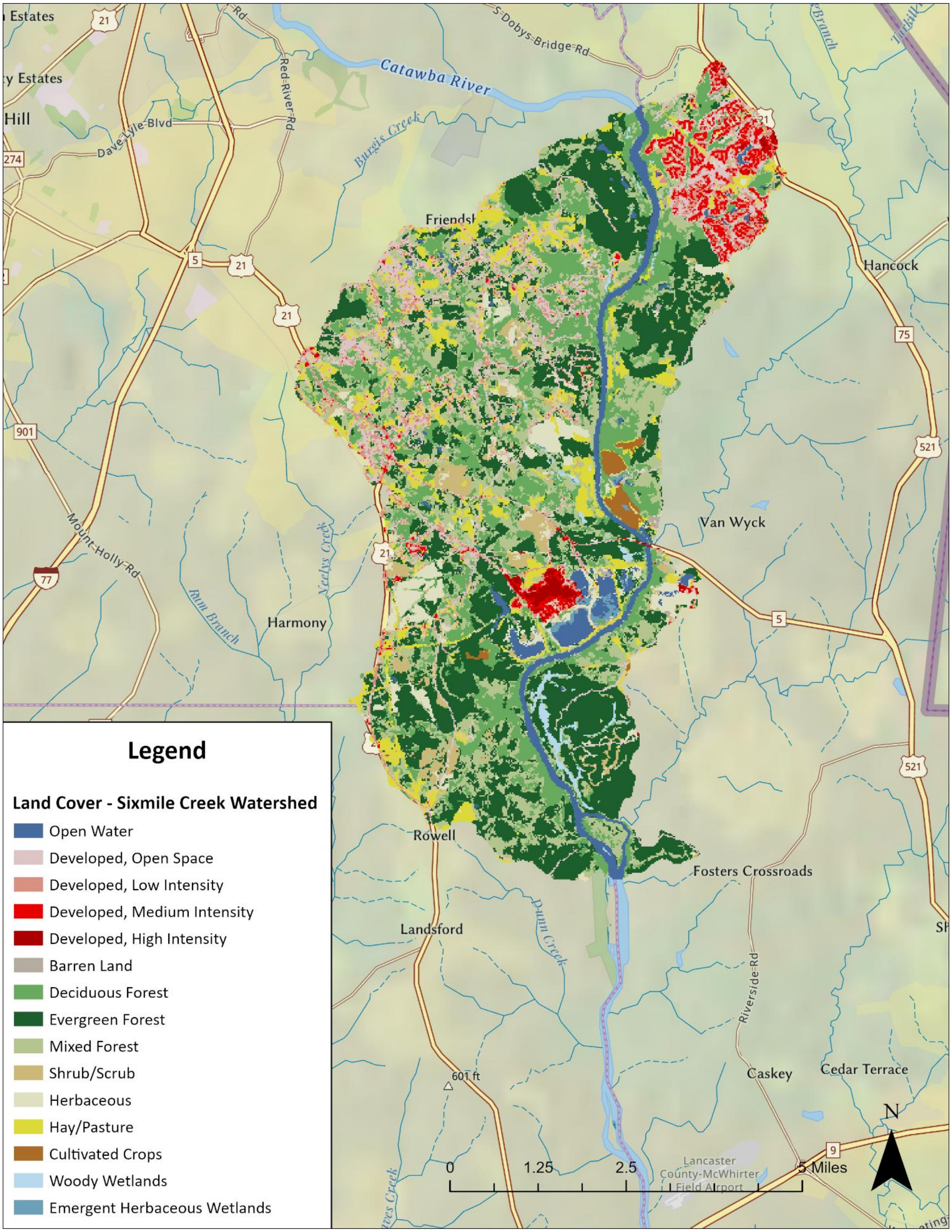
The results of the desktop and field analyses indicated that roughly 64% of the project area is forested, 11% developed, 9% agriculture, 8% open water, and the remaining 8% barren land, shrub/scrub, emergent herbaceous wetlands, woody wetlands, and herbaceous vegetation (see Table 2). Forested land cover is consistent throughout each of the three watersheds at approximately 64%. Sixmile Creek watershed is the most developed due to urbanized areas at the Carolina Lakes Golf Club and Catawba River. Agricultural land cover is highest in the Waxhaw Creek watershed with roughly 21% of the watershed characterized as pastureland and/or cultivated crops.



Map 3: Land Cover - Fishing Creek Watershed

Land Cover	Acres	Percent
Forests	23,261	64
Open Water	4,247	12
Developed	2,806	9
Shrub/Scrub	2,240	6
Agriculture	2,285	6
Herbaceous	931	3
Woody Wetlands	253	1
Barren Land	81	< 1
Emergent Herbaceous Wetlands	37	< 1
Total	**36,141**	**100**

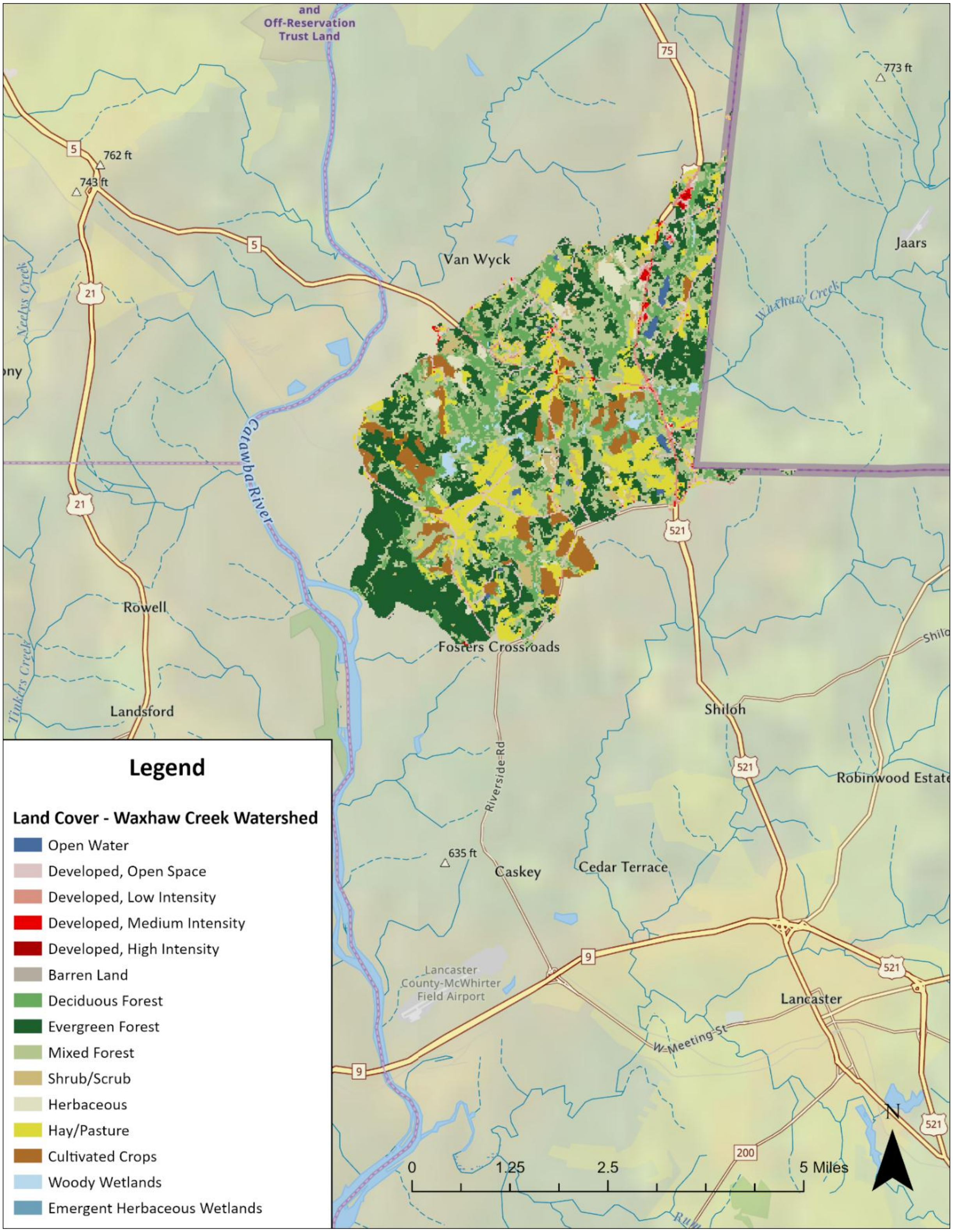
Table 3: Land Cover - Fishing Creek Watershed



Map 4: Land Cover - Sixmile Creek Watershed

Land Cover	Acres	Percent
Forests	17,870	63
Developed	4,406	15
Agriculture	2,384	8
Open Water	1,307	5
Herbaceous	1,247	4
Shrub/Scrub	889	3
Woody Wetlands	223	1
Emergent Herbaceous Wetlands	97	< 1
Barren Land	83	< 1
Total	**28,506**	**100**

Table 4: Land Cover - Sixmile Creek Watershed



Map 5: Land Cover - Waxhaw Creek Watershed

Land Cover	Acres	Percent
Forests	7,195	66
Agriculture	2,247	21
Developed	789	7
Herbaceous	282	3
Shrub/Scrub	244	2
Woody Wetlands	106	1
Open Water	79	1
Barren Land	3	< 1
Emergent Herbaceous Wetlands	0	0
Total	**10,945**	**100**

Table 5: Land Cover - Waxhaw Creek Watershed

	Fishing Creek		Sixmile Creek		Waxhaw Creek	
Land Cover	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**
Forests	23,261	64	17,870	63	7,195	66
Barren Land	81	< 1	83	< 1	3	< 1
Developed	2,806	8	4,406	15	789	7
Open Water	4,247	12	1,307	5	79	1
Agriculture	2,285	6	2,384	8	2,247	21
Shrub/Scrub	2,240	6	889	3	244	2
Emergent Herbaceous Wetlands	37	< 1	97	< 1	0	0
Herbaceous	931	3	1,247	4	282	3
Woody Wetlands	253	1	223	1	106	1
Total	**36,141**	**100**	**28,506**	**100**	**10,945**	**100**

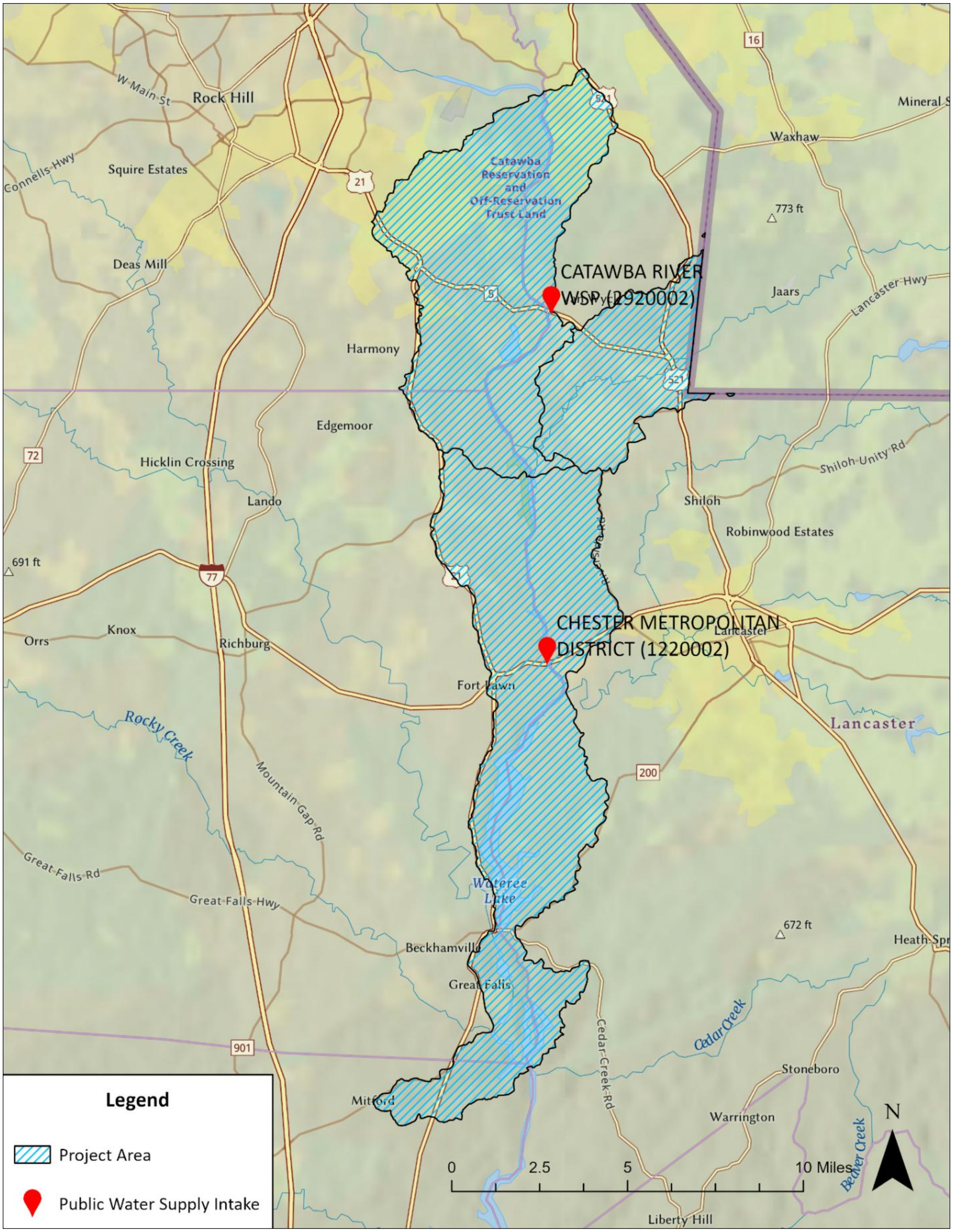
Table 6: Land Cover Distribution by Watershed

2.6. Source Water Intakes

Source water is any body of water that provides drinking water to public water systems and public/private wells. Source water protection measures are important because they help prevent contamination and reduce the risk of exposure to contaminated water.

The CMD water system is the primary drinking water provider for the project area. The system serves about 16,500 customers, producing an average of 2 million gallons of water daily. Raw water is drawn from the Fishing Creek Reservoir and pumped to the water treatment facility, which has a treatment capacity of 7.6 million gallons per day. To ensure the water meets health requirements, the CMD uses sampling and testing methodologies approved by the EPA and SCDES (CMD, 2024).

The Catawba River WSP provides water almost exclusively through wholesale to Lancaster County in South Carolina and Union County in North Carolina. The water sold to these counties serves approximately 173,000 customers. Raw water from the Catawba River is screened and pumped to a reservoir and lightly pre-oxidized with chlorine dioxide before it reaches the water treatment plant. To ensure the water meets health requirements, the Catawba River WSP uses sampling and testing methodologies approved by the EPA and SCDES. See Map 6 for the intake locations for these systems (Catawba River WSP, 2024).



Map 6: Public Water Supply Intakes in Project Area

2.7. Population

Approximately 19,215 people reside in the project area (see Table 7). More than half of the population in the project area is concentrated in the Sixmile Creek watershed where population centers include neighborhoods adjacent to the Catawba River and at the Carolina Lakes Golf Club. The Waxhaw Creek and Fishing Creek watersheds are less populous and rural.

Population data used in this section was retrieved from EPA's EnviroAtlas. The geospatial layer for total population is based on the EnviroAtlas 2016 dasymetric dataset that reallocates 2010 U.S. Census population data from census blocks to 30-meter pixels based on topography and land cover. The dasymetric map uses the 2011 National Land Cover Dataset (NLCD 2011) to portray areas such as open water, ice or snow, wetlands, and slopes over 25% as less likely to be inhabited. The dasymetric population data was then summarized by 12-digit hydrologic unit code (HUC) to create the map layer (EPA EnviroAtlas, 2024).

According to the South Carolina Revenue and Fiscal Affairs Office, the population for York County is estimated to increase by 21% over the next ten years (2025-2035). Over the same time period, Chester County is estimated to decrease by 2% and Lancaster County increase by 26%. This translates to a 20% increase in population for the three counties combined (SC Revenue and Fiscal Affairs, 2023). An increase in population may have significant impacts on water quality. For example, population growth increases the demand for urban development. Urban development creates impervious surfaces, which leads to stormwater runoff. Stormwater runoff may carry pollutants like sediments and chemicals into nearby water bodies.

Watershed	HUC 12	Population
Waxhaw Creek Watershed	030501030603	5,915
Sixmile Creek-Catawba River Watershed	030501030604	10,183
Fishing Creek Reservoir-Catawba River Watershed	030501030606	3,117
Total		**19,215**

Table 7: Estimated Population in Project Area

3. WATERSHED ANALYSIS

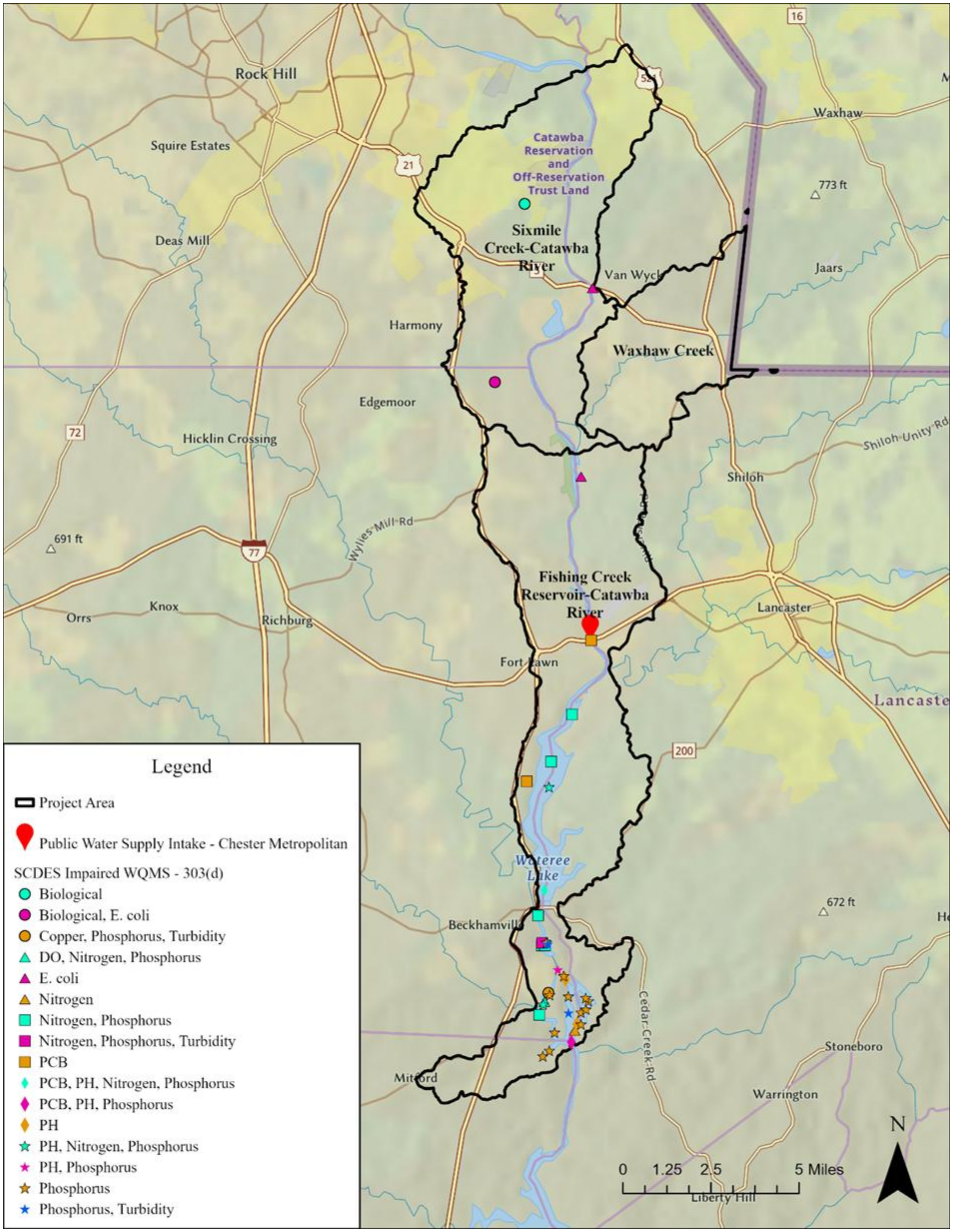
3.1. Water Quality Impairments and Sources

SCDES is entrusted with enforcing state water quality standards. The standards detailed in *R.61-68 Water Classification & Standards*, were established to protect South Carolina's surface and groundwater resources. The purpose of this is to establish general rules and specific numeric and narrative criteria along with anti-degradation rules, for the protection of classified and existing water uses. These guidelines also establish procedures to classify the waters of the State (SCDHEC, 2023). SCDES's *R.61-69* is a regulation that defines most of the state's waters and includes their name, county location, classification, designation, brief description of the water body and any site-specific numeric criteria that apply to the listed water body. According to the latest publication for *R.61-69* and

SCDES geospatial data, the waterbodies within the project area are classified as freshwaters (FW) with designated uses including contact recreation, fish consumption, and aquatic life (SCDHEC, 2023).

3.2. Water Quality Monitoring Stations

There are 37 impaired SCDES WQMSs listed on the 303(d) List of Impaired Waters in the project area (see Map 7 and Table 8). Nutrients (phosphorus, nitrogen), bacteria (*E. coli*), and sediment (turbidity) are the specific impairments this plan addresses. Additionally, most of the selected watersheds are located outside of MS4 permit areas, highlighting an additional need for a WP to address these nonpoint source pollution issues.



Map 7: SCDES 303(d) Impaired WQMSs in Project Area

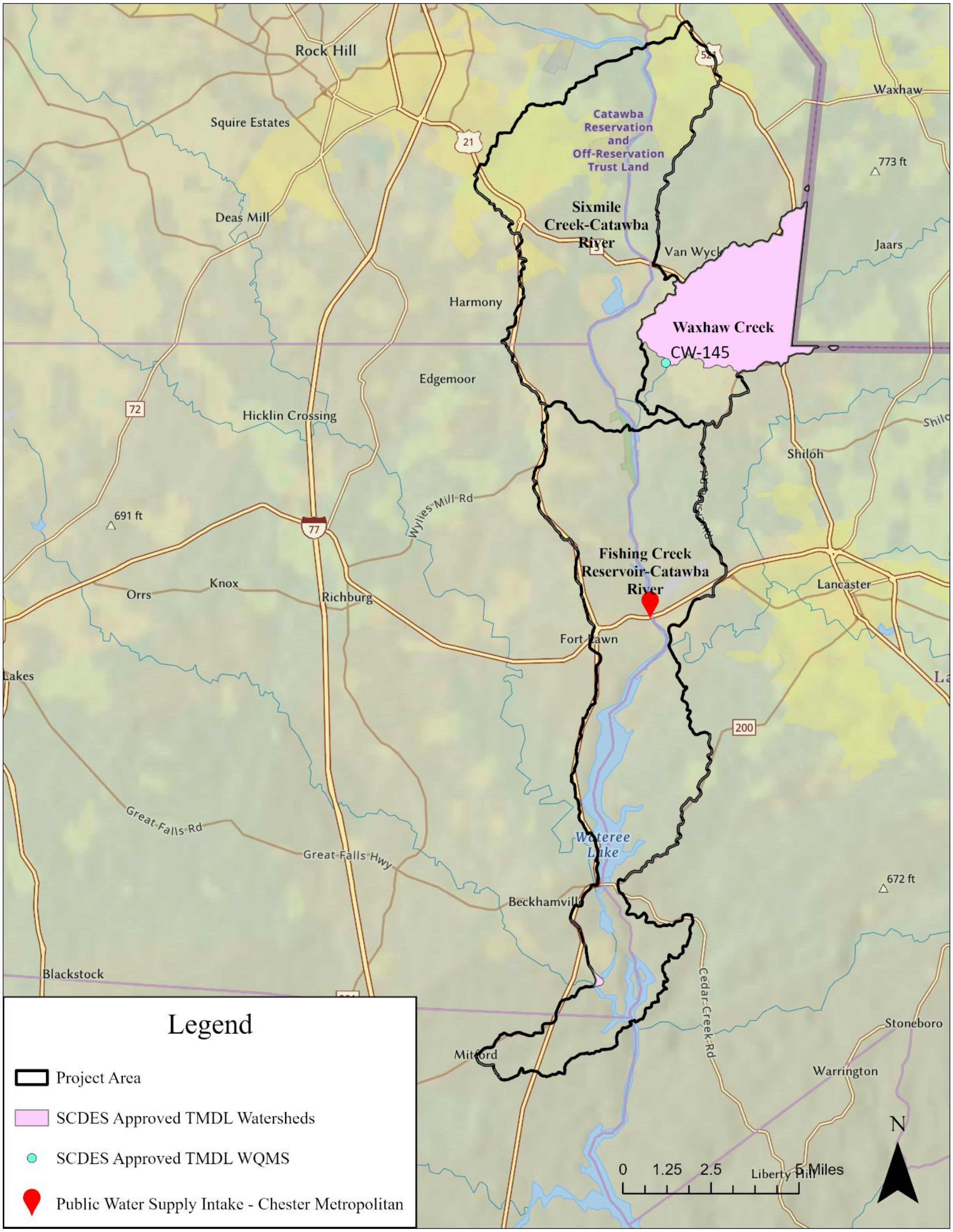
HUC 12	Station	Use	Status	Impairment
030501030606	CW-016	FISH	Impaired	PCB
030501030606	CW-016F	AL	Impaired	Nitrogen, Phosphorus
030501030606	CW-033	AL/FISH	Impaired	PCB, pH, Phosphorus
030501030604	CW-041	REC	Impaired	*E_coli*
030501030606	CW-057	AL/FISH	Impaired	PCB, pH, Nitrogen, Phosphorus
030501030606	CW-133	FISH	Impaired	PCB
030501030606	CW-174	AL	Impaired	pH, Nitrogen, Phosphorus
030501030606	RL-01007	AL	Impaired	Phosphorus
030501030606	RL-02319	AL	Impaired	Phosphorus
030501030606	RL-02452	AL	Impaired	Phosphorus
030501030606	RL-03332	AL	Impaired	Nitrogen, Phosphorus, Turbidity
030501030606	RL-03351	AL	Impaired	Copper, Phosphorus, Turbidity
030501030606	RL-03353	AL	Impaired	Phosphorus, Turbidity
030501030606	RL-03458	AL	Impaired	Phosphorus, Turbidity
030501030606	RL-04375	AL	Impaired	Phosphorus
030501030606	RL-04379	AL	Impaired	Phosphorus
030501030606	RL-05391	AL	Impaired	Phosphorus
030501030606	RL-05414	AL	Impaired	Phosphorus
030501030606	RL-05416	AL	Impaired	Phosphorus
030501030606	RL-06429	AL	Impaired	Phosphorus
030501030606	RL-06431	AL	Impaired	Phosphorus
030501030606	RL-06443	AL	Impaired	pH
030501030606	RL-08046	AL	Impaired	Nitrogen, Phosphorus
030501030606	RL-08062	AL	Impaired	Nitrogen, Phosphorus
030501030606	RL-09094	AL	Impaired	Phosphorus
030501030606	RL-10102	AL	Impaired	Phosphorus
030501030606	RL-10106	AL	Impaired	Nitrogen, Phosphorus
030501030606	RL-11117	AL	Impaired	DO, Nitrogen, Phosphorus
030501030606	RL-11119	AL	Impaired	Nitrogen, Phosphorus
030501030606	RL-13072	AL	Impaired	Nitrogen, Phosphorus
030501030606	RL-13134	AL	Impaired	pH, Phosphorus
030501030606	RL-15023	AL	Impaired	pH, Nitrogen, Phosphorus
030501030606	RL-15104	AL	Impaired	pH
030501030606	RL-16115	AL	Impaired	Nitrogen
030501030604	RS-03511	AL/REC	Impaired	Biological, *E_coli*
030501030604	RS-06176	AL	Impaired	Biological
030501030606	RS-12088	REC	Impaired	*E_coli*

Table 8: 303(d) Impaired WQMSs in the Project Area

3.3. Total Maximum Daily Load

Section 303(d) of the Clean Water Act (CWA) and the EPA require states to develop total maximum daily loads (TMDL) for waterbodies that do not meet designated uses where technology-based controls are in place. A TMDL establishes allowable loadings for pollutants or other quantifiable parameters for a water body based on the relationship between pollutant sources and in-stream water quality conditions. States are then able to implement water quality-based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of its water sources (SCDHEC, 2005).

In 2005, SCDHEC published a TMDL for Fecal Coliform for the Sixmile Creek, Twelvemile Creek, Waxhaw Creek watersheds in the Catawba River Basin. The purpose of this report (SCDHEC Technical Report Number: 031-05) is to assist SCDES with establishing pollutant load allocations for impaired water bodies by determining the wasteload allocation (WLA), load allocation (LA), and margin of safety (MOS). Definitions for these terms can be found in the *Key Terms* section of this plan. SCDHEC included three WQMSs from HUC 03050103 within the Catawba River Basin on the 2004 South Carolina Section 303(d) list for exceedances of the fecal coliform bacteria water quality standards. Of these three, only one (CW-145) falls within the project area. Map 8 shows the location for WQMS CW-145. Table 9 provides details for the portion of the project area that is in the TMDL. The *Not Supported* identifier indicates that there is an impairment caused by a pollutant addressed by a TMDL at this site. The associated pollutant is listed in the *Cause* column. The *Fully Supported* identifier signifies that water at the sampling is not currently impaired by the pollutant addressed by the TMDL. *InTMDL* means that the site was included in the original approved TMDL effort (SCDHEC, 2005). Additional details regarding the TMDL can be found in Section 5.



Map 8: SCDES TMDL WQMS

HUC	Station	County	Use	Cause	Use Support 2022	TMDL	Approval Date
030501030603	CW-145	Lancaster	Recreation	FC	Not Supported	InTMDL	9/2005
030501030606	CW-174	Chester	Recreation	FC	Fully Supported	InTMDL	8/2001

Table 9: TMDL Data for Project Area (SCDHEC, 2005)

4. POLLUTANT SOURCE IDENTIFICATION

The Fishing Creek Reservoir is a man-made impoundment located in Chester County, South Carolina. Like many bodies of water, it can be affected by various sources of pollution. The specific sources of pollution for Fishing Creek Reservoir in South Carolina may include:

1. *Agricultural Runoff*: Pesticides, fertilizers, and sediment from nearby agricultural activities that can wash into the reservoir, leading to water contamination.
2. *Industrial Discharges*: Factories and industrial facilities in the vicinity may release pollutants into the reservoir through wastewater discharge.
3. *Stormwater Runoff*: Urban areas with impervious surfaces like roads and parking lots can contribute to stormwater runoff that carries pollutants such as oil, heavy metals, and debris into the reservoir.
4. *Sewage and Wastewater*: Improperly treated sewage and wastewater discharges from residential and commercial areas can introduce harmful bacteria and chemicals into the water.
5. *Septic Systems*: Faulty or poorly maintained septic systems from homes near the reservoir can leak sewage and contaminants into the groundwater, which may eventually reach the reservoir.
6. *Trash and Debris*: Litter and debris from recreational activities, such as boating and fishing, can accumulate in the reservoir, impacting water quality and aquatic life.
7. *Invasive Species*: The introduction of non-native species can disrupt the ecosystem and lead to water quality issues.
8. *Erosion*: Natural erosion processes and land development can result in sedimentation in the reservoir, clouding the water and impacting aquatic habitats.
9. *Wildlife and Livestock*: Wildlife and livestock near the reservoir may contribute to nutrient runoff and fecal contamination.

It is important to note that water quality management for the Fishing Creek Reservoir, like other bodies of water, typically involves monitoring, regulations, and efforts to mitigate these pollutant sources. Local environmental agencies, conservation groups, and government bodies often work together to protect and improve the water quality of reservoirs and other natural resources.

5. BACTERIA POLLUTION SOURCES

Bacteria pollution can be attributed to both point and nonpoint sources within the project area. Table 10 provides some examples including wastewater effluent, agricultural land cover, and urban runoff.

Category	Pollutant Source	Point / Nonpoint Source
Wastewater	Private Septic Systems	Nonpoint
	Private Wastewater Treatment Facilities	Point
Agriculture	Livestock	Nonpoint
	Cropland	Nonpoint
Urban	Stormwater Runoff	Nonpoint

Table 10: Potential Point and Nonpoint Sources of Bacteria Pollution in Project Area

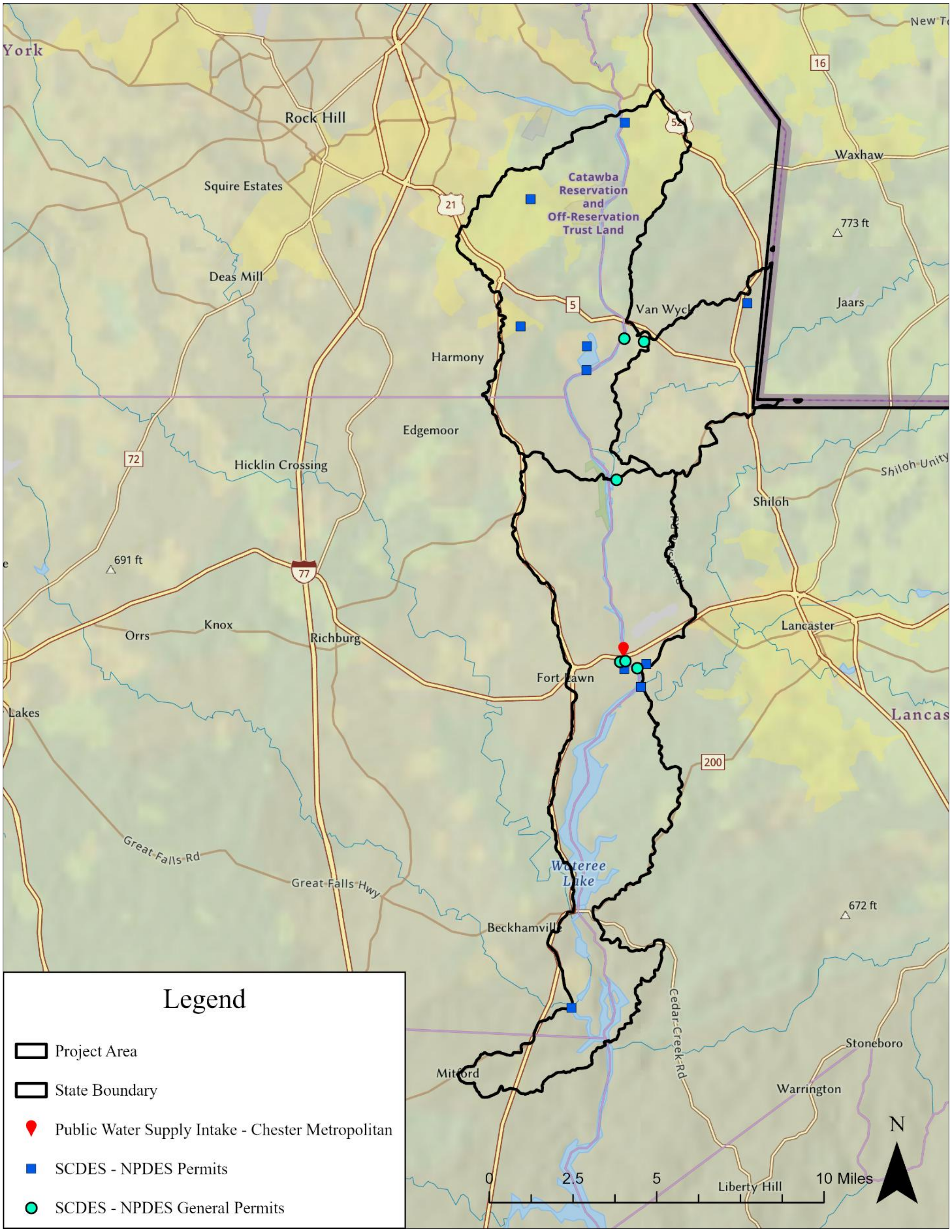
5.1. Bacteria Pollution – Point Sources

The EPA defines point source pollutants as any discernable, confined and discrete conveyance (*e.g.* pipe, ditch, well, concentrated animal feeding operation) from which pollutants are or may be discharged (EPA, 2022).

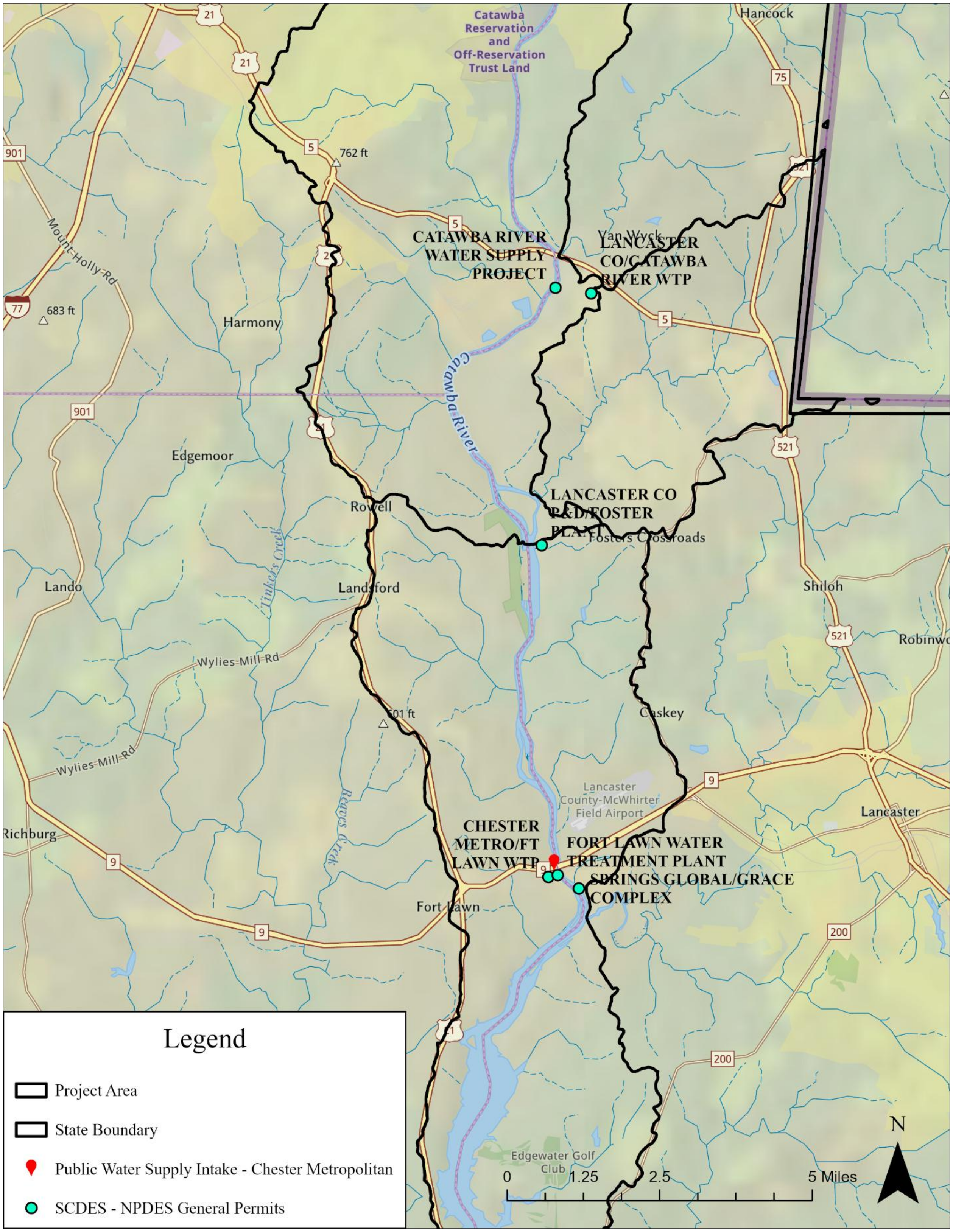
Point sources are regulated through the EPA's National Pollution Discharge Elimination System (NPDES) program. The NPDES program was created by the federal government as a part of the CWA in 1972 to help address water pollution by regulating point sources discharging into public waters. The CWA authorizes the program to state, tribal, and territorial governments, which allows them to conduct permitting and enforcement steps (EPA, 2022). Table 11 and Maps 9 through 11 below detail the NPDES sites within the project area.

NPDES	Name	Status	Type	HUC 12	Description
SCDES NPDES Discharges					
SC0021211	Great Falls WWTF	Active	Municipal	030501030606	Sewerage Systems
SC0046892	Lancaster/Catawba River	Active	Municipal	030501030606	Sewerage Systems
SC0003255	Springs Global/Grace Complex	Active	Industrial	030501030606	Finishers of Broadwoven Fabrics of Manmade Fiber and Silk
SC0003255	Springs Global/Grace Complex	Active	Industrial	030501030606	Finishers of Broadwoven Fabrics of Manmade Fiber and Silk
SC0001015	New-Indy Catawba LLC.	Active	Industrial	030501030604	Pulp Mills
SC0001015	New-Indy Catawba LLC.	Active	Industrial	030501030604	Pulp Mills
SC0032417	Cedar Valley Mobile Home Park	Active	Domestic	030501030604	Operators of Residential Mobile Home Sites
SC0041807	Saratoga Properties LLC.	Active	Domestic	030501030603	Nursing and Personal Care Facilities, NEC
SC0027189	Utility Services of SC	Active	Domestic	030501030604	Operators of Dwellings Other Than Apartment Buildings
SC0047864	Lancaster County/Indian Land WWTP	Active	Municipal	030501030604	Sewerage Systems
SCDES NPDES General Permit					
SCG570031	Lancaster County/Foster Plant	Active	Industrial	030501030606	Operators of Nonresidential Buildings
SCG646007	Chester Metro/Fort Lawn WTP	Active	Municipal	030501030606	Water Supply
SCG646012	Lancaster County/Catawba River WTP	Active	Municipal	030501030604	Water Supply
SCG646086	Springs Global/Grace Complex	Active	Domestic	030501030606	Water and Wastewater Treatment

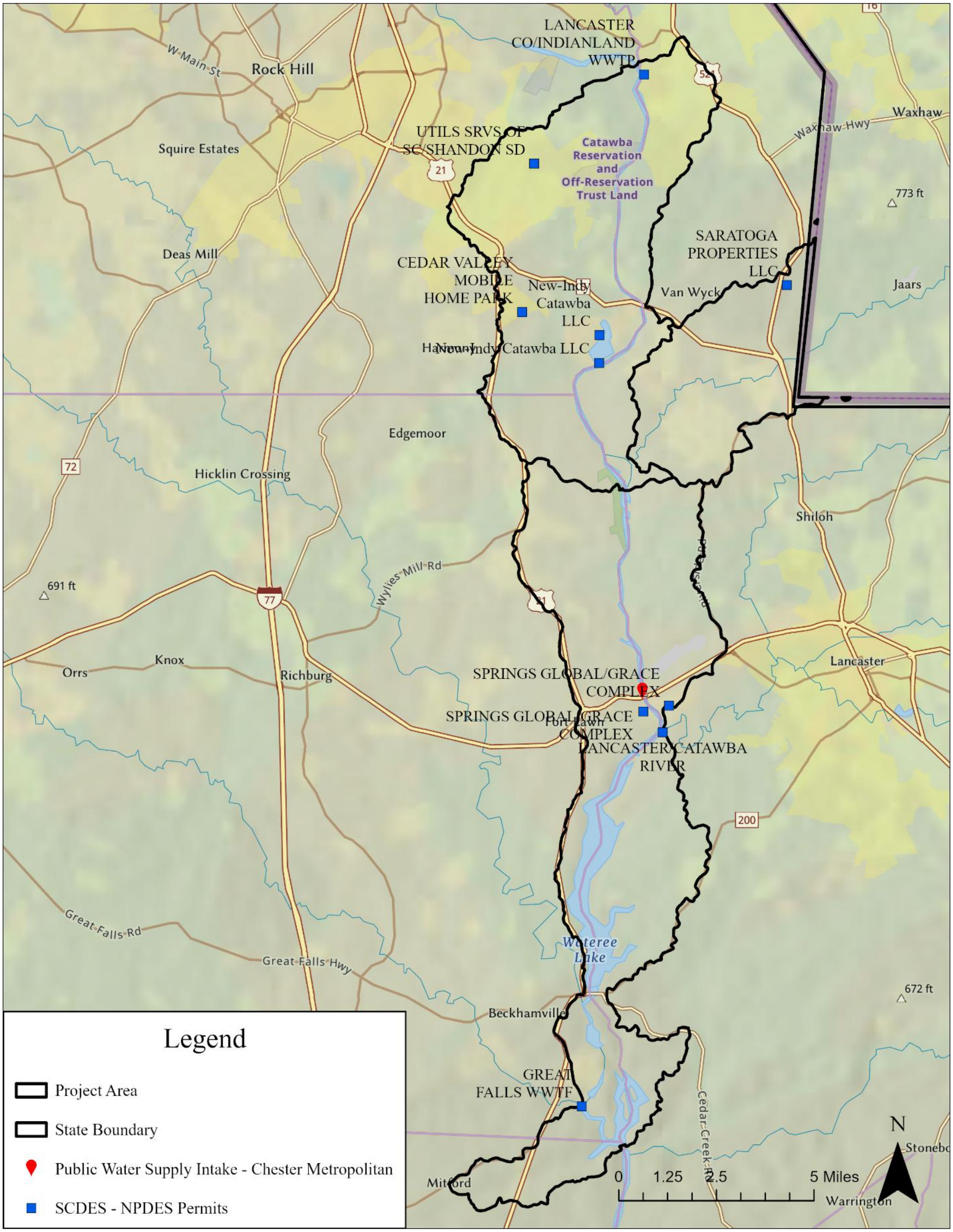
Table 11: NPDES Sites in Project Area



Map 9: SCDES NPDES Sites in Project Area



Map 10: SCDES - NPDES General Permit Sites in Project Area



Map 11: SCDES - NPDES Permit Sites in Project Area

5.2. Bacteria Pollution – Nonpoint Sources and Estimated Pollutant Load

EPA defines nonpoint source pollution as any source of pollution that does not meet the point source definition under the Clean Water Act. Nonpoint sources are runoff from rain (or snowmelt) carrying natural and anthropogenic pollutants to waters, such as lakes, rivers, and groundwater (EPA, 2024).

Nonpoint sources of bacteria pollution can originate from a variety of sources within the environment. This WP specifically focuses on locations for failing septic systems, agricultural activity, and urban land cover. Many residents in the project area live in rural locations, which precludes them from receiving municipal sewer services. In those cases, residents rely on private septic systems for wastewater treatment. Nonpoint sources of bacteria pollution from agricultural activity and stormwater runoff originate from about 9% (cultivated crop and hay/pastureland) and 11% (developed) of land respectively.

The EPA PLET is a customizable spreadsheet model used in watershed planning level decision-making. The tool is designed to determine annual average pollutant loads from nonpoint pollution sources and estimate BMP pollutant load reduction rates. The PLET Data Server was used to download watershed specific data for the project area. However, one limitation of PLET is that it does not calculate bacteria nonpoint source pollutant loading. A combination of peer reviewed literature and PLET Data Server values were used to determine bacteria loads for sections including Septic Systems, Agriculture – Livestock, Agriculture – Cropland, and Urban.

5.2.1. Bacteria Pollution – Septic

Septic systems can have a significant impact on local drinking water wells and surface water bodies. System maintenance is the key to a properly operating septic tank. Septic tanks operate by storing generated wastewater, allowing the solids to settle at the bottom of the tank as sludge, with the fats, oils and greases floating to the top. Microorganisms then break down the sludge and eliminate most contaminants. The partially treated wastewater then flows out of the tank and through a drain field. If the drain field is overcome with too many liquids and solids, they will flood and cause sewage to back up into the home. The water table below the drain field captures any remaining bacteria contamination released from the septic system. Shallow water tables and ground water are connected through subsurface passages to surface water riverine systems. Therefore, bacteria pollutants entering the groundwater can be transported into surface waters (EPA, 2022).

Based on USDA soils data, the soils within the project area are predominantly *well drained*. The USDA assigns soil types to a particular drainage class, which is defined as the frequency and duration of wet periods under conditions like those under which the soil formed. Seven classes of natural soil drainage are recognized by the agency including *excessively drained*, *somewhat excessively drained*, *well drained*, *moderately well drained*, *somewhat poorly drained*, *poorly drained*, and *very poorly drained*. The USDA describes *well drained* soils as follows: water is removed from the soil readily but not rapidly. Internal free water occurrence commonly is deep or very deep; annual duration is not specified. Water is available to plants throughout most of the growing season in humid regions. Wetness does not inhibit root growth for significant periods during most growing seasons (USDA, 2017). Based on the interconnectedness between groundwater and surface water and the soils present in the project area, the aggregate effect of failing septic systems can directly impact water quality over time. Table 12 provides a summary of the drainage class soils data for the project area. The data included in Table 12 was retrieved from the USDA Soil Survey tool.

Drainage Class Rating	Percent of Project Area
Well Drained	76.2%
Moderately Well Drained	8.8%
Other (water)	7.5%
Somewhat Poorly Drained	5.3%
Excessively Drained	1.4%
Poorly Drained	0.7%
Somewhat Excessively Drained	0.1%
Total	**100%**

Table 12: USDA Soils Data for Project Area – Drainage Class

SCRWA utilized PLET to determine the estimated number of septic systems, population per septic system, and septic system failure rate in the project area. Of the 2,199 total septic systems, 662 are considered failing. Table 13 details the septic system data retrieved from PLET.

Watershed	Septic Systems	Population per Septic System	Percent Failure Rate	Failing Septic Systems
Sixmile Creek-Catawba River	984	3	27	266
Fishing Creek Reservoir-Catawba River	790	3	27	213
Waxhaw Creek	425	3	43	183
Total	**2,199**	**NA**	**NA**	**662**

Table 13: Septic Systems and Failure Rate in Project Area

According to the EPA, bacteria load from failing septic tanks per household amounts to 2.76E+06 CFU/hour, which is 2.42E+10 CFU/year (EPA, 2022). Using this data, it was estimated that the existing bacteria load from failing septic systems in the project area is 1.60E+13 CFU/year. Table 14 shows the total estimated bacteria loading (CFU/year) from failing septic systems.

Estimated Septic Systems	Estimated Failing Septic Systems	Bacteria Load per Household (CFU/year)	Total Estimated Bacteria Loading (CFU/year)
2,199	662	2.42E+10	1.60E+13

Table 14: Estimated Bacteria Loads from Septic Systems in Project Area

5.2.2. Bacteria Pollution – Agriculture

Livestock, such as cattle, with access to waterbodies can deposit bacteria loads directly into waterbodies through their fecal matter. Over time, this can lead to water quality impairments for bacteria such as *E. coli*. There are three SCDES WQMSs throughout the project area listed as impaired for *E. coli* (see Table 8).

5.2.3. Bacteria Pollution – Agricultural Livestock

Estimating the number of cattle in the project area was calculated by identifying the total number of cattle in Fairfield, Chester, Lancaster, and York counties from the most recent USDA Census of Agriculture (2017). The calculation from the 2017 USDA Census of Agriculture uses the total number of cattle within the county divided by the total acreage of pastureland within the county. For this plan, SCRWA multiplied the Census of Agriculture calculation by the acreage of pastureland within each of the three watersheds. The data and calculated results can be found in Table 15.

County	Total Cattle	Acres of Pastureland in County	Acres of Pastureland in Watershed(s)	Estimated Number of Cattle in Watershed(s)
Fairfield	3,695	19,138	147	28
Chester	6,909	44,596	1,429	221
Lancaster	7,185	45,388	2,662	421
York	16,566	77,680	1,613	344
Total	**34,355**	**186,802**	**5,852**	**1,076**

Table 15: Estimated Cattle Population in Project Area

SCRWA was not able to get an accurate count of all livestock during site surveys. In lieu of site survey data, a combination of PLET Input Data server estimates and/or USDA Census of Agriculture estimates were used (see Table 16). Data from SCDES's Load Estimation and Reduction Spreadsheet was used to convert animal bacteria load to a pasture beef cow equivalent (PBCE) (see Table 17). Total fecal coliform loading from livestock was determined using SCDES's Load Estimation and Reduction Spreadsheet and Larsen's *Manure Loading into Streams from Direct Fecal Deposits* (SCDHEC, 2017) (Larsen, 1995). Larsen states that one 1,000-pound beef cow can deposit into streams a 2.98E+09 load of fecal coliform per day. The total estimated bacteria load from livestock in the project area can be found in Table 18. Table 19 further refines the data, showing the average annual estimated bacteria load from livestock from pastureland within the project area.

Watershed	Cattle	Swine (Hog)	Sheep	Horse	Turkey	Chicken	Duck
Fishing Creek	199	5	17	136	35,556	19,638	9
Sixmile Creek	399	1	26	124	32,678	6,517	3
Waxhaw Creek	478	3	44	202	113,446	710,401	18
Total	**1,076**	**9**	**87**	**462**	**181,680**	**736,556**	**30**

Table 16: Total Estimated Number of Agricultural Animals in Project Area

	Cattle	Horse	Sheep	Total
Count	1,076	462	87	1,625
Livestock Equivalents	1	1.1	0.04	N/A
Pasture Beef Cow Equivalent (PCBE)	1,076	508	3	1,587

Table 17: Agricultural Animal Population Count and PBCE Conversion

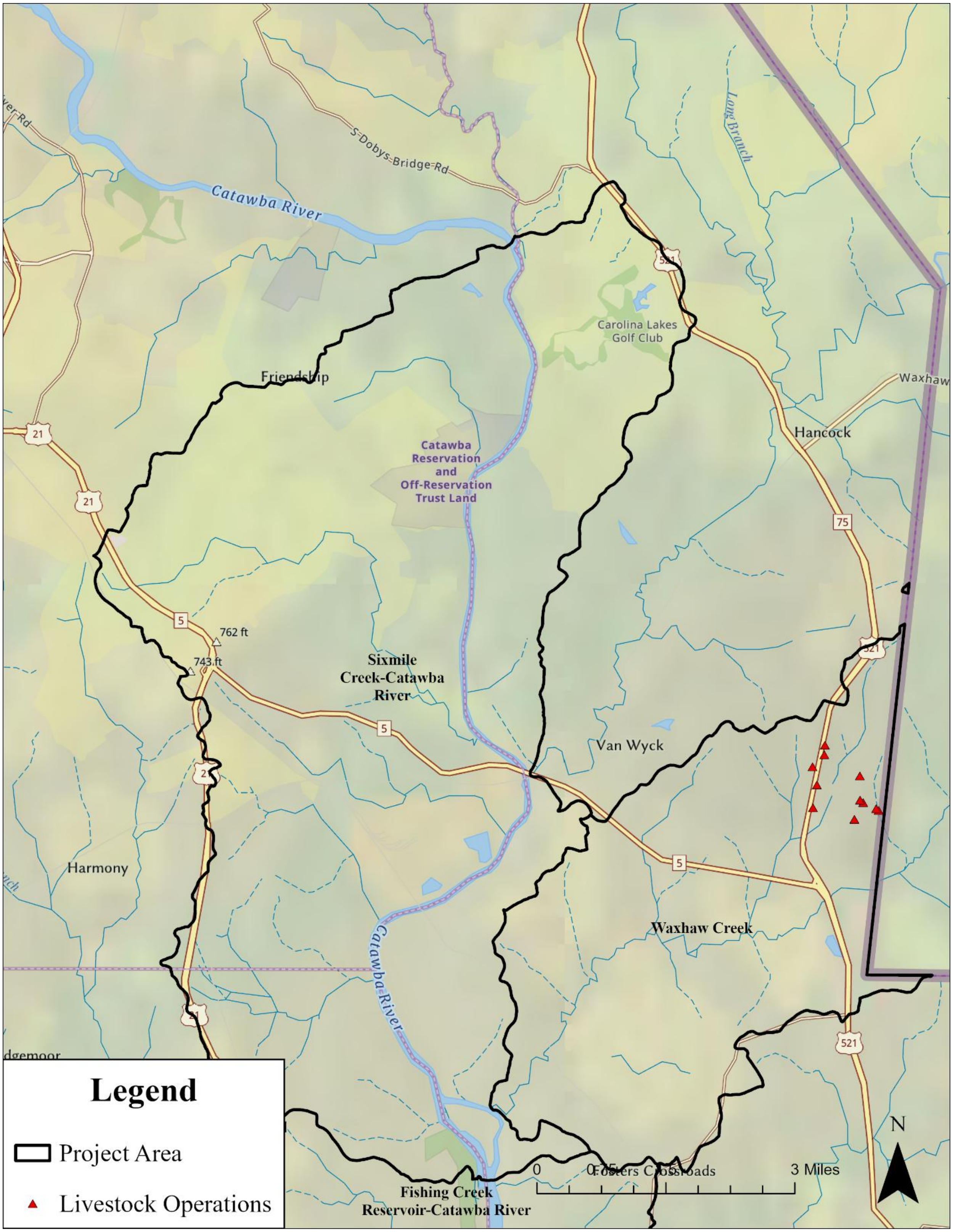
Livestock	PCBE Count	Equivalent (FC/day)	Fecal Coliform Load (CFU/yr)
Cow	1,076	3.84E+10	1.51E+16
Cow (in-stream)	1,076*	2.98E+09	1.17E+15
Horse	508	3.84E+10	7.12E+15
Sheep	3	3.84E+10	4.20E+13
Total	1,587	1.18E+11	6.84E+16

Table 18: Total Estimated Bacteria Load from Livestock in Project Area

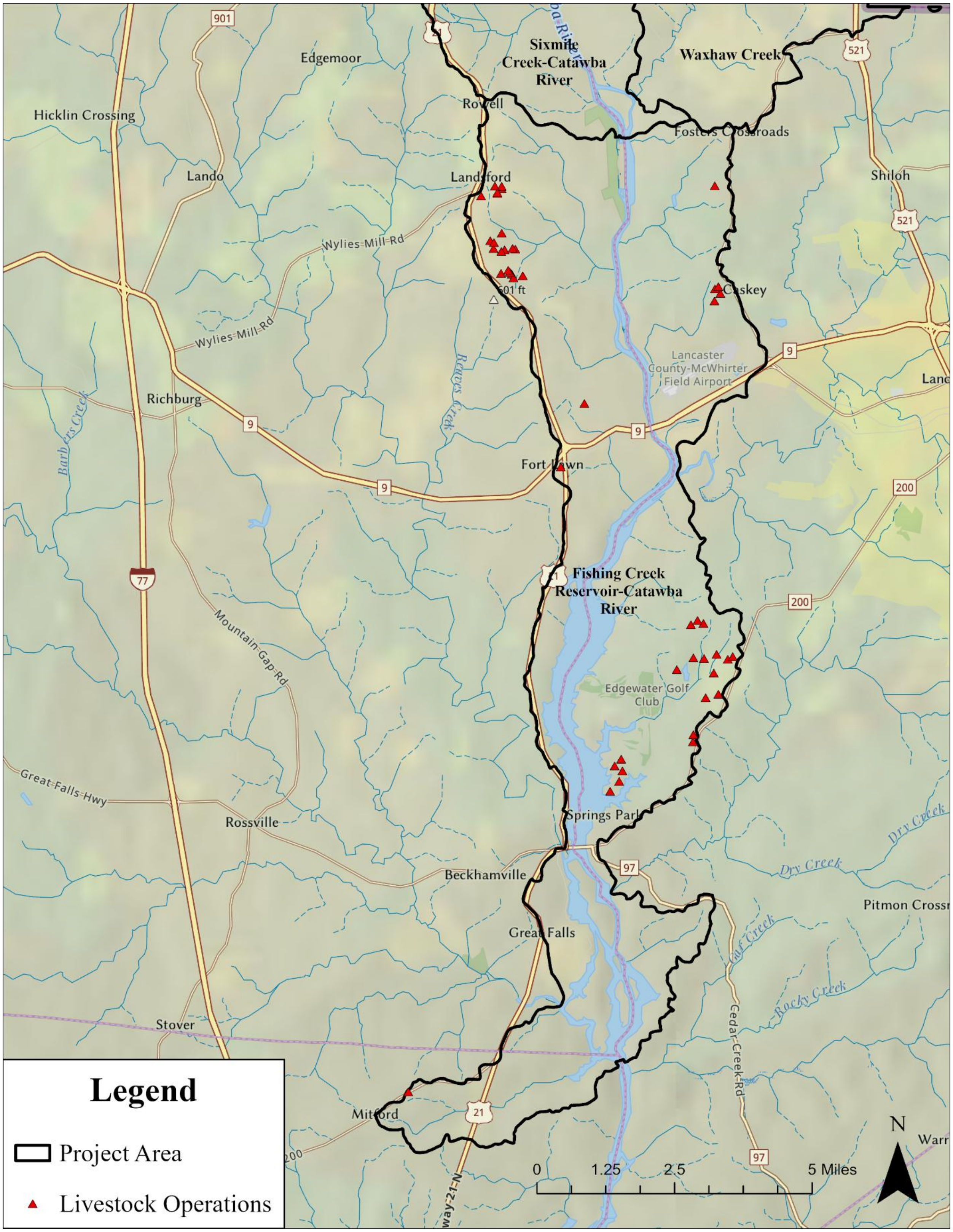
*Count included at 1,076 for consistency, though it is likely not plausible.

Total Estimated Bacteria Load from Livestock (CFU/yr)	Total Pastureland in Project Area (Acres)	Average Annual Livestock Bacteria Load from Pastureland (CFU/yr)
6.84E+16	5,852	1.17E+13

Table 19: Average Annual Livestock Bacteria Load from Pastureland in Project Area



Map 12: Livestock Operations (Sixmile Creek-Catawba River and Waxhaw Creek Watersheds)



Map 13: Livestock Operations (Fishing Creek Reservoir-Catawba River Watershed)

5.2.4. Bacteria Pollution – Agricultural Cropland

Data presented in Section 2.5 shows that cultivated crops represent roughly 3% of all total land cover. Croplands are a potential source of bacteria loading. Manure-based fertilizers applied to crops contain bacteria that may wash into nearby waterways during rain events. The total acreage calculated using the NLCD (2020) data resulted in 1,064 acres in the project area. The PLET model does not estimate bacteria loads for agricultural croplands. Shaver, *et al*. (2007) published *Fundamentals of Urban Runoff Management - Technical and Institutional Issues* and provided an annual fecal coliform loading of 2.70E+10 CFU/ha-year from crop farms (Shaver, 2007). Crop farms apply to all cultivated crops for the purpose of this analysis. This rate was used to calculate bacteria loading for 1,064 acres of cropland in the project area. The results are shown in Table 20.

Land Cover	Fecal Coliform Loading (CFU/ha-yr)	Cropland (Acres)	Cropland (Hectares)	Fecal Coliform Loading (CFU/yr)
Cultivated Crops	2.70E+10	1,064	431	1.16E+13

Table 20: Total Estimated Bacteria Load from Cropland in Project Area

5.2.5. Bacteria Pollution – Urban

Stormwater runoff can originate from many different land covers, including urbanized areas. Urban areas typically have high percentages of impervious surfaces, which act as easy pathways to waterbodies for stormwater runoff. Prior to Low Impact Development (LID) strategies, most urban areas were built without a focus on stormwater management. Some results of urban stormwater runoff include channelized streams, increased erosion, and flooding, especially in low lying areas. Wildlife, pet waste, and urban infrastructure are the primary contributors to bacteria pollution in stormwater runoff.

The data presented in Section 2.5 shows that *developed* land cover represents roughly 11% of all total land cover in the project area. The total acreage calculated using the NLCD (2020) data resulted in 8,001 urban acres in the project area. The PLET model does not estimate bacteria loads for urban land cover. As an alternative, SCRWA utilized Shaver, *et al*. (2007) to determine bacteria loading (Shaver, 2007). The publication includes bacteria pollutant loads for developed land (ranges) including *commercial*, *single family low density residential*, and *multifamily residential* (see Table 21). These values were then applied to the NLCD (2020) *developed* land cover data.

Land Use Category	NLCD Developed Land Cover	Fecal Coliform Loading (kg/yr)	Acres	Hectares	Fecal Coliform Loading (CFU/yr)
Commercial	*Developed, High Intensity*	5.8E+09	1,143	463	2.69E+12
Single Family Low Density Residential	*Developed, Low Intensity*	9.3E+09	2,285	925	8.6E+12
Multifamily Residential	*Developed, Medium Intensity*	2.1E+10	762	308	6.47E+12
Total		**3.61E+10**	**4,190**	**1,696**	**6.12E+13**

Table 21: Total Estimated Bacteria Load from Urban Land

6. SEDIMENT POLLUTION SOURCES

According to the EPA, sediment is becoming the most common source of pollution throughout the country (EPA, n.d.). Sediments are defined as loose sand, clay, silt, and other soil particles that settle at the bottom of a water body. They can originate from natural or anthropogenic sources including soil erosion or decomposing plants and animals. The project area is a good example of excess sediments impacting water quality. With population growth expected upstream, the effects from urbanization will compound the problems associated with sediment nonpoint source pollution. Sediments cause cloudy or turbid water – preventing animals from seeing food, preventing natural vegetation from growing, increasing drinking water treatment costs, clogging fish gills, and creating conditions that can activate species of algae.

SCRWA downloaded watershed data from the PLET Input Data Server, NLCD (2020), and USDA Census of Agriculture (2017) to calculate sediment loads. The total estimated sediment load contributing to the project area totals 5,967 tons per year. Table 25 provides a breakdown of sediment contribution from each land use in the project area.

6.1. Sediment Pollution – Nonpoint Sources

Based on the number of impairments in the project area, contributions from nonpoint source sediment pollution are assumed to be prevalent throughout the project area. Possible activities in the project area contributing to nonpoint source sediment pollution include construction sites, agricultural operations, stormwater runoff, and forestry practices.

PLET was utilized to determine the estimated nonpoint source pollutant loads from sediment. NLCD (2020) and USDA Census of Agriculture (2017) data replaced some of the automatically populated values downloaded through the PLET Input Data Server. This was done to create a more accurate representation of pollutant loads.

6.1.1. Sediment Pollution – Agricultural

Runoff from agricultural fields and pastures can contain large quantities of sediment, especially in overgrazed pastures and crop fields. The runoff is transported from agricultural fields into the nearby waterbodies after rain events. Other factors such as overgrazing and pivot irrigation systems also add to the nonpoint source sediment pollution problems. Specifically, pivot irrigation systems can oversaturate cropland soils, exceeding the soil's infiltration capacity, leading to increased sedimentation from runoff and/or erosion. The estimated sediment pollutant load originating from agricultural land in the project area is provided in Table 22.

	Sediment (tons/year)		
Watershed	**Cropland**	**Pastureland**	**Combined**
Fishing Creek Reservoir-Catawba River	57	668	726
Sixmile Creek-Catawba River	81	717	798
Waxhaw Creek	1,420	574	1,994
Total (ton/year)	**1,559**	**1,959**	**3,518**

Table 22: Total Estimated Sediment Load from Agricultural Land in Project Area

6.1.2. Sediment Pollution – Forest

The primary contributors for sediment pollution originating from forested land come from logging road use, clearcutting, gullying, and mismanaged/poorly installed forestry BMPs. However, based on conversations with the South Carolina Forestry Commission (SCFC) Environmental Programs Manager, and past BMP forester, forestry BMP compliance by logging companies averages 99% compliance (Holly Welch - SCFC, personal communication, July 2021). Therefore, sediment loading from forestry practices are likely attributable to clear cutting and gullying. SCFC programs, such as Stewardship Management, are proven tools that effectively manage forested land. The estimated sediment pollutant load originating from forested land in the project area is provided in Table 23 below.

	Sediment (tons/year)
Watershed	**Forest**
Fishing Creek Reservoir-Catawba River	517
Sixmile Creek-Catawba River	399
Waxhaw Creek	206
Total (ton/year)	**1,122**

Table 23: Total Estimated Sediment Load from Forested Land in Project Area

6.1.3. Sediment Pollution – Urban

Land disturbance and impervious surfaces represent the greatest contributions to urban nonpoint source pollution. Some urban characteristics that contribute to sediment loading include construction site activity, streets, yards, and streams. Impervious surfaces, like streets, prevent rainfall from being absorbed by natural landscapes. This can lead to a high volume of water flowing over areas with loose sediments (*e.g.* yards), which contribute to sediment deposition in nearby waterbodies. Streambanks with loose soils that accept a high volume of water during rain events can erode, causing sediments to deposit throughout the stream channel. Careful consideration should be given to proposing local ordinances for construction sites during the WP's proposed BMP implementation period. The estimated sediment pollutant load originating from urban land in the project area is provided in Table 24.

	Sediment (tons/year)
Watershed	**Urban**
Fishing Creek Reservoir-Catawba River	466
Sixmile Creek-Catawba River	730
Waxhaw Creek	132
Total (ton/year)	**1,328**

Table 24: Total Estimated Sediment Load from Urban Land in Project Area

TOTAL ESTIMATED SEDIMENT NONPOINT SOURCE POLLUTION LOADING					
Sediment (tons/year)					
Watershed	**Cropland**	**Pastureland**	**Forest**	**Urban**	**Total**
Fishing Creek Reservoir-Catawba River	57	668	517	466	**1,708**
Sixmile Creek-Catawba River	81	717	399	730	**1,927**
Waxhaw Creek	1,420	574	206	132	**2,332**
Total	**1,558**	**1,959**	**1,122**	**1,328**	**5,967**

Table 25: Total Estimated Sediment Load in Project Area

7. NUTRIENT POLLUTION

Nutrient pollution is considered one of the most widespread and difficult challenges for water quality in the US (EPA, 2018). Excess levels of nitrogen and phosphorus can cause both economic and environmental impacts such as harmful algal blooms in surface waters, increased drinking water treatment costs, and aquatic habitat degradation (EPA, 2015). Nutrient pollution is associated with both point and nonpoint sources and is most often attributed to anthropogenic influences. Table 26 provides examples of potential sources of nutrient pollution in the project area.

Agriculture	Urban	Wastewater	Industrial
✓ Soil Erosion ✓ Fertilizer Application ✓ Livestock	✓ Yard Waste ✓ Stormwater Runoff ✓ Fertilizers/Pesticides	✓ WWTPs ✓ Septic Systems	✓ Factories

Table 26: Potential Sources of Nutrient Pollution in Project Area

Annual nutrient loading for the project area was calculated using the PLET model. The model estimates that the project area contributes 22,486 pounds of phosphorus per year and 120,339 pounds of nitrogen per year to the region with most of the loading attributed to agricultural practices, urban development, forestry, and septic systems. The breakdown of the total estimated annual nutrient loading for each watershed per land cover is presented in Table 31.

7.1. Nutrient Pollution – Point Source

Detailed in Section 5.1, there are 14 active NPDES permitted sites within the project area. These include sites identified as either municipal, industrial, or domestic. Effluent from WWTPs and industrial producers can be causes of point source nutrient pollution. SCRWA recommends regularly monitoring these facilities for nutrient violations.

7.2. Nutrient Pollution – Nonpoint Sources

There are 29 SCDES WQMSs impaired for either Total Nitrogen (TN) or Total Phosphorus (TP) and 14 impaired for both TN and TP (see Table 8). The aggregate effect from upstream influence and local urbanized impervious area has resulted in impaired water with widespread elevated nutrient measurements.

The PLET model was used to determine the estimated nonpoint source pollutant loads from nutrients in the project area. NLCD (2020) and USDA Census of Agriculture data replaced some of the automatically populated values downloaded through the PLET Input Data Server. This was done to create a more accurate representation of pollutant loads.

7.2.1. Nutrient Pollution – Agriculture

Much like sediment pollution, runoff from agricultural fields and pastures can be filled with nitrogen and phosphorus rich soils and animal manures. Without proper mitigation, over time the accumulated effect from the runoff often results in impaired water. Utilizing nutrient management planning, improving soil health in crops and pastureland, practicing planned/managed grazing, ensuring proper manure management, and restricting livestock access to waterbodies are proven methods to reduce nutrient loading. The estimated pollutant load from agricultural land in the project area is provided in Table 27.

	Nutrient Load (lbs./year)					
	Cropland		Pastureland		Combined	
Watershed	**N**	**P**	**N**	**P**	**N**	**P**
Fishing Creek Reservoir-Catawba River	1,457	215	13,071	1,644	14,528	1,859
Sixmile Creek-Catawba River	1,981	295	13,590	1,731	15,572	2,026
Waxhaw Creek	10,455	2,418	9,048	1,250	19,503	3,668
Total	**13,893**	**2,928**	**35,709**	**4,625**	**49,603**	**7,553**

Table 27: Total Estimated Nutrient Load from Agricultural Land in Project Area

7.2.2. Nutrient Pollution – Forest

Like sediment loads from forested land, nutrient loads come from logging road use, clearcutting, gullying, and mismanaged/poorly installed forestry BMPs. Specific sources for nutrient loading from forested land can be difficult to identify. Gullying is often isolated from regular forestry practices. SCFC programs and private consulting foresters offer solutions to effectively managing forested land and reducing nutrient loads. The estimated sediment pollutant load originating from forested land in the project area is provided in Table 28.

	Nutrient (lbs./year)	
	Forest	
Watershed	**N**	**P**
Fishing Creek Reservoir-Catawba River	6,051	2,835
Sixmile Creek-Catawba River	4,648	2,177
Waxhaw Creek	2,018	933
Total (lbs./year)	**12,717**	**5,945**

Table 28: Total Estimated Nutrient Load from Forested Land in Project Area

7.2.3. Nutrient Pollution – Urban

Land disturbance and impervious surfaces together represent the greatest contributions to urban nonpoint source pollution. With an increase in impervious surfaces in this region, landscapes will continue to lose the ability to naturally filter precipitation during rain events. The result of increased land disturbance and impervious surfaces will cause higher volume and overland flow of stormwater and discharge them into nearby waterways. Nitrogen and phosphorus can be associated with construction site land disturbance activity, runoff from impervious surfaces, and excess lawn fertilizer application. The estimated sediment pollutant load originating from urban land in the project area is presented in Table 29.

	Nutrient (lbs./year)	
	Urban	
Watershed	**N**	**P**
Fishing Creek Reservoir-Catawba River	20,258	3,117
Sixmile Creek-Catawba River	31,758	4,887
Waxhaw Creek	5,750	885
Total (lbs./year)	**57,766**	**8,889**

Table 29: Total Estimated Nutrient Load from Urban Land in Project Area

7.2.4. Nutrient Pollution – Septic/Wastewater

Domestic wastewater contains nutrients from sources such as human waste and household cleaning supplies. Failing septic systems can leach these nutrients and enter nearby waterbodies through the various scenarios presented in Section 5.3. The calculation for nutrient nonpoint source loading from septic/wastewater was made using PLET data (*i.e.* septic system failure rates). Without the benefit of having updated GIS (or other) data indicating an accurate septic system count within the project area, the calculations for septic/wastewater nutrient pollutant represent a maximum amount. The total estimated nutrient load from septic/wastewater sources can be found in Table 30.

	Nutrient (lbs./year)	
	Septic/Wastewater	
Watershed	**N**	**P**
Fishing Creek Reservoir-Catawba River	82	32
Sixmile Creek-Catawba River	102	40
Waxhaw Creek	70	27
Total (lbs./year)	**254**	**99**

Table 30: Total Estimated Nutrient Load from Septic/Wastewater Sources in Project Area

TOTAL ESTIMATED ANNUAL NUTRIENT NONPOINT SOURCE POLLUTION LOADING												
Nutrient (lbs./year)												
	Urban		Cropland		Pastureland		Forest		Septic		Total	
Watershed	**N**	**P**	**N**	**P**	**N**	**P**	**N**	**P**	**N**	**P**	**N**	**P**
Fishing Creek Reservoir-Catawba River	20,258	3,117	1,457	215	13,071	1,644	6,051	2,835	82	32	**40,919**	**7,843**
Sixmile Creek-Catawba River	31,758	4,887	1,981	295	13,590	1,731	4,648	2,177	102	40	**52,079**	**9,130**
Waxhaw Creek	5,750	885	10,455	2,418	9,048	1,250	2,018	933	70	27	**27,341**	**5,513**
Total	**57,766**	**8,889**	**13,893**	**2,928**	**35,709**	**4,625**	**12,717**	**5,945**	**254**	**99**	**120,339**	**22,486**

Table 31: Total Estimated Annual Nutrient Load in Project Area

8. PROPOSED BMPS

Specific BMPs are proposed for future implementation based on existing water quality impairments in the project area and the BMPs treatment purpose. Table 32 lists these BMPs and their treatment purposes.

There are two BMP bundles included in the table. An *agriculture-pastureland bundle* consists of an alternative watering source, stream crossing, manure composting (structure), and heavy use area stabilization. An *agriculture-cropland bundle* includes nutrient management, soil stabilization, and critical area planting.

		Treatment		
	BMP	**Bacteria**	**Nutrient**	**Sediment**
	Septic System Repair or Replacement	✓	✓	
	Cover Crop (High Till for TP and Sediment)		✓	
	Grass Buffer/Filter Strip (35 Feet) (for Cropland)		✓	✓
	Conservation Tillage (30-59% Residue)		✓	✓
	Forest Buffer (100 feet) (for Pasture and Crop)		✓	✓
	Site Prep/Hydro Mulching/Seeding/Fertilizer			✓
	Streambank Fencing		✓	✓
	Alternative Water Source (less than 401-600 gallons)		✓	✓
	Grass Buffer/Filter Strip (35 Feet) (for Pastureland)		✓	✓
	Heavy Use Stabilization			✓
	LID/Filter/Buffer Strip	✓	✓	✓
	Porous Pavement	✓	✓	✓
	LID/Rain Barrel	✓	✓	✓
Pastureland Bundle	Alternate Watering Source and Fencing	✓	✓	✓
	Stream Crossing	✓	✓	✓
	Manure Composting	✓	✓	✓
	Heavy Use Area Stabilization	✓	✓	✓
Cropland Bundle	Nutrient Management	✓	✓	✓
	Soil Stabilization	✓	✓	✓
	Critical Area Planting (*e.g.* Cover Crop, No Till)	✓	✓	✓

Table 32: Proposed BMPs and Treatment Purpose

Septic System Repair/Replacement: This BMP includes identifying faulty septic systems to repair or replace, including rehabilitating drainfields as necessary. Septic system maintenance guidance published by the EPA suggests that an average household septic system should be inspected at least every three years by a service professional. Systems should be pumped every three to five years. The drainfield is a part of the system and should be free of parked cars and should not be exposed to root structures from trees (EPA, 2022).

Cover Crop (High Till for TP and Sediment): Cover crops, such as grasses, legumes, forbs, and other herbaceous plants are established for seasonal cover on agricultural fields. Cover crops stabilize soil by increasing organic matter content and establishing root systems. For maintenance, USDA NRCS suggests evaluating the cover crop to determine if the cover crop is meeting the planned purpose(s). If the cover crop is not meeting the purpose(s) adjust the management, change the species of cover crop, or choose a different technology (USDA, 2015).

Grass Buffer (35 feet): Linear strips of grass or other non-woody vegetation that are maintained to filter nutrients, sediment, and other pollutants from nonpoint source runoff. The USDA NRCS suggests the following for maintenance: conduct all farming operations parallel to the strip boundaries except on headlands or end rows with gradients less than the criteria set forth in this standard, time mowing or harvest of buffer strips to maintain appropriate vegetative density and height for optimum trapping of sediment from the upslope cropped strip during the critical erosion period(s), fertilize buffer strips as needed to maintain stand density, mow or harvest sod turn strips and waterways at least once a year, spot seed or totally renovate buffer strip systems damaged by herbicide application after residual action of the herbicide is complete, and redistribute sediment that accumulates along the upslope edge of the buffer strip/crop strip interface as needed. The sediment should be spread evenly upslope over the cultivated strip when needed to maintain uniform sheet flow along the buffer/cropped strip boundary (Chesapeake Bay Program, 2018).

Conservation Tillage: Manages the amount, orientation, and distribution of crops and other plant residue on the soil surface year-round while limiting soil-disturbing activities used to grow and harvest crops in systems where the field surface is tilled prior to planting. The primary purpose is to reduce sheet, rill, wind erosion and excessive sediments in surface waters and improve soil health by increasing organic matter content. USDA NCRS suggests for maintenance measures to evaluate/measure the crop residue cover and orientation for each crop to ensure the planned amounts and orientation are being achieved, adjust management as needed to either plan a new residue amount or orientation, and if there are areas of heavy residue accumulation (because of movement by water or wind) in the field, spread the residue prior to planting so it does not interfere with planter operation (USDA, 2017).

Forest Buffer (100 feet): An area predominantly covered by trees and/or shrubs located adjacent to and up-gradient from a watercourse or water body. The primary purpose is to reduce the transport of sediments to surface water, and reduce the transport of pathogens, chemicals, pesticides, and nutrients to surface and ground water. USDA NRCS suggests preparing an operation and maintenance plan to include: limiting access or damage from vehicles, equipment, livestock, and wildlife, during tree planting and until riparian buffer establishment to protect new plants and minimize erosion, compaction, and other site impacts, inspecting the site at an appropriate time following planting to determine whether the survival rate for tree and shrubs meets practice and client objectives, replacing dead trees or shrubs and controlling undesirable vegetative competition until the buffer is or will progress to a fully functional condition, controlling undesirable plant species that may include but not be limited to those on the federal or state invasive species and noxious weed lists, inspecting the trees, shrubs, and site periodically, and protecting the plantings and site from adverse impacts of insects, diseases, competing vegetation, fire, livestock, excessive vehicular and pedestrian traffic, wildlife, concentrated flows, nonfunctioning tree shelters and/or weed barriers, etc., and applying fertilizers, pesticides, and other chemicals used to maintain buffer function in a way that will not impact water quality (USDA, 2020).

Site Prep/Hydro Mulching/Seeding/Fertilizer: Site Preparation consists of a treatment of sites to enhance the success of natural or artificial regeneration of desired trees and/or shrubs. The purpose is to manage soil conditions, naturally available water, and seasonally high water to favor tree and shrub establishment and survival. Hydro Mulching consists of applying plant residues or other suitable materials to the land surface. The purpose is to improve the efficiency of moisture management, reduce irrigation energy used in farming/ranching practices and field operations, improve the efficient use of irrigation water, prevent excessive bank erosion from water conveyance channels, reduce concentrated flow erosion, reduce sheet, rill, and wind erosion, improve plant productivity and health, and maintain or increase organic matter content. The maintenance of this BMP should comply with all local, state, and federal laws and ordinances, and with the state's best management practices for water quality (USDA, 2017) (USDA, 2020).

Streambank Fencing and Soil Stabilization: Streambank, or exclusionary, fencing is a common method for limiting livestock access to waterbodies. Limiting livestock access to waterbodies ensures that fecal waste is not directly deposited into the water body. Fencing also keeps livestock from disturbing loose soils near waterbodies thereby reducing the sediment load. USDA NRCS suggests regular inspection of permanent, temporary, and portable fences be part of an ongoing maintenance program ensuring proper fence function for the practice's lifespan. As a minimum, the following should be included in the operation and maintenance plan: conduct inspections of fences after storms and other disturbance events, repair or replace loose or broken material, gates, and other forms of ingress and egress, remove trees and limbs, repair or replace water gaps as necessary, repair eroded areas as necessary, repair or replace markers or other safety and control features as required, and maintain fladry or signage as necessary (USDA, 2022).

Alternative Water Supply: Alternative livestock watering systems are designed to provide an alternative to watering animals directly from streams, rivers, and lakes. The purpose is to decrease soil erosion and help maintain stable stream banks when a stream side filter is re-established, and provide a year-round supply of clean, freeze-proof water for livestock through a well-designed watering system. When used in conjunction with protected heavy-use areas, they provide a solid, mud-free watering area. It also provides more flexibility in managing forage grazing systems, manure distribution and pasture utilization and develops wildlife habitat along stream sides where the riparian zone has been re-established. For maintenance, USDA NRCS suggests regularly checking the flow of water to the trough, looking for leaks and fixing them right away, checking the float valve regularly to make sure it is working, stop any leaks and cleanup eroded areas, and drain and cleanout troughs at least once a year (USDA, 2020).

Stream Crossing: A stabilized area or structure constructed across a stream to provide controlled access for people, livestock, equipment, or vehicles. For maintenance, the USDA recommends that at a minimum include the following items in the operation and maintenance plan: detail the appropriate conditions when the crossing can be safely used and when it should not be used by a predetermined depth, inspect the stream crossing/appurtenances/approaches/associated fence and exclusion gates at least annually and after each major storm event, remove accumulated organic material, woody material, or excess sediment, and replace surfacing stone for livestock crossing as needed (USDA, 2022).

Heavy Use Stabilization Area: The purpose of this BMP is to stabilize or protect intensively used areas on agricultural land. The purpose is to reduce soil erosion and provide a stable, noneroding surface. For maintenance purposes, the USDA NRCS suggests preparing an operation and maintenance plan and reviewing it with the operator prior to practice installation. The minimum requirements to be addressed in the plan include periodic inspections (annually and immediately following significant rainfall events), prompt repair or replacement of damaged components, especially surfaces that are subjected to wear or erosion, requirements for the regular removal and management of manure, as needed, for livestock heavy use areas, and restrict uses, as needed, to protect the stand and to allow vegetative recovery for vegetated heavy use areas (USDA, 2022).

LID/Filter/Buffer Strip: A filter or buffer strip is a strip or area of vegetation that treats overland flow, or sheet flow, from impervious surfaces by filtering sediment, organic matter, and other pollutants allowing some of the stormwater to infiltrate into the soil. Filter/buffer strips also work to slow the velocity of runoff and are generally used to treat small drainage areas, such as parking lots, sidewalks, and roadways. It is important to maintain sheet flow through the filter/buffer strip to avoid concentrated flows that will reduce their effectiveness (EPA, 2021).

Porous Pavement: This is an alternative to conventional asphalt. Porous pavements use a variety of media, often supported by a structural matrix, concrete grid, or modular pavement. The porous media allows water to percolate through the pavement to a subbase for gradual infiltration into the underlying soil (EPA, 2023).

LID/Rain Barrel: Rain barrels are used as stormwater harvesting devices designed to capture and store rooftop runoff for later use. Rain barrels are smaller storage devices, usually less than 100 gallons, which are typically designed for a residential setting and smaller rainwater reuse opportunities, such as watering gardens or lawns (EPA, 2023).

Nutrient Management (Determined Rate): A nutrient management plan manages the amount, source, placement, and timing of plant nutrients and soil amendments. The purpose is to reduce the amount of nutrients applied to agricultural fields without affecting production. The amount of nutrients entering waterbodies at the edge of field is reduced through this BMP. For BMP maintenance, the USDA NRCS suggests reviewing or revising plans periodically to determine if adjustments or modifications are needed. At a minimum, review and revise plans as needed with each soil test cycle, changes in manure management volume or analysis, plants and crops, or plant and crop management. Monitor fields receiving animal manures and biosolids for the accumulation of heavy metals and phosphorus.

For animal feeding operation, significant changes in animal numbers, management, and feed management will necessitate additional manure analyses to establish a revised average nutrient content. Calibrate application equipment to ensure accurate distribution of material at planned rates. For products too dangerous to calibrate, follow equipment manufacturer guidance on proper equipment design, plumbing, and maintenance. Document the nutrient application rate. When the applied rate differs from the planned rate, provide appropriate documentation to explain the difference. Use material generated from cleaning nutrient application equipment in an environmentally safe manner. Collect, store, or field apply excess material in an appropriate manner. Recycle or dispose of nutrient containers in compliance with State and local guidelines or regulations (USDA, 2019).

The following are SCRWA's recommendations for proposed BMP installation locations in the project area:

Agriculture BMPs

Agriculture BMPs presented in this plan will be used to manage agricultural land cover for pastureland and cropland operations. The purpose of these BMPs is to limit bacteria, sediment, and nutrient nonpoint source pollutants from agricultural land entering Fishing Creek and its tributaries. SCRWA recommends prioritizing agricultural operations one hundred acres and above for future BMP installations.

Agriculture – Pastureland BMPs should be installed on land cover categorized as pastureland. SCRWA recommends prioritizing *streambank fencing*, *alternative water sources*, *grass buffer/filter strips (35 feet) (for pastureland)*, *forest buffer (100 feet) (for pasture and crop)*, and *heavy use stabilization* projects in the Waxhaw Creek watershed. Despite low agricultural land cover in the Sixmile Creek and Fishing Creek-Catawba River watersheds, SCRWA nevertheless encourages Agriculture-Pastureland BMP installation in these watersheds as opportunities become available.

Agriculture – Cropland BMPs should be installed on land cover defined as cropland. SCRWA recommends prioritizing *cover crop (high till for TP and sediment)*, *grass buffer/filter strip (35 feet) (for cropland)*, *conservation tillage (30-59% residue)*, and *forest buffer (100 feet) (for pasture and crop)* in the Waxhaw Creek watershed. To supplement the landscape scale BMPs for cropland, SCRWA recommends focusing on education and outreach strategy topics related to sediment and nutrient loading from cropland throughout the project area.

Forest BMPs

Forest land is defined as land that is at least 10% forested and timber land is forest land that is available for harvest and capable of productivity over time (Congressional, 2022). Roughly 64% of land cover in the project area is forested, and almost 100% of the forested land is privately owned by families or corporations. SCRWA recommends installing forest BMPs like site prep/hydro mulching/seeding/fertilizer in the three watersheds where there are landowners willing to participate in this or other forest BMPs. Partnerships with organizations like the SCFC can help identify eligible landowners for BMPs like this as well as others.

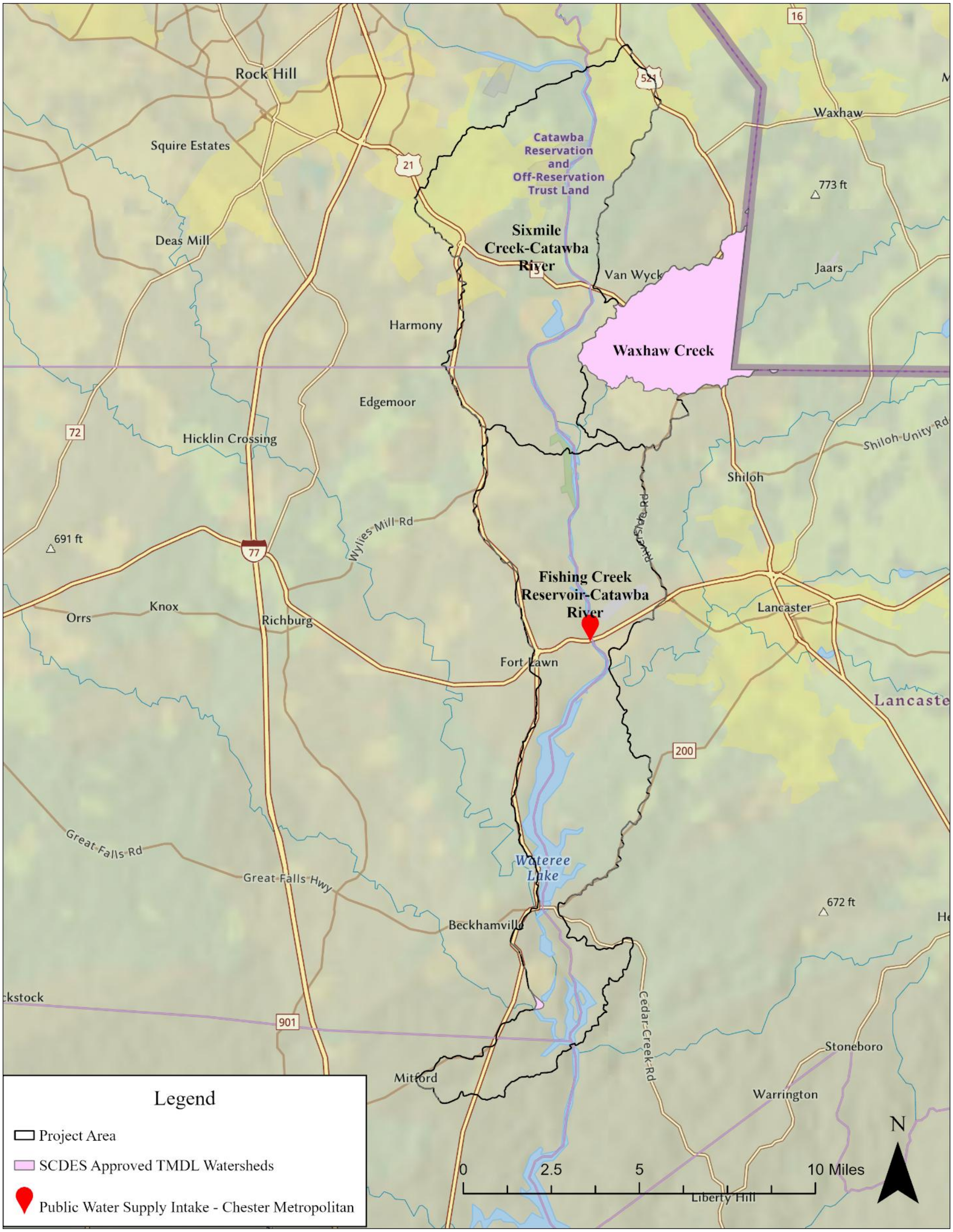
Septic/Urban BMPs

SCRWA recommends installing/repairing septic systems in all three watersheds. Urban BMPs are most effective in treating stormwater runoff from developed land cover. In the Fishing Creek-Catawba River watershed, SCRWA recommends installing *LID/filter/buffer strips* and *porous pavement* projects at commercial/industrial properties in Great Falls and Fort Lawn. Regarding *LID/rain barrels*, SCRWA recommends installing these at single family and multi-family residences in neighborhoods like Edgewater by True Homes and apartment complexes like The Falls Apartments in Great Falls, SC. For the Waxhaw Creek watershed, SCRWA recommends installing *LID/filter/buffer strips* on commercial property at Fosters Crossroads, *porous pavement* projects at industrial properties along the Lancaster Industrial Park corridor at Industrial Park Road, and *LID/rain barrels* at single family residences in the Riverchase Estates neighborhood. It was determined that no practical urban bmp installation opportunities exist in the Sixmile Creek watershed.

9. LOAD REDUCTIONS

9.1. Load Reduction – Bacteria

A portion of the Waxhaw Creek watershed in the project area has a TMDL in place for bacteria (see Map 12). Ultimately, a TMDL establishes the allowable pollutant loads (or other quantifiable parameters) for a water body based on the relationships between pollutant sources and in-stream water quality conditions, so states can then implement water quality-based controls to reduce pollution from point and nonpoint sources and restore and maintain the quality of its water resources (USEPA 1991). The TMDL represents calculations for the maximum amount of a pollutant allowed to enter a water body so that the water body will meet water quality standards for that pollutant. A TMDL consists of a wasteload allocation (WLA), a load allocation (LA), and a margin of safety (MOS). The WLA is the fraction of the total pollutant load apportioned to point sources and includes stormwater discharges regulated under the NPDES program as point sources. The LA is the fraction of the total pollutant load apportioned to nonpoint sources. The MOS is a percentage of the TMDL that accounts for the uncertainty associated with model assumptions and data limitations (SCDHEC, 2005).



Map 74: SCDES TMDL – Waxhaw Creek Watershed

Table 33 summarizes the TMDL calculations completed by SCDES for WQMS CW-145 (SCDHEC, 2005). Because data in the TMDL are calculated for CFU, it is necessary to convert the measurements to MPN (counts), which accounts for SCDES's change in standards from Fecal Coliform to *E.coli*. The conversion requires multiplying the Fecal Coliform measurements by the *E.coli* conversion rate of 0.8725.

Table 34 represents annual prescribed reductions. Bacteria load reductions from the TMDL for the Waxhaw Creek watershed are incorporated into the overall bacteria load reduction measurements, where necessary, using data for WQMS CW-145.

SCDES WQMS	WLA* (CFU/day)	LA** (CFU/day or % reduction)	MOS***	TMDL (CFU/day or percent reduction)	Percent Reduction
CW-145	1.21E+08	1.57E+12	8.28E+10	1.66E+12	86
Fecal Coliform to *E. coli* Conversion					
SCDES WQMS	**WLA (counts/day)**	**LA (counts/day or % reduction)**	**MOS**	**TMDL (counts/day or percent reduction)**	**Percent Reduction**
CW-145	1.06E+08	1.37E+12	7.22E+10	1.45E+12	86

Table 33: TMDL Summary for Bacteria Reductions in Waxhaw Creek Watershed
*Waste Load Allocation
**Load Allocation
***Margin of Safety

SCDES WQMS	WLA (counts/year)	LA (counts/year or % reduction)	MOS	TMDL (counts/year or % reduction)
CW-145	3.87E+10	5.00E+14	7.22E+10	5.29E+14

Table 34: Annual Bacterial Reductions (TMDL)

For the portion of the project area not covered by the TMDL, SCRWA used best professional judgement (BPJ) to determine bacteria load reductions. This included incorporating feedback from landowner participation and the best options for BMP installations specific to the sources of bacteria pollution and their efficiency in mitigating the contributing land cover/activity.

Table 35 shows the total anticipated annual bacteria load reduction after all proposed BMPs are installed. The list of BMPs proposed for addressing bacteria pollution can be found in Table 32.

An *agriculture-pastureland bundle* includes alternative watering source, exclusionary fencing, stream crossing, manure composting (structure), and heavy use area stabilization. An agriculture-cropland bundle includes nutrient management, soil stabilization, and critical area planting. The frequency of these installations will depend on available funding from the grants awarded. It should be noted that each grant has specific guidance, and the guidance should be considered during the implementation phase.

For the agriculture-pastureland projects proposed, SCRWA believes that most bacteria load reductions will come from alternative watering sources and exclusionary fencing BMPs. The load reductions for each agriculture-pastureland BMP presented in Table 32 apply a 30% bacteria load reduction efficiency based on literature value for off-stream watering and fencing (Simpson, 2009). SCRWA anticipates three cattle farms totaling roughly 600 cattle in the project area will participate during the proposed implementation period. Livestock farms in the Waxhaw Creek watershed should be prioritized in the implementation planning process.

For the agriculture-cropland projects proposed, SCRWA believes that most of the bacteria load reductions will come from farmers installing critical area planting BMPs. The load reductions for each agriculture-cropland BMP presented in Table 35 apply a 20% bacteria load reduction efficiency based on SCDHEC data for critical area planting (SCDHEC, 2017). The BMPs listed for cropland should be treated as a bundle (*i.e.* one project). SCRWA anticipates three crop farms totaling roughly 150 acres will participate during the BMP implementation period.

For urban BMP projects, SCRWA anticipates bacteria load reductions will be achieved through an array of targeted installations including LID/filter/buffer strips and porous pavement for developed land cover and LID/rain barrels for single and multi-family residences. For each project phase, the plan proposes to install three LID/filter/buffer strips, three porous pavement projects, five multi-family rain barrels, and 20 single family rain barrels. For each project phase, the LID/filter/buffer strips are projected to treat roughly 120 acres of commercial/developed land cover. The three porous pavement projects will cover approximately 60 acres of industrial/developed land cover.

The WP proposes to replace/repair 100 septic systems during each project phase, one agriculture-pastureland bundled project, and one agriculture-cropland bundled project.

TOTAL ESTIMATED BACTERIA LOAD REDUCTION				
Category	**BMP**	**Bacteria Removal per Single BMP (CFU/year)**	**Estimated Number of Projects**	**Total Bacteria Reduction (CFU/ year)**
Septic	Septic Repair/Replacement[1]	2.42E+10	100	**2.42E+12**
Agriculture – Pastureland Bundle	Alternate Watering Source and Fencing[2]	7.00E+12 (per one cow/year)	1 (200 cattle)	**1.40E+15**
	Stream Crossing			
	Manure Composting (structure)			
	Heavy Use Area Stabilization			
Agriculture – Cropland Bundle	Nutrient Management	1.09E+10 (per one acre)	1 (20% cropland area)	**3.27E+11**
	Soil Stabilization			
	Critical Area Planting (*e.g.* Cover Crop, No Till)[3]			
Total				**1.40E+15**
Conversion to *E. coli* (MPN/100mL)*				**1.22E+15**

Table 35: Total Estimated Bacteria Load Reduction After BMP Install
*Utilized SCDES's change in standards from Fecal Coliform to *E. coli*. conversion rate is 0.8725.

9.2. Load Reduction – Nutrients and Sediment

The project area does not include a TMDL for either nutrients or sediments. Of the 37 impaired SCDES WQMSs in the project area, 29 are impaired for either TN, TP, and/or turbidity. The BMPs best suited for mitigating pollutants contributing to these impairments are listed in Table 32.

Like the proposed load reduction schedule for bacteria nonpoint source pollution, nutrient and sediment load reductions will be achieved using the same phased BMP implementation schedule (see Section 12). Tables 25 and 31 show the estimated annual nonpoint source nutrient and sediment loads, and Table 36 outlines the total estimated annual nutrient and sediment load reduction after BMPs are installed. Among the various cost-share funding opportunities for BMP implementation, the CWA

[1] Reference: (EPA, 2022).
[2] Reference: (Simpson, 2009).
[3] Reference: (SCDHEC, 2017).

Section 319 Grant is the most commonly used. EPA guidelines for this grant state that the funding is to be applied within a three-year time frame.

TOTAL ESTIMATED NUTRIENTS AND SEDIMENT LOAD REDUCTION			
Watershed	**N Reduction (lbs./year)**	**P Reduction (lbs./year)**	**Sediment Reduction (tons/year)**
Sixmile Creek-Catawba River	708	134	82
Fishing Creek Reservoir-Catawba River	865	150	80
Waxhaw Creek	1,817	327	178
Total	**3,390**	**611**	**340**

Table 36: Total Estimated Annual Nutrient and Sediment Load Reduction

10. FINANCIAL AND TECHNICAL ASSISTANCE

Table 37 provides the total estimated cost for installing all proposed BMPs over a 15-year implementation timeline. Estimated BMP costs were taken from USDA NRCS Environmental Quality Incentives Program (EQIP), US Army Corps of Engineers (USACE) published state payment schedules for South Carolina, EPA Stormwater Best Management Practices literature, and the Ohio State University published literature. Cost-share rates for implementing these BMPs are dependent upon available funding sources and implementation costs. Implementation costs should be considered as estimates subject to change after publication.

BMP	Average Cost	Units	# of Projects	Total Estimated Cost
Septic System Repair or Replacement	$4,000	None	300	$1,200,000
Cover Crop (High Till for TP and Sediment)	$64.11	Acre	185	$11,860.35
Grass Buffer/Filter Strip (35 Feet) (for Cropland)	$188.37	Acre	185	$34,848.45
Conservation Tillage (30-59% Residue)	$2,365.39	None	185	$437,597.15
Forest Buffer (100 feet) (for Pasture and Crop)	$1,737.48	Acre	1860	$3,231,712.80
Site Prep/Hydro Mulching/Seeding/Fertilizer	$686.13	Acre	21,000	$14,408,730
Streambank Fencing	$2.85	Feet	500	$1,425
Alternative Water Source (less than 401-600 gallons)	$450.58	None	500	$225,290
Grass Buffer/Filter Strip (35 Feet) (for Pastureland)	$188.37	Acre	1,550	$291,973.50
LID/Filter/Buffer Strip	$1.30	Feet	3	$6,075
Porous Pavement	$5	Feet	3	$1,045,440
Rain Barrel	$100	None	3	$300
Total (15 Year Project Period)				**$20,895,252**

Table 37: Total Estimated Cost for Full BMP Installation

10.1. Forest BMP Funding Options

Funding for forest management BMPs is limited. Most BMPs installed on forested land in South Carolina are completed by logging companies or private consulting foresters. Listed below are two applicable programs for BMP implementation offered by the USDA and the SCFC.

SCFC Stewardship Program

Landowners can join the SCFC's Forest Stewardship Program (FSP) with minimal costs. Landowners are provided with a professional forester that provides consultation for methods to best manage their forested land including rotational harvesting, seed planting, and prescribed burning. The FSP provides reimbursement for these plans. The eligibility requirement for this program is ownership of at least 50 forested acres. The parcel(s) must also be considered a Forest Stewardship Priority Parcel (*i.e.* parcels with greater than 50% FSP priority pixels). Reimbursements fall between $600 and $2,000 for each approved Stewardship Management Plan (South Carolina Forestry Commission, 2022).

USDA NRCS Healthy Forests Reserve Program

The Healthy Forests Reserve Program (HFRP) helps private forest landowners restore, enhance, and protect forestland resources on their land through easements and financial assistance. The HRFP also contributes to the recovery of endangered and threatened species under the Endangered Species Act, improves plant and animal biodiversity, and enhances carbon sequestration.

Some benefits to HFRP are that it provides landowners with a 10-year restoration agreement and 30-year or permanent easements for specific conservation actions. Eligibility requirements dictate that the land must be privately owned and can restore, enhance or increase the recovery of threatened or endangered species, improve biological diversity or increase carbon storage (USDA, n.d.).

Other USDA NRCS programs include EQIP, CSP, and RCPP. All of these have components built in that help private landowners improve their forestland.

10.2. Riparian Buffer Funding Options

There are several federal funding program opportunities for riparian buffer BMP implementation projects. Listed below are some options for consideration.

<u>CWA Section 319 Program</u>

This program focuses on preventing or reducing nonpoint sources of pollutants from entering waterbodies. This allows the beneficial uses of the water resources to be maintained or restored. EPA provides annual funding to SCDES to implement nonpoint source pollution mitigation strategies. The funding is open to a competitive grant process for applicants interested in implementing nonpoint source strategies outlined in an approved WP. Applications for this funding are open to stakeholder groups, government entities, or other public agencies associated with the watershed planning process. The 319 grant pays up to 60% of eligible project costs, with the applicant providing a 40% non-federal match (EPA, 2021).

<u>USDA NRCS EQIP</u>

EQIP provides cost sharing and technical assistance for the planning and installation of environmentally beneficial and cost-effective conservation practices that address natural resource concerns. Together, USDA NRCS personnel and producers invest in solutions that conserve natural resources for the future while also improving agricultural operations. EQIP contracts are set for five to 10 years. Agricultural or non-industrial forestry producers are eligible applicants for this funding (USDA, n.d.).

10.3. Agriculture BMP Funding Options

The following funding options include federal program funding options from the EPA and USDA. The goal of these programs is to reduce agricultural nonpoint source pollution by helping to install the agricultural BMPs detailed in this plan.

<u>CWA Section 319 Program</u>

See description in Section 10.2.

<u>USDA Farm Service Agency (FSA) Conservation Reserve Program (CRP)</u>

Established in 1985, CRP is one of the largest voluntary conservation programs provided to agricultural producers. In exchange for an annual rental payment, producers agree to remove environmentally sensitive land from agricultural production and plant species that will improve the environmental health and quality of their land. The long-term goal of the program is to reestablish valuable land to improve water quality, prevent erosion, and reduce loss of wildlife habitat. The contract agreement between the producer and USDA FSA lasts between 10 and 15 years. In South Carolina, applications are received between January and March of each year (USDA, n.d.).

USDA NRCS Conservation Stewardship Program (CSP)
This program provides technical and financial assistance to producers so they can build on existing conservation efforts while strengthening operations, such as grazing conditions, crop resiliency, or wildlife habitat development. Eligible agricultural land covers include cropland, grassland, prairie land, pastureland, rangeland, non-industrial private forest land, tribal land, and other forms of agricultural land. At its core, CSP is a problem-solving mechanism for producers. For example, a CSP plan can solve problems related to soil loss, water loss, and promote energy efficiencies for on-farm activities. NRCS field offices receive applications at any time throughout the year (USDA, n.d.).

USDA NRCS EQIP
See description in Section 10.2.

10.4. Urban BMP Funding Options
The following funding options include federal and state program funding options from the EPA and SCDES.

CWA Section 319 Program
See description in Section 10.2.

South Carolina State Revolving Fund (SRF) Program
The SRF program provides low-interest rate loans for building or repairing drinking water or wastewater plants, collection and distribution systems, and stormwater quality improvement projects. The program is directed by SCDES and the South Carolina Rural Infrastructure Authority (RIA), Office of Local Government (OLG) (SCDES, 2025).

11. EDUCATION AND OUTREACH
11.1. Overview
Targeted and consistent education and outreach are crucial for the success of voluntary initiatives like watershed planning. Through tailored messages and activities, stakeholders are more likely to understand, be aware of, and engage in meeting the plan’s objectives – to implement recommended BMPs in priority areas of the project area. Targeted education ensures that the right information reaches the right people, whether they are farmers, private forest landowners, well owners, homeowners, businesses, or local community organizations. Consistent outreach efforts will establish trust and long-term relationships with local stakeholders, which will in turn play a large role in locating priority parcels to implement BMPs on.

Detailed below are the recommended education and outreach strategies for the recommended BMPs and project area land cover.

11.1. Outreach Goals

Goal 1: Increase awareness among local stakeholders about the benefits and implementation of Agricultural BMPs.

Goal 2: Educate homeowners and communities on the importance of Septic System Repairs and maintenance.

Goal 3: Promote the establishment and preservation of Riparian Buffer BMPs along waterways.

Goal 4: Raise awareness about effective Shoreline Management techniques for waterfront property owners.

Goal 5: Educate landowners and stakeholders about Forest Management practices to protect water quality.

Goal 6: Advocate for Urban/Stormwater BMPs to reduce runoff pollution in developed areas.

11.2. Key Messaging

Agricultural BMPs

Highlight the economic and environmental benefits of implementing practices such as cover crops, rotational grazing, and nutrient management. Emphasize the role of farmers in protecting water quality and reducing nutrient runoff.

Forest Management

Educate landowners on sustainable forest management practices that protect water quality, preserve biodiversity, and enhance ecosystem health. Promote the use of forestry BMPs, including streamside management zones, selective harvesting, and reforestation.

Riparian Buffer BMPs

Educate stakeholders on the role of riparian buffers in reducing erosion, improving water quality, and providing habitat. Provide information on available resources, technical assistance, and financial incentives for establishing and maintaining riparian buffers.

Urban BMPs

Educate stakeholders on topics related to stormwater runoff, specifically, how it is generated from different land covers and how human behavior influences the pollutant loading from stormwater. This can include various options provided by SCDES's Stormwater Smart Outreach Tools.

Septic System Repairs

Communicate with homeowners the importance of regular maintenance and proper functioning of septic systems for preventing groundwater contamination. Provide resources and guidance for homeowners to identify signs of septic system issues and the steps for repairs.

11.3. Outreach Strategies and Activities

Local/National Initiatives
Some options for participation include EPA's Annual SepticSmart Week on October 2, 2023, and the Annual Household Hazardous Waste Day in Chester County.

Demonstration Sites and Field Days
Establish riparian buffer demonstration sites and host field days to showcase their benefits and proper establishment. Organize field days to demonstrate erosion control techniques and native vegetation planting in applicable locations.

Educational Materials
Develop print materials to be distributed in the project area including brochures, fact sheets, and online resources specific to each BMP category. Create videos, infographics, and case studies highlighting successful BMP implementations.

Local Partnerships
Collaborate with agricultural organizations, conservation groups, and forestry experts to deliver targeted BMP education. Partner with local municipalities to implement urban/stormwater BMPs and engage community members through workshops and outreach events. County Soil and Water Conservation Districts are ideal for watershed planning collaboration.

Technical Assistance
Provide on-site technical assistance to farmers, landowners, and homeowners regarding BMP implementation. Offer guidance and resources for obtaining permits, funding, and financial incentives related to BMP adoption. USDA NRCS field office staff are available to offer this type of assistance to stakeholders.

Workshops and Training Sessions
Conduct specialized workshops for farmers on agricultural BMP implementation and cost-sharing programs. Organize septic system maintenance workshops for homeowners and provide resources for repairs. USDA NRCS and County Soil and Water Conservation District personnel can help with executing workshops and/or training sessions in the project area.

12. IMPLEMENTATION TIMELINE AND MILESTONES

Many WQMSs within the project area do not currently meet state water quality standards due to the recreational use impairments detailed in this document. These impairments reflect years of consistent bacteria, nutrient, and sediment nonpoint source pollution loading. The proposed BMP implementation timeline consists of a 15-year implementation period split into three five-year phases (Tables 38 through 40). It is also important to acknowledge the external factors outside of the project area causing water quality issues. With population growth and climate change as two primary external factors, the proposed BMP implementations are designed to address current and future nonpoint source pollution impacts. The goal of this plan is for all WQMSs within the project area to meet the state water quality standards by the conclusion of the project timeline (*i.e.* 2039).

Years 1-5		
Action	**Number of Projects**	**Total Acres Treated**
Agriculture – Cropland BMPs		
Forest Buffer (100 feet)	-	120
Cover Crops	-	70
Grass Buffer (35 feet)	-	70
Conservation Tillage	-	70
Agriculture – Pastureland BMPs		
Forest Buffer (100 feet)	-	600
Streambank Stabilization and Fencing	-	200
Alternative Water Supply	-	200
Grass Buffer (35 feet)	-	600
Heavy Use Stabilization	-	200
Forest BMPs		
Site Prep/Mulch/Seed/Fertilizer	-	7,000
Septic		
Failing Septic System – Repair Replace	100	-
Urban BMPs		
LID/Filter/Buffer Strip	1	120
Porous Pavement	1	60
Rain Barrel – Single Family	10	-
Rain Barrel – Multi-Family	15	-
Education and Outreach	1	-

Table 38: Years 1-5 Implementation Timeline

Years 5-10		
Action	**Number of Projects**	**Total Acres Treated**
Agriculture – Cropland BMPs		
Forest Buffer (100 feet)	-	120
Cover Crops	-	70
Grass Buffer (35 feet)	-	70
Conservation Tillage	-	70
Agriculture – Pastureland BMPs		
Forest Buffer (100 feet)	-	500
Streambank Stabilization and Fencing	-	150
Alternative Water Supply	-	150
Grass Buffer (35 feet)	-	500
Heavy Use Stabilization	-	150
Forest BMPs		
Site Prep/Mulch/Seed/Fertilizer	-	7,000
Septic		
Failing Septic System – Repair Replace	100	-
Urban BMPs		
LID/Filter/Buffer Strip	1	120
Porous Pavement	1	60
Rain Barrel – Single Family	10	-
Rain Barrel – Multi-Family	15	-
Education and Outreach	1	-

Table 39: Years 5-10 Implementation Timeline

Years 10-15		
Action	**Number of Projects**	**Total Acres Treated**
Cropland BMPs		
Forest Buffer (100 feet)	-	70
Cover Crops	-	45
Grass Buffer	-	45
Conservation Tillage	-	45
Pastureland BMPs		
Forest Buffer (100 feet)	-	450
Streambank Stabilization and Fencing	-	150
Alternative Water Supply	-	150
Grass Buffer	-	450
Heavy Use Stabilization	-	150
Forest BMPs		
Site prep/mulch/seed/fertilizer	-	7,000
Septic		
Failing Septic System – Repair Replace	100	-
Urban BMPs		
LID/Filter/Buffer Strip	1	120
Porous Pavement	1	60
Rain Barrel – Single Family	10	-
Rain Barrel – Multi-Family	15	-
Education and Outreach	1	-

Table 40: Years 10-15 Implementation Timeline

13. EVALUATION CRITERIA

Once installed, BMPs often go unmanaged and eventually lose their efficiency at mitigating pollutants. Therefore, it is important to track their integrity and performance through specific evaluation methods. One proven method to ensure that BMPs remain efficient is through consistent education and proper maintenance. Agencies such as the EPA, USDA, and SCFC provide landowner education and BMP tracking materials (*e.g.* fact sheets and BMP maintenance checklists). SCRWA and other Stakeholder Team members have access to these materials and can easily distribute them to the appropriate landowners. There are other methods, such as online surveys through platforms like ArcGIS that are public facing, easy to use, and accessible.

The following are some options for evaluating the success of mitigation strategies proposed in this plan:

<u>Agriculture</u>

1) Number of farmers who attend education and outreach training (*e.g*. manure management training or nutrient management training).
2) Number of acres addressed with manure or nutrient management plans.
3) Number of cows prevented from access to streams and/or fenced out of riparian buffer areas.

<u>Forestry</u>

1) Number of private forested landowners who attend education and outreach training (*e.g.* SCFC Forest or Stewardship Management Plan training).
2) Number of acres addressed with SCFC Forest or Stewardship Management Plans.

<u>Septic</u>

1) Number of failing septic systems identified and mapped.
2) Number of septic systems inspected by a professional.
3) The number of septic systems upgraded to a more efficient system.

<u>Urban</u>

1) Number of stakeholders who attend urban education and outreach training.
2) Area of impervious surfaces treated by LID BMPs.

Water quality monitoring data is a key element that can assist in determining current conditions, developing targeted management strategies, and tracking progress over time. It is recommended that current sampling at active monitoring stations be repeated regularly to track water quality trends and that additional monitoring be considered to better identify specific sources of pollutants, to establish a more comprehensive baseline of conditions, to track water quality standard attainment, and track watershed conditions throughout BMP implementation phases. The following are some specific recommendations:

1. **Stream Monitoring** – It is recommended that additional sites be established in-stream to better assess specific sources of pollutants and track the success of installed BMPs listed in this plan.

   Additional monitoring sites can include tributaries not currently monitored, or those that drain to current monitoring sites. Additional monitoring could be achieved through the WaterWatch group or the SC AAS program. SC AAS is a public water quality network, administered by SCDES, that trains citizen volunteers on water quality sampling. SC AAS is comprised of educators, volunteers, and local government officials who are tasked with providing baseline information about stream conditions and helping monitor and track water quality parameters within their local communities (SCDES, 2024).

Success would be dependent on the watershed and BMPs implemented. For example, with the watersheds with the most septic systems, it is anticipated that after implementing inspection, repair, and education/outreach that bacteria concentrations during dry weather flows would decrease.

2. **Microbial Source Tracking (MST)** – Sources of bacteria in specific locations in the project area are a cause for concern. Given the listed impaired WQMSs for bacteria (CW-041, RS-03511, and RS-12088) in the project area, it is likely that both upstream and local agricultural operations are the primary sources of *E. coli* impairment. Implementing an MST program that can identify the source of the bacteria (*e.g.* human or livestock), which could help stakeholders control the problem. For example, if a human marker is detected, the focus would be searching for failing septic systems. It is suggested that samples are taken on a quarterly basis, preferably during rain events. Laboratories able to process this information include:

   - Luminultra Microbial Monitoring
   - University of South Carolina Arnold School of Public Health

14. CLIMATE CHANGE CONSIDERATIONS

South Carolina is experiencing a change in climate, with most of the state warmed by one-half to one degree Fahrenheit in the last century and the Atlantic Ocean, along the coast of South Carolina, rising about one to one-and-a-half inches every decade. With these changes to the state's climate comes an increase in water levels which in turn erode beaches, submerge low sea level lands, and exacerbate coastal flooding. South Carolina is experiencing a rate of sea level rise that is higher than the global average, due to the rate at which the state's land surface is sinking. The rising temperature will contribute to negative effects such as reduced crop yields and harm to health of livestock. Climate change also contributes to the increase in tropical storms and hurricanes that the state has experienced during the last 20 years, with future predictions including a higher rate of more intense storms in the long term (EPA, 2016).

As the threat of climate change continues to increase, it is important to address the potential and actual impacts that it may have on water resources. This WP includes proposed BMPs designed in part to adapt to changes in climate. Specifically, riparian buffers and the suite of agriculture BMPs proposed can sustain their efficiency and effectiveness as more climate change threats and extreme weather events occur. Their maintenance is critically important for the long-term success mitigating nutrients and sediment loading. Below is a short explanation providing more detail on the proposed BMPs and how they address climate change.

<u>Riparian Buffers</u>

Riparian buffers serve a variety of purposes in restoration and conservation, including many advantages that combat against the effects that climate change has on water quality. Forested/vegetated riparian buffers can help to prevent excess erosion, filter nutrients, and mitigate stormwater flow. Riparian buffers, along with the other proposed BMPs, are estimated to eliminate 3,756 pounds of nutrients from entering the project watersheds each year. This will serve to offset the increased nutrient load due to climate change.

Agricultural BMPs

Agricultural practices contribute to climate change through erosion and the release of excess nutrients. The release of excess nutrients from nitrogen rich fertilizers causes a chain reaction that ultimately affects climatic conditions. The proposed agricultural BMPs will address these issues using techniques such as no-till farming/conservation tillage, buffers, fencing, and streambank stabilization to reduce the inflow of bacteria, nutrients, and sediment into the watershed. Installing these BMPs will help reduce the impact caused by more intense weather events in the watershed.

15. ENVIRONMENTAL JUSTICE CONSIDERATIONS

Environmental Justice plays a crucial role in planning efforts as it ensures equitable access to natural resources, clean water, and protection from environmental hazards for all communities. Integrating environmental justice principles allows for addressing the disproportionate impact of pollution and water-related issues on marginalized communities. By involving marginalized communities in the planning process, diverse perspectives can be considered which promotes more effective and culturally sensitive management strategies. An inclusive approach helps to create a sustainable and comprehensive WP that is equitable to all community members in the project area. The following are considerations made for this WP.

15.1. Socioeconomic Indicators

The socio-economic indicators within the project area reflect a community that is less economically prosperous than South Carolina as a whole. According to the US Census Bureau, the annual average household income in South Carolina is $88,488, while the median household income for the state was $67,804 (US Census Bureau, 2022). Both the average annual income and median annual income of the counties in project area are lower than the state average and median income. 14.50% of South Carolina’s population is in poverty. Two counties (Chester and Fairfield) in the project area have a higher percentage in poverty than the state average (South Carolina Revenue and Fiscal Affairs Office, 2021). Table 41 through 43 shows the socioeconomic indicators and their results.

South Carolina Average Household Income	$88,488
South Carolina Median Household Income	$59,447
Average Household Income – Project Area	$58,880
Median Household Income – Project Area	$57,431

Table 41: Average and Median Household Income in SC and the Project Area

County	Average Household Income	Median Household Income
Chester	$55,754	$46,500
Fairfield	$60,926	$40,766
Lancaster	$60,647	$68,993
York	$58,192	$73,466

Table 42: Average and Median Household Income for Counties in Project Area

Population with Percent in Poverty 2021		
State	**Population**	**Percent in Poverty**
South Carolina	736,098	14.5%
County	**Population**	**Percent in Poverty**
Fairfield	4,212	20.6%
Chester	5,530	17.3%
Lancaster	11,670	11.8%
York	27,670	9.7%

Table 43: Population with Percent in Poverty (2021)

15.2. Engaging with Community Leaders

Local community leaders should be actively involved from the outset when pursuing environmental justice. Leaders from relevant non-profit organizations and local interest groups are uniquely positioned to be advocates, possessing a deep understanding of the community's dynamics. They can offer valuable insights into the most effective ways to communicate with the local populations. Community leaders are important intermediaries between the community and decision-makers, ensuring that the concerns and needs of various groups are properly addressed. Public input sessions can be a tool that allows for the heritage and culture of community members to be recognized by the community as a whole. Creating this kind of inclusiveness promotes discussion, especially with topics related to public health.

15.3. Distributing Benefits and Burdens

New projects should prioritize creating a fair balance where benefits are shared equally across the community. This means providing access to clean air, water, recreational spaces, and other environmental resources. Harmful impacts, such as pollution or resource depletion, should not be disproportionately placed on specific groups, particularly those from economically disadvantaged or minority communities. To achieve equitable distribution, it is crucial to have a detailed understanding of the community's demographic and socioeconomic conditions, ensuring that environmental projects do not deepen existing inequalities.

15.4. Removing Barriers

Eliminating barriers to existing benefits is crucial to ensuring equitable access. These barriers can be economic, such as fees that limit access to amenities or services. For instance, charging an entrance fee to a public park can exclude lower-income individuals and families, depriving them of the benefits the space offers. Physical barriers, such as fences or structures that limit access to environmental resources, can also present obstacles. These not only restrict access but also symbolize broader social and economic divides, reinforcing exclusion and inequality.

Institutional barriers are often harder to identify and overcome. These barriers can include policies and practices that limit meaningful involvement by community members on topics related to the environment. Such barriers may include bureaucratic red tape, lack of transparency, or decision-making processes exclude marginalized groups.

Promoting environmental justice and equitable access requires a comprehensive approach that addresses a range of barriers and ensures the fair distribution of environmental benefits and burdens to all communities. It requires a strong commitment by local stakeholders to ensure that environmental policies and projects are inclusive and fair for all members of the community.

16. CONCLUSION

The WP for the Fishing Creek Reservoir-Catawba river, Sixmile Creek-Catawba River, and Waxhaw Creek watersheds recommend incremental water quality improvements over the proposed 15-year implementation timeline. The future success of this plan will depend on available funding and the continued engagement involving local stakeholders, including those not listed as Planning Team for this plan. The proposed BMPs listed in this plan were chosen for their specific ability to mitigate the causes of impairments for the project area. A key factor in the long-term success of this plan will be the maintenance of the recommended BMPs. Without following the maintenance plans for each BMP, their overall effectiveness will diminish with time. SCRWA recognizes that the recommended BMPs and education and outreach strategies alone will not cure all of the water quality issues affecting the project area. Much of what affects the area likely comes from upstream influences. SCRWA intends to pursue future CWA Section 319 funding to address the issues through the Catawba-Wateree River Basin. This in essence is an intentional commitment to developing a long-term targeted strategy at improving water quality in the Catawba-Wateree Basin.

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