Givhans Ferry Watershed-Based Plan

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Prepared For

BCDCOG
BERKELEY-CHARLESTON-DORCHESTER COUNCIL OF GOVERNMENTS

Prepared By

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CISA

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Photograph on cover: Bluffs along Edisto River at Givhans Ferry State Park (provided by Kaley Foley, SCPRT)

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Commonly Used Acronyms

Abbreviation	Full Name
BMP	Best Management Practice
CWS	Charleston Water System
EPA	United States Environmental Protection Agency
FC	Fecal Coliform
GIS	Geographic Information System
MPN	Most Probable Number
SCDES	South Carolina Department of Environmental Services
TMDL	Total Maximum Daily Load
WBP	Watershed-Based Plan

Acknowledgements

This WBP could not have been possible without the grant funding provided by SCDES, and the support of many individuals. The main Project Team members are listed in Table 1.

Table 1: Givhans Ferry WBP Project Team

Organization	Name	Title
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The Project Team would like to thank the following professionals and community stakeholders for their participation in focus group meetings, contributions to data collection, review of plan drafts, and input for recommendations to include in this report:

Table 2: Givhans Ferry WBP Stakeholders

Organization	Name	Title
SC Department of Environmental Services (SCDES)	Amanda Ley	*Edisto River Watershed Manager*
	Frank Nemeth	*Watershed Coordinator*
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	Shea McCarthy	*Nonpoint Source Coordinator*
Charleston Water System	Jason Thompson	*Source Water Manager*
South Carolina State Parks	Kaley Foley	*Givhans Ferry Park Manager*
	Austin Mitchum	*Colleton State Park Manager*
Dorchester County	Kacy Byrd	*Stormwater Compliance Specialist*
	David Garber	*GIS Coordinator*
	Mike Goldstein	*Deputy Public Works Director*
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	Deidra Bartley	*Zoning and Floodplain Administrator*
Friends of the Edisto	Norman Brunswig	*Board Chairman*
Edisto Riverkeeper	Hugo Krispyn	*Executive Director/Edisto Riverkeeper*
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	Beatriss Calhoun	*Water Resources Agent*
	Janet Steele	*Forestry and Wildlife Agent*
	Jonathan Croft	*Agriculture Extension Agent*
	Katie Collins	*Statewide Stream Bank Repair Program Coordinator*
SC Department of Natural Resources	Bill Marshall	*Program Director, SC Scenic Rivers and Heritage Trust programs*
	Chris Workman	*Watershed Districts Program Manager*
	Scott Harder	*Hydrology Program Manager*
	Lorianne Riggin	*Office of Environmental Programs Director*
The Nature Conservancy	Liz Fly	*Director of Resilience and Ocean Conservation*
	Melissa Strickland	*SC GIS Manager*
	David Bishop	*Coastal and Midlands Conservation Director*
	Eric Krueger	*Director of Science and Stewardship*
ACE Basin Task Force	Charles Lane	*Chairman*
	Mac Baughman	*Member*

Organization	Name	Title
Dorchester County Greenbelt Committee	Edsel Taylor	*Property owner and former warden of MacDougall Correctional Institute*
Edisto Natchez-Kusso Tribe	Glen Creel	*Chief*
	Donnie Creel Sr.	*Vice Chief*
	Sabrina Creel	*Secretary*
	Brian Coleman	*Treasurer/Chairman*
	Michael Muckelvaney	*Council*
	Dana Muckelvaney	*Council*
	Jeremey Muckelvaney	*Council*
	Neil Gorski	*Council*
	Leon Creel	*Council*

Executive Summary

Background Information

McCormick Taylor Inc. (MT) was contracted by the Berkeley-Charleston-Dorchester Council of Governments (BCDCOG) to develop a watershed-based plan (WBP) to identify and quantify sources of nonpoint source pollution (nutrients, sediment, and bacteria), analyze impairments related to low dissolved oxygen, and provide project recommendations within the Givhans Ferry Watershed, which is composed of four HUC-12 watersheds (Lower Indian Field Swamp, Halfway Gut Creek-Four Hole Swamp, Poorly Branch-Edisto River, and Skull Branch-Edisto River), and a portion of one additional HUC-12 (Deep Creek-Edisto River). This watershed study area covers 99,559 acres and extends southward from the Town of Harleyville, including the run of Lower Indian Field Swamp flowing towards the Edisto River; along the Skull Branch-Edisto River drainage from west of I-95 and following the Dorchester and Colleton County line; and generally follows the drainages of Halfway Gut Creek/Four Hole Swamp and Poorly Branch, until they eventually drain to Givhans Ferry State Park in Ridgeville, SC. The Givhans Ferry Watershed is part of the larger Edisto River basin draining to the Charleston Water System's intake near Givhans Ferry State Park. These watersheds provide a critical source of drinking water for the City of Charleston, Charleston County, Berkeley County, and Dorchester County.

This WBP for Givhans Ferry addresses key issues impacting source water protection and water quality issues within the watershed, which includes Total Maximum Daily Load (TMDL) requirements related to fecal coliform (FC) bacteria in the Lower Indian Field Swamp subwatershed. The watershed faces problems typically associated with stormwater runoff, impacts associated with septic systems, agriculture, and increasing development, such as stream erosion, water quality degradation, and loss of natural resources. The purpose of this WBP is to utilize the framework of the United States Environmental Protection Agency's (EPA) nine required elements to identify, quantify, and provide recommendations to reduce pollutants in the watershed. This WBP will also provide recommendations to measure and monitor progress and discuss funding needs and opportunities. Additionally, this plan will incorporate components that address climate change consideration, and the protection of public drinking water sources in the watershed.

The total population in this watershed is approximately 7,125 people. Currently, the largest land cover types in the watershed are forest (76%, which includes 39,263 acres of woody wetlands; 30.139 acres of deciduous, evergreen, and mixed forests; 3,882 acres of shrub/scrub; and 2,276 acres of emergent herbaceous wetlands) and agriculture/cropland (10%). Developed land uses include residential land use (5%), roads (1%), commercial land use (0.2%), and industrial (0.1%). The area of impervious surfaces in the Givhans Ferry Watershed is estimated to be 2,191 acres (2%) in total. At this level of imperviousness in a watershed, the stream health is predicted to be "sensitive," as is discussed in **Section 2.6.4 Existing Imperviousness**.

Water Quality Modeling and Results

A combination of two models – the Watershed Treatment Model (WTM) and Model My Watershed – and manual calculations from reference values were used to quantify pollutant loads in the watershed corresponding to three scenarios: current conditions, current conditions with recommendations, and future climate conditions. These tools were used to estimate pollutant loads based on current and future land use and management strategies. Under existing conditions, the watershed is estimated to produce loads of 177 tons/yr total nitrogen (TN); 19 tons/yr total phosphorus (TP); 13,280 tons/yr total suspended solids (TSS); and 1.69E+16 MPN/yr of *E. coli* bacteria. The greatest amount of TN comes from forest (54%) and cropland (12%); most TP comes from forest (39%) and channel erosion (23%); most TSS comes from channel erosion (41%) and forest (28%); and the majority of bacteria load can be attributed to forests (47%) and low-density residential development (24%). Although forest ranked as a top contributor to all four pollutants of interest, this is attributed to the fact that forest land covers 76% of the watershed. To better understand the human impacts on the watershed, the totals of urbanized land and human waste sources of bacteria, nutrients, and sediments were summarized separately. The models indicate that these sources contribute 19% to overall TN, 24% to overall TP, 13% to overall TSS, and 46% of the total *E. coli* load in the watershed. WTM analysis of the human-related sources indicates the largest sources of TN and TP in the watershed are Low Density Residential (35% TN and 38% TP), roads (27% TN and 21%TP) and septic systems (17% TN and 20% TP). Sediment, measured in the form of total suspended solids (TSS), can be attributed to channel erosion and accounts for 42% of the load. Finally, Low Density Residential (53%), septic systems (19%), and Medium Density Residential (17%) areas produce the most bacteria in the developed areas in the watershed.

Stakeholders did express concerns about runoff from livestock operations. As described in **Section 4.2.1 Agriculture** the Current Conditions scenario estimated livestock (assumed to be in pasture, grassland or chicken houses) pollutant loadings for the entire Givhans Ferry Watershed are 12 tons/yr TN; 1 tons/yr TP; 935 tons/yr TSS; and 3.44E+13 MPN/yr of *E. coli* bacteria. It is important to note that this modeled load calculation reflects the *potential* for pollutant loads associated with individual animals. It does not reflect the calculated load reductions of required BMPs (e.g., covering chicken litter to prevent it from running off during storm events). Furthermore, as discussed in **Section 3.5 Impaired Waters**, there is a TMDL for bacteria in Lower Indian Field Swamp, and the use support of the two TMDL monitoring stations is listed as not supported. Additional monitoring is recommended for these watersheds to determine if there are water quality impairments and what the source may be.

Stakeholders were also concerned about future conditions in the watershed, considering both climate change (such as increased precipitation, increases in bacteria concentrations in stormwater) and land use/land cover changes as a result of development. In future conditions, low density residential areas are expected to produce the largest loads for TN (53%), TP (49%), and bacteria (58%). Medium density residential is expected to produce the second highest loads for TN (27%), TP (25%), and bacteria (29%). Channel erosion contributes the greatest amount of TSS load in the watershed (51%).

As a complement to the modeled loading based on land uses, the project team also created a load duration curve (LDC) that combined USGS flow observations with five years of monitoring data provided by Charleston Water System (CWS) for *E. coli*. The vast majority of all CWS *E. coli* observations at the intake are below the regulatory limit. This is in alignment with the bacteria monitoring summary (found in **APPENDIX A: Water Quality Monitoring Data**): across the entire Givhans Ferry Watershed, 96% of the 1,982 bacteria (*E. coli*) measurements were below the regulatory threshold of 349 MPN/100mL. The subwatershed with the highest number of exceedances was Lower Indian Field Swamp; however, that includes observations from before the

TMDL was published. As stated in **Section 3.5 Impaired Waters**, aside from the three[1] TMDL monitoring stations, there are currently no listed SCDES monitoring stations impaired for bacteria (FC or *E. coli*) in any of the subwatersheds for Givhans Ferry.

Recommendations

In total, 28 pollution reduction practices are proposed for this WBP. Stakeholders stressed the importance of implementing wide riparian buffers (more than the South Carolina Department of Natural Resources' recommended 50 foot minimum buffer) through changing existing local ordinances; habitat protection by acquisition, conservation or other means to minimize impervious surface and create and sustain buffers; restoring natural stream channels as a means for slowing the movement of stormwater runoff; and reducing sources of human waste stemming from septic tanks and pet waste. Recommendations for practices to reduce nonpoint source pollution associated with chicken houses and other livestock were calculated using BMP efficiencies provided by USEPA. Pollutant load reductions were calculated for both existing and recommended practices and projects, such as stormwater best management practices (BMPs), pet waste education, septic system improvement, and enhanced riparian buffers. In addition to load reductions attributed to livestock waste management BMPs, improvements to riparian buffers and residential septic systems are two of the more effective practices to reduce nutrient, sediment, and bacteria load reductions from developed land uses. If all recommended practices and programs (including conservation) are initiated, the result would remove 109 tons of nitrogen, 28 tons of phosphorus, 4,104 tons of sediment, and 1.95E+15 MPN/year of *E. coli* bacteria.

The estimated cost of all design, construction, maintenance, and public education associated with these projects is $178,603,423. It would be difficult for any of the project partners to afford to implement these recommendations all at once or without additional funding support. We recommend that each of the counties and municipalities evaluate opportunities to implement smaller portions of recommendations as they are able. This WBP lists several opportunities for grant funding sources and partner organizations that can support the gradual implementation of this WBP. Over time, the results of completed projects will be monitored and evaluated to inform future steps towards comprehensive implementation.

[1] Note that station E-100 is at the upstream boundary of Four Hole Swamp (located in the Halfway Gut Creek HUC-12 watershed). Although E-100 is located within the boundaries of this WBP, the TMDL and the monitoring data associated with this station are more reflective of water quality in the next HUC-12 upstream of this point (Santee Branch – Four Hole Swamp).

1.0 Introduction

1.1 Background, Purpose, and Need

1.1.1 Watersheds and Why They Matter

According to the United States Environmental Protection Agency (EPA), a watershed is a land area that drains to one stream, lake, or river. Watersheds exist at different geographic scales and nest within one another based on landscape composition qualities such as topography, geomorphology, and soil composition. A smaller watershed that drains into a smaller stream may be within a much larger watershed where the smaller stream eventually drains into a lake or a larger river. In this sense, the concept of the watershed facilitates tracking water as it travels through different stages of the water cycle.

All water travels over a watershed as surface water, or underground as groundwater. Along this process, water may function as a vehicle that carries material across a watershed as it flows to a receiving downstream water. Sediment, nutrients, and other pollutants may travel this way until eventually accumulating in the larger waterbody.

This accumulation of pollution from across a watershed is considered nonpoint source (NPS) pollution because the sum of pollution cannot be pinpointed to a single entity or point source. Changes to a watershed, such as a storm event that deposits significant precipitation, or a construction project that disturbs soil, may eventually be reflected in the larger waterbody.

Watersheds are independent of any political boundaries but are significantly impacted by human activity. Human activity in this watershed includes various developed land uses, lawn care, pet and livestock waste, septic systems, and sanitary sewer overflows. The presence of impervious terrain, such as asphalt roads, parking lots, or bridges, reduces the infiltration capacity of soil and facilitates the transfer of runoff over land. Human activity and human-induced pollution are more easily carried over impervious surfaces (Figure 1-1), negatively impacting water quality.

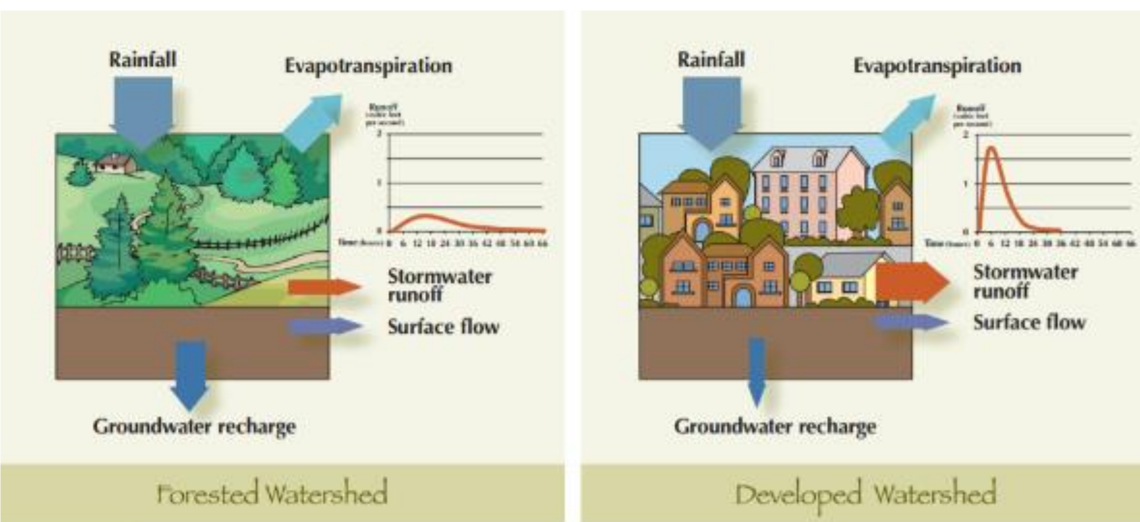

Figure 1-1: Visual representation of runoff differences between forested and developed urban watersheds (Image from SC Sea Grant, SCDNR, and NOAA)

Understanding watersheds and addressing water quality from a watershed-based approach facilitates understanding how small changes can accumulate to generate region-wide impacts. While this does not make the problem any less complex, it illustrates how a solution to water quality issues must be, by necessity, holistic and inclusive of all potential stakeholders within an area.

1.2 Givhans Ferry Impairment and TMDL

The primary focus of the Givhans Ferry WBP is a concerted, watershed-based approach to address water quality concerns for drinking water sources. As is illustrated in **Figure 1-2**, there are both surface water intakes and source water protection areas (SWPA), as well as public water supply wells (PWSW) and protection zones. In order to understand the current status of surface drinking water sources, the project team reviewed publicly available information from the SCDES GIS Clearinghouse[2]. This included, but was not limited to, water quality monitoring stations, impaired waters, and Total Maximum Daily Loads (TMDLs). Currently, there are 14 total SCDES water quality monitoring stations within the watershed: 5 random, 4 fixed, 2 special studies, and 3 historic. Of those stations, 6 are listed on the 2022 303(d) list for dissolved oxygen and mercury (a full description can be found in **Section 3.5 Impaired Waters**). Part of the watershed contains an approved Total Maximum Daily Load (TMDL) watershed for Indian Field Swamp[3] (as shown) for Fecal Coliform (FC) bacteria. A TMDL is a 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 specific pollutant. The existing TMDL (created in 2006) for this watershed requires a 60% reduction in existing FC bacteria loads to station E-032. Note that SCDES conducted sampling for fecal coliform at this station from 2001-2012 and in 2009, and for *E. coli* in 2009, 2013-2021. As of 2022, the use for station RS-010373 is fully supported but is not met for station E-032.

In addition to evaluating potential sources of bacteria, the Givhans Ferry WBP will provide analysis of sources of nutrients (nitrogen and phosphorus) and total suspended solids, and calculate potential benefits associated with the reduction of these pollutants in the watershed. Currently, there are no impairments or TMDLs associated with nutrients or sediment in the Givhans Ferry Watershed; however, implementation of a variety of programs and practices within the watershed will simultaneously reduce bacteria and nutrients, which in turn improves water quality for both recreational and source water uses.

Note that FC bacteria do not threaten human health by themselves. Their presence is an indicator of potential harmful pathogens from human and animal feces, such as disease-causing bacteria, viruses, and protozoans that live in human and animal digestive systems[4]. Reducing the concentration of fecal bacteria should in turn reduce the presence of pathogens.

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[2] SCDES Geospatial Hub (2024). SC Dept. of Environmental Services. Office of Technology. Available at https://scdes.gov/gis

[3] SCDES. 2006. Total Maximum Daily Load Document Indian Field Swamp. Available online at https://des.sc.gov/sites/des/files/docs/HomeAndEnvironment/Docs/tmdl_indianfield_fc.pdf

[4] USEPA. 2012. Water Monitoring & Assessment: Fecal Bacteria. Available online at https://archive.epa.gov/water/archive/web/html/vms511.html

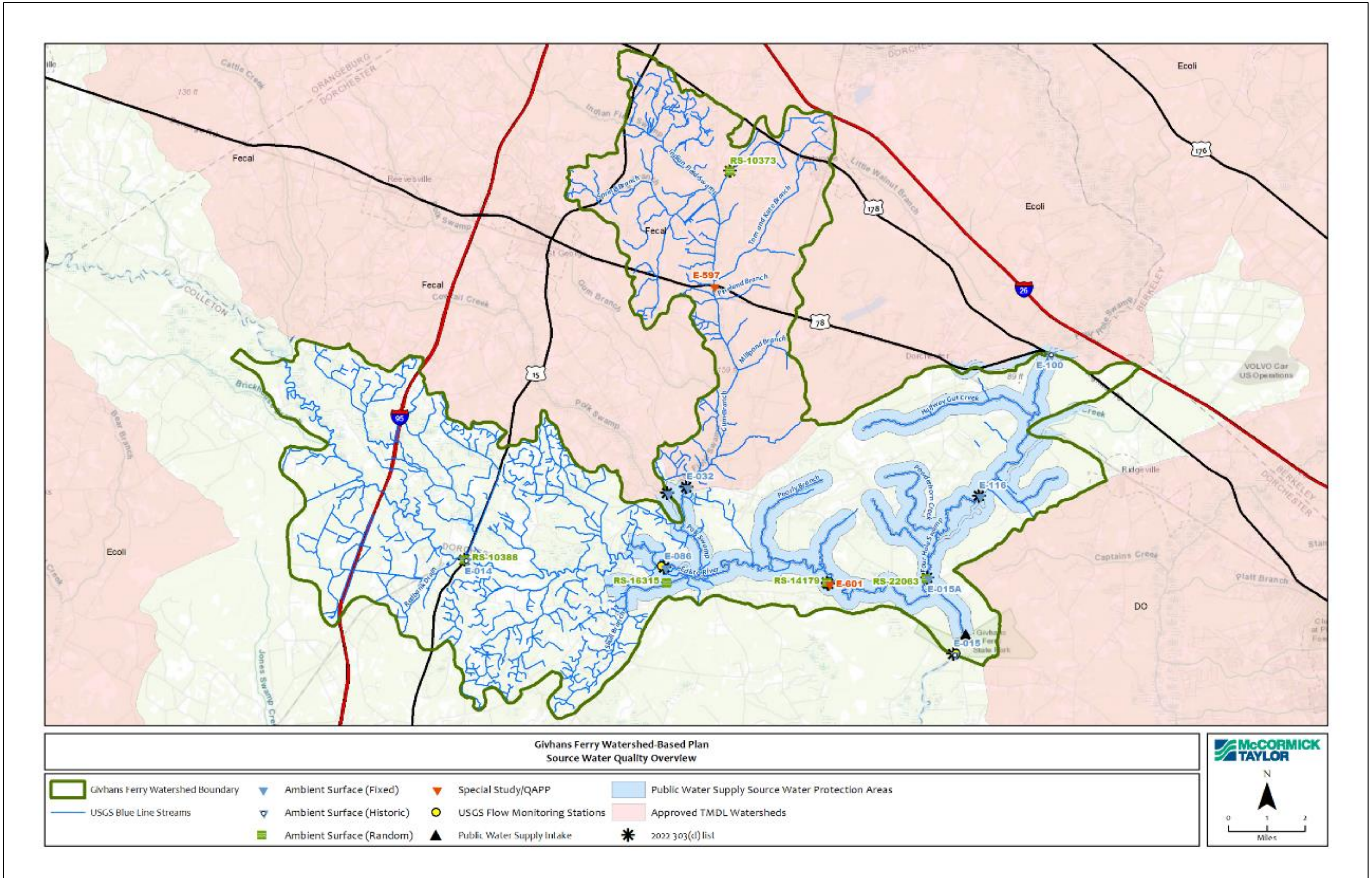

Figure 1-2: Givhans Ferry Watershed source water quality concerns

1.3 Watershed-Based Plan

1.3.1 General Purpose and Context

Section 1. Introduction – Introduces the Watershed Management Plan, Goals and Objectives, and the overall planning context.

Section 2. Existing Conditions – Provides a detailed description of the watershed landscape, land uses, living resources and political boundaries. This section is largely based on information from existing data and reports.

Section 3. In-Stream Water Quality Monitoring – Provides a summary of currently available monitoring data in the watershed and a description of current water quality impairments.

Section 4. Pollutant Source Assessment – Describes the potential causes of water quality degradation in the watershed. This section also introduces the calculation of the pollutant loading based on existing land cover/land use conditions and assists in identifying the sources of various pollutants.

Section 5. Implementation Plan – Includes descriptions of the recommended management strategies and restoration projects, estimates of the water quality benefits that would be realized from plan implementation, and a schedule of future activities. This section includes cost estimates for strategy implementation, identifies potential funding sources, and describes schedules and monitoring programs to document plan implementation and changes in the watershed condition over time.

Section 6. Recommendations – Includes recommendations for programs, policies, and projects to improve water quality and protect source water.

1.3.2 EPA Required Nine Elements

The United States Environmental Protection Agency has established a series of nine essential watershed elements (A – I criteria) that must be addressed in the watershed plan for subsequent projects to be eligible for restoration and preservation funds under section 319 of the federal Clean Water Act. The plan was designed to satisfy these requirements. The elements are listed here with the plan sections that address each.

A. Identification of pollutant causes and sources to achieve load reductions addressed in watershed management plan:
    - Section 4.2 Land Use Nonpoint Sources
    - Section 4.3 Human Waste Pollution Sources
    - Section 4.4 Point Sources
B. Estimate of load reductions anticipated to be achieved through specified management measures:
    - Section 4.5 Watershed Pollutant Loads
    - Section 4.6.8 Pollutant Load Reductions
C. Description of nonpoint source management measures necessary to achieve load reductions:
    - Section 4.6 Recommended Practices and Strategies
D. Estimate of technical and financial assistance, cost, and authorities necessary to implement the watershed management plan:

  - Section 5.3.1 Priorities and Estimated Costs
  - Section 5.3.2 Potential Funding Sources
- E. Information or education component to enhance public understanding of watershed management:
  - Section 5.1 Community Engagement
- F. Schedule for implementing the nonpoint source management measures specified in the plan:
  - Section 5.4 Schedules and Milestones
- G. Interim, measurable milestones to determine implementation of nonpoint source management measures:
  - Section 5.4 Implementation Schedule
- H. Criteria to determine if load reductions are being achieved:
  - Section 5.5.2 Evaluation Methods
- I. Monitoring components to evaluate effectiveness of implementation efforts:
  - Section 5.5.1 Monitoring Program

1.4 Project Goals and Objectives

The overall goal of this plan is to identify and address point and nonpoint pollution sources in the watershed. Of upmost importance for this planning effort is fecal coliform bacteria, for which high historical concentrations have resulted in a TMDL that includes the Indian Field Swamp HUC-12 watershed, which encompasses 30% of the Givhans Ferry Watershed. Furthermore, the potential impact of climate change on the sources and magnitudes of pollutants will be examined. Lastly, the effects these pollutants may have on the surface source water intake for the Charleston Water System (CWS) will be discussed and recommendations for overcoming these challenges will be provided.

To accomplish that goal, the Project Team assessed watershed conditions (with field visits, stakeholder feedback, and desktop analysis), and this plan establishes common water quality management goals and strategies, identifies potential conservation areas, and recommends structural Best Management Practices (BMPs). As such, the watershed-based plan serves as guidance and a progress monitoring tool to reduce bacterial contamination and improve overall water quality in the Givhans Ferry Watershed. The Berkeley-Charleston-Dorchester Council of Governments (BCDCOG) plans to build upon the success of this WBP in order to support the development of subsequent plans for other watersheds in the tri-county region.

This plan is designed to provide a variety of water quality management strategies. The strategies vary in scope and obligation, from regional programmatic water quality monitoring coordination systems, to targeted stream buffer restoration projects. While Section 319 grant funds are envisioned as a viable funding source for many of the BMPs, this plan also provides strategies which could be successfully implemented by individual organizations or through the leveraging of local groups such as the ACE Basin Task Force, Clemson Carolina Clear program, Friends of the Edisto River, or the planning staff in Dorchester and Colleton Counties.

2.0 Analysis of Watershed Conditions

For the purpose of this watershed-based plan, the Project Team has analyzed available and predicted data for both existing conditions and future conditions in Givhans Ferry Watershed, including climate, soils, land use, and waste treatment processes. The following sections summarize the findings of this research.

2.1 Watershed Location and Boundaries

2.1.1 Jurisdictional Boundaries

The Givhans Ferry Watershed encompasses 99,559 acres of land and extends across three different political jurisdictions consisting of two counties (Dorchester and Colleton), and parts of two municipalities (Harleyville and Ridgeville). Currently, the sections of the Givhans Ferry Watershed are not in urbanized portions of Dorchester County that are part of a Municipal Separate Storm Sewer System (MS4) area; however, the South Carolina Department of Transportation (SCDOT) is a large MS4 that has responsibilities for DOT-owned and maintained roadways (such as I-95, Highways 15 and 78) that are within the watershed boundary.

2.1.2 Subwatershed Boundaries

McCormick Taylor subdivided the overall Givhans Ferry Watershed into five subwatersheds, as shown in **Table 2-1** and **Figure 2-1**. The purpose was to provide a method for geographically describing areas to differentiate pollutant sources and recommendations in this WBP. In each of the five subwatersheds, forest is the predominant land cover. The amount of developed area (all land use classes except for forest, rural, and open water) was minimal across the HUC-12 watersheds (6%). A more detailed discussion of Land Cover/Land Use analysis is included in **Section 2.6.3** of this WBP.

Table 2-1: Land Use in Subwatersheds of the Givhans Ferry HUC-12 Watershed

Land Use	Lower Indian Field Swamp	Skull Branch	Halfway Gut Creek	Poorly Branch	Deep Creek
Low Intensity Residential	1,472.08	1,231.68	774.04	281.01	116.78
Medium Intensity Residential	16.11	768.57	13.57	204.34	2.52
Commercial	51.27	17.19	108.21	0.22	0.49
Roadway	248.51	435.73	139.13	118.47	16.54
Industrial	29.98	47.36	34.43	-	-
Cropland	3,570.15	3,983.03	1,550.2	762.97	66.51
Barren land	216.31	66.13	100.84	32.05	-
Forest	22,030.95	29,991.84	14,105.12	7,601.16	1,828.41
Rural	1,713.66	2,468.88	1,212.07	667.09	32.74
Open Water	138.17	563.61	274.06	402.33	52.44
Total Area (Acres):	**29,487.2**	**39,574.04**	**18,311.67**	**10,069.65**	**2,116.44**

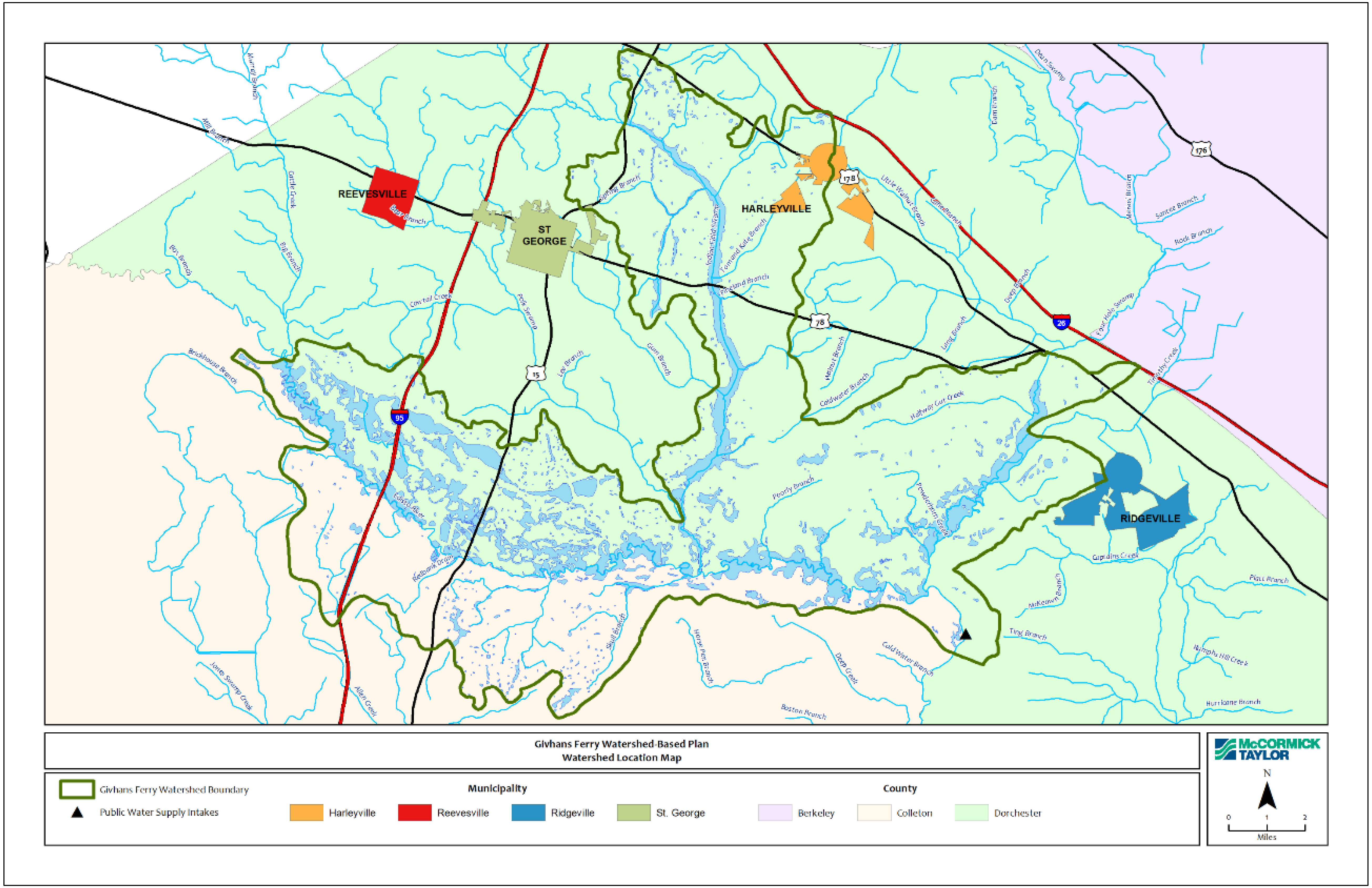

Figure 2-1: Givhans Ferry Watershed and Jurisdictional Boundaries

2.2 Climate

Climate influences soil formation and erosion processes, stream flow patterns, vegetation coverage, and a significant part of the geomorphology of a watershed. Precipitation not only provides water to streams and vegetation, but the intensity, frequency, and amount of rainfall can greatly influence watershed characteristics.

2.2.1 Historic Temperature Data

Based on the 1991 – 2020 Summary of Monthly Normals,[5] the region/study area has a temperate climate with a mean annual temperature of 75.3°F. The monthly average maximum, minimum, and mean temperatures for the Summerville 4W station are summarized in **Table 2-2** below.

Table 2-2: Summary of Monthly Temperature Normals for Summerville 4W* (1991-2020)

Month	Average Max. Temp (°F)	Average Min. Temp (°F)	Mean Temp (°F)
January	58.2	34.5	46.4
February	61.9	37.0	49.4
March	68.5	42.2	55.4
April	75.6	49.5	62.6
May	82.3	59.1	70.7
June	87.2	67.2	77.2
July	90.1	70.9	80.5
August	89.7	70.4	80.1
September	84.7	64.8	74.8
October	76.6	53.0	64.8
November	67.7	42.2	54.9
December	61.3	37.4	49.3
Annual Mean	**75.3**	**52.4**	**63.8**

**National Centers for Environmental Information, Station Summerville 4W(US00388426)*

Analysis of Historic Precipitation Data

The mean annual rainfall is the precipitation value utilized for the water quality analysis method in the Watershed Treatment Model (WTM), as described in **Section 4.0 Pollutant Source Assessment**. Several sources of precipitation information were analyzed for the Givhans Ferry Watershed and are summarized in **Table 2-3**. The Project Team focused on a long-serving station called "Summerville 4W", for which records are available from 1898 to present. For additional context, a report from Climate Division 7, which is close to Dorchester and Colleton Counties, was included. This record comprises data from multiple stations in the region and has a longer time series. The data are very similar statistically due to averaging across stations; the extremes are muted somewhat in comparison to the single station. The precipitation values that are bolded are the ones that CISA recommended for analysis in the WTM model. This range of precipitation values will help inform the climate scenarios for future conditions.

[5] National Centers for Environmental Information. https://www.ncei.noaa.gov/access/us-climate-normals/#dataset=normals-monthly&timeframe=30&location=SC&station=USC00388426

Table 2-3: Summary of Historic Precipitation Data for Summerville 4W

Annual Precipitation (in)	Summerville 4W (1898-2022)	Climate Division 7 (1895-2020)
Lowest recorded	27.7	29.5
5th percentile	35.4	38.2
10th percentile	39.5	40.2
25th percentile	44.6	43.1
median	49.7	47.1
mean	50.7	47.8
75th percentile	57.3	51.9
90th percentile	62.8	57.1
95th percentile	66.7	60.0
Highest recorded	73.9	71.83

2.2.2 Analysis of Future Climate Conditions

There are several broad areas for climate considerations in Givhans Ferry WBP which have implications for watershed management issues, such as changes in temperature and precipitation projections. Climate considerations potentially change current and future water quality management actions, which could result in future cost savings and a more resilient watershed. These considerations prompted a WTM exercise that envisions a future climate scenario that integrates modeled changes to temperature and precipitation in the Givhans Ferry Watershed (as described in **Section 4.5.2**). These climate impacts were also considered through the context of watershed planning and the EPA Nine Elements of a watershed-based plan. The climate projection analysis of the Givhans Ferry Watershed indicates a need to plan for shifts in temperature and precipitation, and the potential future impacts those shifts will have on bacterial contamination. This section describes some of these implications and provides potential strategies to address them, helping create a more resilient watershed.

In the Dorchester and Colleton County areas, climate change is resulting in an increase in average temperature over time, and changes in seasonal and daily temperature patterns (for instance, a warming of overnight lows and a rise in average winter temperatures). Extreme heat will be a core impact of climate change in the Givhans Ferry Watershed, which is expected to see more frequent and severe heatwaves in most climate scenarios.[6] In the watershed area, Coupled Model Intercomparison Phase 5 (CMIP5) models suggest a doubling of days per year above 100°F, a ~60% increase in days above 95°F, and a ~2°F increase in average annual temperature by the mid-century.[7] Temperature change could drive increased recreational use of the watershed (such as swimming and boating) and potentially affect BMP efficacy and upkeep.

Furthermore, climate change is resulting in an increase in average rainfall in the Givhans Ferry Watershed. It is also changing the frequency and intensity of precipitation events and patterns, which in turn impacts the frequency and intensity of both drought and heavy rainfall events.[8] The number of extreme rainfall events

[6] 4th National Climate Assessment Southeast Chapter, see https://nca2018.globalchange.gov/chapter/19/
[7] Climate and Hazard Mitigation Planning (CHaMP) Tool, see https://champ.rcc-acis.org/
[8] 4th National Climate Assessment Southeast Chapter, see https://nca2018.globalchange.gov/chapter/19/

observed since the 1950s is increasing and their frequency is expected to further double or triple by the end of the century.[9] Precipitation change introduces water quality planning considerations such as managing stormwater runoff, flooding, sampling water quality measures, fecal coliform bacterial loads, and BMP capacity and efficacy. Increases in extreme rainfall events and flooding can pose a particular challenge for watershed management if a short duration rainfall event exceeds BMP capacity.

Because precipitation is a key input into the WTM model, CISA evaluated available annual precipitation data from Coupled Model Intercomparison Phase (CMIP6) models and compared it to available historical averages. A recent evaluation of CMIP6 models suggests that CMIP6 models continued to improve in accuracy for the southeast region but tend to underestimate shifts in precipitation indices representing both average and extreme precipitation conditions.[10] In CISA's analysis, model data from the watershed area show an increase in annual precipitation over time, in line with existing projections available for the Southeast. Shared Socioeconomic Pathway 5 (SSP5) is the scenario used in the model and is equivalent to Representative Concentration Pathway 8.5 (RCP 8.5), or a high carbon emissions future.

Based on guidance from CISA, the consultant used the 90th percentile total annual rainfall (62.8 inches) from the Summerville 4W weather station historic precipitation data. This reflects a shift in the CMIP6 data, as illustrated in **Figure 2-2**.

[9] 4th National Climate Assessment Section 7.2.2, see https://science2017.globalchange.gov/chapter/7/

[10] For several examples, see the NOAA Climate Program Office's Water Utility Study. https://cpo.noaa.gov/Meet-the-Divisions/Climate-and-Societal-Interactions/Water-Resources/Water-Utility-Study

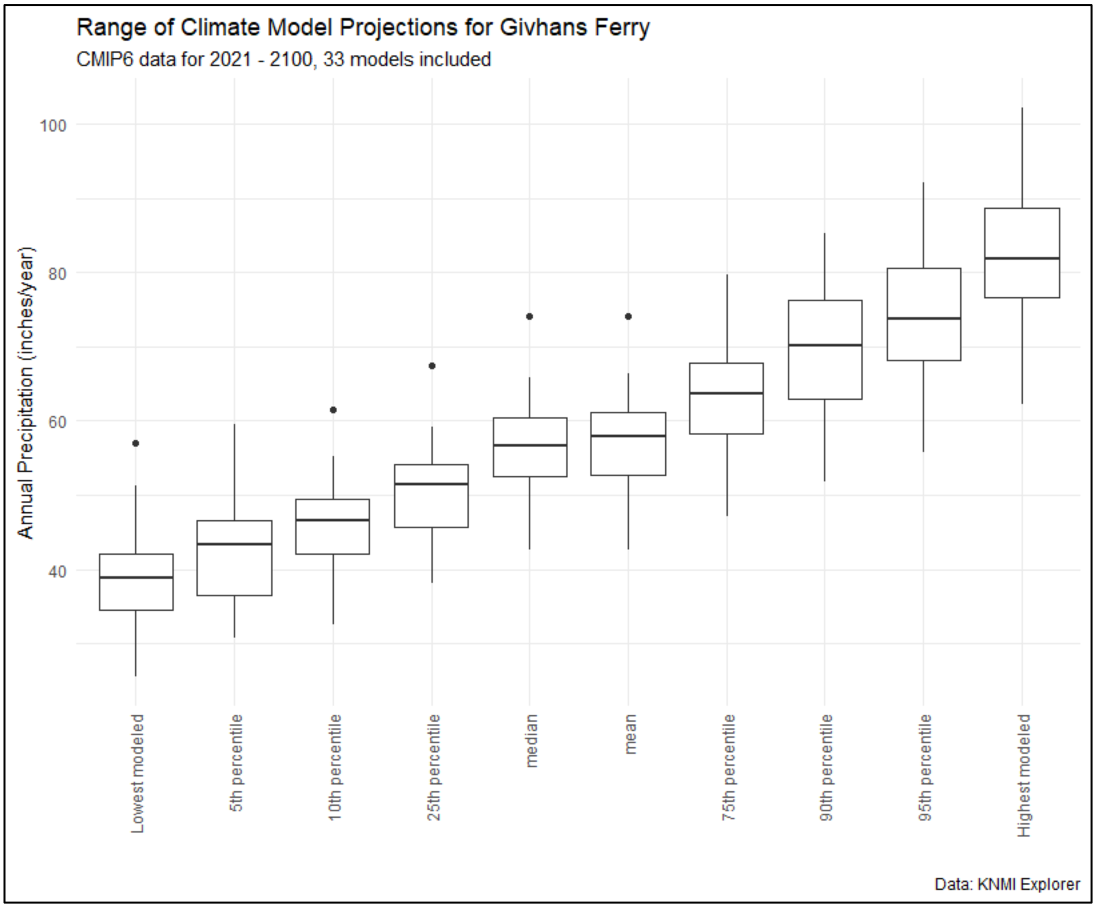

Figure 2-2: Range of Climate Model Projections for Annual Precipitation

2.3 Surface Water Resources

2.3.1 Streams and Rivers

The Givhans Ferry Watershed contains 375.86 miles of streams (based on 2018 National Hydrography dataset[11]), as summarized in **Table 2-4** and shown in **Figure 2-3.** Along these waterways, there are currently three SCDES regulated dams, and all are located within Dorchester County. A high-hazard (C1) dam is a structure where failure will likely cause loss of life and/or serious damage to infrastructure. A significant hazard (C2) dam is a structure where failure will not likely cause loss of life, but infrastructure may be damaged. A low-hazard (C3) dam, such as the three located within the watershed, is a structure where failure may cause limited property damage. Dams have the potential to impact water quality in positive or negative ways. Water held in reservoirs tends to heat up and increase the downstream temperature of the river. If water is released from the bottom of a dam, it can be low in dissolved oxygen which can cause problems for fish downstream. If the water is allowed to fall over a spillway, it may mix more oxygen into the water.

Additionally, reservoirs have the potential to produce large amounts of algae and other plants which can increase the concentration of nutrients in the water. Large amounts of algae and aquatic plants are the result of excess nutrients and can strip the water column of nutrients, while also creating a significant amount of nutrient

[11] USGS. 2022. https://www.usgs.gov/national-hydrography/national-hydrography-dataset

cycling within a reservoir.[12] A substantial die-off of algae and plants (seasonal or otherwise) can cause a spike in nutrient concentrations in the reservoir's water and cause low dissolved oxygen (DO) concentrations as a result of decomposition of the excess plant material. This low DO, high nutrient water flows out of the reservoir via the tailwaters exiting the dam, which results in similar processes occurring downstream – excessive aquatic vegetation/algal growth, subsequent die-off, and increased oxygen consumption.

Additionally, sediments settle out in reservoirs behind dams, which helps reduce sediment loads downstream of the dam. However, sediments also have the potential to trap pollutants and toxic chemicals which can become resuspended in the water if the sediments are disturbed.

Table 2-4: Tributaries of the Givhans Ferry Watershed

Name	Miles
Big Branch	2.27
Brickhouse Branch	0.03
Edisto River	34.40
Four Hole Swamp	9.15
Gum Branch	1.44
Halfway Gut Creek	4.97
Indian Field Swamp	12.92
Millpond Branch	1.80
Pineland Branch	1.59
Polk Swamp	1.81
Poorly Branch	3.17
Powderhorn Creek	3.71
Redbank Drain	3.29
Skull Branch	4.77
Spring Branch	4.96
Timothy Creek	0.04
Tom and Kate Branch	5.41
Unnamed	280.13
TOTAL	**375.86**

[12] EPA. 2022. https://www.epa.gov/nutrientpollution/effects-dead-zones-and-harmful-algal-blooms

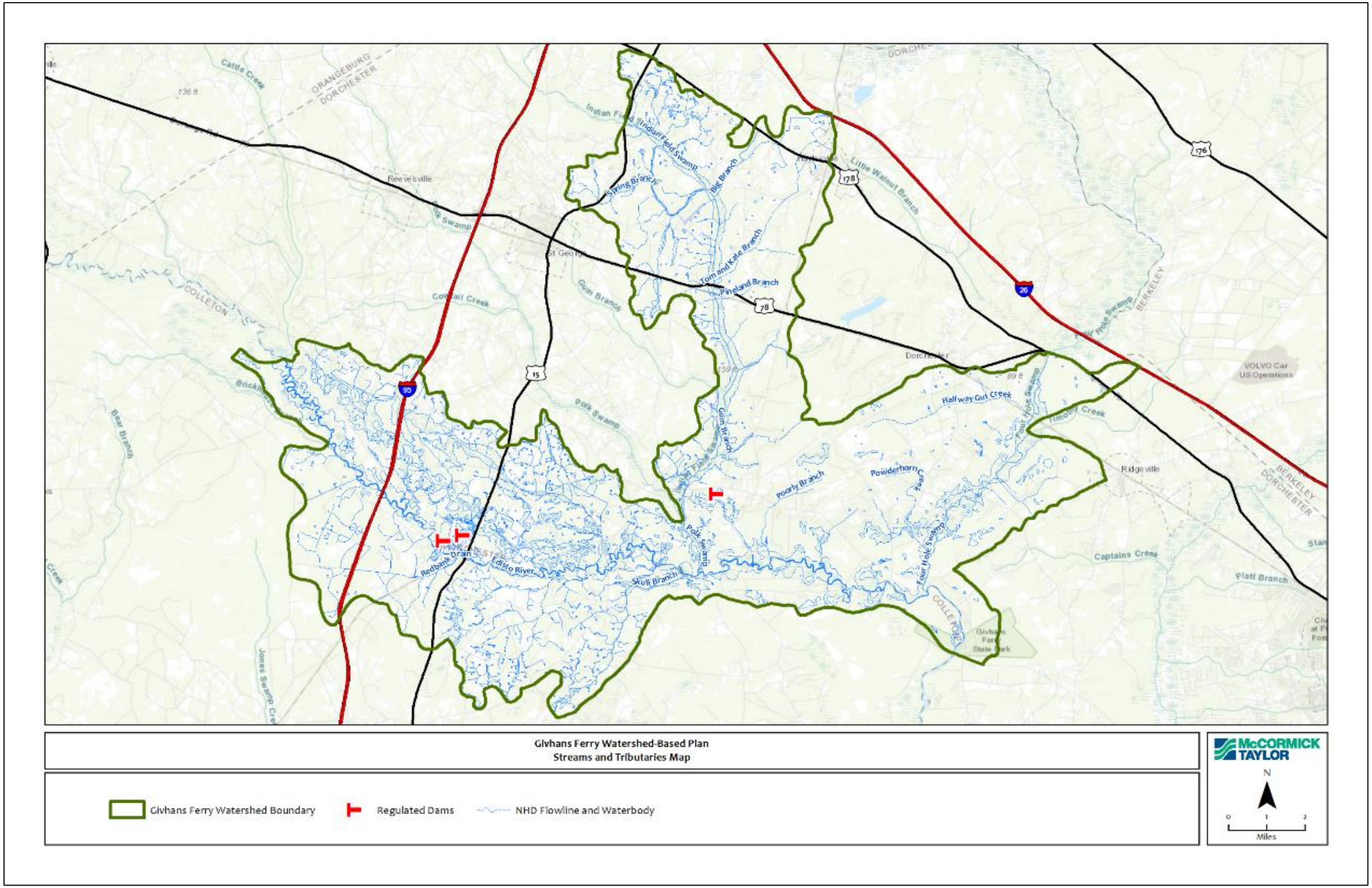

Figure 2-3: Givhans Ferry Watershed Tributaries, Waterbodies, and Dams

2.3.2 Riparian Buffer Analysis

The consultant team performed analysis of the current condition of riparian buffers in the watershed via Geographic Information System (GIS) data, aerial imagery, and site visits. Streamlines were defined by the National Hydrography Dataset (NHD). The summary table of buffer requirements by each jurisdiction in the watershed is summarized in **Table 2-5**. The existing conditions of the riparian buffers in the watershed are in varying degrees of health and functionality as illustrated by the photos in **Figure 2-4.** Four hundred and one (401) miles of stream buffers were analyzed (**Figure 2-5**) to determine the presence of a minimum buffer width of 30 ft in accordance with Colleton County's recommended buffer width requirements (Dorchester County does not currently have a county-wide buffer requirement). It was determined that 91 miles (23%) of stream buffers did not meet the minimum width requirement recommended by SCDNR. This length will be targeted to be restored to a minimum 50-ft wide buffer as discussed in **Section 5.2.6 Riparian Buffer Projects.**

Table 2-5: Buffer Recommendations by Jurisdictional Area

Jurisdiction	Buffer Recommendations
Dorchester County	Currently, the County does not have a buffer requirement along the Edisto River. A riparian buffer setback of not less than 30 feet or one-third the depth of a lot or parcel, whichever is less, shall be provided along all streams for the Ashley River.
Colleton County	An undisturbed, natural vegetative buffer shall be maintained along both banks of streams. The buffer shall be a minimum width of 30 feet.
South Carolina Dept. of Natural Resources	A minimum 50 to 100-foot riparian buffer should be established and maintained along both sides of the stream. Native vegetation, typically trees, shrubs, grasses, and forbs, should characterize the buffer. Any development within buffer areas should be avoided. Where possible, the Scenic Rivers Program advocates a more extensive buffer, a minimum of 100 feet, on the stream to allow for additional protection of water quality and preservation of other important values such as aesthetics and wildlife habitat.

Table 2-6: Riparian Buffer Analysis Summary

Buffer Width	County	Length (ft)
< 30 ft	Colleton	175,068
30 – 50 ft	Colleton	22,992
< 50 ft	Colleton	97
	Dorchester	303,569
	Total	303,666
50 – 100 ft	Colleton	54,431
	Dorchester	90,083
	Total	144,514
> 100 ft	Dorchester & Colleton	1,472,411
Grand Total		2,118,652

Figure 2-4 shows pictures collected as part of a field survey of the watershed conducted by the consultant. This process was spread out over several field days and was focused on water bodies depicted in the National Hydrography Dataset (NHD). The result of this field work was the creation of a baseline assessment of existing riparian buffer conditions, as shown in **Figure 2-5**.

Figure 2-4: Photos of observed riparian buffer conditions near the Hwy 19 crossing of Four Holes Swamp [13]

[13] Provided by Kathryn Ellis

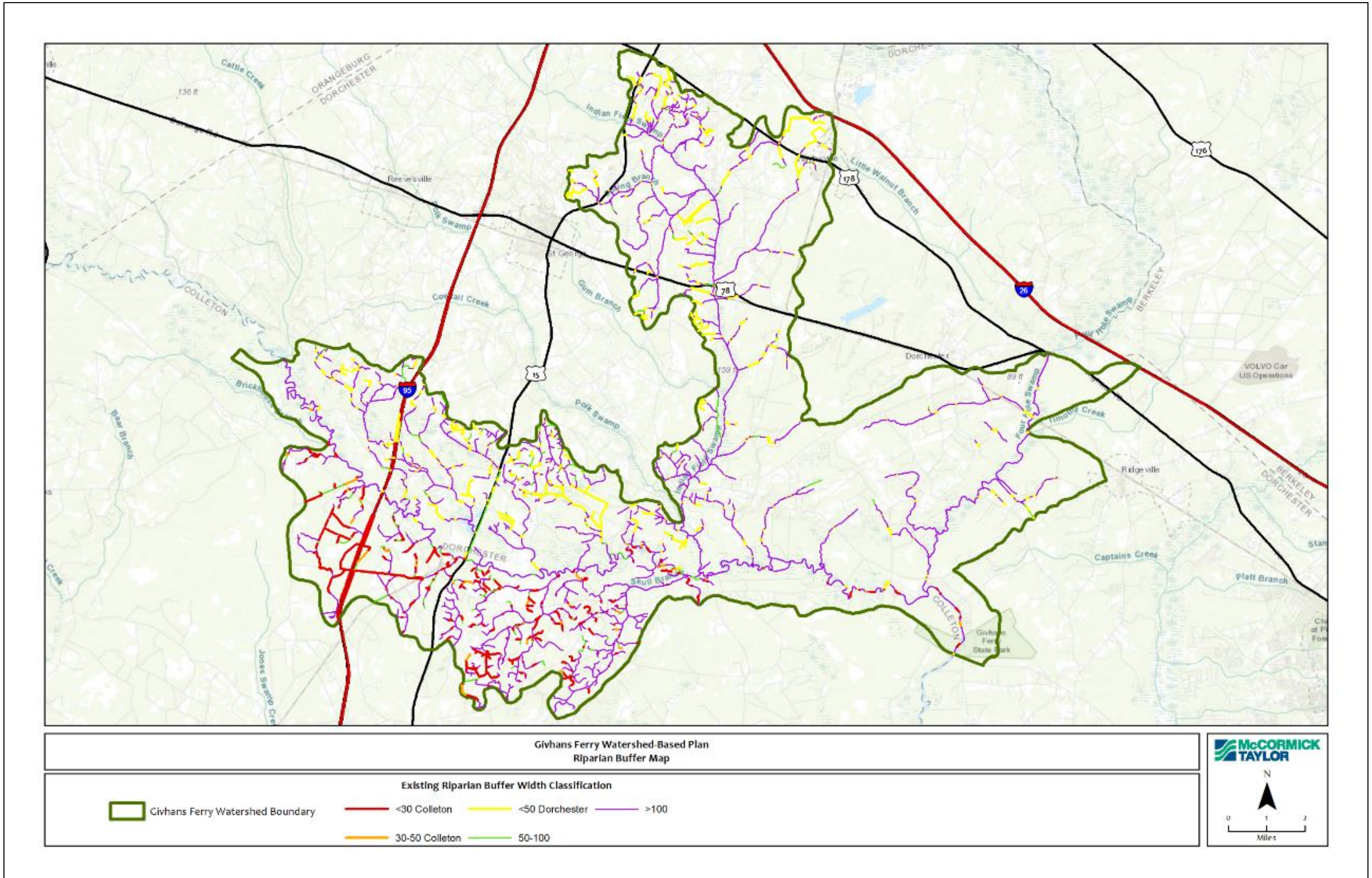

Figure 2-5: Analysis of current riparian buffer widths

2.3.3 Wetlands

Section 404 of the Clean Water Act (EPA, 1972) defines wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils. Wetlands generally include swamps, marshes, bogs, and similar areas."

Wetlands are environmentally sensitive habitats that play an integral part in supporting the water quality and water storage of a watershed. These reservoirs help to control flooding by retaining surface runoff and releasing steady flows of water downstream. Wetlands also support biological diversity, erosion control, and sediment retention.

Table 2-7 summarizes the National Wetland Inventory (NWI) for the Givhans Ferry Watershed. There are 33,046.34 acres of wetland habitat throughout the watershed (USFWS, 2016), the vast majority of which are freshwater forested/shrub wetlands (93%). Note that these wetlands have not been field-verified and there may be wetlands present in the watershed that may not be shown in the NWI. **Figure 2-6** shows wetland types from the NWI in the watershed.

Table 2-7: Wetlands in Givhans Ferry Watershed

Wetland Category	Acres	Percent
Lake	317.89	1%
Freshwater Pond	345.35	1%
Freshwater Emergent Wetland	621.93	2%
Freshwater Forested/Shrub Wetland	30,748.68	93%
Riverine	1,012.49	3%
TOTAL:	33,046.34	

The United States Army Corps of Engineers (USACE) classifies wetlands in accordance with their existing conditions. Existing condition is defined as "the degree of disturbance relative to the ability of a site to perform its physical, chemical, and biological functions." This rating system was created to quantify wetland value as it relates to creating a wetland impact mitigation plan. The rating system gives a numerical value to the wetland based on the four following classifications: 1) fully functional, 2) partially impaired, 3) impaired, and 4) very impaired (ACOE, 2010).

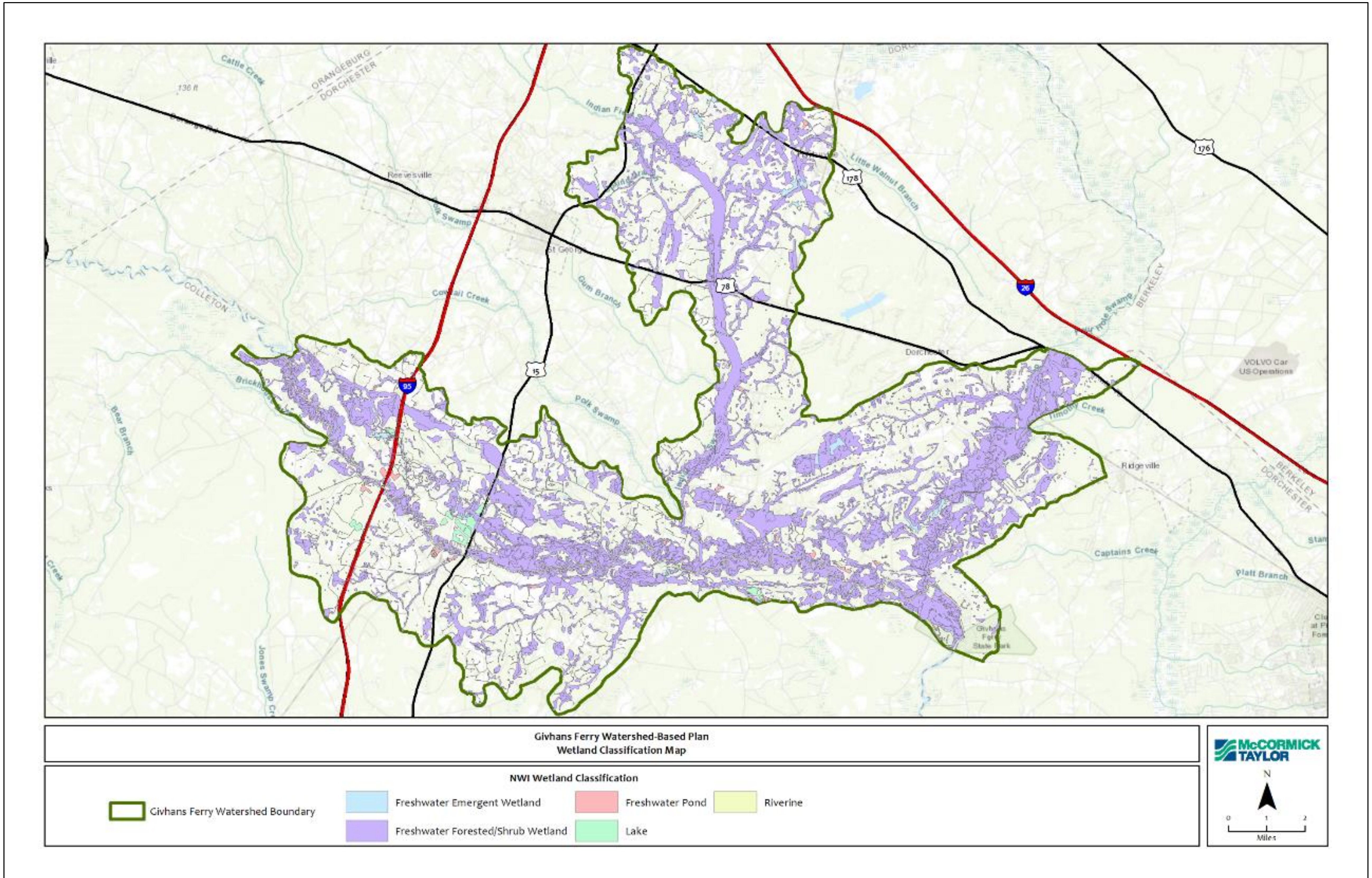

Figure 2-6: National Wetland Inventory Map for the Givhans Ferry Watershed

2.3.4 Floodplains

The process by which streams swell during storms and spill out onto their floodplain is natural. The Federal Emergency Management Agency (FEMA) 100-year floodplains are shown in **Figure 2-7**. Anthropocentric concerns with flooding problems often stem from land development occurring in flood-prone areas and/or structures being built in floodplains. Such flooding concerns are exacerbated when development throughout the watershed, and the associated impervious surfaces, result in increased volumes of runoff and expansion of those flood-prone areas over time. These concerns are also provoked by the gradually increasing storm frequencies and intensities we are experiencing as a result of climate change.

Flooding is a major hazard and concern for both water and wastewater utilities.[14] Floods are high volumes of water flow over areas that are normally dry land and can inundate areas where potential pollutants that are harmful to human health and the environment (such as chemicals, fuel, bacteria, etc.) may be located. The result is a significant and serious risk to anyone or anything the floodwater has contacted, including individual drinking water wells or community water systems. The force of floodwaters can also disrupt or damage water supply infrastructure and directly introduce the contaminated water into the treatment or distribution system.[15] Currently, there are 415 buildings (commercial and residential) located within the FEMA 100-yr floodplain in the watershed planning area.

Flood waters can also increase the concentration of Total Organic Carbon (TOC) in receiving waterbodies for many weeks, which increases the risk of disinfectant byproducts (DBPs) in the drinking water. Disinfectants, such as chlorine, can react with organic material in source water to form DBPs. More information about TOC monitoring and treatment can be found in **Appendix A: Organic Matter**.

Flooding creates additional concerns for septic systems.[16] Septic tanks operate by releasing effluent into the soil, where bacteria filter and digest the waste and contaminants as the wastewater flows through the soil. If the soil is saturated and flooded, the wastewater will not be treated properly and will become a source of nonpoint source pollution in the watershed. Raw sewage and chemicals can cause skin, eye, and respiratory irritation. Flooding of the septic tank may cause the system to back up into the house, creating a health hazard for residents. As is discussed in further detail in **Section 2.7.2**, 95% of all buildings in the Givhans Ferry Watershed are not connected to sanitary sewer, and of those, 8% are within 100 feet of a receiving waterbody.

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[14] USEPA. 2014. Flood Resilience: A Basic Guide for Water and Wastewater Utilities. EPA 817-B-14-006. Available at https://www.epa.gov/sites/default/files/2015-08/documents/flood_resilience_guide.pdf

[15] University of Nebraska-Lincoln Institute of Agriculture and Natural Resources. 2017. Floodwater and stormwater can contaminate your water well. Available at https://water.unl.edu/article/drinking-water-wells/floodwater-and-stormwaters-can-contaminate-your-water-well

[16] USEPA. 2005. Septic Systems – What to Do after the Flood. EPA 816-F-05-029. Available at https://www.epa.gov/sites/default/files/2015-11/documents/2005_09_22_faq_fs_whattodoafteraflood_septic_eng.pdf

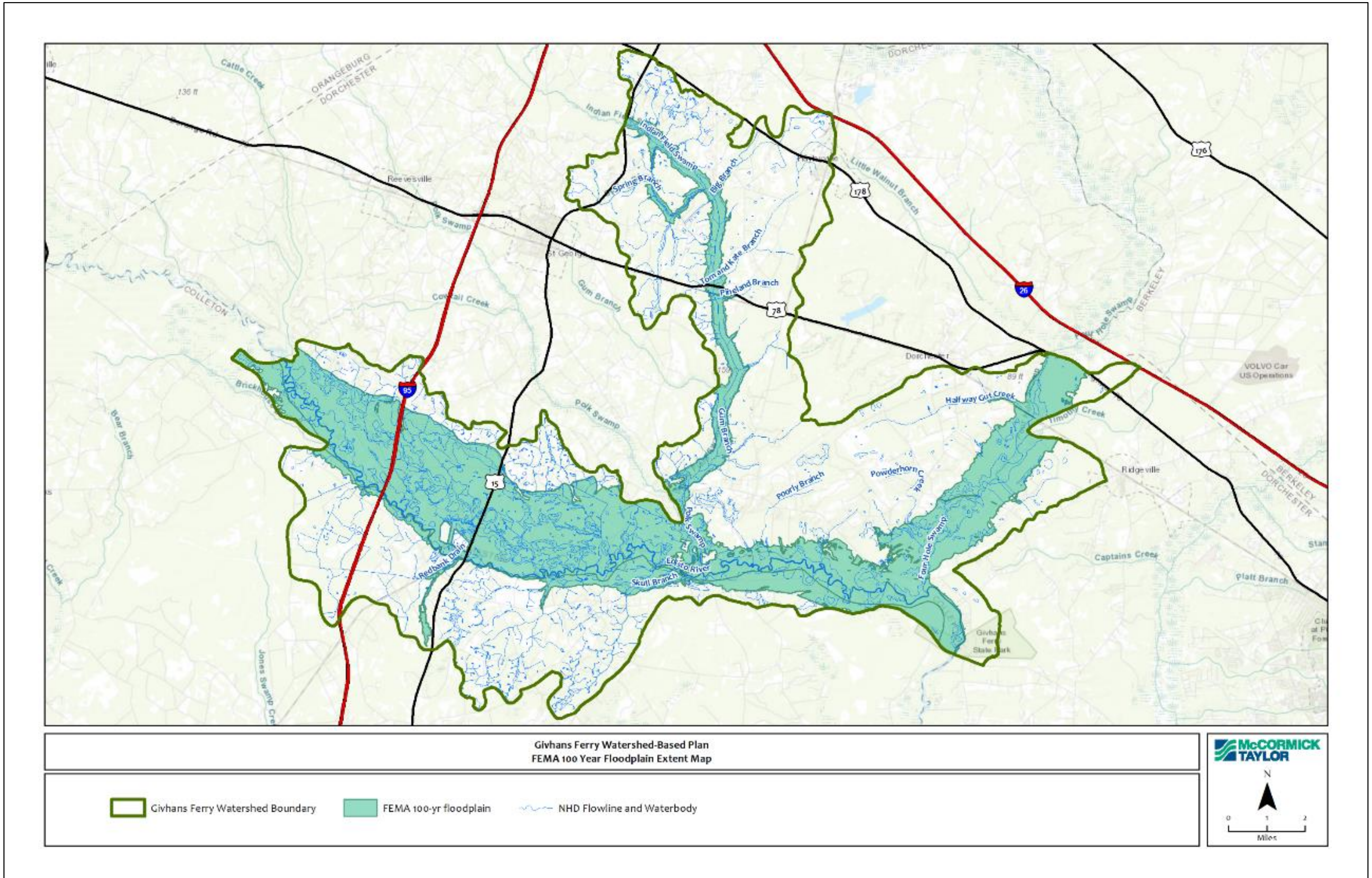

Figure 2-7: 100-year FEMA Floodplain for the Givhans Ferry Watershed

2.4 Geology and Soils

2.4.1 Geology

The geologic formations underlying a watershed have a significant effect on the water resources. Geology is a major determinant of the type of topography and surface features in an area. The chemical composition and minerals of the parent rock or unconsolidated sediments determines in large part the soil characteristics, including erodibility and infiltration rates.

Ecoregions are areas of general similarity in the type, quality, and quantity of environmental resources. Currently, the EPA has mapped four levels of detail for the southeast region. Givhans Ferry Watershed is located within the overall Middle Atlantic Coastal Plain ecoregion, with sections along the river in the Mid-Atlantic Floodplains and Low Terraces (63n) and the uplands within the Carolina Flatwoods (63h)[17]. The 63n region is characterized by large, sluggish rivers, deep-water swamps, and some oxbow lakes. Watersheds and their floodplains originating in this area contain sediment with more weatherable minerals as compared to blackwater floodplains that have their watersheds entirely within the coastal plain. Abrupt textural changes of alluvial deposits are also common in floodplains and terraces. (Griffith et al., 2002[18]). The 63h region can be characterized as a nearly level coastal plain with terraces and shoreline-landforms typically covered by fine-loamy and coarse-loamy soils, with periodically high-water tables. Clayey, sandy, or organic soils also located throughout the region support a rich plant diversity. Less relief, wider upland surfaces, and larger areas of poorly drained soils are also prevalent in this region compared to the adjacent, higher elevation ecoregion 651.

2.4.2 Soils

As summarized in **Table 2-8**, the most common soil series in the Givhans Ferry Watershed are Rains sandy loam (16.8%) and Alpin fine sand (12.7%). The Rains series consists of poorly drained, nearly level soils that formed in loamy sediments. These soils are found on the uplands of the coastal plains (NRCS, 1988). The Alpin series consists of excessively drained soils that formed in thick beds of sandy eolian or marine deposits. These soils are found on uplands and river terraces of the coastal plain (NRCS, 1988).

Figure 2-8 illustrates the locations of the Hydrologic Soil Group (HSG) classifications in the watersheds, as assigned by the United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS). The HSG describes a group of soils having similar runoff potential under similar storm and cover conditions:

- Group A are soils having a high infiltration rate (or low runoff potential) when thoroughly wet. These consist mainly of deep, well-drained sands or gravelly sands. These soils have a high rate of water transmission.
- Group B are soils having a moderate infiltration rate when thoroughly wet.
- Group C are soils that have a slow infiltration rate when thoroughly wet. These soils typically have a layer that impedes the downward movement of water.
- Group D are soils that have a very slow infiltration rate (or high runoff potential) when thoroughly wet. Generally, these are soils that have a clay layer at or near the surface; soils that have a high-water table; and/or soils that are shallow over nearly impervious material.

[17] Mapped ecoregions obtained from https://gis.dhec.sc.gov/watersheds/
[18] Descriptions of ecoregions found here: https://www.nrc.gov/docs/ML1127/ML112710639.pdf

There are also three dual HSG classifications (A/D, B/D, and C/D). These soils are given two classifications to make a distinction between a drained and undrained condition. For the purposes of this watershed study, in order to make a conservative estimate of runoff potential, all three dual HSG groups were assumed to be undrained (HSG D). The HSG soils within the Givhans Ferry Watershed make up 2.0% of the total soils within the drainage area.

The soils within the Givhans Ferry Watershed are predominantly poorly drained with just under three-quarters of the soils (70.8%) in the watershed being classified as hydrologic group D. The remaining area of the Givhans Ferry Watershed is mainly hydrologic group A (21.2%), with the remaining classified as hydrologic group B (4%) and C (3.3%).

Table 2-8: Givhans Ferry Hydrologic Soil Group Classifications

Soil Series Name	HSG	Area (acres)	Total Area	Percent
Chipley fine sand, 0 to 2 percent slopes	A	11.10	1,023	21%
Echaw loamy fine sand	A	11.49		
Seagate fine sand	A	51.24		
Alpin fine sand, 0 to 6 percent slopes	A	612.94		
Chipley sand, 0 to 2 percent slopes	A	14.13		
Coosaw loamy fine sand	A	46.44		
Echaw fine sand	A	94.57		
Blanton loamy fine sand, 0 to 6 percent slopes	A	40.75		
Foxworth fine sand, 0 to 6 percent slopes	A	121.26		
Blanton fine sand, 2 to 6 percent slopes	A	4.35		
Blanton fine sand, 0 to 2 percent slopes	A	14.68		
Bonneau fine sand, 0 to 2 percent slopes	B	34.64	190	4%
Bonneau fine sand, 2 to 6 percent slopes	B	40.22		
Norfolk loamy fine sand, 0 to 2 percent slopes	B	26.93		
Norfolk loamy fine sand, 2 to 6 percent slopes	B	6.58		
Chisolm fine sand, 0 to 6 percent slopes	B	34.33		
Foreston loamy fine sand, 0 to 2 percent slopes	B	7.99		
Seagate sand	B	38.77		
Goldsboro loamy fine sand	C	6.32	160	3%
Yauhannah fine sandy loam	C	28.92		
Emporia loamy fine sand, 2 to 6 percent slopes	C	12.81		
Goldsboro loamy sand, 0 to 2 percent slopes	C	12.41		
Izagora silt loam, 0 to 2 percent slopes	C	3.69		

Soil Series Name	HSG	Area (acres)	Total Area	Percent
Johns loamy sand, 0 to 2 percent slopes	C	3.51		
Noboco loamy sand, 0 to 2 percent slopes	C	50.96		
Yauhannah loamy fine sand, 0 to 2 percent slopes	C	41.73		
Albany loamy sand, 0 to 2 percent slopes	D	236.90	3,420	71%
Coxville fine sandy loam	D	18.59		
Hobcaw fine sandy loam	D	191.42		
Dunbar fine sandy loam	D	20.22		
Leon sand, 0 to 2 percent slopes	D	73.82		
Lynchburg loamy fine sand, 0 to 2 percent slopes	D	50.16		
Lynn Haven fine sand	D	36.21		
Paxville fine sandy loam	D	63.35		
Ocilla loamy sand	D	0.49		
Pelham loamy sand, 0 to 2 percent slopes	D	6.31		
Ogeechee loamy fine sand	D	134.67		
Plummer loamy sand	D	77.69		
Santee loam	D	13.88		
Yemassee loamy fine sand	D	54.09		
Haplaquents, loamy	D	44.41		
Torhunta-Osier association	D	288.89		
Nemours fine sandy loam, 0 to 2 percent slopes	D	21.59		
Albany fine sand, 0 to 2 percent slopes	D	95.27		
Brookman clay loam, frequently flooded	D	36.64		
Coxville loam	D	25.55		
Daleville silt loam	D	6.81		
Elloree loamy fine sand, occasionally flooded	D	17.00		
Grifton fine sandy loam, frequently flooded	D	141.74		
Jedburg loam	D	9.74		
Leon sand, 0 to 2 percent slopes	D	4.77		
Lumbee fine sandy loam, occasionally flooded	D	7.47		
Lynn Haven fine sand	D	314.55		
Mouzon fine sandy loam, occasionally flooded	D	56.19		

Soil Series Name	HSG	Area (acres)	Total Area	Percent
Nakina fine sandy loam	D	6.76		
Ogeechee fine sandy loam	D	11.05		
Osier loamy fine sand, frequently flooded	D	52.67		
Pantego sandy loam	D	0.65		
Ocilla sand, 0 to 2 percent slopes	D	2.01		
Pelham sand	D	141.17		
Rains sandy loam, 0 to 2 percent slopes, Atlantic Coast Flatwoods	D	814.14		
Rutlege loamy fine sand, frequently flooded	D	88.51		
Wahee fine sandy loam	D	1.50		
Yemassee fine sandy loam	D	174.07		
Lynchburg loamy sand, 0 to 2 percent slopes	D	47.61		
Pickney loamy sand	D	31.92		
Water	Water	38.48	38	0.8%

The depth to groundwater was estimated using the soil survey information, as summarized in **Table 2-9**. A little over 80% of the watershed has a shallow groundwater elevation, which presents several water quality concerns. In the WTM, the depth to groundwater influences both the septic system failure rate (surface discharge from the system), and pollutant transport from septic systems to groundwater and proximate waterways. When a septic system intersects with the groundwater table, it can cause the system to back up and discharge to the surface.

The soil type and depth both affect the ability of the soil to filter pollutants. In general, coarse or sandy soils have a lower pollutant removal, and pollutant removal increases with increasing depth to groundwater. For this reason, the WTM applies a 50% discount factor for TN, TP, and bacteria removal in sandy or gravely soils. The WTM assumes 100% bacteria removal for depths greater than three feet; 83.2% of the soils in the Givhans Ferry Watershed have a depth to groundwater less than three feet. The WTM assumes no nitrogen removal at depths less than three feet, 13.4% removal at depths between three and five feet, and 3.4% removal at depths greater than five feet. Phosphorus removal is also dependent on depth to groundwater. The WTM assumes 50% TP removal in depths less than three feet, 80% removal at depths between three and five feet, and 100% removal at depths greater than five feet. Finally, the WTM assumes that 100% of the TSS load is removed by soil filtering.

Table 2-9: Depth to Groundwater Givhans Ferry Watershed

Depth to Groundwater (ft)	Soil Fraction (%)
Less than 3 feet	83.2
3-5 feet	13.4
Greater than 5 feet	3.4

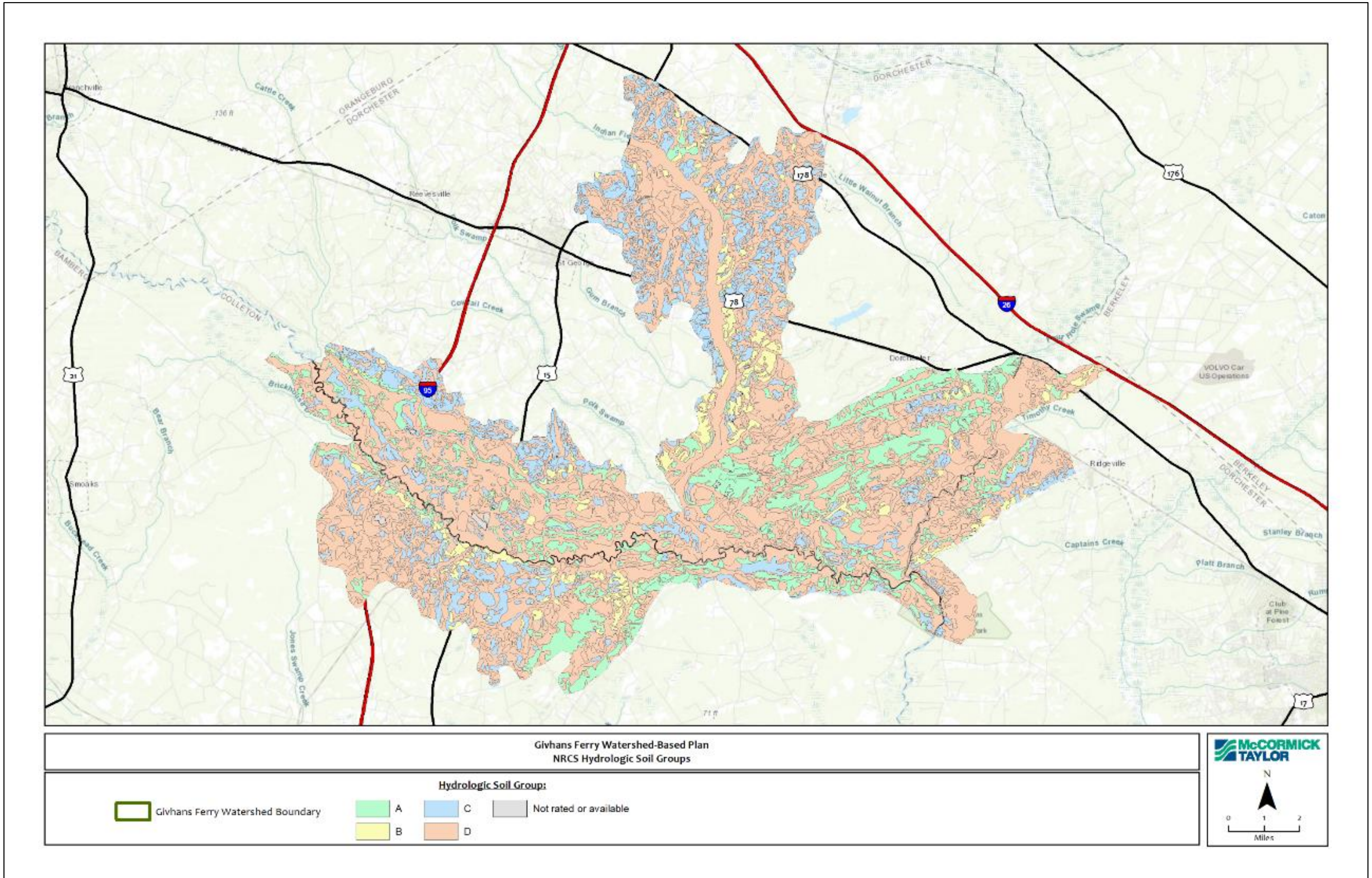

Figure 2-8: Hydrologic Soil Groups in the Givhans Ferry Watershed

2.4.3 Soil Erodibility

Modification of the hydrologic regime due to land disturbance in a watershed can result in elevated volumes of stormwater runoff flowing into creeks, streams, and other waterbodies. These increased volumes and the quick delivery of these runoff events can lead to the scour of stream channels, incision, and streambank erosion. Hydrologic scour of the streambed can also limit key microhabitats (e.g., leaf packs, sticks, and coarse substrate) for aquatic species. While it is difficult to delineate the different sources of sediment that are being delivered to streams (e.g., streambank erosion as opposed to upland sources such as construction sites), instream sedimentation and subsequent lack of microhabitat are a result of sediment input to streams from streambank erosion. Channel widening through streambank erosion can also exacerbate low flow conditions because channels become overly wide and shallow.

The influence of streambank erosion was quantified throughout the Givhans Ferry Watershed using a geospatial assessment that involved an analysis of the Universal Soil Loss Equation (USLE) K-factor values within 10 feet of all existing natural stream channels. This data was obtained from the USDA NRCS web soil survey. The USLE K-factor—having units of tons/acre—is a measure of the susceptibility of a soil to particle detachment and transport by rainfall. The K-factor was calculated from direct soil loss measurements for a series of benchmark soils from study plots located across the United States. It is calculated assuming the highest potential for erosion: soil is in cultivated (plowed or disturbed), continuous fallow (bare soil, no vegetation or protective cover) conditions (Schwabb et al., 1993). Without field measurements, it is the best available measure of a specific soil's susceptibility to streambank erosion. Moreover, the K-factor values most likely underestimate the risks of streambank erosion because the erosive power of stream flows on (most likely) saturated streambank soils is presumed to be greater than that of rainfall. The sub-surface K-factor was used so that bank and channel erodibility was most closely reflected by the data. The degree of soil erodibility is classified as shown in **Table 2-10** and illustrated in **Figure 2-9**.

Table 2-10: Givhans Ferry Watershed Stream Soil Erodibility

K-factor	Length (ft)	Percent
Low Erodibility <0.24	4,323,617.96	87.6%
Medium Erodibility 0.24-0.32	593,770.66	12%
High Erodibility >0.32	16486.22	0.3%
Null or Unavailable	0	0%

The average sub-surface K-factor related to streambank erosion for the entire Givhans Ferry Watershed ranges from 0.02 to 0.55 tons/acre, and the area weighted average is 0.15 tons/acre. For the available data, it appears as though the watershed has a low potential for erosion. However, as will be discussed in the Stakeholder Input (**Section 2.9**), there were many observations of erosion problems in the watershed.

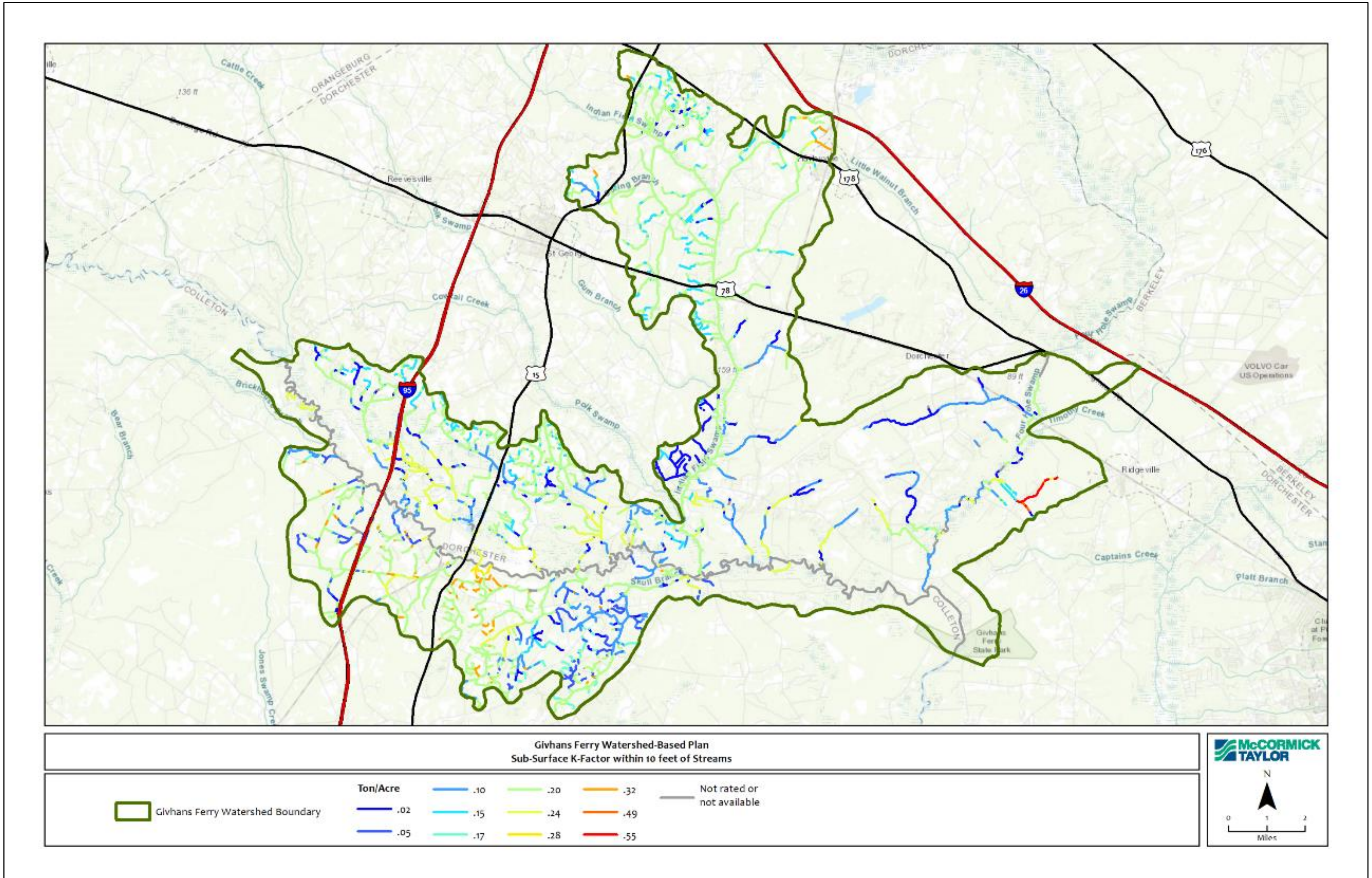

Figure 2-9: Sub-surface K-Factor within 10 feet of Streams in the Givhans Ferry Watershed

2.5 Endangered or Protected Species

Table 2-11 and **Table 2-12** summarize the rare, threatened, and endangered species that have ranges or habitat in Givhans Ferry Watershed, according to a report (included in Appendix B of this WBP) by the SC Department of Natural Resources Heritage Trust Program (SCNHP). There are 49 tracked species that are found within the Givhans Ferry Watershed boundary; however, the exact locations of these species are not labeled in the SCNHP report due to the sensitive nature of this information.

In total, about 1,000 species are tracked by the SCNHP and are considered rare for a variety of reasons: there is a lack of data, the species are regionally or locally endemic or rare, or they are beginning to show a downward trend in population. Each species is given a global rank by Natureserve (G-rank) which indicates its relative state of imperilment across its global range, with the rankings as follows:

1. Critically imperiled: typically having 5 or fewer occurrences or 1,000 or fewer individuals
2. Imperiled: typically having 6 to 20 occurrences, or 1,001 to 3,000 individuals
3. Vulnerable/rare: typically having 21 to 100 occurrences, or 3,001 to 10,000 individuals
4. Apparently secure: uncommon but not rare, but with some cause for long-term concern; typically having 101 or more occurrences, or 10,001 or more individuals
5. Secure: common, widespread, abundant, and lacking major threats or long-term concerns

The State Wildlife Action Plan (SWAP)[19] is a comprehensive plan that addresses the species that the State has deemed to have the greatest conservation need due to factors such as rarity, threats, lack of management funding, and lack of data.

[19] SCDNR. 2015. State Wildlife Action Plan. Available at https://www.dnr.sc.gov/swap/index.html

Table 2-11: Rare, Threatened, or Endangered Plant Species in the Givhans Ferry Watershed

Common Name	Scientific Name	G-Rank	Protection Status*	SWAP Priority
Blackstem Spleenwort	*Asplenium resiliens*	G5	NA	Moderate
Aquatic Milkweed	*Asclepias perennis*	G5	NA	NA
Cherokee Sedge, Wolftail Sedge	*Carex cherokeensis*	G4/G5	NA	NA
Gholson's Sedge	*Carex gholsonii*	G4/G5	NA	NA
Southern Willdenow's Sedge, Widow Sedge	*Carex basiantha*	G5	NA	NA
Spiked Medusa, Smooth-lipped Eulophia	*Orthochilus ecristatus*	G2/G3	NA	High
Moonseed, Yellow Parilla	*Menispermum canadense*	G5	NA	NA
Swamp Coreopsis	*Coreopsis gladiata*	G4/G5	NA	NA
Sarvis Holly	*Ilex amelanchier*	G4	NA	NA
Shadow Witch	*Ponthieva racemosa*	G4/G5	NA	NA
Chipola Dye-flower; Cileate-leaf Tickseed	*Coreopsis integrifolia*	G1/G2	ARS	High
Green-fly Orchid	*Epidendrum conopseum*	G4	NA	NA
Carolina Birds-in-a-nest, Carolina Macbridea	*Macbridea caroliniana*	G2/G3	NA	High
Blue Witchgrass	*Dichanthelium caerulescens*	G2/G3	NA	NA
Ware's Hairsedge	*Bulbostylis warei*	G3/G4	NA	NA

** ARS = At Risk Species*

Table 2-12: Rare, Threatened, or Endangered Animal Species in the Givhans Ferry Watershed

Common Name	Scientific Name	G-Rank	Protection Status*	SWAP Priority
Carolina Gopher Frog	*Lithobates capito*	G2/G3	ARS	Highest
Purse Casemaker Caddisfly	*Hydroptila tridentata*	G1	NA	NA
American Shad	*Alosa sapidissima*	G5	NA	Highest
Hickory Shad	*Alosa mediocris*	G4	NA	Highest
Blueback Herring	*Alosa aestivalis*	G3/G4	NA	Highest
Atlantic Sturgeon	*Acipenser oxyrinchus*	G3	LE	Highest
Spotted Turtle	*Clemmys guttata*	G5	ARS	High
Star-nosed Mole	*Condylura cristata*	G5	NA	High
Swallow-tailed Kite	*Elanoides forficatus*	G5	MBTA	Highest
Eastern Red Bat	*Lasiurus borealis*	G3/G4	NA	Highest
Hoary Bat	*Lasiurus cinereus*	G3/G4	NA	Highest
Big Brown Bat	*Eptesicus fuscus*	G5	NA	Highest
Evening Bat	*Nycticeius humeralis*	G5	NA	NA
Brazilian Free-tailed Bat	*Tadarida brasiliensis*	G5	NA	NA
Bannerfin Shiner	*Cyprinella leeds*	G4	NA	High
Sawcheek Darter	*Etheostoma serrifer*	G5	NA	Moderate
American Bumble Bee	*Bombus pensylvanicus*	G3/G4	ARS	NA
Banded Sunfish	*Enneacanthus obesus*	G5	NA	Moderate
Ironcolor Shiner	*Notropis chalybaeus*	G4	NA	Moderate
Red-cockaded Woodpecker	*Dryobates borealis*	G3	LE	Highest
Rafinesque's Big-eared Bat	*Corynorhinus rafinesquii*	G3/G4	NA	Highest
Great Egret	*Ardea alba*	G5	MBTA	NA
American Eel	*Anguilla rostrata*	G4	NA	Highest
Flat Bullhead	*Ameiurus platycephalus*	G4	NA	Moderate
Painted Bunting	*Passerina ciris*	G5	MBTA	Highest
Little Blue Heron	*Egretta caerulea*	G5	MBTA	Highest
Coastal Plain Crayfish	*Procambarus ancylus*	G4/G5	NA	Moderate
Shaggy Crayfish	*Procambarus hirsutus*	G4	NA	Moderate
Black Mottled Crayfish	*Procambarus enoplosternum*	G4/G5	NA	Moderate
Snowy Egret	*Egretta thula*	G5	MBTA	Moderate
White Catfish	*Ameiurus catus*	G5	NA	Moderate
Carolina Slabshell	*Elliptio congaraea*	G3	NA	Moderate
Eastern Ellipto	*Elliptio complanata*	G5	NA	Moderate
Blackbanded Sunfish	*Enneacanthus chaetodon*	G3/G4	NA	High

** ARS = At Risk Species; MBTA = Migratory Bird Treaty Act; LE = Federally Endangered*

2.6 Growth and Development

2.6.1 Demographic Characteristics

Population for the Givhans Ferry Watershed area was estimated from block-level 2020 US Census American Community Survey[20] (ACS) data. The area of the block that fell within the Givhans Ferry Watershed was calculated as a percentage of the overall HUC-12 watershed area and then multiplied by the population. Following this methodology, we estimated that the Givhans Ferry Watershed has an estimated population of 7,125. As of July 2023, the entire Charleston Water System's current service area encompasses 455 square miles and a total of 123,000 accounts (which equates to an estimated population of 450,000).

A similar methodology was followed to calculate the minority population (3,314) and low-income population (3,205) within the Givhans Ferry HUC-12 watershed using data from the EPA's Environmental Justice Screening and Mapping Tool[21] (EJScreen). EJScreen's socioeconomic indicator for Low-income is defined as household income that is less than or equal to twice the federal poverty level. Percent People of Color (or minority population) is defined as individuals who list their racial status as a race other than white alone and/or list their ethnicity as Hispanic or Latino.

[20] United States Census Bureau. 2020. American Community Survey. Available at https://www.census.gov/programs-surveys/acs

[21] USEPA. 2021. Environmental Justice Screening and Mapping Tool. Available at https://www.epa.gov/ejscreen

2.6.2 Significant Cultural and Tribal Resources in the Watershed

Cultural resources include any natural or manmade sites, events, activities, or historic structures and can have a general social significance in the community. Cultural resources can enhance community interaction as well as provide beneficial social outlets for the community. Upon selecting BMPs to improve water quality and reduce pollutants, we will consult with the South Carolina Department of Archives and History to determine if any cultural resources or archaeological remains exist within or near the project area.

Within the Givhans Ferry Watershed there are three historic sites listed on the National Register:

Appleby's Methodist Church[22] is located southwest of St. George, and was listed on the National Register on February 14, 1978 because of its religious and architectural significance. This Greek Revival church is thought to have been built in 1840-1850 and is presumably named for James Preston Appleby who donated four acres of land for the church site. Included with the church is a cemetery dating to the late 19th century.

Carroll Place[23] is one of the oldest plantation houses in Dorchester County. It was included on the National Register on July 25, 1974 for its political, social, and architectural significance. It is a Georgian upcountry style building and appears on the Robert Mills survey of 1820. The plantation was home to several prominent South Carolina politicians, including Joseph Kroger, John S. Murray, and James Carroll.

St. Paul Campground[24] is located in Harleyville and was listed on the National Register on April 30, 1998. It is believed to have been established in 1880 and is an excellent example of a Methodist camp meeting ground, complete with a tabernacle, tents, stores, and privies. The buildings and grounds are used for one week each year (the third Sunday in October). This property's areas of significance in the community include religion, social history, architecture, and ethnic heritage.

The Givhans Ferry Watershed is home to the Edisto Natchez-Kusso Tribe of South Carolina[25]. The tribe descends from the Kusso Indians, who were documented to be in the Lowcountry from at least 1670 onward, and the Natchez Indians, who were displaced from what is now Mississippi by the French in 1720s. Many of the Natchez sought refuge in Cherokee, North Carolina. One group relocated to Charleston in 1734 and was later followed by a second group in 1747. The tribe was granted land along the Edisto River by the Governor of South Carolina. Between 1840 and 1850, members of the tribe moved off the reservation and settled in different communities such as Creeltown and Four Holes. The Four Hole Indian Freedom Organization was established in 1969 in response to the closure of their Indian School and difficulties enrolling in a newly integrated public school system. The tribe is the largest State-recognized tribe in South Carolina and is seeking federal recognition.

As development continues to expand towards and within the watershed study area, both current and future impacts to important historical/cultural resources and areas of tribal significance, as well as measures to protect and preserve them, should be considered.

[22] South Carolina Department of Archives and History. Appleby's Methodist Church. Available at http://www.nationalregister.sc.gov/dorchester/S10817718001/index.htm

[23] South Carolina Department of Archives and History. Carroll Place. Available at http://www.nationalregister.sc.gov/dorchester/S10817718002/index.htm

[24] South Carolina Department of Archives and History. St. Paul Camp Ground. Available at http://www.nationalregister.sc.gov/dorchester/S10817718008/index.htm

[25] Edisto Natchez-Kusso Tribe of South Carolina. https://www.natchezkussotribeofscedisto.website/history

2.6.3 Existing Land Cover and Land Use

Land cover indicates the physical land type, such as forest or open water. Land use describes how people manage the landscape, such as for development or conservation. Similar types of land cover can be managed or used differently[26]. For example, a forested area could be managed for forestry or protected as a conservation area.

Determination of existing land cover and land use was based on the most recent National Land Cover Dataset[27] (NLCD), published in 2019. Land cover classifications were combined with zoning data provided by Colleton County, Dorchester County, and the Town of Harleyville. This data was organized into ten different categories that were used as inputs into the Watershed Treatment Model (WTM), as is illustrated in

Figure *2-10* and summarized in **Table 2-13**. Because WTM does not have an input for cultivated cropland, this land cover was modeled outside of WTM in a separate tool (Model My Watershed) which is better suited for rural watersheds. Some land cover classifications were combined to fit a particular land use category in the WTM. Forest areas included forest, shrub/scrub, and wetlands NLCD land covers. Rural areas included pasture/hay and grassland/herbaceous. Roadway areas were estimated by creating a 10-ft buffer around road centerlines.

The largest land use categories in Givhans Ferry Watershed are forest (75,559 acres) and cultivated crops (9,934 acres), which comprise approximately 86% of the watershed in total. Industrial (112 acres) and commercial (177 acres) were the smallest land use categories in the watershed.

[26] NOAA. 2020. What is the difference between land cover and land use? Available at https://oceanservice.noaa.gov/facts/lclu.html

[27] Multi-Resolution Land Characteristics Consortium. 2019. National Land Cover Database (NLCD) 2016. https://www.mrlc.gov/national-land-cover-database-nlcd-2016

Table 2-13: Existing Land Cover and Land Use in the Givhans Ferry Watershed

WTM Category	NLCD and Zoning Category	Area (acres)	Percent
Industrial	Industrial	112	0.1%
Active Construction	Barren Land	415	0.4%
Roadway	Roadway	952	1.0%
Water	Open Water	1,431	1.4%
Cultivated Crops	Cultivated Crops	9,934	10.0%
Commercial	*Commercial*	107	
	Community Commercial	18	
	Highway Commercial	15	
	Light Commercial	20	
	Light Industrial	0	
	Rural Neighborhood Commercial	1	
	Town Center	16	
Commercial Total		177	0.2%
Forest	*Deciduous Forest*	1,015	
	Emergent Herbaceous Wetlands	2,276	
	Evergreen Forest	28,483	
	Mixed Forest	640	
	Shrub/Scrub	3,882	
	Woody Wetlands	39,263	
Forest Total		75,559	76%
Low Density Residential (LDR)	*Agricultural Residential*	3,229	
	Institutional/Recreational	11	
	Low Intensity Development	560	
	Rural Development-1	20	
	Single Family Residential	38	
	Traditional Neighborhood Residential	13	
	Transitional Residential District	8	
LDR Total		3,879	3.9%
Medium Density Residential (MDR)	*Agricultural (Flex-1)*	4	
	Rural Development-2	974	
	Rural Residential	16	
	Single Family Manufactured Housing (R1MA)	12	
MDR Total		1,005	1.0%
Rural	*Grassland/Herbaceous*	4,341	
	Pasture/Hay	1,754	
Rural Total		6,095	6.1%
Total Area		99,557	

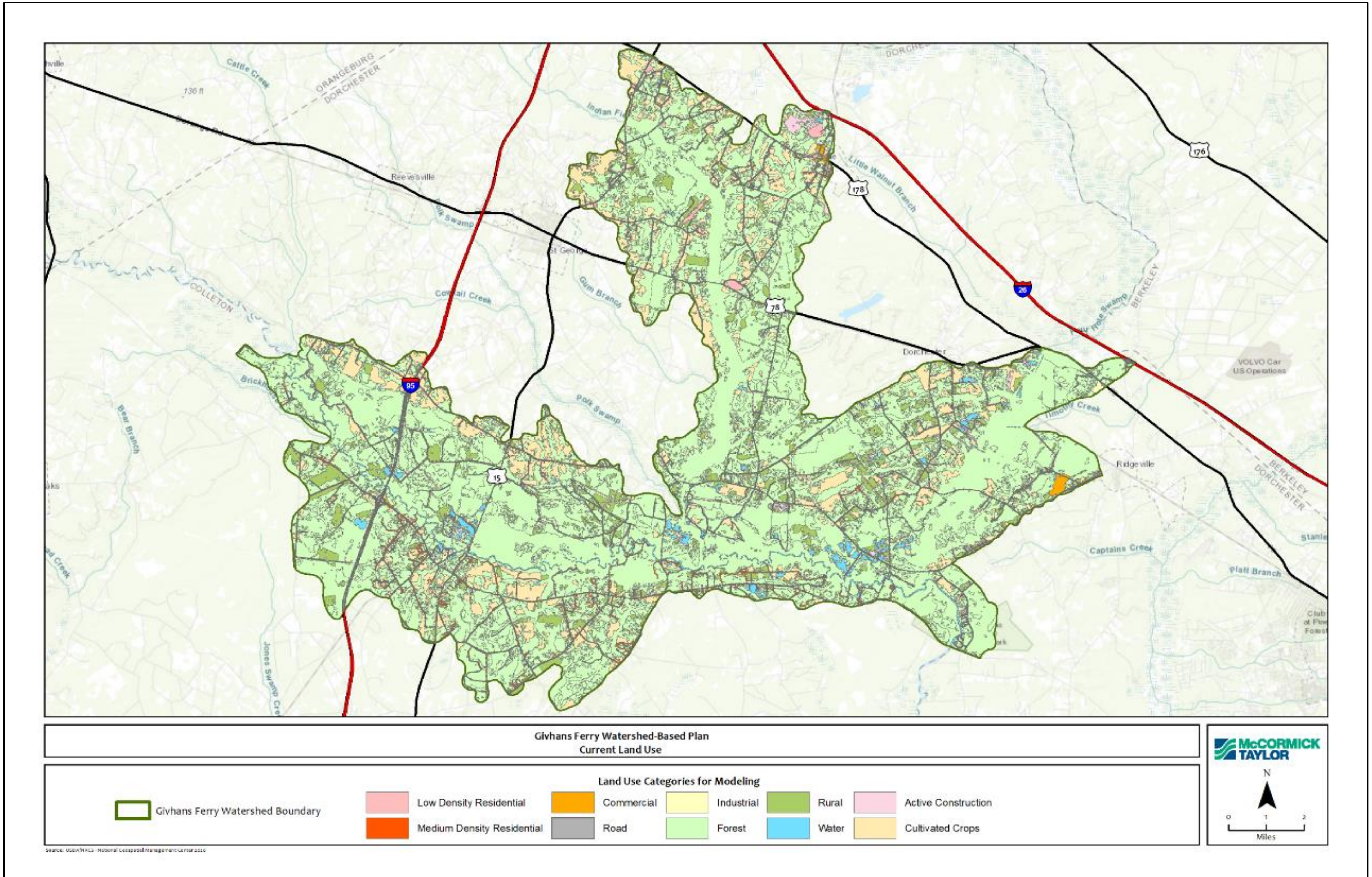

Figure 2-10: Givhans Ferry Watershed Existing Land Use Modeling Categories

2.6.4 Existing Imperviousness

Impervious surfaces are hard surfaces that do not allow water to infiltrate slowly into the ground as it would in pervious landscapes, such as a forest, meadow, or open field. Examples of impervious surfaces include roadways, parking lots, driveways, sidewalks, and rooftops. These surfaces generate higher volumes of stormwater runoff, which is typically concentrated into drainage infrastructure (such as gutters, pipes, and ditches), which in turn accelerate flow rates and direct stormwater to a receiving waterbody. This accelerated, concentrated runoff often causes stream erosion and habitat degradation. Runoff from impervious surfaces picks up and washes off contaminants (oil, metals, sediment, etc.) and is highly polluted relative to the minimal amounts of runoff generated from pervious areas. In general, undeveloped watersheds with small amounts of impervious cover are more likely to have better water quality in local streams than urbanized watersheds with greater amounts of impervious cover. Impervious cover is a primary factor when determining pollutant characteristics and loadings in stormwater runoff.

The degree of imperviousness in a watershed also affects aquatic life. There is a strong relationship between watershed impervious cover and the decline of a suite of stream indicators. As imperviousness increases, the potential stream quality decreases, as referenced in research indicating that stream quality begins to decline at or around 10% imperviousness[28]. However, there is considerable variability in the response of stream indicators to impervious cover observed from 5-20% imperviousness due to historical effects, watershed management, riparian width and vegetative protection, co-occurrence of stressors, and natural biological variation. Due to this variability, one cannot conclude that streams draining low impervious cover will automatically have good habitat conditions and healthy aquatic organisms.

The Givhans Ferry Watershed contains impervious cover in the residential, industrial, and commercial areas. Approximately 6% of the watershed (6,125 acres) consists of land uses associated with impervious surfaces, including residential land use (5%), commercial land use (0.2%), industrial (0.1%), and roads (1%). Even in these developed areas, impervious surfaces do not cover every square foot of land area. The amount of actual impervious surface cover is less than the total area, and not every land use category includes the same proportions of actual impervious cover. For example, as a percentage, low density residential use includes less impervious cover than commercial or institutional development. **Table 2-14** estimates these ranges for the different development land cover categories for the overall Givhans Ferry Watershed and each of the five subwatersheds. The increased intensity of these land uses is reflected implicitly in the land cover but is not explicitly measured in this dataset. The mean percent imperviousness for each land use[29] is summarized as follows:

- Low intensity residential: 20%
- Medium intensity residential: 25%
- Industrial: 72%
- Commercial: 85%
- Roadway: 98%

[28] Schueler, T., L. Fraley-McNeal, and K. Cappiella. 2009. Is Impervious Cover Still Important? Review of Recent Research. Journal of Hydrologic Engineering. 14(4). https://doi.org/10.1061/(ASCE)1084-0699(2009)14:4(309)

[29] Caraco, D. 2013. *Watershed Treatment Model 2013 Documentation.* Center for Watershed Protection.

The imperviousness for the overall watershed is 2%, with only one of the subwatersheds' imperviousness significantly higher than this. The Deep Creek subwatershed (coincidentally, also the smallest subwatershed because it is not a full HUC-12) has the greatest percentage of impervious surfaces (3%). At this level of imperviousness in a watershed, the stream health is expected to be good quality but sensitive, as illustrated in **Figure 2-11**.

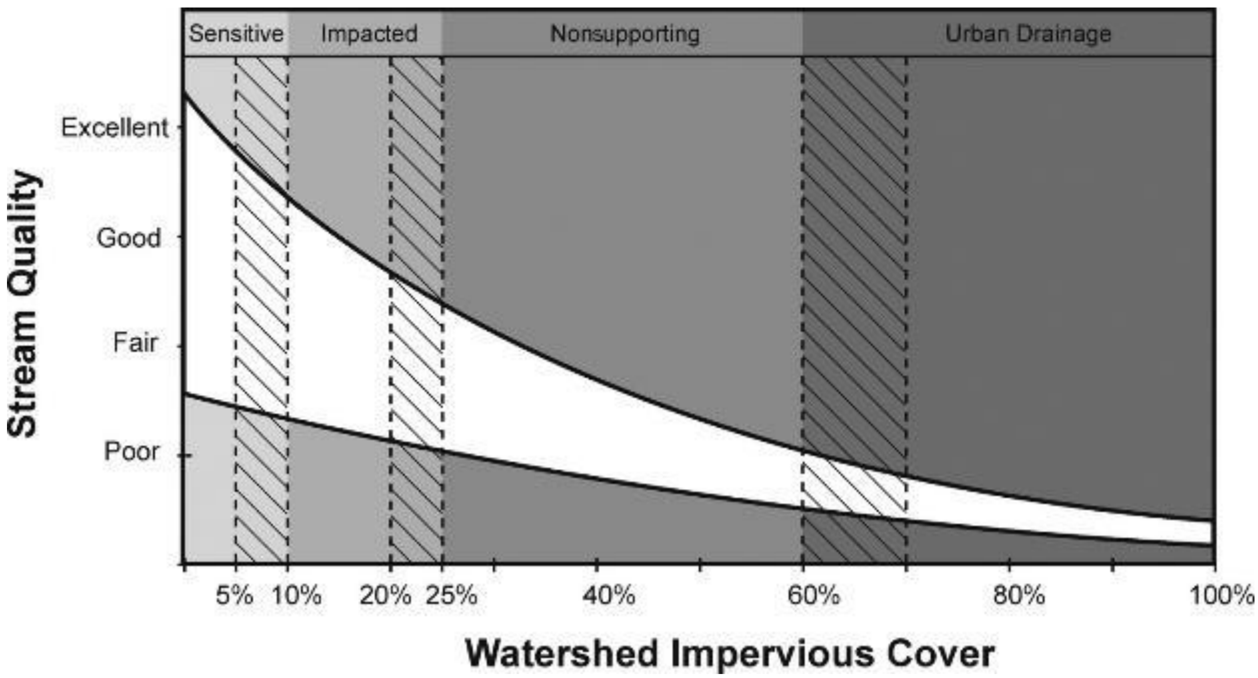

Figure 2-11: Stream Water Quality as a factor of Watershed Impervious Cover (Schueler et al., 2009)

Table 2-14: Givhans Ferry Watershed Impervious Area Estimate

Land Use	Givhans Ferry		Deep Creek		Poorly Branch		Halfway Gut Creek		Lower Indian Field Swamp		Skull Branch	
	Total Area (acres)	Impervious Area (acres)	Total Area (acres)	Impervious Area (acres)	Total Area (acres)	Impervious Area (acres)	Total Area (acres)	Impervious Area (acres)	Total Area (acres)	Impervious Area (acres)	Total Area (acres)	Impervious Area (acres)
Residential Development												
Low Intensity	3,879	776	117	23	284	57	774	155	1,472	294	1,232	246
Medium Intensity	1,005	251	3	1	204	51	14	4	16	4	769	192
Commercial	177	151	0	0	0	0	108	92	51	43	17	14
Industrial	112	80	-	-		-	34	24	30	22	47	34
Roadway	952	933	17	17	110	108	139	136	249	244	436	427
Agriculture/Cropland*	9,934	-	67	-	763	-	1,550	-	3,570	-	3,983	-
Barren Land*	415	-	-	-	32	-	101	-	216	-	66	-
Forest*	75,559	-	1,827	-	7,601	-	14,105	-	22,031	-	29,992	-
Rural*	6,095	-	33	-	667	-	1,212	-	1,714	-	2,469	-
Open Water*	1,431	-	52	-	403	-	277	-	138	-	563	-
Total Area	**99,559**	**2,191**	2,116	41	10,064	216	18,314	411	29,487	607	39,574	913
% Impervious		**2%**		2%		2%		2%		2%		3%

* Not impervious; included for total area calculation
(Adapted from Table 2-2a in Technical Release 55[30])

[30] USDA NRCS. 1986. Urban Hydrology for Small Watersheds TR-55. Available at https://www.nrc.gov/docs/ML1421/ML14219A437.pdf

2.6.5 Future Development

In consultation with both the Colleton County and Dorchester County Planning Staff, the Project Team created a Future Condition model for the purpose of estimating the increase in future pollutant loads that will result from future development combined with climate change across the Givhans Ferry Watershed, should no additional management measures be implemented. The Future Condition model is a worst-case scenario for development which assumes that any parcel that is zoned for development and not currently in a conservation easement will be built out, as illustrated in **Figure 2-12** and summarized in **Table 2-15**. This scenario is based solely on zoning and does not include NLCD information for vegetated cover except for areas that are protected by conservation easements. **Figure 2-12** helps illustrate the vulnerability of the watershed to future change.

Table 2-15: Givhans Ferry Watershed Future Land Use

WTM Category	Source Scenario	Area (acres)
LDR	Environmental Conservation	13,220
	Institutional/Recreational	27
	Low Density Traditional Neighborhood	3603
	Low Intensity Development	742
	Riparian Corridor	27,149
	Rural Development-1	1,216
	Rural Neighborhood	12,804
	Rural Residential	126
	LDR Total	58,887
MDR	Agricultural (Flex-1)	114
	Medium Density Traditional Neighborhood	845
	Rural Crossroads	818
	Rural Development-2	22,335
	Single Family Residential	93
	MDR Total	24,205
Multifamily	Employment Mixed Use	2,754
	Transit Oriented Development	1,766
	Multifamily Total	4,520
Commercial	Commercial	107
	Community Commercial	103
	Highway Commercial	41
	Light Commercial	37
	Rural Neighborhood Commercial	2
	Town Center	25
	Commercial Total	315
Industrial	Industrial	2
	Light Industrial	2
	Industrial Total	4
Forest	Conserved Areas	10279
Open Water	Water	412

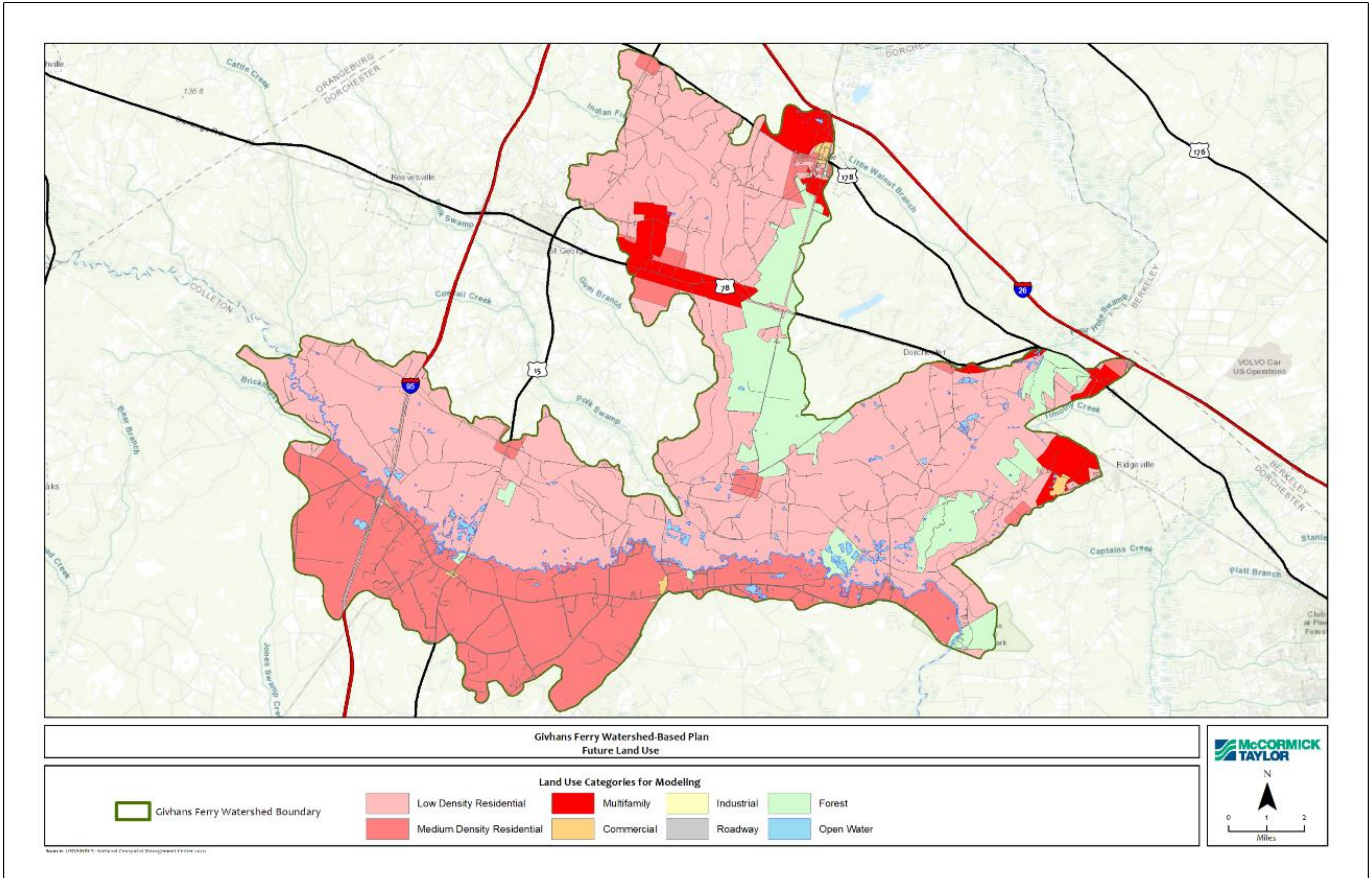

Figure 2-12: Givhans Ferry Watershed Future Land Use Modeling Categories

2.7 Human Wastewater Treatment

2.7.1 Town of Harleyville WWTP

The Town of Harleyville's wastewater collection system currently provides service to 303 customers, consisting of 268 residential and 35 commercial users. The Town's wastewater treatment plant is located at the west end of Range Road, about 500 ft east of the Tom and Kate Branch that feeds into the Edisto River via the Indian Field Swamp as shown in **Figure 2-13.** The plant is currently permitted for 150,000 gpd (0.15 MGD) and the Town is in the process of expanding its WWTF to 225,000 GPD (0.25 MGD). As indicated in recent Discharge Monitoring Reports (DMRs), influent flow frequently approached or exceeded 80% of permitted flow (i.e., 0.12 MGD). Partial funding for the WWTF expansion will be provided through a South Carolina Infrastructure Investment Program (SCIIP) grant.[31]

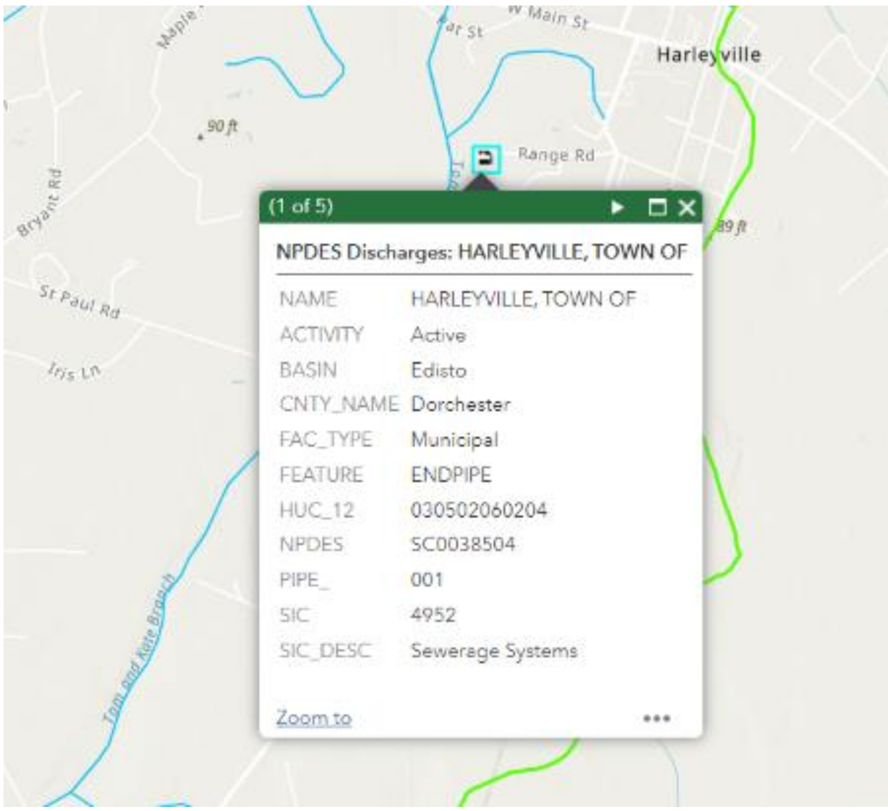

Figure 2-13: Harleyville Wastewater Treatment Plant Location

2.7.2 Onsite Sewage Disposal Systems (OSDS)

The number of residential and commercial parcels within the study area not connected to the Harleyville sanitary sewer system was estimated from GIS information related to proximity to the sanitary sewer lines (Lateral Line, Gravity Main, and Pressurized Main). Parcels that did not have sanitary sewer data within the parcel or within a four-foot distance from the parcel boundary were considered non connected. The Project Team estimates that there are 6,016 residential and commercial buildings that are currently not connected to

[31] https://bcdcog.com/public-notice/

sanitary sewer and thus are assumed to have onsite sewage disposal systems (i.e., septic tanks). The assumed failure rate[32] of these septic systems is 10%. The Project Team also utilized GIS analysis to determine that 462 buildings (8% of total buildings with septic systems) are within 100 feet of a waterway, which could pose a greater threat to water quality in the event of a system failure.

The SCDES Division of Onsite Wastewater provided information regarding the regulatory requirements of septic systems. Regulations require a minimum 6-inch separation from the zone of seasonal saturation and a septic system. Soils evaluations are part of the permitting process, and an inspection is conducted before the OSDS is covered up. Currently, there are no restrictions on the number of systems permitted in a particular area; however, limiting factors include setbacks from property lines, wells, ponds, and other structures as well as the topographical features of the site.

If SCDES is made aware of a malfunctioning system, then there is an enforcement process that could lead to civil penalties if not corrected. Currently SCDES does not offer assistance to have the system repaired. The most common types of septic systems are the conventional trench systems. Because the Department does not regulate or keep records of repairs, it is not possible to estimate the failure rate for systems in this watershed.

2.8 Surface Water Withdrawals/Drinking Water Intakes

2.8.1 Charleston Water System

Charleston Water System, the water utility department serving the areas of Berkeley, Charleston, and Dorchester counties, has a customer base serving a population of 450,000 in the tri-county area. It has two source water supplies, one on the Edisto River and one at the Bushy Park Reservoir, as well as an additional backup source from the Goose Creek Reservoir. The steam pumping station, originally known as Saxon's Station, became the Hanahan Treatment Plant in 1917 and has served the tri-county area since. With several expansions throughout its 100 years of service, the plant currently has a capacity of 115.4 million gallons per day.

CWS-supplied drinking water for the Berkeley, Charleston, and Dorchester tri-county area flows through deep tunnels (**Figure 2-14**) from either the Edisto River from the intake at Givhans Ferry (**Figure 2-15**) or the Bushy Park Reservoir, then into the Hanahan Treatment Plant. Once it arrives at the plant, pH is adjusted and larger impure particles called floc are formed by rapid mixing with aluminum sulfate (alum), a coagulant that helps these impurities stick together. The water then flows into flocculation basins where flow is slowed down. As the flow is slowed down existing floc is given time to grow bigger. From there the water flows into sedimentation basins where these heavier floc particles sink to the bottom and are removed. From here any remaining microscopic particles and microorganisms are cleared as the water travels through large filters made of sand, gravel, and anthracite. Finally, Charleston Water System uses chlorine dioxide and chloramines, a combination of chlorine and ammonia, to protect against bacteria and disinfect water. Fluorine is also added in order to support dental health. Finished water is then stored on site until distribution in large clear wells. The clean water is then pumped into a distribution system where it is delivered through 1,800 miles of pipe network to more than 110,000 homes and businesses in the tri-county area.

[32] EPA. 2002. Onsite Wastewater Treatment Systems Manual. https://nepis.epa.gov/Adobe/PDF/30004GXI.pdf

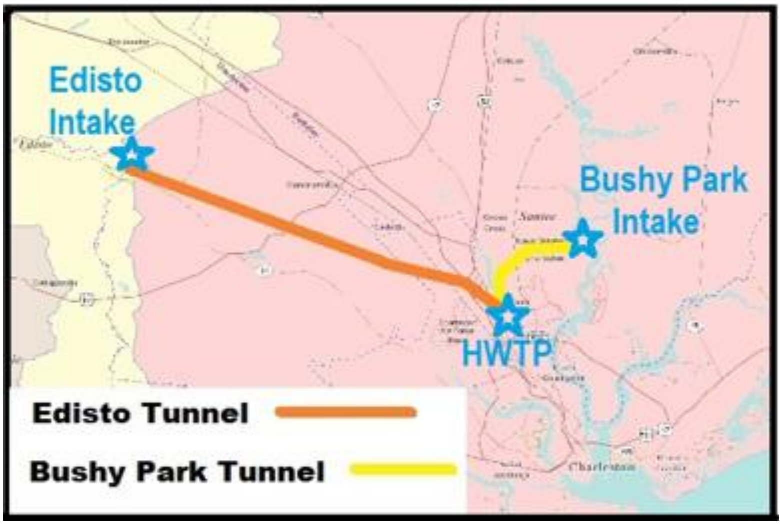

Figure 2-14: Location of CWS intakes, tunnels, and water treatment plant[33]

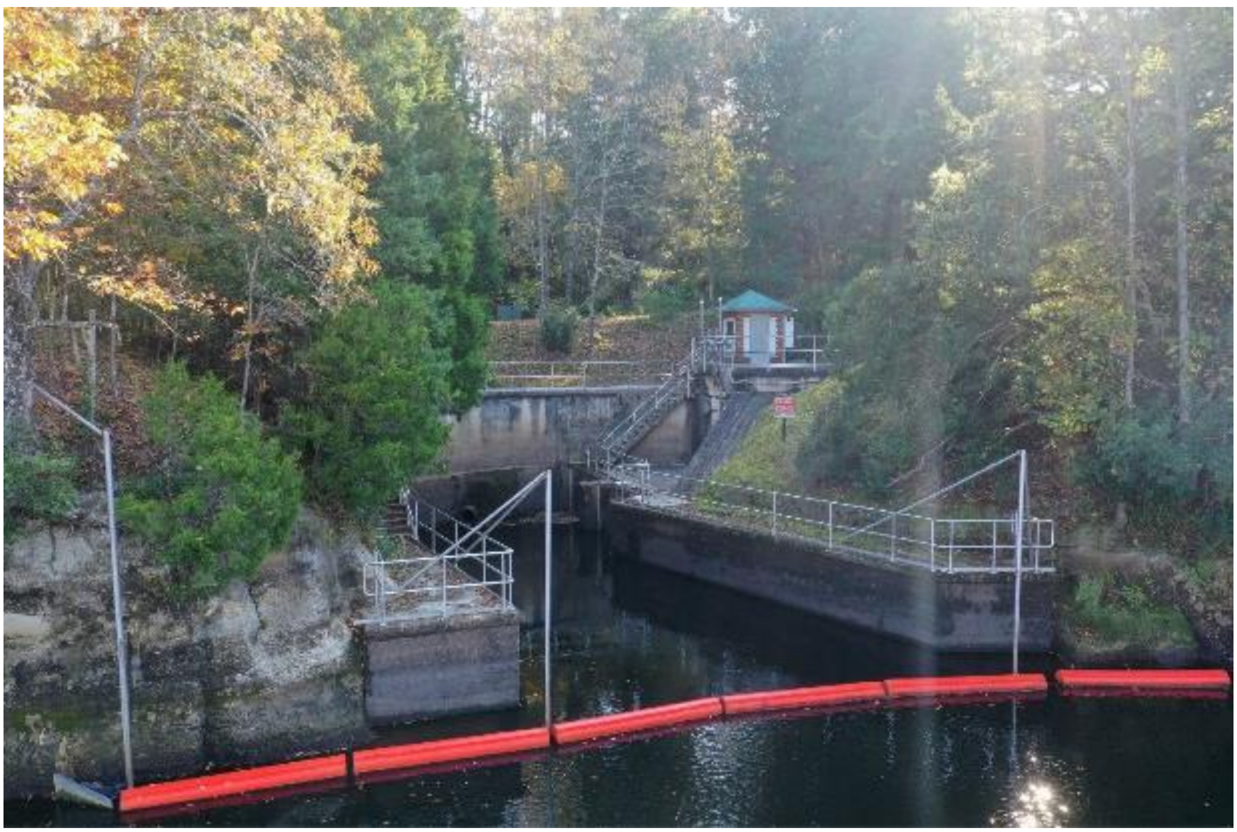

Figure 2-15: Givhans Ferry Source Water Intake[34]

[33] Provided by Jason Thompson, Charleston Water System
[34] Provided by Jason Thompson, Charleston Water System

Figure 2-16: Hanahan Water Treatment Plant (source Charleston Water System) [35]

2.9 Stakeholder Input

Throughout the planning process, stakeholders representing varied interests and backgrounds were solicited for input on multiple topics related to the study area: existing conditions within the watershed; provide pertinent data; conservation, historical and cultural priorities; current and future land uses; climate change considerations; possible pollution sources and environmental/water quality concerns; and to identify projects and activities to address those concerns. The project team worked with stakeholders to learn not only what most concerned them about their watershed, but also what they wanted preserved about their watershed - and the ways they, their colleagues, and neighbors suggest the watershed (and water quality) could be protected and improved. Interested parties were also provided with an opportunity to review the draft plan and provide comments that were considered and incorporated into the final document.

Both the large size (99,557 acres) and the predominantly rural nature of the study area presented unique challenges to convening stakeholders within the watershed. We were concerned that meetings would be poorly attended if they were held in locations that were not convenient for most of the identified parties. Another interesting challenge we faced was that the stakeholders who live in the watersheds included in the study area are not actually served by (i.e., are not customers of) the drinking water source this plan is intending to address. Most are served by private wells. Few are served by other public/municipal systems (not Charleston Water System).

The solution was to use a combination of smaller in-person meetings in the watershed and also provide a publicly accessible webmap to facilitate documentation of additional concerns and comments.

[35] Source: Water Treatment Process available at https://www.charlestonwater.com/149/Water-Treatment

2.9.1 Stakeholder in-Person Meetings

Instead of attempting to convene multiple stakeholder groups and hosting meetings across the watershed, the project team instead chose to host one-on-one meetings with interested stakeholders over the course of the grant period. At the chosen convenience of the individual stakeholder or stakeholder group, these meetings were held virtually, in person, by telephone and via email correspondence as summarized in **Table 2-16**. In hindsight, it is our opinion that these more personal meetings allowed each of the individual representatives and stakeholder groups to better engage, more freely share their knowledge and openly express their concerns for issues within the watershed than perhaps they might have if the meetings had been held as large group meetings.

The success of a watershed-based plan ultimately depends on the participation and commitment from community members, residents, municipal jurisdictions, agencies – those who live, work, and have a vested interest in the watershed, THEIR watershed. Stakeholders from the study area helped identify concerns and priorities, shape this plan's goals, provide input on the webmap, and provide guidance in developing the recommended strategies. Their continued support is critical to implementing those identified strategies and implementing the meaningful projects and practices that have been recommended as part of this planning effort.

Table 2-16: Summary of Participating Stakeholder Input

Organization / Individual Stakeholder	Meeting/ Engagement format	Interests and Concerns
Charleston Water System	Virtual	• CWS owns and operates the source water intake located on the Edisto River in Givhans Ferry • Helped develop the Edisto River Basin to ensure water quantity availability for all uses and protection of resource • Concerns include lack of stormwater pond management/maintenance, sand pits causing turbidity events, and runoff from livestock areas • Goals for WBP include limiting impervious area, limiting erosion, identify areas to limit nutrient and bacteria runoff
Dorchester County	Virtual, Email	• Concerns that borrow pits may impact well water • Most neighborhoods are on septic systems • No known issues with poultry farms/litter application • County stormwater master plan does not include modeling for this watershed • Plans for a new county park (in partnership with Audubon) along Wire Road. Plans for rain gardens, educational signage.

Organization / Individual Stakeholder	Meeting/ Engagement format	Interests and Concerns
Colleton County	Virtual, Email	• Rural watershed without much infrastructure • Most residences on septic systems • Flood vulnerable properties • Conservation areas
Carolinas Integrated Sciences and Assessments (CISA)	Virtual, Email	• Provided climate analysis for previous WBPs as well as for the SC Office of Resilience
South Carolina Audubon	In person (watershed tour), Email	• Sand mines disrupt existing hydrology and may dry out adjacent wetlands • Necessity for long term monitoring: water level, macroinvertebrates • Encourage more local landowners to put property – especially those along streams and river – into conservation easements
Clemson Extension/Carolina Clear	Virtual	• Clemson Be Septic Safe program involves educating realtors and homeowners • Clemson Healthy Pond Conference provides education and training for pond owners and maintenance contractors • Carolina Yards class teaches homeowners about sustainable landscape practices (responsible use of fertilizers, plating native vegetation, managing stormwater on site) • Clemson Stream Bank Repair program provides resources for homeowners and installs projects (mostly on public property) • Extension agents available in Dorchester and Colleton Counties; however, only Dorchester County has contract with Carolina Clear to do public outreach/education for MS4 requirements
The Nature Conservancy	Virtual, Email	• TNC resilient and connected land analysis identifies high priority conservation/resilience properties • TNC Nature-Based Exchange
Charles Lane, Stakeholder	Phone	• Concerned about threat from future development • Urban sprawl is impetus for protecting land along the Edisto River and Four Holes Swamp • Farm loss in SC is catastrophic (14% of state land left); need to support small scale sustainable agriculture

Organization / Individual Stakeholder	Meeting/ Engagement format	Interests and Concerns
Mac Baughman, Stakeholder/Property Owner	Virtual	• Septic tanks may not have been installed up to standards; maintenance upkeep is a problem • Areas without buffer on Edisto are vulnerable to fertilizer and pesticides in runoff • Not aware of any issues with chicken farms • Loss of N. Charleston paper mill leaves forested land vulnerable. The closest mills are in Georgetown, Eastover, or Savannah. Forest management is a way to earn extra income, and people cannot afford to just hold on to land. As a result, they may sell for development. • State conservation bank and local land trusts provide education and funding opportunities for landowners • Sand mining can cause turbidity issues in streams and rivers. There has been a problem with one mine dewatering its settlement pond into the Edisto River. It takes a long time for fine sediments to settle out of water, and may impact fishery in river • Brownfields are a concern (examples: Showa Denko Carbon and Dominion Energy at Canadys) • Litter pickup is important because residents are limited by the number of convenience sites that accept electronic waste, commercial truck tires. Additionally, there should be sites open on Sundays to accommodate working families.
Edsel Taylor, Stakeholder/Property Owner	Virtual	• Family has lived around Four Holes Swamp for generations and have put conservation easements on property • Concerned about potential for pollution to leach out of the Oak Ridge Landfill, and the proximity of the landfill to multiple bald eagle nests • Litter floats down the swamp onto his property • Concerned about major developments being established in the upstream reaches of Timothy Creek near I-26 (outside of Givhans Ferry Watershed, drains directly into it). Observed cloudy water in the creek due to construction.

Organization / Individual Stakeholder	Meeting/ Engagement format	Interests and Concerns
Givhans Ferry State Park	Virtual	• Erosion along Hwy 61/Givhans Ferry Road • Clogged ditches along Givhans Ferry Road that need to be cleared • Limestone bluffs in the Park are protected SCDNR heritage trust site for endangered species • Potential for demonstration rain garden/stormwater wetland to be installed on site with educational signage
Colleton State Park	Email	• Multiple areas along the river's edge have been eroding; working with resource management team to restabilize areas naturally • Not aware of any problems associated with livestock or brownfields
Edisto Natchez-Kusso Tribe	In person (Tribal Council Meeting)	• Importance of access to river for religious ceremonies and fishing • noted observations of deformed fish (tumors) downstream of SCE&G/Dominion ash ponds • areas on reservation are prone to flooding during heavy rainfall events
Dorchester Soil and Water Conservation District	In person (Board Meeting)	• No known issues with livestock operations; these are usually permitted and required to meet certain treatment standards (with associated mandatory monitoring)
Town of Harleyville	Email	• Working on updates/expansion of existing wastewater treatment plant (the only WWTP in the Givhans Ferry Watershed)
Friends of the Edisto	Email	• Important to keep water clean and safe for recreation

2.9.2 Stakeholder Webmap Input

The project team utilized a webmap[36] as a tool to record observations and engage stakeholders in the watershed, as illustrated in **Figure 2-17**. The tool allowed users to place color-coded points, lines, and polygons to indicate different features or concerns within the watershed, such as erosion problems, stormwater BMPs, recreational areas, farms, and large impervious areas. Additionally, areas notable for their amount of pet waste and those containing excessive litter were also highlighted. The user could also include notes and/or pictures with each entry.

Table 2-17 summarizes the data collected in the webmap. The total number of responses was 52, with three responses for locations outside of the watershed. The most frequent response was "other" and included responses such as locations of farm animals and septic systems.

Table 2-17: Summary of Stakeholder Responses

Type	Count	Examples	Stakeholder Concern
Brownfields	9	• Sundaran Clayton • Showa Denko Carbon/Resonac • Oak Ridge Landfill • Argos USA Cement Plant • Sandy Pines Convenience Center • Grover Convenience Site • SCE&G Ash Pond	• Perceived water quality threats from seepage/runoff from industrial sites and waste disposal areas. • Although not currently active, stakeholders remember finding deformed fish downstream of the Ash Pond
Conservation Areas	6	• Brosnan Forest • Private property conservation easements • Ducks Unlimited conservation easement • Way Tract (Timothy Creek) • Future Dorchester County Park/Audubon protected land on former sand mine	• Goals to protect properties adjacent to waterways for wildlife, native vegetation, and water quality • Desire to limit future development encroaching on ACE Basin • Concern of impact sand mining will have on local hydrology; potential to dry out surrounding wetlands
Livestock/ Animals	17	• Identified small hobby farms with horses, cows, and goats • Identified larger poultry houses • Identified fields used for crops • Bee City Zoo & Honey Bee Farm	• Potential source of bacteria (from feces) and sediment (from livestock access to streams/disturbance of stream banks) in surface water

[36] Givhans Ferry stakeholder web map available at https://mtgis.maps.arcgis.com/apps/webappviewer/index.html?id=55dcd898500c4d2a876607c69b2f6caf

Type	Count	Examples	Stakeholder Concern
Flooding	5	• Culvert near Givhans Ferry Park does not drain well • Spring Road covered with water; adjacent forest is drowned out • Powder Horn Road (Halfway Gut Creek crossing) floods • Area near Cornelia Ann Road floods	• Potential for flood waters to carry pollutants into receiving waters as well as upland areas • Potential to increase septic tank failures • Impaired abilities for transportation
Septic System Issues	1	• New septic system installations at end of Pine Bluff Rd (near Edisto River)	• Potential for failure in areas in the floodplain
Recreation Areas	7	• Palmetto Mudway • Patridge Creek Gun Club • Colleton State Park • Givhans Ferry State Park • Future Dorchester County Park • Messervy Boat Landing • Mars Oldfield Landing	• Public access to water is important for recreation, fishing, and religious ceremonies • Some uses of land may have unintended consequences for water quality and wildlife
Litter	1	• Litter along Hwy 15	• Needs to be cleaned up and prevented from happening again
Other	3	• New fire station • Indian Field Swamp • Edisto Natchez-Kusso tribal headquarters	

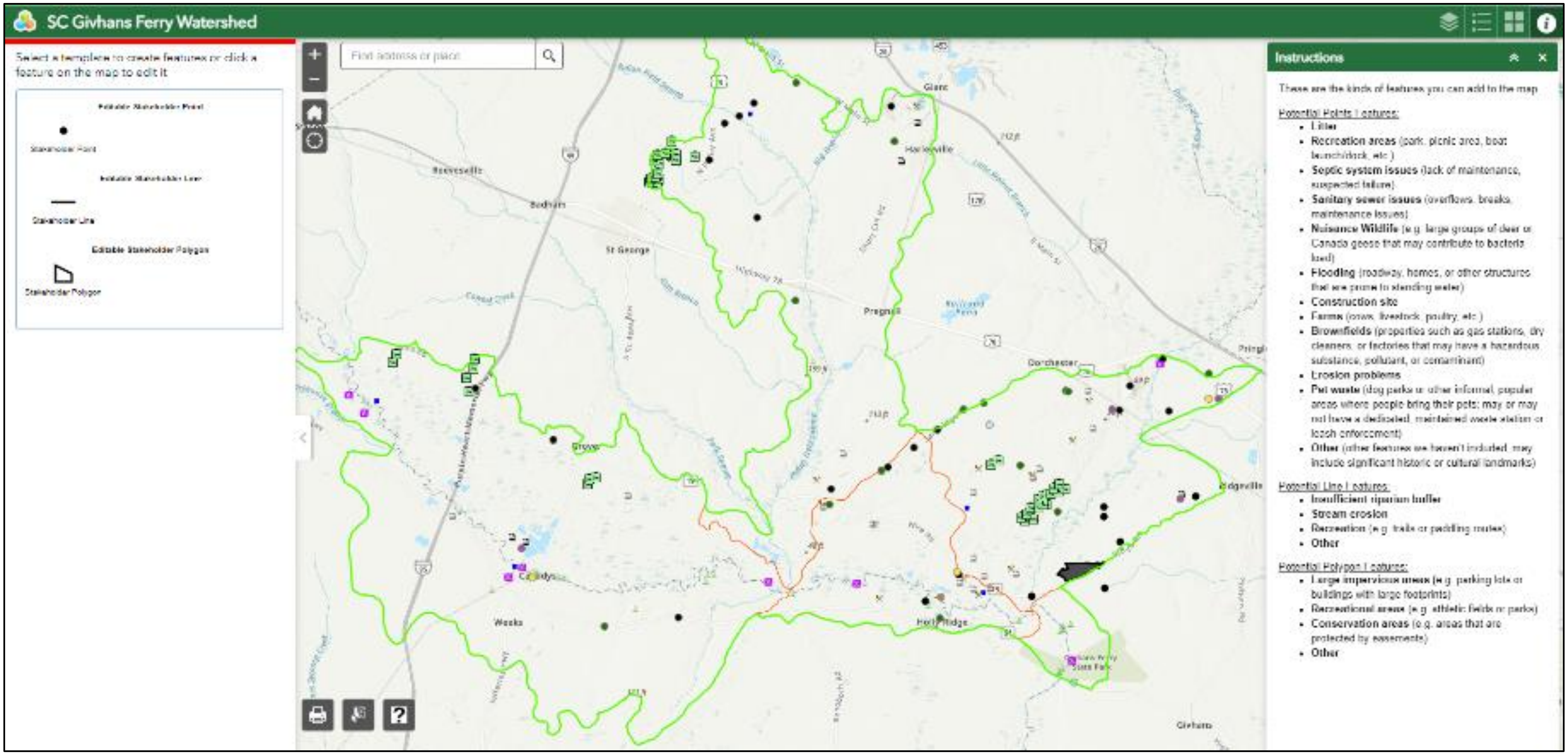

Figure 2-17: Screenshot of Givhans Ferry Watershed Stakeholder Webmap

3.0 In-Stream Water Quality Monitoring

3.1 Use Designations and Classifications

State water quality standards are determined based on the water use classification for each waterbody. Water use classifications are based on the desired uses of a waterbody and not necessarily the actual water quality. Classifications are used to determine permit limits for point source discharge facilities that are regulated by National Pollutant Discharge Elimination System (NPDES) permits. This also means that waterbodies can be reclassified if the desired or existing use justifies reclassification. The tributaries and lakes in the Givhans Ferry Watershed are all freshwater (FW) and are defined by SCDES in R.61-68 (2014):

Freshwaters (FW) are freshwaters suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of 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.

In addition to water-use classifications, the state has four "use support" designations:

1. Aquatic Life Use Support (AL) – based on the composition and functional integrity of the biological community.
2. Recreational Use Support (REC) – the degree to which a waterbody meets fecal coliform bacteria water quality standards. Waters that have fecal coliform excursions in greater than 25% of samples are considered non-supporting of recreational uses.
3. Fish Consumption Use Support (FISH) – a risk-based approach is used to evaluate fish tissue data and to issue consumption advisories.
4. Drinking Water Use Support (DW) – nonattainment occurs when the median concentration (based on a minimum of three samples) for any pollutant exceeds the appropriate drinking water Maximum Contaminant Level (MCL).

3.2 Antidegradation Rules

The SC Regulation R.61-68, Water Classifications and Standards, details the State's antidegradation rules. Antidegradation rules provide a minimum loss of protection to all waters of the State and include conditions under which water quality degradation is allowed. The State's antidegradation rules require existing uses to be maintained and water quality be protected regardless of the water's classification. Conditions under which water quality degradation is allowed that apply to the Givhans Ferry Watershed include:

- Existing uses and water quality necessary to protect uses may be affected by instream modifications as long as the stream flows protect classified and existing uses and water quality supporting these classified uses is consistent with riparian rights to reasonable use of water.
- Benefits the people and economy of an area where water quality would remain adequate to fully protect existing and classified uses; and
- Natural conditions cause a depression of dissolved oxygen (DO).

3.3 Numeric and Narrative Criteria

Water quality standards for waters classified as freshwater are listed in **Table 3-1**.

Table 3-1: Freshwater Water Quality Standards in the State of South Carolina (R. 61-68)

Parameter	Standard
(a) Garbage, cinders, ashes, oils, sludge, or other refuse	None allowed
(b) Treated wastes, toxic wastes, deleterious substances, colored or other wastes, except those given in (a) above	None alone or in combination with other substances or wastes in sufficient amounts to make the waters unsafe or unsuitable for primary contact recreation or to impair the waters for any other best usage as determined for the specific waters which are assigned to this class.
(c) Toxic pollutants listed in the appendix	As prescribed in Section E of this regulation
(d) Stormwater, and other nonpoint source runoff, including that from agricultural uses, or permitted discharge from aquatic farms, concentrated aquatic animal production facilities, and uncontaminated groundwater from mining	Allowed if water quality necessary for existing and classified uses shall be maintained and protected consistent with antidegradation rules.
(e) Dissolved oxygen	Daily average not less than 5.0 mg/l with a low of 4.0 mg/1.
(f) *E. coli*	Not to exceed a geometric mean of 126/100 ml based on at least four samples collected from a given sampling site over a 30-day period, nor shall a single sample maximum exceed 349/100 ml.
(g) pH	Between 6.0 and 8.5
(h) Temperature	As prescribed in E.12 of this regulation
(i) Turbidity (except for Lakes) Lakes only	Not to exceed 50 NTUs provided existing uses are maintained. Not to exceed 25 NTUs provided existing uses are maintained.

3.4 Historic Water Quality Sampling Data

Water quality monitoring stations in the Givhans Ferry Watershed are shown in **Figure 3-1**. Historic monitoring was conducted over varying time periods from 1999-2021 by SCDES at several stations throughout the watershed. As part of this watershed-based plan, water quality data from Charleston Water System that was collected at their Edisto intake from 2001-2023 was also used in conjunction with SCDES data. A summary of available water quality data is contained in **Table 3-2**, and the corresponding explanation of abbreviations is listed in **Table 3-3**. **APPENDIX A: Water Quality Monitoring Data** contains summary graphs of the nutrient (TN and TP), turbidity, organic matter, and bacteria (FC and *E. coli*) for the watershed area.

Table 3-2: Water Quality Monitoring Locations in Givhans Ferry Watershed

Station	Subwatershed	Organization	Measured Parameters	Time Period
E-014*	Skull Branch-Edisto River	SCDES	AD, ALK, AMM, BOD, CA, CD, CR, CU, DEPTH, DO, FC, HARD, FE, TKN, NO2/NO3, MG, MN, PB, PH, HG, NI, TN, TOC, TP, TEMP, TSS, TURB, ZN	May 2000 - Jul 2019; Periodically for each Parameter
E-015*	Deep Creek-Edisto River	SCDES	AD, ALK, AMM, BOD, CA, CD, CR, CU, DEPTH, DO, FC, HARD, FE, TKN, NO2/NO3, MG, MN, PB, PH, HG, NI, TN, TOC, TP, TEMP, TSS, TURB, ZN	Jan 1999 - Jul 2020; Periodically for each Parameter
E-015A	Halfway Gut Creek - Four Hole Swamp	SCDES	ALK, AMM, BOD, CA, CD, CR, CU, DEPTH, DO, ECOLI, FC, HARD, FE, TKN, NO2/NO3, MG, MN, PB, PH, HG, NI, TN, TOC, TP, TEMP, TSS, TURB, ZN	Jan 2001 - May 2022; Periodically for each Parameter
E-032	Lower Indian Field Swamp	SCDES	ALK, AMM, BOD, CA, CD, CR, CU, DEPTH, DO, ECOLI, FC, HARD, FE, TKN, NO2/NO3, MG, MN, PB, PH, HG, NI, TN, TOC, TP, TEMP, TSS, TURB, ZN	Feb 2001 - Dec 2021; Periodically for each Parameter
E-086	Skull Branch- Edisto River	SCDES	ALK, AMM, BOD, CA, CD, CR, CU, DEPTH, DO, ECOLI, FC, HARD, FE, TKN, NO2/NO3, MG, MN, PB, PH, HG, NI, TN, TOC, TP, TEMP, TSS, TURB, ZN	Jan 1999 – Dec 2021; Periodically for each Parameter
*E-100[a]	Halfway Gut Creek – Four Hole Swamp	SCDES	ALK, AMM, BOD, CA, CD, CR, CU, DEPTH, DO, FC, HARD, FE, TKN, NO2/NO3, MG, MN, PB, PH, HG, NI, TN, TOC, TP, TEMP, TSS, TURB, ZN	Jan 1999 – August 2008; Periodically for each Parameter
E-116	Halfway Gut Creek – Four Hole Swamp	SCDES	ALK, BOD, CA, CD, CR, CU, DEPTH, DO, ECOLI, HARD, FE, TKN, NO2/NO3, MG, MN, PB, PH, HG, NI, TN, TP, TEMP, TSS, TURB, ZN	Jan 2019 – Dec 2021; Periodically for each Parameter
E-597	Lower Indian Field Swamp	SCDES	No data available	
E-601	Poorly Branch-Edisto River	SCDES	Fish tissue data only	
RS-10373*	Lower Indian Field Swamp	SCDES	ALK, AMM, BOD, CA, CD, CR, CU, DO, FC, HARD, FE, TKN, NO2/NO3, MG, MN, PB, PH, HG, NI, TN, TP, TEMP, TSS, TURB, ZN	2010 (monthly), 2019 (quarterly); Parameter Dependent
RS-14179	Poorly Branch-Edisto River	SCDES	ALK, AMM, BOD, CA, CD, CR, CU, DEPTH, DO, ECOLI, FE, TKN, NO2/NO3, MN, PB, PH, HG, NI, TN, TP, TEMP, TURB, ZN	2014 (monthly and quarterly); Parameter Dependent
RS-16315	Skull Branch- Edisto River	SCDES	ALK, AMM, BOD, CA, CD, CR, CU, DEPTH, DO, ECOLI, HARD, FE, TKN, NO2/NO3, MG, MN, PB, PH, HG, NI, TN, TP, TEMP, TURB, ZN	2016 (monthly and quarterly); Parameter Dependent
Edisto Intake[b]	Deep Creek- Edisto River	CWS	ECOLI, TOC, TURB	Jan 2001 – March 2023 (weekly)

*no *E. coli* sampling at this station; historic data included FC only

[a]Site is located on boundary edge of HUC-12 watershed, thus monitoring data is more relevant to upstream watershed (Santee Branch – Four Hole Swamp)

[b]CWS has many more measured parameters; these are the only data utilized for the WBP

Table 3-3: Summary of Water Quality Monitoring Parameters in Givhans Ferry Watershed

Parameter	Name	Units	Quality Standards for Freshwaters
AD	= aldrin	mg/kg	
ALK	= alkalinity	mg/L	
AMM	= ammonia	mg/L	
BOD	= biochemical oxygen demand	mg/L	
CA	= calcium	mg/L	
CD	= cadmium	mg/L	
CR	= chromium	mg/L	
CU	= copper	mg/L	
COLOR	= color	PCU	
DEPTH	= depth	m	Depth of water sample = 0.3 m
DO	= dissolved oxygen	mg/L	Daily avg. > 5.0 mg/L
ECOLI	= *Escherichia coli*	#/100mL	Monthly avg. <126 MPN/100mL; Single sample <349 MPN/100mL
FC	= Fecal coliform	#/100mL	TMDLs converted to *E. coli*
FE	= iron	mg/L	
HARD	= total hardness	mg/L	
HG	= mercury	mg/L	
MG	= magnesium	mg/L	
MN	= manganese	mg/L	
NI	= nickel	mg/L	
NO2/NO3	= nitrite/nitrate	mg/L	
OP	= orthophosphate	mg/L	
PB	= lead	mg/L	
PH	= pH		Between 6.0 and 8.5
TEMP	= temperature	deg C	
TKN	= total Kjeldahl nitrogen	mg/L	
TN	= Total Nitrogen	mg/L	*0.69 mg/L
TOC	= total organic carbon	mg/L	MCL dependent on Treatment Technique
TP	= total phosphorus	mg/L	*36.56 µg/L (0.03656 mg/L)
TSS	= total suspended solids	mg/L	
TURB	= turbidity	NTU	< 50 NTUs for streams
ZN	= zinc	mg/L	

*At the time of publishing this WBP, there are no numeric criteria for nutrients in streams and rivers in South Carolina. Values for recommendations provided by EPA[37]

[37] EPA. 2000. Ambient Water Quality Criteria Recommendations. Information Supporting the Development of State and Tribal Nutrient Criteria for Rivers and Streams in Nutrient Ecoregion IX. https://www.epa.gov/sites/default/files/documents/rivers9.pdf

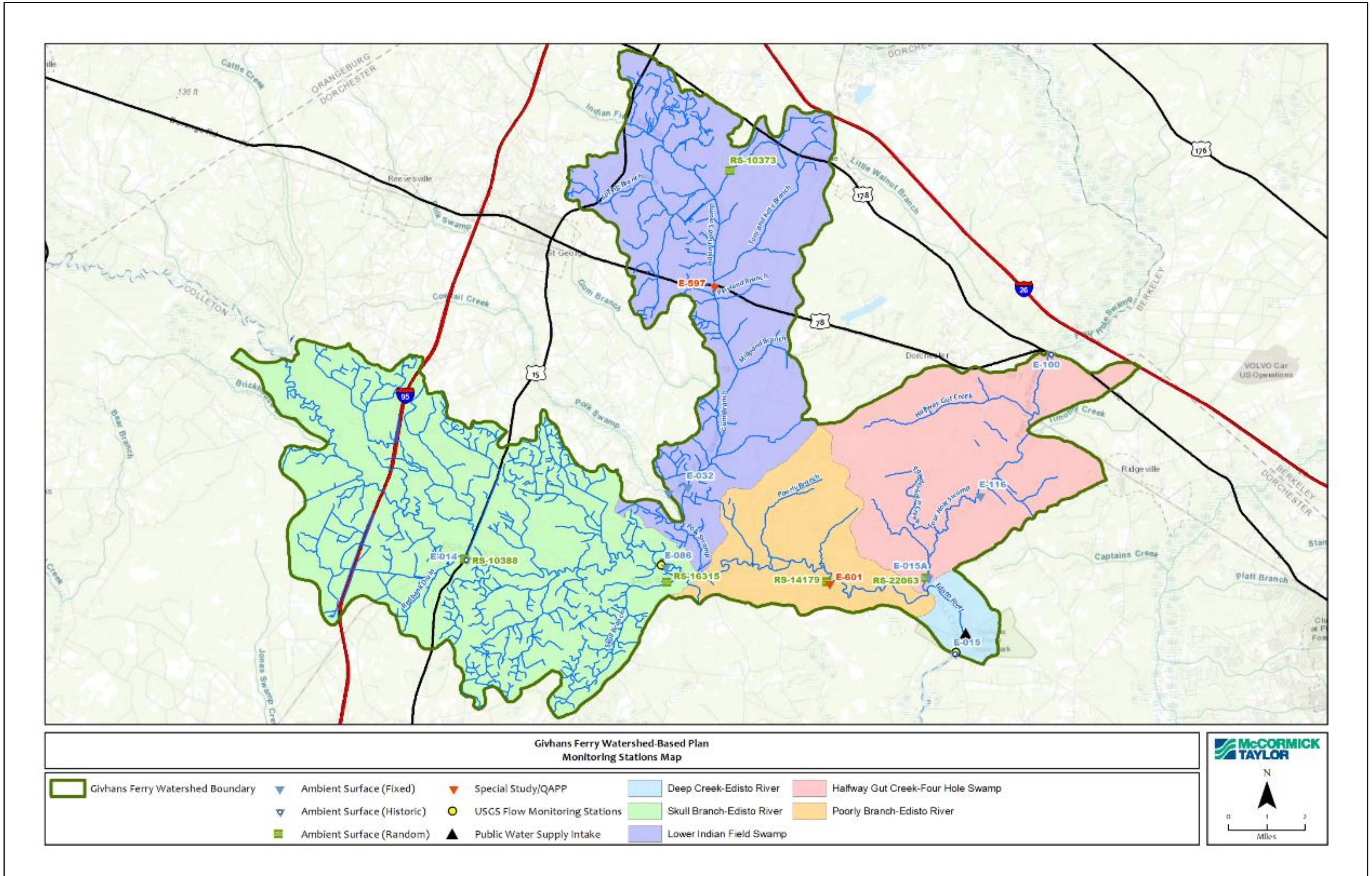

Figure 3-1: Water Quality Monitoring Locations in Givhans Ferry Watershed

3.5 Impaired Waters

Waterbodies that do not meet these designated uses are "impaired" and identified by the state in accordance with the Federal Clean Water Act Section 303(d), known as the "303(d) list." The 303(d) list is updated every two years by SCDES. The current 2022 303(d) list[38] includes 6 SCDES monitoring stations in the Givhans Ferry Watershed, as summarized in **Table 3-4** and shown in **Figure 3-2**. It is important to note that low dissolved oxygen is not an abnormality but is a common occurrence in blackwater systems.[39] Most species that live in these types of systems are also adapted and suited to this type of habitat. Some human activities, such as deforestation and impounding of waters, can exacerbate low dissolved oxygen levels. Several stations, including E-601, are impaired for mercury. Although this WBP does not address mercury, stakeholders from the Edisto Natchez-Kusso tribe expressed concerns about the safety of eating fish caught downstream of industrial sites, such as the retired SCE&G coal-fired power plants. Usually, mercury originates from air sources that are then deposited in waterbodies.

The state uses the 303(d) list to target waterbodies that need to be restored to meet water quality standards. Generally, a total maximum daily load (TMDL) is developed for waters identified on the 303(d) list. A TMDL is the calculation of the maximum amount of a pollutant that is allowed to enter a waterbody so that the waterbody will meet its water quality standards for a particular pollutant. A TMDL must include both point and nonpoint sources of pollution and some margin of safety. There are three TMDL monitoring stations within the watershed that are listed as not supported for their designated uses. Two (E-032 and RS-10373) are located in Indian Field Swamp, which has a TMDL for FC[40]. The TMDL reduction goal for this watershed is 60% for intermittent sources, including current and future MS4, construction, and industrial discharges. The third monitoring station (E-100) is non-supporting for *E. coli* and although the monitoring station falls within the boundary for Halfway Gut Creek, it is located at the headwaters of this watershed and is more reflective of the upstream HUC-12 watershed that is not within the project area for the Givhans Ferry WBP. E-100 is within a TMDL for the Lower Four Hole Swamp[41] and probable sources of bacteria include direct and indirect loading from livestock, failing septic systems, surrounding wildlife, and other agricultural activities.

[38] SCDES. 2022. South Carolina 303(d) List of Impaired Waters & TMDLs. Available https://des.sc.gov/programs/bureau-water/south-carolina-303d-list-impaired-waters-tmdls
[39] Lorianne Riggin, Director of Environmental Program SCDNR. Personal communication, September 23, 2022.
[40] SCDES. 2006. Total Maximum Daily Load Document Indian Field Swamp. Available at https://des.sc.gov/sites/des/files/docs/HomeAndEnvironment/Docs/tmdl_indianfield_fc.pdf
[41]SCDES. 2020. Total Maximum Daily Load Document Cow Castle Creek, Lower Four Hole Swamp, and Tributaries. Available at https://des.sc.gov/sites/des/files/media/document/Lower%20Four%20Hole%20Swamp%20and%20Tributaries.pdf

Table 3-4: Summary of Impaired Monitoring Stations in Givhans Ferry

Station	Use	Impairment	County	HUC-12	2020 Status
E-015	FISH	MERCURY	COLLETON	Deep Creek	Impaired
E-601	FISH	MERCURY	COLLETON	Poorly Branch	Impaired
E-014	FISH	MERCURY	COLLETON	Skull Branch	Impaired
E-100	REC	E. COLI	DORCHESTER	Halfway Gut Creek	InTMDL (E. COLI)
E-032	AL	DO	DORCHESTER	Lower Indian Field Swamp	Impaired (DO) InTMDL (FC)
RS-14179	AL	DO	COLLETON	Poorly Branch	Impaired
RS-10373	AL	DO	DORCHESTER	Lower Indian Field Swamp	WnTMDL (FC) WOC (PB)

AL = aquatic life; DO = dissolved oxygen

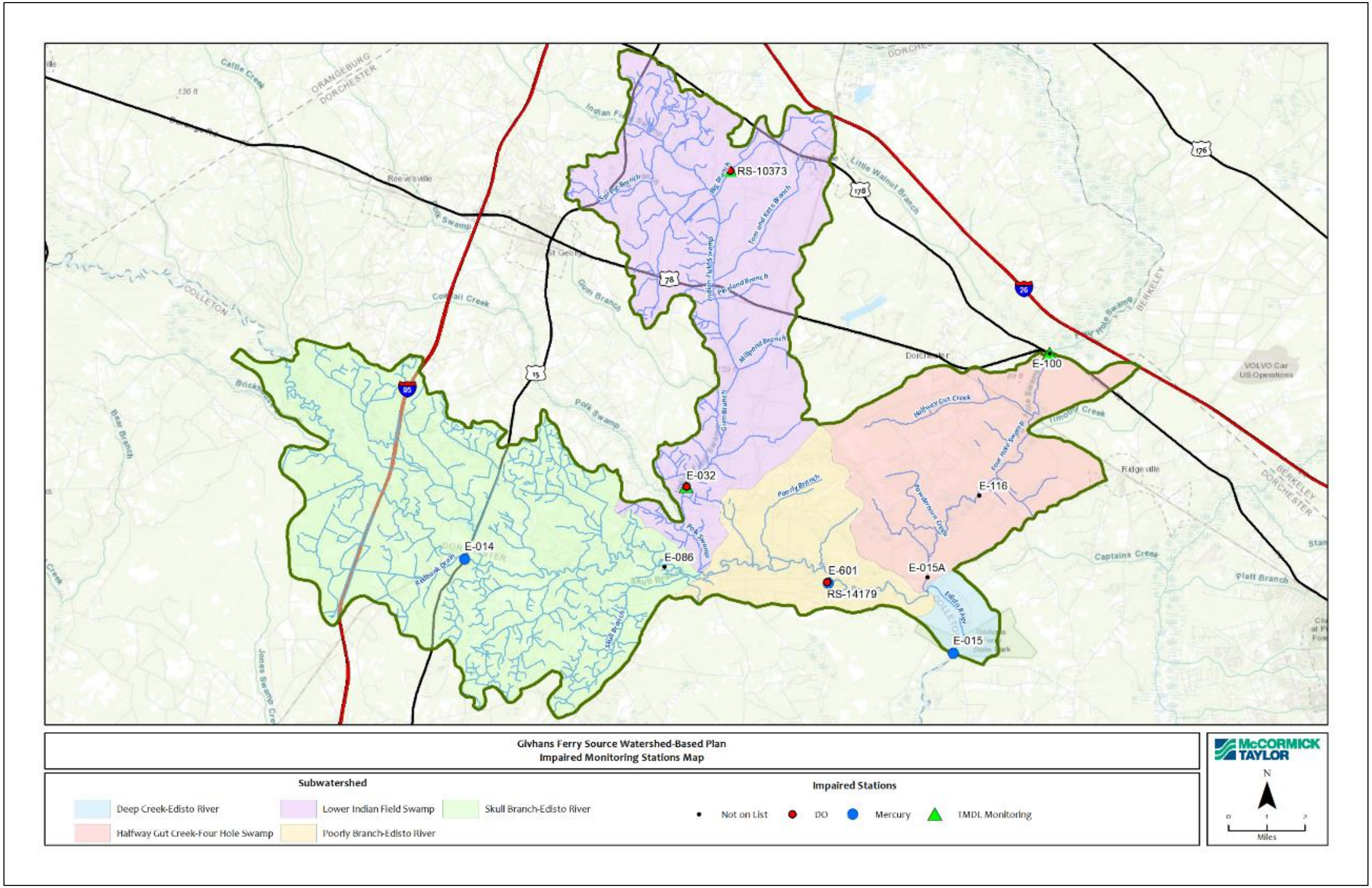

Figure 3-2: Impaired Monitoring Stations (2022) in Givhans Ferry Watershed

4.0 Pollutant Source Assessment

Potential sources of pollutants are discussed in the following sections based on review of available data and information. Sources of nutrients, sediment, metals, bacteria, and other pollutants are considered in relation to where these sources may occur in the watershed and the potential impacts they may have on water quality (for both public drinking water and recreation) and aquatic life.

4.1 Summary of Scenarios for WTM Analysis

In order to evaluate the pollutant sources and associated annual TN, TP, TSS, and bacteria loads, three scenarios were evaluated in the WTM: Current Condition, Future Condition, and Recommended Condition. The Current Condition is a representation of existing factors, such as land use, management practices, and precipitation. The Future Condition analyzes pollutant loads that will result from future development and climate change across the study area if no additional management measures are implemented. The Recommended Condition includes structural and nonstructural management practices to reduce pollutant loads identified in the Current Condition Scenario; examples include recommendations for stream restoration, septic system maintenance/repair, and education programs for pet waste and septic systems. A summary of the input variables for WTM are summarized in **Table 4-1**. Please note that the WTM calculates bacteria loads in terms of FC (as reflected in the FC loading rates below). To reflect the current water quality standard, all FC loads calculated in WTM were converted to *E. coli* by multiplying the WTM loads by 0.8725.[42]

[42] Fecal coliform values can be converted to *E. coli* values using a standard conversion factor of 0.8725, that represents the ratio of 349/400. 349 is the water quality standard (WQS) for *E. coli* and 400 the WQS for fecal coliform.

Table 4-1: Givhans Ferry Watershed WTM Scenarios

Variable	Current	Future	Recommendation
Annual Precipitation	50.7” (mean)	66.7” (95th percentile)	50.7” (mean)
Dwelling Units	3,383	19,027	3,383
Buffer Length	varies	Same as Current	Additional 91 miles of 50 ft wide
Land Use	2019 NLCD + Zoning	Dorchester County FLU + Colleton Zoning	2019 NLCD + Zoning
Residential FC loading (MPN/100mL)	9,000	15% increase (10,350)	9,000
Commercial FC loading (MPN/100mL)	3,000	15% increase (3,450)	3,000
Roadway & Industrial FC loading (MPN/100mL)	2,000	15% increase (2,300)	2,000
Unsewered Dwelling Units	3,080 (91%)	18,076 (91%)	3,080 (91%)
Unsewered Dwelling Units within 100ft of waterway	210 (7%)	1,446 (8%)	210 (7%)
OSDS base failure rate	10%	10%	10%
Miles of sanitary sewer	14.3	14.3	14.3
Volume per SSO overflow (gallons)*	2,000	2,000	2,000
Pet Waste Education	Yes, 40% awareness	Yes, 40% awareness	Yes, 40% awareness
Stormwater BMPs Capture discount Design discount Maintenance discount	 80% 1.0 0.6	 80% 1.0 0.6	 80% 1.0 0.6

*Assumed value based on county average spill size. No available spill information for the Harleyville WWTP system on the SCDES SSO database. Utilities are only required to report overflows of 500 gallons or more[43]

4.2 Land Use Nonpoint Sources

The purpose of this section is to make a distinction between sources of nonpoint pollution that are directly linked to human waste (Sanitary Sewer Overflows and Septic Systems, **Section 4.3**) and those that are related to other uses of the land (such as agriculture and suburban development). The focus of the analysis was on the current condition of the watershed. These values were calculated using the WTM Existing Conditions, which reports bacteria as fecal coliform. Those values were converted to *E. coli* – the current water quality standard – by multiplying FC values by 0.8725.

[43] SCDES. 2023. Wastewater (Sewer) Overflows. Available at https://des.sc.gov/programs/bureau-water/wastewater/wastewater-sewer-overflows

4.2.1 Agriculture

Livestock

Livestock production can lead to increased pollutant concentrations in downstream waterbodies. Where livestock have unlimited access to streams, animals may contribute fecal matter directly to streams and cause severe disturbance to stream banks. Runoff from livestock facilities (pasture, paddocks, manure storage areas, etc.) can introduce sediment, nutrients, bacteria, and toxins to surface waters – all of which can pose a direct threat to water quality at the downstream public water intake. The Forest and Agriculture (FA) district zoning classification in Dorchester and Colleton Counties exists to "conserve, sustain, and protect agricultural areas" but does not appear to have limitations on numbers of animals.

Figure 4-1: Observed Cows in the Givhans Ferry Watershed[44]

GIS shapefiles related to SCDES livestock permit information were obtained from the SCDES GIS Clearinghouse[45] and showed that there are a total of 48 SCDES Regulated Permits for Livestock Operations in this area. Note that some permits have multiple structures or uses associated with them; for example, there is one NPDES permit for Burns Poultry and that covers one building, two burial locations, and six manure utilization areas. However, of these 48 total permits, only 15 are listed as *active* in the database. There are two medium-sized poultry operations (Lindsay Grooms Poultry Farm and Burns Poultry, LLC), both located in the Lower Indian Field Swamp subwatershed. There are four poultry burial areas and all are located in the Lower Indian Field Swamp subwatershed as well. The remaining nine permits are for poultry manure utilization areas (MUA), with three located in the Skull Branch subwatershed (36 acres) and six in Lower Indian Field Swamp (74 acres).

SC R.61-43 describes the Standards for Permitting of Agricultural Animal Facilities. Permits[46] issued under this regulation are no-discharge permits and are required for any producer who operates an animal facility where animal manure and other animal by-products are generated, handled, treated, stored, processed, or land-applied. The regulation further stipulates that manure shall not be placed directly in or allowed to come into

[44] Picture provided by Kathryn Ellis

[45] SCDES Geospatial HUB (2024). SC Dept. of Environmental Services. Office of Technology. Available at https://scdes.gov/gis

[46] Available at https://des.sc.gov/sites/des/files/Library/Regulations/R.61-43.pdf

contact with groundwater and/or surface water. Additionally, the Animal Facility Management Plan must establish an application rate for each manure utilization area based on agronomic application rate of the specific crops being grown and the manure/other animal byproducts' impact on the environment.

Based on data from the USDA National Agricultural Statistics Service, Model My Watershed estimates that there are total of 321 cows, 202 horses, 397 sheep, 161,030 chickens, 1,109 pigs, and 4 turkeys for an estimated total of 163,063 livestock animals in the Givhans Ferry Watershed. These numbers are calculated using average animal per farmland acre based on county-level data from the USDA[47] as reported by Model My Watershed. These estimates indicate that Lower Indian Field Swamp had the highest numbers of animals [pigs (431), chickens (63,047), cows (127), and sheep (143)]. The next highest estimated number of livestock animals were in Skull Branch (40,160 total livestock) and Halfway Gut Creek (39,605 total livestock), followed by Poorly Branch (16,537 total livestock), and finally Deep Creek (2,944 total livestock; note that Deep Creek is also the smallest subwatershed). The project team conducted several windshield surveys of the watershed with stakeholders and also met with the Dorchester County Soil and Water Conservation District[48] commissioners and staff to better understand the potential impacts of livestock in the watershed. Although there were no permitted facilities for any livestock other than poultry, there did not seem to be evidence of damage from smaller unpermitted facilities (family or hobby farms). For example, there were no observations of cattle in streams or unlawful discharge of chicken litter into waterways.

Table 4-2: Givhans Ferry Watershed Livestock Population Estimates

Subwatershed	Cows, Beef	Horses	Sheep	Chickens, Broilers	Pigs/ Hogs/ Swine	Turkeys
Deep Creek	5	4	7	2,908	20	0
Poorly Branch	32	20	40	16,333	112	0
Skull Branch	79	70	118	39,614	278	1
Lower Indian Field Swamp	127	67	143	63,047	431	2
Halfway Gut Creek	78	41	89	39,128	268	1
Total	**321**	**202**	**397**	**161,030**	**1,109**	**4**

[47] USDA. 2023. National Agricultural Statistics Service available at https://www.nass.usda.gov/Quick_Stats/index.php
[48] SCDNR. 2023. Dorchester Conservation District available at https://www.dnr.sc.gov/conservation/districtsdnr/dorchester.html

Stakeholders did express concerns about runoff from livestock operations. As previously discussed in **Section 3.5 Impaired Waters**, there is a TMDL for FC in Lower Indian Field Swamp. As will be addressed in **Section 5.6.1 Monitoring Program**, additional monitoring is recommended for this watershed to better pinpoint potential bacteria hotspots and determine what the source of the impairment may be.

Nutrient, TSS, and bacteria loading for livestock was calculated with the following assumptions:

- Published agricultural BMPs from NRCS for livestock do not separate animals (such as cows, horses, sheep, pigs, and turkeys) from the land use type (e.g. pasture) where they are typically found. Therefore, although both the WTM and Model My Watershed can calculate pollutant loads for individual animals, these loads did not translate to the recommended treatment methods. The standard pollutant loading rates for these unconfined animals were calculated manually using standard references provided by SCDES[49] which calculate TN, TP, TSS and FC (which was then converted to *E. coli*).
- There are recommended treatment strategies for chicken litter that are based on pollutant loads from individual chickens. Therefore, the pollutant loads associated with chickens were calculated by inputting the number of individual chickens into the Watershed Treatment Model.

All FC loads were converted to *E. coli* using the 0.8725 conversion factor which represents the ratio of the water quality standard (WQS) for *E. coli* compared to the WQS for FC (349/400)[50]. Lower Indian Field Swamp had the highest *E. coli* loads associated with chickens (**Table 4-3**), accounting for nearly 39% of the entire load associated with this source in the entire Givhans Ferry Watershed. Skull Branch had the largest pasture and grassland area, and thus had the highest TN, TP, TSS, and E. coli loads, accounting for 41% of the load for this source in the overall watershed (

[49] Amanda Ley, SCDES Watershed Coordinator, personal communication, July 14, 2023.

[50] SCDES. 2013. Technical Report 15-2020. Development and Adoption of the Escherichia coli Freshwater Water Quality Standard. Available at https://des.sc.gov/sites/scdph/files/media/document/Synopsis%20E.%20coli%20Standard%20Adoption.pdf

Table 4-4).

Table 4-3: Givhans Ferry Watershed Poultry Pollution Load Estimates

Subwatershed	Chickens, Broilers	TN (lb/yr)	TP (lb/yr)	*E. coli* (MPN/yr)
Deep Creek	2,908	52	9	1.67E+12
Poorly Branch	16,333	294	49	9.41E+12
Skull Branch	39,614	713	119	2.28E+13
Lower Indian Field Swamp	63,047	1,135	189	4.07E+13
Halfway Gut Creek	39,128	704	117	2.25E+13
Total	**161,030**	**2,898**	**483**	**9.71E+13**
Total (tons/yr)		**1.4**	**0.25**	

Table 4-4: Givhans Ferry Pasture & Grassland and Associated Loads

Subwatershed	Subwatershed Area (acre)	Pasture/Grassland Area (acre, %)	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	*E. coli* (MPN/yr)
Deep Creek	2,116	33 (2%)	122	4	10,056	1.85E+11
Poorly Branch	10,065	667 (7%)	2,490	77	204,632	3.76E+12
Skull Branch	39,574	2,469 (6%)	9,216	286	757,732	1.39E+13
Lower Indian Field Swamp	29,487	1,714 (6%)	6,397	198	525,471	9.66E+12
Halfway Gut Creek	18,315	1,212 (7%)	4,525	140	371,627	6.84E+12
Total	**99,557**	**6,095 (6%)**	**22,750**	**705**	**1,869,518**	3.44E+13
Total (tons/yr)			**11**	**0.4**	**935**	

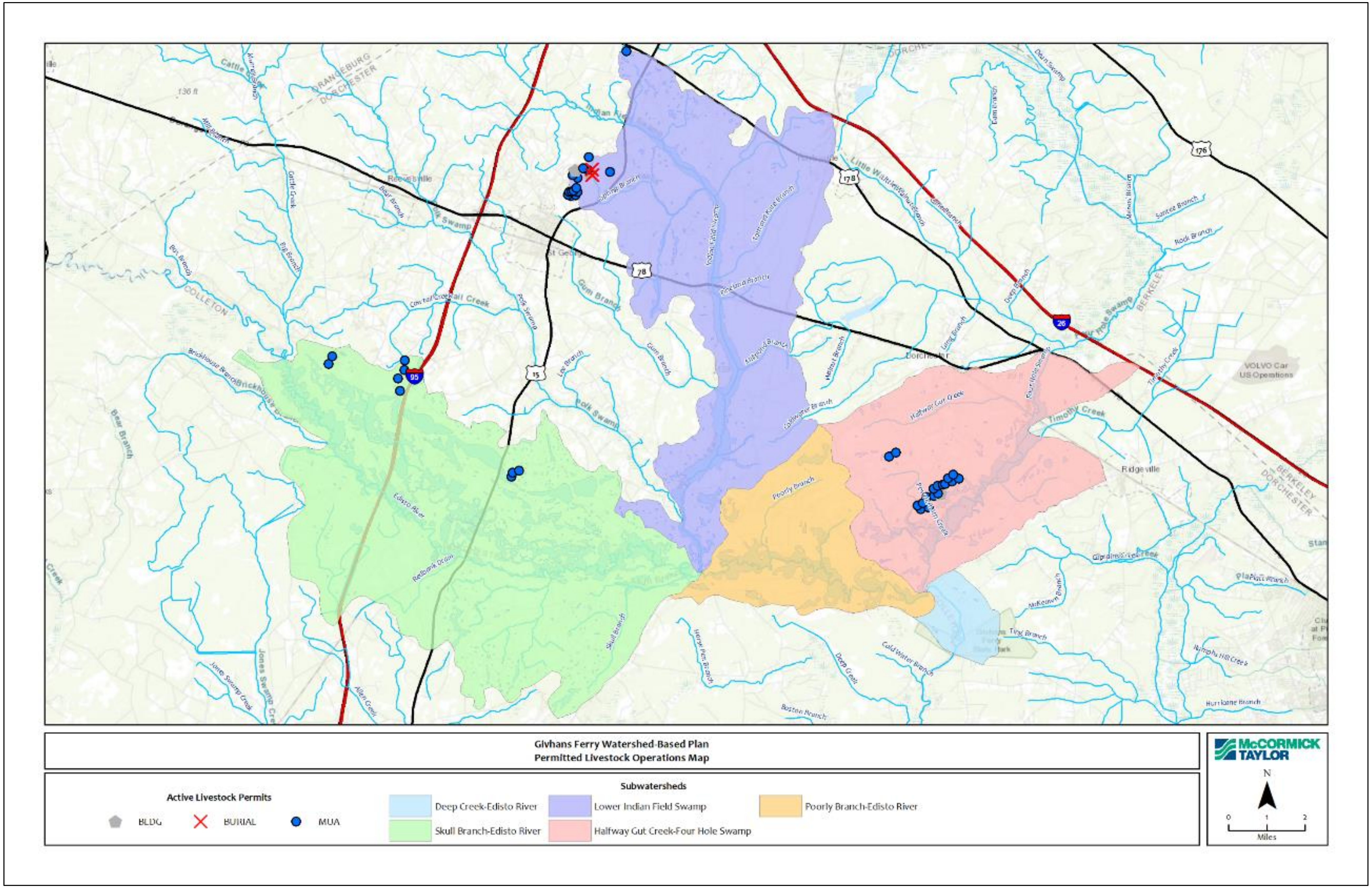

Figure 4-2: Livestock Operations in Givhans Ferry Watershed

Cropland

Nonpoint source pollutants associated with agricultural crop production may include nutrients, sediment, and bacteria, which can threaten public water intakes, aquatic life, and recreational uses of the waterways. Nutrients in agricultural runoff originate from exposed soil as well as from applied fertilizers. Sediment loading occurs through erosion of bare or disturbed soils. Bacteria may originate from livestock manure applied to agricultural land as fertilizer. The WTM does not calculate any pollutant loads for cropland areas. Instead, the Model My Watershed application was used to evaluate nutrient and sediment loads (bacteria is not calculated in this model). Cropland accounts for 10% of the land use in the entire Givhans Ferry watershed and is estimated to contribute 21 tons/yr TN; 2 tons/yr TP; 1,273 tons/yr TSS (**Table 4-5**).

Table 4-5: Givhans Ferry Cultivated Cropland and Associated Loads

Subwatershed	Subwatershed Area (acre)	Cropland Area (acre, %)	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Deep Creek	2,116	67 (3%)	478	39	76,275
Poorly Branch	10,065	766 (8%)	2,159	167	157,627
Skull Branch	39,574	3,988 (10%)	18,796	1,417	1,226,743
Lower Indian Field Swamp	29,487	3,571 (12%)	16,180	1,259	852,812
Halfway Gut Creek	18,315	1,552 (8%)	4,310	304	232,703
Total	**99,557**	**9,944 (10%)**	**41,923**	**3,186**	**2,546,160**
Total (tons/yr)			**21**	**2**	**1,273**

4.2.2 Forests

Silviculture, which involves managing forests for a particular goal, can have both positive and negative effects on water quality and aquatic habitat. When a forest is managed to prevent catastrophic fires, a watershed is at less risk for high sediment loading that would occur after such an event. On a much smaller scale, fire prevention techniques may increase sediment loading due to removal of vegetation during prescribed burns or thinning. Forest land cover included four categories from the NLCD dataset: deciduous forest, evergreen forest, mixed forest, and shrub/scrub. Forests account for 75,559 acres in the Givhans Ferry Watershed (**Table 4-6**), but there are no large silviculture industries in the watershed (as reported by stakeholders). There is a large parcel of privately protected (through a conservation easement) forest in the Lower Indian Field Swamp subwatershed (6,174 acres, of the total 14,400 acres of the property, are within the Givhans Ferry watershed boundary). Owned by the Norfolk Southern Railway Company, it is known as the Brosnan Forest and is one of the largest remaining stands of longleaf forest in the United States[51].

As a general estimate of pollutant loads associated with forested land in the Current Condition of the Givhans Ferry Watershed, WTM calculates 94 tons/yr TN; 8 tons/yr TP; 3,778 tons/yr TSS; and 7.91E+14 MPN /yr of *E. coli* bacteria. It is important to note that 76% of the entire watershed is forested, which is why the pollutant loads from forested land appear very high. Skull Branch had the most amount of forest coverage (29,992 acres) and the highest number of loads for TN (74,980 lb/yr), TP (5,998 lb/yr), TSS (2,999,200 lb/yr), and *E. coli* (3.14E+14 MPN/yr). The subwatershed with the next highest forest area and associated loads is Lower Indian Field Swamp followed by Halfway Gut Creek, Poorly Branch, then Deep Creek.

Table 4-6: Givhans Ferry Forest Acreage and Associated Loads

Subwatershed	Subwatershed Area (acre)	Forest Area (acres)	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	*E. coli* (MPN/yr)
Deep Creek	2,116	1,828 (86%)	4,570	366	182,800	1.91E+13
Poorly Branch	10,065	7,601 (76%)	19,003	1,520	760,100	7.96E+13
Skull Branch	39,574	29,992 (76%)	74,980	5,998	2,999,200	3.14E+14
Lower Indian Field Swamp	29,487	22,031 (75%)	55,078	4,406	2,203,100	2.31E+14
Halfway Gut Creek	18,315	14,105 (77%)	35,263	2,821	1,410,500	1.48E+14
Total	**99,557**	**75,557 (76%)**	**188,893**	**15,111**	**7,555,700**	**7.91E+14**
Total (tons/yr)			**94**	**8**	**3,778**	

[51] Norfolk Southern Corp. 2023. Nature-Based Solutions: Brosnan Forest. Available at https://www.norfolksouthern.com/en/commitments/sustainability/nature-based-solutions

4.2.3 Open Water

Open water, such as lakes and impoundments, are important for habitat and hydrology in the watershed. Approximately 1% of the land use in the entire Givhans Ferry watershed is open water (**Table 4-7**). In the WTM, there are no bacteria loads associated with open water. However, it is widely recognized that fresh water can attract wildlife and therefore may have the potential to concentrate their feces in nearby areas, which could then be picked up by stormwater runoff entering the open water.

Table 4-7: Givhans Ferry Open Water and Associated Loads

Subwatershed	Subwatershed Area (acre)	Open Water Area (acres)	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Deep Creek	2,116	52 (2%)	666	26	8,060
Poorly Branch	10,065	402 (4%)	5,146	201	62,310
Skull Branch	39,574	564 (1%)	7,219	282	87,420
Lower Indian Field Swamp	29,487	138 (0.5%)	1,766	69	21,390
Halfway Gut Creek	18,315	274 (1%)	3,507	137	42,470
Total	**99,557**	**1,430 (1%)**	**18,304**	**715**	**221,650**
Total (tons/yr)			**9**	**0.4**	**111**

4.2.4 Wildlife

Warm-blooded animals such as deer and birds (geese, gulls, etc.) can be another potential source of nonpoint source pollution in the watershed. Natural areas that support wildlife (such as forests, wetlands, and open water) are generally considered to represent the natural, unimpacted state of the watershed, and wildlife feces are considered a background source of nutrients and bacteria in surface water. The WTM does not explicitly calculate a specific loading associated with wildlife; however, if bacteria concentrations are very high in a particular area, microbial source tracking (MST) could be useful to determine if the bacteria originate from human or a variety of animal species (domestic dogs and cats; livestock; or wildlife). More discussion of MST is included in **Section 5.6.1 Monitoring Program**.

4.2.5 Sand Mines/Barren Land

In addition to pollutants associated with forested land use, there is also pollution related to runoff from areas where the forest has been cleared and a sufficient vegetative cover has not been reestablished. Utilizing SCDES records for general NPDES permits (which includes mining activities) and NLCD land cover classifications (barren land), McCormick Taylor identified 15 mines and 415 acres of barren land in the study area (**Table 4-8**). Barren land is a very small overall area in the watersheds (0.4%). Note that not all barren areas correspond with a mine, however, all sources of bare soil could have the potential to erode into nearby streams and carry nutrients and sediment with it. The WTM estimates the pollutant loads associated with these activities as "active construction" in the WTM model, and they accounted for a total of 728 tons/yr TN; 0.2 tons/yr TP; and 728 ton/yr TSS. Barren land covered the most area (216 acres) in the Lower Indian Field Swamp subwatershed, where loading was also the highest for TN (1,114 lb/yr), TP (223 lb/yr) and TSS (757,341 lb/yr). The subwatersheds with the next largest barren areas were Halfway Gut Creek (101 acres), followed by Skull Branch (66 acres) and Poorly Branch (32 acres). Only three of the subwatersheds had permitted sand mines: Halfway Gut Creek (9), Poorly Branch (5), and Lower Indian Field Swamp (1). Deep Creek and Skull Branch had no sand mines and therefore the associated loads from barren land most likely are a result of other land clearing activities. There are no *E. coli* loads associated with barren land.

Table 4-8: Givhans Ferry Sand Mines, Barren Land Acreage, and Associated Loads

Subwatershed	Subwatershed Area (acre)	Barren Land (Acre)	Number of Sand Mines	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Deep Creek	2,116	0 (0%)	0	0	0	0
Poorly Branch	10,065	32 (0.3%)	5	165	33	112,199
Skull Branch	39,574	66 (0.2%)	0	340	68	231,410
Lower Indian Field Swamp	29,487	216 (1%)	1	1,114	223	757,341
Halfway Gut Creek	18,315	101 (1%)	9	521	104	354,127
Total	**99,557**	**415 (0.4%)**	**15**	**2,140**	**428**	**1,455,077**
Total (tons/yr)				**1.1**	**0.2**	**728**

4.2.6 Urban/Suburban Runoff

Urban/suburban runoff is similar to cropland runoff in that it includes nutrients, sediment, bacteria, and toxins. However, a major difference lies in how and when the runoff from urban and suburban landscapes is delivered to waterbodies. Urban/suburban runoff is usually routed from impervious surfaces either directly to the waterbodies or somewhere just upstream of the waterbodies. These different runoff characteristics threaten streams and other waterbodies from urban/suburban runoff in several different ways. The first, and potentially most influential threat, is from the increased stormwater discharges that are delivered directly to streams where both the volume and velocities of the flows are often drastically higher than runoff from undeveloped lands. Secondly, the increased overland flow that is often associated with urban/suburban impervious surfaces decreases the amount of stormwater that flows through subsurface processes from which groundwater is recharged, thus leading to lower base flows. Thirdly, urban/suburban land uses can increase pollutant loads in stormwater runoff through erosion from disturbed areas (e.g., construction sites), build-up and wash-off of pollutants, illicit connections, and dumping into storm sewers. Another common threat from urban/suburban development is the increase in stream temperatures due to lack of shading as well as heated stormwater runoff from ponds and impervious areas. Finally, a decreased population and diversity of plants and animals is usually observed in urban/suburban areas due to the poor quality of habitat. All of these mechanisms can contribute to waterbody impairment, both from a human health and aquatic life perspective.

A small portion of the Givhans Ferry Watershed has been developed into suburban and urban lands (6,750 acres or 7% of the entire watershed), which includes residential, commercial, industrial, and road land uses. **Table 4-9** summarizes the contributions of each of the seven urban/suburban land uses for each of the model pollutants and runoff volume. In summary, for the current conditions, the WTM estimates that the annual pollutant contribution of urban/suburban development is 27 tons/yr TN; 4 tons/yr TP; 953 tons/yr TSS; and 6.21E+14

MPN/yr of *E. coli* bacteria. Across the entire watershed study area, roadways and low-density residential uses contribute the most TN and TP; roadways contribute the most TSS, while low density residential uses contribute the most *E. coli* bacteria loads. In the table below the subwatersheds have been abbreviated as DC (Deep Creek), PB (Poorly Branch), SB (Skull Branch), LIFS (Lower Indian Field Swamp), and HGC (Halfway Gut Creek).

Table 4-9: Current Conditions Estimated Pollutant Loads

Urban/Suburban Land Use	Subwatershed Area (acres)	Area (acres)	TN (lb/year)	TP (lb/year)	TSS (lb/year)	*E. coli* (MPN/year)
LDR (<1 du/acre)*		**4,498 (5%)**	**23,866**	**3,523**	**556,881**	**4.07E+14**
DC	2,116	*739 (35%)*	*739*	*109*	*17,252*	*1.26E+13*
PB	10,065	*281 (3%)*	*1,677*	*248*	*39,136*	*2.86E+13*
SB	39,574	*1,232 (3%)*	*7,591*	*1,121*	*177,117*	*1.29E+14*
LIFS	29,487	*1,472 (5%)*	*9,167*	*1,353*	*213,899*	*1.56E+14*
HGC	18,315	*774 (4%)*	*4,692*	*693*	*109,477*	*8.00E+13*
MDR (1-4 du/acre)*		**1,004 (1%)**	**7,631**	**1,126**	**178,049**	**1.30E+14**
DC	2,116	*3 (0.1%)*	*23*	*3*	*544*	*3.98E+11*
PB	10,065	*204 (2%)*	*1,522*	*225*	*35,521*	*2.59E+13*
SB	39,574	*767 (2%)*	*5,856*	*864*	*136,646*	*9.98E+13*
LIFS	29,487	*16 (0.1%)*	*123*	*18*	*2,873*	*2.10E+12*
HGC	18,315	*14 (0.1%)*	*106*	*16*	*2,465*	*1.80E+12*
Commercial		**178 (0.2%)**	**2,839**	**297**	**58,122**	**1.61E+13**
DC	2,116	*0.5 (0.02%)*	*8*	*1*	*161*	*4.46E+10*
PB	10,065	*0.2 (0.00%)*	*3*	*0*	*65*	*1.81E+10*
SB	39,574	*18 (0.05%)*	*288*	*30*	*5,893*	*1.63E+12*
LIFS	29,487	*51 (0.2%)*	*816*	*86*	*16,718*	*4.64E+12*
HGC	18,315	*108 (0.6%)*	*1,723*	*181*	*35,285*	*9.79E+12*
Roadway		**959 (1%)**	**18,164**	**1,974**	**1,058,257**	**6.28E+13**
DC	2,116	17 (0.8%)	323	35	18,803	1.12E+12
PB	10,065	118 (1.2%)	2,230	242	129,915	7.71E+12
SB	39,574	436 (11%)	8,260	898	481,240	2.86E+13
LIFS	29,487	249 (0.8%)	4,721	513	275,076	1.63E+13
HGC	18,315	139 (0.8%)	2,630	286	153,222	9.09E+12
Industrial		**111 (0.1%)**	**1,497**	**170**	**55,099**	**5.41E+12**
DC	2,116	-	-	-	-	-
PB	10,065	-	-	-	-	-
SB	39,574	47 *(0.1%)*	634	72	23,342	2.29E+12
LIFS	29,487	30 *(0.1%)*	406	46	14,940	1.47E+12
HGC	18,315	34 *(0.2%)*	457	52	16,816	1.65E+12
Total Urban/Suburban		**6,750**	**53,997**	**7,091**	**1,906,408**	**6.21E+14**
Total (tons/yr)			**27**	**4**	**953**	

**du = dwelling unit*

4.2.7 Streambank Erosion

Modification of the hydrologic regime due to land development in a watershed can result in elevated volumes of stormwater runoff being delivered to creeks, streams, and other waterbodies. These increased volumes and the quick delivery of these runoff events can lead to scour of stream channels, incision, and streambank erosion. Hydrologic scour of the streambed can also limit key microhabitats (e.g., leaf packs, sticks, and coarse substrate) for aquatic species. While it is difficult to delineate the different sources of sediment that are being delivered to streams (e.g., streambank erosion as opposed to upland sources such as construction sites), instream sedimentation and subsequent lack of microhabitat are, to some degree, a result of sediment input to streams from streambank erosion. Channel widening through streambank erosion can also exacerbate low flow conditions because channels become overly wide and shallow. **Section 2.4.3** of this watershed plan describes how the USLE K-factor was calculated and used to estimate the soil's susceptibility to erosion.

The estimated annual loads for the current condition in the Givhans Ferry Watershed that can be attributed to stream bank erosion (**Table 4-10**) are 5 tons/yr TN; 4 tons/yr TP; and 5,466 tons/yr TSS. Although the WTM assumes that there is no bacteria loading associated with streambank erosion, there is evidence that suggests that fecal coliform bacteria can attach to sediment particles and colonize and persist in biofilms and sediments in ditches and streams.[52] However, bacteria that is persistent in the environment likely has not been recently excreted from a warm-blooded animal, and probably is not associated with actual disease-causing pathogens.

Table 4-10: Current Conditions Estimated Erosion Pollutant Loads

Subwatershed	Stream Length (miles)	TN (lb/year)	TP (lb/year)	TSS (lb/year)	*E. coli* (MPN/year)
Deep Creek	8	212	170	212,311	-
Poorly Branch	21	1,123	899	1,123,266	-
Skull Branch	215	4,065	3,252	4,064,558	-
Lower Indian Field Swamp	111	3,439	2,751	3,439,287	-
Halfway Gut Creek	27	2,092	1,674	2,092,393	-
Total	**382**	**10,932**	**8,745**	**10,931,815**	-
Total (tons/yr)		**5**	**4**	**5,466**	

[52] McCormick Taylor and Moffatt & Nichol. 2020. May River Watershed Action Plan Update & Modeling Report. Available at https://www.townofbluffton.sc.gov/DocumentCenter/View/2068/2020-May-River-Action-Plan-Update-and-Model-Report

4.3 Human Waste Nonpoint Pollutant Sources

Human waste is a direct contributor to fecal coliform pollution (freshwater standards are based on the number of *E. coli* colonies) and negatively impacts water quality if it contacts surface water resources, such as through sanitary sewer spills or septic system infiltration. In general, human sewage contamination represents a direct health risk and usually originates from a controllable source. Most sanitary sewer systems are inspected on a regular basis and have a capital improvements budget to allow for repairs. Because septic systems are privately owned and maintained, it is more difficult for local government or other organizations to identify and fix underperforming septic systems.

Human waste contains nutrients, bacteria, and solids that can pollute waterways. Fecal indicator bacteria (FIB), such as *E. coli*, are bacteria that are normally prevalent in the intestines and feces of warm-blooded animals and are used to identify sources of fecal pollution and pathogens. The FIB are used because direct testing for pathogens (what actually presents the human health risk) is very expensive. In other words, it is possible to find FIB in areas where there are no pathogens present. This section provides estimates, based on the current condition of the watershed, of sources that may contribute to human waste and the potential negative impacts these systems may have on water quality.

4.3.1 SSOs

Sanitary Sewer Overflows (SSOs) are sources of sediment, nutrients, bacteria, and toxins during storm events. These overflows are caused when surface water enters sewer systems beyond their designed flow capacity, or there is a mechanical/electrical failure of the system, causing the sewers to overflow and release raw sewage. During these events, the released sewage may enter nearby waterbodies and cause an acute increase in pollutant concentrations. **Section 2.7.1 Town of Harleyville WWTP** describes the municipal sewer service areas in Givhans Ferry Watershed; in total there are 14.3 miles of sanitary sewer lines coverage (including gravity, force main, and lateral lines) connecting 303 homes and businesses in the Lower Indian Field Swamp subwatershed to the Harleyville wastewater treatment plant. Based on online SCDES reports for SSOs[53] in Dorchester and Colleton Counties (including areas outside of the Givhans Ferry Watershed), the average size of spill was 2,000 gallons. However, please note that there are no records of SSOs within the Town of Harleyville. Using the average spill size for each county, the WTM estimates that the average annual loads associated with SSOs associated with the Town of Harleyville WWTP are 2 lb/yr TN; 13 lb/yr TSS; and 1.32E+13 MPN/yr *of E. coli*.

4.3.2 Onsite Sewage Disposal Systems

Onsite sewage disposal systems (OSDS), also called septic systems, that are not properly maintained are a potential source of nutrients and bacteria in surface and groundwater. In the Givhans Ferry Watershed, 95% of the residential dwellings are not currently served by municipal sewer systems and are assumed to have septic systems (**Table 4-11**). Based on an assumption of 10% failure rate, sandy soils, and a conventional system type installed at a density of 1-2 units/acre, the WTM predicts the average annual loading associated with septic systems (in the current condition) to be 2 tons/yr TN; 0.4 tons/yr TP; 15 tons/yr TSS; and 5.45+13 MPN/yr *of E. coli*.

[53] https://des.sc.gov/programs/bureau-water/wastewater/wastewater-sewer-overflows

Table 4-11: Current Conditions Estimated Septic System Loads

Subwatershed	Number of OSDS	TN (lb/year)	TP (lb/year)	TSS (lb/year)	*E. coli* (MPN/year)
Deep Creek	127	78	13	518	1.03E+11
Poorly Branch	489	626	104	4,177	1.13E+13
Skull Branch	1,924	1,975	329	13,164	3.29E+13
Lower Indian Field Swamp	2,126	1,030	172	6,864	8.05E+12
Halfway Gut Creek	1,351	711	118	4,739	2.13E+12
Total	**6,017**	**4,419**	**737**	**29,462**	**5.45E+13**
Total (tons/yr)		2	0.4	15	

4.4 Point Sources

4.4.1 NPDES Permits

The National Pollutant Discharge Elimination System (NPDES) was developed by EPA to regulate point source pollutant discharges to surface waters. In South Carolina, NPDES permitted dischargers must comply with discharge limitations that are set by SCDES to protect downstream waterbodies.

Table 4-12, **Table 4-13**, and **Figure 4-3** list and illustrate the five NPDES permitted facilities and 17 NPDES general permits within the Givhans Ferry Watershed boundary. The NPDES discharges may contribute to declines in aquatic species populations in combination with other sources of potential nonpoint source pollution (stormwater runoff, agriculture, and hazardous waste), and some may be significant pollutant sources in the watershed. However, if the conditions of the NPDES permit are met, there should be minimal impact to water quality. In Givhans Ferry Watershed, there are four industrial and one municipal NPDES permitted facilities. A concern with these sites is that non-metallic minerals could be transported from the property via stormwater runoff and end up in the Givhans Ferry Watershed, which then could have the potential to impact downstream resources (such as the CWS drinking water intake).

Table 4-12: NPDES Permits in the Givhans Ferry Watershed

NPDES	Name	Activity	Type	Description
SC0002020	SCE&G/CANADYS STATION	Active	Industrial	Electric Services
SC0002020	SCE&G/CANADYS STATION	Active	Industrial	Electric Services
SC0038555	SHOWA DENKO CARBON	Active	Industrial	Carbon and Graphite Products
SC0038504	HARLEYVILLE, TOWN OF	Active	Municipal	Sewerage Systems
SC0022586	ARGOS CEMENT LLC	Active	Industrial	Cement, Hydraulic

Table 4-13: NPDES General Permits in the Givhans Ferry Watershed

NPDES	Name	Activity	Type	Description
SCG750003	CIRCLE C TRAVEL PLAZA	Active	Industrial	Carwashes
SCG730761	PALMETTO SAND-PINE BLUFF MINE	Active	Industrial	Construction Sand and Gravel
SCG730761	PALMETTO SAND-PINE BLUFF MINE	Active	Industrial	Construction Sand and Gravel
SCG730761	PALMETTO SAND-PINE BLUFF MINE	Active	Industrial	Construction Sand and Gravel
SCG731254	OL THOMPSON CONSTR/EDISTO OAKS MINE	Active	Industrial	Miscellaneous Non-metallic minerals
SCG731168	G5-Silver Mine Two	Active	Industrial	Miscellaneous Non-metallic minerals
SCG731369	THOMPSON-CAINHOY/WIRE ROAD SOUTH MINE	Active	Industrial	Miscellaneous Non-metallic minerals
SCG731367	MATTHEW HALTER/MAXIMUS MINE	Active	Industrial	Miscellaneous Non-metallic minerals
SCG731428	WELBY'S CONSTRUCTION/COLDWATER MINE	Active	Industrial	Miscellaneous Non-metallic Minerals
SCG731392	J.R. WILSON CONST/PRINGLE MINE	Active	Industrial	Miscellaneous Non-metallic Minerals
SCG730024	SANDERS BROS CONST/BIG OAK MNE	Active	Industrial	Miscellaneous Nonmetallic Minerals, Except Fuels
SCG730668	WELBYS CONST MAT/DORCHESTER MINE	Active	Industrial	Miscellaneous Nonmetallic Minerals, Except Fuels
SCG730411	TRI COUNTY INVEST/BOYKIN RIDGE	Active	Industrial	Miscellaneous Nonmetallic Minerals, Except Fuels
SCG730990	CRYSTAL MINERALS MINE	Active	Industrial	Other
SCG730933	D&A LLC/GUERARD MINE	Active	Industrial	Other
SCG730385	MEM LLC/MIXSON MINE	Active	Industrial	Other
SCG730517	SCDOT/GROVER PIT	Active	Industrial	Other

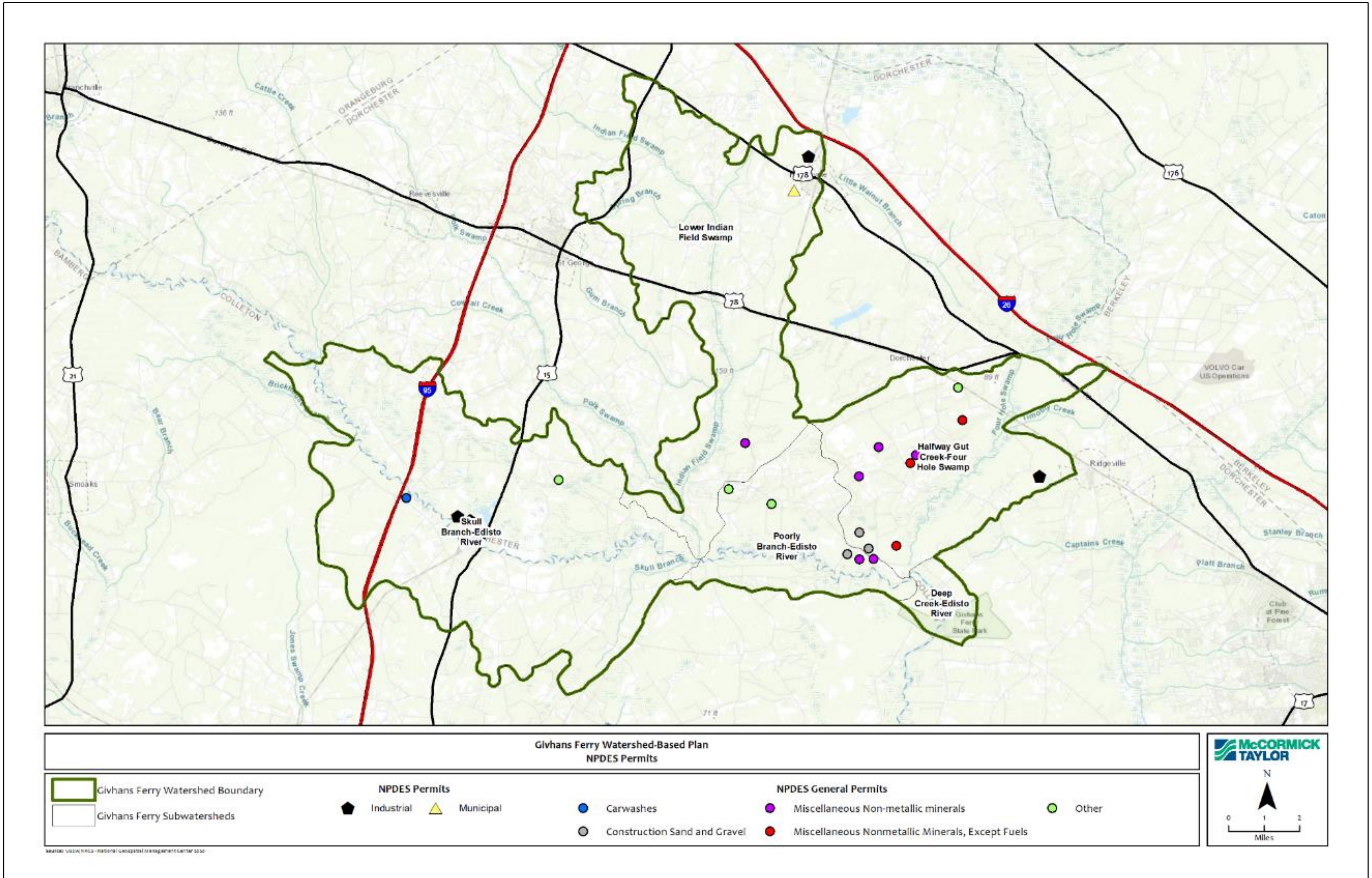

Figure 4-3: SCDES Permitted NPDES Locations in the Givhans Ferry Watershed

4.5 Watershed Pollutant Loads

The existing and future pollutant loads for the watershed were estimated using the Center for Watershed Protection's Watershed Treatment Model (WTM) and can track sediment, nutrients, and bacteria on an annual basis. The model incorporates many simplifying assumptions that allow the watershed manager to assess various programs and sources. The WTM estimates the load from a watershed without treatment measures in place and considers primary (land use) and secondary sources (such as human sewage and channel erosion). Treatment options include erosion and sedimentation control, stormwater structural best management practices, pet waste education, and riparian buffers. The WTM calculates bacteria loading in terms of FC; therefore, it was necessary to apply a conversion factor (0.8725) to translate the loads to be in terms of *E. coli* for this WBP.

4.5.1 Pollutant Loads from Current Conditions

The total estimated untreated (assuming no BMPs) loads from all sources, are summarized in **Table 4-14.** The estimated loads are 177 tons/yr TN; 19 tons/yr TP; 13,280 tons/yr TSS; and 1.69E+15 MPN/year of *E. coli* bacteria. The greatest amount of TN comes from forest (54%) and cropland (12%); most TP comes from forest (39%) and channel erosion (23%); most TSS comes from channel erosion (41%) and forest (28%); and the majority of bacteria load can be attributed to forests (47%) and low-density residential development (24%). To better understand the human impacts on the watershed, the totals of urbanized land and human waste sources of bacteria, nutrients, and sediments were summarized separately. Those values are highlighted in tan in **Table 4-14**. The human-related sources contribute 19% to overall TN, 24% to overall TP, 13% to overall TSS, and 46% of the total *E. coli* load in the watershed. Low density residential contributes the most TN (35%), TP (38%), and bacteria (53%) for human sources. Barren land (42%) and roads (31%) contribute the most TSS. Also note that septic systems contribute to the second highest quantity of bacteria (19% of the human source load).

Table 4-14: Summary of Current Conditions Estimated Pollutant Loads by Source

Source	TN (lb/year)	TP (lb/year)	TSS (lb/year)	*E. coli* (MPN/year)
Low Density Residential (<1du/acre)	23,866	3,523	556,881	4.07E+14
Medium Density Residential (1-4 du/acre)	7,631	1,126	178,049	1.30E+14
Commercial	2,839	297	58,122	1.61E+13
Roadway	18,164	1,974	1,058,257	6.28E+13
Industrial	1,497	170	55,099	5.41E+12
Barren Land	2,140	428	1,455,077	-
Forest	188,893	15,111	7,555,700	7.91E+14
Cropland	41,923	3,186	2,546,160	0.00E+00
Pasture/Grassland	22,750	704	1,869,518	3.44E+13
Open Water	18,304	715	221,650	-
Channel Erosion	10,932	8,745	10,931,815	-
Septic	4,419	737	29,462	5.45E+13
SSOs	2	-	13	1.32E+12
Livestock (chickens only)	2,898	483	-	9.71E+13
ALL SOURCES TOTAL:	3.53E+05	3.83E+04	2.66E+07	**1.69E+15**
ALL SOURCES (tons/yr)	177	19	13,280	
HUMAN SOURCES TOTAL:	**6.73E+04**	**9.38E+03**	**3.44E+06**	**7.72E+14**
HUMAN SOURCES (tons/yr)	**34**	**5**	**1,718**	

Table 4-15 summarizes the primary (land use) and secondary (septic, SSO, erosion, and livestock) pollutant loads for each of the five subwatersheds. There are two ways to compare the results. First is the total load generated for the subwatershed (white rows) and the second is to normalize the loads by dividing the totals by the area in the subwatershed (normalized loads, light blue rows). Normalized values allow for an equal comparison of the subwatersheds based on how much of a particular pollutant is generated per acre of the subwatershed. The highest overall loads for TN, TP, TSS, and *E. coli* come from Skull Branch, which is also the largest subwatershed by area. The normalized loads for TN range from 3.3 lb/yr/acre (Halfway Gut Creek) to 3.6 lb/yr/acre (Poorly Branch) which are two of the smaller subwatersheds. The normalized loads for TP range from 0.37 lb/yr/acre (Deep Creek) to 0.41 lb/yr/acre (Lower Indian Field Swamp). The normalized loads for TSS range from 244 lb/yr/acre (Halfway Gut Creek) to 257 lb/yr/acre (Lower Indian Field Swamp). And finally, the normalized loads for *E. coli* range from 1.54E+10 MPN/yr/acre (Halfway Gut Creek) to 1.67E+10 MPN/yr/acre (Deep Creek).

Identifying these watersheds that generate the most type of nonpoint source pollution may help stakeholders focus efforts on where to implement structural and nonstructural practices. For example, the largest bacteria load is located in Skull Branch which also had the largest estimated loads attributed to septic systems; strategies to reduce these loads should focus on septic system inspections, repairs, and potential for connection to sanitary sewer.

Table 4-15: Current Conditions Estimated Pollutant Loads by Subwatershed

Subwatershed	Area (acre)	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	*E. coli* (MPN/yr)
Deep Creek, total	2,116	7,271	775	526,781	3.53E+13
Deep Creek, normalized (lb/yr/acre)		3.4	0.37	249	1.67E+10
Poorly Branch, total	10,065	36,279	3,897	2,516,781	1.66E+14
Poorly Branch, normalized (lb/yr/acre)		3.6	0.39	250	1.65E+10
Skull Branch, total	39,574	139,595	15,008	9,973,124	6.45E+14
Skull Branch, normalized (lb/yr/acre)		3.5	0.38	252	1.63E+10
Lower Indian Field Swamp, total	29,487	100,262	12,175	7,572,666	4.71E+14
Lower Indian Field Swamp, normalized (lb/yr/acre)		3.4	0.41	257	1.60E+10
Halfway Gut Creek, total	18,315	60,728	7,059	4,471,802	2.81E+14
Halfway Gut Creek, normalized (MPN/yr/acre)		3.3	0.4	244	1.54E+10

Another way to evaluate loads on a watershed scale is to create a load duration curve (LDC). Because one of the subwatersheds has a TMDL for bacteria, and there is long term flow and water quality data available at the source water intake, it was useful to create an LDC for *E. coli*. The results are depicted in **Figure 4-4** below. The blue line represents the maximum allowable *E. coli* load based on the observed flow and the water quality standard of 349 MPN/100mL. The orange circles represent the calculated load based on the observed flow and *E. coli* measurement. Orange circles below the blue line indicate that the water quality is within the regulated limits. As illustrated in this figure, the vast majority of all CWS *E. coli* observations at the intake are below the limit. This is in alignment with the bacteria monitoring summary (found in **Section 3.4 Historic Water Quality Sampling Data**): across the entire Givhans Ferry Watershed, 96% of the 1,982 bacteria (FC and *E. coli*) measurements were below the regulatory threshold. The subwatershed with the highest number of exceedances was Lower Indian Field Swamp; however, that includes observations from before the TMDL was published. As stated in Section 3.5, there are currently three TMDL monitoring stations within the Givhans Ferry watershed that are not meeting standards for bacteria (FC or *E. coli*), so monitoring will need to continue to evaluate the success of the two TMDL plans and the recommendations of this WBP.

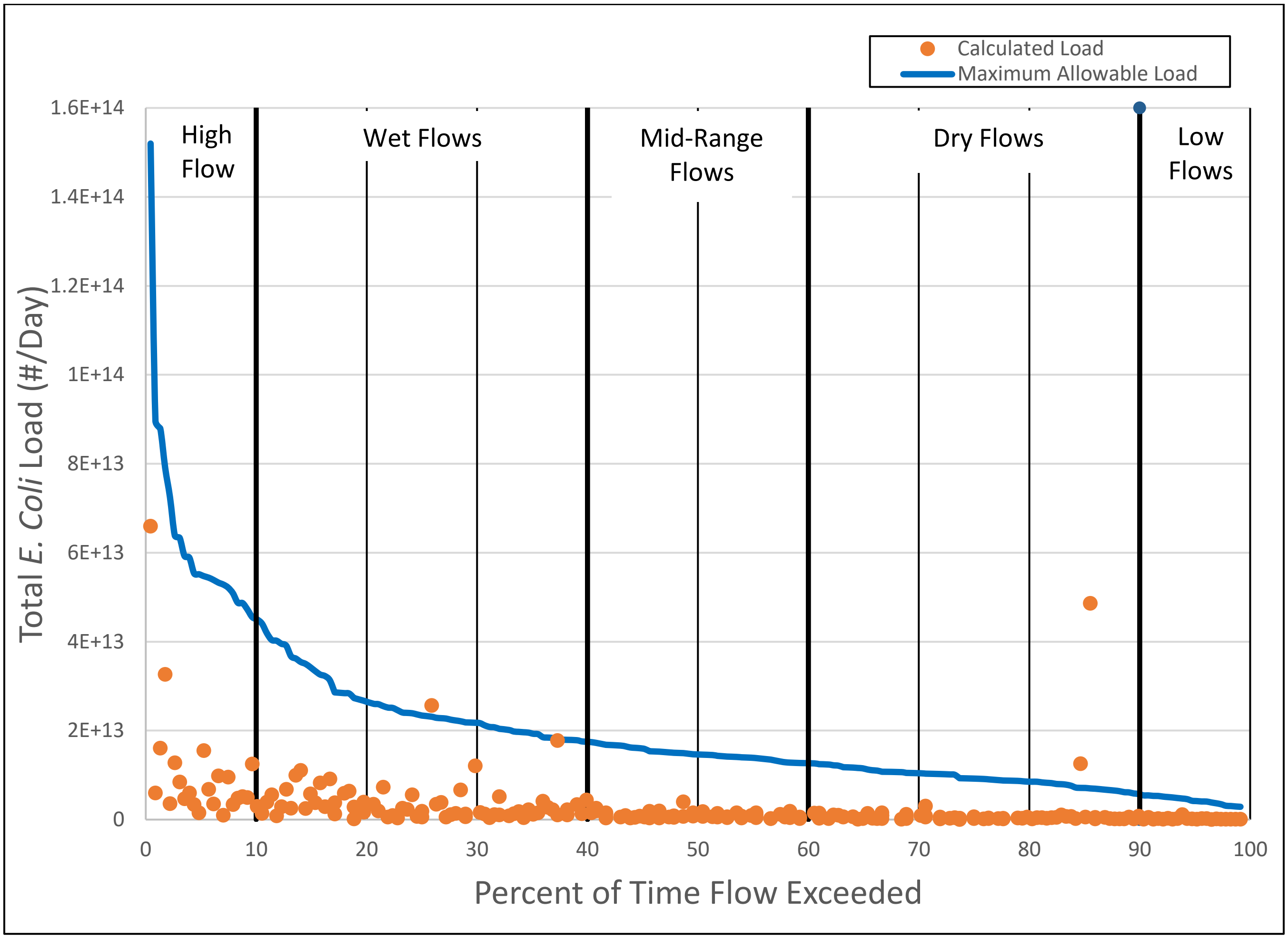

Figure 4-4: Flow Duration Curve for Givhans Ferry Watershed at Source Water Intake

Fortunately, there are multiple existing programs and practices to help reduce the current levels of bacteria within the Givhans Ferry Watershed. **Table 4-16** summarizes the load reduction benefits associated with structural and nonstructural programs and practices currently implemented in the watershed. Inputs in the WTM included an estimated fertilizer application for residential turf areas of 200 lb N/acre (which is the default value in WTM). Pet waste education was assumed to have a 30% awareness in the watershed. There were limited official records of existing stormwater infrastructure; therefore, the existing stormwater infrastructure benefits were estimated using the procedure described in this section (below). In all existing practices, except turf management, there is a reduction in runoff and pollutants (the addition of TN and TP are a result of assumed lawn fertilization). In the Recommended Condition, the benefits of a lawn education program will be included in the analysis of load reductions.

Based on discussions with both Dorchester and Colleton Counties, the pollutant removal capacity for existing BMPs in the watershed was estimated to come from existing wet detention ponds. There are no known low impact development or manufactured treatment devices for water quality treatment in this area. Dorchester County GIS provided spatial information pertaining to the types and size of ponds in the county. Out of the 430 ponds identified in the Dorchester County areas of the Givhans Ferry watershed, 17 were classified by the County as being stormwater BMPs (the rest were borrow pits and recreational ponds). Unfortunately, there were no such records for the Colleton County side of the watershed. Given the current rural nature of the overall watershed, it is not likely that stormwater ponds will be a significantly useful tool for water quality. Each individual wet stormwater pond is assumed to treat 10-25 acres of drainage area, based on design recommendations provided by *Low Impact Development in Coastal South Carolina: A Planning and Design Guide*. All 17 stormwater ponds were classified by Dorchester County to be treating runoff in commercial areas. Thus, the drainage area was estimated to be 170 acres consisting of 145 acres of impervious surfaces (85%). Based on the precipitation, design standards, and maintenance in Dorchester County, the WTM user manual stipulates various "discount factors" to calculate the effectiveness of stormwater BMPs:

- Capture Discount (D1): the existing BMPs captured 1" of runoff (which equates to 80% of annual rainfall events being 1" or less)
- Design Discount (D2): there are specific standards (the Dorchester County Stormwater Management Design Manual) that are legally binding (enforced by permits) = 1
- Maintenance Discount (D3): maintenance is specified but poorly enforced = 0.6

A desktop riparian buffer analysis was conducted and grouped buffer widths into four categories: 20 ft, 30ft, 50 ft, and 100 ft. Total riparian buffer length was counted as twice the length of the stream segment in that area (for the right and left banks to be counted separately).

Finally, the benefits of pet waste programs and public education, such as through Dorchester County's existing partnership with the Ashley Cooper Stormwater Education Consortium (ACSEC), were calculated in the WTM. The awareness of these programs varies with the method of contact: 40% for television, 30% for newspaper, 25% for radio, 13% for billboard, 8% for brochure, and 7% for workshops. The current ACSEC Strategic Plan[54] outlines planned programming that will be used to address pollutants of concern that are also found in pet waste: bacteria and nutrients. ACSEC plans to utilize a mass-media campaign (billboard, television) to encourage the public to properly dispose of pet waste.

Using these inputs, the WTM calculates a load reduction for existing stormwater infrastructure to be 20,922 lb/yr TN; 4,386 lb/yr TP; 684,906 lb/yr TSS; and 2.26E+14 *E. coli* bacteria per year.

Table 4-16: Estimated Pollutant Reduction Benefits from Existing Practices

Program/Practice	TN (lb/year)	TP (lb/year)	TSS (lb/year)	*E. coli* (MPN/year)
BMPs (Ponds)	672	261	46,912	1.26E+13
Riparian Buffers	19,434	4,019	637,994	2.08E+14
Pet Waste Education	815	106	-	6.18E+12
EXISTING PRACTICE LOAD REDUCTION:	**20,922**	**4,386**	**684,906**	**2.26E+14**

[54] Clemson Cooperative Extension. 2018. Stormwater Outreach Strategic Plan: 2018-2023. Available at https://www.clemson.edu/extension/carolinaclear/files/acsec/acsec-2018_2023-strategic-plan-final.pdf

Table 4-17 shows the pollutant reduction after applying existing programs and practices to the total of all pollutant sources. Existing riparian buffers are responsible for the majority of nutrient, sediment, and even bacteria removal in the current condition. This is because these buffers slow down stormwater, encourage sediment deposition and infiltration, and promote biological processes for nutrient uptake in plants. The resulting overall runoff volume reduction associated with buffers also allows less bacteria to enter surface waters.

Table 4-17: Estimated Net Loads from All Sources and Existing Practices

	TN (lb/year)	TP (lb/year)	TSS (lb/year)	*E. coli* (MPN/year)
ALL SOURCES TOTAL:	3.53E+05	3.83E+04	2.66E+07	1.69E+15
EXISTING PRACTICE LOAD REDUCTION	2.09E+04	4.39E+03	6.85E+05	2.26E+14
EXISTING LOAD	3.32E+05	3.39E+04	2.59E+07	1.47E+15
Percent Reduction %	6%	11%	3%	13%

Table 4-18 shows the pollutant reduction after applying existing programs/practices to *only* the existing human-related pollutant load (excluding forest, cropland, rural, open water, livestock, and channel erosion).

Table 4-18: Estimated Net Loads from Human Activities and Existing Practices

	TN (lb/year)	TP (lb/year)	TSS (lb/year)	*E. coli* (MPN/year)
CURRENT HUMAN LOAD	6.73E+04	9.38E+03	3.44E+06	7.72E+14
EXISTING PRACTICE LOAD REDUCTION	2.09E+04	4.39E+03	6.85E+05	2.26E+14
EXISTING HUMAN LOAD	4.64E+04	4.99E+03	2.76E+06	5.46E+14
Percent Reduction %	31%	47%	20%	29%

4.5.2 Pollutant Loads from Future Conditions

Future conditions in the watershed consider both climate changes such as increased precipitation, increases in bacteria concentrations in stormwater, as well as pressures from development. As development increases, not only are rural and forested areas converted to urban/suburban land uses, but there are also increases in the secondary sources of pollutants. For example, as new homes and businesses are built, the local department of public works/utilities may add more sanitary sewer lines in the watershed, which in turn increases the chances for sanitary sewer overflows.

In the WTM, the current conditions were compared to a future scenario that reflects how a warmer climate may increase bacteria concentration as well as produce more annual precipitation:

- Annual precipitation increases from 48.14” to 62.08”
- 15% increase in FC concentration in runoff
- Development reflects a transition from mostly forested to more residential land use

The increases in development included incorporation of:

- Future land use, which utilizes the Dorchester County Future Land Use plan and assumes Colleton County will develop to the ultimate capacity of the current zoning.
- Future dwelling units increase from 6,319 to 19,027
  - assumed 1 dwelling unit per 4 acres of low density residential
  - assumed 4 dwelling units per 1 acre for medium density residential
  - assumed 10 dwelling units per acre for multifamily residential
- 95% of the dwelling units utilize septic systems (about 200% increase in septic systems)
- Sanitary sewer length remains the same for Harleyville WWTP. There are currently no plans to build an additional WWTP to serve the Givhans Ferry area

The results of the future analysis are provided in the following tables: **Table 4-19** summarizes all pollutant source loads and highlights **Table 4-20** human-related pollutant sources. In future conditions, we anticipate that low density residential areas will produce the largest loads for TN (53%), TP (49%), and bacteria (58%). Medium density residential is expected to produce the second highest loads for TN (27%), TP (25%), and bacteria (29%). Channel erosion contributes the greatest amount of TSS load in the watershed (51%).

Table 4-19: Givhans Ferry Watershed Future Pollutant Loads

WTM Category	Source Scenario	Area (acres)	TN (lb/year)	TP (lb/year)	TSS (lb/year)	*E. coli* (MPN/year)
LDR	Environmental Conservation	13,220				
	Institutional/Recreational	27				
	Low Density Traditional Neighborhood	3603				
	Low Intensity Development	742				
	Riparian Corridor	27,149				
	Rural Development-1	1,216				
	Rural Neighborhood	12,804				
	Rural Residential	126				
	LDR Total	58,887	4.43E+05	6.54E+04	1.03E+07	8.69E+15
MDR	Agricultural (Flex-1)	114				
	Medium Density Traditional Neighborhood	845				
	Rural Crossroads	818				
	Rural Development-2	22,335				
	Single Family Residential	93				
	MDR Total	24,205	2.27E+05	3.35E+04	5.29E+06	4.44E+15
Multifamily	Employment Mixed Use	2,754				
	Transit Oriented Development	1,766				
	Multifamily Total	4,520	6.35E+04	9.38E+03	1.48E+06	1.25E+15
Commercial	Commercial	107				
	Community Commercial	103				
	Highway Commercial	41				
	Light Commercial	37				
	Rural Neighborhood Commercial	2				
	Town Center	25				
	Commercial Total	315	6.23E+03	6.52E+02	1.28E+05	4.07E+13
Industrial	Industrial	2				
	Light Industrial	2				
	Industrial Total	4	6.66E+01	7.57E+00	2.45E+03	2.77E+11
Forest	Conserved Areas	10279	6.23E+03	6.52E+02	1.28E+05	4.07E+13
Open Water	Water	412	5.27E+03	2.06E+02	6.39E+04	0
Roadway	Roadway Total	950	2.23E+04	2.42E+03	1.30E+06	8.86E+13
Septic	Onsite Sewage Disposal		3.36E+04	5.60E+03	2.24E+05	4.50E+14
SSO	Sanitary Sewer Overflows		2.00E+00	0.00E+00	1.30E+01	1.32E+12
Erosion	Channel Erosion		1.95E+04	1.56E+04	1.95E+07	0
Livestock	Chickens		2.90E+03	4.83E+02	0	9.71E+13
	ALL Sources Total		**8.30E+05**	**1.34E+05**	**3.84E+07**	**1.51E+16**
	ALL Sources Total (ton/yr)		**415**	**67**	**19,208**	

The estimated total future loads related to human sources are 96% of all TN, 87% of all TP, 49% of all TSS, and 99% of all *E. coli*. In the future conditions, based on maximized land development per zoning, the estimated loads produced by barren land, cropland, pasture, and grassland is eliminated due to land conversion. As we saw examples during our field visits, even the sand mine areas are being converted to residential uses. Therefore, the focus of recommendations in this WBP will be to enhance best management practices for residential development and channel protection, while simultaneously addressing current sources of pollution related to cropland, pasture, and grassland (erosion control and nutrient management). The recommendations are summarized in **Section 5.0 Implementation Plan**.

Table 4-20: Givhans Ferry Watershed Future Pollutant Loads from Human Sources

WTM Category	Source Scenario	Area (acres)	TN (lb/year)	TP (lb/year)	TSS (lb/year)	*E. coli* (MPN/year)
LDR	LDR Total	58,887	4.43E+05	6.54E+04	1.03E+07	8.69E+15
MDR	MDR Total	24,205	2.27E+05	3.35E+04	5.29E+06	4.44E+15
Multifamily	Multifamily Total	4,520	6.35E+04	9.38E+03	1.48E+06	1.25E+15
Commercial	Commercial Total	315	6.23E+03	6.52E+02	1.28E+05	4.07E+13
Industrial	Industrial Total	4	6.66E+01	7.57E+00	2.45E+03	2.77E+11
Roadway	Roadway Total	950	2.23E+04	2.42E+03	1.30E+06	8.86E+13
Septic	Onsite Sewage Disposal		3.36E+04	5.60E+03	2.24E+05	4.50E+14
SSO	Sanitary Sewer Overflows		2.00E+00	0.00E+00	1.30E+01	1.32E+12
	Human Sources Total		7.96E+05	1.17E+05	1.87E+07	1.50E+16

5.0 Implementation Plan

The implementation plan includes a description of the recommended management strategies and restoration projects and provides an estimation of the water quality benefits that would be realized from plan implementation. This section includes cost estimates for strategy implementation, identifies potential funding sources and partners, and describes monitoring programs to document plan implementation and changes in the watershed condition over time. The recommendations of this plan also incorporate considerations related to climate change and source water protection in order to help ensure the long-term success of these projects.

5.1 Community Engagement

Development of the plan has included positive community engagement efforts to both inform the public about watershed issues and to encourage them to participate. The following sections describe efforts in place throughout the assessment and planning process, and the strategies for future outreach. **Table 5-1** summarizes potential partnering organizations to help execute the recommendations in this WBP.

Table 5-1: Outreach and Education Partnerships

Program	Program Goals or Outcomes
Clemson Extension	Provide stormwater education, outreach, and public involvement opportunities for water quality and livestock waste management
Dorchester County Soil & Water Conservation Districts	Develop and implement programs to protect and conserve soil, woodland, riparian, and wetland resources
SC Forestry Commission	Provide support and education for forestry
Long Leaf Alliance	Provide public education for conservation, riparian buffers, water quality
Lowcountry Land Trust	Provide public education for conservation, riparian buffers, water quality
SC Natural Heritage Program	Provide information regarding rare, threatened, or endangered species with ranges in the watershed
South Carolina Native Plant Society	Provide speakers/information/plants for rain garden and sustainable landscaping practices. The Lowcountry Chapter of SCNPS also provides grants for projects in the eight coastal counties.
Palmetto Pride	Provide support for litter removal
SC Wildlife Federation	Provide support for invasive species removal
Friends of the Edisto	Protect and enhance the Edisto River Basin's natural and cultural character and resources through conservation and responsible use.
Edisto Riverkeeper	Engages in advocacy, stewardship, education, and outreach to achieve a healthy, flowing, sustainable Edisto River system.
Audubon South Carolina	Manages more than 30 thousand acres in South Carolina, of which 18,396 are associated with the Francis Beidler Forest draining to the Edisto River (including 1,827 acres in the Givhans Ferry watershed). Audubon supports using bird- and climate-friendly forestry. There are nine chapters that support conservation through education and advocacy.

5.1.1 Outreach Strategies

The following strategies may be used to gain additional community support and involvement.

Website – Partners such as Dorchester and Colleton Counties, can add information about the watershed plan to existing resources to keep the public informed about the watershed plan. The purpose of the website will be to disseminate important information about implementation and monitoring of recommendations from this WBP as well as advertise upcoming events (such as litter sweeps), and accomplishments (highlighting successful completion of projects and recommendations from this plan).

Social Media – Facebook and Instagram accounts can be created specifically for information related to programs and news about the Givhans Ferry Watershed; or, updates about programs and progress related to the WBP can be posted to existing social media accounts, such as https://www.facebook.com/BCDCoG/ or https://www.facebook.com/ashleycooperstormwater. This is another means of providing quick, engaging updates to all interested parties without having to produce a formal update to the website.

Factsheets – The Counties could choose to develop their own version of stormwater related factsheets, or they could take advantage of the publications already available from Clemson University's Home & Garden Information Center's database of factsheets, including these specifically geared towards water: https://hgic.clemson.edu/category/water/

- Aquatic and Shoreline Plant Selection (HGIC 1709)
- Rainwater Harvesting Systems Guidance for Schoolyard Applications (HGIC 1729)
- Illicit Discharges and Water Pollution (HGIC 1850)
- Shorescaping Freshwater Shorelines (HGIC 1855)
- Bioretention Cells: A Guide for Your Residents (HGIC 1862)
- Introduction of Bioswales (HGIC 1863)

Media Coverage – Publicizing and reporting on activities related to the implementation of the Givhans Ferry Watershed Plan can be accomplished through broadcast and print news media outlets, such as the *Post and Courier* newspaper. Reaching out to local television news media would also provide an opportunity to reach a broad audience about upcoming and completed activities and projects related to the WBP.

Mailings – Direct mailings allow the project partners to fill potential information gaps (people who do not read the paper, participate in social media, or follow local government news). Fliers, postcards, and posters can all be used to inform residents in the Givhans Ferry Watershed about the benefits of the proposed stormwater practices. They could generate a list of the addresses of the residents in the watershed (could be included with the DPU's water billing statements), which could be used to send invitations to meetings and workshops or provide other information about nonpoint source pollution outreach events (for example: storm drain markings, construction of stormwater detention basins, etc.).

Community Meetings – Providing stakeholders, such as residents and business owners, in Givhans Ferry Watershed the opportunity to provide feedback and receive updates on aspects of this plan and its implementation will greatly enhance the public's support of this work. The Counties or BCDCOG could host meetings in their own facilities, or at locations within the watershed such as Colleton State Park, Givhans Ferry State Park, or within specific groups such as the Edisto Natchez-Kusso Tribe or the Dorchester County Soil & Water Conservation Service office. Topics of meetings may include:

- Overview of watershed, implementation strategy, and benefits

- Possible funding sources
- General stormwater education seminars (what is stormwater and why it could be a problem)
- Public education and outreach opportunities
- Training for Adopt-a-Stream monitoring protocol
- Workshops for septic system maintenance

Individual Outreach – Working with property owners in the Givhans Ferry Watershed is a crucial link between the planning and implementation phases. This will be especially important when trying to inventory and assess the current condition of existing septic systems in the watershed (identifying those that need repairs or replacement). Through the other education outreach/involvement opportunities listed in this section, it may be possible to identify individuals who would be willing to participate in activities such as stream restoration, riparian buffer plantings, and other stormwater BMPs. One method of individual outreach could involve sending targeted mailings to property owners with septic systems. Another possibility could be the Dorchester Soil and Water Conservation District reaching out to property owners with cattle and/or streambank erosion for help applying for grant funding for various agricultural BMPs (vegetative filter strips, buffer plantings, cattle fencing, alternative watering sources, stream crossings, etc.). Another option to try to engage residents is door-to-door outreach. In areas where recommended projects would be implemented, this would be a good follow-up approach to mailings and provide an opportunity for residents to learn about the positive water quality outcomes. The Counties or BCDCOG could coordinate with a consultant or other WBP stakeholders (such as Edisto Riverkeeper, or Clemson Extension) to organize volunteers or employees to undertake this task.

Watershed Association – Interested citizens, City/County representatives, professionals, and educational partners can form a Givhans Ferry Watershed Association to oversee the implementation and periodic evaluation of this watershed management plan. This organization would function as a non-profit organization that can partner with the City/County jurisdictions to apply for grants and implement public outreach/education endeavors. There are many examples of successful groups in the state of South Carolina (such as the Gills Creek Watershed Association in Columbia or the May River Watershed Action Plan Advisory Committee) and across the region (such as the Ellerbe Creek Watershed Association in Durham, NC) that could be used as a reference for the organization and work of a watershed organization.

Workshops – Workshops related to specific measures that residents can implement on their property will both build support and provide the tools for individual action. Potential workshop topics are varied and may include lawn care, pet waste, septic system maintenance, native and invasive vegetation, and rain gardens. The Dorchester Soil and Water Conservation District, Clemson Extension, and/or Edisto Riverkeeper could coordinate these workshops.

Professional Training Opportunities – Training geared towards specific audiences (HOAs, landscapers, maintenance crews, etc.) will prepare the "boots on the ground" in the Givhans Ferry Watershed to manage newly-installed BMPs effectively. Examples of courses offered through Clemson Extension are the *Master Pond Manager* and *Master Rain Gardener* certifications:

https://www.clemson.edu/extension/water/hybrid-training/mpm/index.html

https://www.clemson.edu/extension/raingarden/mrg/index.html

Community-wide Programs

Several recommendations are made to implement community-wide programs that are based on education and community engagement. Participation by watershed residents in practices that they can implement at their homes, businesses, schools, and places of worship is crucial. These programs are generally referred to as 'source control' strategies, as they reduce or eliminate the pollutant at its source before it can enter the waterway.

Residential Lawn Care Education – Educate watershed residents on the impact of various lawn care practices on water quality. Excess fertilizer can run off into waterways and be a significant source of nutrients, in addition to being potentially unnecessary and costly to the property owner. Topics would include soil testing, recommended fertilizer levels, non-phosphorus fertilizers, organic fertilizers, conversion of lawn to native vegetation, and mowing practices. Programs could be implemented or sponsored by the Counties, Dorchester SWCD, and/or Clemson Extension Services. Reducing nutrient pollution in source water helps reduce plant and algal growth, which in turn reduces the amount of organic carbon that needs to be removed from the drinking water to prevent disinfection byproducts. Additionally, education related to reducing lawn area helps improve climate resiliency of urban/suburban landscapes. Native plants require less maintenance and irrigation, and larger woody or herbaceous plants can reduce runoff better than turf.

Pet Waste Education – Proper disposal of pet waste helps protect the source water for the Charleston Water System by reducing both bacteria and nutrients from source water. In many neighborhoods, improperly disposed pet waste can be a source of fecal bacteria and nutrients, particularly from dogs. An outreach program to educate residents on the environmental and hygiene/health impacts of pet waste disposal is already in place in Dorchester County through their partnership with the Ashley-Cooper Stormwater Education Consortium; there is always a need to continue and expand the program, especially with the anticipated future increase in residential land uses that could bring more pets into the watershed. The program should be coupled with pet waste disposal stations, signage in high-traffic dog walking areas, and possibly a local ordinance for removal and proper disposal of pet waste.

At this time, the WTM does not calculate load reductions associated with practices such as reducing the number of domestic animals (dogs and cats) kept as outdoor pets or reducing the feral cat population. In addition to reducing bacteria, reducing the number of outdoor/feral cats in the watershed will yield other positive environmental results such as protecting smaller animals (birds, reptiles, amphibians, and mammals) that would be hunted and killed otherwise. The Audubon Society estimates that domestic cats kill between 1.4 to 3.7 billion birds and 6.9 to 20.7 billion mammals each year in the continental United States.

Septic System Education – Septic systems, or on-site disposal systems (OSDS), can be contributors of viruses, pathogens, and nitrogen to the groundwater and eventually to surface waters. This is a substantial threat in the Givhans Ferry Watershed, where 95% of residential dwellings are not connected to the sanitary sewer system. Furthermore, with potential increases in rainfall and an upward shift in bacteria concentrations due to warmer weather, managing septic systems should be a key consideration of climate resiliency in this watershed. Regular maintenance of these systems is necessary to ensure long-term operation and safe source water supplies. Educational materials and workshops can be developed to present recommendations and explain existing local ordinances for septic tank pumping, drain field care and percolation testing, proper disposal of household hazardous waste, and general best management practices for proper maintenance and operation. Programs could be organized by the City and County, with support from SCDES and the BCDCOG. The WTM offers several options to estimate reductions of the pollutant loads associated with septic systems. These four practices represent different techniques that either improve performance or reduce the number of septic systems in the watershed: OSDS education, OSDS repair, OSDS upgrade, and OSDS conversion to sanitary sewer/WWTP. It is the recommendation of this plan to gather more detailed information pertaining to the current status of septic systems in this watershed before determining the types of practices needed to estimate load reductions, as described in **Section 5.2.4 Septic System Recommendations** in this WBP.

Rain Barrels / Downspout Disconnect – Many towns and cities have traditionally used gutter and downspout systems to 'connect' stormwater from homes, businesses, schools to the storm drain system. Disconnecting these systems to direct rainwater from roofs to open grassy areas or to rain barrels and cisterns reduces the overall volume of stormwater runoff, conserves water use, reduces pollutants entering the stream, and provides clean water for gardens and everyday outside use. Encouraging stormwater to be detained and treated via infiltration onsite reduces the downstream burden on stormwater infrastructure, which improves the community's climate resiliency. Additionally, onsite use of water reduces the amount of organic matter that can be conveyed downstream (which presents a source water treatment concern). An education program can include rain barrel workshops to distribute rain barrels and instruction for their installation and use. Programs can be implemented by educational partners such as Clemson Extension or Dorchester SWCD. Additionally, the Clemson Extension program offers a "Master Rain Gardener" certification program that is focused on rain garden and rainwater harvesting system design for both residents and landscape professionals. For more information, see Sections 4.6 Rainwater Harvesting and 4.7 Impervious Surface Disconnection in *Low Impact in Coastal South Carolina: A Planning and Design Guide*.

Rain Gardens / Bioswales – Dorchester County, Colleton County, Harleyville, and Ridgeville should include rain gardens and bioswales in future capital improvement projects. This also provides an opportunity for educational signage for the public, as shown in an example project from the City of Aiken (**Figure 5-1**). Outreach and Education partner organizations (such as Dorchester SWCD, Friends of the Edisto, and the SC Native Plant Society) can also encourage residents to participate in workshops and programs, such as the Carolina Rain Garden Initiative, to install rain gardens on private property. Educational messaging to residents should include information about how rain gardens provide opportunities to infiltrate and absorb stormwater runoff, mange erosion, beautify the home landscape, create pollinator and bird-friendly habitats, and protect clean water downstream. Smaller stormwater practices such as these, which are spread out across the watershed, will help the landscape mimic the natural hydrologic cycle and increase on-site infiltration and treatment of stormwater, which is a form of climate resiliency. These programs should make a connection for homeowners about how their landscape choices help protect their drinking water.

Figure 5-1: Example rain garden and educational signage in City of Aiken

5.2 Recommended Practices and Strategies to Reduce Pollutant Loads

These practices and recommendations occur at different scales and are undertaken by different organizations as described below.

5.2.1 Agricultural Best Management Practices

Livestock Operations

Cattle, horses and other pastured livestock may have free access to streams and ponds, which could allow their waste to be deposited directly into the waterbody. Landowners and managers of agricultural facilities should consider management practices that eliminate or reduce animal access to streams and wetlands, such as livestock exclusion fencing and designated stream crossing areas to reduce direct potential nutrient inputs from animal waste. The installation of alternative watering sources such as watering tanks/troughs or other systems that divert the water access for cattle away from streams can reduce streambank erosion and soil disturbance that is caused when animals repeatedly access streams as the primary watering source. Keeping livestock out of streams can help to reduce bacteria loading and stream bank erosion. BMP options to consider include:

- Litter Storage and Management
    - Types of practices that will help reduce pollutants from manure and litter may include short term storage of animal waste and by-products (NRCS 318-CPS-1[55]), Waste Storage Facility (NRCS 313-CPS-1[56]) and Nutrient Management (NRCS 590-CPS-1[57]). Short-term storage uses nonstructural measures to store solid or semisolid organic agricultural waste or manure (bedding, litter, spilled feed, or soil mixed with manure) between collection and utilization. A stockpile should be located outside the 100-yr floodplain, at least 100 ft from all drainageways, in locations where the seasonal high-water table is greater than 2 ft below the bottom of the stored manure (unless a geosynthetic liner is used), and a 30-ft vegetative buffer should be located on the downslope side of the pile (to filter out solids from runoff). A waste storage facility may include storage ponds or tanks and solid waste stacking structures. Lastly, a nutrient management plan for nitrogen, phosphorus, and potassium accounts for all known measurable sources (fertilize, biosolids, compost, etc.) and removal (plant uptake) of these nutrients. This plan should be created in cooperation with a land grant university's guidance along with detailed testing of the in-situ soils and mature/litter source.
- Livestock/cattle exclusion fencing:
    - This involves constructing permanent fencing along streams in livestock pastures that prevents animals from accessing the stream channel and land adjacent to the stream (riparian area). Excluding livestock has been shown to reduce nitrogen, phosphorus, pathogens, and sediment loads in streams by eliminating direct deposition of animals' waste and the trampling of stream

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[55] USDA NRCS. 2020. Short Term Storage of Animal Waste and By-Products. Available at https://www.nrcs.usda.gov/sites/default/files/2022-09/Short_Term_Storage_Of_Animal_Waste_And_Byproducts_318_CPS_9_2020.pdf

[56] USDA NRCS. 2023. Waste Storage Facility. Available at https://www.nrcs.usda.gov/sites/default/files/2023-08/313_NHCP_PO_Waste_Storage_Facility_2016.pdf

[57] USDA NRCS. 2019. Nutrient Management. Available at https://www.nrcs.usda.gov/sites/default/files/2022-09/Nutrient_Management_590_NHCP_CPS_2017.pdf

banks. This encourages the growth of vegetation, which in turn filters runoff, stabilizes channels, and may remove nitrogen from groundwater.[58]

- Heavy use area stabilization:
    - This practice is installed to protect and improve water quality by providing a stable, non-eroding surface for areas frequently used by animals, people, or vehicles. It is used in areas where livestock is concentrated, such as feeding areas, portable hay rings, watering facilities, feeding troughs, and mineral areas. Commonly used surface treatments may include concrete, bituminous concrete, and gravel.[59]
- Controlled stream access for livestock watering
    - Stream crossings provide access to another field or area. Ford crossings are best suited for a wide, shallow watercourse with a firm stream bed; they are typically constructed with concrete or rock but are best suited for infrequent use. For crossings that will be used often, a bridge or culvert would be the best option to protect water quality. A culvert or bridge also is the best choice for sites where the stream channel is narrow, or the banks are steep.[60]
- Alternative watering sources (such as tanks or troughs):
    - Tanks and troughs provide a water source for livestock or wildlife that is an alternative to a sensitive resource. When possible, the watering facility should be located away from streams, ponds, or riparian areas to limit the potential for fecal contamination or surface pollution. Additionally, they should be located in areas to minimize erosion problems (for example, avoid steep slopes).[61]

Cultivated Crops

For areas within the watershed that are used for cultivated crop production (for example: wheat, hay, soybeans, peanuts, corn, etc.), there are several options to reduce nonpoint source pollution that may be caused by erosion (as eroded sediments, bacteria and nutrients from fertilizers are transported to adjacent streams and wetlands). Soil erosion can allow both sediment and nutrients to enter waterbodies, whether through the disturbance of stream and ditch banks or by way of overland runoff from agricultural fields. Vegetated buffers and filter strips can provide erosion control around fields, which helps to reduce nitrogen, phosphorus, TSS, and bacteria from entering waterways. The following management practices should be considered to reduce soil erosion and nutrient runoff from agricultural sources:

- Critical area planting:
    - This practice establishes permanent vegetation on sites that are eroding or have the potential for high erosion rates[62]. It is used on sites that have physical, chemical, or biological conditions that prevent the establishment of vegetation with normal seeding/planting methods. A

[58] NC State Extension. 2023. Livestock Exclusion Fencing: Lessons Learned. AG-948. Available at https://content.ces.ncsu.edu/livestock-exclusion-fencing-lessons-learned

[59] USDA. 2020. Conservation Practice Overview: Heavy Use Area Protection. Available at https://www.nrcs.usda.gov/sites/default/files/2022-09/Heavy_Use_Area_Protection_561_Overview_9_2020.pdf

[60] USDA. 2020. Conservation Practice Overview: Stream Crossing. Available at https://www.nrcs.usda.gov/sites/default/files/2022-10/Stream_Crossing_578_NHCP_PO_2020.pdf

[61] USDA NRCS. 2020. Conservation Practice Standard: Watering Facility. Available at https://www.nrcs.usda.gov/sites/default/files/2022-10/Watering_Facility_614_NHCP_CPS_2020.pdf

[62] USDA NRCS. 2016. Critical Area Planting. Available at https://www.nrcs.usda.gov/sites/default/files/2022-09/Critical_Area_Planting_342_CPS.pdf

combination of vegetative and structural measures may be necessary on slopes steeper than 3:1 to ensure adequate stability.

- Cover crops:
  - Grass, small grains, or legumes are grown for seasonal protection and soil improvement. This practice improves overall soil health by reducing erosion, adding fertility to the soil, and increasing infiltration and aeration of the soil. Additionally, cover crops improve water quality by filtering sediment, pathogens, and dissolved and sediment-attached pollutants from runoff.[63]
- Conservation tillage:
  - This includes any tillage and planting system that covers 30 percent or more of the soil surface with crop residue after planting to reduce soil erosion by water. Where soil erosion by wind is the primary concern, any system that maintains at least 1,000 pounds per acre of flat, small grain resident equivalent on the surface throughout the critical wind erosion period. There are several types of conservation tillage including no-till, in-row subsoiling, strip-till, and ridge-till. These practices, which manage crop residues at the soil surface, have been shown to improve nutrient cycling, increase water conservation and availability, reduce runoff and leaching of nutrients off-site, and enhance crop productivity and profitability. [64]
- Vegetated filter strips:
  - This is an area of herbaceous vegetation that is placed near environmentally sensitive areas that need to be protected from sediment, suspended solids, and dissolved contaminants in runoff. The minimum flow length through the strip should be 20 feet for suspended solids and 30 feet for dissolved contaminants and pathogens in runoff. When appropriate, native grass and forb species should be utilized to provide benefits for wildlife and pollinators. Similarly, whenever possible, the minimum strip widths should be increased.[65]
- Controlled Drainage:
  - This practice is a component of a water management system that can control the stage, discharge, delivery, or direction of water flow. Installation of water control structures, such as checks, flashboard risers, and check dams, can slow the flow of water in ditches and from fields to allow for the settling of sediment and nutrients. Structures such as sluice gates and sediment traps can provide silt management in ditches or canals.[66]
- Streambank and shoreline protection:
  - This practice is utilized to stabilize streambanks of natural or constructed channels and shorelines of lakes or reservoirs susceptible to erosion. In general, incised segments or segments that contain the 5-year return period (20% probability) flow or greater flows should be evaluated for further degradation or aggradation. The channel should not be realigned without an assessment of the upstream and downstream fluvial geomorphology. Bank treatments

[63] USDA NRCS. 2014. Conservation Practice Standard: Cover Crop. Available at https://www.nrcs.usda.gov/sites/default/files/2022-09/Cover_Crop_340_Overview.pdf
[64] SARE. 2024. Conservation Tillage Systems in the Southeast: What is Conservation Tillage? Available at https://www.sare.org/publications/conservation-tillage-systems-in-the-southeast/chapter-1-introduction-to-conservation-tillage-systems/what-is-conservation-tillage/
[65] USDA NRCS. 2016. Conservation Practice Standard: Filter Strip. Available at https://www.nrcs.usda.gov/sites/default/files/2022-09/Filter_Strip_393_CPS.pdf
[66] USDA NRCS. 2017. Conservation Practice Standard: Structure for Water Control. Available at https://www.nrcs.usda.gov/sites/default/files/2022-10/Structure_for_Water_Control_587_CPS_Oct_2017.pdf

should be installed at a depth at or below the anticipated lowest depth of streambed scour. Where toe protection alone is inadequate to stabilize the bank, the upper bank should be shaped to a stable slope with established vegetation. To the extent possible, habitat forming elements that provide cover, food, pools and water turbulence (such as stumps, fallen trees, debris and sediment bars) should be retained.[67]

Load Reductions from Agricultural BMP recommendations are summarized in **Table 5-2.** The Best Management Practice Efficiency References for Pollutant Load Estimation Tool[68] were used to calculate the benefits of each of the agricultural BMPs.

Table 5-2: Pollutant Reductions Provided by Agricultural BMPs

Recommendations	TN (lb/year)	TP (lb/year)	TSS (lb/year)	*E. coli* (MPN/year)
Litter management	406	68	-	9.5E+13
Livestock exclusion fencing	910	61	239,320	2.1E+12
Heavy use area stabilization	819	27	123,399	6.9E+12
Stream crossing/controlled access	683	31	112,181	1.7E+12
Alternative water source	819	18	74,787	2.1E+12
Critical area planting	228	14	52,351	3.4E+12
Streambank stabilization w/ fencing	4,100	3,280	4,099,431	0.0E+00
Streambank stabilization w/o fencing	820	962	1,639,772	0.0E+00
Controlled drainage	3,459	279	-	2.7E+14
Cover crop	2,096	56	63,654	2.3E+14
Conservation tillage	734	287	292,808	2.7E+14
Vegetated filter strip	3,563	350	337,366	6.8E+14
Total Reduction	**18,635**	**5,432**	**7,035,071**	**1.6E+15**
Total (tons/yr)	**9.3**	**2.7**	**3,517.5**	

5.2.2 Forestry Best Management Practices

Through discussions with stakeholders, several suggestions for forestry best management practices were provided. Although no large forestry programs are in place in the watershed, it is assumed that there is the potential for many smaller landowner forested tracts to be harvested. With the closing of the paper mill in North Charleston, there is concern that these forested acres will be converted to residential and commercial development in the near future.

In the event that forestry continues in the watershed, here are recommendations from several programs:

- Encourage all harvesting operations to follow the voluntary guidance from the SC Forestry Commission BMPs for logging jobs to prevent problems before they start
- Encourage Timber Operation Professionals certification for loggers
- Encourage American tree farm certification

[67] USDA NRCS. 2020. Conservation Practice Standard: Streambank and Shoreline Protection. Available at https://www.nrcs.usda.gov/sites/default/files/2022-10/Streambank_Shoreline_Protection_580_CPS_10_2020.pdf
[68] USEPA. 2023. Best Management Practice Efficiency References for the Pollutant Load Estimation Tool. Available at https://ordspub.epa.gov/ords/grts/r/grtsadm/files/static/v287/BMP%20Efficiency%20References%20Doc%20082023.pdf

- Encourage planting the “right tree in the right place” to provide resilience to wildfire, drought, disease, and insects.

5.2.3 Municipal Programs

Watershed management strategies that can be implemented broadly by either the municipalities or counties are described here. The recommendations in this section focus reduction of illicit discharges to the stormwater system, and prevention of sanitary sewer overflows (SSOs). SSOs are spills from structures (pipes, pump stations, etc.) in a wastewater conveyance system that can cause untreated sewage to spill into city streets, streams, and other areas before the untreated sewage reaches a treatment facility. Illicit discharges are defined as water discharges to the municipal separate storm drain system that are not entirely composed of stormwater. That is, they are harmful and often illegal connections to the stormwater system from business or commercial activities. In some cases, the recommendation may be to build on or add frequency to existing programs.

Sanitary Sewer Overflow Prevention – The WTM estimates that SSOs from sanitary sewer system are a relatively small source of bacteria in the overall Givhans Ferry Watershed. Problems that can cause chronic SSOs include:

- Too much rainfall or snowmelt infiltrating through the ground into leaky sewer systems;
- Runoff that is directly connected to sewer systems;
- Sewers and pumps too small to carry sewage from newly developed subdivisions or commercial areas;
- Blocked, broken, or cracked pipes due to tree roots, pipe settlement, and material build-up within pipes;
- Power failures that prevent the system from functioning; or
- Vandalism to the sanitary sewer conveyance system.

Practices to reduce or eliminate SSOs include routine sewer system cleaning or maintenance; repairing broken or leaking sewer service lines; enlarging or upgrading the sewer/pump station capacity or reliability; and construction of wet weather storage and treatment facilities to treat excess flows. Additionally, the Town of Harleyville and Dorchester County can provide public education to prevent blockages in existing sanitary sewer systems by discouraging flushing wipes and encouraging residents to dispose of fats, oils, and grease (FOG) properly. Note that the Harleyville WWTP is about to be expanded and improved to provide better service.

Hotspot and Illicit Discharge Detection and Elimination (IDDE) – Dry weather flows discharging from storm drain systems can contribute significant loads to stream systems. Inspection and testing of water quality from outfalls, or from upland ‘hotspots’ during dry weather can assist in the detection of inappropriate discharge entering the stream both from storm drains and from other pipes potentially conveying discharge. Hotspots generally include commercial and industrial properties that may be specific sources of pollutants from poor housekeeping practices that allow pollutants to wash into the storm drain system. When an illicit discharge is found it can be tracked to its source for resolution. Discharge types can include sewage and septage flows, wash water flows such as laundry and car washing discharge, liquid waste such as oils and paints, landscape irrigation, dumpster runoff, and tap water.

5.2.4 Septic System Recommendations

In addition to the public education recommendations included in the WBP Implementation Plan, there must be an effort to survey and assess the existing septic systems in the Givhans Ferry Watershed. This presents a challenge, as septic systems are typically privately owned and maintained, making it more difficult for local governments or other organizations to identify problems. The benefit of having a local government, such as Dorchester County or the Town of Ridgeville, is that they could help homeowners apply for grant funding or other financial assistance to help cover repair costs.

Nearly all of the residential properties in the Givhans Ferry Watershed are not connected to the sanitary sewer system, and thus septic systems may have a substantial contribution to bacteria pollution. According to the GIS desktop analysis summarized in **Table 5-3**, the subwatershed with the most potential residential septic systems is Lower Indian Field Swamp. We recommend starting the survey in this subwatershed and then moving on to the other subwatersheds in descending order. We recommend utilizing the billing system for the Harleyville and Dorchester County wastewater systems to identify customers who have an account for sewer; all other address points in the watershed (provided by County GIS) are assumed to have septic systems. A note can be included with the yearly property tax statement that would include questions like:

- Do you (or someone you know) have problems with your septic system?
- Do your toilets, sinks, or bathtubs consistently back up?
- Does your septic system need to be pumped frequently?
- Do you have standing water or a foul odor in the yard where your septic system is located?

The letter would then inform the residents that a particular grant fund or capital improvement project from the local jurisdiction can help provide funding to cover the cost of repairing or replacing septic systems that are currently failing. Clemson Extension and Counties could partner with septic maintenance companies to perform the inspections and provide recommendations. Once the number and location of failing septic systems have been identified, then the BCDCOG or Clemson Extension could support the counties as they apply for funding to help homeowners make the necessary changes. Additionally, Dorchester County supports a recommendation that the county does not approve any major subdivisions (11 or more lots) that use septic systems in the area in the future.

Table 5-3: Residential Septic Systems by Subwatershed

Subwatershed	Number of Residences with Septic
Deep Creek	58
Halfway Gut Creek	421
Lower Indian Field Swamp	1,339
Poorly Branch	737
Skull Branch	525

In the WTM there are several ways to calculate benefits from septic system projects. These four practices represent different techniques to either improve septic system performance or reduce the number of septic systems in the landscape.

1. Education
    a. Assume 40% of septic systems (1,232) owners hear the messaging and 25% of those (308) are willing to change behavior
2. Repair
    a. Assume existing 10% of septic systems (308) are inspected and 25% of those (77) are willing to repair their systems

3. Upgrade
    a. Assume 10% of septic systems (308) are inspected and 25% of those (77) are willing to upgrade to a recirculating sand filter system[69] (designed for sites that have shallow soil cover, inadequate permeability, high groundwater, and limited land area)
4. Retirement/Connect to WWTP
    a. Assume 25% of septic systems (770) are retired (assume 10% failure rate of existing systems and 7% of existing systems are within 100 ft of waterway)

The WTM pollutant load reductions associated with these practices for septic systems is summarized in **Table 5-4**.

Table 5-4: Pollutant Reductions Provided by Septic System Improvements

Recommendations	TN (lb/year)	TP (lb/year)	TSS (lb/year)	*E. coli* (MPN/year)
Implementation of education, repair, upgrades, and retirement	2.00E+03	3.34E+02	1.34E+04	2.48E+13
Total (tons/yr)	1	0.2	7	

5.2.5 Stormwater Best Management Practices

Stormwater retrofit projects include many types of projects that capture and treat stormwater runoff from impervious surfaces in existing development. We selected the following BMPs, in combination with some previously described techniques (e.g. rain barrels and rain gardens) to treat various land use types:

- **Bioretention** cells and **bioswales** are shallow depressional areas that are filled with an engineered soil media and are planted with trees, shrubs, and other herbaceous vegetation. In addition to stormwater pollution reduction, they can provide other benefits such as improved aesthetics, wildlife habitat, urban heat island mitigation, and improved air quality. The WTM estimates pollutant removal as a factor of treatment efficiency, runoff reduction, and other factors (such as assumed maintenance and design standards).[70]
- **Wet ponds** are stormwater storage practices that are a combination of a permanent pool, micropool, or shallow marsh that promote a good environment for gravitational settling (sediments and phosphorus), biological uptake (nutrients), and microbial activity. Ponds are widely applicable for most land uses and are best suited for larger drainage areas.
- **Permeable pavement** systems are alternative paving surfaces (such as pervious concrete, porous asphalt, permeable pavers, concrete grid pavers, or plastic grid pavers) that capture and temporarily store runoff by filtering it through voids in the pavement into an underlying stone reservoir. Filtered runoff may be collected and returned to the conveyance system or allowed to infiltrate into the surrounding soil.

[69] https://www3.epa.gov/npdes/pubs/finalr_7e6.pdf
[70] Caraco, Deb. 2013. Watershed Treatment Model (WTM) 2013 documentation. Available at https://owl.cwp.org/mdocs-posts/watershed-treatment-model-documentation-final/

- **Green roofs** are systems that capture and store rainfall in an engineered growing media that is designed to support plant growth. A portion of the captured rainfall evaporates or is taken up by plants, which helps reduce runoff volumes, peak runoff rates, and pollutant loads on developed sites.
- **Grass channels** are a preferable alternative to grey infrastructure, such as curb and gutter, inlets, and storm drains, because of their ability to provide a modest amount of runoff filtering and volume attenuation (less runoff and pollutants). Their water quality treatment can be enhanced when compost amendments are added to the bottom of the channel.

Additionally, establishing a residential downspout disconnection program (applicable in LDR and MDR land uses, which total 4,884 acres in the entire Givhans Ferry watershed) was another recommendation. It was assumed that 100% of the residential areas were applicable for this technique, and that education surrounding disconnection would have a 40% awareness factor (the largest credit for awareness based on media type is for television).

There was very little stakeholder input for specific BMP types or locations, so we have provided a sampling of benefits that could be derived from different types of BMPs across the entire watershed. We assumed BMPs would most likely be situated in medium density residential (20% impervious), industrial (72% impervious), commercial (85% impervious), and roadways (98% impervious). We assumed 10% of each of these land uses was treated by a BMP as described in **Table 5-5.** BMPs that promote infiltration of stormwater were selected for each land use; note that even in poorly drained soils it is possible to get infiltration (with an underdrain) in BMPs such as bioretention.

Table 5-5: Recommended Retrofit Projects by Land Use Type

Land Use	10% of area (acres)	Dominant HSG	Depth to Groundwater	Recommended BMPs
MDR	101	D	< 3 ft	Bioretention, wet ponds, rain barrels
Industrial	11	D	< 3 ft	Bioretention, wet ponds
Commercial	18	D	< 3 ft	Permeable pavement, green roofs
Roadways	95	D	< 3 ft	Grass channel, bioswales

The net benefits of all retrofit projects would be a reduction in pollutant loads of 0.5 tons/yr TN; 0.1 tons/yr TP; 20 tons/yr TSS; and 1.08E+13 MPN/yr of *E. coli* bacteria per year. The individual project pollutant and runoff reductions are summarized in **Table 5-6**. Stormwater retrofit projects like these are useful for climate resilience planning and adaptation and help protect source water quality.

Table 5-6: Pollutant Reductions Provided by Each Retrofit Project

BMP	Acres Treated	TN (lb/year)	TP (lb/year)	TSS (lb/year)	*E. coli* (MPN/year)
Residential Impervious Disconnection		7.63E+01	1.00E+01	2.69E+03	8.77E+11
Residential wet pond	45	8.44E+01	3.66E+01	5.74E+03	1.54E+12
Residential bioretention	45	1.60E+02	3.42E+01	4.73E+03	1.54E+12
Residential rain barrels	11	4.55E+01	5.98E+00	1.61E+03	5.23E+11
Industrial wet pond	5.5	1.87E+01	5.92E+00	1.36E+03	3.64E+11
Industrial bioretention	5.5	3.56E+01	5.53E+00	1.12E+03	3.64E+11
Commercial bioretention	8.5	6.06E+01	8.47E+00	1.93E+03	6.30E+11
Commercial permeable pavement	8.5	4.69E+01	7.11E+00	1.62E+03	4.05E+11
Commercial green roof	1.0	6.21E+00	8.16E-01	2.19E+02	7.14E+10
Roadway bioretention	47.5	3.69E+02	4.56E+01	1.20E+04	3.90E+12
Roadway grass swale	47.5	1.36E+02	1.53E+01	7.87E+03	5.57E+11
TOTAL:		**1.04E+03**	**1.76E+02**	**4.09E+04**	**1.08E+13**
Total (tons/yr)		**0.5**	**0.1**	**20**	

5.2.6 Riparian Buffer Projects

Well-managed and adequately sized buffers are important for processing nutrients, filtering pollutants, providing habitat, retaining flood waters, and providing erosion prevention. Research has indicated that approximately 80% of nitrogen removal is achieved by stream buffers approximately 80-90 ft wide and widths of 150 feet or wider are more likely to consistently achieve their maximum potential for nitrogen removal.[71] The minimum 80-foot stream buffer width recommended for nitrogen removal was estimated to provide around 66% removal of total phosphorus. However, for this analysis, we will use the minimum buffer requirement associated with recommendations from SCDNR (50 feet) to be applied to 91 miles of streams.

The benefits of existing (EX) and recommended (REC) actions in the riparian buffers are summarized in

Table 5-7 below. Education refers to ensuring that property owners know what ordinances specify as acceptable and unacceptable activities in the buffer, and that signage is available for homeowners to identify these protected areas. This signage could be provided by the Counties, Clemson Extension, Edisto Riverkeeper, or the Dorchester Soil & Water Conservation District. Riparian buffers also enhance source water protection by filtering pollutants from runoff before they reach the downstream intake point. A robust riparian buffer also helps offset potential climate change challenges such as increased precipitation and increased in-stream water temperature, by providing vegetation to reduce erosion and shade the stream.

Table 5-7: Pollutant Reductions Provided by Riparian Buffer Activities

Riparian Buffer Condition	TN (lb/year)	TP (lb/year)	TSS (lb/year)	*E. coli* (MPN/year)
91 miles of 50' wide buffer	1.30E+04	2.70E+03	4.33E+05	1.39E+14
Total (tons/yr)	7	1	217	

[71] Bason, C. 2008. Recommendations for an Inland Bays Watershed Water Quality Buffer System. Delaware Center for the Inland Bays. Rehoboth Beach, DE.

5.2.7 Conservation Recommendations

The Nature Conservancy, in partnership with several other conservation organizations such as Lowcountry Land Trust and Ducks Unlimited, keeps records of currently protected lands in South Carolina. These properties have been placed under conservation easements and will be maintained for perpetuity. A conservation easement is a voluntary, legal agreement that permanently limits uses of the land in order to protect its conservation values[72]. For the purposes of this WBP, the current conditions land use was a combination of the National Land Cover Dataset and zoning. The current land use is assumed to carry forth into the future condition for these conserved lands in the Givhans Ferry Watershed, as summarized in **Table 5-8** and illustrated in **Figure 5-2**. Approximately 10% of the entire Givhans Ferry Watershed is currently protected with conservation easements.

Table 5-8: Targeted Future Conservation Area Details

Model Category	Land Use	
Active Construction	Barren Land	**3**
Cultivated Crops	Cultivated Crops	**124**
Open Water	Open Water	**140**
Roadway	Roadway	**26**
Low Density Residential	Agricultural Residential	171
	Institutional/Recreational	6
	Low Intensity Development	1
	LDR Total	**178**
MDR	Rural Development 2	**9**
Forest	Deciduous Forest	65
	Emergent Herbaceous Wetlands	94
	Evergreen Forest	4,733
	Mixed Forest	24
	Shrub/Scrub	370
	Woody Wetlands	4,176
	Forest Total	**9,462**
Rural	Grassland/Herbaceous	302
	Pasture/Hay	60
	Rural Total	**362**
Total Area		10,304

[72] National Conservation Easement Database. 2024. What is a Conservation Easement. Available at https://www.conservationeasement.us/what-is-a-conservation-easement/

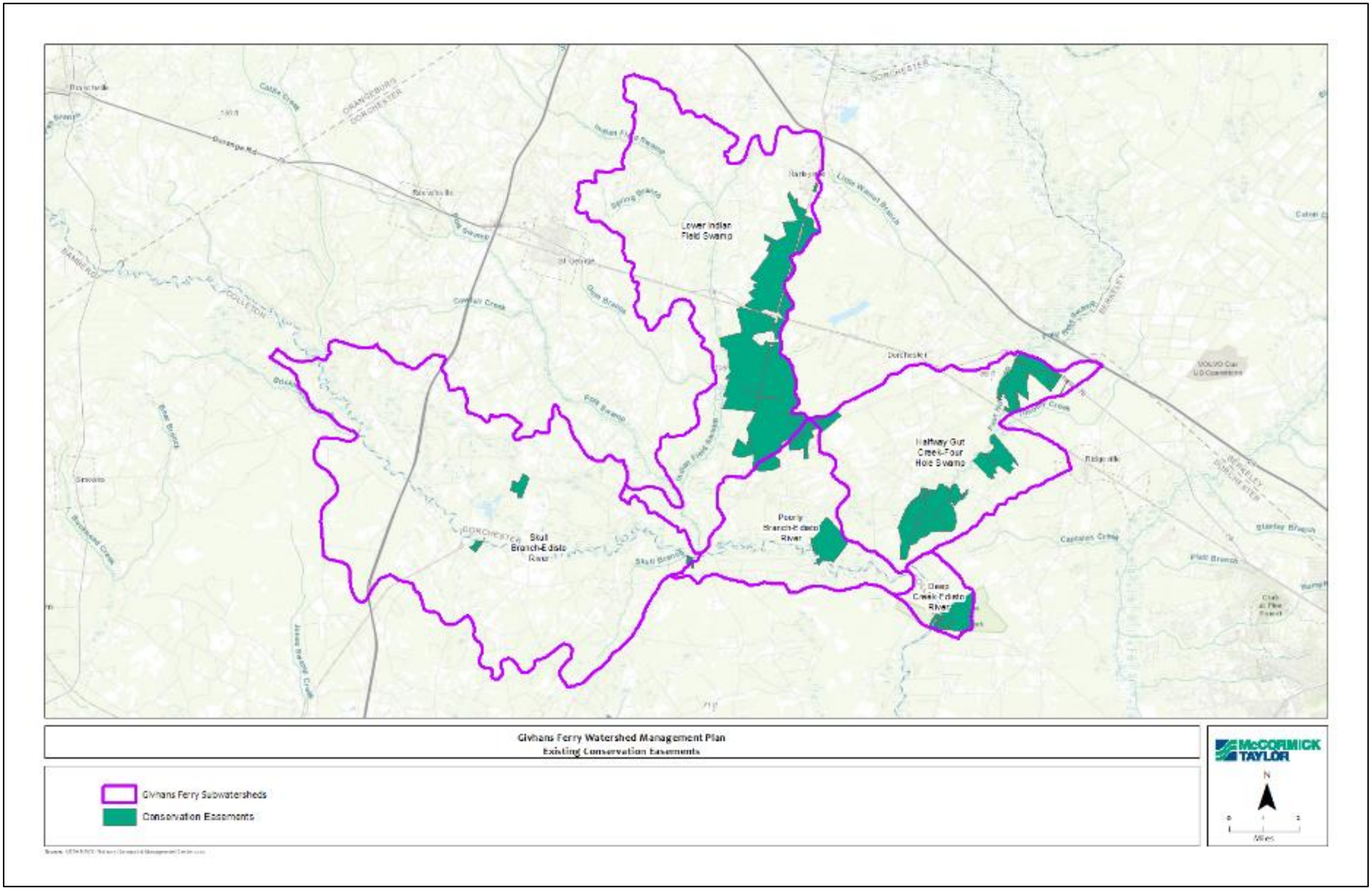

Figure 5-2: Existing Conservation Easements in the Givhans Ferry Watershed

In addition to existing conservation easements, conservation groups in South Carolina examined and documented natural habitats and resources statewide to create the first Conservation Vision map in 1998. Twenty years later, the Conservation Vision was updated using the blueprint from the South Atlantic and Appalachian Landscape Conservation Cooperatives (LCCs) – which integrated feedback from SCDNR, USFWS, USFS, local land trusts, and other conservation partners such as Ducks Unlimited, The Nature Conservancy, the National Audubon Society, and other federal, state and local groups. The 2018 Conservation Vision[73] map focuses on several conservation area types:

- CORE AREAS: Large, functioning blocks of habitat, typically anchored by public lands, such as wildlife management areas, wildlife refuges, state parks or national forests. These core lands typically are open for recreation and large enough to sustain healthy populations of plants and wildlife. Conserving these areas not only maintains our natural legacy but also can reduce regulatory burdens designed to protect rare species.
- BUFFERS: Private lands adjacent to core areas increase the size of the core areas and buffer them from outside impacts. Conservation easements protect land at a fraction of the cost of acquisition and keep those lands on the local tax rolls.
- CORRIDORS: Connected lands permit wildlife to move between core areas to access food, water, habitat and mates. Without effective corridors, core areas become isolated and lose species and ecological function over time. Corridors can be protected by acquisitions or conservation easements.
- CULTURAL AREAS: From battleground sites to Native American artifact preserves, our cultural resources are treasured statewide.
- ADDITIONAL RESILIENCE AREAS: Above average resilient lands from TNC's Connected and Resilient Landscapes data that were not captured using the filtered version of the LCC data.

This vision map (**Figure 5-3**) helps identify areas in the watershed that will be prioritized for conservation easements to help protect habitats, plants, and animals, as well as source water. The conservation area would be made up of portions of 57,789 acres (approximately 58% of the entire Givhans Ferry Watershed), as summarized in **Table 5-9**. It may be easier to establish permanent conservation easements on publicly owned parcels rather than privately held property, as private property would either need to be purchased or otherwise require additional targeted outreach to convince the landowner to agree to the stipulations of an easement. Groups such as the ACE Basin Task Force have had success persuading private citizens in the Givhans Ferry area to put their property in a conservation easement.

Table 5-9: Conservation Vision Areas

Vision Area Type	Total Area (acres)
Core Areas	33,435
Buffers	17,170
Corridors	5,823
Additional Resilience Areas	1,360
Total Area	**57,789**

[73] Bishop, David. 2018. *A Conservation Vision for South Carolina* [white paper]. The Nature Conservancy (SC).

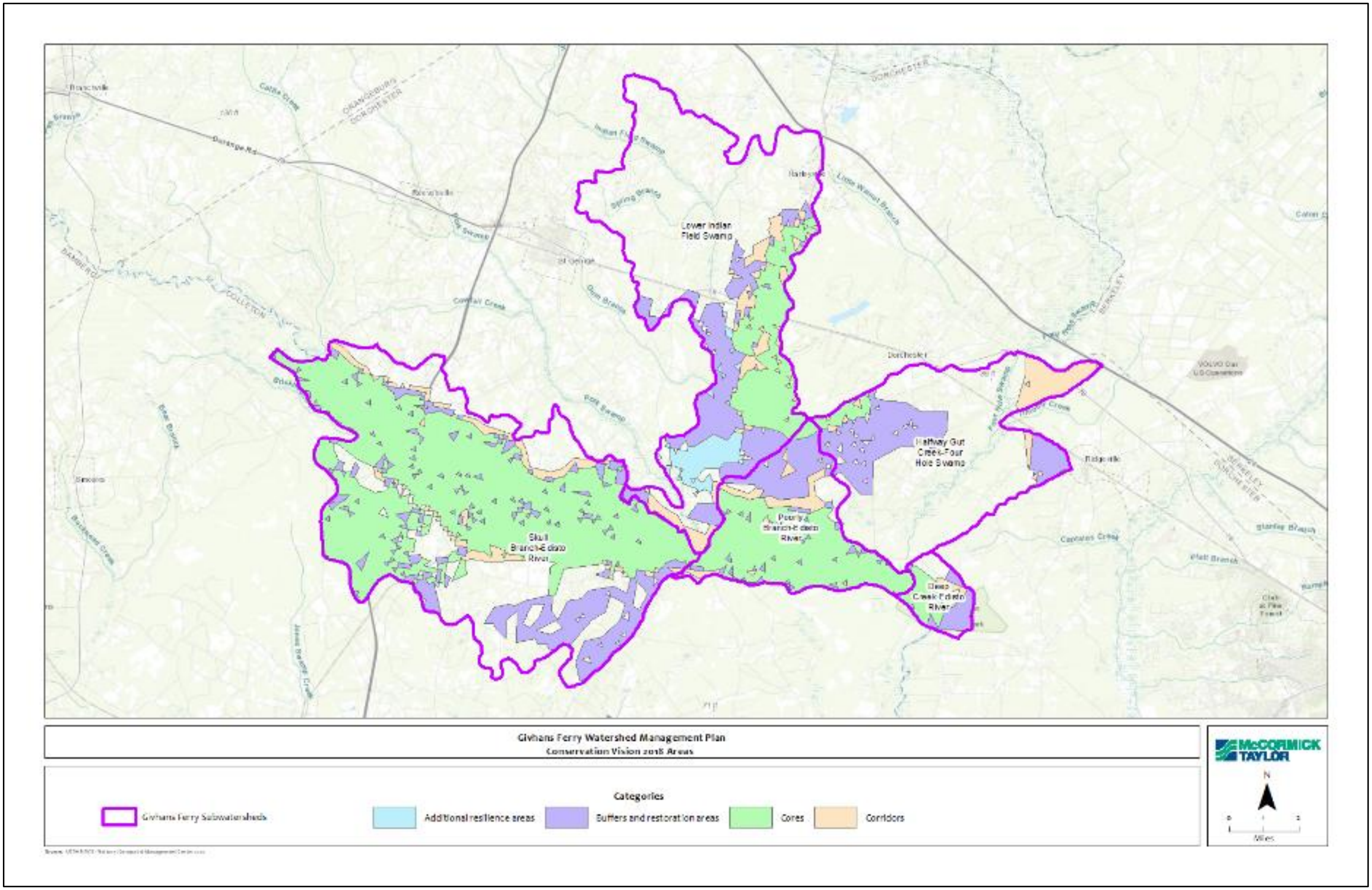

Figure 5-3: Conservation Vision 2018 for Givhans Ferry Watershed

An estimate of the impact the Conservation Vision could have for this watershed is to compare the current land use (combination of zoning and NLCD) and the proposed future land use (assume all parcels will be developed as zoned) is summarized in **Table 5-10**. Notably, cultivated cropland and rural areas (grassland and pasture) are completely displaced by development. Forested land could potentially be reduced by 83%. The increases in low density residential (LDR) and medium density residential (MDR) could be 1,646% to 2,367% of the current area.

Table 5-10: Targeted Future Conservation Area Details

Model Category	Land Use	Current Area (acres)	Future Area (acres)	% Change
Active Construction	**Barren Land**	**137.56**	**-**	**-100%**
Commercial	Commercial	44.23	44.23	
	Community Commercial	5.66	78.10	
	Rural Neighborhood Commercial	0.28	0.49	
Commercial Total		**50.17**	**122.82**	**145%**
Cultivated Crops	**Cultivated Crops**	**3,081.91**	**-**	**-100%**
Forest	Deciduous Forest	600.66		
	Emergent Herbaceous Wetlands	1,257.99		
	Evergreen Forest	18,688.00		
	Mixed Forest	351.48		
	Shrub/Scrub	2,670.54		
	Woody Wetlands	23,236.30		
	Conservation Easements		7,761.11	
Forest Total		**46,804.96**	**7,761.11**	**-83%**
Industrial	Industrial	74.65	74.65	
	Industrial		0.18	
	Light Industrial		2.08	
Industrial Total		**74.65**	**76.90**	**3%**
LDR	Agricultural Residential	1,380.79		
	Low Intensity Development	377.47	479.98	
	Rural Development-1	19.26	1,173.12	
	Traditional Neighborhood Residential	13.05		
	Transitional Residential District	7.95		
	Environmental Conservation		7677.70	
	Low Density Traditional Neighborhood		679.16	
	Riparian Corridor		19,233.50	
	Rural Neighborhood		2,149.72	
LDR Total		**1,798.52**	**31,393.1**	**1646%**

(continued on next page)

Table 5-10 continued…

Model Category	Land Use	Current Area (acres)	Future Area (acres)	% Change
MDR	Agricultural (Flex-1)	2.87	111.72	
	Rural Development-2	623.05	14,898.60	
	Single Family Manufactured Housing (R1MA)	1.46	-	
	Medium Density Traditional Neighborhood		133.45	
	Rural Crossroads		331.75	
MDR Total		**627.38**	**15,475.52**	**2367%**
Road	Roadway	502.01	546.70	9%
Rural	Grassland/Herbaceous	2,924.20	-	
	Pasture/Hay	701.43	-	
Rural Total		**3,625.63**	**-**	**-100%**
Multifamily	Employment Mixed Use	-	796.55	
	Transit Oriented Development	-	485.34	
Multifamily Total		**-**	**1,281.88**	
Water	Open Water	1,111.34	1156.04	4%
Grand Total		**57,814.14**	**57,814.14**	

The benefits of protecting the areas included in the 2018 Conservation Vision would prevent 91 tons of TN, 17 tons of TP, 849 tons of TSS and 4.7E+15 MPN/yr. coli bacteria from entering adjacent waterways in the Givhans Ferry Watershed, as summarized in **Table 5-11.**

Table 5-11: Benefits of Protecting Conservation Vision Areas

Scenario	TN (lb/year)	TP (lb/year)	TSS (lb/year)	*E. coli* (MPN/year)
Existing Condition	1.89E+05	1.71E+04	7.46E+06	9.22E+14
Future Condition	3.70E+05	5.12E+04	9.16E+06	5.63E+15
Difference	181,298	34,036	1.70E+06	4.70E+15
Difference (tons)	91	17	849	N/A

5.2.8 Qualitative Benefits of Recommended Practices

Each management strategy has its own set of watershed benefits. Benefits include estimated pollutant reductions, improvements to aquatic and riparian habitat, and community benefits such as improved aesthetics or access to recreational opportunities. The following sections address the overall impact that the suite of management measures will have on water quality and source water protection in qualitative and quantitative terms.

The benefits from enacting the suite of recommendations extend beyond the numeric pollutant load reduction. **Table 5-12** highlights various ways that different projects can have a positive impact in the Givhans Ferry Watershed, from community aesthetics and engagement to flood control.

Table 5-12: Watershed Benefits for Selected Practices

Practice	Water Quality	Runoff Reduction	Channel Protection	Flood Control	Instream Habitat	Community Aesthetics	Community Engagement
Lawn Care Education	●				○	○	●
Pet Waste Education	●				○	●	●
Downspout Disconnect	○	●	○	○	○	●	●
Stream Restoration/ Buffers	○	○	●		●	●	○
Stormwater BMPs	●	○	○	○		●	
SSO Repair/ Abatement	●				○	○	
Septic System Education	●				○	○	●
Septic System Repair	●				○	○	
Stream Clean Up	●		○		○	●	●
Erosion and Sediment Control	●	○	○	○	○	○	

● *Primary benefit is the intended outcome of the initiation of a specific action.*
○ *Secondary benefit is an ancillary benefit provided through the initiation of a specific action but not considered to be the determining factor in the execution of that action.*

5.2.9 Pollutant Load Reductions

Pollutant load reductions have been estimated for the recommendations in this WBP, as summarized in **Table 5-13** below. In total, 28 pollution reduction strategies were included in this WBP. The 10 practices that contribute to the greatest amount of bacteria reduction are shown in **Figure 5-4**. Vegetated filter strips along cropland account for over one-third of potential bacteria removal for the entire watershed, followed by conservation tillage (14%) and controlled drainage (14%). If all recommended practices and programs are initiated, the result would be a reduction of 1.6E+15 MPN/year of *E. coli* bacteria in the Givhans Ferry Watershed. The reduction in bacteria will improve water quality for recreational use.

The existing and proposed practices combined remove 28 tons of nitrogen from the watershed. The practices that contribute to the greatest amount of TN reduction are shown in **Figure 5-5.** Streambank stabilization with fencing accounts for 23% of TN reduction, followed by vegetated filter strips (20%) and controlled drainage from cropland (19%). Programs that reduce TN help prevent harmful algal blooms and help keep nitrates out of drinking water.

The existing and proposed practices that contribute to TP reduction (total amount of 7 tons) are shown in

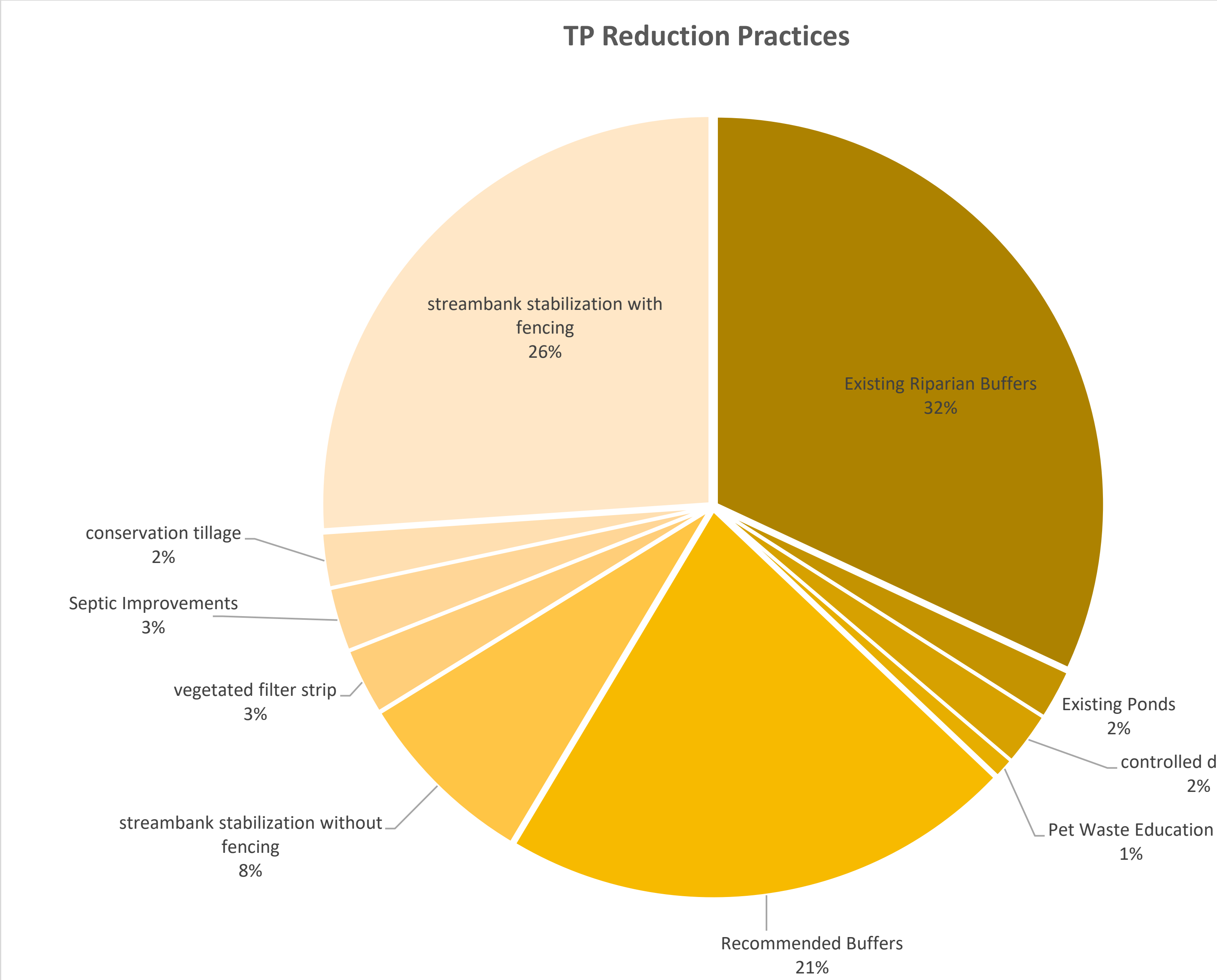

Figure 5-6. Programs that reduce TP help prevent harmful algal blooms, which can simultaneously reduce dissolved oxygen in surface water and increase organic matter in the source water intake and require extra treatment prior to distribution to customers. Existing riparian buffers (32%), recommended buffers (21%), and streambank stabilization with fencing (26%) make a significant impact on phosphorus reductions.

The practices that contribute to the overall TSS reduction (4,104 tons) are shown in **Figure 5-7**. As with phosphorus removal, existing riparian buffers (34%), recommended buffers (23%) and streambank stabilization with fencing (28%) contribute to the most TSS reduction. Removing sediment from streams and rivers creates a better habitat for aquatic organisms and reduces the amount of sediment to be removed from drinking water.

Table 5-13: Pollutant Reductions Provided by All Current Practices and Recommendations

Existing and Recommended Practices	TN (lb/year)	TP (lb/year)	TSS (lb/year)	*E. coli* (MPN/year)
Existing Ponds	6.72E+02	2.61E+02	4.69E+04	1.26E+13
Existing Riparian Buffers	1.94E+04	4.02E+03	6.38E+05	2.08E+14
Pet Waste Education	8.15E+02	1.06E+02	-	6.18E+12
Recommended Buffers	1.30E+04	2.70E+03	4.33E+05	1.39E+14
Septic Improvements	2.00E+03	3.34E+02	1.34E+04	2.48E+13
Rooftop Disconnection	7.63E+01	1.00E+01	2.69E+03	8.77E+11
Residential wet pond	8.44E+01	3.66E+01	5.74E+03	1.54E+12
Residential bioretention	1.60E+02	3.42E+01	4.73E+03	1.54E+12
Residential rain barrels	4.55E+01	5.98E+00	1.61E+03	5.23E+11
Industrial wet pond	1.87E+01	5.92E+00	1.36E+03	3.64E+11
Industrial bioretention	3.56E+01	5.53E+00	1.12E+03	3.64E+11
Commercial bioretention	6.06E+01	8.47E+00	1.93E+03	6.30E+11
Commercial permeable pave	4.69E+01	7.11E+00	1.62E+03	4.05E+11
Commercial green roof	6.21E+00	8.16E-01	2.19E+02	7.14E+10
Roadway bioretention	3.69E+02	4.56E+01	1.20E+04	3.90E+12
Roadway grass swale	1.36E+02	1.53E+01	7.87E+03	5.57E+11
Litter management	4.06E+02	6.76E+01	0.00E+00	9.5E+13
Livestock exclusion fencing	9.10E+02	6.06E+01	2.39E+05	2.1E+12
Heavy use area stabilization	8.19E+02	2.68E+01	1.23E+05	6.9E+12
Stream crossing/controlled access	6.83E+02	3.10E+01	1.12E+05	1.7E+12
Alternative water source	8.19E+02	1.83E+01	7.48E+04	2.1E+12
Critical area planting	2.28E+02	1.41E+01	5.24E+04	3.4E+12
Streambank stabilization w/ fencing	4.10E+03	3.28E+03	4.10E+06	0.0E+00
Streambank stabilization w/o fencing	8.20E+02	9.62E+02	1.64E+06	0.0E+00
Controlled drainage	3.46E+03	2.79E+02	0.00E+00	2.7E+14
Cover crop	2.10E+03	5.58E+01	6.37E+04	2.3E+14
Conservation tillage	7.34E+02	2.87E+02	2.93E+05	2.7E+14
Vegetated filter strip	3.56E+03	3.50E+02	3.37E+05	6.8E+14
TOTAL LOAD REDUCTION	55,604	13,031	8,207,282	**1.95E+15**
Total (tons/yr)	**28**	**7**	**4,104**	

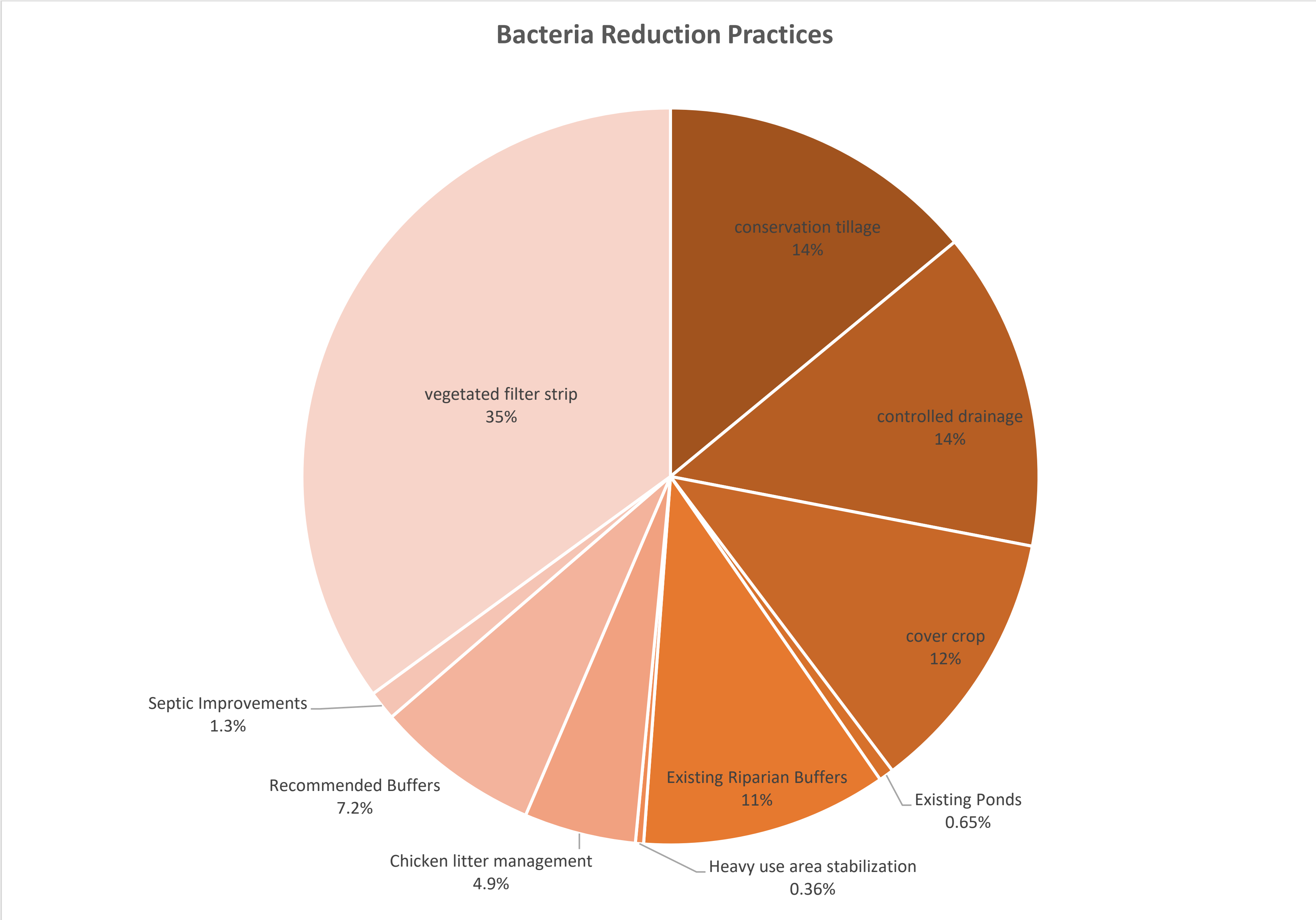

Figure 5-4: Practices that contribute the most to overall bacteria reduction.

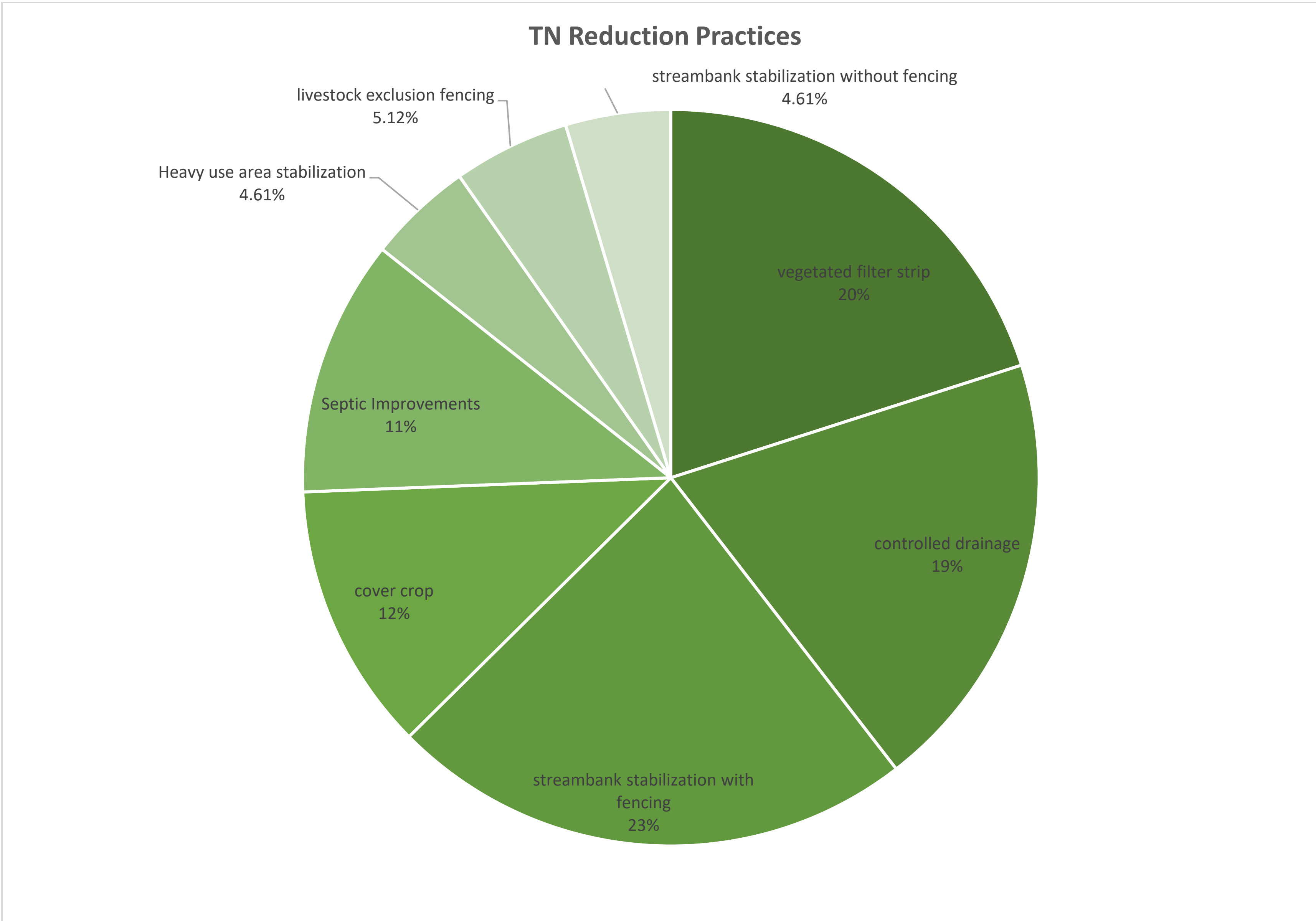

Figure 5-5: Practices that contribute the most to overall TN reduction.

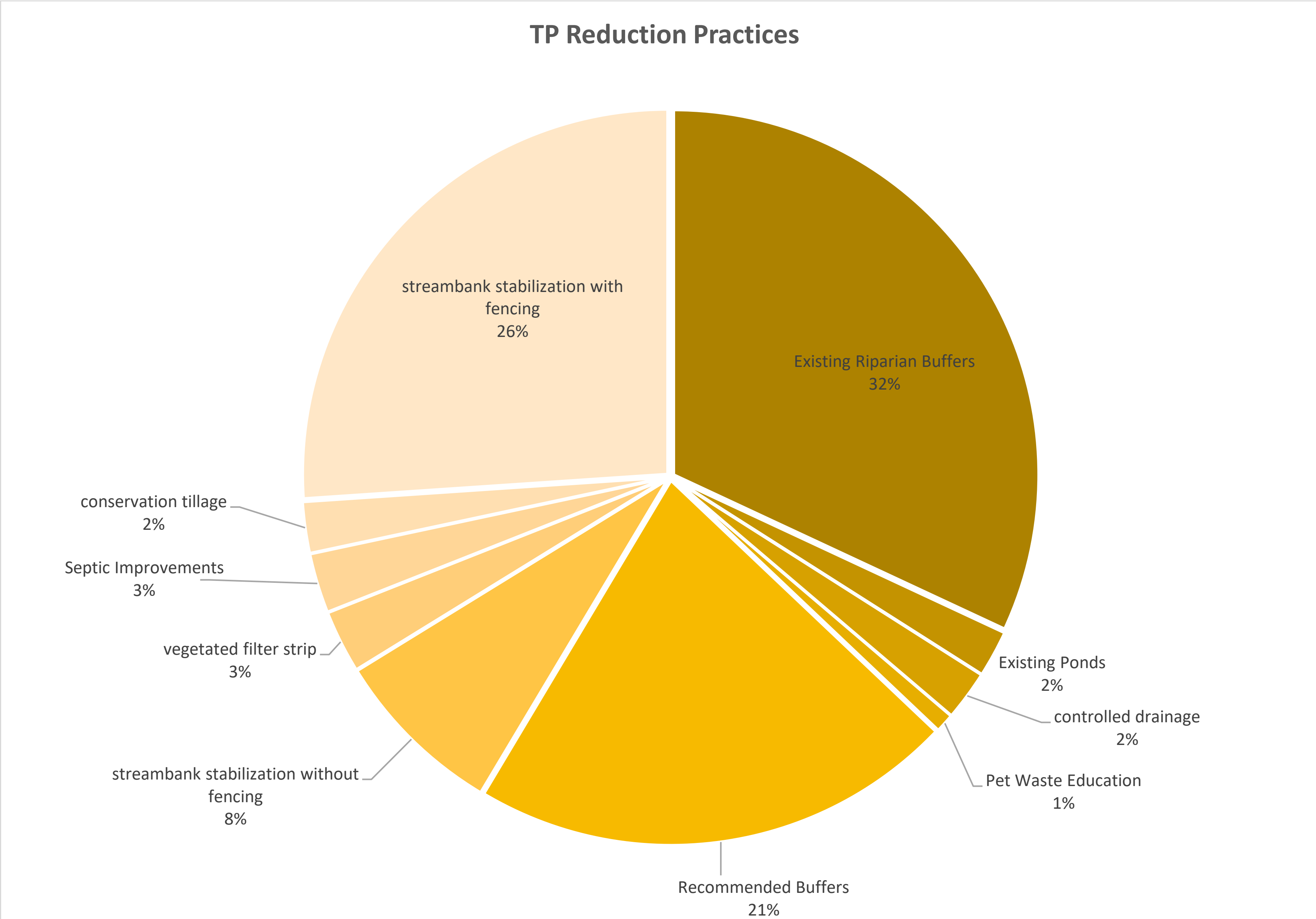

Figure 5-6: Practices that contribute the most to overall TP reduction.

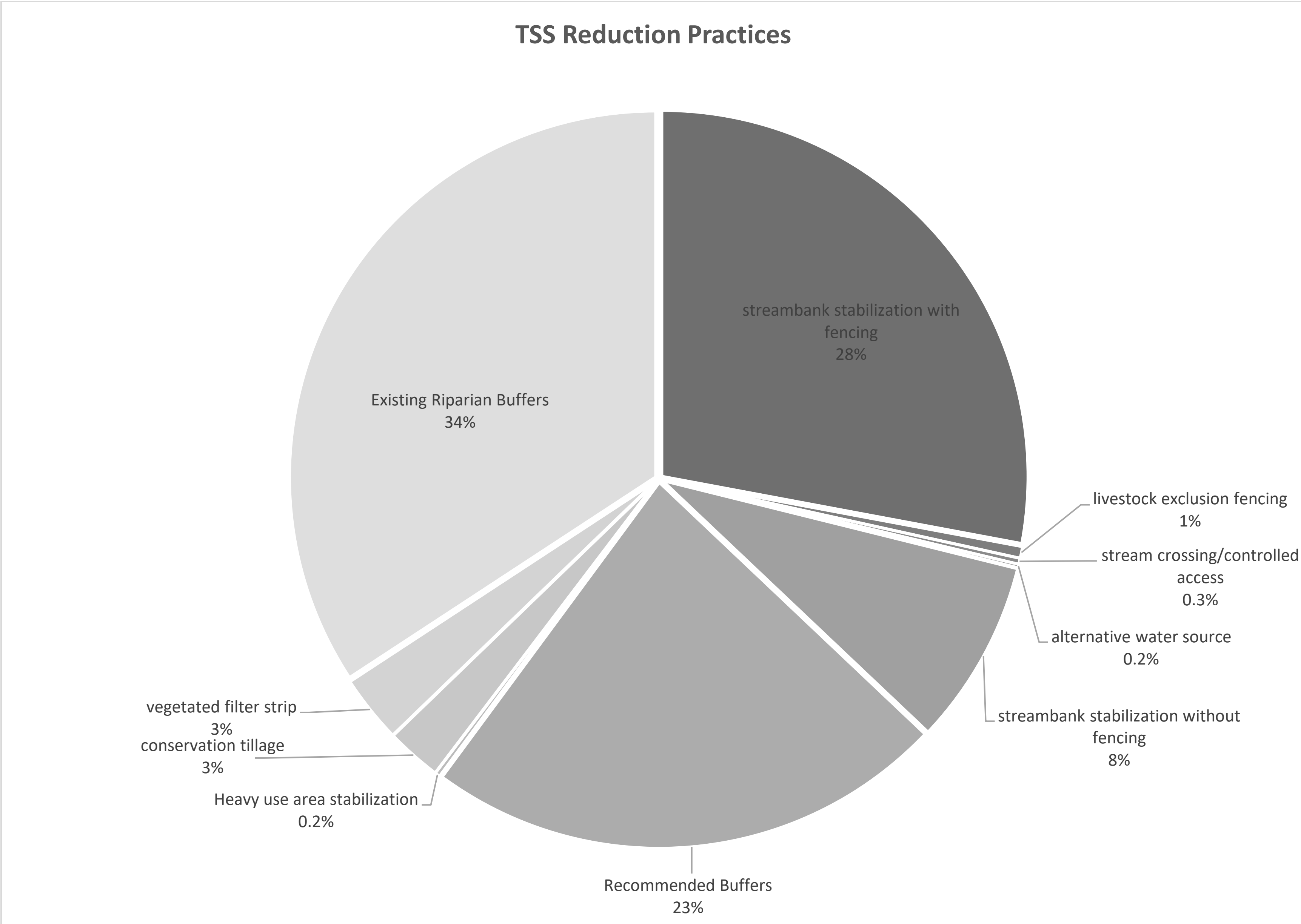

Figure 5-7: Practices that contribute the most to overall TSS reduction.

A summary of the benefits from implementing all recommended stormwater retrofit projects in the current condition in the Givhans Ferry Watershed are listed in **Table 5-14**. **Table 5-15** summarizes the pollutant loads and reductions for the future scenario. One of the strategies to reduce pollution in the future condition is to conserve land (preserve existing condition); however, even with maintaining the same number of livestock inputs and implementing BMPs and conservation, the adjusted future loads are still higher than the untreated existing source load (but on the same order of magnitude). It is likely that the current and future condition pollution loads are a conservative overestimate of the actual load. This emphasizes the importance of a multipronged approach to nonpoint source pollution as well as the need for periodic evaluation.

Table 5-14: Overall Benefits from Recommendations in Current Conditions

Condition	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	*E. coli* (MPN/yr)
Existing All Sources Load	3.53E+05	3.83E+04	2.66E+07	1.69E+15
Existing and Recommended Practices Load Reduction	5.56E+04	1.30E+04	8.21E+06	1.95E+15
Adjusted Existing Load	2.97E+05	2.53E+04	1.84E+07	-2.63E+14
Percent Load Reduction	16%	34%	31%	116%

Table 5-15: Overall Benefits from Recommendations in Future Conditions

Condition	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	*E. coli* (MPN/yr)
Future All Sources Load	8.30E+05	1.34E+05	3.84E+07	1.51E+16
Implementation of Conservation Vision	1.81E+05	3.40E+04	1.70E+06	4.70E+15
Existing and Recommended Practices Load Reduction	5.56E+04	1.30E+04	8.21E+06	1.95E+15
Adjusted Future Load	5.93E+05	8.70E+04	2.85E+07	8.45E+15
Percent Load Reduction	29%	35%	26%	44%

WBPs are meant to be living documents that will be evaluated and updated periodically. This is an opportunity to revisit this WBP after continued monitoring and evaluation of the proposed projects in order to guide future recommendations. See **Section 5.6.1 Monitoring Program** for discussion of how monitoring can be used to understand and treat sources of bacteria in the watershed.

The project partners and stakeholders will build off each success and use adaptive management strategies to periodically evaluate and change priority projects and programs. The evaluation process will be described in more detail in **Section 5.6 Measures of Success**.

5.3 Climate Change Recommendations

Climate adaptation is the practice of implementing plans and strategies in response to current and predicted climate impacts, usually with the goal of decreasing damage and increasing resilience.[74] Reasons for using climate ready planning include saving communities money (by mitigating future damages), increasing equitable outcomes and co-benefits, and broadening planning by directly linking watershed management to other local planning goals.[75] This section provides a process for implementing climate considerations into watershed planning in the Givhans Ferry Watershed Area, with recommendations on:

1. Seeing the watershed as infrastructure
2. Adopting a climate planning framework
3. Integrating climate planning with the EPA 9 Elements

5.3.1 Step 1: See the Watershed as Infrastructure

River landscapes are complex systems that benefit individuals and neighborhoods, forming part of the community landscape.[76] Viewing watershed planning as a solely technical problem decreases the likelihood that planning goals will be met. Plans that instead recognize watersheds as sources of social and economic value are more likely to achieve their goals and bring value to the community,[77] because planning that considers changing conditions is flexible and able to change alongside a changing climate.[78]

There is a growing paradigm of viewing water systems through an infrastructure lens. Through this lens, the watershed becomes an "essential service" to the community.[79] Watersheds create and distribute benefits to the community, and management strategies that consider these benefits a form of infrastructure are more likely to succeed.[80] Planning that only considers traditional inputs (such as impervious surface or bacterial contamination) in isolation is more likely to fail.[81]

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[74] IPCC AR5, Chapter 15. https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap15_FINAL.pdf

[75] For examples of climate ready planning, consult the Adaptation Clearinghouse Water Sector Database: https://www.adaptationclearinghouse.org/sectors/water/

[76] Burbach et al. (2019). Catalyzing Change: Social Science for Water Resources Management. https://doi.org/10.1111/j.1936-704X.2019.03307.x

[77] Verbrugge et al. (2019). Integrating sense of place in planning and management of multifunctional river landscapes: experiences from five European case studies. https://doi.org/10.1007/s11625-019-00686-9

[78] Bloemen et al. (2018). Lessons learned from applying adaptation pathways in flood risk management and challenges for the further development of this approach. https://doi.org/10.1007/s11027-017-9773-9

[79] Logan & Guikema. (2020). Reframing Resilience: Equitable Access to Essential Services. https://doi.org/10.1111/risa.13492

[80] Narayanan et al. (2020). From Awareness to Action: Accounting for Infrastructure Interdependencies in Disaster Response and Recovery Planning. https://doi.org/10.1029/2020GH000251

[81] Schell et al. (2020). The ecological and evolutionary consequences of systemic racism in urban environments. https://doi.org/10.1126/science.aay4497

5.3.2 Step 2: Adopting a Climate Planning Framework

Carolinas Integrated Sciences & Assessments (CISA) selected two planning frameworks, *Co-Benefits* and *Equitable Adaptation*, which could be used to guide climate-ready planning in the Givhans Ferry Watershed Area. Frameworks are useful because they simplify the planning process and allow a community to focus on its goals and the actions it can take to meet them.

Co-Benefits

Co-Benefits is the idea that climate planning is more likely to be successful if it considers more than one benefit to the community.[82] This framework has been used in a variety of planning contexts, particularly where problems intersect within a confined geographic area and multiple groups can join to collaborate.[83] Implementing co-benefits through a watershed plan is as simple as listing and categorizing them according to local priorities, and then using this list as a baseline in decision making (See **Figure 5-8**). For a given BMP (in this example a rain garden), all the benefits are listed and grouped by topic. Some topics may address the goals of the watershed plan, while others are co-benefits that may be goals in other local plans and/or provide tangible benefits to the community. Consideration of co-benefits can lower risk and increase resilience. For example, two BMPs may be comparable when solely considering watershed pollutant reductions, but a green infrastructure BMP could have additional benefits such as increasing the watershed's recreational value, absorbing carbon pollution from the atmosphere (carbon capture) and providing protection from extreme heat by lowering nearby ground temperatures. If the initial cost is the only metric used to make planning decisions, then a BMP which provides fewer co-benefits could be chosen instead of a BMP which provides more co-benefits or a higher cost-benefit ratio. Depending on the co-benefits considered, this would increase risk and decrease resilience.

[82] Diringer et al. (2020). Incorporating Multiple Benefits into Water Projects: A Guide for Water Managers. https://pacinst.org/publication/incorporating-multiple-benefits-into-water-projects/

[83] Rotatori et al. (2020). Breathing Life Back into Cities. https://rmi.org/insight/breathing-life-back-into-cities

Figure 5-8: A diagram from Diringer et al. illustrating an implementation of the co-benefit's framework for watershed management.

Equitable Adaptation

The Equitable Adaptation framework incorporates considerations of social and environmental equity into climate planning choices. Managing risks from climate change while adequately addressing equity concerns is often a challenge for community planning.[84] Equity means working to remove barriers and helping everyone in a community thrive.[85] Future changes in climate and resulting impacts (e.g., extreme weather events or watershed disturbances) will not be felt equally in the community, which worsens pre-existing inequality.[86]

Research in other contexts shows that not meeting this challenge can result in maladaptation, or the failure of adequately adapting to the situation at hand.[87] In the area of watershed planning and stormwater management, there is a growing recognition of the utility of considering equitable adaptation in managing future impacts. [88] The Chesapeake Bay Watershed is a leading example in incorporating equity into watershed management. Their Environmental Justice and Equity Dashboard (see **Figure 5-9**) includes information that can be used to create outreach programs for at-risk communities and help locate green infrastructure projects in socially vulnerable areas.[89] The watershed dashboard assists local governments in the watershed in creating projects that benefit underserved communities by breaking down demographic and watershed data using a web-based Geographic Information System (GIS).

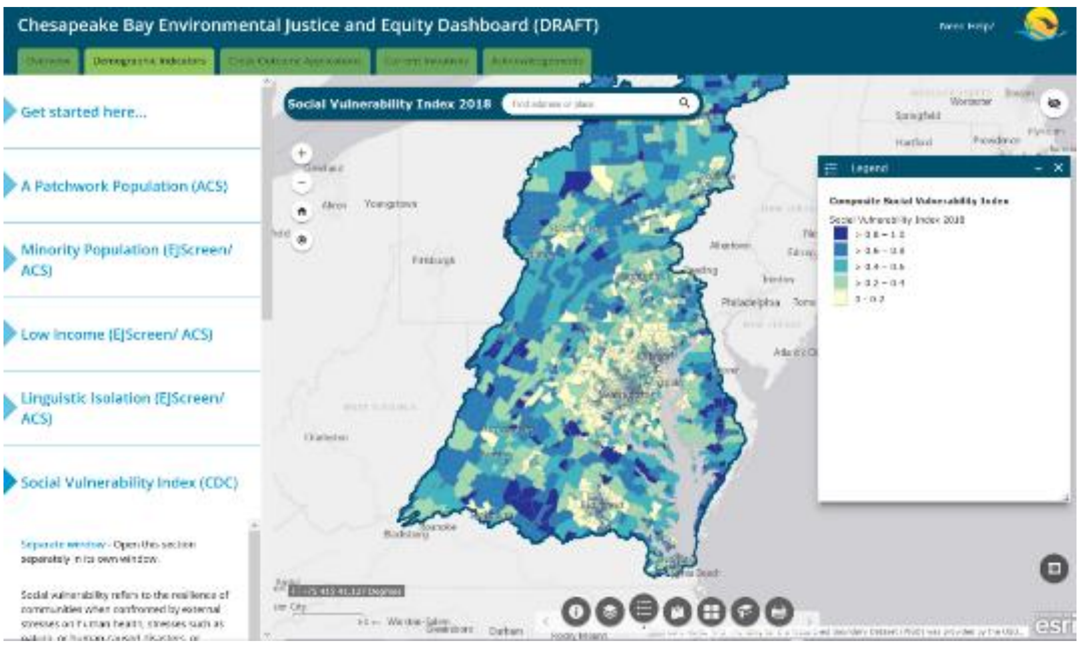

Figure 5-9: A screenshot of the Chesapeake Bay Program's GIS dashboard

84 Jabobs & Street. (2020). The next generation of climate services. https://doi.org/10.1016/j.cliser.2020.100199
85 U.S. Climate Action Network, see https://www.usclimatenetwork.org/justice_equity_diversity_and_inclusion
86 Hsiang et al. (2017). Estimating economic damage from climate change in the United States. https://doi.org/10.1126/science.aal4369
87 Magnan et al. (2016). Addressing the risk of maladaptation to climate change. https://doi.org/10.1002/wcc.409
88 Georgetown Equitable Adaptation Toolkit, see https://www.georgetownclimate.org/adaptation/toolkits/equitable-adaptation-toolkit/resilient-water.html
89 View the dashboard live at https://gis.chesapeakebay.net/diversity/dashboard

Environmental Justice Considerations

EPA defines Environmental Justice as the fair treatment and meaningful engagement of all people regardless of race, color, national origin, or income, with respect to the development, implementation and enforcement of environmental laws, regulations, and policies. Education and outreach activities identified in this plan should ensure that communities who are historically underserved and under-represented are actively invited and engaged as part of the planning process. The selection of potential projects for implementation should evaluate and prioritize efforts that are located in areas and would serve to provide benefit to historically underserved communities, including low- and moderate-income neighborhoods and households, and tribal nations (such as the Edisto Natchez-Kusso tribe).

The EPA's Environmental Justice screening and mapping tool known as EJScreen, is an effective resource that utilizes both environmental and demographic indicators to help support user's decisions regarding efforts such as grant writing and funding opportunities, educational outreach and programs, community and environmental awareness efforts, etc. Example outputs from the tool follow below. For example, **Figure 5-10** illustrates the percent of residents who identify as people of color (POC). One of the areas with the highest POC is the western section of Lower Indian Field Swamp below Hwy 78 and above the confluence with Polk Swamp. Another is the eastern edge of Halfway Gut Creek near Harleyville and the Edisto Natchez-Kusso tribal headquarters. Also, the western tip of the Skull Branch subwatershed where the Edisto River forms the boundary between Dorchester and Colleton Counties has a large POC population.

Figure 5-11 illustrates areas in the Givhans Ferry watershed of lower income. These areas mirror the areas with a larger percentage of POC. In fact, much of the Lower Indian Field Swamp subwatershed is characterized by a population of more than 40% low-income persons. These areas should be prioritized for septic system improvements, green/low impact development stormwater BMPs, and stream buffers in order to provide co-benefits and equitable adaptation for the community, while simultaneously reducing nonpoint source pollution.

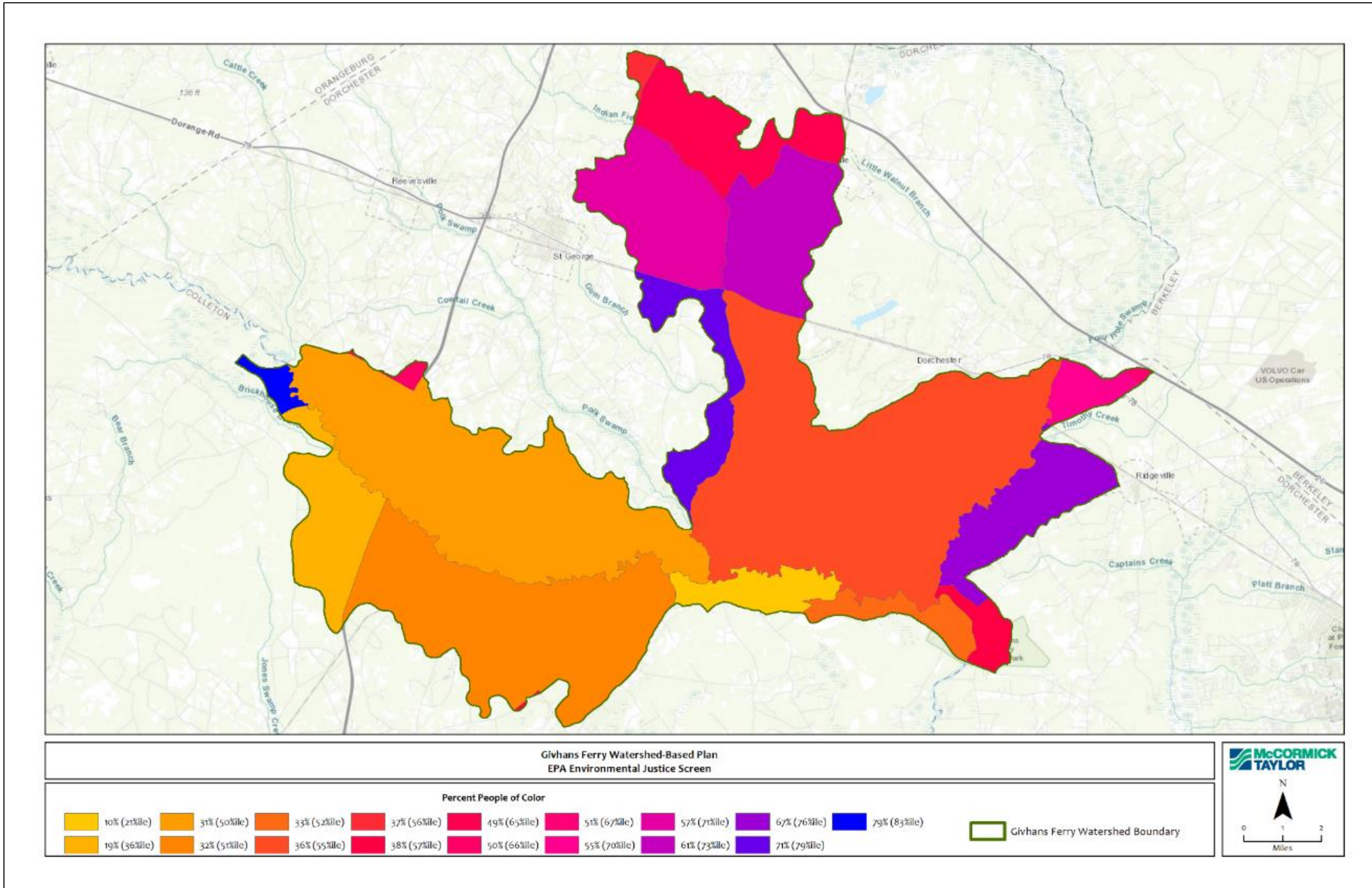

Figure 5-10: Percent of Residents Identifying as People of Color in the Givhans Ferry Watershed

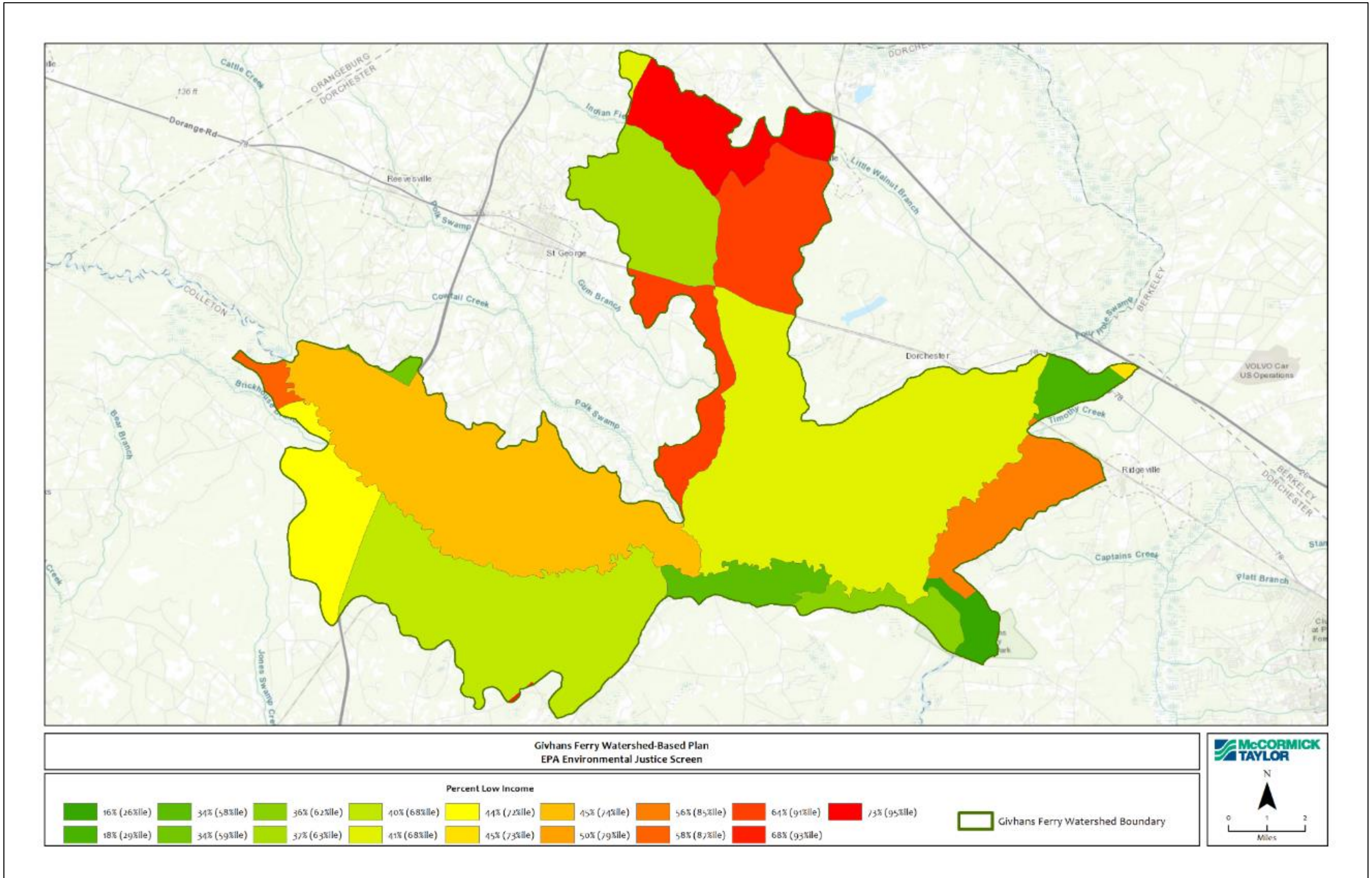

Figure 5-11: Percent Low Income Residents in the Givhans Ferry Watershed

5.3.3 Step 3: Integrate Climate Planning with EPA 9 Elements for Watershed-Based Plans

Climate planning can be used to expand the reach of management measures in the Givhans Ferry WBP and achieve the goals of the EPA 9 Elements of a watershed-based Plan. The potential application of climate informed planning is particularly prominent in three of the EPA's 9 Elements.

Education and Outreach

Community groups facing adverse watershed impacts may be a reservoir of community knowledge and resilience: faith-based organizations, ethnic networks, community-based organizations, etc. Co-management can engage these community assets, but the relationship between citizens and government must go beyond stakeholder engagement and involve them in the decision-making process.[90] This co-management strategy can be aided by considering how communications about the watershed take place in the community[91]; framing communications to resonate with different priority community concerns while still addressing broad water quality remediation goals.[92]

To align with EPA guidelines, educational outreach activities must be created to encourage public participation and awareness. Building equity into the communication ensures all segments of the population (e.g. low-income communities, people of color, or other frontline communities) have a voice throughout the process and ensures education reaches communities that did not have prior access to information.[93] Community education and outreach are instrumental to a successful watershed-based plan and are more successful when directed towards vulnerable populations, warranting increased attention to accessibility.[94] For example, in the Michigan Huron Watershed area communicating relevant watershed impacts was highly effective because all citizens were informed of the risk and involved in decision-making.[95] Following are examples of guides and toolkits available to draw from:

Education and Outreach Guides and Toolkits

- NOAA Office for Coastal Management's Enhanced Engagement and Risk Communication for Underserved Communities: Research Findings and Emerging Best Practices.
- American Rivers' Water Justice Toolkit: A Guide to Address Environmental Inequities in Frontline Communities.
- EPA's Environmental Justice Screening and Mapping Tool - EJScreen

Best Management Practices (BMPs)

Because they serve as new components in the watershed system, BMPs can be a source of co-benefits and may reduce structural inequality if equity is considered in their design, location, and implementation. Concentrating stormwater management investment in certain areas may disproportionately benefit that area and can lead to green-gentrification or other unintended planning consequences.

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[90] Wyborn et al. (2019). Co-Producing Sustainability: Reordering the Governance of Science, Policy, and Practice. https://doi.org/10.1146/annurev-environ-101718-033103

[91] Yuen et al. (2017). Guide to Equitable, Community-Driven Climate Preparedness Planning. https://www.adaptationclearinghouse.org/resources/guide-to-equitable-community-driven-climate-preparedness-planning.html

[92] Orlove et al. (2020). Climate Decision-Making. https://doi.org/10.1146/annurev-environ-012320-085130

[93] Georgetown Equitable Adaptation Toolkit, see https://www.georgetownclimate.org/adaptation/toolkits/equitable-adaptation-toolkit/resilient-water.html

[94] Floress et al. (2015). The Role of Social Science in Successfully Implementing Watershed Management Strategies. https://doi.org/10.1111/j.1936-704X.2015.03189.x

[95] Cheng et al. (2017). Risk Communication and Climate Justice Planning: A Case of Michigan's Huron River Watershed. https://doi.org/10.17645/up.v2i4.1045

Incorporating co-benefits and equitable adaptation in locating and prioritizing investment for new watershed infrastructure could lead to prioritizing green infrastructure BMPs.[96] Green infrastructure BMPs (such as rainwater harvesting, rain gardens, bioswales, permeable pavements, green roofs, urban tree canopy, and land conservation[97]) can be less expensive compared to other types of BMPs.[98] The following are a variety of information hubs and efforts that could provide a template for prioritizing and implementing green infrastructure BMPs in the Givhans Ferry Watershed Area:

Green Infrastructure BMP Guides

- SC Forestry Commission's Evaluating and Conserving Green Infrastructure Across the Landscape: A Practitioner's Guide.
- FEMA's Building Community Resilience With Nature-Based Solutions: A Guide for Local Communities.
- NOAA Office for Coastal Management's Natural Instructure Hub.
- EPA's Soak Up the Rain Hub.
- Green Infrastructure Center's South Carolina Reports, Books, and Guides.

Green Infrastructure BMP Examples

- Charleston SC
- SC Floodwater Commission
- American Forest partner cities
- The Nature Conservancy partner geographies
- MIT Senseable City Lab Treepedia
- The Center for Watershed Protection

Funding Options

Communities are increasingly preparing their watersheds and stormwater infrastructure to protect against the impacts of extreme rainfall events and other climate changes.[99] Considering climate change in this way can save money, while failing to proactively address climate risks can increase costs and limit the ability to raise capital.[100]

Municipalities are also using specialized income taxes and financial tools to fund green infrastructure projects. For example, in response to lack of funds and growing climate risks, Grand Rapids, Michigan set a 1.5% income tax and a stormwater credit trading program to fund green infrastructure BMPs.[101] In addition to creative financing tools[102], considering climate change can also unlock new sources of funding and meet federal requirements of various planning activities:

[96] Seddon et al. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. https://doi.org/10.1098/rstb.2019.0120

[97] EPA (2022). What is Green Infrastructure? https://www.epa.gov/green-infrastructure/what-green-infrastructure

[98] Odefey et al. (2012). Banking on Green: A Look at How Green Infrastructure Can Save Municipalities Money and Provide Economic Benefits Community-wide. Link.

[99] Morrison. (2021). What lurks beneath: A new answer to more intense storms. https://www.washingtonpost.com/climate-solutions/2021/06/06/stormwater-infrastructure-sensor/

[100] Painter. (2020). An inconvenient cost: The effects of climate change on municipal bonds. https://doi.org/10.1016/j.jfineco.2019.06.006

[101] For more information, see http://glpf.org/blog/creative-partnership-forges-a-path-to-innovative-green-infrastructure-funding-in-grand-rapids/

[102] A useful tool for TRW partners is the American Flood Coalition's funding database, see https://floodcoalition.org/resources/floodfundingfinder/

1. Private firms seeking carbon offsets: certain BMPs (e.g., permanent green infrastructure projects which absorb sufficient carbon) may have co-benefits such as carbon capture which can be monetized as carbon offsets and sold to private firms. While the marketplace and standards for carbon offsets are emerging, this could become a viable source of supplemental funding. Recent research found 30% of companies in the U.S. have set a net zero target, suggesting this market may emerge within the timeline for the implementation schedule set for this plan.[103] For example, Microsoft is spending $1 billion on carbon offsets by 2025, some of which could potentially be allocated towards green infrastructure.[104] At least one project in South Carolina, protection of the Francis Beidler Forest (located just north of the Givhans Ferry Watershed) has already been funded by a carbon market.[105] Given the large acreage of forest currently in the Givhans Ferry Watershed, the protection of which is important to various stakeholders (the ACE Basin Task Force, SC Audubon, the Nature Conservancy, Friends of the Edisto), this may be a feasible tool for conservation and water quality protection.
2. Federal grant requirements: Partners implementing Givhans Ferry Watershed Plan may be required to consider environmental justice when seeking federal funding. For example, the Justice 40 initiative will require that 40% of federal investments in certain categories go to disadvantaged communities for covered programs. In the interim guidance, one such category includes all federal programs investing in "critical clean water and waste infrastructure."[106] Considering equitable adaptation and climate planning is also likely to benefit applications for other types of grant-based or philanthropic funding.

[103] Cullen et al. (2021). Leveling up net zero climate leadership in the United States: An analysis of subnational net zero targets & recommendations for the Federal Government. https://www.smithschool.ox.ac.uk/publications/wpapers/workingpaper21-01.pdf
[104] For more information, see https://blogs.microsoft.com/blog/2020/01/16/microsoft-will-be-carbon-negative-by-2030/
[105] For more information, see https://www.postandcourier.com/news/sc-forests-are-protected-for-trapping-carbon-with-a-little-help-from-california/article_323ee998-39ed-11e9-a438-df43b4df1939.html
[106] White House Guidance Memo M-21-28, see https://www.whitehouse.gov/wp-content/uploads/2021/07/M-21-28.pdf

5.4 Implementation

5.4.1 Priorities and Estimated Costs

The estimated cost to implement all these projects and preventative measures is $178,603,423 (**Table 5-16, Table 5-17**, and **Table 5-18**). Currently, the BCDCOG, counties, and municipalities do not have funding set aside for these projects. The jurisdictions in the Givhans Ferry Watershed cannot support the financial burden of all the recommended projects in this watershed-based plan without help from outside funding opportunities. This watershed plan has included several potential funding programs and financing mechanisms that could support the implementation of these activities. The following ranked list suggests which of these might be appropriate pursuits based on several factors including the timing of the opportunity, the project(s) it could support, and the organizational capacity needed to pursue it.

Table 5-16: Cost Estimate to Implement Recommended Projects for Developed Land Uses

Project Type	Construction	Design	Maintenance	Total
Stormwater BMPs				
Bioretention	$2,954,025	$590,805	$6,988	$3,551,818
Wet Pond	$2,755,550	$551,110	$85,715	$3,392,375
Permeable Pavement	$4,443,120	$888,624	$1,703,196	$7,034,940
Green Roof	$871,200	$174,240	$357,192	$1,402,632
Grass Swale	$2,528,900	$505,780	$3,186,414	$4,197,974
Residential Disconnection	Free			
Total				$19,579,738
Riparian Buffer Restoration	**Construction**	**Design**	**Maintenance**	**Total**
	$130,450,320	$26,090,064	$1,681,680	$158,222,064
Recommended Project Total:				**$177,801,802**

Table 5-17: Cost Estimate[107] to Implement Recommended Projects for Livestock and Agriculture

Project Type	Cost	Unit
Linear Streambank Fencing		
Barbed Wire, Multi-strand	$2.20	Linear Foot
Protective Fence	$2.05	Linear Foot
Alternative Watering Source		
Fiberglass Tank on Concrete	$2.69	Gallon
Precast Concrete Tank	$4.77	Gallon
Steel Tank	$2.47	Gallon
Shallow Well, 100 ft. deep or less	$45.58	Foot
Heavy Use Areas		
Reinforced Concrete with sand or gravel foundation	$423.83	Cubic yard
Rock/Gravel on Geotextile	$45.69	Cubic yard
Riparian Buffer		
Bare-root, hand planted	$2,939.33	Acre
Direct Seeding	$1,199.40	Acre
Filter Strip		
Introduced Species	$171.31	Acre
Native Species	$216.69	Acre
Stream Crossing		
Bridge	$52.41	Sq. foot
Culvert Installation	$2.98	Diameter
Low water crossing, concrete block	$10.27	Sq. foot
Low water crossing, geocell	$4.57	Sq. foot
Conservation Cover		
Introduced Species	$162.64	Acre
Native Species	$194.58	Acre
Pollinator Species	$579.57	Acre
Cover Crop		
Cover Crop - Basic (Organic and Non-organic)	$62.25	Acre
Cover Crop - Basic Organic	$95.26	Acre
Structure for Water Control		
Earth Check	$1,015.57	Number
Rock Check	$1,361.83	Number
Slide Gate - Flood Dike	$61.21	Foot
Waste Storage Facility (litter management)		
Bedded pack – concrete floor and concrete walls	$7.35	Sq. foot

[107] USDA NRCS. 2024. Regional Conservation Partnership Program Standard Costs for Fiscal Year 2024. Available at https://www.nrcs.usda.gov/sites/default/files/2024-01/fy24-kansas-rcpp-eqip.pdf

Table 5-18: Cost Estimate to Implement Community-Based Programs

Project Type	Cost	Unit	Quantity	Extended Cost
Workshop (general cost)				
Printed materials (fliers)	$0.72-$1.01	Per flier	200	$173
Printed materials (tri-fold brochure)	$1.60-$2.40	Per brochure	200	$480
Printed materials (maps / posters)	$6.00-$40.00	Per map	5	$115
Newspaper ad in local paper	$312-$540	Per advertisement	1	$426
Workshop space	$200	Per workshop	1	$200
Workshop staff	No cost	Per workshop	-	-
Workshop supplies and food	$100-$200	Per workshop	1	$150
		Per workshop		$1,544
Conservation Easement	$5,000 - $20,000	Per tract		varies
Pet Waste Education				
Bag stations	$400	Per station	100	$40,000
Waste pick-up signage	$100	Per sign	100	$10,000
Workshop	$1,543.80	Per workshop	1	$1,544
		Practice Total		$51,544
Rainwater **Harvesting**				
50-gallon Rain barrel distribution	$100-$200	Per barrel	5,974	$597,353
Workshop	$1,543.80	Per workshop	1	$1,544
		Practice Total		$598,897
Septic System Education				
Septic System Inspections	$180-$312	Per household	602	$148,902
Workshop	$1,543.80	Per workshop	1	$1,544
		Practice Total		$149,636
Community Program Total				**$801,621**

5.4.2 Potential Funding Sources

Funding needed to implement components of the plan will vary depending on the type of strategy. Funding will come from current program resources, local and state government funding, and a variety of grants, cost share programs, and private programs that focus on water quality, and environmental restoration. Examples of grant funding sources and the types of projects they may serve are listed below in **Table 5-19**.

Table 5-19: Funding Source Summary

Program	Funder/Partner	Program Goals or Outcomes
Nonpoint Source Implementation Program (Section 319)	SCDES/EPA	Assist in implementing projects for urban and agricultural runoff, land conservation for water quality benefits, natural channel design, and streambank stabilization.
SC Rural Infrastructure Authority (RIA) Grants	SC RIA	Assist municipalities in keeping up with repairs or upgrades to aging or overburdened infrastructure.
State Revolving Fund (SRF)	SCDES	Provide low-interest rate loans for sanitary sewer repairs and stormwater quality improvement projects
Regional Conservation Partnership Program (RCPP)	NRCS	Support projects including a range of on-the-ground conservation activities implemented by farmers, ranchers, and forest landowners such as land management, restoration, and public works/watersheds.
Conservation Reserve Enhancement Program (CREP)	USDA FSA	Partners work with FSA to develop agreements for conservation goals on agricultural lands, such as riparian buffers, filter strips, wetlands, and pollinator plantings.
Environmental Quality Incentives Program (EQIP)	NRCS	Helps farmers maintain or improve production while conserving natural resources on working landscapes.
North American Wetlands Conservation Act (NAWCA) Grants	USFWS	These projects must involve long-term protection, restoration, and/or enhancement of wetlands and associated uplands habitats for the benefit of all wetlands-associated migratory birds.
Five Star & Urban Waters Restoration Program	NFWF	Design and planning services for habitat, water quality, and social media campaigns.
Resilient Communities Program	NFWF	Enhance community capacity to plan and implement resiliency projects and improve the protections afforded by natural ecosystems by investing in green infrastructure and other measures.
Environmental Education Association of SC Mini-Grant	EEASC	Provide grants up to $1,000 for innovative projects that support environmental education and stewardship.
Champions of the Environment	SCDES	Provide up to $2,500 for K-12 students and educators to implement projects that prevent or reduce pollution in the air, water, or land; and restore, preserve, or enhance natural areas.

5.5 Schedules and Milestones

A preliminary schedule for the implementation of the activities discussed above is provided in **Table 5-20**.

Table 5-20: Timeline of Implementation

Measurable Milestones													
Sources	BMPs	Location	Years 1 to 3	Years 4 to 6	Years 7 to 9	Years 10 to 12	Years 13 to 15	Preventative Measures	Years 1 to 3	Years 4 to 6	Years 7 to 9	Years 10 to 12	Years 13 to 15
Community-Wide Programs													
Pet Waste	install waste stations	trails, parks, HOAs	x	x	x	x	x	Pet waste PSAs	x	x	x	x	x
	provide portable waste bags	public events	x	x	x	x	x						
Trash	install trash cans	public trails, parks	x	x	x	x	x	Litter PSAs	x	x	x	x	x
Funding Opportunities:	Apply for grants: 319, EEASC mini-grant, Champions of the Environment								x	x	x	x	x
Potential Partnerships:	Clemson Extension, Dorchester SWCD, SC Native Plant Society, Palmetto Pride, Friends of the Edisto, College of Charleston												
Septic													
Residential Septic Systems	Field-verify location and condition of septic systems by subwatershed	Lower Indian Field Swamp	x					Education on preventative maintenance	x	x	x	x	x
		Skull Branch		x				Education on repair and upgrades	x	x	x	x	x
		Halfway Gut Creek			x								
		Poorly Branch				x							
		Deep Creek					x						
	Repair/Upgrade failing systems	varied		x	x	x	x						
Funding Opportunities:	Apply for grants: 319, SC RIA								x	x	x	x	x
Potential Partnerships:	SCDHEC, Clemson Extension, Friends of the Edisto, Dorchester County, Colleton County												
Sanitary Sewer													
Sanitary Sewer Overflows	Inspection and Maintenance (DPU)	varies	x	x	x	x	x	Wipes and FOG Education	x	x	x	x	x
Funding Opportunities:	Apply for grants: 319, SC RIA, SRF									x	x	x	x
Potential Partnerships	SCDHEC, Dorchester County												

Measurable Milestones													
Urban/Suburban													
Channel Erosion	Riparian Buffer Restoration Projects	public property	x	x	x	x	x	Floodplain education for residents	x	x	x	x	x
		private property	x	x	x	x	x	Riparian buffer education for residents	x	x	x	x	x
Residential and Commercial Development	Downspout/ Impervious Surface Disconnection	Residential areas	x	x	x	x	x						
	Stormwater BMP retrofits	residential disconnection	x	x	x	x	x	Engage HOAs with Master Pond Manager Program	x	x	x	x	x
		wet ponds	x	x	x	x	x	Encourage homeowners and professionals to obtain Master Rain Gardener Certification	x	x	x	x	x
		bioretention	x	x	x	x	x	Engage homeowners to participate in Carolina Yards program	x	x	x	x	x
		rainwater harvesting	x	x	x	x	x						
		permeable pavement	x	x	x	x	x						
		green roof	x	x	x	x	x						
		grass swale	x	x	x	x	x						
Funding Opportunities:	Apply for grants: 319, NFWF Five Star & Urban Waters Restoration, SC RIA, SRF, EEASC, Champions of the Environment								x	x	x	x	x
Potential Partnerships	SCDHEC, Clemson Extension, Dorchester SWCD, Friends of the Edisto												
Agricultural													
Forestry	TOP certification	varies	x	x	x	x	x	Educate and engage forested land owners about conservation easements	x	x	x	x	x
Permitted Poultry	conduct MST to see if existing BMPs are effective	varies	x	x									
Permitted Swine	conduct MST to see if existing BMPs are effective	varies	x	x									
Hobby Farms	manure management		x	x	x	x	x	Engage homeowners to participate in Clemson outreach for manure management	x	x	x	x	x
Funding Opportunities:	Apply for grants: 319, NRCS RCPP, NRCS EQIP								x	x			
Potential Partnerships	Clemson Extension, SC Forest Commission, Dorchester County SWCD, Center for Heirs Property												

5.5.1 Permitting Schedule and Timeline

Agency permitting timelines are generally contingent on project size and complexity. Below is a generalized description of the permitting steps and associated review times for standard permitting needs for engineering activities. Projects involving impacts to wetlands or streams are governed by the Army Corps of Engineers (ACOE). Prior to submitting a permit application for impacts, you are required to submit a request for Jurisdictional Determination (JD) to the ACOE.

A JD consists of completion of a field survey and inventory of natural resource features, followed by a jurisdictional wetland report, including color photographs, data sheets, and maps depicting the location, acreage, and Cowardin classifications of the water and wetland features. Sensitive habitats are also usually identified during the field survey and described in the report. The total time of completion and issuance of approval is approximately 6 months.

Permitting for stream restoration primarily consists of completing an SCDES Notice of Intent (NOI) application to alter stormwater. This application is more commonly known as an NDPES or stormwater permit. The extent of the land disturbance (acreage) will determine if a short form application is sufficient or if a Comprehensive Stormwater Pollution Prevention Plan (C-SWPPP).

USACE Wetland Permit

Depending on the amount of impacts to environmental resources, the project may fall under a Regional General Permit (GP), or a Nationwide Permit (NWP) if impacts to wetlands are less than 3.0 acres and impacts to streams are less than 300 linear feet. Depending on design constraints, an individual 401/404 ACOE permit may be required. The design will also reflect the need for "minimization and avoidance" of WOTUS as required by the ACOE. The expected wait time for the approval of a GP or NWP is approximately 6 to 9 months. The wait time for the issuance of approval of an individual report is approximately 9 to 18 months.

SCDES Water Quality Certification (Section 401)

All activities requiring a U.S. Army Corps of Engineers Permit for the discharges into waters or wetlands, must also receive a Water Quality Certification (Section 401) from SCDES. Upon receipt of the 401-certification form, SCDES submits to the USACE for review for completeness. Once SCDES receives the Joint Public Notice from the USACE, a 30-day comment period is initiated. If no appeals are received, SCHEC will submit final certification to the USACE and the applicant.

Negotiations and Permit Acquisition

The negotiation and permit acquisition process can be confusing and untimely if not properly guided at certain bottleneck areas. The bullet points below provide highlights for the process of obtaining an ACOE 401/404 permit:

- Application submitted and application acknowledged. ACOE Project Manager assigned.
- Review of application for completeness.
- Public Notice prepared and published in newspaper. This initiates the State certification process.
- Public comment period.
- Comments received and assessed. Concerns and objections categorized.
- Alternatives analysis. Mitigation plan worked out. Resolution of concerns.
- Preparation of decision document.
- Recommendation of permit issuance or permit denial.
- Permit issued or denied
- Permit decision appealed if necessary

SWPPP/NOI:
Activities that disturb over 1 acre of land are required to submit a Notice of Intent (NOI) to SCDES. SCDES has 15 days to reply to a request for more information, and 30 days to approve or deny the permit request. However, for projects that disturb more than 5 acres of land, and/or are part of a larger common plan, a comprehensive stormwater pollution plan (C-SWPPP) to get permit approval. A C-SWPPP is a site-specific document or collection of documents that identifies the potential sources of stormwater pollution resulting from the construction activities associated with the project. Additionally, the C-SWPPP describes stormwater control measures, such as BMPs, to reduce or eliminate the identified pollutants and contains detailed construction plans and hydrologic analysis. Although the review time for SCDES does not change with the size of the project, the drafting of a C-SWPPP is generally considered to be at least a three-month engineering task.

5.6 Measures of Success

It will take a much larger effort to return a watershed to a goal of a water quality threshold after it is impaired than the actions it took for it to become polluted. While the best management practices proposed provide an overall net pollution reduction, any progress, however small, is a change in the right direction. The city, county, and stakeholders will build off each success and use adaptive management strategies to periodically evaluate and change priority projects and programs.

5.6.1 Monitoring Program

Monitoring data for any waterbody is a crucial element that can assist in determining current conditions, developing targeted management strategies, and tracking progress over time. It is recommended that additional monitoring be conducted to better pinpoint sources of pollutants, to establish a solid baseline of conditions, to track progress made towards attaining water quality standards, and to track changes in stream and watershed condition as implementation of restoration projects occurs. This is also known as adaptive management. Some specific recommendations are provided here:

Stream Monitoring – The sampling conducted by SCDES and CWS are currently the only water quality monitoring in the watershed and should be continued regularly to track trends in baseflow water quality. There are opportunities for the County and/or volunteer organizations (such Edisto Riverkeeper/Friends of the Edisto) to support monitoring in this watershed. The S.C. Adopt-a-Stream Program (SC AAS) is a public water quality monitoring network administered by SCDES. SC AAS is comprised of local communities, educators, volunteers, and local government officials, tasked with a role in providing baseline information about stream conditions, and helping to monitor and track water quality parameters.

Other monitoring locations should include:

- Areas with potential or observed bacteria hotspots, such as ditches adjacent to larger livestock operations or residential developments.
- Locations downstream of implemented projects to measure water quality improvements.

Microbial Source Tracking (MST) – Sources of bacteria throughout the watershed are cause for concern. Initiating a Microbial Source Tracking effort can identify the source of the bacteria (e.g., human, pets, livestock, and wildlife), which will then help managers develop potential solutions to address the sources of bacterial contamination. For example, if the source is indicated as canine, a focus on pet waste education and the installation of pet waste stations would be more helpful than if the human marker was detected; then the focus would shift to searching for potential septic or sanitary sewer sources.

5.6.2 Evaluation Methods

In addition to the monitoring data proposed in **Section 5.6.1**, the success of this watershed plan will be evaluated based on several criteria:

1. Urban Sources (Residential and Commercial land use types)
    a. The number of contacts for outreach/education (through television, billboards, etc.)
    b. The number of pet waste stations installed
    c. The number of marked storm drains
    d. The number of rain barrels distributed/voluntarily installed
    e. The amount of impervious surfaces treated by installation of stormwater retrofits
    f. The number of volunteers trained and certified by the SC Adopt-a-Stream program
        i. The number of samples collected and analyzed by volunteers
2. Sewer Sources
    a. The number of attendees at FOG and wipes educational programs
    b. The length of sewer lines inspected and upgraded (coordinate with utilities)
    c. As there are currently no reported spills in the watershed, the public records of spills should be monitored in case any are reported
3. Septic Sources
    a. The number and location of septic systems identified and mapped
    b. The number of septic systems inspected
    c. The number of septic systems upgraded to more efficient systems
    d. The number of households on septic that connect to sanitary sewer system
4. Agriculture Sources
    a. The length of riparian buffers added to areas downstream of livestock operations
    b. The number of homeowners who receive training on proper manure management for their small hobby farms
    c. Number of properties placed under conservation easements to limit future land development
5. Forestry Sources
    a. Number of landowners to become certified or utilize qualified logging professionals who are certified in the Timber Operations Professional Program (TOP).
    b. Number of properties placed under conservation easements to limit future land development

6.0 Recommendations

The purpose of this watershed-based plan is to restore and protect water quality in the Givhans Ferry watershed study area. The Givhans Ferry watersheds are a valuable resource because they drain directly to the source water intake for the Charleston Water System. The source water is vulnerable to pollution from bacteria, nutrients, sediment, and organic material.

Recommendations that will help **reduce bacteria loading** into the Givhans Ferry Watershed include:

- Continuing public education about the importance of proper pet waste disposal;
- Encouraging residential livestock owners to participate in a manure management program provided by Clemson;
- Encouraging commercial livestock businesses to participate in manure and fertilization best practices recommended by the NRCS and SWCD;
- Conducting a sanitary system assessment in the watershed to determine if there are any leaking pipes and manholes, particularly along stream and water crossings;
- Determining the locations of septic systems and ensuring that they are maintained, or that the property owners connect to the sanitary sewer; and
- Implementation of recommended best management practices that encourage infiltration, such as bioretention or vegetated swales.

Recommendations that will help **reduce nutrient loading** in the Givhans Ferry Watershed include:

- Ensuring that the existing and future stormwater infrastructure in the watershed are maintained properly;
- Encouraging all logging jobs to follow the voluntary BMPs provided by the SC Forestry Commission;
- Encouraging timber landowners to contract with loggers that have fulfilled the certification; requirements from the Timber Operations Professional (TOP) program;
- Encouraging agricultural landowners to follow best practices for soil tillage, fertilization, and soil sampling;
- Keeping the vegetated buffer around the tributaries and lakes intact; and
- Conducting the recommended outreach workshops, specifically strategies that homeowners should employ to retain stormwater on their own property (e.g. rain gardens, rain barrels, and impervious surface disconnection).

Recommendations that will help **reduce sediment loading** into Givhans Ferry Watershed include:

- Ensuring that the existing and future stormwater infrastructure in the watershed are maintained properly;
- Ensuring that clear-cut areas follow forestry best management practices to limit erosion;
- Ensuring that other land-disturbing activities have sufficient erosion & sediment control practices in place, and that inspections are conducted regularly throughout construction; and
- Encouraging robust riparian buffers that are not impacted by cattle.

In the longer term, it is recommended that further evaluation of the priority list of potential stormwater and stream restoration sites be undertaken in future phases of this management plan. This evaluation should include detailed estimates for permitting and preliminary construction drawings. Communication with the owners of the private stormwater retrofit and stream restoration sites identified for priority consideration should also be started. Cooperation from these landowners will vary, but landowner cooperation and collaboration are essential for program success. Additionally, as BMP design and treatment standards evolve, potential BMPs may need to be updated or reconsidered to ensure they are providing the intended benefits.

A final important recommendation is continued watershed education opportunities for the community. These can be collaborative with other educational groups such as the Dorchester Soil and Water Conservation District, Clemson Extension, Friends of the Edisto, or student groups from local high schools and colleges. This can be accomplished with formal training workshops (such as Adopt-a-Stream and rainwater harvesting) or more passively through interpretive signage in greenways and boardwalks through conserved riparian areas. An educated and engaged community will make an impact on water quality.

APPENDIX A: Water Quality Monitoring Data

Nutrients

Nutrients are an element or chemical essential to life. Two nutrients that are important for consideration regarding streams, wetlands and overall watershed health are nitrogen and phosphorus. Currently, there are no numeric criteria for nutrients in freshwater streams and rivers in South Carolina. SCDES is currently collaborating with USEPA and researchers in the state to form a South Carolina Blackwater Project group - the purpose of this organization is to develop more realistic standards for blackwater and other nontraditional streams for which monitoring data can otherwise indicate that a system is of compliance with traditional freshwater stream criteria for parameters such as nutrients and dissolved oxygen, but not necessarily due to human influence. The EPA's Ecoregional Nutrient Criteria for Rivers and Streams[108] has been cited to provide some context of what the implications are for the nutrient concentrations observed in the watershed in the absence of state criteria. The non-regulatory numeric nutrient criteria in Ecoregion IX are 0.69 mg/L for total nitrogen and 36.56 µg/L for total phosphorus (to convert to mg/L, multiply 36.56 by 1000 which equals 0.03556 or 3.5x10E-3 mg/L).

The following two figures (A-1 and A-2) summarize available historical monitoring data for total nitrogen (TN) and total phosphorus (TP) at various SCDES ambient surface water monitoring stations from January 1999 to July 2023. These data were selected for presentation in the watershed management plan due to their relevance to WTM model outputs.

Sources of nitrogen and phosphorus in the watershed may include runoff from livestock or pet waste, fertilizer use, leaching from septic tanks, or erosion of natural deposits.[109] It is important to consider the impacts to both the natural ecosystem and the source water when evaluating the impact of nutrients.

Figure A-1 represents the SCDES monitoring stations in the Givhans Ferry watershed E-014, E-015, E-015A, E-032, E-086, E-100, E-116, RS-10373, RS-14179, and RS-16315 have records of 679 TN measurements (from 1999 to 2023), of which 269 samples (40% of the samples) were above the EPA's non-regulatory water quality recommendation for rivers and streams (0.69 mg/L). The lowest measured value was 0.227 mg/L and the highest was 4.42 mg/L.

The National Primary Drinking Water Regulations have established criteria for nitrate (10 mg/L) and nitrite (1 mg/L) in potable water[110], but none for phosphorus. The purpose of these limits is to protect infants below the age of six months who could become seriously ill, and if untreated, die if they drink water containing nitrates and nitrites above these thresholds. Note that the current drinking water treatment process is very effective at removing pollutants from source water, and that source water quality is not regulated by drinking water standards. However, none of the residents of this watershed receive their drinking water from CWS; most rely on private wells. Concerns about the nitrate and nitrite are warranted for wells.

[108] EPA. 2000. https://www.epa.gov/nutrient-policy-data/ecoregional-nutrient-criteria-rivers-and-streams
[109] EPA. 2021. https://www.epa.gov/nutrientpollution/sources-and-solutions
[110] EPA. 2022. https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations

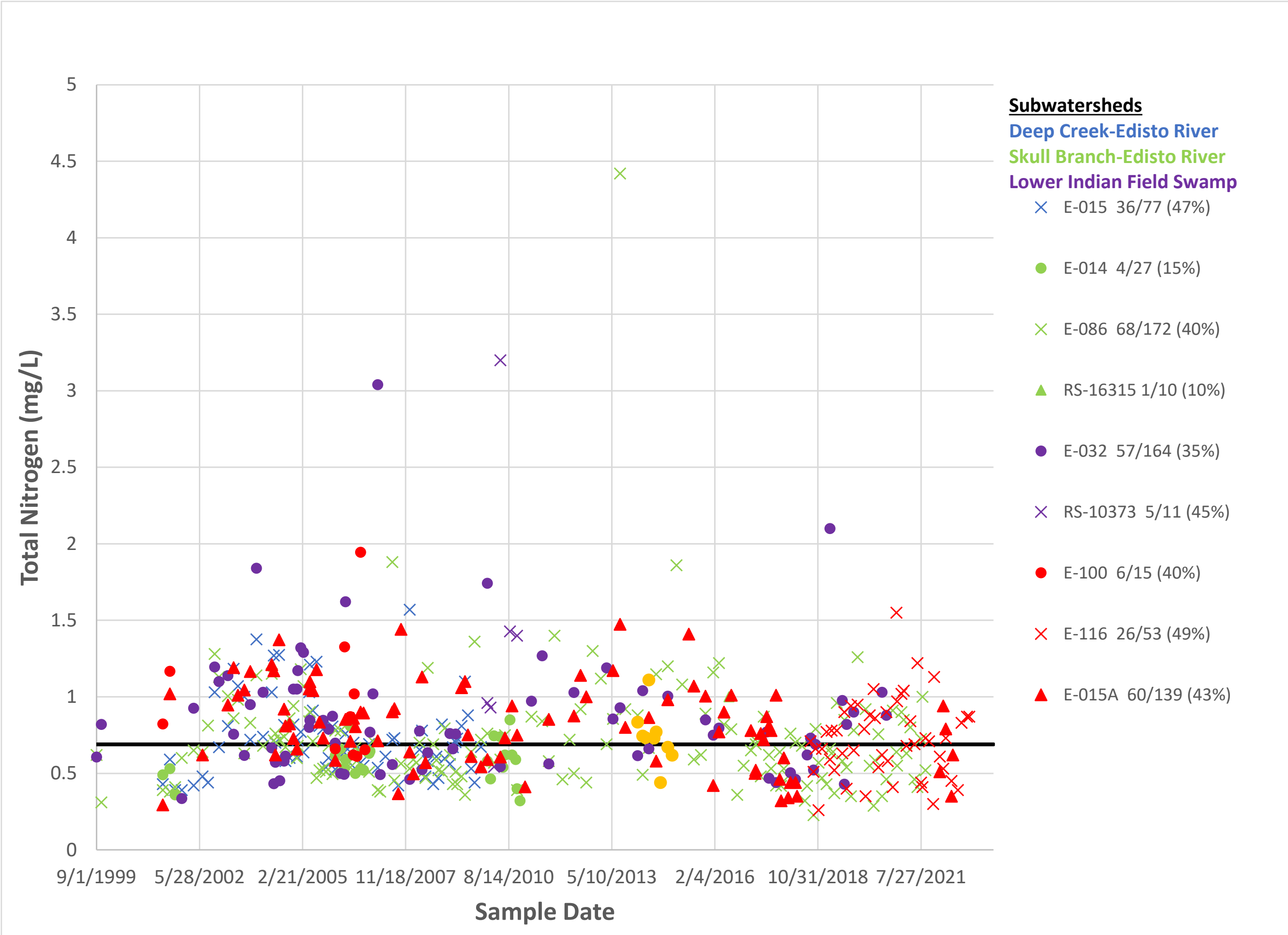

Figure A-1: Monitoring Results for Total Nitrogen in the Deep Creek-Edisto River Subwatershed

Figure A-2 illustrates the results of 739 total phosphorus (TP) samples collected by SCDES from January 2001 to July 2023. In total, 519 samples (70% of the total samples) were above the water quality recommendation of 0.03656 mg/L for freshwater rivers and streams; note this is not a regulatory threshold. The lowest measured TP concentration was 0.02 mg/L and the highest was 1.3 mg/L.

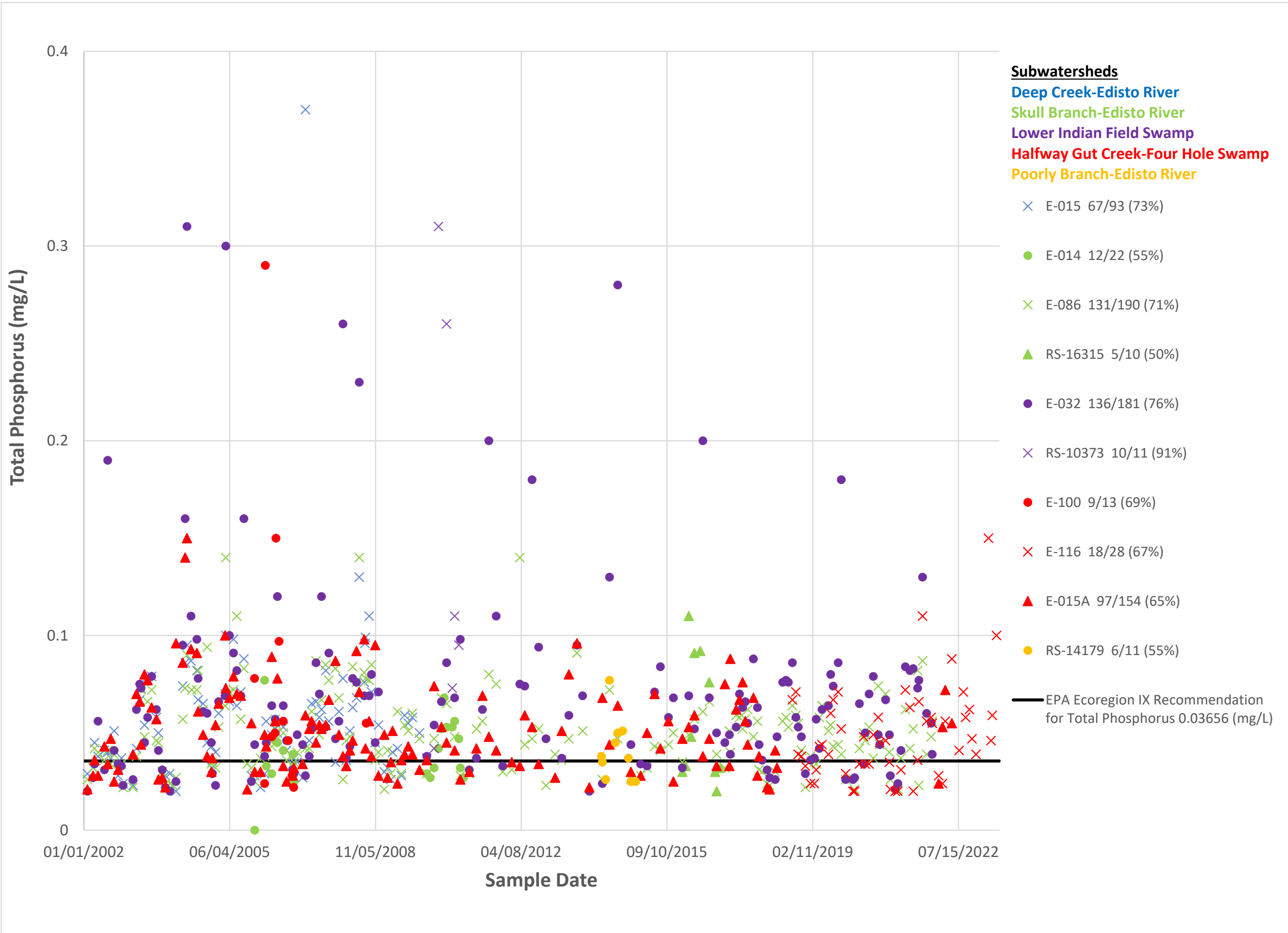

Figure A-2: Monitoring Results for Total Phosphorus in the Givhans Ferry Watershed

Turbidity

Figure A-3 illustrates the SCDES and CWS turbidity monitoring results from 1,948 samples collected from January 1999 to March 2023. Note that turbidity is not calculated as part of the WTM analysis. However, Total Suspended Solids (TSS) are calculated in WTM. There are no standards for TSS currently in R.61-68, but there is the freshwater standard for turbidity. Turbidity and TSS are typically well-correlated; however, the relationships are site specific and dependent on factors like organic matter content, particle size, and color. Turbidity measurements at monitoring stations E-105 ranged from a low of 0.88 NTU to a high of 310 NTU. Six of the samples' turbidity levels were above the water quality standard (50 NTU).

From a water treatment perspective, neither TSS nor turbidity are concerns for the Givhans Ferry Watershed at this time. However, if construction or other land-disturbing activities (such as clear-cutting or mining) increase the sediment load in stormwater runoff, it has the potential to become an issue.

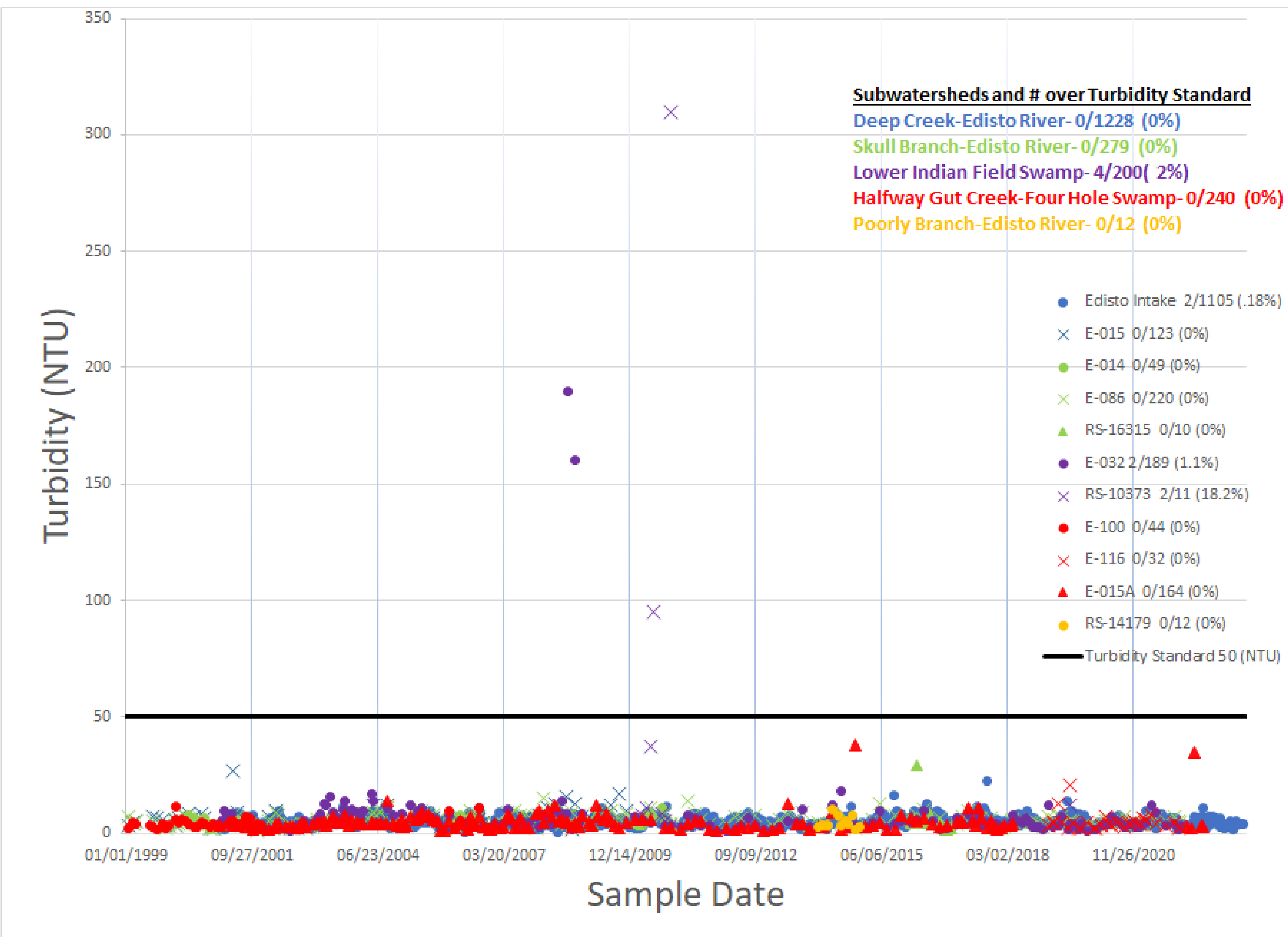

Figure A-3: Monitoring Results for Turbidity in the Givhans Ferry Watershed

Organic Matter

The Edisto River and its tributaries are classified as blackwater systems, which are distinguished by significant terrestrial contributions of organic matter such as decaying forest and marsh materials. Organic matter, measured as Total Organic Carbon (TOC), is a concern for the Givhans Ferry Watershed. Monitored TOC from E-015, E-014, E-086, E-032, E-100, E-015A and the CWS Edisto intake are shown in **Figure A-4**. The Edisto River has high background levels of TOC, and the CWS must use additional flocculants (aluminum sulfate, also known as alum) to reduce the color of the water that results from these compounds. Color is a secondary drinking water standard, but breakthroughs in color will result in complaints from customers. Additionally, the formation of disinfection byproducts, including trihalomethanes (TTHMs) and haloacetic acids (HAAs) can occur if TOC levels are high in the finished water. The reason why drinking water containing these byproducts in excess of the Maximum Contaminant Levels (MCLs) is a concern because they may cause liver or kidney problems, or nervous system effects, and may contribute to an increased risk of getting cancer. However, please note that the observed TOC in the raw (untreated) drinking water is not indicative of the safety of the drinking water after treatment; rather these concerns are included here to illustrate the importance of the water treatment process.

CWS provides a Monthly Operating Report to SCDES that includes 12 months of Raw TOC, Finished TOC, and Percent Removal Data. Different levels of TOC removal are required based on the concentration in the water, as illustrated in **Figure A-4**. The average raw water TOC concentration throughout the Givhans Ferry Watershed is 9.28 mg/L with a low of 2.3 mg/L (Edisto Intake on 10/01/2019) and a high of 33(E-100 on 07/16/2001).

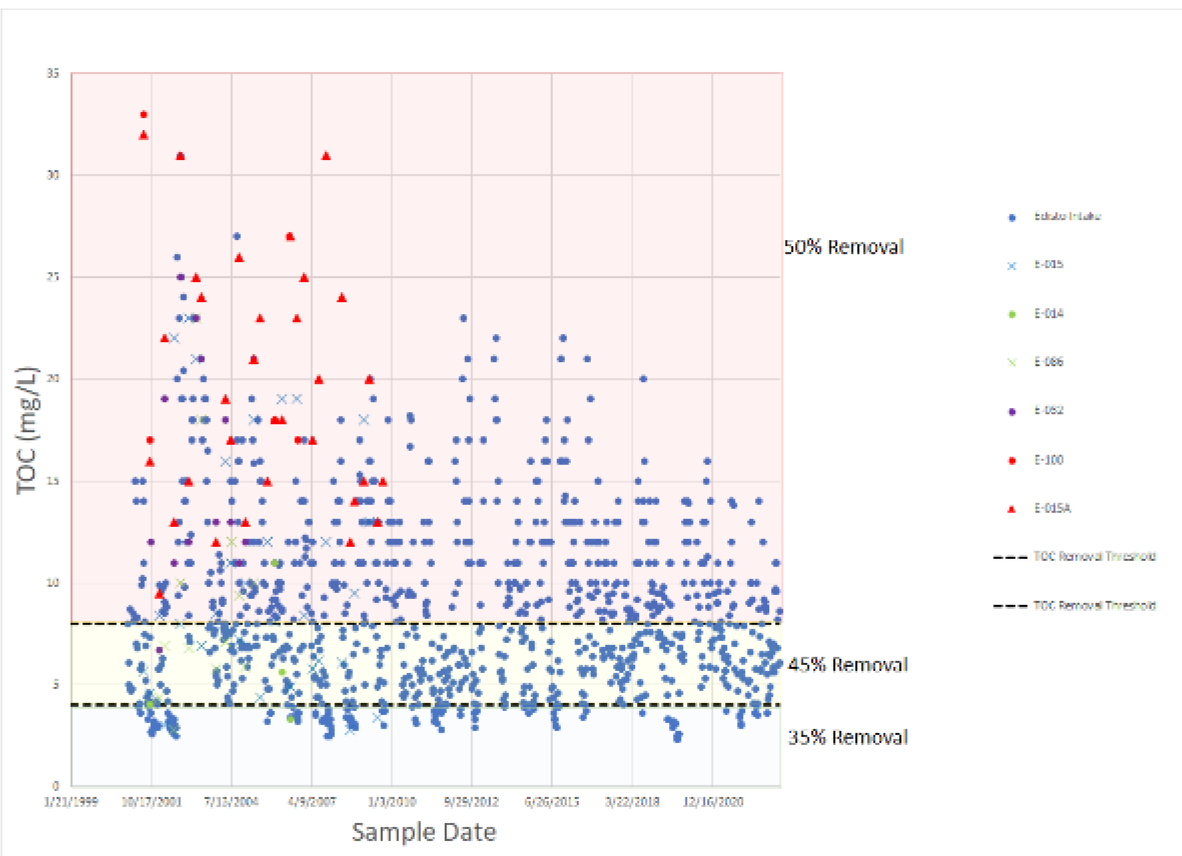

Figure A-4: Monitoring Results and Removal Requirements for Total Organic Carbon

Bacteria

Figure A-5 summarizes the monitoring available fecal coliform and *E. coli* data (note that FC numbers were calculated as *E. coli* using a conversion factor of 0.8725[111]). Monitoring results from both SCDES and CWS included a total, 1,982 measurements were observed from January 1999 to March 2023. The largest recorded measurement was 2,746.8 MPN/100 mL (at E-032 on 11/12/2009), and the smallest detectable was 0.875 MPN/100 mL (collected several times by CWS). Over the entire record, 1,905 measurements (96%) were below the standard of 349 MPN/100 mL; and 77 measurements (4%) were above the standard. The three highest *E. coli* concentrations were observed at E-105 (2746.8 MPN/100 mL), at the Edisto intake (2419.6 MPN/100mL), and at E-086 (2419.6 MPN/100mL). The subwatershed with the highest percent of bacteria concentration exceedances was Lower Indian Field Swamp (23%), which is not surprising as this area has a TMDL for FC.

It is important to note that the Edisto Intake bacteria data may have lower overall bacteria concentrations for two reasons. First, many of the sampling stations occur along smaller streams with less volume compared to the larger volume of flow at the wider channel near the intake. If both were exposed to the same amount of bacteria, the load would be lower at the intake due to the higher volume of water. Also, CWS has observed that flow through smaller channels (which do not have flow monitoring stations), such as sections of Four Hole Swamp, drops drastically during the summer months due to evapotranspiration rates and lack of topographical gradient. As a result, pollutant loads are more concentrated. Also, there is a potential difference in sampling methodology; it may be that some grab samples in other parts of the watershed are obtained close to the shoreline, whereas the CWS samples are collected from the center of the channel in the tunnel. Holding times (the amount of time between sample collection and processing) for each sampling organization (SCDES and CWS) as well as the effect the retention time of the bacteria traveling through the tunnel system may also be a factor in skewing results.

[111] Fecal coliform values can be converted to *E. coli* values using a standard conversion factor of 0.8725, that represents the ratio of 349/400. 349 is the water quality standard (WQS) for *E. coli* and 400 the WQS for fecal coliform.

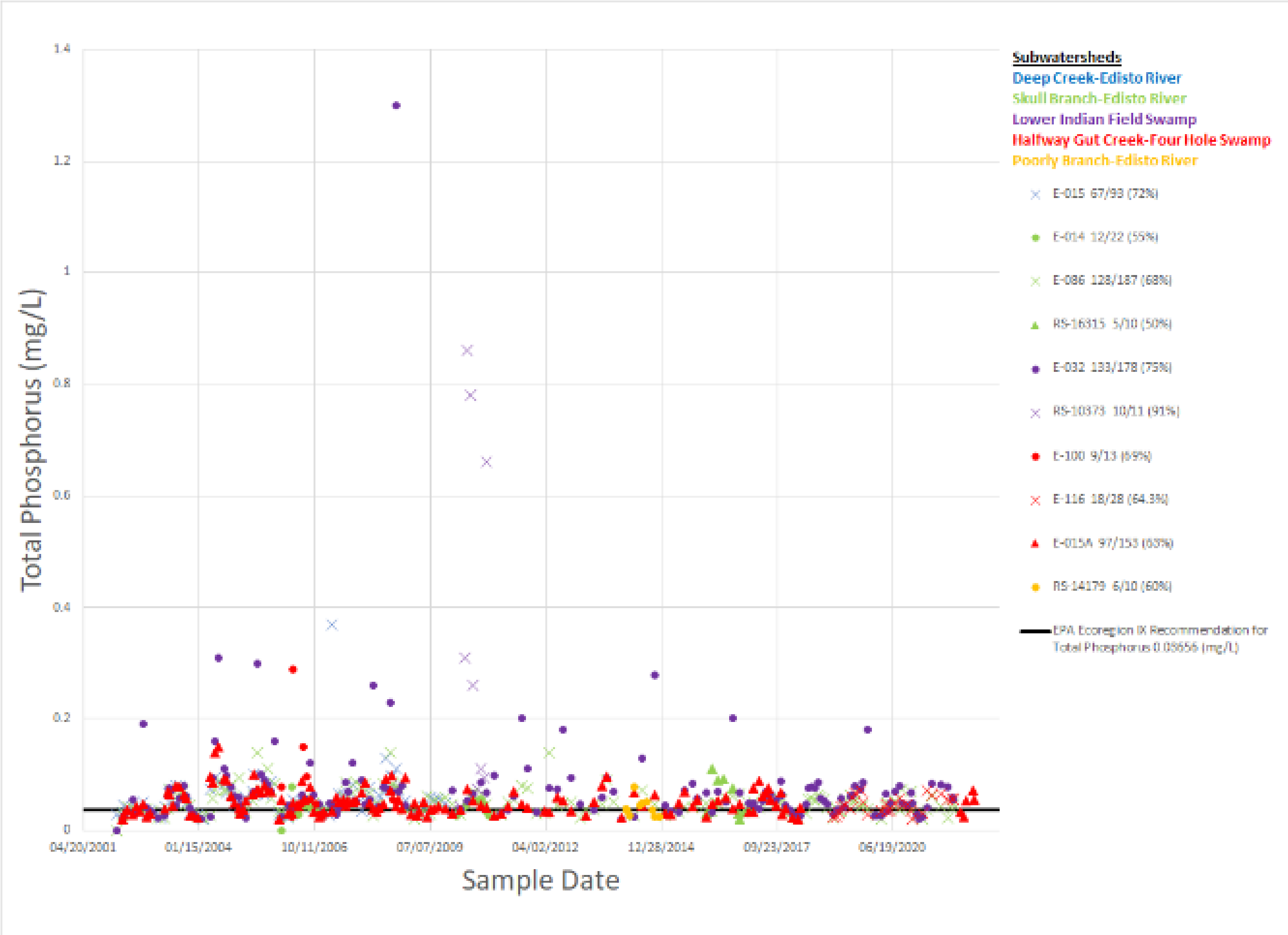

Figure A-5: Monitoring Results for E. coli in Givhans Ferry Watershed