LAKE KEOWEE
SOURCE WATER PROTECTION TEAM
Our Water. Our Future. Our Responsibility.

Watershed-Based Plan for the Little River-Lake Keowee and Keowee River-Lake Keowee Watersheds

An Action Plan for Protection and Restoration Activities

THE LAKE KEOWEE SOURCE WATER PROTECTION TEAM

for

THE SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

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Acknowledgements

The Lake Keowee Source Water Protection Team (LKSWPT) was established in 2017, by the Friends of Lake Keowee Society (FOLKS), Seneca Light & Water, and Greenville Water, to protect and improve water quality throughout the area flowing into Lake Keowee. In 2018, the Board of Directors was expanded to include four additional organizations. Funding for this project was provided to LKSWPT and was awarded from SC Department of Health and Environmental Control (SCDHEC). Duke Energy's Keowee Toxaway Relicensing Agreement spurred the creation of the LKSWPT and Duke Energy's continued engagement is truly appreciated. Additionally, Clemson University's Center for Watershed Excellence provided the septic evaluation and analysis portion of this plan. The dedication and involvement of board members and collaborators in this project will surely lead to substantial water quality preservation and improvements throughout these watersheds.

Officers and Board Members of the LKSWPT include:

- Advocates for Quality Development
- Friends of Lake Keowee Society (FOLKS)
- Greenville Water
- Oconee County
- Pickens County
- Seneca Light & Water
- Upstate Forever

Collaborators with the LKSWPT include:

- Clemson University (Center for Watershed Excellence)
- Duke Energy

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List of Acronyms

ACS	American Community Survey (United States Census Bureau)
AL	Aquatic Life
AMSL	Above Mean Sea Level
APCSP	Anderson and Pickens County Stormwater Partners
AWEP	Agricultural Water Enhancement Program
BIO	Biological [Water Quality Criteria]
BOD	Biochemical Oxygen Demand
BMP	Best Management Practice(s)
CAFO	Concentrated Animal Feeding Operation
CC	Cane Creek [watershed]
CE	Conservation Easement
CFU	Colony Forming Unit
CLM	Upstate Forever's Critical Lands Map
CRP	Conservation Reserve Program
CSP	Conservation Steward Program
CU	Clemson University
CWA	Upstate Forever's Critical Watershed Area
DAR	Daughters of the American Revolution
ECHO	EPA's Enforcement and Compliance History Online
E. coli	*Escherichia coli*
EFDC	Environmental Fluid Dynamics Code
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FC	Fecal Coliform
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FOLKS	Friends of Lake Keowee Society
FSA	Farm Service Agency

FW	Fresh Water
GIS	Geographic Information System
gSSURGO	Gridded Soil Survey Geographic Database
GW	Greenville Water
HUC	Hydrologic Unit Code
INDNR	Indiana Department of Natural Resources
InVEST	Integrated Valuation of Ecosystem Services and Trade-Offs (model)
LA	Load Allocation
LCC	Little Cane Creek [watershed]
LKSWPT	Lake Keowee Source Water Protection Team
ml	Milliliter
MOS	Margin of Safety
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer System
MST	Microbial Source Tracking
ND	No Discharge
NHD	National Hydrography Dataset
NLCD	National Land Cover Dataset
NLT	Naturaland Trust
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
ONRW	Outstanding Natural Resource Waters
Pb	Lead (atomic symbol)
(R)USLE	(Revised) Universal Soil Loss Equation
SC AAS	South Carolina Adopt-A-Stream
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SCFC	South Carolina Forestry Commission
SMP	Shoreline Management Plan

SMS4	Small Municipal Separate Storm Sewer System
SMZ	Streamside Management Zones
SSO	Sanitary Sewer Overflow
STEPL	Spreadsheet Tool for Estimating Pollutant Loads
STORET	EPA's Water Quality Storage and Retrieval Data Warehouse
SWAT	Soil and Water Assessment Tool
SWCD	Soil and Water Conservation District
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TN	Trout, Natural [water classification]
TNC	The Nature Conservancy
TP	Total Phosphorus
TPGT	Trout, Put, Grow, Take
TSS	Total Suspended Solids
UF	Upstate Forever
USDA	United States Department of Agriculture
USLE	Universal Soil Loss Equation
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
WBP	Watershed-Based Plan
WLA	Waste Load Allocation
WOTUS	Waters of the United States
WQMS	Water Quality Monitoring Station
WQX	EPA's Water Quality Data
WWTP	Wastewater Treatment Plant

1) Executive Summary

The Lake Keowee Watershed (Hydrologic Unit Codes 03060101-03, -02) (the focus area) is a 184,000-acre watershed located in the upper portion of the Savannah River Basin in Oconee and Pickens Counties, South Carolina, with a small northern portion extending into Transylvania County, North Carolina. The watershed drains to Lake Keowee, which serves as a drinking water supply for Greenville Water and Seneca Light & Water, serving over 250,000 residents in Oconee, Pickens, Anderson, Laurens, and Greenville Counties. Duke Energy owns and manages the reservoir basin which includes a 1,500-foot protected buffer around the lake (Figures 1&3). Additionally, the city of Walhalla provides water to over 7,000 customers and is establishing a new water treatment plant and water intake on the Cane Creek branch of the Little River arm of Lake Keowee near the Seneca Light & Water intake.

This watershed-based plan (WBP) addresses non-point sources of bacteria, nutrients, and sediment pollution and identifies critical areas for protection and restoration throughout the focus area. Additionally, this plan provides strategies to reduce or eliminate pollutant loads, recommends potential funding opportunities and technical resources for pollution mitigation practices, and outlines a comprehensive public outreach strategy to increase public awareness about water quality issues as it relates to the identified pollutants of concern.

Pollutants and Sources – There are three Total Maximum Daily Loads (TMDL) for Fecal Coliform (FC) bacteria in the focus area approved by the US Environmental Protection Agency (EPA). The TMDL for Little Eastatoe Creek (SV-341) was developed in 2000; the TMDL for Cane and Little Cane Creeks (SV-342 and SV-343) was developed in 2005; and the TMDL for Burgess Creek (RS-02466) was developed in 2010. These three TMDLs identify the maximum bacteria load that can be received by their respective subwatersheds, while still meeting state water quality standards. Primary sources of bacteria in the focus area are faulty septic systems, agricultural activities, pet waste, and wildlife. Although no water quality monitoring stations indicate elevated levels of nutrients or sediment, this watershed is prime for significant development over the next 20 years. As such, this WBP proactively addresses potential sources of nutrients and sediment such as urbanization, agricultural activities, shoreline erosion, and inadequate riparian buffers.

Pollutant Load Reductions – To address the pollutants of concern, Lake Keowee Source Water Protection Team (LKSWPT) analyzed necessary load reductions as detailed in the TMDLs, potential sources of pollution from both desktop and windshield surveys, and possible annual load reductions based on current conditions, as outlined in Sections 5-8 (Table 1). A summary of pollutant load reductions is found in Table 1.

Table 1. Pollutant Load Reductions Needed in the Lake Keowee Watersheds

Pollutant of Concern	Load Reductions Needed
Bacteria	2.05E+14 counts/year
Sediment	11,017.4 tons/year
Nutrients	577,179.7 lbs/year

Pollutant Load Recommendations – This WBP presents a set of pollutant mitigation strategies to reach necessary pollutant load reductions such as the implementation of land protection as well as a suite of restoration Best Management Practices (BMPs) including septic tank repair/replacements, agricultural BMPs, wetland and riparian buffer restoration/enhancement, shoreline management, voluntary dam removal, stormwater BMPs, pet waste stations, wildlife BMPs, and forestry management. Table 2 outlines the approximate number of BMPs recommended to achieve the necessary pollutant load reductions outlined in Table 1, derived using the standard annual pollutant removal rates for each BMP (Appendix A and B). The five primary BMPs recommended for implementation throughout the focus area are septic repair/replacement, agricultural BMPs (e.g. exclusion fencing, heavy use areas, stream crossings), land protection, pet waste stations, and riparian buffer restoration. Based on load reduction data and cost estimates available, these five BMPs will successfully and efficiently meet the recommended bacteria load reductions within the Lake Keowee watersheds.

Table 2. Recommended BMPs and Annual Load Reductions in the Lake Keowee Watersheds

BMP	# of Projects	Bacteria Load Reduction (counts/year)	Sediment Load Reduction (tons/year)	Nutrient Load Reduction (lbs/year)	Total Cost Estimate
Septic Repair/ Restoration	545	1.32E+13		23,599	$2,452,500
Agricultural BMPs Package	11	1.79E+14	85	600	$212,652
Pet Waste Stations	6	1.28E+13			$1,800
Land Protection	10 CE's* or 550 acres		62,827	28,886,000	$232,500
Riparian Buffer Restoration	98 (acres)		65	1,595	$39,661.58
Total		**2.05E+14 counts/year**	**62,977 tons/year**	**28,911,794 lbs/year**	**$2,974,392.26**

**CE = Conservation Easement*

Prioritizing BMP Installation Locations – LKSWPT conducted an in-depth Geographic Informational Systems (GIS) land prioritization analysis at a parcel-by-parcel level for 10 categories of protection and restoration strategies using the identified load reductions needed for each pollutant of concern, and strategies to achieve those pollutant loads reductions. While 10 categories were analyzed, the final recommendations focused primarily on the BMPs listed in

Table 2. LKSWPT utilized weighted criteria to analyze each parcel within the Lake Keowee watersheds to identify priority lands for protection (i.e., protecting lands that would, if developed, have the biggest [negative] impact on water quality), restoration/enhancement (i.e., restore lands that are attributing to current pollutant loads or would provide significant water quality benefits if restored), and/or BMPs (i.e., water pollution mitigation practices). Each criterion was assigned a total number of possible points based on its importance to water quality protection or restoration. The results identify lands that should be protected or improved to provide the most benefit to water quality. These analyses resulted in the creation of detailed GIS layers for each protection/restoration strategy. These GIS layers facilitate the targeted and strategic implementation of improvement projects in areas of the watershed that will yield the most positive water quality impacts, and aid in achieving the pollutant load reductions needed by focusing on lands best suited for the recommended strategies.

WBP Implementation – LKSWPT developed a targeted public outreach and education strategy, project implementation timeline, and water quality monitoring strategy to guide the facilitation of these recommendations. Building on the success of current partnerships within the watershed, LKSWPT recommends utilizing the results of the land prioritization analyses to inform BMP implementation to meet pollutant load reductions and target public outreach efforts within the focus area. Supplemental BMPs can be added to each phase as funding and resources allow. Taking advantage of the successful network of engaged partners and stakeholders will greatly enhance the success BMPs and public outreach strategy implementation. Additionally, a robust water quality monitoring strategy will ensure that BMP success is measured and problem areas further investigated. Table 3 below details the BMP implementation goals over a 10-year, 3-phase implementation period (Section 23).

Table 3. WBP Implementation Overview

BMP		BMP Project Goal
Primary BMPs	Septic Repairs	545 septic tank repairs or restorations
	Agricultural BMPs	11 agricultural projects (Packages)
	Pet Waste Stations	Install 6 pet waste stations at parks or pet-related businesses
	Land Protection	10 conservation easements, or 550+ acres of land protected
	Riparian Buffer Restoration	2 riparian buffer restoration projects, strengthened buffer ordinances
Supplemental BMPs	Wetland Restoration	List of possible wetland mitigation locations and interested landowners
	Shoreline Management	Enforcement of the Shoreline Management Plan (SMP)
	Stormwater BMPs	Strengthen stormwater regulations outside of MS4s; 1-2 BMP demonstration sites
	Wildlife BMPs	Improved wildlife management and public outreach/education
	Forestry BMPs	Encourage the use of South Carolina Forestry Commission's BMP Foresters and suite of BMPs

2) General Watershed Information

2.1) Watershed Summary

This WBP pertains to the Little River-Lake Keowee (Little River) and Keowee River-Lake Keowee (Keowee River) Watersheds (Hydrologic Unit Codes (HUCs) 03060101-03, -02) of the Seneca River Watershed (HUC 03060101), collectively referred to as the focus area or watersheds, as shown in Figure 1. The Seneca River Watershed is contained within the upper portion of the Savannah River Basin. The portion of the Savannah River Basin inside South Carolina encompasses 3,171,462 acres and is subdivided into 34, 10-digit HUC watersheds that flow from the Blue Ridge and Piedmont regions of the state to the Sandhills, the Upper and Lower Coastal Plain, and Coastal Zone regions. Within the focus area there are 808.5 stream miles 17,356.6 acres of lake waters, and nearly 184,000 acres total[1] (Table 4). The watersheds are situated within Oconee and Pickens Counties, South Carolina, and extend slightly into Transylvania County, North Carolina. Duke Energy built the Lake Keowee reservoir for hydropower operations in 1967; additional uses include drinking water supply, cooling water for the Oconee Nuclear Station, and recreation. The majority of streams in the focus area are classified as Fresh Waters (FW), with some waters near the top of the Keowee River watershed classified as Trout Natural (TN), Trout: Put, Grow and Take (TPGT), and Outstanding National Resource Waters (ONRW) (SC Watershed Atlas, 2017).

Table 4. Lake Keowee Watersheds Characteristics

Watershed	HUC-10 Code	Total Acreage	All Streams (miles)	Lake (acres)
Keowee River	0306010102	78,837.3	386.5	7,598.2
Little River	0306010103	104,996.4	422	9,758.4
Total		**183,833.7**	**808.5**	**17,356.6**

2.2) Location and Hydrology

The focus area is located within Oconee and Pickens Counties in South Carolina and extends slightly into Transylvania County, North Carolina. Within South Carolina, the upper portion of the focus area is within the Blue Ridge Ecoregion, and the lower portions of the focus area is within the Piedmont Ecoregion (Figure 1). The Blue Ridge Ecoregion is characterized by forested, high-slope terrain reaching up to 6,004 feet, with some of the richest biodiversity in the eastern United States. The Piedmont Ecoregion is characterized by gently rolling to hilly slopes, narrow stream valleys dominated by forests, farms, and orchards.[2] Elevations in this area range from 375 to 1,000 feet.[3] At the upper end of the area draining to Lake Keowee, the Whitewater,

[1] (SCDHEC, 2019)
[2] (Griffith, Omernik, & Comstock, 2002)
[3] (United States Geological Survey, 2019)

Thompson, Horsepasture, and Toxaway Rivers join at Lake Jocassee, which then flows directly into Lake Keowee. The entire length of the Keowee River is now submerged beneath Lake Keowee. Additional flow into the Keowee River Arm of Lake Keowee is mainly from: Fall Creek, Eastatoe Creek, Little Eastatoe Creek, Little Crow Creek, Crow Creek, and Mile Creek. The Little River arm of Lake Keowee receives flow from: Little River, Stamp Creek, Flat Shoals River, Burgess Creek, Oconee Creek, Crooked Creek, Cane Creek, and Little Cane Creek. The Lake Keowee reservoir is the 8th largest in volume in the state of South Carolina with approximately 870,000 acre-feet of water.[4]

2.3) Population

The focus area includes the communities of Salem, Seneca, Tamassee, a portion of Six-Mile, Walhalla, and West Union with an estimated cumulative population of 33,371 (Figure 1). The population for the focus area was determined as the summation of total population for each Block Group, the smallest geographical unit for which the US Census Bureau publishes data, within the focus area as provided by the US Census American Community Survey (ACS) 2017 5-Year Estimates.[5]

2.4) Climate

The focus area experiences a moderate climate and is situated at roughly 34°55'N latitude and -82°55'W longitude. The annual mean temperature for the region is 57.6°F, with average temperatures ranging from 27°F–88°F.[6] Since the beginning of the 20th century however, temperatures in the state have increased 0.5°F.[7] Average annual rainfall throughout the focus area is 66.85 inches, with precipitation relatively evenly distributed year-round. Annual precipitation for the state of South Carolina has been below average during most of the 2000's (12 of 16 years during 2000 –2015).[8]

2.5) Geology and Soils

The primary geological features of the focus area are the Walhalla thrust sheet and the Six Mile thrust sheet,[9] separated by the Seneca thrust fault line. The Walhalla thrust sheet is characterized by high-grade gneisses and quartzite, while the Six Mile thrust sheet is comprised of a number of rock types (e.g., mica, schist, red-weathering biotite schist, gneiss) that are commonly deeply weathered.

Nearly 75% of the soils in the focus area are classified as sandy loams. Principal soils include Hayesville, Evard, Lloyd, Halewood, and Edneytown. The Soil K-factor, the soil erodibility

[4] (South Carolina Department of Natural Resources (SCDNR), 2013)
[5] (US Census Bureau, 2013-2017)
[6] (National Oceanic and Atmospheric Administration, 2019)
[7] (National Oceanic and Atmospheric Administration, 2019)
[8] (United States Climate Data, 2019)
[9] (South Carolina Department of Natural Resources (SCDNR))

factor, for the soils in the focus area range from 0.02 to 0.64.[10] K-values closer to 1.0 indicate higher soil erodibility and greater need for protection measures. Overall, the soils found in the focus area are well-drained, moderately permeable soils.

2.6) Land Cover

Sourced from the 2016 National Land Cover Dataset (NLCD),[11] land cover in the focus area has been divided into eight categories, as shown in Table 5 and Figure 2. Excluding open water (9.2%), the top three land cover classes are forest (69.5%), developed land (11.7%), and agricultural (6.19%).

Table 5: Land Cover in the Lake Keowee Watersheds from 2011-2016

Land Cover Type	Land Cover in 2011	Land Cover in 2016
Water	17,008.09	17,023.21
Developed	19,290.31	21,635.01
Barren	424.55	272.21
Forest	124,946.76	128,594.03
Shrub/Scrubland	2,615.59	1,866.12
Pasture/Hay	9,519.39	11,452.22
Cultivated Crops	14.67	2.67
Herbaceous	10,717.65	3,976.42
Wetlands	415.66	130.77
Total	**184,952.6**	**184,952.6**

2.6.1) Changes in Land Cover from 2011-2016

Improvements in land cover monitoring and characterization led to the reclassification and correction of previous errors in land classes from 2011 to 2016.[12] Because of this, land cover changes from 2011 to 2016 are seemingly drastic in some categories, specifically forested and herbaceous (grassy) lands, however these changes are a result of the newer models of land classification used in the development of the 2016 NLCD.

Overall, developed land increased by 5.7%, seen primarily along the shoreline of Lake Keowee. The increase in forested land cover of 1.4% is attributed mostly to land reclassification, and importantly, no loss of forested land cover occurred in the protected lands corridor along the northern rim of the focus area.

[10] (USDA NRCS, 2019)
[11] (Multi-Resolution Land Characteristics Consortium (MRLC), 2016)
[12] (Yang, et al., 2018)

Figure 1: Lake Keowee Watersheds

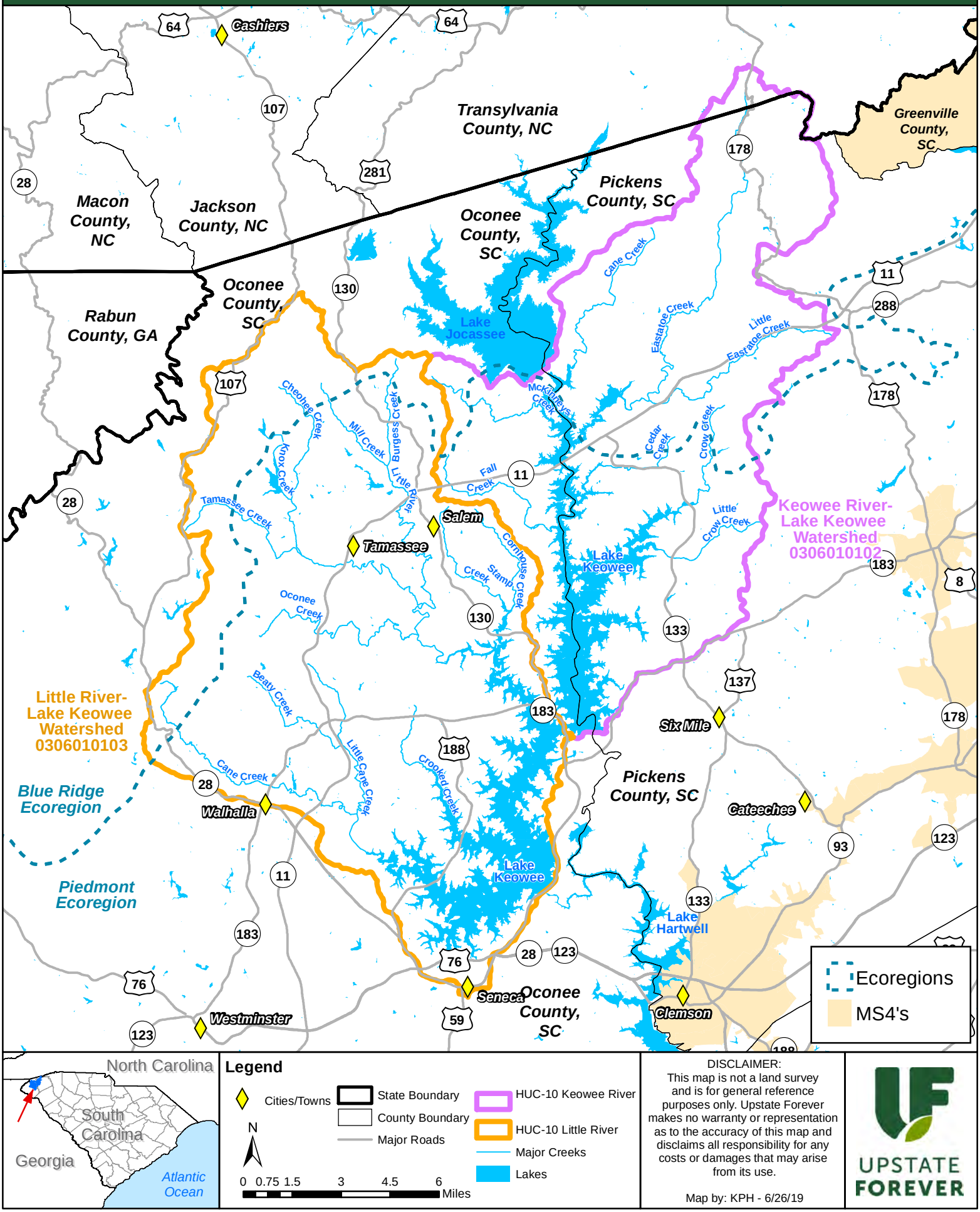
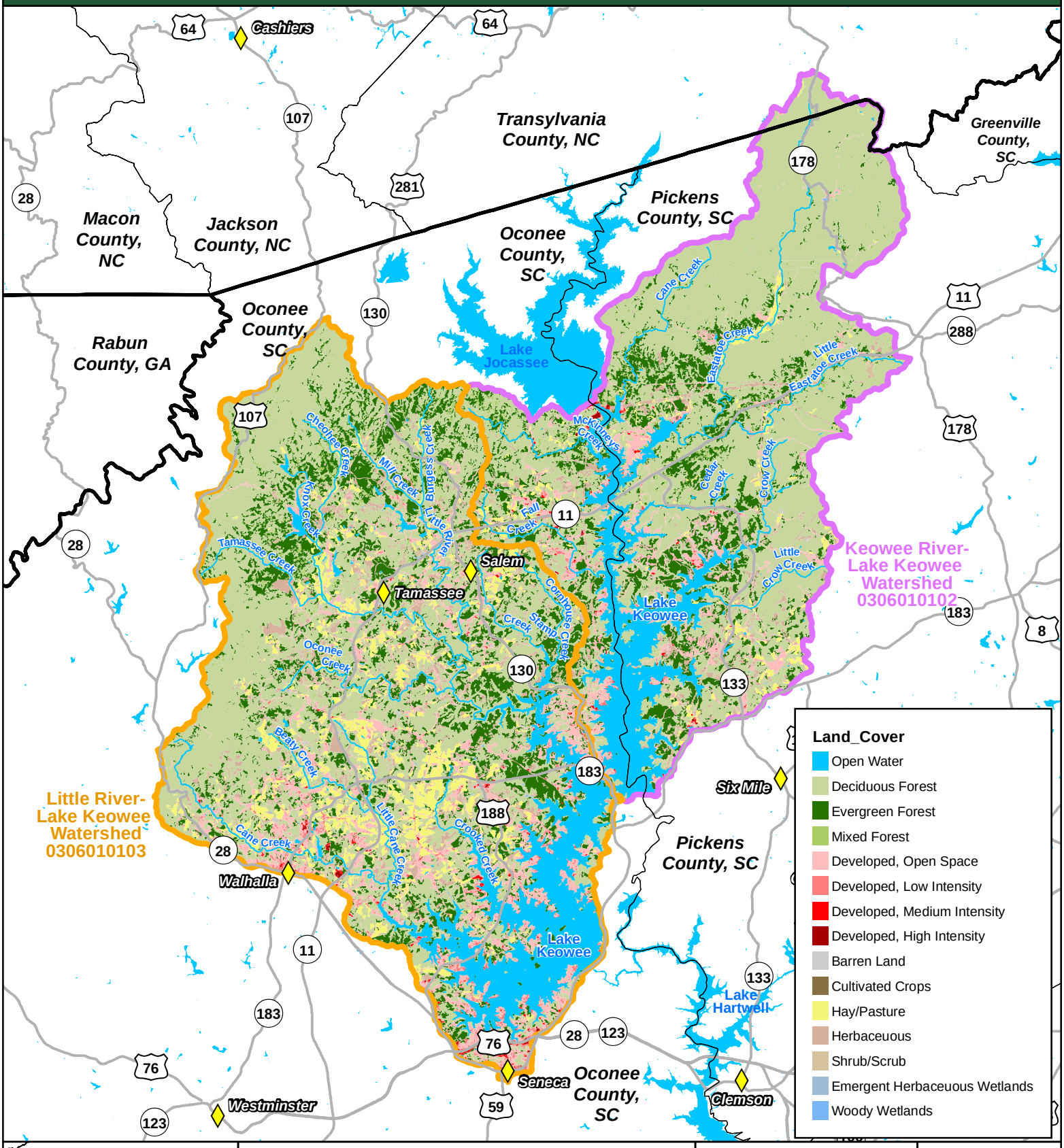


Figure 2: Land Cover



DISCLAIMER:
This map is not a land survey and is for general reference purposes only. Upstate Forever makes no warranty or representation as to the accuracy of this map and disclaims all responsibility for any costs or damages that may arise from its use.

Map by: KPH - 6/26/19

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2.7) Source Water Intakes

Greenville Water and Seneca Light & Water withdraw water from Lake Keowee to provide drinking water to over 250,000 residents within Oconee, Pickens, Anderson, Laurens, and Greenville Counties. Greenville Water owns and operates an intake pump (S23103) that is located on Lake Keowee near the base of the Keowee River-Lake Keowee HUC 12 watershed.[13] The Seneca Light & Water intake pump (S37101) is located on Lake Keowee near the base of the Cane Creek-Little River HUC 12 watershed. Duke Energy owns and manages the reservoir basin, which includes a 1,500-foot protected buffer around the Lake (Figure 3). Additionally, the city of Walhalla provides water to over 7,000 customers and is establishing a new water treatment plant and water intake on the Cane Creek branch of the Little River arm of Lake Keowee near the Seneca Light & Water drinking water intake.

2.8) Benefits of Watershed-Based Plans

WBPs enhance source water protection planning efforts by evaluating all anticipated potential nonpoint source impacts to source waters throughout an entire watershed. Through a variety of strategies (e.g., land protection, agricultural BMPs, septic system repairs, and improved riparian buffers) it is possible to efficiently reduce and/or prevent nonpoint source pollutants from running off lands and contaminating waterways and drinking water resources. These actions improve water quality and prevent increases in treatment costs for utilities and ultimately their customers. WBPs outline specific actions and strategies for water quality protections and improvements that will help to ensure sustainable and safe drinking water supplies for local communities. Additionally, approved WBPs are eligible for funding opportunities through the Section 319 program for nonpoint source reduction land improvement projects (e.g., septic system repairs, agricultural improvement projects, land protection).

2.9) Previous Work in the Keowee Watersheds

Numerous water quality studies and implementation projects have been completed within the Lake Keowee Watersheds. These studies include routine water quality sampling, BMP implementation projects, watershed planning (at a smaller scale), as well as hydrologic modeling of pollutant loading to tributaries. Additionally, as part of the Federal Energy Regulatory Commission (FERC) relicensing process for the Keowee-Toxaway Hydroelectric Project, Duke Energy completed extensive studies (i.e., environmental assessments of aquatic and terrestrial communities, cultural resource surveys, water quality and quantity analyses, recreation needs analysis, and shoreline management study) between 2012-2014.[14] A summary of studies and implementation projects are listed below.

[13] (SCDHEC, 2019)
[14] (Duke Energy Carolinas, LLC, n.d.)

Cane and Little Cane Section 319 Grant (2006-2009)

In 2006 The Friends of Lake Keowee Society (FOLKS) was awarded a Section 319 grant for Cane and Little Cane Creek Watersheds. FOLKS worked in partnership with Clemson Extension (CU Ext.) in Oconee County to address bacterial loading to these watersheds from 2006-2009. Through this grant FOLKS and CU Ext. repaired 18 septic systems and installed agricultural BMPs on two farms to control runoff into nearby waterways. Additionally, FOLKS and CU Ext. worked with local communities to mark 210 storm drains to prevent residents from dumping wastes in storm drains and to identify and fix sanitary service overflows in these areas.[15]

FOLKS Bacteria Water Quality Monitoring (2015-2018)

FOLKS has collected routine water samples at 11 sites in tributaries in the Cane Creek and Little Cane Creek Watersheds since 2016. The samples are analyzed for bacteria *Escherichia coli* (*E. coli)* by Greenville Water's Laboratory. Results show that the samples exceeded SCDHEC's single grab sample *E. coli* water quality standard of 349 CFU/100 ml up to 75% of the time. Additionally, FOLKS partnered with Dr. Barbara Campbell at Clemson University to conduct microbial source tracking of water quality samples at select sites SCDHEC Site SV-342 (Folks CC) and SV-343 (Folks-LCC). Microbial source tracking is used to identify the source of fecal bacteria in water samples. According to the results, the microbial sources detected in the water samples were human and swine, thereby indicating the influences of on-site wastewater systems and wildlife on bacteria levels in the watersheds.[16] See Section 3 for additional information on water quality monitoring results.

Cane Creek and Little Cane Creek Watershed-Based Plan Grant Plan to Address *E.coli* Impairment, Oconee County (2018)

FOLKS contracted the Clemson University Center for Watershed Excellence to complete a WBP, through the SCDHEC Section 319 grant program, for the Cane Creek and Little Cane Creek watersheds in 2017 to address bacterial impairments. The plan recommended a combination of on the ground BMP projects and policy revisions to reduce bacteria levels and attain water quality standards.[17] The priority projects identified through the planning process are as follows:

1. Stormwater management redesign of Sertoma Field, Walhalla, SC;
2. Riparian reforestation program to help stabilize banks throughout the watershed;
3. Repair failing septic systems and tie into sewer where available;
4. Catch basin maintenance;
5. Installation of grease interceptor at areas of high failures;

[15] (Friends of Lake Keowee Society (FOLKS), 2006-2009)
[16] (Callahan, 2018)
[17] (Callahan, 2018)

6. Trapping wild hogs;
7. Extending buffer areas along agricultural areas; and
8. Lot scale BMPs and stormwater retrofits.

Modeling the Water Quantity and Quality in Lake Keowee (2018)

Clemson University Civil Engineering faculty (Dr. Earl Hayter, Dr. Ashok K. Mishra, and Dr. Anoop Valiya Veettil) developed a surface water modeling system for the Cane Creek and Little Cane Creek watersheds that consists of the Soil and Water Assessment Tool (SWAT) watershed loading model and Environmental Fluid Dynamics Code (EFDC) three-dimensional hydrodynamic and water quality model. The model was developed to provide a continuous, predictive water pollution loading model for Lake Keowee, specifically how failing septic systems contribute to nutrient pollutant loads.[18]

2.10) Watershed Assessment

UF conducted an in-depth watershed assessment involving both desktop and windshield surveys to gather information about land use, potential sources of pollution, and field verification of areas of concern.

Desktop Survey

Utilizing aerial photography, Google search engine, and GIS data, Upstate Forever (UF) was able to identify potential sources of pollution including livestock/farms, poultry operations, and large tracts of development. Because much of the watershed is private property, aerial photography assisted in the identification of areas of concern, especially on private lands. Aerial photography was used to inform windshield surveys and served as points of reference for land prioritization recommendations (Sections 9-21).

Windshield Surveys

Based on the results of the desktop survey, UF conducted two windshield surveys to visit farms, poultry operations, and other potential sources of pollution. The windshield surveys revealed that the majority of agricultural farms with livestock have proper fencing installed to exclude animals from waterways. Additionally, poultry operations that appeared active via aerial photography were found to be not operational upon site visits. Based on field observations the most common livestock present in the Lake Keowee watersheds are cows, horses, goats, and donkeys.

[18] (Veettil & Mishra, 2018)

3) Water Quality Monitoring and Assessment

3.1) Introduction to Water Quality Monitoring and Impairments

SCDHEC is entrusted with the responsibility of enforcing state water quality standards. These standards, R. 61-68 Water Classification & Standards, have been established to protect South Carolina's surface and groundwater resources. The purpose of this regulation is to create general rules, specific numeric and narrative criteria, and anti-degradation rules for the protection of classified and existing water uses and to establish procedures to classify waters of the State.[19] Waters that are listed as impaired, or not meeting specific numeric and narrative criteria, are placed on the biannual South Carolina 303(d) List of Impaired Waters & TMDLs so that the source of impairment can be described and corrective actions can be implemented to improve water quality.[20] Once a site is placed on the 303(d) List, it can only be removed if:

1. The site meets water quality standards (Standard Attained); or
2. The site was listed in error; or
3. A TMDL is developed and approved. This does not mean that the site meets water quality standards, but that the potential pollutant source(s) and amount of pollutant reduction needed to meet water quality standards are identified.

3.2) Available Water Quality Data

Water quality monitoring within the focus area includes both regulatory and drinking water utility monitoring stations, as well as citizen-science monitoring sites. Citizen groups from Friends of Lake Keowee Society (FOLKS) and the SC Adopt-A-Stream program (SC AAS) have broadened the range of water quality monitoring within the focus area through their citizen driven monitoring efforts. While data collected by SC AAS is not permitted to be used for regulatory purposes, citizen monitoring is helpful in identifying sources of pollution and providing baseline information on streams not monitored by SCDHEC.

3.2.1 SCDHEC Water Quality Monitoring Stations

SCDHEC strategically places water quality monitoring stations across the state of South Carolina to evaluate surface and groundwater water quality. Within the focus area, there are a total of 20 ambient SCDHEC water quality monitoring stations (WQMS), both active and inactive, (Table 6) and an additional nine random lake and stream water quality sampling stations. These sites are sampled for a combination of water quality parameters including pollutant and macroinvertebrate populations. Special study sites determine if, and to what extent, nonpoint source runoff is impacting these waterways. See Sections 3.3 and 3.4 for details on current water quality impairments.

[19] (South Carolina Department of Health and Environmental Control (SCDHEC), 2014)
[20] (South Carolina Department of Health and Environmental Control (SCDHEC), 2019)

Table 6: SCDHEC Water Quality Monitoring Station (WQMS) Locations and Status

WQMS	WQMS Location	Type	Years Sampled	2018 303(d) List Status
SV-203	LITTLE RVR AT S-37-24 7.1 MI NE OF WALHALLA	Ambient, Base	Active	--
SV-230	EASTATOE CREEK AT S-39-143	Ambient, Historic	Inactive	Impairment: Lead
SV-338	LK KEOWEE ABOVE SC ROUTE 130 AND DAM	Ambient, Lake	Active	--
SV-341	LITTLE EASTATOE CREEK AT S-39-49	Ambient, Macro	Inactive 96, 00, 05*	Non-Supporting TMDL
SV-342	CANE CREEK AT S-37-133	Ambient, Macro	Inactive 96, 00*	Non-Supporting TMDL
SV-343	LITTLE CANE CREEK AT S-37-133	Ambient, Macro	Inactive 96, 00, 05, 09, 13, 17*	Non-Supporting TMDL
SV-361	LK KEOWEE IN FOREBAY OF LITTLE RIVER DAM	Ambient, Base	Active	--
SV-676	ROCKY BOTTOM CREEK AT US 178	Special Study Site, Macro	87, 90, 96, 00, 05*	--
SV-684	CRANE CREEK AT WINDING STAIRS RD	Special Study Site, Macro	96, 00, 05*	--
SV-741	EASTATOE CREEK AT SR 129	Special Study Site, Macro	96, 00, 05*	--
SV-742	OCONEE CREEK AT SR 129	Special Study Site, Macro	96, 00, 05*	--
SV-743	FLAT SHOALS RIVER AT SR 129	Special Study Site, Macro	96, 00, 10, 14, 16*	--
SV-806	LITTLE EASTATOE CREEK@ MOCCASIN RD	Special Study Site	2008	Non-Supporting TMDL
SV-807	LITTLE CANE CREEK@ NELLIE RD	Special Study Site	2001	Impairment: *E. coli*
SV-808	LITTLE CANE CREEK@ AUSTIN EDWARDS RD	Special Study Site	2004, 2005	Non-Supporting TMDL
SV-809	LITTLE CANE CREEK@ OCONEE BELLE LANE	Special Study Site	2004, 2005	Non-Supporting TMDL
SV-810	LITTLE CANE CREEK@ PICKENS HIGHWAY	Special Study Site	2004, 2005	Non-Supporting TMDL
SV-811	UNNAMED TRIB TO LITTLE CANE CREEK	Special Study Site	2004, 2005	Non-Supporting TMDL
SV-812	UNNAMED TRIB TO LITTLE CANE CREEK @ TAYLOR RD	Special Study Site	2004, 2005	Non-Supporting TMDL
SV-813	LITTLE CANE CREEK NEAR HWY 11	Special Study Site	2012	Non-Supporting TMDL
RL-10016	LAKE KEOWEE 1.25MI SE OF NEW HOPE CHURCH	Ambient, Lake	2010	Impairment: Lead
RL-11032	LAKE KEOWEE	Random, Lake	2011	--
RL-11044	LAKE KEOWEE	Random, Lake	2011	--
RL-12052	LAKE KEOWEE	Random, Lake	2012	--
RL-12060	LAKE KEOWEE	Random, Lake	2012	--
RL-12068	LAKE KEOWEE	Random, Lake	2012	--

WQMS	WQMS Location	Type	Years Sampled	2018 303(d) List Status
RL-13076	LAKE KEOWEE	Random, Lake	2013	--
RS-02466	BURGESS CREEK AT S-37-171 (RTE 171, WHITEWATER FALLS RD)	Ambient	2002	Non-Supporting TMDL
RS-12089	NORTH FORK LITTLE RIVER AT S-37-73 -CRESTWOOD DR-WSW OF SALEM	Random, Stream	2012	--

**Years macroinvertebrate sampling was done*

3.2.2 Seneca Light & Water

The Seneca Light & Water Filter Plant tests raw water (untreated) at their intake (Figure 3) for many parameters including bacteria and sediment. Archival data collected for this WBP includes daily data from 2015-2019, over 1,800 *E. coli* samples total.

3.2.3 Greenville Water

Greenville Water samples water quality at a few locations around Lake Keowee, primarily at their raw water intake (Figure 3) for many parameters including bacteria and sediment. Archival data collected for this WBP includes daily data from 2014-2019, with nearly 2,400 samples total of *E. coli*.

3.2.4 FOLKS (Cane Creek and Little Cane Creek WBP)

As a part of the development of the Cane and Little Cane Creek WBP, FOLKS monitored *E. coli* levels at 11 locations within the Cane and Little Cane Creek subwatersheds from 2016-2018. The 11 locations are representative of both rural and urban catchments. The samples were delivered to Greenville Water for analysis.[21]

Table 7: FOLKS Water Quality Monitoring Sites

	Site	Watershed
1	FOLKS CC	Cane Creek
2	CC at N Poplar St.	Cane Creek
3	CC at Sertoma Field	Cane Creek
4	CC at Torrington	Cane Creek
5	N. Laurel St (Walhalla)	Cane Creek
6	FOLKS LCC	Little Cane Creek
7	LCC Rte 183 Bridge	Little Cane Creek
8	Beaty Creek at Hwy 11 Bridge	Little Cane Creek
9	LCC Tributary at Taylor Rd	Little Cane Creek
10	LCC Tributary at Winstead Rd	Little Cane Creek
11	LCC at Country Junction	Little Cane Creek

[21] (Callahan, 2018)

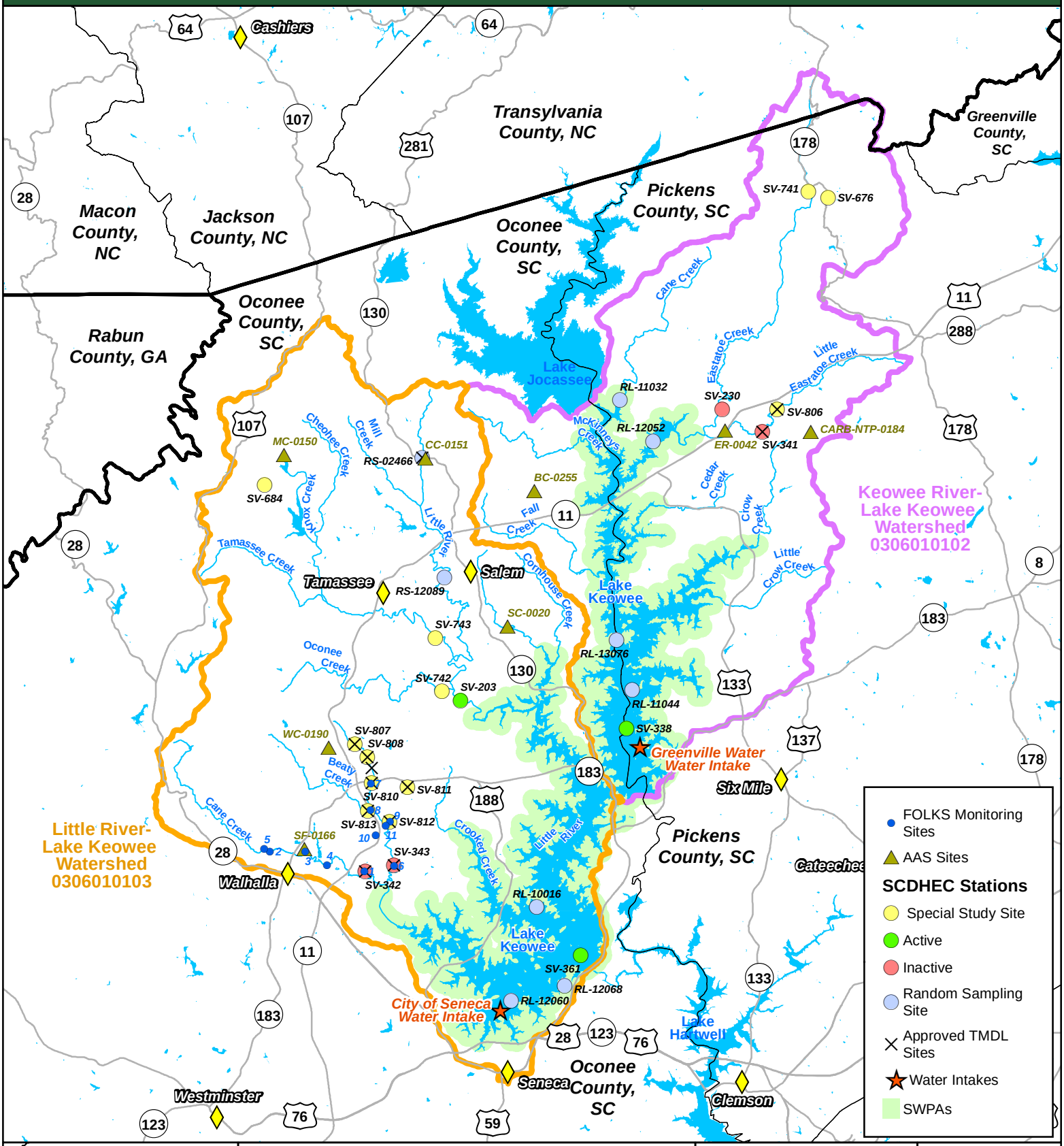
3.2.5 South Carolina Adopt-A-Stream

The SC AAS is led in partnership by SCDHEC and The Clemson University Center for Watershed Excellence. Water quality data is collected by certified citizen scientist volunteers and submitted into an online database that is used for screening data for educational purposes. There are eight SC AAS sites within the focus area.

Table 8: SC AAS Water Quality Monitoring Sites

Site	Water body	Group	Parameters	# of Samples	Years
CARB-NTP-0184	Creek at Rocky Bald	Oak Grove Lakers	*E. coli*, pH, DO, Temperature, Macros, Conductivity	5	2018-2019
ER-0042	Eastatoe River	K&G Crain	*E. coli*, pH, DO, Temperature, Conductivity	28	2016-2019
BC-0255	Boone's Creek	Friends of Jocassee	Macro and Habitat	1	2019
CC-0151	Cantrell Creek	Otter Waters	*E. coli*, pH, DO, Temperature, Conductivity	1	2018
MC-0150	Moody Creek	Otter Waters	*E. coli*, pH, DO, Temperature, Conductivity	2	2018
SC-0020	Stamp Creek	Chesson	*E. coli*, pH, DO, Temperature, Conductivity, Macros, Habitat	17	2017-2019
SF-0166	Sertoma Field	CU Center for Watershed Excellence	*E. coli*, pH, DO, Temperature, Conductivity	1	2018
WC-0190	William's Creek	Walhalla High School	*E. coli*, pH, DO, Temperature, Conductivity	9	2018-2019

Figure 3: Monitoring Stations, Intakes, and Source Water Protection



DISCLAIMER:
This map is not a land survey and is for general reference purposes only. Upstate Forever makes no warranty or representation as to the accuracy of this map and disclaims all responsibility for any costs or damages that may arise from its use.

Map by: KPH - 10/21/19

UPSTATE FOREVER

3.3) Bacteria Impairments

Prior to 2013, South Carolina used Fecal Coliform (FC) as the bacterial indicator to evaluate the safety of freshwaters for recreational purposes. The standard for FC was a maximum daily concentration of 400 Coliform Forming Units (CFU) per 100 milliliters (ml) of water and a 30-day geometric mean of 200 CFU per 100 ml. Water samples that exceeded this standard more than 10% of the time were considered impaired and unsafe for recreation. Sites considered impaired for FC were then placed on SCDHEC's biennial 303(d) list (Figure 4). In 2013 SCDHEC switched to *Escherichia coli (E. coli)* as the bacterial indicator for freshwaters. The current SC standard for *E. coli* is a daily concentration not to exceed 349 MPN/100 ml and 30-day geometric mean of 126 MPN/100 ml. FC and *E. coli* are typically not a threat themselves to human health; however, their presence in freshwaters is indicative of fecal pollution in surface waters. Fecal contamination is considered a human health risk because it may contain disease-causing organisms such as pathogenic bacteria, viruses, protozoa, or parasites.[22]

Due to this relatively recent transition in bacteria standards, the majority of the available water quality data for the water quality monitoring sites in the focus area are for FC. Consequently, in this WBP the bacteria load reductions were calculated using FC data, referred to generically as "bacteria", and converted to *E. coli* using a conversion factor provided by SCDHEC.[23]

3.3.1 *E. coli* Data from SCDHEC

Of the 20 SCDHEC water quality monitoring stations, only 10 have *E. coli* data within the past five years of available results (2014-2018). None of the stations' sampling data indicate significant *E. coli* exceedances; however, 13 stations are listed as impaired or non-supporting of state *E. coli* standards according to the 2018 303(d) list. Table 9 below details water quality monitoring results as obtained from EPA's Water Quality Database (WQX) and attainment status according to the 2018 303(d) Draft List of Impaired Waters. While only one station is listed as impaired on the 2018 303(d) Draft List of Impaired Waters, 11 are listed as non-supporting of the State's bacterial water quality standards, which indicates that while there is an approved TMDL, the water quality is still not meeting standards.

[22] (United States Environmental Protection Agency (EPA), 1986)
[23] (South Carolina Department of Health and Environmental Control (SCDHEC), 2013)

Table 9. SCDHEC Water Quality Monitoring Stations and Status[24]

WQMS	Total Samples	Sample Years	Average Result*	Max Value*	Number of Exceedances	% Exceedances	2018 303(d) List Status
SV-203	34	2013-2018	324.44	2,419.6	7	20.59%	--
SV-230	49	2009	169.58	1,230.4	5	10.2%	--
SV-338	26	2013-2018	2.2	6.3	0	0%	--
SV-341	102	2009-2017	344.7	3,265.6	30	29.41%	Non-Supporting TMDL
SV-342	48	2009	293.38	2,419.6	8	16.67%	Non-Supporting TMDL
SV-343	47	2009	329.29	1,953.6	11	23.4%	Non-Supporting TMDL
SV-361	15	2013-2018	13.89	172.2	0	0%	--
SV-743	11	2016	222.15	866.4	1	9.09%	--
SV-806	53	2013-2017	304.05	1,732.9	13	24.53%	Non-Supporting TMDL
SV-807	n/a	2004-2005	n/a	n/a	n/a	n/a	Non-Supporting TMDL
SV-808	n/a	2004-2005	n/a	n/a	n/a	n/a	Non-Supporting TMDL
SV-809	n/a	2004-2005	n/a	n/a	n/a	n/a	Non-Supporting TMDL
SV-810	n/a	2004-2005	n/a	n/a	n/a	n/a	Non-Supporting TMDL
SV-811	n/a	2004-2005	n/a	n/a	n/a	n/a	Non-Supporting TMDL
SV-812	n/a	2004-2005	n/a	n/a	n/a	n/a	Non-Supporting TMDL
SV-813	n/a	2004-2005	n/a	n/a	n/a	n/a	Non-Supporting TMDL
RL-13076	5	2013	3.8	8.5	0	0%	--
RS-02466	n/a	2002	n/a	n/a	n/a	n/a	Non-Supporting TMDL
RS-12089	n/a	2012	n/a	n/a	n/a	n/a	Impaired for *E. coli*

**Average results and Maximum Value in MPN/100 mL*

3.3.2 *E. coli* Data from Seneca Light & Water

Of the 1,800 samples of raw water at the Seneca Light & Water intake, none exceeded the State's water quality standard of 349 MPN/100 ml (daily) and 30-day geometric mean of 126 MPN/100 ml (Table 10).

Table 10. E. coli Results from Seneca Light & Water Raw Water Intake (2015-2019)

WQMS	Total Samples	Average Result*	Max Value*	Number of Exceedances
Seneca Light & Water Raw Water Intake	1,795	3.15	86	0

**Average results and Maximum Value in MPN/100 mL*

3.3.3 *E. coli* Data from Greenville Water

Of the nearly 2,400 samples of raw water at the Greenville Water intake, none exceeded the State's water quality standard for bacteria (Table 11).

[24] (United States Environmental Protection Agency (EPA), 2019)

Table 11. E. coli Results from Greenville Water Raw Water Intake (2014-2019)

WQMS	Total Samples	Average Result*	Max Value*	Number of Exceedances
Greenville Water Raw Water Intake	2,347	2.23	58	0

**Average results and Maximum Value in MPN/100 mL*

3.3.4 *E. coli* Data from FOLKS

Data obtained from FOLKS during the development of the Cane and Little Cane Creek Watershed Management Plan indicates that *E. coli* levels were above the State's daily water quality standard of 349 colonies per 100 ml in 26 out of 60 total samples within the Cane and Little Cane Creek subwatersheds (Table 12).

Table 12. E. coli Results from FOLKS Water Quality Monitoring Stations[25]

WQMS	Total Samples	Year(s) Sampled	Average Result	Max Value	Number of Exceedances
FOLKS CC	15	2015, 2016, 2018	337	1300	8
CC at N Poplar St.	5	2016, 2018	300	490	2
CC at Sertoma Field	5	2016, 2018	784	2400	3
CC at Torrington	2	2016	290	360	1
N. Laurel St (Walhalla)	2	2018	390	650	1
FOLKS LCC	15	2015, 2016, 2018	285	920	2
LCC Rte 183 Bridge	2	2016	513	730	2
Beaty Creek at Hwy 11 Bridge	1	2016	260	260	0
LCC Tributary at Taylor Rd	4	2016, 2018	320	550	1
LCC Tributary at Winstead Rd	4	2016, 2018	794	1700	3
LCC at Country Junction	5	2016, 2018	368	580	3

**Results based on daily maximum (E. coli) of 349 col/100 mL*

3.3.5 *E. coli* Data from SC AAS

Between 2016 and 2019, 55 samples collected from seven locations were analyzed for *E. coli*. Of these, only three samples were in exceedance of the State's daily maximum water quality standard of 349 col/100 ml (Table 13).

Table 13. E. coli Results from SC AAS Water Quality Monitoring Stations (2016-2019)

WQMS	Total Samples	Average Result*	Max Value*	Number of Exceedances
CARB-NTP-0184	5	20	67	0
CC-0151	1	200	200	0
ER-0042	27	78	933	1
FMC-0234	3	366	566	2
MC-0150	1	33	33	0

[25] (Callahan and Zurqani, 2018)

WQMS	Total Samples	Average Result*	Max Value*	Number of Exceedances
SC-0020	9	70	133	0
SF-0166	1	66	67	0
WC-0190	8	54	133	0

**Average results and Maximum Value in col/100 mL*

3.4) Biological Impairments

Biological criteria include both narrative expressions and numeric values of the biological characteristics of aquatic communities based on appropriate reference conditions.[26] Biological criteria serve as an index of aquatic community health. There are several factors that can contribute to a stream being listed as biologically impaired. The primary stressors influencing stream biological integrity include sediment, habitat quality, dissolved oxygen, pH, metals, and nutrients.

The most recent 303(d) List of Impaired Waters (2018) listed many waters throughout the State of SC and within the focus area as "Waters of Concern" for lead (Pb). This development resulted from the process by which SCDHEC analyzes lead in water quality monitoring samples. A major suspected cause of the lead detection is atmospheric deposition therefore groundwater resources are not expected to be impacted.

3.5) Summary of Water Quality Data

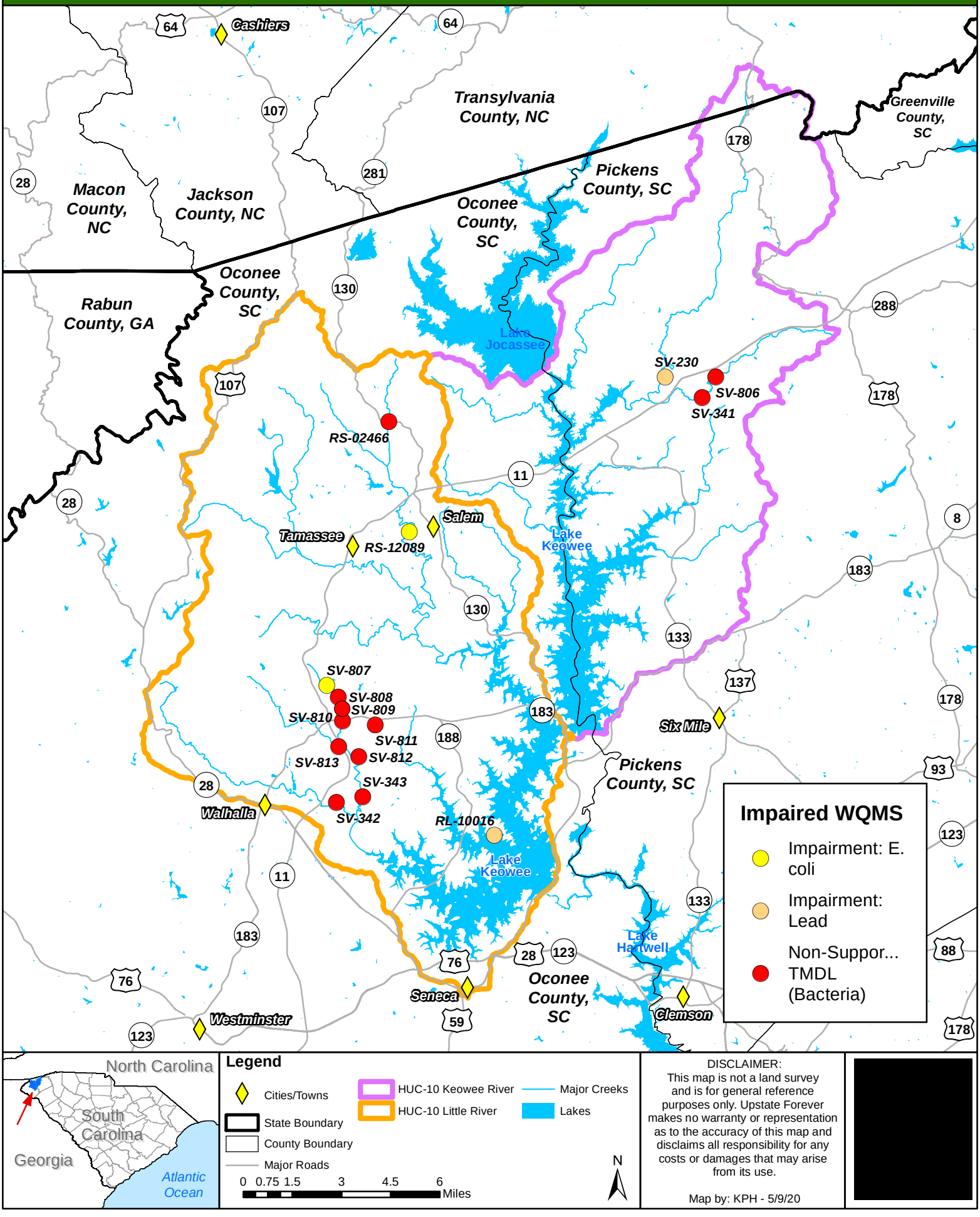
According to the most recent SCDHEC, FOLKS, and SC AAS monitoring results, bacterial contamination continues to be an issue in the focus area, especially in the lower portion of the Little River watershed (HUC-0306010103) (Figure 3). While bacterial contamination is not a problem at drinking water intakes as shown by Greenville Water and Seneca Light & Water data, bacterial contamination is the most prominent pollutant within the focus area with 12 SCDHEC water quality monitoring stations listed as impaired for bacteria on the 2018 303(d) List of Impaired Waters. All 12 monitoring stations are located within existing TMDLs, however, are not supported, meaning they are still not meeting the State's *E. coli* standard for freshwaters. Bacteria sources and reductions needed are detailed in Sections 4 and 5.

While no formal biological impairments are in place currently, measures outlined in Sections 6 and 7 for Sediment and Nutrients will address the protection and improvement of aquatic habitats within the focus area.

It should be noted that although two SCDHEC water quality monitoring stations within the focus area are listed as "Waters of Concern" for lead (Pb) on the 2018 303(d) List, addressing this contaminant of concern is beyond the purview of this WBP.

[26] (South Carolina Department of Health and Environmental Control (SCDHEC), 2014)

Figure 4: WQMS Listed as Impaired on 2018 303(d) List



4) Bacterial Pollution Sources

4.1) Bacterial Pollution Sources

Bacterial pollution can be attributed to both point and nonpoint sources within the focus area. Potential sources of bacterial pollution in the focus area include wastewater effluent, agriculture land uses, urban runoff, and wildlife (Table 14).

Table 14. Potential Point and Nonpoint Sources of Bacterial Pollution in the Focus Area

Wastewater	Agriculture	Urban	Wildlife
• Septic Tanks • Private Wastewater Treatment Plants	• Cattle • Horses • Sheep & Goats • Poultry • Swine • Cropland	• Stormwater Runoff • Domestic Pets	• Deer • Feral Hogs • Waterfowl • Beavers

4.1.1) Point Sources of Bacterial Pollution

As defined in Section 502(14) of the Clean Water Act, a point source pollutant is any discrete and confined conveyance (e.g., pipe, ditch, channel, tunnel, well, confined animal feeding operation) from which pollutants are discharged.[27]

National Pollution Discharge and Elimination System (NPDES) Sites – The National Pollution Discharge and Elimination System (NPDES) controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Major municipal dischargers include all facilities with design flows greater than one million gallons per day, while minor dischargers are less than one million gallons per day.[28] There are nine NPDES permit holders in the focus area that have bacterial limits which are listed in Table 15 and shown on Figure 5. No bacteria violations have been reported. All NPDES information for these facilities was obtained from the following website https://echo.epa.gov/facilities/facility-search.[29]

[27] (United States Environmental Protection Agency (EPA), n.d.)
[28] (United States Environmental Protection Agency (EPA), 2019)
[29] (United States Environmental Protection Agency (EPA), 2019)

Table 15. Permitted NPDES Sites in the Focus Area

Map Id	NPDES Permit #	Facility Name	Facility Type	Compliance Violations (years 2016-2019)
1	SC0026727	Tamassee DAR School	Domestic	None
2	SC0022322	Keowee Key Utility Systems, Inc.	Domestic	None
3	SC0049093	Ingersoll Rand/Torrington FAC GW Rem	Industrial	None
4	SC0000515	Duke Energy/Oconee Nuclear	Industrial	None
5	SCG646049	Greenville Water/Adkins Filter	Municipal	None
6	SCG250261	Koyo Bearings USA	Industrial	None
7	SCG646009	Seneca WTP	Municipal	None
8	SCG250067	Tyco Healthcare/Kendall	Industrial	None
9	SCR000731	Schlumberger Industries, Inc.	Industrial	None
10	ND0088790	JACAAB Utilities	Industrial	None

Wastewater Treatment Operations – Wastewater treatment plants (WWTPs) are considered a point source of bacteria pollution. There are three small, private WWTPs permitted in the focus area: Keowee Key Utility Systems, Inc. (SC0022322), Tamassee DAR School (SC0026727), and The Reserve at Lake Keowee (also listed as a No-Discharge (ND) site; ND0083232). The first two WWTPs are permitted for discharge with monthly *E. coli* geometric means not to exceed 126 MPN/100mL and a daily maximum of 349 MPN/100mL. There have not been any recorded compliance violations. The third WWTP (Reserve at Lake Keowee), is a non-discharge facility that discharges to an effluent spray field on-site (i.e. not directly to a water system), however, it has the same *E. coli* requirements; no violations are recorded.

Although there are no large public WWTPs within the focus area, some of the homes in the focus area are serviced by sewer and could be affected by Sanitary Sewer Overflows (SSOs). SSOs can occur during both dry and wet weather conditions. Possible causes include: heavy rain events that overwhelm the pipes or system, blockages in the pipes, construction activities, and equipment failures. SCDHEC tracks SSO events that cause a health concern, reach a water body, or are estimated to exceed 500 gallons. SSOs are reported by SCDHEC as the net volume of wastewater lost to the environment.[30] According to SCDHEC there have been a total of 21 SSOs in Oconee County with an estimated cumulative volume of 635,450 gallons since May 2016, and a total of 16 SSOs in Pickens County with an estimated cumulative volume of 48,832 gallons since October 2016. Of these SSOs, three occurred at the base of the Little River-Lake Keowee HUC-10 watershed in Oconee County from 2017-2018 with an estimated cumulative volume of 8,400 gallons of untreated wastewater discharged into local waterways.[31]

[30] (South Carolina Department of Health and Environmental Control (SCDHEC), 2019)
[31] (South Carolina Department of Health and Environmental Control (SCDHEC), 2019)

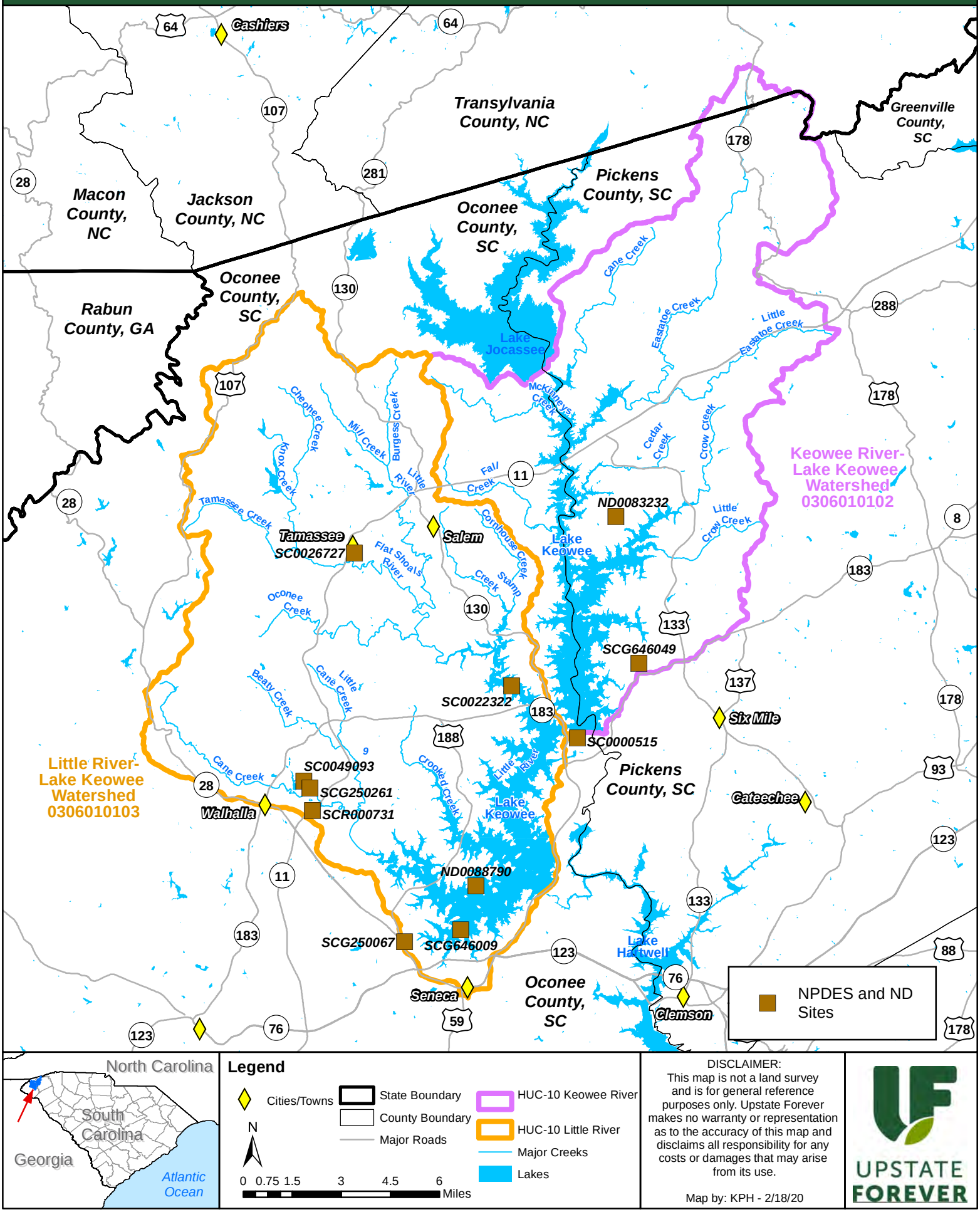
No-Discharge (ND) Class B Sludge Application Sites - There are three permitted No-Discharge Class B Sludge land application sites in the focus area (Table 16 and Figure 5). These are sites where WWTPs are permitted to land apply wastewater treatment effluent, non-hazardous sludge, and septage. These permits are considered ND because there is no direct discharge to surface waters.[32] However, these sites have been included in this WBP as they have potential to contribute bacteria and nutrients to surface waters if managed improperly (e.g., if the applications take place during or preceding rain events).

Table 16. No-Discharge Permits in the Lake Keowee Watersheds

Map Id	Permit #	Generator	Facility Type
1	ND0083232	The Reserve at Lake Keowee	Lagoon/Wastewater
2	SC0022322	Keowee Key Utility Systems Inc.	Wastewater
3	ND0088790	JACABB Utilities	Wastewater

[32] (South Carolina Department of Health and Environmental Control (SCDHEC), 2018)

Figure 5: NPDES and No-Discharge Sites



4.1.2) Nonpoint Sources of Bacteria Pollution in the Lake Keowee Watersheds

Nonpoint source pollution is caused by rainfall moving over and through the ground, transporting bacteria to waterways as it flows across the land surface. Nonpoint source bacteria pollution typically comes from septic systems, agriculture (e.g., livestock operations, cropland, and sediment), domestic pets, stormwater runoff, and wildlife. Approximately 60% of the land in the watershed is rural. Accordingly, this plan focuses bacterial load reductions on bacterial inputs from agriculture, failing septic tanks, and domestic pets (Section 5).

Agriculture - Livestock (e.g., cattle, horse, and goats) is the primary agricultural concern for increasing the concentration of bacteria in waterways of the focus area. Livestock with access to streams can contribute bacteria directly into waterways through their fecal matter or indirectly by disturbing stream banks and causing erosion. Runoff from agricultural facilities (e.g., barnyards, feeding areas, manure storage areas) can also lead to increases in bacteria levels as well as other contaminants (e.g., fertilizers, pesticides, and sediment). Fertilizers such as manure and sludge, when applied to cultivated crops can also cause increased bacteria levels if applied in excess amounts or before rain events. Poultry operations are another concern in the focus area.[33] Poultry farms can pose a threat to water quality as they can generate significant amounts of chicken litter, dander, ammonia, and other wastes, which can contaminate local waterways if not managed properly.

Cattle located within the focus area

The number of livestock animals in the watershed was estimated by combining information from the 2017 United States Department of Agriculture (USDA) Census of Agriculture with a GIS analysis of the acreage of farmland in the focus area. The acreage of farmland within the watershed is based on an analysis of the 2016 NLCD within ArcGIS. The USDA Census of Agriculture provides the total acreage of farmland and total animal counts for each county; based on this, a ratio of animals per acre in Pickens and Oconee County was calculated. This ratio was

[33] (United States Department of Agriculture (USDA), 2017)

then applied to the acreage of farmland within the watershed to estimate the total number of farm animals living within the boundaries of the watershed area. An example formula is shown below.

Formula 1. Calculating the Total Number of Animals in the Lake Keowee Watersheds

$$\text{Number of (Cattle) in the Focus Area} = \left(\frac{\text{Total Number of (Cattle) within the County}}{\text{Total Acreage of Agricultural Lands within the County}} \right) \times \text{Acreage of Agricultural Lands within Focus Area}$$

Agricultural land, which for the purposes of this plan include the Pasture/Hay NLCD land cover classifications, is found throughout the focus area and comprises approximately 11,452.22 acres.[34] Based on these calculations, an estimated 2,541 cattle live in this watershed. Other farm animals that could impact surface water bacteria levels include horses, goats, sheep, swine, and poultry (Table 17).

Table 17. Livestock Estimations in the Lake Keowee Watersheds

Livestock Type	Number of Livestock
Cattle	2,541
Swine	74
Sheep & Lamb	91
Horses	208
Poultry	8,333
Goats	156
Total	**11,403**

Agricultural bacterial load reductions represent the bacteria load projected to be removed annually through the use of agricultural BMPs installed on high priority agricultural sites within the focus area. In this plan, the typical agricultural BMP package includes exclusion fencing, heavy use area protection, alternate water source, and riparian buffer improvements (e.g., grass, vegetation, and other erosion control techniques).

Typical Agricultural BMP Package	▪ 1,686 feet of Livestock Exclusion Fencing ▪ 1 well ▪ 1 Alternate Water Source ▪ 599 feet of waterline ▪ 2,138 square feet of Heavy Use Area protection ▪ 0.23 acres of Improved Buffer

[34] (Multi-Resolution Land Characteristics Consortium (MRLC), 2016)

Croplands are another potential source of bacteria levels in waterways. Manure applications, such as for fertilizer, contain bacteria that may wash into nearby waterways during rain events. Severely eroded soils can contribute fertilizers, pesticides, and sediment to surface waters in the area. Based on overall acreage cropland, cultivated crops do not appear to be a primary source of bacterial loading in the focus area, as there are less than three acres of cropland in the entire region (Table 5).

Septic Systems – Damaged or improperly maintained septic systems can be a significant nonpoint source of bacteria to surface and groundwater resources. Septic systems typically have four main components: an exit pipe that transports the wastewater out of the home to the septic tank, a septic tank where waste material naturally breaks down, a drain field where the effluent is discharged, and a soil layer that filters and breaks down wastewater contaminants. Improper connections, clogs, heavy use, or unmaintained systems increase the chance that untreated wastewater will leak into surface and groundwater resources.

Based on the Septic Suitability Geospatial Analysis[35] completed by the Clemson University Center for Watershed Excellence, it is estimated that approximately 13,763 homes in the Lake Keowee watersheds are on septic systems.

Domestic Pets - Domestic pet waste is a threat to human health and water quality when not disposed of properly. Pet waste left on the ground can be carried by stormwater into nearby waterways during rain events, and is a concern in developed areas containing higher densities of impervious surfaces. Developed land (commercial and residential) accounts for roughly 12% of total land cover in the focus area and is concentrated near the cities/towns of Walhalla, Tamassee, Seneca, and Salem, as well as residential developments directly around the Lake Keowee reservoir.

According to the USDA, a single dog can produce approximately 274 lbs of waste each year.[36] Pet waste can contain harmful organisms such as bacteria, viruses, and parasites. Using the total number of households within a watershed area and a formula prepared by the American Veterinary Medical Foundation shown below, it was determined that roughly 7,711 dogs live within the focus area.

[35] (Callahan & Zurqani, 2019)
[36] (United States Department of Agriculture (USDA), 2005)

Formula 2. Estimated Number of Dog-Owning Households

Number of Dog Owning Households	=	National % of Dog Owning Homes*	x	Total Number of Households
5,175 Homes with Dogs	=	0.376	x	13,763 Homes

**This number comes from the Humane Society of the US's 2017-2018 American Pet Products Association Survey and is the average of dog-owning households with small, medium, and large dogs*[37]

Formula 3: Estimated Number of Dogs within the Watershed

Number of Dogs	=	National Average of Dogs in Homes*	x	Total Number of Dog-Owning Households
7,711	=	1.49	x	5,175 Dog-Owning Households

**This number comes from the Humane Society of the US's 2017-2018 American Pet Products Association Survey*

According to the calculated number of dogs within the watershed and the EPA dog waste statistic (dog can produce 274 lbs /year), dogs living within the focus area produce approximately 2.12 million lbs of waste annually to the Lake Keowee watersheds.

Wildlife – Nuisance wildlife has the potential to impact bacteria levels in water and is likely a contributor to elevated levels of bacteria in this watershed. Examples of nuisance species include deer, geese, beavers, and feral hogs. A single Canada goose can produce an average of 82 grams (2.6 ounces) of waste a day.[38] Feral hogs, present in the focus area, are a threat to water quality because their rooting behavior contributes to soil erosion while their fecal matter contains viruses and pathogens which can be transmitted to human populations.[39]

[37] (American Pet Products Association, 2017-2018)
[38] (Lake Access, 2019)
[39] (South Carolina Department of Natural Resources (SCDNR), 2017)


Feral hogs feeding in field located in Upper Keowee Watershed

Stormwater Runoff – Urbanized areas, particularly those built prior to stormwater management requirements, are at an increased risk of negatively impacting nearby waterways from the high density of impervious surfaces. Impacts, such as increased surface water runoff, decreased groundwater recharge, stream channelization, and heightened erosion and flooded areas can all attribute to impaired water quality. Bacteria runoff in an urban setting is largely attributed to wildlife and pet waste, but can also result from leaking sewer infrastructure.

5) Bacterial Load Reductions

A TMDL is the calculation of the maximum amount of a pollutant allowed to enter a water body so that the water body will meet and continue to meet water quality standards for that particular pollutant. A TMDL determines a pollutant reduction target at which a water body can assimilate pollutant loads and still meet state water quality standards. Bacterial load reductions for this plan were based on the three bacteria TMDLs for four WQMS: Little Eastatoe Creek, Cane Creek, Little Creek, and Burgess Creek, listed below and summarized in Table 18:

1. Total Maximum Daily Load for Fecal Coliform in Little Eastatoe Creek (SV-341) (SCDHEC, 2000)
2. Total Maximum Daily Load for Fecal Coliform in Cane and Little Creeks (SV-342, SV-343) (SCDHEC, 2005)
3. Total Maximum Daily Load for Fecal Coliform in the Burgess Creek Watershed (RS-02466) (SCDHEC, 2010)

TMDL is expressed as "the sum of all Waste Load Allocations (WLAs: point source loads), Load Allocations (LAs: nonpoint source loads and background), and a Margin of Safety (MOS), which accounts for uncertainty concerning the relationship between effluent limitations and water quality".[40] FC values have been converted to *E. coli* values by multiplying by 0.8725.[41] The TMDLs are calculated using the following equation seen in Formula 4. Although Formula 4 outlines the standard TMDL equation, because there are no point sources within the focus area

[40] (United States Environmental Protection Agency (EPA), 2019)
[41] (South Carolina Department of Health and Environmental Control (SCDHEC), 2013)

and WLAs are not included in the calculations in this plan. Table 18 is a summary of the three TMDL documents, and the values were taken from the aforementioned documents.

Formula 4. TMDL Calculation

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

Table 18. TMDL Summary of Bacterial Reductions within the Lake Keowee Watersheds

WQMS	Existing Nonpoint LA (counts/day)*	MOS*	TMDL (counts/day)*	% Reduction	Reduction Needed (counts/day)*
			Existing LA + MOS		*TMDL x % Reduction (Formula 9)*
SV-341	1.00E+11	n/a	1.00E+11	18.20%	1.83E+10
SV-342	3.66E+11	8.73E+09	3.75E+11	54%	2.03E+11
SV-343	4.52E+11	8.20E+09	4.60E+11	65%	2.99E+11
RS-02466	6.26E+11	1.13E+09	6.38E+10	66%	4.21E+10

**The numbers in this row were converted to E. coli by multiplying the FC numbers by 0.8725* [42]

5.1) Bacterial Load Reduction Calculations

The bacteria load reductions outlined in this plan are based on the TMDL documents referenced above. In this particular case, the TMDLs include only nonpoint sources in the bacteria load calculations since there are no contributing point sources within the focus area. This information was used to calculate specific nonpoint source bacteria load reductions for the focus area.

Waste Load Allocations:

Waste Load Allocation (WLA) – WLA represents all point sources of bacteria to the water (e.g., wastewater treatment facilities, combined feeding operations). No WLA values are included in these calculations because there are no point sources contributing to waste loads in these watersheds.

MS4 WLA (% Reduction) – This represents the waste load allocation associated with the municipal stormwater sources NPDES permit. The focus area does not include any Municipal Separate Storm Sewer System (MS4) areas, and therefore does not include MS4 Waste Load Allocations within the TMDL documents

Load Allocations:

Existing Nonpoint Load Allocation (LA) - Existing Nonpoint LA represents the bacterial load from nonpoint sources and is calculated, as shown below, using the sum for all four WQMS

[42] (South Carolina Department of Health and Environmental Control (SCDHEC), 2013)

under TMDLs. Subtracting the MOS from the TMDL Existing Load helps in calculating the nonpoint load reduction (counts/day).

Margin of Safety (MOS) - A TMDL consists of WLA, LA, and a MOS. The MOS is a percentage of the TMDL that accounts for the uncertainty associated with the TMDL model's assumptions and data limitations.[43]

TMDL (Formula 4) – The TMDL consists of the WLA (point source load), LA (nonpoint source load), and the MOS in counts/day. In the case of the TMDLs in the Lake Keowee Watersheds, there are no WLAs, so the TMDL consists of the LA and the MOS.

Nonpoint Load Reduction Needed (Formulas 5 and 6) – This number was calculated using TMDL data for the four creeks within the focus area, and represents the bacteria reduction needed from nonpoint sources per day and year in the watershed in order to meet water quality standards. Formula 5 shows the calculations for daily nonpoint load reductions needed. Formula 6 multiplies Formula 5 by 365 to calculate the annual nonpoint load reductions needed.

Formula 5. Calculating Daily Nonpoint Load Reductions Needed

Nonpoint Load Reduction Needed (counts/day)	=	TMDL (counts/day)	x	TMDL Nonpoint % Reduction Needed

Table 19. Daily Nonpoint Load Reductions Needed in the Lake Keowee Watersheds

WQMS	Nonpoint Load Reduction Needed (counts/day)	=	TMDL (counts/day)	x	TMDL Nonpoint % Reduction Needed
SV-341	1.83E+10	=	1.00E+11	x	18.20%
SV-342	2.03E+11	=	3.75E+11	x	54%
SV-343	2.99E+11	=	4.60E+11	x	65%
RS-02466	4.21E+10	=	6.38E+10	x	66%

[43] (South Carolina Department of Health and Environmental Control (SCDHEC), 2005)

Formula 6. Calculating Annual Nonpoint Load Reductions Needed

Nonpoint Load Reduction Needed (counts/year)	=	Nonpoint Load Reduction Needed (counts/day)	x	365 days/year

Table 20. Annual Nonpoint Load Reductions Needed in the Lake Keowee Watersheds

WQMS	Nonpoint Load Reduction Needed (counts/year)	=	Nonpoint Load Reduction Needed (counts/day)	x	365 days/year
SV-341	6.67E+12	=	1.83E+10	x	365
SV-342	7.39E+13	=	2.03E+11	x	365
SV-343	1.09E+14	=	2.99E+11	x	365
RS-02466	1.54E+13	=	4.21E+10	x	365
TOTAL	**2.05E+14**				

Table 21 summarizes the nonpoint load reductions needed in the focus area based on the TMDL documents for stations SV-341, SV-342, SV-343, and RS-02466, as detailed throughout Section 5.1 and in Tables 18-20. This information is used to calculate the BMP load reductions included in this plan. Because the current water quality standards are listed as *E. coli*, estimated load reductions needed and BMP load reductions included in this plan are listed in *E. coli* values. In order to meet the required bacterial reductions as set in place by the TMDLs, a reduction of 2.05E+14 counts/year would be necessary.

Table 21. Estimating E. coli Load Reductions Needed in the Lake Keowee Watersheds

WQMS	Watershed	Counts/day (Formula 5)	Counts/year (Formula 6)	Watershed Sum (counts/year)
SV-341	Little River-Lake Keowee	1.83E+10	6.67E+12	6.67E+12
SV-342	Keowee River-Lake Keowee	2.03E+11	7.39E+13	1.98E+14
SV-343		2.99E+11	1.09E+14	
RS-02466		4.21E+10	1.54E+13	
			TOTAL	**2.05E+14**

5.2) Bacterial Load Reductions per BMP

In order to meet the TMDL bacterial loading reduction requirements detailed in Section 5.1, BMPs were used to target bacteria pollution sources (septic, agricultural, and pet waste) in the focus area. Table 22 outlines the approximate number of BMPs recommended to achieve the needed annual bacteria reductions per the TMDL. These estimations were derived using the standard annual bacteria removal rates for each BMP multiplied by the suggested number of

BMPs in the watershed to attain the necessary reductions. The standard bacteria removal rates per BMP that were used to estimate the loads for all sources are found in Appendix A and B and shown below.

Table 22. Recommended BMPs to meet Annual Bacterial Load Reductions

BMP	Standard Bacteria Removal per BMP[44]	# of Projects	Total Bacteria Reduction Per BMP
Septic Repair/Replacement	2.42E+10	545	1.32E+13
Agricultural BMPs Package	1.62E+13	11	1.79E+14
Pet Waste Station	2.14E+12	6	1.28E+13
Total			**2.05E+14**

6) Sediment Pollution Sources and Load Reductions

6.1) Sediment Pollution

According to the EPA, sediment is the most common pollutant in rivers, streams, lakes, and reservoirs in the country.[45] Sediment can come from both natural sources (e.g., erosion) and human induced activities (e.g., construction and agriculture). Excess sediment has the potential to degrade water quality and aquatic habitats. For example, too much sediment can increase the cost of drinking water treatment, lead to flooding issues, clog fish gills, and destroy aquatic habitats. Although approximately 30% of sedimentation can be attributed to natural erosion, the remaining 70% is caused by accelerated erosion from human land use practices.[46] Table 23 details the potential point and nonpoint sources of sediment pollution in the focus area.

Table 23. Potential Sources of Sediment Pollution in the Lake Keowee Watersheds

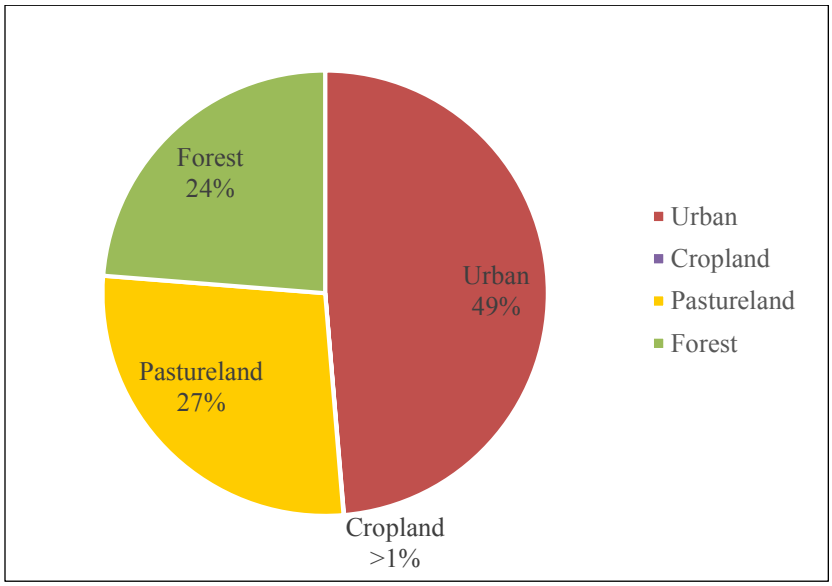
Agriculture	Urban	Forestry
• Croplands • Livestock Operations	• Stormwater Runoff • Construction	• Road Construction • Road Use • Clear Cutting

Annual sediment loading for the watershed was calculated using the Spreadsheet Tool for Estimating Pollutant Load (STEPL). The STEPL model estimates annual sediment and nutrient loading based on the Universal Soil Loss Equation (USLE) and considers sediment loading from land uses (e.g., urban, cropland, pastureland, and forest lands)[47] as well as the number of animals within the focus area (Table 17). Using this tool, it is estimated that cumulatively, the focus area contributes 11,017.38 tons of sediment per year to the region, largely attributed to pasturelands,

[44] Appendix A and B
[45] (Shelton, 2005)
[46] (Shelton, 2005)
[47] (United States Environmental Protection Agency (EPA), 2019)

urban development, and forests. Urban development accounts for the greatest contribution of sediment runoff in the region at 5,360 tons/year, which is nearly half of the estimated annual sediment load in the watersheds. Pasturelands make up the second highest source of sediment at 3,037 tons/year, followed by forest lands at 2,616 tons/year. Accordingly, with only 14.67 acres of croplands in the watersheds, croplands account for less than 1% of annual sediment loading at only 3.4 tons/year. The breakdown of annual sediment loading per land use is shown in Figure 6.

Figure 6. Annual Sediment Loading per Land Use Category



6.1.1) Point Sources of Sediment Pollution

As stated in Section 4.1, the NPDES permit system, operated by SCDHEC in South Carolina, protects water quality by regulating point sources of pollution from being discharged into Waters of the United States.[48] Sediment is regulated from stormwater point sources within the MS4 program area, stormwater from construction sites, and stormwater associated with industrial permits,[49] however, there are no MS4 designations within the focus area. See Table 15 for a complete list of NPDES permits in the focus area.

6.1.2) Nonpoint Sources of Sediment Pollution

The excess sedimentation of freshwaters from nonpoint source pollution is a prevalent problem in the focus area. Nonpoint sources of sediment pollution typically include construction sites, agriculture (e.g., livestock operations, cropland), stormwater runoff, and forestry practices. Sediment is considered a nonpoint source pollutant both inside and outside of MS4 boundaries (Table 23). In fact, sediment has been identified as one of the top five pollutants of concern in the region by the Anderson Pickens County Stormwater Partners, a group of Small Municipal

[48] (United States Environmental Protection Agency (EPA), 2017)
[49] (United States Environmental Protection Agency (EPA), 2018)

Separate Storm Sewer Systems (SMS4s) community partners dedicated to the regional stormwater education concept.[50]

Agriculture - The most common source of pollution from agriculture is soil that is washed from fields during rain events.[51] This sediment often transports contaminants including fertilizers, pesticides, and heavy metals into waterways. Agricultural practices that exacerbate sediment erosion include overgrazing, misplaced and mismanaged feeding operations, over plowing, and poorly timed or excessive fertilizer, pesticide, and irrigation water applications. Additionally, livestock with access to streams can also contribute to sediment pollution by causing erosion along streambanks.

Agricultural sediment load reductions represent the projected amount of sediment removed annually through agricultural BMPs installed on high priority agricultural sites in the focus area.

Urban – In general, the urbanization of watersheds often has negative impacts on water quality. Activities most associated with urbanization are land disturbances; channelization of streams, expansion of impervious surfaces, and increases in the stormwater runoff.[52] Sediment pollution from urban areas is usually linked to mismanaged construction sites but can also come from streets, yards, and the stream itself. In Pickens County, all activities disturbing one or more acres of land, or smaller sites (< 1 acre) within a larger common plan, are permitted and inspected by the County to ensure compliance with the Stormwater Ordinance,[53] and enforced by the Stormwater Management Department. Oconee County does not have a stormwater management program therefore, the Oconee County Stormwater Ordinance follows requirements set by SCDHEC land disturbance permits, which are reviewed by the Planning Director.

Forestry - Sediment pollution associated with forestry practices is most often attributed to the construction and use of logging roads. However, the removal of trees and vegetation along streambanks, and mechanical tree planting activities can contribute to increases in sediment loading to waterways.[54] This is a concern because there is a high potential for growth in the residential and commercial development sectors in Oconee and Pickens counties, with nearly 50,000 acres of land predicted to be consumed in the next 25 years.[55] As a result, runoff volume and annual suspended sediment loads are projected to increase in the watershed.

6.1.3) Preventing Sediment Pollution

Land Protection – Land protection can be used as a unique tool to prevent future sedimentation from land development. Sediment reductions from land protection represent the amount of sediment that is prevented from impacting waterways if significant land development is avoided.

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[50] (Clemson Cooperative Extension, 2018)
[51] (United States Environmental Protection Agency (EPA), 2005)
[52] (South Carolina Adopt A Stream Program (SC AAS))
[53] (Pickens County Stormwater Department, 2007)
[54] (United States Environmental Protection Agency (EPA), 2018)
[55] (CityExplained, Urban3, 2017)

This number was derived using the estimated Annual Pollutant Loads by Land Use for Total Suspended Solids (TSS) for the conversion of undeveloped land into single family low density residential.[56] In this calculation Current Land Use is represented as a combination of TSS loading from agricultural pasture lands and forest lands within the High Priority Land Protection parcels. Refer to the calculation below for the total estimated sediment removal rates using land protection BMPs.

Formula 7. Estimated Sediment Removal from Land Protection in the Lake Keowee Watersheds

Estimated TSS Removal from Land Protection	=	TSS Load per Single Family Low Residential Land Use	-	TSS Load per Current Land Use (TSS Agricultural + TSS Forest)
1,142.3 tons/acre/year	=	2,013 tons/acre/year	-	(155.5 + 715.3) tons/acre/year

Riparian Buffer Restoration – Properly operating riparian buffers can reduce sediment reaching waterways by slowing stormwater and preventing erosion. Sediment removal estimates for riparian buffers represent the amount of sediment that is prevented from impacting waterways if riparian buffers are protected, enhanced, and/or restored. Examples of actions include, but are not limited to: riparian buffer protection ordinances, planting vegetation, implementing a variety of erosion control techniques, and/or stream enhancement/restoration activities. These removal estimates were determined using STEPL. It was determined that the sediment removal per typical riparian buffer restoration project within the focus area is equal to 32.5 tons/year.[57]

6.2) Sediment Load Reductions per BMP

Sediment load reductions were estimated for three BMP categories: protected lands, agricultural lands, and riparian buffers. As mentioned in Section 6.1, the watershed contributes 11,017.38 tons of sediment per year to the region with the majority of the loading attributed to pasturelands and urban development. Table 24 outlines the approximate number of BMPs recommended to achieve a reduction of this amount. These estimations were derived using the standard annual sediment removal rates for each BMP multiplied by the suggested number of BMPs in the watershed to attain the necessary reductions. The number of Agricultural BMPs was obtained from the recommended number of projects necessary to meet bacteria load reductions (Section 5.2), and the acreage of Land Protection is based on Upstate Forever's minimum acreage requirement for placement of land under a conservation easement (CE) (55 acres), considering 1 easement per year of the 10-year implementation plan (Section 24). In total, the combined installation of the BMP projects listed in Table 24 is estimated to prevent nearly 630,000 tons of

[56] Appendix A
[57] Appendix C

sediment from entering the water system annually, which far exceeds the watersheds' annual loading estimate of 11,017.38 tons/year.

Table 24. Total Annual Recommended Sediment Reductions and BMPs

BMP	Standard Sediment Removal per BMP	# of Projects	Total Sediment Reduction Per BMP
Agricultural BMP Package	7.73 tons/year	11	85.03 tons/year
Land Protection	1,142.3 tons/acre/year	10 CE's* or 550 acres	628,265 tons/year
Riparian Buffer Restoration	32.5 tons/year	2	65 tons/year
Total			**628,415.03 tons/year**

**CE = Conservation Easement*

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7) Nutrient Pollution Sources and Load Reductions

7.1) Nutrient Pollution

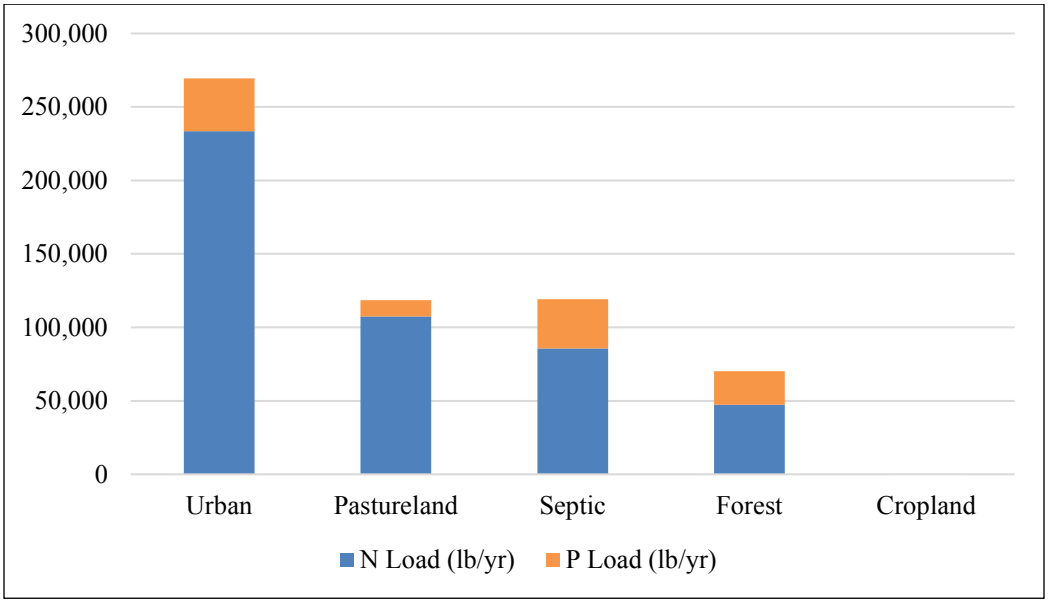
Nutrient pollution is considered one of the most widespread and difficult challenges for water quality in the US.[58] Excess levels of nitrogen and phosphorus can cause both economic and environmental impacts such as algal blooms in surface waters, increased drinking water treatment costs, and aquatic habitat degradation.[59] Nutrient pollution is associated with both point and nonpoint sources, and is most often attributed to human activities (Table 25).

Table 25. Potential Sources of Nutrient Pollution in the Lake Keowee Watersheds

Agriculture	Urban	Wastewater	Industrial
• Livestock • Fertilizer applications • Soil erosion	• Stormwater Runoff • Yard Waste • Yard Fertilizers • Pet waste	• WWTPs • Septic Systems	• Factories

Annual nutrient loading for the watershed was calculated using the STEPL model. Using this tool, it is estimated that cumulatively, the watershed contributes 103,252.05 lbs of phosphorus per year and 473,927.68 lbs of nitrogen to the region with the majority of the loading attributed to urban development, followed by pasturelands and septic systems. The breakdown of annual nutrient loading per land use is shown in Figure 7.

Figure 7. Annual Nutrient Loading per Land Use Category for the Lake Keowee Watersheds



[58] (United States Environmental Protection Agency (EPA), 2018)
[59] (The United States Environmental Protection Agency (EPA), 2015)

7.1.1) Point Sources of Nutrients

The primary point sources of nutrients include sewage treatment plants, industry, and factories. As stated in Section 4.1 the NPDES system controls water pollution by regulating point sources that discharge pollutants into Waters of the United States (WOTUS).

NPDES Discharges - There are ten NPDES facilities permitted to discharge into surface waters in the Lake Keowee Watersheds (Table 15, Figure 5). These facilities are regulated by SCDHEC to ensure compliance with the Clean Water Act. None of the listed NPDES facilities (Table 15) have compliance violations for nutrients (Total Phosphorus (TP) and Total Nitrogen (TN)).

ND Sludge Applications - There are three permitted No-Discharge Class B Sludge land application sites in the watershed (Table 16, Figure 5). These are sites where water treatment facilities are permitted to apply wastewater treatment effluent, non-hazardous sludge, and septage.

7.1.2) Nonpoint Sources of Nutrients

Nutrient pollution (i.e., nitrogen and phosphorus) from nonpoint sources is common in the Lake Keowee Watersheds. Excess nitrogen and phosphorus washes into local waterways from agricultural and urban sources as well as from domestic wastewater.

Agriculture - Agriculture is considered one of the largest sources of nitrogen and phosphorus pollution to waterways in the country.[60] Fertilizers and animal manure, both rich with nitrogen and phosphorus, are the primary causes of nutrient pollution from agriculture when not managed properly. Restricting livestock access to streams and properly managing fertilizer applications protects water quality by reducing the amount of excess nutrients from washing into local waterways.

Agricultural nutrient load reductions reflect the amount of nutrients projected to be removed annually through the use of agricultural BMPs (Section 4.1.2) installed on high priority agricultural sites within the focus area.

Urban - Nutrient pollution from urban areas is typically attributed to stormwater runoff. As impervious surfaces in a region increase (e.g., roads, parking lots, roof tops) landscapes lose their ability to absorb precipitation during rain events. As a result, stormwater washes off these surfaces at higher volumes and speeds, picking up pollutants in the process, and then discharging into local rivers and streams. Nitrogen and phosphorous can be found in yard waste, fertilizers, and pet waste.

Wastewater - Domestic wastewater contains nutrients (i.e., nitrogen and phosphorus) from human waste, food scraps, as well as certain soaps and detergents. Consequently, improperly managed septic systems are a potential source of nutrient pollution in the Lake Keowee

[60] (United States Environmental Protection Agency (EPA), 2018)

Watersheds. When improperly managed, septic systems can release nitrogen and phosphorus into local waterways or groundwater.[61]

7.1.3) Preventing Nutrient Pollution

Land Protection – Nutrient reductions (i.e., TP, TN) from land protection represent the amount of nutrients that are prevented, from undeveloped lands, from impacting waterways if significant development of the land is avoided. This number was derived using the estimated annual pollutant loads by land use for TP and TN for the conversion of undeveloped land into single family low density residential.[62] In this calculation, current land use is represented as a combination of TP and TN loading from agricultural pasture lands and forest lands within the high priority land protection parcels. Refer to the calculation below for the total estimated nutrient removal rates using land protection BMPs.

Formula 8. Estimated Total Possible Nutrient Reductions from Land Protection

Estimated Nutrient Removal from Land Protection	=	Nutrient Load per Single Family Low Residential Land Use	-	Nutrient Load per Current Land Use (Agricultural + Forest)

Table 26. Total Possible Nutrient Load Reductions from Land Protection

Indicator	Estimated Nutrient Removal from Land Protection	=	Nutrient Load per Single Family Low Residential Land Use	-	Nutrient Load per Current Land Use (Agricultural + Forest)
Phosphorus	4.5 tons/acre/year	=	5.5 tons/acre/year	-	(0.06 + 0.9) tons/acre/year
Nitrogen	21.7 tons/acre/year	=	40.3 tons/acre/year	-	(1.9 + 16.6) tons/acre/year

Riparian Buffer Restoration – Properly operating riparian buffers can reduce nutrients reaching waterways by slowing stormwater, preventing erosion, and water filtration. Nutrient removal estimates for riparian buffers represent nutrient loading prevented from impacting waterways if riparian buffers are protected, enhanced, and/or restored. Examples of actions include, but are not limited to: riparian buffer protection ordinances, planting vegetation, implementing a variety of erosion control techniques, and/or stream enhancement/restoration activities. Using EPA's STEPL model it was determined that the nutrient removal per typical riparian buffer restoration project within the focus area is equal to 82.1 lbs/year (phosphorus) and

[61] (United States Environmental Protection Agency (EPA), 2018)
[62] (Shaver, 2007)

715.5 lbs/year (nitrogen). In the Lake Keowee watersheds, the average parcel size of a high priority parcel for riparian buffer restoration/enhancement is 49 acres.

7.2) Nutrient Load Reductions per BMP

As mentioned in Section 7.1, the focus area contributes 103,252.05 lbs of phosphorus per year and 473,927.68 lbs of nitrogen per year to the region (total of 577,179.73 lbs/year), with the majority of the loading attributed to urban development, forest lands, and pasturelands. Table 27 outlines the approximate number of BMPs recommended to achieve a reduction of this amount. These estimations were derived using the standard annual nutrient removal rates for each BMP multiplied by the suggested number of BMPs in the watershed to attain the necessary reductions. The recommended numbers for Septic Repairs/Replacements and Agricultural BMPs were taken from the recommended number of projects to meet bacterial load reductions (Table 22), and the recommended number for Riparian Buffer BMPs was taken from the total annual recommended sediment reductions (Section 6.2).

Table 27. Total Annual Recommended Nutrient Reductions and BMPs

BMP	Standard TP Removal per BMP	Standard TN Removal per BMP	# of Projects	Total Nutrient Reduction Per BMP (lbs/year)
Septic Repair/Replacement	12.2 lbs/year	31.1 lbs/year	545	23,598.5 lbs/year
Agricultural BMP Package	10.16 lbs/year	44.34 lbs/year	11	599.5 lbs/year
Land Protection	4.5 tons/acre/year (9,120 lbs/acre/year)	21.7 tons/acre/year (43,400 lbs/acre/year)	550 acres	28,886,000 lbs/year*
Riparian Buffer Restoration	82.1 lbs/year	715.5 lbs/year	2	1,595.2 lbs/year
Total				**28,911,793.2 lbs/year**

**Values in these cells were converted from tons to lbs by multiplying values by 2,000*

Completion of the projects in Table 27 would prevent over 28 million lbs (or 14,455.9 tons) of nutrients from entering the water system annually. This far exceeds the watersheds' annual loading estimate of 103,252.05 lbs of phosphorus per year and 473,927.68 lbs of nitrogen.

8) Load Reduction Summary and Cost Estimates

As summarized in Table 28, the annual recommended load reductions for bacteria, sediment, and nutrients would be met with the implementation of septic, agricultural, land protection, and riparian buffer restoration projects. Included in these estimations are 545 septic system repairs and 11 agricultural projects, in order to calculate the total sediment and nutrient load reductions.

Table 28. Annual Load Reductions and Recommended BMPs in the Lake Keowee Watersheds

BMP	# of Projects	Bacteria Load Reduction (counts/year)	Sediment Load Reduction (tons/year)	Nutrient Load Reduction (lbs/year)
Septic Repair/ Restoration	545	1.32E+13	n/a	23,598.5
Agricultural BMP Package	11	1.79E+14	85.03	599.5
Pet Waste Stations	6	1.28E+13	n/a	n/a
Land Protection	10 CE's or 550 acres	n/a	628,265	28,886,600
Riparian Buffer Restoration	2	n/a	65	1,595.2
Total		**2.05E+14 counts/year**	**628,415.03 tons/year**	**28,911,793.2 lbs/year**

NRCS 2020[63] EQIP rates were used to determine agricultural and riparian buffer BMP project costs. For a standard riparian buffer project, site preparation and establishment for a forested buffer is $303.53/acre. Considering the average size of non-agricultural high priority parcels for riparian buffers in the Lake Keowee Watersheds is 49 acres, the average riparian buffer enhancement/restoration project would cost $19,830.79 (refer to Sections 12 and 14 for more details on funding option). A typical agricultural BMP package, which is detailed in Appendix B, averages around $22,539.15. While land protection costs can vary significantly, UF's Land Trust estimates a price of $23,250 to close a single conservation easement; costs include staff time, due diligence, and stewardship fees. In sum, the total cost for implementing the recommended BMPs for the Lake Keowee Watersheds is $2,974,392.26 which is $297,439.23/year over a 10-year implementation timeline (Section 23).

Table 29. Lake Keowee Watersheds Project Implementation Cost Estimates

BMP	Average Cost	Recommended Projects	Estimated Cost
Septic Repair/ Restoration	$4,500	545	$2,452,500
Agricultural BMP Package	$22,539.15	11	$247,930.65
Pet Waste Stations	$300	6	$1,800
Land Protection (CE's)	$23,250	10	$232,500
Riparian Buffer Restoration	$404.71/acre	2 (98 acres)	$39,661.58
Total			**$2,974,392.26**

[63] (United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS), 2020)

9) Parcel Prioritization Methodology

UF developed a GIS-based parcel prioritization analysis for nine categories of protection, restoration, and BMP implementation utilizing weighted criteria to analyze each parcel within the focus area. Each criterion was assigned a total number of possible points based on its importance to water quality protection and/or restoration. Cumulative points for each parcel were used to identify the parcels most important to protecting or improving water quality. Parcels that are already protected/preserved through conservation easements, national, state, or city/county parks, or owned by conservation organizations were removed from the protection analysis; all parcels were included in the restoration and BMP analyses. The results identify lands that should be protected or improved to provide the most benefit to water quality. The criteria and associated point system were analyzed using GIS and available data layers.

Before beginning the analyses, parcel layers for each county within the focus area were added and clipped to the watershed boundary. For each analysis, parcels were analyzed based on various factors that are key to protecting high quality waters and/or improving impaired waters; specific details are provided throughout Sections 10-21. Once the results were compiled in ArcGIS, they were then exported to an Excel spreadsheet for further review and refinement. For a detailed overview of the criteria and scoring for each category, refer to Appendix D.

9.1) Scoring Methodology

Scoring of individual criteria was weighted based on importance to water quality in each category. Relevant criteria were evaluated, points were assigned to each parcel as appropriate, and the points were summed for each parcel in each category. Some criteria were included in multiple categories. The end result is a score for each parcel in per individual categories. A higher point value indicates increased importance to water quality within each category (Protection, Restoration/Enhancement, BMPs).

9.2) Analyzing and Refining Results

The results identify the high priority parcels for actions to protect and improve water quality. If the analysis identified a large number of parcels as “high priority” the results were further refined to provide an actionable strategic plan for initial implementation. Specific refinement strategies varied and are discussed within the individual results and recommendations sections. Implementation of these cost-effective solutions will help protect and improve water quality. An overview of the practices analyzed is shown in Table 30. The results are presented in summary and map formats.

9.3) Parcel Prioritization Categories

Parcels in the focus area were analyzed in nine categories utilizing the parcel prioritization methodology. While the Land Protection category focuses on high-quality existing lands that are recommended for protection in their current state, the remaining eight categories focus on lands most important for restoration practices specific to each category.

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Table 30. Summary of Parcel Prioritization Categories

Category	Summary of Category's Main Goals
Land Protection	Protecting lands that remain in good condition or may be currently providing significant benefits to water quality and will help mitigate future impairments or loss of benefits. If developed, these lands would have the biggest impact on water quality.
Septic System Repair/ Replacement	Identifying locations most susceptible to septic system failure based on age of septic system and soil suitability.
Agricultural BMPs	Identifying agricultural parcels that may be contributing sources of bacteria or sediment pollution for the implementation of agricultural BMPs.
Wetland Restoration & Enhancement	Identifying parcels containing impacted, low quality, or inundated wetlands that could provide additional water quality benefits if restored or enhanced to a higher quality wetland.
Riparian Buffer Restoration & Enhancement	Identifying parcels with highly sensitive riparian buffers that, if restored, would provide significant water quality benefits such as slowing and filtering stormwater runoff, reducing flooding, stabilizing streambanks, and minimizing erosion.
Voluntary Dam Removal	Identifying parcels containing dams that may be suitable for voluntary dam removal at the property owner's discretion and approval if the owner is no longer receiving enough benefits to outweigh the liability and maintenance responsibilities.
Shoreline Management	Identifying parcels adjacent to drinking water reservoirs or intakes that are high priority for shoreline management BMPs with the end goal of reducing pollutants directly entering drinking water sources.
Stormwater BMPs	Identifying parcels within developed areas that may be appropriate for installation of stormwater retrofits, which would reduce stormwater runoff and pollutant loading into nearby waterways in an urbanized setting.
Pet Waste Stations	Identifying parcels that may be suited for the installation of a pet waste stations to encourage proper disposal of pet waste and reduce bacteria loadings from pets, targeting high traffic pet locations such as parks or veterinary offices.
Wildlife	Identifying strategies for reducing the impacts of wild animals, specifically wild boar and waterfowl, to minimize pollutant loads.
Forestry	Identifying strategies for proper forest management to manage/reduce loads of sediment and nutrients to nearby waterways.

The goal of this analysis is to identify parcels that, if developed, would have the biggest impact on water quality. Protecting lands that remain in good condition or may be currently providing significant benefits to water quality can help mitigate future impairments or loss of benefits. Parcels that are already protected were removed from this analysis, such as parks, heritage preserves, utility owned properties, and properties already known to be protected by a conservation easement (Figure 8).

10.1) Land Protection Criteria

Table 31 is an overview of the specific criteria and possible points that were used to evaluate each parcel in the focus area. Each parcel's total score was used to determine those that are of high (20-31 points), medium (10-19 points), and low (0-9 points) priority for protection (Figure 9). For a detailed overview of the criteria and scoring, refer to Appendix D.

Table 31. Criteria and Ranking System for Land Protection Prioritization

Criteria	Ranking	Points	Total Possible Points per Category
Critical Watershed Area (CWA)	High Priority CWA	4	4
	Medium Priority CWA	3	
Stream Order	Headwater (1st and 2nd Order) Streams	4	4
Stream Classifications	ORW and TN Streams	4	4
	TGPT Streams	3	
	FW Streams with No Impairments	2	
	FW Streams with 1 or More Impairments	1	
Highly Sensitive Riparian Buffer Areas	43+ Acres of Riparian Buffers	4	4
	20-42.99 Acres of Riparian Buffers	3	
	8-19.99 Acres of Riparian Buffers	2	
	2-7.99 Acres of Riparian Buffers	1	
Forested Riparian Buffer Areas	Falls within the Highly Sensitive Riparian Buffer Area and has Forested Land Cover	1	1
Wetlands	*FW Forested/Shrub, FW Emergent, Riverine Wetlands	3	3
	FW Pond and Lake Wetlands	2	
Hydric Soils	50+ Acres of Hydric Soils	3	3
	30-49.99 Acres of Hydric Soils	2	
	5-29.99 Acres of Hydric Soils	1	
100-Year Floodplain	100-Year Floodplain with no Urban/Developed Land	2	2
	100-Year Floodplain with Urban/Developed land	1	
Source Water Protection Areas	Source Water Protection Areas	2	2
Average Stream Length	Longer-than-Average Stream Length	2	2
Adjacency to Existing Protected Land	Adjacent to Existing Protected Land	1	1
Parcel Size	50 Acres or Larger	1	1
TOTAL POSSIBLE PROTECTION POINTS PER PARCEL			**31**

10.2) Land Protection Results and Recommendations

Out of 31 points possible in this category, the highest score a parcel achieved is 25. This analysis identified 132 parcels as high priority for protection in order to maintain the land in its current state (Figure 10). To further refine high priority results, parcels meeting the following qualifications were selected for more in-depth analysis:

1. 100 acres or greater
2. High priority for both Protection and Wetland Restoration
3. High priority for both Protection and Voluntary Dam Removal
4. Parcels with 50 acres or greater non-urban land cover (50+ acres of agricultural, forested, or existing riparian buffer coverage)
5. Parcels were REMOVED if use is a golf course or university

The refined results identified 99 parcels for initial protection efforts. These parcels are located throughout the focus area and nearly 67% of the high priority parcels are 100 acres or more (Figure 9). Only two parcels scored 25 points; one is located at the northern reach of Lake Keowee at Cane Creek and the other is located where the Little River meets Lake Keowee. Concentrations of high priority parcels for protection are located along the northern rim of the existing protected lands, along the western region of Lake Keowee, and the Little Eastatoe and Crow Creeks.

Based on these results, the LKSWPT recommends to focus land protection efforts along the existing protected lands corridor at the top of the focus area to expand acreage of protected lands, protect sensitive headwater streams, and prevent urban encroachment from nearby developing towns and cities.

10.3) Land Protection Strategies and Potential Funding Sources

Land protection can be accomplished through a variety of mechanisms and funding sources. The following are suggested land protection strategies and cost share programs that could be utilized in the focus area to protect sensitive lands in the region.

10.3.1) Conservation Easement

A conservation easement is a voluntary contract between a landowner and a qualified land trust, which allows the landowner to legally restrict certain land uses from occurring on their property. These agreements are permanent and remain with the land even after it has been sold or willed to heirs. Based on information obtained from UF's Land Trust, it is estimated that the total average cost estimated for an easement is $23,250. This includes $6,250 for staff time and fees and $9,500-17,000 for stewardship fees for the property that involves the annual monitoring of the property in perpetuity.

10.3.2) Deed Restriction

While not the preferred land use protection option, property owners could place restrictions on the deed to limit the allowable uses or development of the property, which could protect priority parcels. Deed restrictions are subject to enforcement by a third party that may not have the resources to ensure land is protected.

10.3.3) Fee Simple Purchase

Entities, such as water utilities, could purchase priority parcels and voluntarily restrict certain undesirable land uses from occurring on their property to protect water quality. Restrictions could be permanent or temporary, depending on continued management and ownership decisions.

10.3.4) Land Donation

While this option would likely have limited availability, some current property owners may be interested in donating land, or a portion of their land, through a fee-simple donation, charitable contribution, donation with life estate, or bequest to an organization or business dedicated to stewarding the land for environmental benefits.

10.3.5) Water Utility Funded Watershed Protection Programs

Water utility funded watershed management plans are another alternative for protecting lands within source water protection areas. An example of such a program is the Lake Maumelle and Lake Winona Management Plan in Central Arkansas.[64] It is well documented that what happens on the land impacts water quality, therefore land acquisition and management can be an effective tool for the protection of drinking water sources. For example, preserving lands around source waters can help reduce loading and impacts of nonpoint source pollution on drinking water sources, recharge streams and groundwater sources, reduce risk of hazardous spills, and lower overall treatment costs for operators.[65] Using this WBP, drinking water utilities can identify high priority lands for protection and/or restoration and then work with local communities and landowners to develop strategies to purchase priority properties and/or create a management plan for parcels surrounding the source water.

10.3.6) Section 319 Funding

The EPA provides annual funding to SCDHEC for projects that reduce or prevent nonpoint source water pollution by implementing an approved WBP. SCDHEC distributes these Section 319 funds through grants that will pay up to 60 % of eligible project costs, with a 40 % non-federal match generally provided by the landowner. For land protection, this grant funding could compensate landowners for a portion of their due diligence costs (e.g., closing fees, land appraisal, earnest fee, title search fee).

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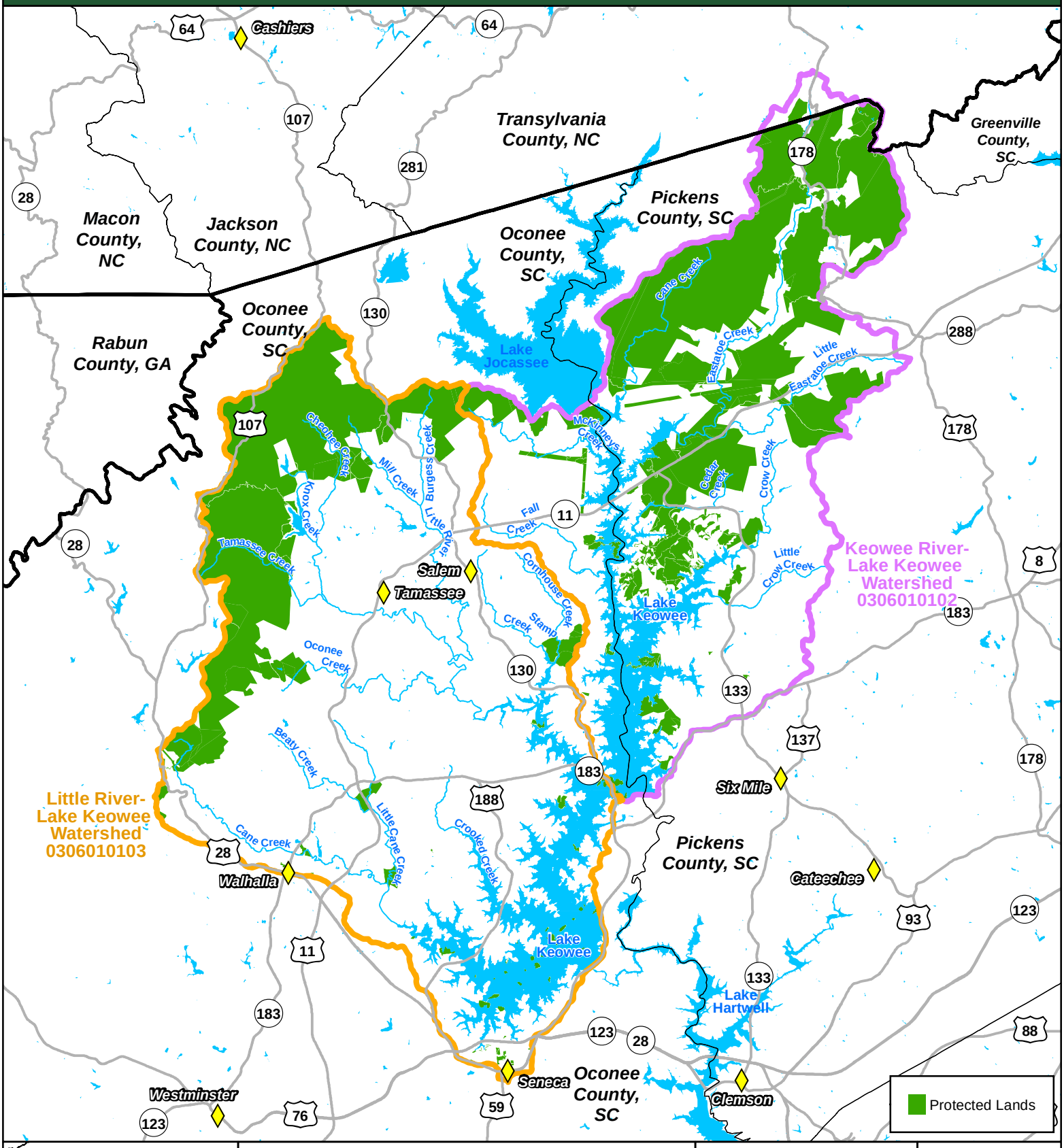
[64] (Tetra Tech, Inc., 2007)
[65] (Trust for Public Land (TPL), 2004)

Figure 8: Protected Land



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Map by: KPH - 6/27/19

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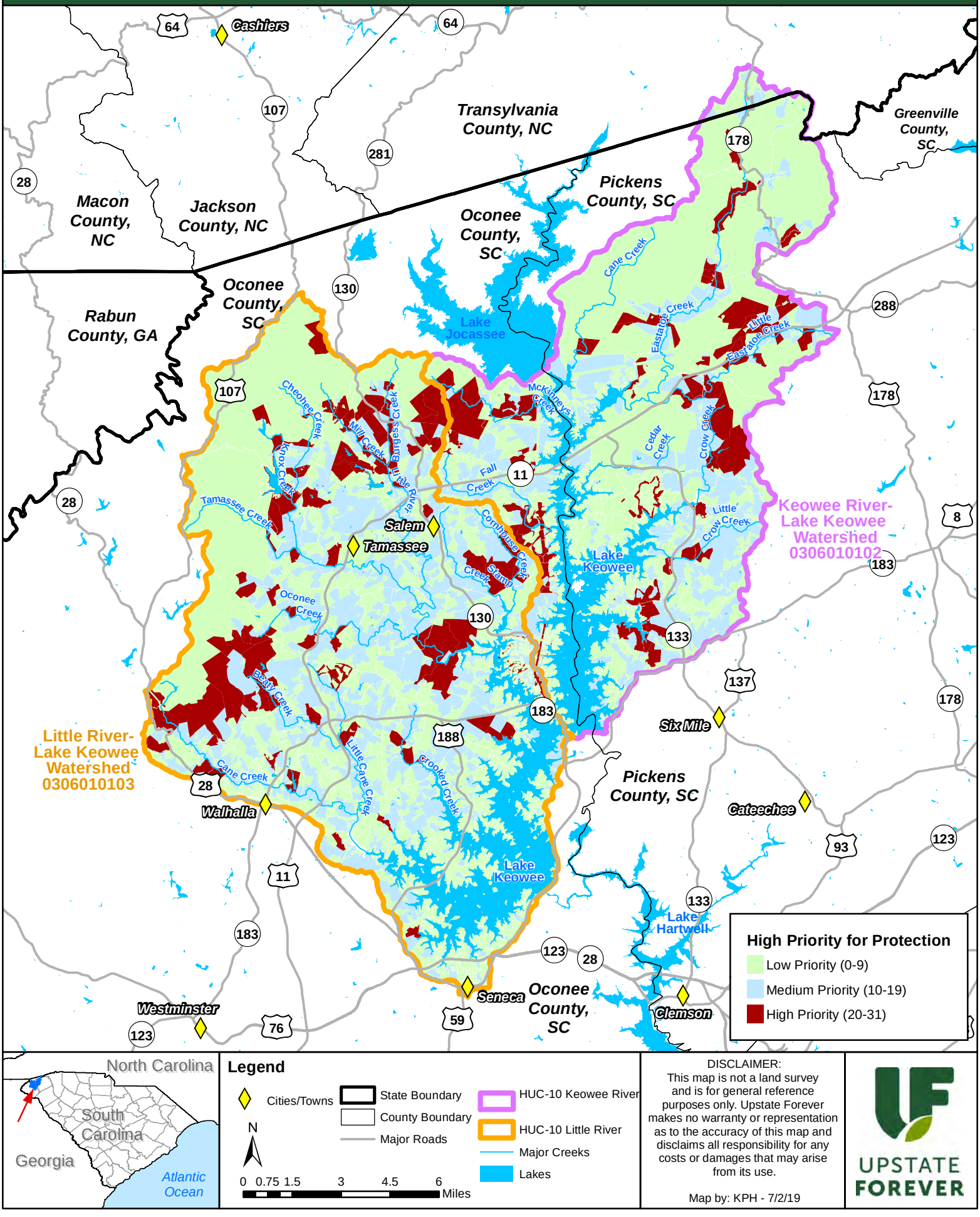
Figure 9: Parcel Prioritization for Land Protection



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Map by: KPH - 7/2/19

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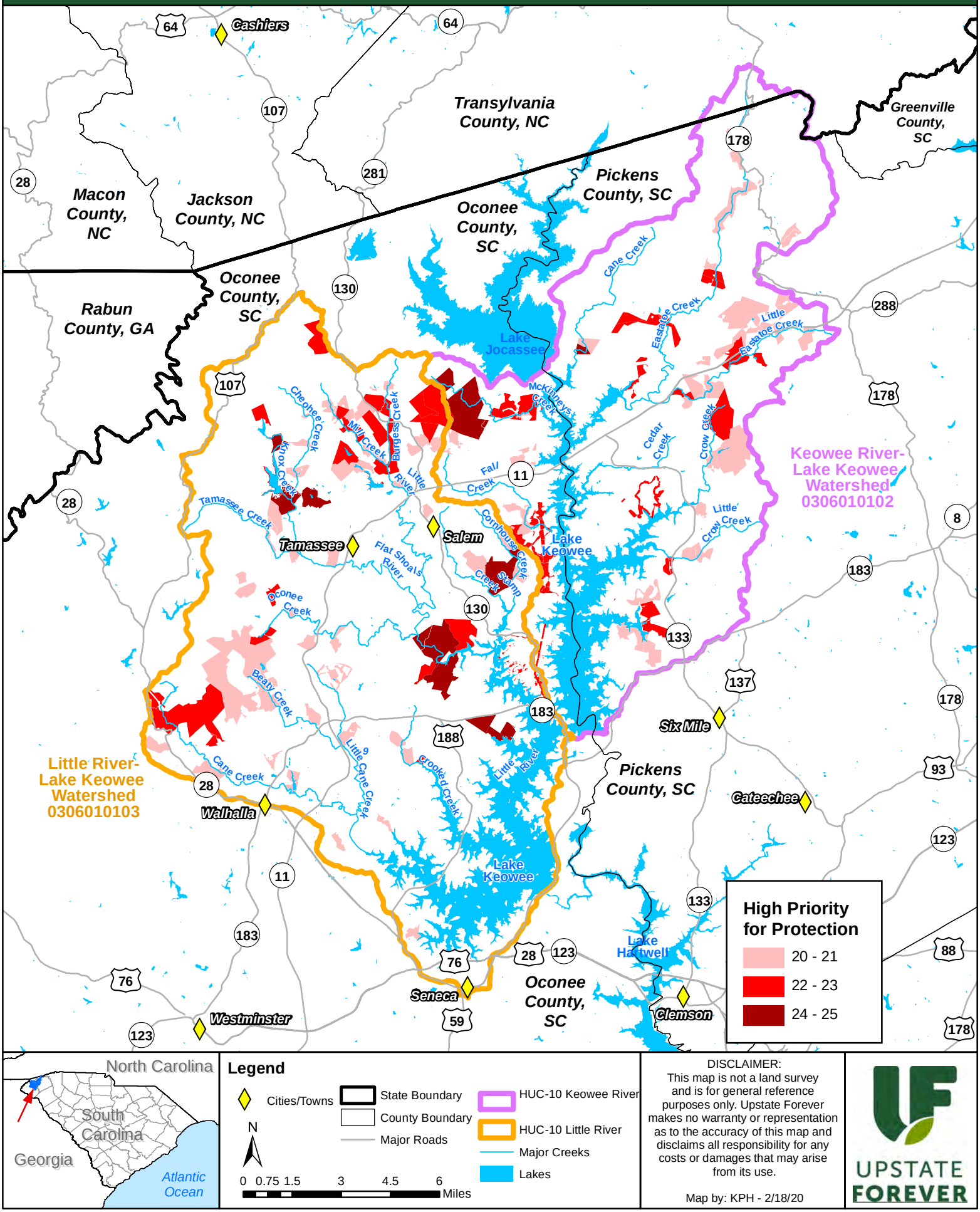
Figure 10. High Priority Parcels for Land Protection



11) Analyzing Parcels for Septic Repair/Restoration

According to the EPA, over 40% of homes in South Carolina rely on onsite wastewater systems, such as septic systems, to manage household wastewater. Damaged or improperly maintained septic systems can be a significant source of bacteria and nutrients to surface and groundwater resources. It is recommended that septic tanks should be pumped every five years to maintain efficiency, however, many homeowners are not likely to repair or replace failing septic systems until they experience issues such as a sewage backup or pooling in the area of the drainage field.[66]

11.1) Septic System Repair/Replacement Criteria

The Clemson Center for Watershed Excellence developed a report[67] that utilized a geospatial analysis to identify the potential impacts of failed septic systems and the prioritized locations for septic system repairs/replacements. This analysis was based on the age of septic systems and the soil suitability for proper septic system performance. Table 32 summarizes the criteria used for this analysis. For the full report and details on this analysis, refer to Appendix E.

Table 32. Criteria and Ranking System for Septic Suitability

Criteria	Ranking
Septic System Identification	Homes are >500' from sewer lines
	Homes within 300' of open waters
Age of Septic Systems	Categorized in groups by age (no information, pre-1970, 1971-2000, 2001-2019)
	Lots with more than one home were assigned the age of the oldest residence on the property
Soil Suitability (based on NRCS SSURGO database)	"Not Limited" – favorable for septic tanks; good performance and low maintenance expected
	"Somewhat limited" – moderately favorable; limitations can be overcome or minimized; fair performance and moderate maintenance expected
	"Very limited" – unfavorable for septic tanks; limitations cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance expected.

[66] (United States Environmental Protection Agency (EPA), 2002)
[67] (Callahan & Zurqani, 2019)

11.2) Septic System Results and Recommendations

According to the Septic Suitability Report,[68] greater than 65% of land in the focus area is rated as very limited for septic suitability. Additionally, 54% of homes with septic systems that have year-built data and are within 300' of waterways were installed before the year 2000, which increases the likelihood of failure. Grouping soil suitability with age of septic systems near waterways resulted in the identification of high priority areas for septic repairs/replacements. Predominantly, high priority locations are along the Eastatoe, Little Eastatoe, Fall, and Crow Creeks in the Keowee River-Lake Keowee Watershed and Cane Creek, Flat Shoals River, and Little River in the Little River-Lake Keowee Watershed.

LKSWPT recommends to first focus on completing Phases 1 and 2 of the "Find and Fix" septic program as detailed in the 2018 Cane Creek WBP.[69] This program can serve as a pilot program for the entirety of the focus area. The Cane and Little Cane Creek subwatersheds were identified as a problem area from the public survey and public meetings and already has a detailed action plan. Once this program has been established, LKSWPT recommends expanding the program to the entire focus area, focusing outreach on the identified high priority areas.

Additionally, Mile Creek Park has been identified as a potential problem location. Mile Creek Park has historically had issues with their onsite septic systems and RV dumping stations, especially during the summer months. Because the park is directly on the lake and high usage rates between March and October possible bacteria runoff is heightened. LKSWPT recommends working with Mile Creek Park to fix the failing septic systems and improve the RV dumping stations.

11.3) Septic System Strategies

According to the EPA STEPL Model, a typical septic system generates 2.42E+10 bacteria a year.[70] The following BMPs are considered the most relevant and effective for residential areas in the watershed for bacteria pollution relating to onsite wastewater.

11.3.1) Replace/Repair Septic System

Replacing and/or repairing malfunctioning septic systems is recommended throughout the focus area. Repairing these systems not only improves water quality but also improves quality of life for residents dealing with failing septic systems since many failures cause sewage backup in homes and/or yards.

[68] (Callahan & Zurqani, 2019)
[69] (Callahan, 2018)
[70] (United States Environmental Protection Agency (EPA), 2019)

Examples of a Septic Tank Replacement, Before and After Maintenance, and Drainline

11.3.2) Extending Sewer Lines

In regions with a high concentration of failing septic systems, extending municipal sewer lines to areas of concern may be the most cost-effective long-term solution. Careful consideration and analysis should be given to this before it is viewed as a viable option given the significant financial investment required.

11.4) Septic System BMP Unit Cost Estimates and Funding Options

Many homes in the focus area are not within access to municipal sewer serve and therefore require an onsite septic system for household wastewater treatment. Traditional septic systems and drain fields work well if properly installed and maintained, but replacements and repairs are sometimes necessary. The following table outlines the cost estimates and funding options for septic BMPs (Table 33).

Table 33. Septic System BMP Unit Cost and Potential Funding Sources

Nonpoint Sources of Bacteria Pollution	BMP	Estimated BMP Unit Cost	Potential Funding Sources
Septic Tanks	Replace/repair onsite failing septic systems and leach fields Tie into existing sewer line	$4,500 per system	SCDHEC 319(h) Funds Local Governments or Organizations USDA Rural Utilities Service - State Revolving Funds USDA Rural Development US Department of Housing and Urban Development HUD)

There are a few cost share programs available for homeowners to assist with septic system repair and replacements. The costs for extending sewer lines are not included in this plan as these expenses are contingent upon many factors including depth to pipe, bedding materials, and potential easement costs. If the situation warrants the extension of sewer the local sewer provider will be able to provide a more accurate estimate of total costs of the project prior to construction.

11.4.1) Section 319 Funding (SCDHEC)

The EPA provides annual funding to SCDHEC for projects that reduce or prevent nonpoint source water pollution by implementing an approved WBP. SCDHEC distributes these Section 319 funds through grants that may pay up to 60 % of eligible project costs, with a 40 % non-federal match, typically provided by the homeowner.

11.4.2) Local Governments or Organizations

Local counties, municipalities, sewer authorities, or nonprofits may be able to assist homeowners by providing financial support for septic system improvements or sewer tie-ins as funding becomes available.

11.4.3) USDA Rural Utilities Service – Water and Environmental Programs

The Rural Utilities Service provides financial assistance to eligible organizations for projects involving water, wastewater, and solid waste disposal systems in rural areas. Through this program, non-profit organizations are provided technical and financial assistance to provide water and waste disposal-related technical assistance and/or training to rural water systems, and towns and cities with a population of 10,000 or less. The revolving fund program is also given to non-profits to assist rural communities with water/wastewater systems.[71]

11.4.4) US Department of Agriculture (USDA) Rural Development Office

The Section 504 Very Low-Income Housing Repair Program offers low-interest loans to rural residents who earn less than 50% of the area median income. Moderate income is defined as "the greater of 115% of the US median family income or 115% of the average of the state-wide and state non-metro median family incomes, or 115/80ths of the area low-income limit".[72] The moderate-income limit for the watershed (based on Oconee County, SC) is $86,850 for one to four-person homes and $114,650 for five to eight plus person homes. The average median income for the focus area is $57,553.[73] Of the 20 census block groups in the watershed, 95% have median incomes below the moderate-income limit. These low-interest loans are to be used specifically to render the home more safe or sanitary. Additionally, this program offers grants to elderly very-low-income homeowners to remove health and safety hazards. Homeowners over 62 years of age may be eligible for these grant funds.

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[71] (United States Department of Agriculture (USDA) Rural Development, 2019)
[72] (United States Department of Agriculture (USDA), 2019)
[73] (United States Census Bureau, 2017)

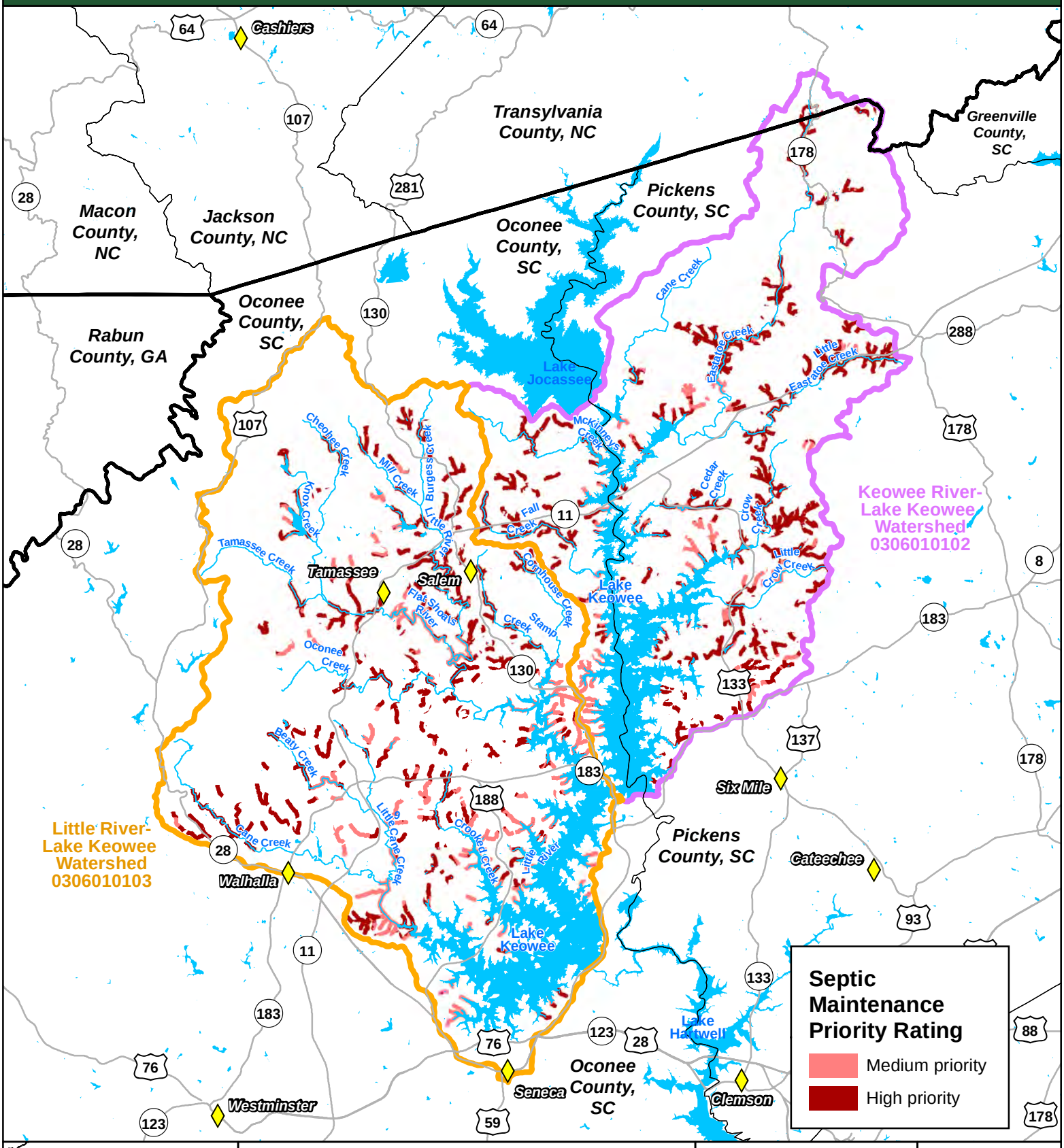
11.4.5 US Department of House and Urban Development (HUD)

HUD provides funding to states that can be used to repair septic systems through the Community Development Block Grant (CDBG).[74] The grants are to be used to improve the living conditions of low to moderate income residents. Applications are available through SC Department of Commerce.[75]

[Remainder of page intentionally left blank]

[74] (United States Environmental Protection Agency (EPA), 2020)
[75] (South Carolina Department of Commerce, 2020)

Figure 11: Septic Maintenance Priority Ratings



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Map by: KPH - 12/4/19

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12) Analyzing Parcels for Agricultural BMPs

Implementing agricultural BMPs reduces bacteria, nutrient, and sediment pollution in nearby streams while maintaining, and often improving, conditions for livestock. For the purposes of this plan, agricultural land includes pasture (livestock), hay, and cultivated crops. Livestock are considered the primary agricultural source of bacterial pollution throughout the focus area and can also contribute to nutrient and sediment pollution. Therefore, to address bacteria inputs, agricultural BMPs will focus on restricting animal access to streams with the exception of the urban areas around the cities of Seneca, Walhalla, and the town of Salem, Tamassee and along the major transportation corridors (US-76, SC-183, etc.). When fencing livestock out of streams, it is often necessary to provide an alternative water source for the animals if the stream was their primary source of water; consequently, agricultural BMPs often involve several components such as a combination of exclusion fencing and alternative watering sources.

12.1) Agricultural BMP Criteria for Parcel Prioritization

Examples of Agricultural BMPs include: fencing livestock out of streams, improving heavy use areas, stabilizing streambanks, providing alternative watering sources, and adding riparian buffers to agricultural lands. Table 34 is an overview of the specific criteria and points possible that were used to evaluate each parcel for potential BMPs. Each parcel's total score was used to determine those that are of high (12-17), medium (6-11), and low (0-5) priority for agricultural BMPs (Figure 12). Only parcels that were classified as agricultural were considered in this analysis. For a detailed overview of the criteria and scoring, refer to Appendix D.

Table 34. Criteria and Ranking System for Agricultural BMPs

Criteria	Ranking	Points	Total Possible Points per Category
Land Cover (prerequisite for further analysis)	50% or greater Agricultural Land Cover	2	4
	Agricultural Land Adjacent to Streams	2	
Current Pollutant Export (for each Nitrogen, Phosphorus, and Sediment)	High Range of Export	3	9 (3-point maximum for each pollutant)
	Medium Range of Export	2	
Current Water Quality Impairments	Include, Adjacent to, or Upstream of Existing Impairments	3	3
Permitted and Unpermitted Point Source Pollutants	Unpermitted Point Sources (farms)	1	1
	Permitted Point Sources (CAFO's, biosolid application areas, Animal Management Areas)	1	
TOTAL POSSIBLE AGRICULTURAL POINTS PER PARCEL			**17**

12.2) Agricultural BMP Analysis Results and Recommendations

This analysis identified 28 parcels as high priority for Agricultural BMPs, with the highest achieved score of 13 by only 3 parcels (Figure 13). Only 6% of parcels within the focus area were analyzed for Agricultural BMPs due to a low number of parcels meeting the analysis' requirement of 50% or more agricultural land cover. With only 6.19% agricultural land cover within the entire focus area, agricultural BMPs are not considered the highest priority for addressing pollutants of concern. High priority parcels are located mostly in the Little River-Lake Keowee Watershed (HUC-0306010103), concentrated near the SC-183 and SC-11 corridors. LKSWPT recommends targeting landowners in these areas for Agricultural BMP installations.

12.3) Agricultural BMP Strategies

The following is a list of BMPs considered the most relevant and effective for agricultural areas in the watershed for bacteria and sediment pollution. While they are defined separately, they are most often installed in combination.

12.3.1) Livestock Exclusion Fencing

Installing fences along rivers, streams, and ponds limits livestock access to waterways. This practice ensures that manure is not deposited directly into waters, protects riparian vegetation, and reduces erosion along streambanks.

Examples of Livestock Exclusion Fencing

12.3.2) Armored Streambank Crossings /Culvert Crossing

In certain situations, stream crossing may be necessary to move livestock from one area to another, armored streambank crossings and culvert crossings provide protection to reduce erosion within the crossing area. The type of crossing needed will depend upon site conditions such as size of stream, flow, slope, number of animals, and streambed substrate.

Example of Armored Streambank Crossing (Source: USDA NRCS)[76]

12.3.3) Alternative Watering Sources/Wells and Linear Pipeline

Streams and ponds in pastures are often used as the primary watering source for livestock. If fences restrict livestock's access to water, an alternative watering source will be needed. Alternative watering sources prevent livestock from entering waterways, therefore reducing manure deposited directly into streams, protecting riparian vegetation, and reducing erosion along streambanks. Additionally, providing a clean reliable source of water improves livestock health and reduces risk of mortality from injury or disease. Linear pipelines may be necessary to transport water from the well to the alternative watering sources.

Examples of Alternative Watering Source with Linear Pipeline

[76] https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/newsroom/features/?cid=nrcseprd1389036

12.3.4) Animal Heavy Use Areas

Heavy use areas are areas that experience high concentrations of animals and therefore have a difficult time maintaining vegetation, which can lead to erosion. Installing a durable material (e.g., crush and run gravel) reduces erosion and pollutant loading of stormwater runoff, and can be an alternative to maintaining vegetation in these highly trafficked areas.

Examples of Animal Heavy Use Areas

12.3.5) Riparian Buffers

Riparian buffers are vegetated areas along waterways that stabilize soil, filter runoff, and provide wildlife habitat. The restoration of riparian buffers helps to improve water quality by stabilizing streambanks and reducing manure, sediment, fertilizers, pesticides, and other pollutants from washing into streams.

Example of Riparian Buffer in Agricultural Setting

12.3.6) Drip Irrigation

Drip irrigation systems provide precise, uniform water to the roots of plants either directly on the surface or sub-surface. Benefits of drip irrigation include lower water use, prevention of erosion and soil loss, and maintenance of soil moisture, which can encourage proper plant growth.

Example of a drip irrigation system installed on muscadine vines

12.3.7) Cover Crops

Cover crops can be grasses, legumes, or other forbs that are planted to provide many benefits such as decreased soil erosion, nutrient content, improving soil structure, and more.[77] The use of cover crops reduces the need for fertilizer as they aid with soil nutrient availability. Farmers often use cover crops to help recover a field's soil in between planting seasons of cash crops.

12.4) Agricultural BMP Unit Costs Estimates and Funding Options

Agricultural BMP unit cost estimates are based on information provided by the USDA[78] (Table 35). There are numerous cost share programs available to landowners at the federal, state, and local level. The US Department of Agriculture (USDA), including the Natural Resources Conservation Service (NRCS) and Farm Service Agency (FSA), implements many voluntary programs that help reduce bacteria loading by establishing riparian buffers, protecting wetlands, and conserving water resources.

[77] (United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS), 2020)
[78] (United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS), 2020)

Table 35. Agricultural BMP Unit Costs[79]

BMP	Estimated Cost Per Unit (2020 NRCS Rates)
Linear Streambank Fencing	$2.65/feet
Well (500' deep)	$10,552.55 each
Linear Pipeline	$5.24/feet
Alternative Watering Source	$1,084.85 each
Heavy Use Area	$2.49 square feet
Riparian Buffer	$404.71/acre
Filter Strip	$149.04 acre
Drip Irrigation	$2,711.05 acre

12.4.1) Conservation Stewardship Program (CSP)

CSP is a voluntary program funded through the NRCS that provides financial and technical assistance to eligible producers to conserve and enhance soil, water, air, and related natural resources on their land. Eligible projects include cropland, grassland, prairie land, improved pastureland, rangeland, non-industrial private forest lands, agricultural land under the jurisdiction of an Indian tribe, and other private agricultural land (including cropped woodland, marshes, and agricultural land used for the production of livestock) on which resource concerns related to agricultural production could be addressed.[80]

12.4.2) Conservation Reserve Program (CRP)

The CRP is a land conservation program administered by the Farm Service Agency (FSA), a branch of the USDA. Farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality in exchange for an annual rental payment. Contracts for land enrolled in CRP are 10-15 years in length. The long-term goal of the program is to re-establish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat.[81]

12.4.3) Environmental Quality Incentive Program (EQIP)

The NRCS EQIP program promotes agricultural production while maintaining or improving environmental quality. Typically, up to a 75 % cost-share assistance is offered for project costs and forgone income. Historically underserved farmers can receive up to a 90 % cost share. The specific priorities to be addressed on the property are:

[79] (United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS), 2020)
[80] (United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS), 2020)
[81] (United States Department of Agriculture Farm Service Agency (USDA FSA), 2020)

- Improvement of water quality in impaired waterways;
- Conservation of ground and surface water resources;
- Improvement of air quality;
- Reduction of soil erosion and sedimentation; and
- Improvement or creation of wildlife habitat for at-risk species.

12.4.4) Agricultural Water Enhancement Program (AWEP)

Within EQIP, AWEP provides additional funding to NRCS offices to provide technical and financial assistance to agricultural producers to implement water enhancement activities on agricultural land to conserve surface and groundwater and overall improve water quality. Examples of previously funded projects include high efficiency irrigation systems, nutrient and pest management plans, and agricultural BMPs.

12.4.5) Section 319 Funding

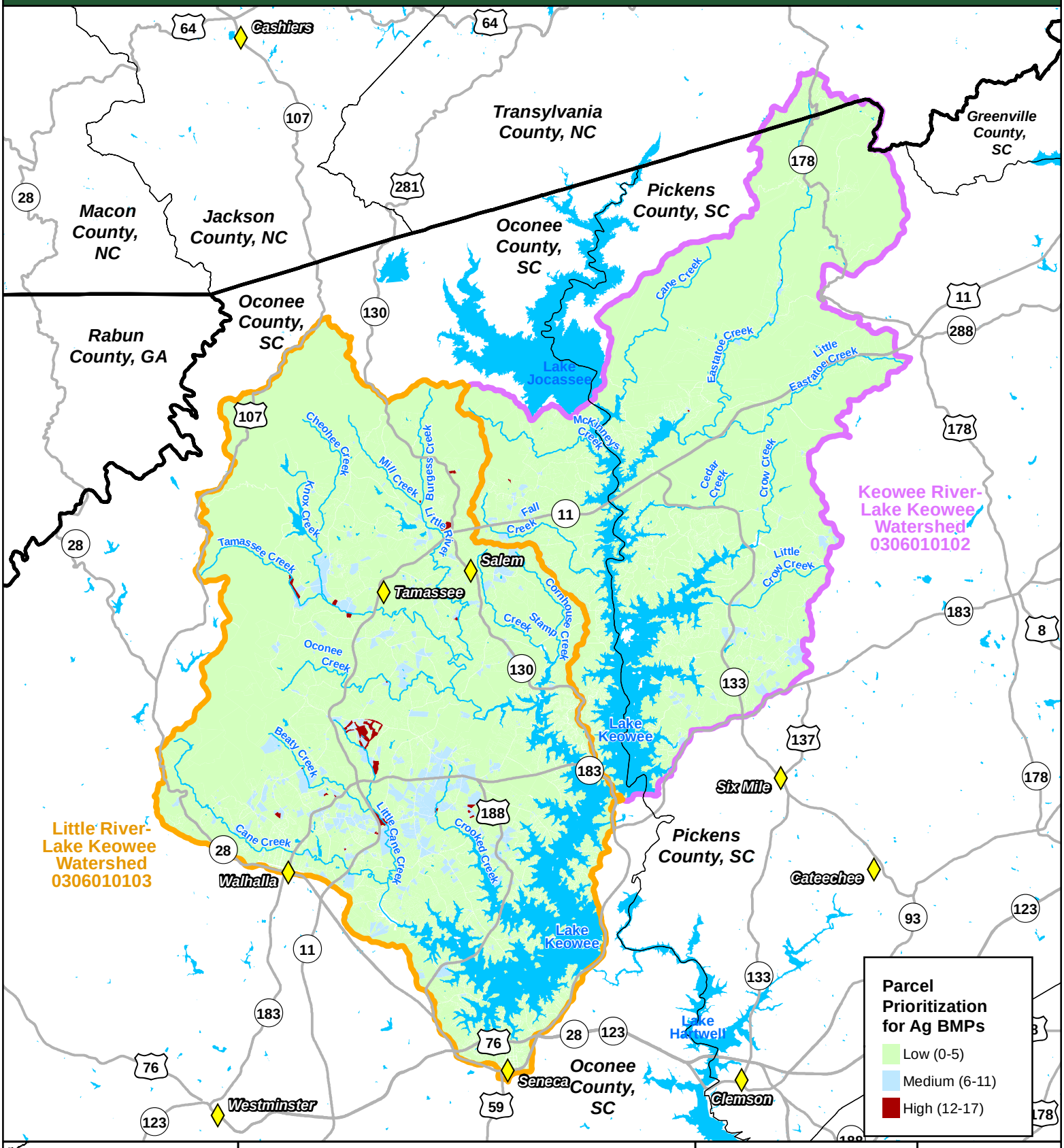
The EPA provides annual funding to SCDHEC for projects that reduce or prevent nonpoint source water pollution by implementing an approved WBP. SCDHEC distributes these Section 319 funds through grants that will pay up to 60 % of eligible project costs, with a 40 % non-federal match generally provided by the landowner.

12.4.6) Partners for Fish and Wildlife Program

The US Fish and Wildlife Service (FWS) sponsors the Partners for Fish and Wildlife Program, which provides technical and financial assistance to conserve or restore native ecosystems. Cost share is determined by multiple factors including: project location, type of habitat being restored, and species that will benefit.[82] This voluntary program primarily involves streambank fencing, tree-planting, and invasive species control. Projects on private lands must improve the habitat of Federal Trust species (i.e., migratory birds, threatened and endangered species, inter-jurisdictional fish, certain marine mammals, and species of international concern) for the principal benefit of the Federal Government. Program projects must be biologically sound, cost effective, and must include the most effective techniques based on state-of-the-art methodologies and adaptive management. These agreements are usually for a period of 10 years or more.

[82] (U.S. Fish and Wildlife Service (USFWS), 2020)

Figure 12: Parcel Prioritization for Agricultural BMPs



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Map by: KPH - 7/11/19

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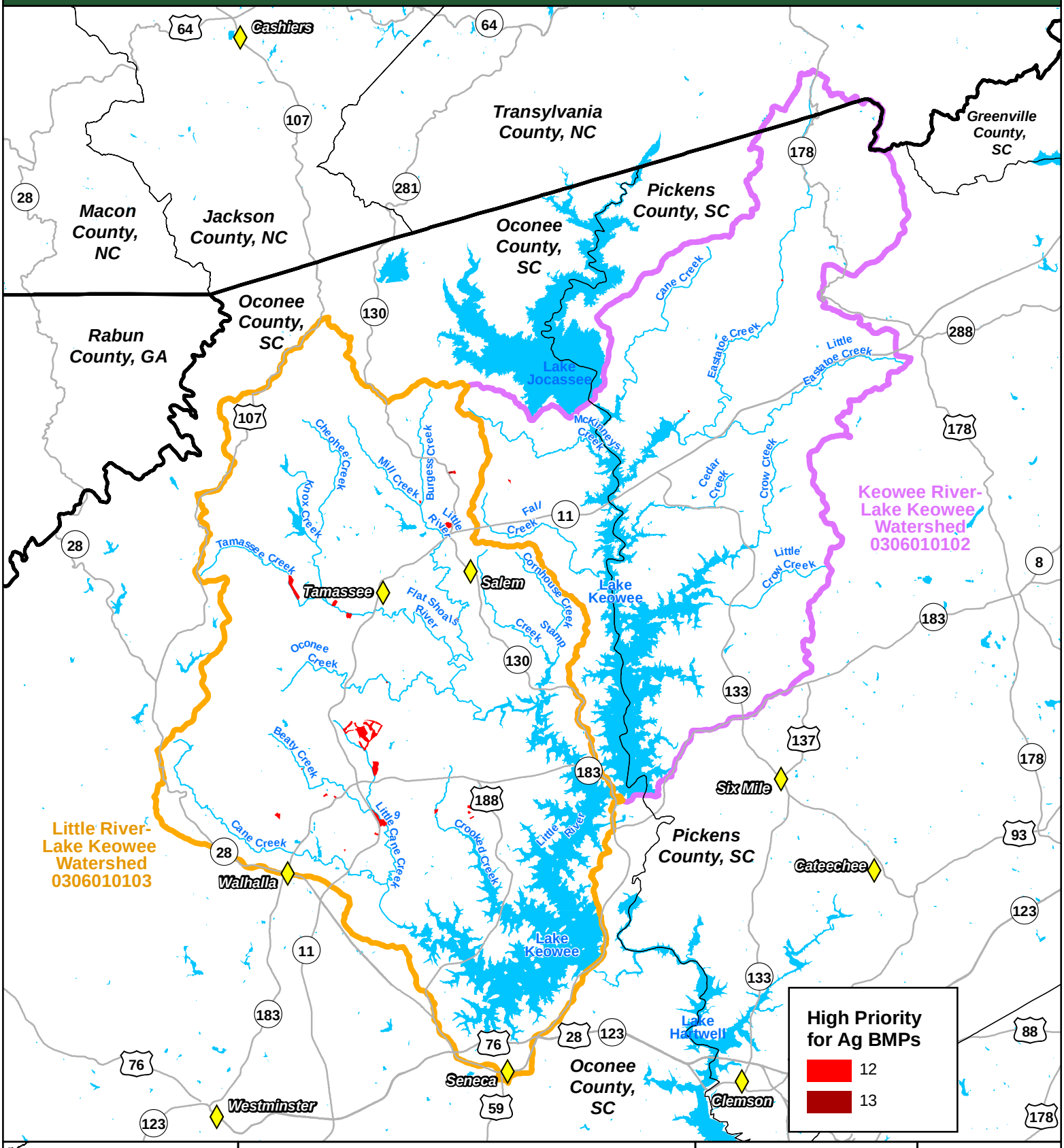
Figure 13. High Priority Parcels for Agricultural BMPs



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13) Analyzing Parcels for Wetland Restoration/Enhancement

This analysis identifies parcels containing impacted, low quality, or inundated wetlands that could provide additional water quality and quantity benefits if restored or enhanced to a higher quality wetland. Wetlands provide many natural ecosystem services such as water filtration, acting as pollutant sinks, wildlife habitat, erosion control, and flood management.[83] Wetlands that have been impacted or inundated are likely no longer providing the myriad of important ecological and water quality benefits that are possible. Restoring impacted, low quality, and inundated wetlands is ecologically beneficial and can reduce the costs of water treatment, flood management, and pollution control by providing those services naturally.

13.1) Wetland Restoration/Enhancement Analysis Criteria

Table 36 is an overview of the specific criteria and possible points that were used to evaluate each parcel. Each parcel's total score was used to determine those that are of high (12-18 points), medium (6-11 points), and low (0-5 points) priority for wetland restoration/enhancement (Figure 14). These ranges were chosen based on the total available points and the highest scores parcels achieved from this analysis. For a detailed overview of the criteria and scoring, refer to Appendix D.

Table 36. Criteria and Ranking System for Wetland Restoration/Enhancement

Criteria	Ranking	Points	Total Possible Points per Category
Restorable Wetlands (prerequisite for further analysis)	Wetlands with special modifiers (excavated, spoil, artificial substrate, diked/impounded, managed, farmed, partially drained/ditched, beaver)	2	4
	Historic Wetlands	2	
Current Water Quality Impairments	Includes, Adjacent to, or Upstream of Existing Impairments	3	3
Current Pollutant Export (for each Nitrogen, Phosphorus, and Sediment)	High Range of Export	3	9 (3-point maximum for each pollutant)
	Medium Range of Export	2	
Water Impoundments and Dams	Low, Medium, and High Hazard Dams	2	2
TOTAL POSSIBLE WETLAND POINTS PER PARCEL			**18**

[83] (United States Environmental Protection Agency (EPA), 2020)

13.2) Wetland Restoration/Enhancement Analysis Results and Recommendations

Based on this analysis, no parcels scored within the high priority range for wetland restoration/enhancement. The highest score, achieved by 9 parcels, is 11. A total of 25 parcels scored 10-11 points, which are the parcels that LKSWPT recommends focusing on first (Figure 15). These parcels are distributed throughout the focus area, but two larger concentrations can be seen along Knox Creek near Tamassee, SC and Cedar Creek near SC-133. It is recommended to coordinate with developers and local or state governments in need of wetlands mitigation credits to provide funding to restore these wetland areas. Additionally, as mentioned in the 2018 Cane Creek WBP, sedimentation issues at Sertoma Park should be addressed and is an ideal candidate for wetland restoration practices.

Example of a Wetland Restoration Project

(*Source: CEEweb for Biodiversity*)

Figure 14. Parcel Prioritization for Wetland Restoration/Enhancement

Figure 14: Parcel Prioritization for Wetland Restoration/Enhancement

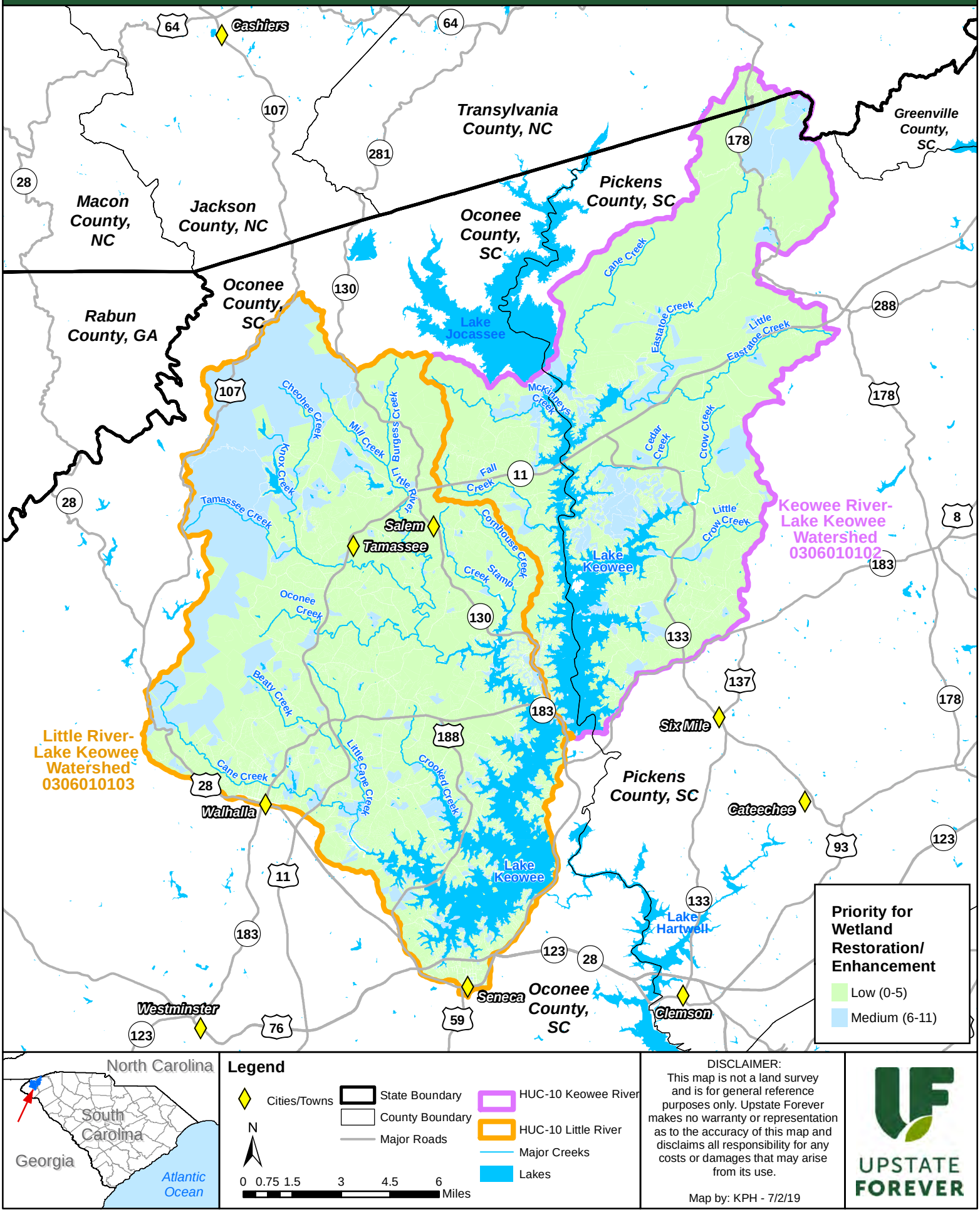

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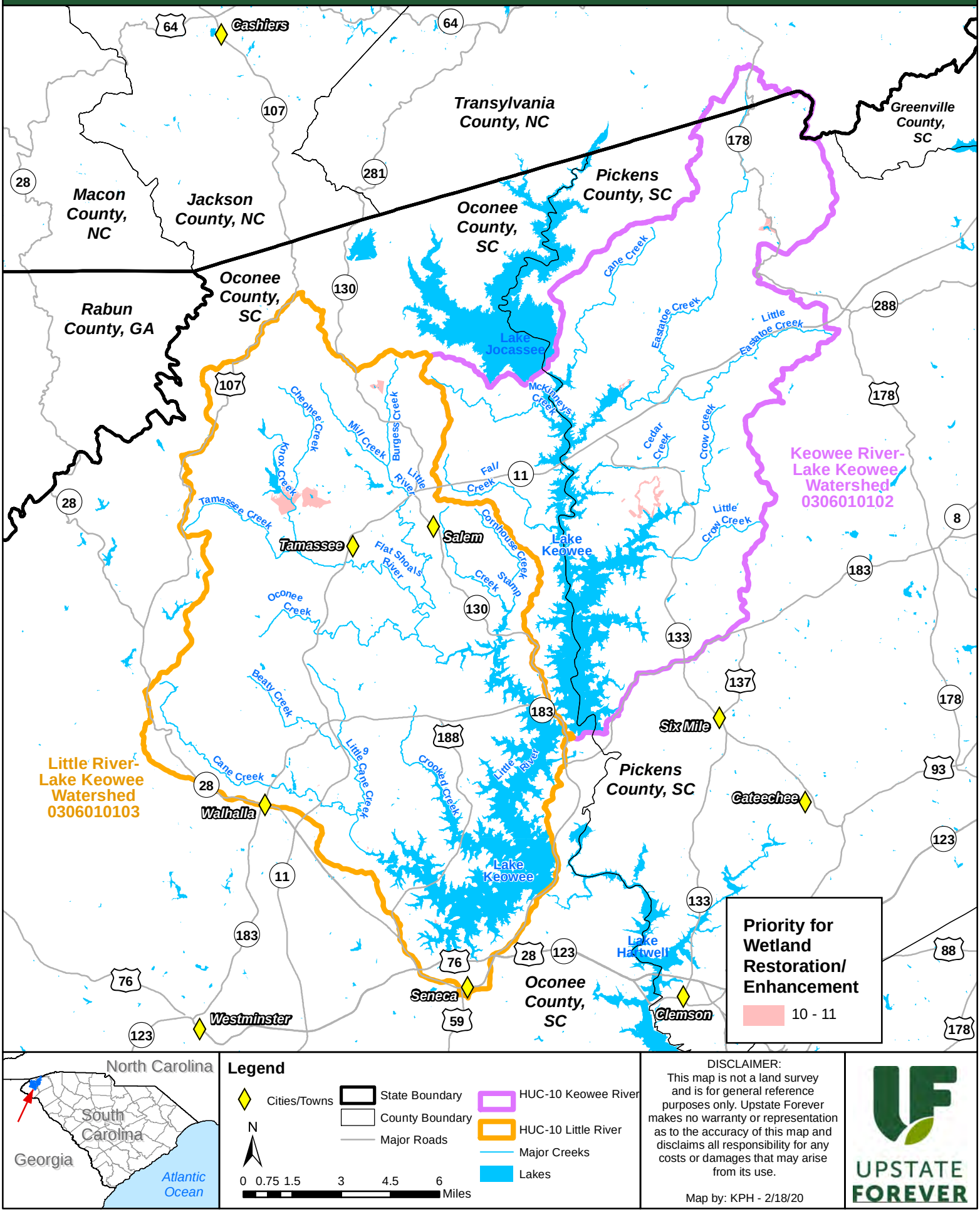
Figure 15. High Priority Parcels for Wetland Restoration/Enhancement



14) Analyzing Parcels for Riparian Buffer Restoration or Enhancement

This analysis identifies parcels that are high priority for riparian buffer restoration/enhancements with the end goal of improving current riparian buffer areas, increasing vegetation coverage, and adding riparian buffers to sensitive areas. The South Carolina Department of Natural Resources (SCDNR) recommends the establishment and maintenance of a riparian buffer as the single most important BMP for the protection of stream and river resources.[84] Riparian buffers provide many ecological benefits such as erosion and nonpoint source pollution control and filtration, wildlife habitat, streambank stabilization, and groundwater recharge.[85] While the necessary width of a buffer to provide such ecosystem, services depends on a number of factors, wider riparian buffers provide more benefits.[86] Increasing the coverage of riparian buffers, especially along impaired or sensitive streams, can reduce water treatment costs, help mitigate future impairments, and assist with erosion and flood control. For the protection of water quality, a minimum buffer width of 40 to 80 feet, bordering each side of the stream or lake is recommended, and is dependent on slope.[87] For the protection of wildlife habitat and scenic value, the SC Scenic Rivers Program, managed by SCDNR, strongly advocates a minimum buffer of 100 feet bordering each side of water bodies.[88]

14.1) Riparian Buffer Restoration/Enhancement Analysis Criteria

Table 37 is an overview of the specific criteria and points possible that were used to evaluate each parcel. Each parcel's total score was used to determine those that are of high (18-26 points), medium (9-17 points), and low (0-8 points) priority for riparian buffer restoration/enhancement (Figure 16). For a detailed overview of the criteria and scoring, refer to Appendix D.

[84] (South Carolina Department of Natural Resources (SCDNR), 2015)
[85] (Pennsylvania Land Trust Association, 2014)
[86] (Pennsylvania Land Trust Association, 2014)
[87] (South Carolina Department of Natural Resources (SCDNR), 2015)
[88] (State of South Carolina Code of Laws)

Table 37. Criteria and Ranking System for Riparian Buffer Restoration/Enhancement

Category	Criteria	Points	Total Possible Points per Category
Highly Sensitive Riparian Buffer Areas (prerequisite for further analysis)	Within/adjacent to the highly sensitive riparian buffer areas layer	4	4
Stream Order	First and Second Order Streams	4	4
Adjacency to Drinking Water Reservoirs or Intakes	Adjacent to Drinking Water Reservoirs or Intakes	4	4
	Adjacent to Waterways	2	
Current Water Quality Impairments	Include, Adjacent to, or Upstream of Existing Impairments	3	3
Current Pollutant Export (for each Nitrogen, Phosphorus, and Sediment)	High Range of Export	3	9 (3-point maximum for each pollutant)
	Medium Range of Export	2	
100-Year Floodplain	Within/adjacent to 100-year floodplain	2	2
TOTAL POSSIBLE BUFFER POINTS PER PARCEL			**26**

14.2) Riparian Buffer Restoration/Enhancement Analysis Results and Recommendations

This riparian buffer parcel analysis identified 184 parcels as high priority for riparian buffer restoration/enhancement (Figure 16). To further refine high priority results, parcels within urban floodplain areas were removed; these parcels are more likely to benefit from stormwater management solutions (Section 17). Of the remaining 165 high priority parcels, 18 parcels scored 20-22 points with the highest achieved score of 22 points by one parcel (Figure 17). Concentrations of high priority parcels are located along the northern rim of already protected lands and at the headwaters of several streams including Cane Creek, Oconee Creek, Cheohee and Knox Creeks, Burgess Creek, as well as along Eastatoe and Little Eastatoe Creek(s). LKSWPT recommends focusing the riparian buffer strategies listed in Section 14.3 on high priority parcels within the focus area.

14.3) Riparian Buffer Restoration/Enhancement Strategies

The following are recommendations for riparian buffer restoration and/or enhancement strategies for the Lake Keowee Watersheds.

14.3.1) Ensure Compliance with Lake Keowee's Shoreline Management Plan

As detailed in Section 16.2, the Duke Energy Carolinas, LLC, which owns and manages Lake Keowee, developed the *Lake Keowee Toxaway Shoreline Management Plan (SMP)*[89] in 2007 as a part of the Federal Energy Regulatory Commission (FERC) Keowee Toxaway Relicensing Agreement. This SMP is thorough and outlines specific use requirements, referring to shoreline

[89] (Duke Energy Carolinas, LLC, 2014)

as according to the SMP, the "Project Boundary for Lake Keowee varies from 800 feet Above Mean Sea Level (AMSL) to 810 feet AMSL, except around project access areas, dams, saddle dikes, and the powerhouse where it follows a metes and bounds description".[90] LKSWPT recommends, where possible, maintaining natural vegetation within the buffer zone up to 810 feet. AMSL, as detailed in the Shoreline Management Guidelines document[91] within the SMP. See Section 16.2 for additional information and recommendations. Additionally, a source water protection area width of 1,500 buffer feet has been designated for the entirety of Lake Keowee to provide extra protection to these important drinking water sources.

14.3.2) City/County Riparian Buffer Ordinances

The most cost-effective way to ensure long-term health of riparian buffers is to work with local governments to adopt land use regulations to establish required riparian buffer zones and to limit activities allowed within riparian buffers. Local governments should develop buffer management plans to coordinate efforts between utilities, industries, and private and commercial landowners within the watershed. Successful plans would consider the implementation of appropriate recommendations of various state and federal agencies on riparian buffer management.

A statewide task force on riparian buffers, convened in 2000 at the University of South Carolina, agreed on a recommended minimum buffer width of 35 feet of native vegetation on each side to protect water quality.[92] LKSWPT recommends developing buffer management plans to include the implementation of buffer widths that meet or exceed the minimum width of 35 feet, restoration programs, considerations of current and future land use, and public education.

A city ordinance is an effective approach to addressing protections for waterways and riparian areas. Possible outcomes include preventing clear-cutting to a waterway's edge, protecting the natural canopy, improving stormwater management in highly urban areas, and providing long-term water quality protection. The EPA has provided technical guidance and examples of successful aquatic buffer ordinances throughout the US.[93] The guidance states that effective buffer ordinances provide guidelines for buffer creation and maintenance, and should require:

- Buffer boundaries to be clearly marked on local planning maps;
- Language that restricts disturbance of vegetation and soil;
- Tables that illustrate buffer width adjustment by slope and type of waterway, and
- Direction on allowable uses and public education.

In nearby Greenville County, a recent study showed a significant loss in riparian buffers from the years 2001 – 2011 along the main stem of the Reedy River.[94] Spurred by these findings and the

[90] (Duke Energy Carolinas, LLC, 2014)
[91] (Duke Energy Carolinas, LLC, 2014)
[92] (University of South Carolina, 2000)
[93] (United States Environmental Protection Agency (EPA), 2019)
[94] (Greenville County, South Carolina, 2017)

well understood water quality benefits provided by buffers, Greenville County staff drafted a buffer ordinance, currently proposed as a 50-foot total buffer zone for streams with drainage areas <50 acres, and a 100-foot total buffer zone for streams with drainage areas >50 acres. As development increases Oconee and Pickens Counties could consider the creation of a buffer ordinance for their respective counties, to provide additional protection to waterbodies

14.3.3) Restoration/Enhancement

Land adjacent to waterways and wetlands can be restored to their natural vegetated state by stabilizing banks, planting native vegetation with appropriate density, and ensuring proper maintenance. Potential partners for restoration projects may include developers in need of stream or wetland mitigation, and landowners interested in protecting or improving their property.

Example of a Riparian Buffer Restoration in Hunnicutt Creek, Clemson University – Channelized Stream Overrun With Invasive Species,, During Construction, After Restoration (Source: Clemson University)

14.3.4) Tree Giveaways

Voluntary participation programs such as tree giveaways are an efficient public education and community involvement tool that can also benefit water quality. Programs like this can be targeted to specific areas, such as the Lake Keowee watersheds, and can be used to encourage landowners to plant trees near streams/shorelines, which will in turn provide water quality and riparian buffer benefits (e.g., streambank stabilization, additional shade/vegetative cover, and erosion control). Trees Upstate is a local nonprofit organization based in Greenville, SC, in collaboration with Duke Energy, hosts tree giveaways throughout the year to promote tree planting across the region.

Tree Giveaways (Source: Trees Upstate)

14.4) Riparian Buffer Enhancement/Restoration Costs Estimates and Funding Options

Riparian buffer enhancement/restoration cost estimates are based on information provided by the USDA.[95] There are numerous cost share programs available to landowners at the federal, state, and local level. The USDA, including the NRCS and FSA, implements many voluntary programs that help reduce bacteria loading by establishing riparian buffers, protecting wetlands, and conserving water resources. Based on 2020 NRCS rates, it costs an estimated $404.71/acre for riparian buffer restoration/enhancement projects.

Table 38. Riparian Buffer BMP Unit Costs[96]

Riparian Buffer BMP Unit	Estimated Cost Per Unit (2020 NRCS Rates)
Tree/Shrub Site Preparation	$190.85/acre
Tree/Shrub Establishment	$213.85/acre
Total	**$404.71**

14.4.1) Environmental Quality Incentive Program (EQIP)

The NRCS EQIP program promotes agricultural production while maintaining or improving environmental quality. Typically, up to a 75 % cost-share assistance is offered for project costs

[95] (United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS), 2020)
[96] (United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS), 2020)

and forgone income. Historically underserved farmers can receive up to a 90 % cost share. The specific priorities to be addressed on the property are:

- Improvement of water quality in impaired waterways;
- Conservation of ground and surface water resources;
- Improvement of air quality;
- Reduction of soil erosion and sedimentation; and
- Improvement or creation of wildlife habitat for at-risk species.

14.4.2) Agricultural Water Enhancement Program (AWEP)

Within EQIP, AWEP provides additional funding to NRCS offices to provide technical and financial assistance to agricultural producers to implement water enhancement activities on agricultural land to conserve surface and groundwater and improve water quality. Examples of previously funded projects include high efficiency irrigation systems, nutrient and pest management plans, and agricultural BMPs.

14.4.3) Section 319 Funding

The EPA provides annual funding to SCDHEC for projects that reduce or prevent nonpoint source water pollution by implementing an approved WBP. SCDHEC distributes these Section 319 funds through grants that will pay up to 60% of eligible project costs, with a 40% non-federal match generally provided by the landowner.

14.4.5) Partners for Fish and Wildlife Program

The US FWS sponsors the Partners for Fish and Wildlife Program, which provides technical and financial assistance to conserve or restore native ecosystems. Cost share is determined by multiple factors including: project location, type of habitat being restored, and species that will benefit.[97] This voluntary program primarily involves streambank fencing, tree-planting, and invasive species control. Projects on private lands must improve the habitat of Federal Trust species (i.e., migratory birds, threatened and endangered species, inter-jurisdictional fish, certain marine mammals, and species of international concern) for the principal benefit of the Federal Government. Program projects must be biologically sound, cost effective, and must include the most effective techniques based on state-of-the-art methodologies and adaptive management. These agreements are usually for a period of 10 years or more.

[97] (U.S. Fish and Wildlife Service (USFWS), 2020)

Figure 16: Parcel Prioritization for Riparian Buffer Restoration/Enhancement

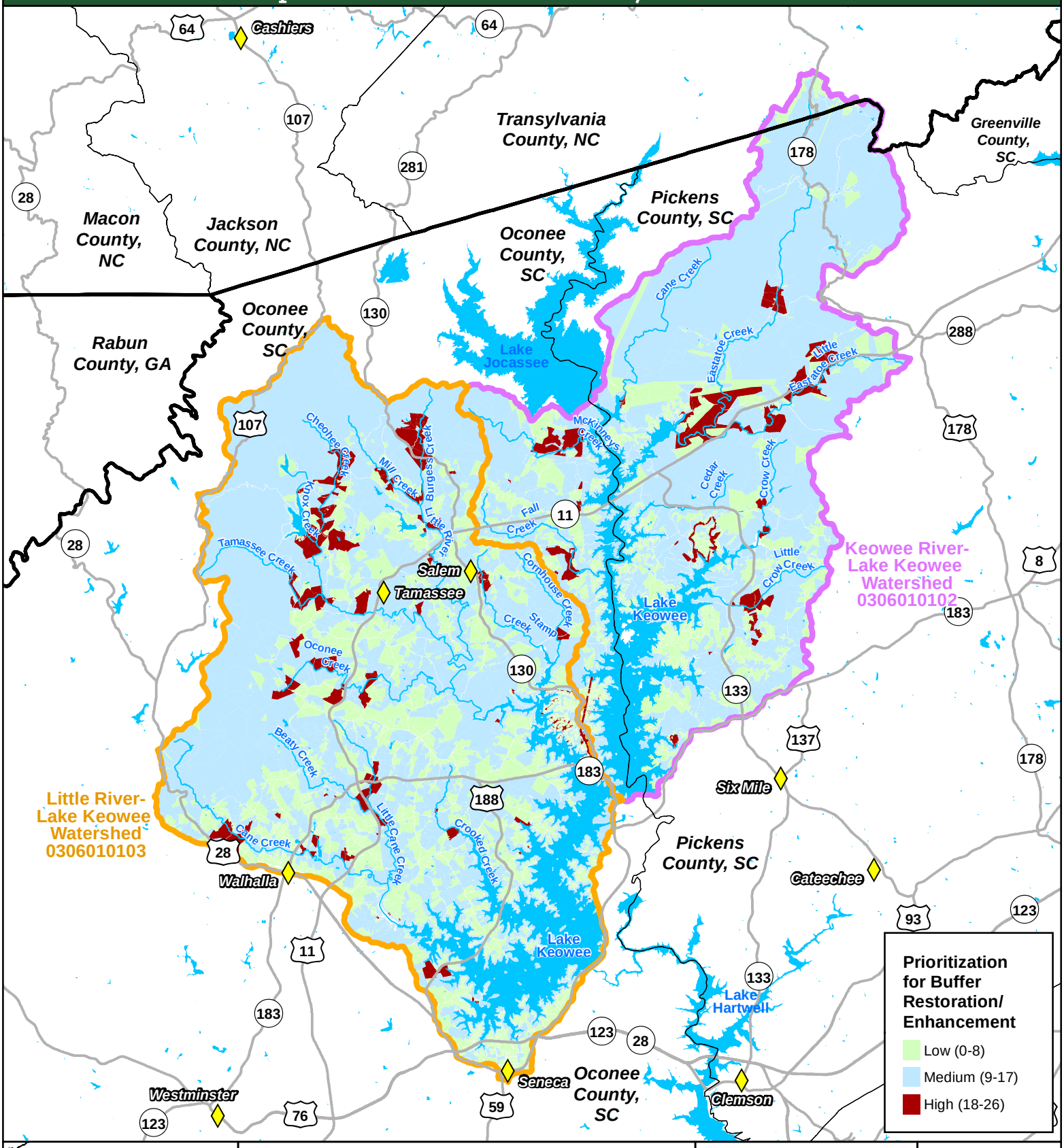


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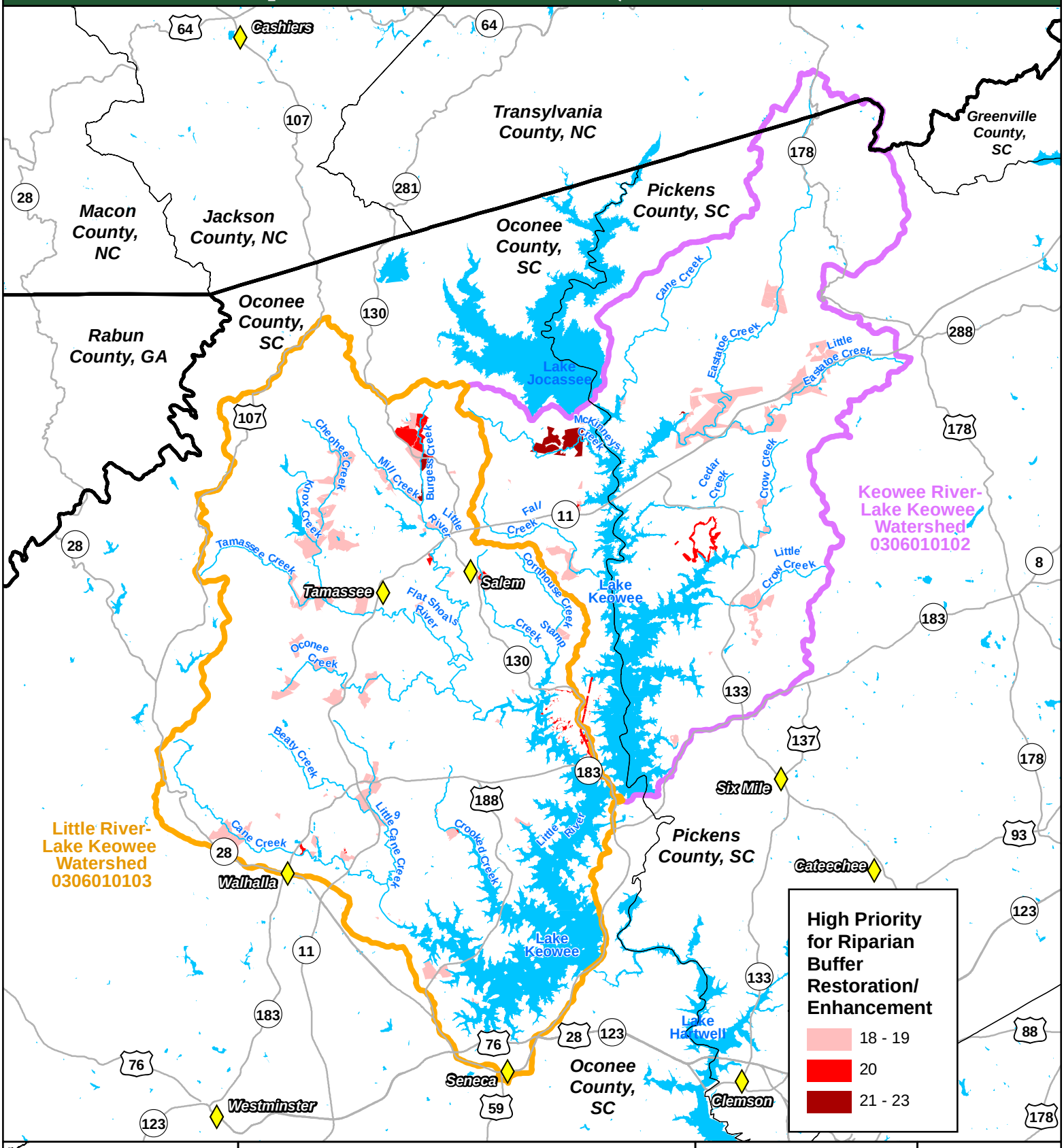
Figure 17. High Priority Parcels for Riparian Buffer Restoration/Enhancement



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15) Analyzing Parcels for Voluntary Dam Removal

This analysis identifies parcels containing dams that may be suitable for voluntary removal, at the property owner's discretion and approval if the owner is no longer receiving enough benefits to outweigh the liability and maintenance responsibilities. Voluntary dam removals would prevent the possibility of future dam breaches and restore natural flows to rivers and streams.

15.1) Voluntary Dam Removal Analysis Criteria

Table 39 is an overview of the specific criteria and possible points that were used to evaluate each parcel. Each parcel's total score was used to determine those that are of high (5 points), medium (2 points), and low/no (0 points) priority for dam removal (Figure 18). For a detailed overview of the criteria and scoring, refer to Appendix D.

Table 39. Criteria and Ranking System for Voluntary Dam Removal

Category	Criteria	Points	Total Possible Points per Category
Water Impoundments and Dams (prerequisite for further analysis)	Low, Medium, and High Hazard Dams	2	2
Current Water Quality Impairments	Includes, Adjacent to, or Upstream of Existing Impairments	3	3
TOTAL POSSIBLE VOLUNTARY DAM REMOVAL POINTS			**5**

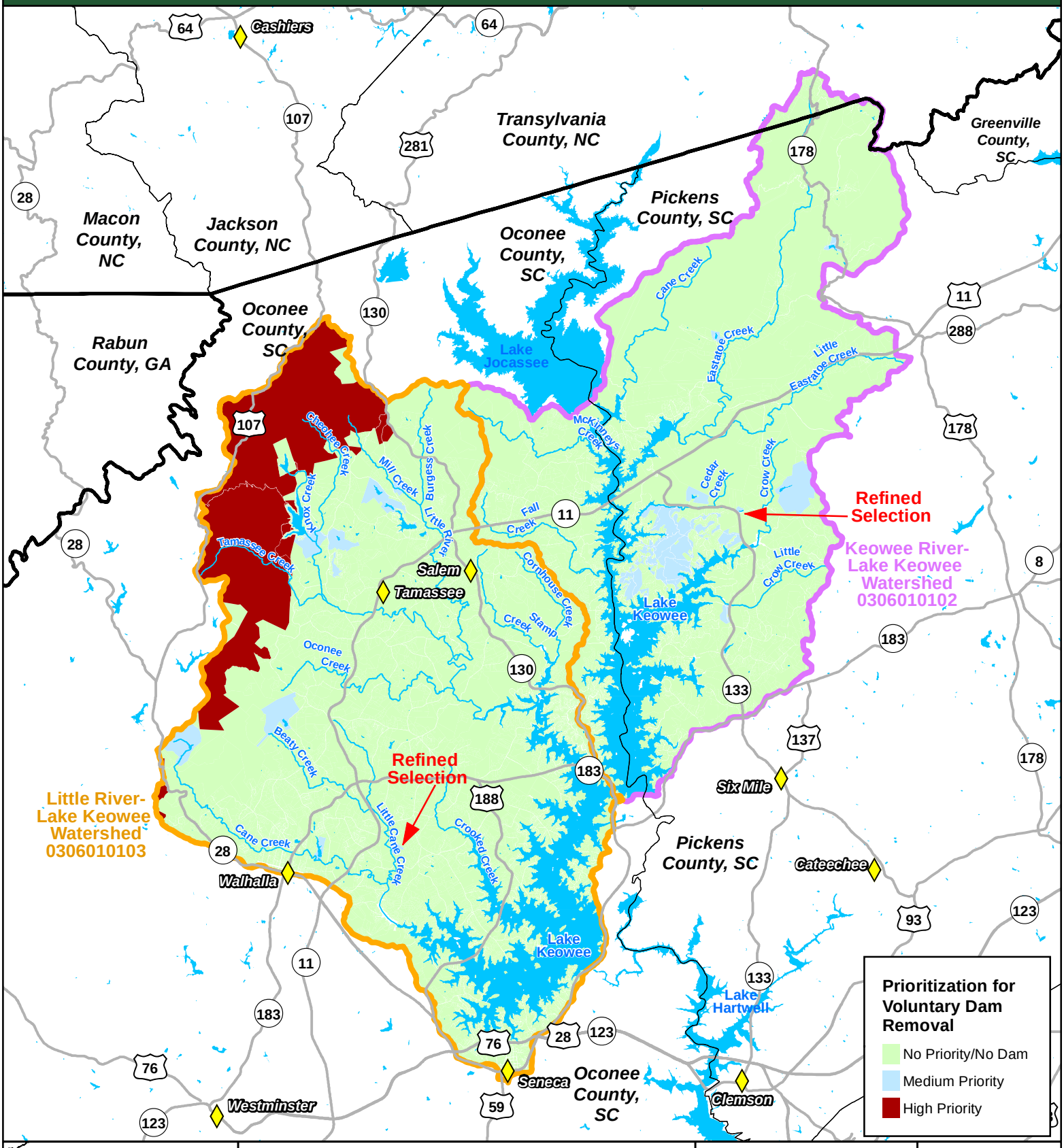
15.2) Voluntary Dam Removal Analysis Results, Recommendations and Funding Sources

This analysis identified only one parcel as high priority and 25 parcels as medium priority for exploring if the landowner would be interested in a voluntary dam removal. To identify parcels including dams with higher probability of successful removal, parcels of high and medium priority that meet the following qualifications were selected for further analysis:

1. Agricultural land use; or
2. Dams on small ponds (impounding less than 50 acres of water); or
3. Parcels were REMOVED if: Dam located in large subdivisions, residential neighborhoods, gated communities, or with obvious recreational usage such as a golf course or boating.

The refined results identified only two parcels that LKSWPT recommends for further evaluation for potential voluntary dam removal (Figure 18), given landowner approval. Both are medium priority; one is an unclassified farm and the other is classified as vacant land. If a dam on agricultural land is providing water to livestock, LKSWPT recommends coordinating EQIP or Section 319 funding to fence cattle out of streams and install an alternate water source to improve water quality.

Figure 18: Parcel Prioritization for Voluntary Dam Removal



16) Analyzing Parcels for Shoreline Management

This analysis identifies parcels adjacent to drinking water reservoirs or intakes that are high priority for Shoreline Management BMPs, with the end goal of reducing pollutants directly entering drinking water sources. Properties adjoining drinking water reservoirs have the potential to directly impact water quality above the intake, with little opportunity for settling or filtration. Proper management of these properties can help to ensure the safety of the drinking water supplies. Managed properly, shoreline parcels have the ability to slow stormwater runoff, protect against streambank erosion, filter pollutants, and help control flooding. Because many drinking water sources are used recreationally and are surrounded by private landowners, encouraging certain management strategies can help to reduce the cost of water treatment and prevent pollutants from directly entering a drinking water reservoir before an intake facility.

16.1) Shoreline Management Analysis Criteria

Table 40 is an overview of the specific criteria and possible points used to evaluate each parcel. Each parcel's total score was used to determine those that are of high (14-20 points), medium (7-13 points), and low (0-6 points) priority for Shoreline Management (Figure 19). For a detailed overview of the criteria and scoring, refer to Appendix D.

Table 40. Criteria and Ranking System for Shoreline Management

Category	Criteria	Points	Total Possible Points per Category
Adjacency to Drinking Water Reservoirs or Intakes (prerequisite for further analysis)	Adjacent to Drinking Water Reservoirs or Intakes	4	4
Current Pollutant Export (for each Nitrogen, Phosphorus, and Sediment)	High Range of Export	3	9 (3-point maximum for each pollutant)
	Medium Range of Export	2	
Highly Sensitive Riparian Buffer Areas	Within/adjacent to the highly sensitive riparian buffer areas layer	4	4
Private Boat Ramps or Docks	Private Boat Ramps	2	3
	Private Docks	1	
TOTAL POSSIBLE SHORELINE MANAGEMENT POINTS			**20**

16.2) Shoreline Management Analysis Results and Recommendations

There are nearly 7,100 parcels along the shoreline of Lake Keowee; this analysis identified 1,517 parcels as high priority, approximately 21.4% of all shoreline parcels (Figure 20 and 21).

16.2.1) Ensure Compliance with Lake Keowee Shoreline Management Plan

LKSWPT recommends ensuring full compliance with the requirements detailed in the SMP, outlined in Sections 14.2.

16.2.2) Restore Lawns along Shorelines

Maintaining/improving natural riparian vegetation along the shorelines of drinking water reservoirs is of utmost importance, especially on source waters. LKSWPT encourages maintaining natural buffers along shorelines by discouraging landowners from mowing lawns down to the shoreline and encouraging the planting natural [native] vegetation. According to the SMP, the "Project Boundary for Lake Keowee varies from 800 feet AMSL to 810 feet AMSL, except around Project Access Areas, dams, saddle dikes, and the powerhouse where it follows a metes and bounds description".[98] LKSWPT recommends, where possible, maintaining natural [native] vegetation within the buffer zone up to 810 feet AMSL, as detailed in the Shoreline Management Guidelines document.

Lakefront Property with Vegetated Buffer vs. Eroded Shoreline
(Source: Upstream Waters Landscape; Clemson University)

16.2.4) Private Boat Dock Maintenance

LKSWPT recommends that the local drinking water utilities work with Duke Energy and shoreline landowners to ensure that private boat docks are well-maintained, free from contaminants, and in compliance with riparian buffer, encroachment, and land use requirements as outlined in the SMP.[99]

[98] (Duke Energy Carolinas, LLC, 2014)
[99] (Duke Energy Carolinas, LLC, 2014)

Figure 19: Parcel Prioritization for Shoreline Management

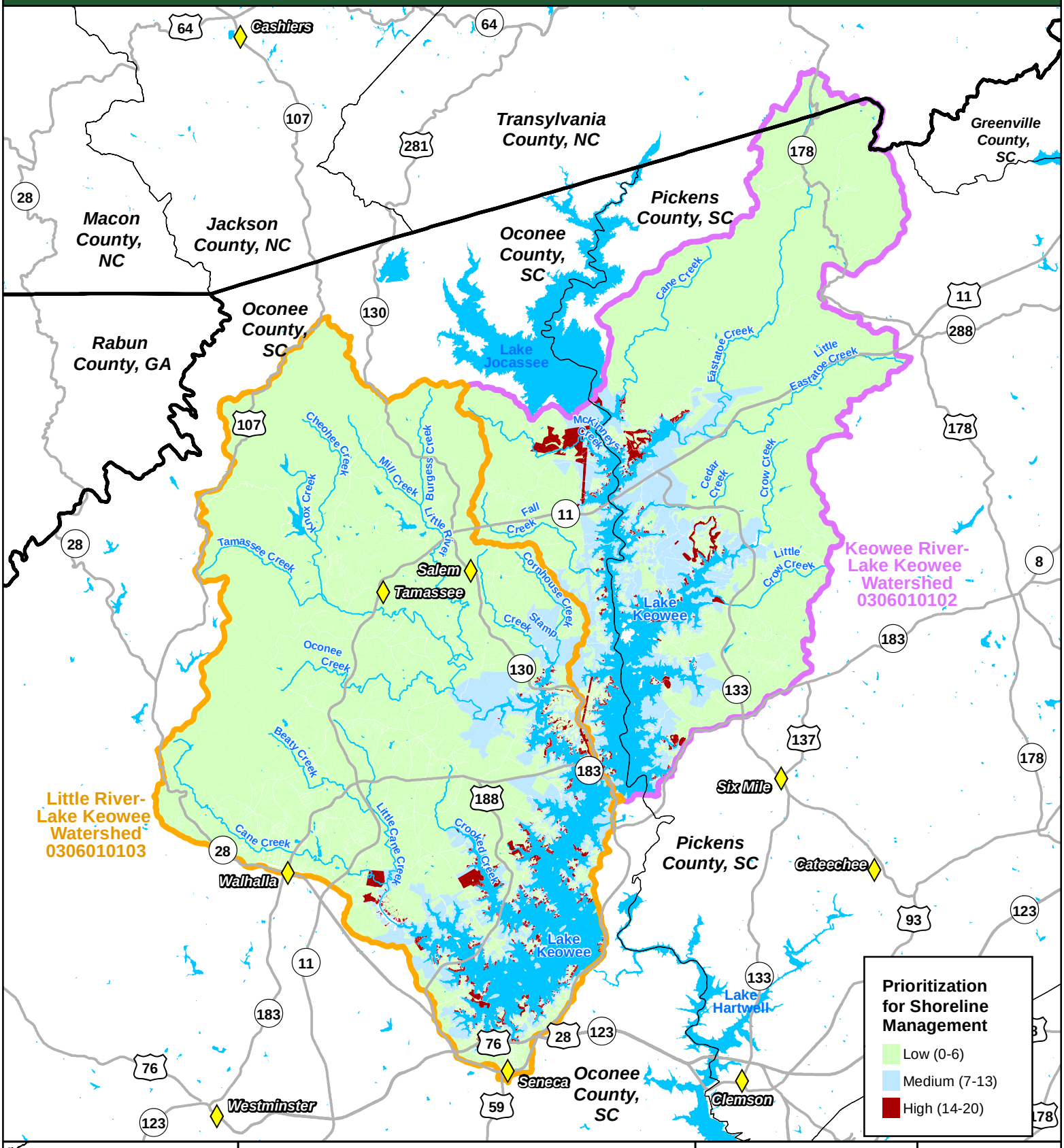


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Figure 20: High Priority Parcels for Shoreline Management

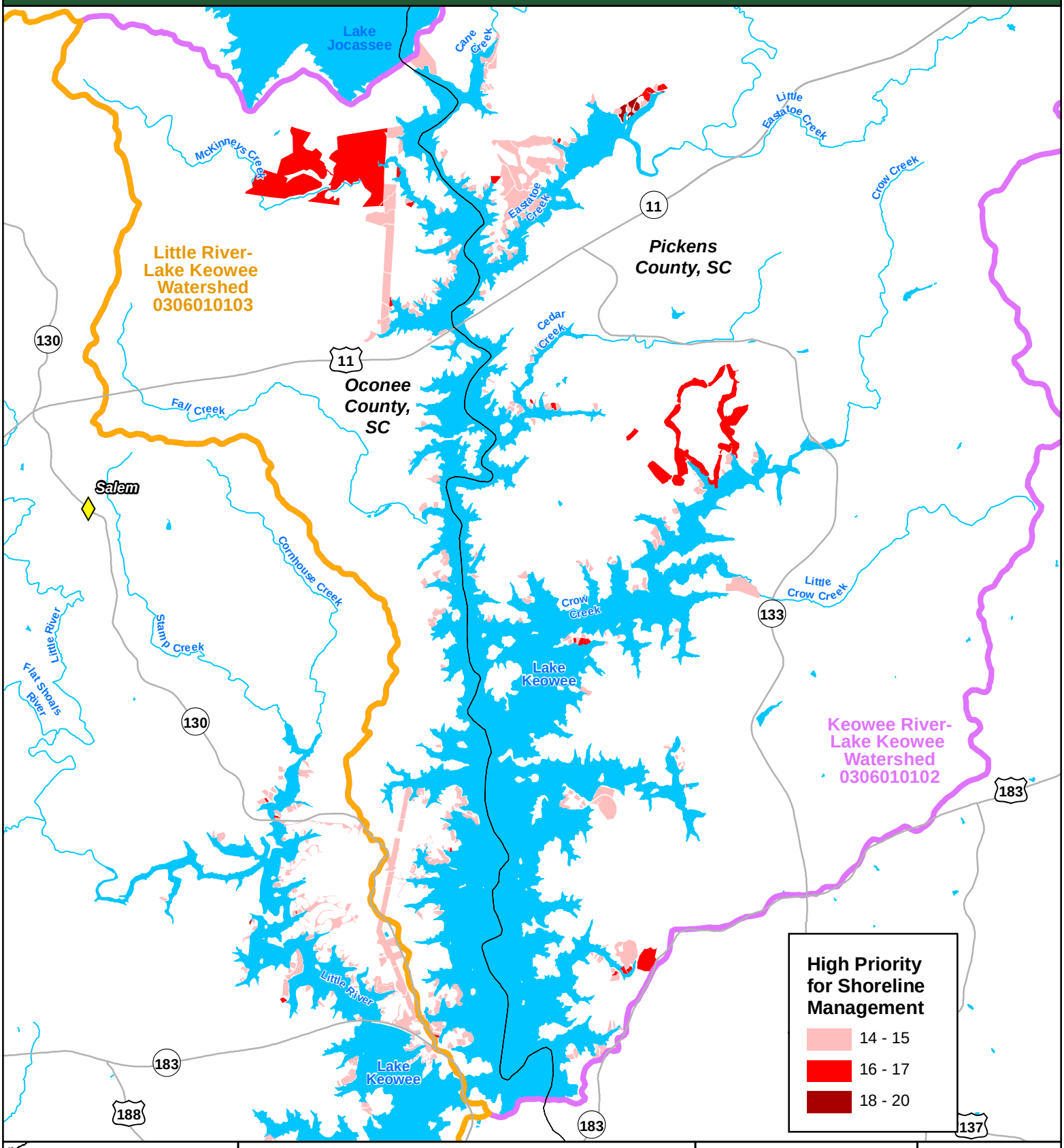

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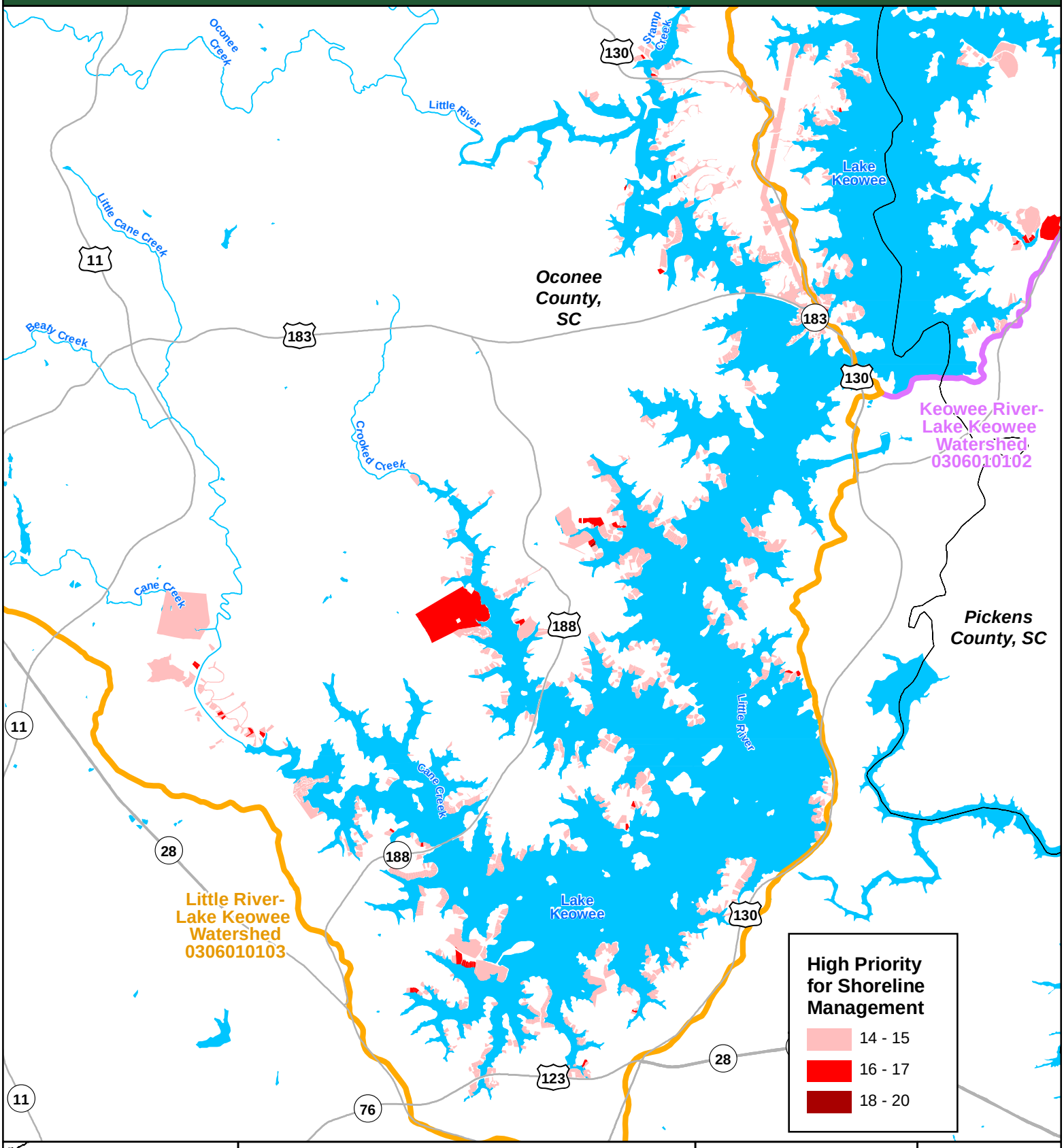
Figure 21: High Priority Parcels for Shoreline Management



Legend

Cities/Towns
State Boundary
County Boundary
Major Roads
HUC-10 Keowee River
HUC-10 Little River
Major Creeks
Lakes
N
0 0.275 0.55 1.1 1.65 2.2 Miles

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17) Analyzing Parcels for Stormwater BMPs

The Stormwater BMPs analysis identifies parcels within developed areas that may be appropriate for stormwater retrofits, a variety of practices that reduce stormwater runoff and pollutant loading into nearby waterways from existing developments. Urbanized areas, particularly those built prior to stormwater management requirements, are at an increased risk of negatively impacting nearby waterways due to the greater density of impervious surfaces. In the Lake Keowee watersheds, developed land comprises approximately 11.7 % of land use, with the majority of this development occurring along the Lake Keowee shoreline. As development continues in region stormwater runoff will increase, leading to impacts such as stream channelization, heightened erosion and flooded areas, and decreased groundwater recharge, all of which can degrade water quality.[100] The installation of lot-scale stormwater BMPs in both residential and public settings will help to mitigate the impacts of stormwater impairments waterways within the Lake Keowee watersheds and protect this important resource.

17.1) Stormwater BMP Analysis Criteria

Table 41 is an overview of the specific criteria and possible points that were used to evaluate individual parcels for stormwater improvements. Each parcel's total score was used to determine those that are of high (12-16 points), medium (6-11 points), and low (0-5 points) priority for Stormwater BMPs (Figure 22). For a detailed overview of the criteria and scoring, refer to Appendix D.

Table 41. Criteria and Ranking System for Stormwater BMPs

Category	Criteria	Points	Total Possible Points per Category
Land Cover (prerequisite for further analysis)	Urban/Developed Land	2	2
	Known Logging Operations	1	
Current Pollutant Export (for each Nitrogen, Phosphorus, and Sediment)	High Range of Export	3	9 (3-point maximum for each pollutant)
	Medium Range of Export	2	
Current Water Quality Impairments	Includes, Adjacent to, or Upstream of Existing Impairments	3	3
Unpermitted Point Source Pollutants	Unpermitted Point Source Pollutants	1	1
Permitted Point Source Pollutants	Permitted Point Source Pollutants	1	1
TOTAL POSSIBLE STORMWATER BMP POINTS			**16**

[100] (Clemson University Cooperative Extension)

17.2) Stormwater BMP Analysis Results, Recommendations, and Potential Funding Sources

This Stormwater BMPs analysis identified five parcels as high priority for installation of stormwater BMPs, all scoring 12 points and all along Burgess Creek. Nearly 40% of parcels were identified as medium priority. Parcels were removed from consideration if they contained agricultural land cover, which is assumed to be included under agricultural BMP considerations. LKSWPT recommends choosing 1-2 of the high priority sites for the installation of Stormwater BMPs serving as a demonstration site(s).

In addition, the results identified 6,108 parcels as high and medium priority (Figure 23). Stormwater management in the Lake Keowee watersheds is overseen by local governments. Currently, Pickens County operates under a SMS4 permit, a NPDES permit designed to protect rivers, lakes and streams from polluted stormwater runoff by managing stormwater discharges for small municipal systems. While Oconee County does not presently fall under SMS4 permit requirements, this is expected to change as populations continue to grow in the region. Therefore, in accordance with the Cane and Little Cane Creek Watershed Plan, the LKSWPT recommends that Oconee County hire a Watershed Planner or Stormwater Manager to help take a proactive approach to stormwater management in the county. This position would provide significant benefit to the region as they could work strengthen stormwater regulations across the county and ensure proper stormwater management, especially in areas of rapid development.

Stormwater pollution is considered the leading source of water pollution in the country, and the Lake Keowee watersheds are no exception. Fortunately, many general stormwater education and outreach efforts already exist that could offer significant benefit to communities within these watersheds. For example, stormwater education and outreach is a core component of Pickens County's SMS4 Permit. As a result, a partnership with the Anderson and Pickens County Stormwater Partners (APCSP), which is responsible for carrying out stormwater education in Pickens and Anderson Counties for the SMS4 permit, could play a key role in stormwater education and outreach in the Lake Keowee watersheds. The APCSP coordinates stormwater related educational programming through Clemson Extension's Carolina Clear program. Programs of specific interest include rain harvesting, planting native plants, rain gardens, pet waste disposal, shoreline management and SC AAS. The information and resources offered through APCSP would greatly benefit both residents, local governments, and utilities. Additionally, LKSWPT could engage the Oconee Soil and Water Conservation District for additional outreach related to natural resource protection in the Oconee County portion of the watershed. Together these groups will be instrumental in assisting with the execution of the stormwater education component of this plan in the Lake Keowee watersheds.

17.2.1) Section 319 Funding (SCDHEC)

The EPA provides annual funding to SCDHEC for projects that reduce or prevent nonpoint source water pollution by implementing an approved WBP. SCDHEC distributes these Section

319 funds through grants that may pay up to 60% of eligible project costs, with a 40% non-federal match. Projects both within and outside of MS4 boundaries are eligible, however it is recommended to contact SCDHEC in advance to confirm eligibility.

17.2.2) EPA Five Star Urban Waters Restoration Grants

The Five Star Urban Waters Restoration Program seeks to restore local natural resources through community-based conservation activities. Projects must be focused on water quality and habitat improvements and can include wetland, forest, riparian and coastal habitat restoration, stormwater management, and educational outreach and stewardship. Grant awards range from $10,000 to $40,000, with $20,000 as the average grant awarded.[101]

17.3) Stormwater BMPs Strategies

17.3.1) Stormwater BMPs

In areas built prior to stormwater control requirements, the installation of stormwater BMPs (e.g., pervious pavement, rain gardens, detention/retention ponds, and rain barrels) could provide a significant reduction in stormwater runoff and pollutants. While focusing on publicly owned parcels (e.g., schools, parks) or parcels upstream from known flooding problems may provide strategic water quality improvements, homeowners can also employ several of these techniques on their properties and help to mitigate nonpoint source pollution in the watershed. For example, Clemson Extension's Carolina Yards program provides homeowners the resources needed to design and maintain a watershed friendly landscape. By encouraging activities such as soil testing, planting of native vegetation, and rainwater harvesting residents are taught to maximize the ability of their landscape to capture and treat stormwater runoff on site.[102] This program would be particularly relevant for residents living along the Lake Keowee shoreline or along rivers and streams that feed into Lake Keowee.

[101] (United States Environmental Protection Agency (EPA), 2020)
[102] (Clemson Extension, 2020)

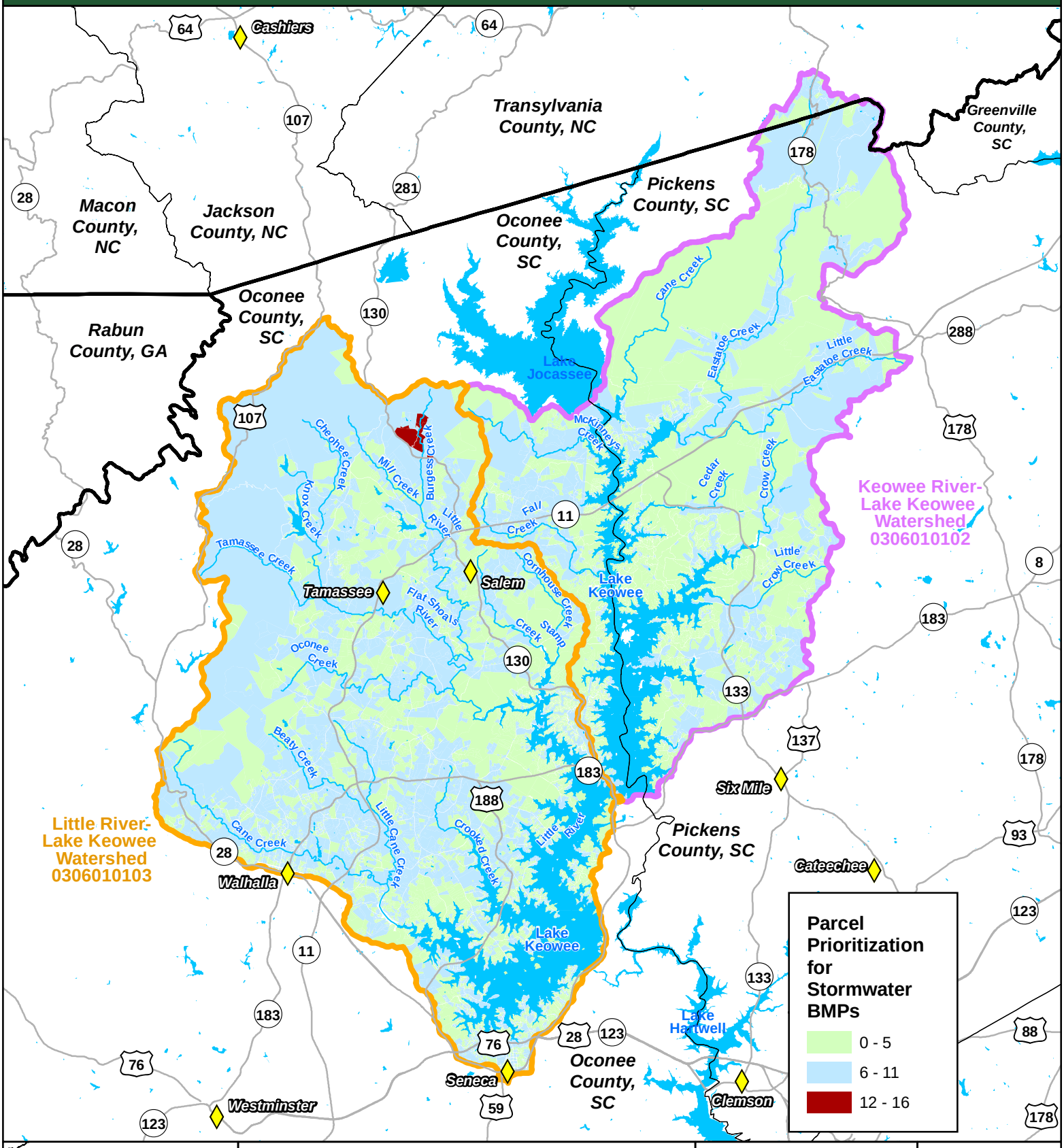
Examples of Carolina Yard program, Rain Barrel (Source: APCSP)

17.3.2) Stormwater BMP Retrofits

In areas built prior to stormwater water quality requirements, or where existing stormwater infrastructure is not sufficient to capture and treat stormwater runoff, stormwater BMP retrofits could be installed to improve stormwater management and protect water quality. For example, on publicly owned parcels (e.g., schools, libraries, and parks) there may be opportunities to install a variety of green infrastructure techniques such as pervious pavement, rain gardens, or rain barrels to slow down and treat runoff. The installation of green infrastructure practices in public settings and with proper signage, would provide excellent opportunities to teach local residents about a variety of stormwater management techniques while also delivering important water quality benefits. Additionally, in older residential neighborhoods, disconnecting downspouts from impervious surfaces, rain harvesting, and rain gardens would help to slow down and capture stormwater runoff on site, which will help to reduce downstream pollutant loading and channel incision.

Examples of pervious pavement and rain garden installed around stormwater inlet

Figure 22: Parcel Prioritization for Stormwater BMPs



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Map by: KPH - 2/18/20

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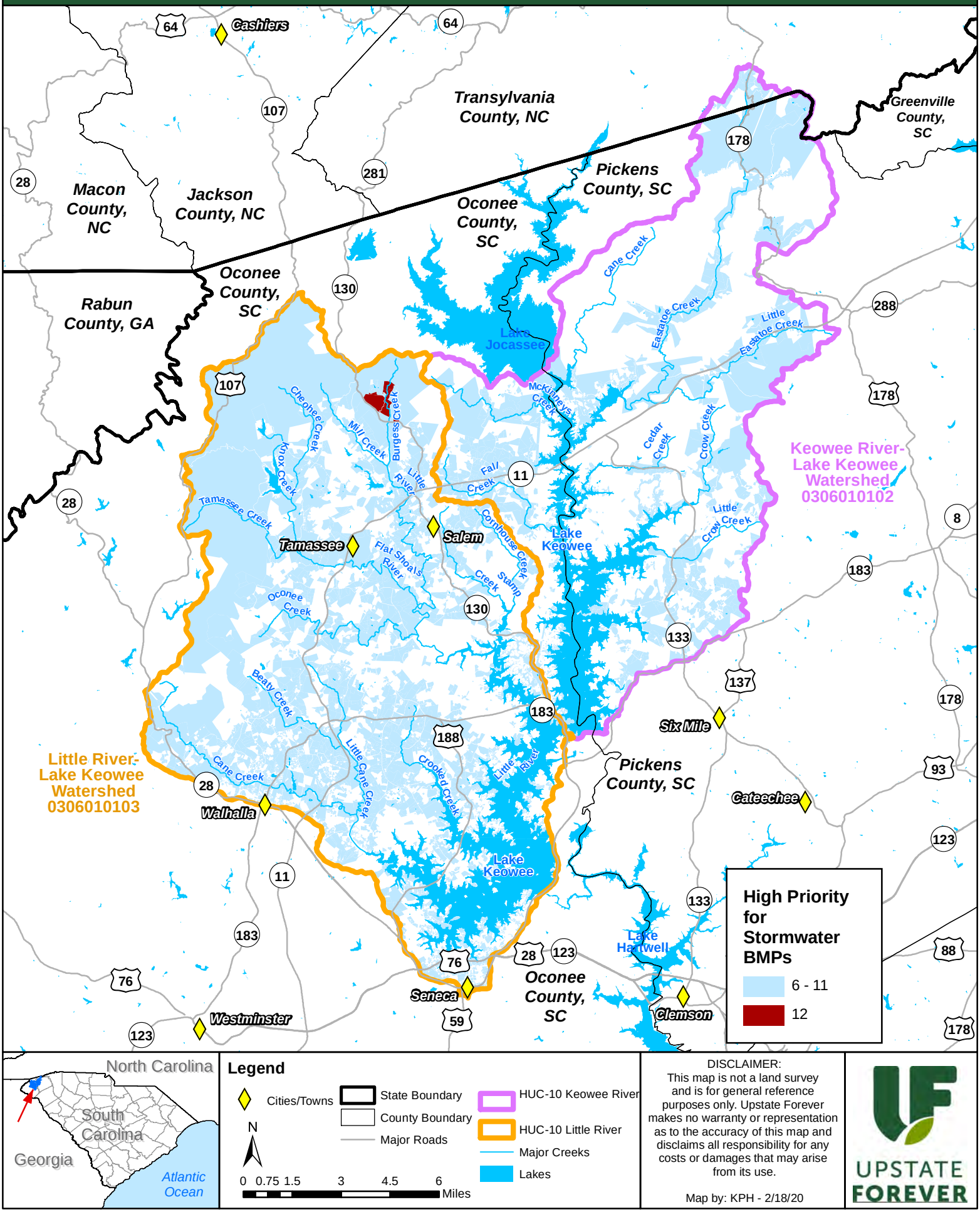
Figure 23: High Priority Parcels for Stormwater BMPs



18) Analyzing Parcels for Pet Waste Stations

This analysis identifies parcels that may be suitable for the installation of a pet waste station to encourage proper disposal of pet waste and reduce bacteria loadings from pets. Domestic pet waste is a threat to human health and water quality when not disposed of properly. Pet waste, which can contain harmful organisms such as bacteria, viruses, and parasites, is carried into nearby waterways during rain events. Based on the national averages for number of dog-owning homes, number of dogs per dog-owning household, and the approximate amount of waste each dog can produce annually, there are an estimated 7,711 dogs in the focus area producing a total of 2.12 million lbs. of waste each year (Section 4.1.2).

18.1) Pet Waste Station Analysis Criteria

Table 42 is an overview of the specific criteria and possible points that were used to evaluate each parcel. Each parcel's total score was used to determine those of high (1-2 points) and low (0 points) priority for pet waste station installations (Figure 24). No medium priority range was included for this analysis as most parcels scoring in this category will receive 1 point at most. For a detailed overview of the criteria and scoring, refer to Appendix D.

Table 42. Criteria and Ranking System for Pet Waste Stations

Category	Criteria	Points	Total Possible Points per Category
High Traffic Commercial Pet Locations	Locations that are likely to have increased dog traffic	1	1
Parks	Existing Public Land	1	1
TOTAL POSSIBLE PET WASTE POINTS			**2**

18.2) Pet Waste Station Analysis Results and Recommendations

Pet waste stations are a cost-effective way to educate people about an important threat to water quality and empower people to properly dispose of their pet's waste. The visibility of this outreach message at popular public locations will educate the general public about water quality and may lead to additional behavioral changes.

This analysis identified 14 parcels as high priority for installation of pet waste stations (Figure 24). These parcels include eight parks, four veterinary facilities, and two pet groomers/boarding facilities (Figure 24 and Appendix G). First priority should be the installation of pet waste stations at public parks, as they are most frequented by dogs and people. Public outreach campaigns on proper pet waste disposal through pet waste related businesses and veterinary offices will also be helpful to reduce this bacterial loading in the focus area.

Examples of a Pet Waste Station in Public Park

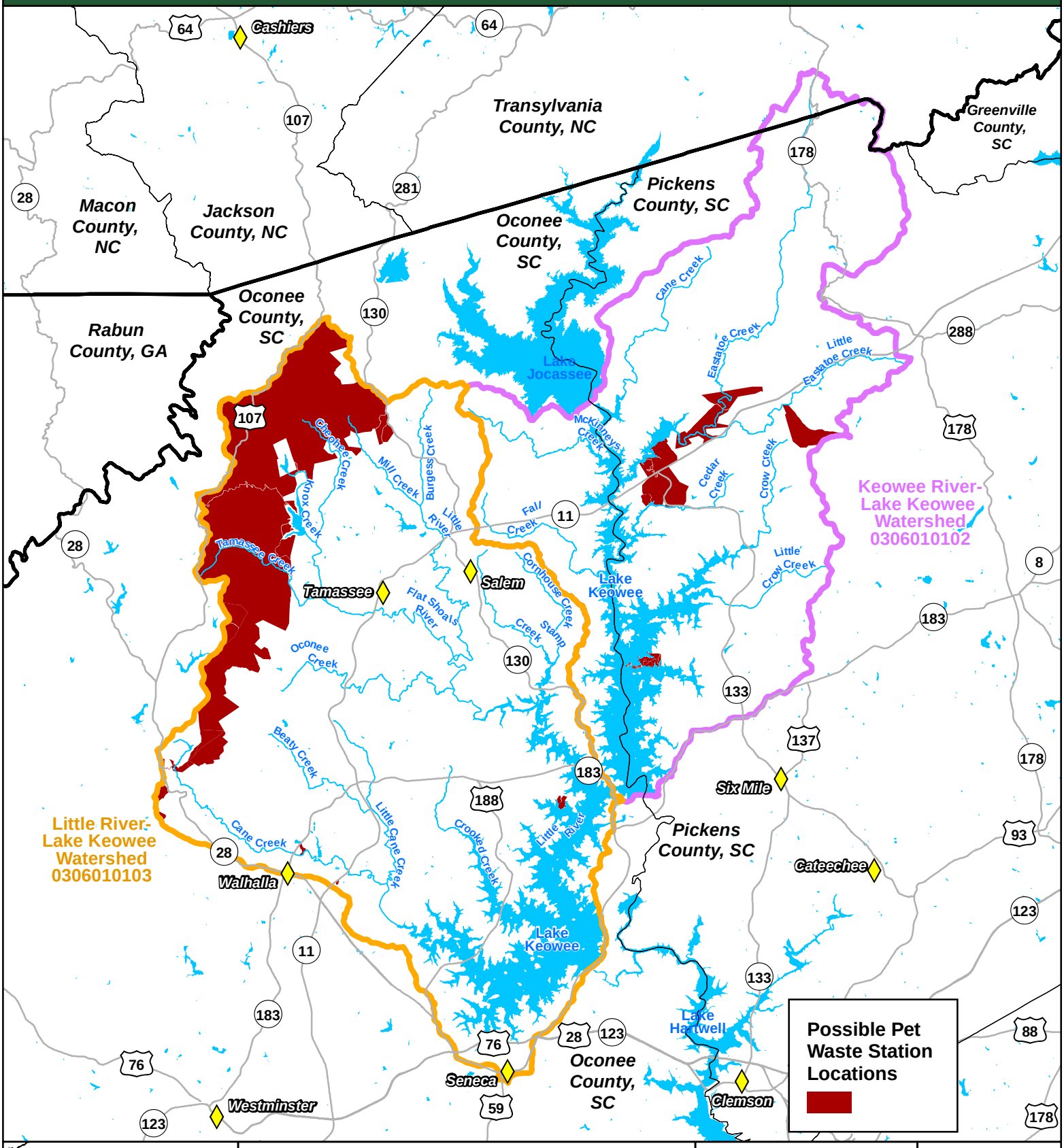
18.3) Pet Waste Station Unit Cost Estimates and Potential Funding Options

Cost estimates for urban BMPs are based on information provided by Greenville County and APCSP. Table 43 outlines funding options and cost estimates for pet waste BMPs.

Table 43. Pet Waste Station Unit Costs and Potential Funding Sources

Nonpoint Sources of Bacteria Pollution	BMP	Estimated BMP Unit Cost	Potential Funding Sources
Domestic Pets	Pet Waste Station	$225 each ($300 for installation with bags)	Oconee County SWCD Pickens County SWCD CU Extension Anderson Pickens Stormwater Partners Local Governments
	Pet Bags	$60/2,000	

Figure 24. High Priority Parcels for Pet Waste Station(s)



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19) Wildlife BMP Strategies

Wildlife populations can contribute to elevated levels of bacteria and sediment in the focus area, however, it can be difficult to track their populations. Therefore, it is recommended that the identification of nuisance populations and target areas be included in this public outreach campaign. For example, educating landowners on the signs of nuisance wildlife activity, such as rooting damage by feral hogs, will help to inventory locations of these wildlife populations. Once nuisance wildlife populations have been identified, the types and locations of BMPs can be prioritized accordingly.

19.1) Wildlife Management Recommendations

Many wildlife management strategies can help mitigate water quality pollutants from other sources as well. LKSWPT recommends advocating for the maintenance of natural riparian buffers, especially at parks and along shorelines, as outlined in Sections 14 and 16. Working with local governments to advocate for more stringent riparian buffer requirements is a crucial step towards reducing pollutants from many sources, including wildlife. Additionally, LKSWPT recommends working with partners such as APCSP to conduct public outreach about how to discourage the congregation of nuisance wildlife populations, especially near waterways.

19.2) Wildlife BMP Strategies

There are a variety of BMPs which can be effective in reducing the impacts of wildlife on water quality. For the Lake Keowee watersheds, it is recommended to utilize those wildlife BMPs that focus on reducing erosion and the direct contribution of fecal matter into waterways (e.g., riparian buffers, population management, and educational signage).

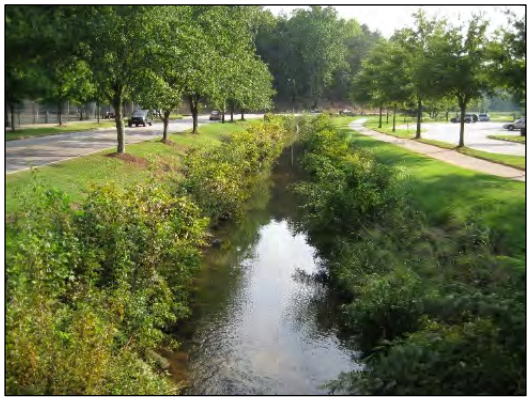
19.2.1) Public Outreach and Education

Working with partners in the region to educate the public on the impacts of nuisance wildlife species on water quality through workshops, website, social media, and print resources is an effective strategy for wildlife management. Print materials can be available for distribution in public locations (e.g., library, local government offices). Topics include safe and proper methods to reduce or eliminate problem species, the benefits of riparian buffers along waterways for discouraging wildlife congregation, and how to best manage fecal contamination in waterways from wildlife.

19.2.2) Riparian Buffers

Vegetated riparian barriers remove bacteria from runoff. Wild hogs tend to be attracted to heavily vegetated areas near streams, thus the effective management of a riparian buffer area would be necessary to ensure wildlife is not destructive to the buffers contributing to erosion. Buffers also discourage waterfowl (e.g., Canada geese) from congregating. Creating a buffer strip of tall thick vegetation will also deter geese from using this shoreline as they typically prefer gently rolling slopes with short vegetation at the water's edge, as it provides a clear line of

vision to avoid predators and provide them easy access to the water.[103] LKSWPT recommends focusing on the high priority sites as identified in Section 14.2, as well as the Lake Keowee shoreline as detailed in Section 16.2.




Riparian Buffer along Stream in Cleveland Park, Greenville, SC (left)
Geese along Mowed Portion of Riverbank in Falls Park, Greenville, SC (right)

19.2.3) Trapping

Trapping is a particularly effective management application in the control of feral hog populations. Trapping can include the harvest or consumption of wildlife, as it is illegal to remove a wild hog alive unless in accordance with a permit.[104] Box, swing, and corral traps are all effective tools used in the trapping of feral hogs. Trapping can also be effective with beaver populations. Wildlife control operators perform wildlife control services on a contract-fee basis and can be hired by landowners who do not wish to directly handle wild animals. Relocating feral hogs is not permitted.


Examples of Corral Traps for Feral Hogs

[103] (Indiana Department of Natural Resources (INDNR), 2018)
[104] (South Carolina Hunting & Fishing Regulations, 2020)

19.2.4) Hunting

Hunting is a common method used to control wildlife populations. Educating landowners and community members about hunting safety and training is a critical component. Out of season permits for species such as deer and feral hogs can be obtained through SCDNR if the populations become problematic in the watershed.[105] There is no closed season for hunting feral hogs on private lands.

19.2.5) No Feeding Wildlife Signage

Feeding wildlife often contributes to increases in nuisance species (e.g., waterfowl) and can contribute to the increase of bacteria in waterways. One way to reduce wildlife populations in these areas is to discourage people from feeding wildlife, especially in public parks through signage and other outreach materials. Clemson Extension's Carolina Clear program has information and signage residents can use to develop effective management strategies to deter Canada geese from settling along shorelines. Canada geese can produce up to two pounds of waste a day and this waste contains 25 times the amount of fecal material as human waste.[106] As geese populations increase in watersheds so do bacteria levels in waterways, which can pose a threat public to public health.

Example of Signage to Discourage Feeding Wildlife in Falls Park, Greenville, SC.

19.3) Wildlife BMP Unit Cost Estimates and Funding Options

Some wildlife BMPs are also mentioned as possible agricultural solutions and can be used to control both wildlife and livestock populations. Because of this, some of the funding sources for wildlife BMPs are also mentioned in the agricultural BMP section (12.4). BMP unit cost

[105] (South Carolina Department of Natural Resources (SCDNR), 2017)
[106] (Clemson Cooperative Extension Home & Garden Information Center, 2020)

estimates come from both the previously mentioned prices in the agricultural BMP section as well as estimates from NRCS. Table 44 provides an overview of wildlife BMP unit costs and possible sources of funding. The USDA, including NRCS and FSA, implements many voluntary programs that help reduce bacteria loading by establishing riparian buffers, protecting wetlands, and conserving water resources (Table 44).

Table 44. Wildlife BMP Unit Costs and Potential Funding Sources

Nonpoint Sources of Bacteria Pollution	BMP	Estimated BMP Unit Cost	Potential Funding Sources
Feral Hogs Beavers Deer Water Fowl Coyote	Linear Streambank Fencing	$2.65/foot	EQIP AWEP CSP County Governments USFWS Section 319 Funds
	Filter Strips	$149.04/acre	
	Riparian Buffers	$404.71/acre	
	Box, Swing, and Corral Traps	$320-460 each	Private Landowners

19.3.1) Section 319 Funding

The EPA provides annual funding to SCDHEC for projects that reduce or prevent nonpoint source water pollution by implementing an approved WBP. SCDHEC distributes these Section 319 funds through grants that will pay up to 60% of eligible project costs, with a 40% non-federal match generally provided by the landowner.

19.3.2) USDA NRCS

There are several voluntary NRCS programs that help reduce bacteria loading by establishing riparian buffers, protecting wetlands, and conserving water resources. Examples include CSP and EQIP. See Section 12.4 for more information on each of these federal cost share programs.

19.3.3) Community Participation

Community participation involves voluntary contributions, both monetary and in-kind, from watershed residents that can be used to meet match requirements for other grant funding source homeowners.

20) Forestry BMP Strategies

According to the SCFC, forests contribute over $21 billion annually to SC's economy and provide employment to over 84,000 SC citizens.[107] With over 64% of the Lake Keowee watersheds classified as forested land cover, forest management is a major consideration as it related to the protection of water quality. Nearly 65% of forested lands in the watersheds are privately owned, which accounts for nearly 45% of land cover overall (Figure 25). Healthy, well managed forests produce clean water; however, improper forest management has the potential to add significant loads of sediment and nutrients to nearby waterways. Fortunately, many resources are available for the proper management of both working and non-working forests.

Significant work has already been done to identify priority areas for forestry conservation and management. The Nature Conservancy (TNC) has published several reports that examine existing forests and their attributes as well as identifying key conservation cores and corridors. As shown in Figure 26, priority forested areas are delineated based on TNC's 2018 Conservation Vision report[108] and summarized below.

Forest Cores – 5,000-acre patches of contiguous forests that are of highest priority for conservation and protection.

Buffers and Restoration Areas – 10,000-acre patches of contiguous forests that are of highest, high, and medium priority for conservation and protection.

Additional Resilient Areas – Contiguous 5,000-acre patches of forests scoring >=1,000 on TNC's resilient lands that are not already captured in other classes.

20.1) Forestry Management Recommendations

LKSWPT recommends working with SCFC to communicate with forest managers to encourage the utilization of the SCFC's courtesy exams and suite of BMPs strategies and design. Utilizing TNC's Conservation Vision Areas (Figure 26), LKSWPT recommends first reaching out to foresters located within the Forest Core classified areas as they are identified as within the highest priority for land protection and conservation.

20.2) Forestry BMP Strategies

Forested watersheds are some of the most important watersheds to protect because of the significant water quality benefits they provide. Ensuring they are not contributing to additional pollutant loading is essential. To ensure water quality impacts are minimized, all silvicultural activities should be conducted in compliance with SC BMPs for Forestry, and compliance should be required in any written contract. For complete BMP recommendations please refer to the South Carolina Best Management Practices for Forestry Manual.[109] The strategies listed below

[107] (South Carolina Forestry Commission (SCFC), 2017)
[108] (The Nature Conservancy (TNC), 2018)
[109] (South Carolina Forestry Commission (SCFC), 1994)

can help to address sediment and nutrient concerns (especially during forestry operations), ensure forest health and regeneration, and provide economic benefit to foresters.

20.2.1) Prescribed Burning

As required by South Carolina Law, the South Carolina Forestry Commission must be notified prior to prescribed burning as precautions must be taken to prevent the fire's escape and manage the smoke to minimize negative impacts. Prescribed burning is a useful silvicultural tool that can be used as a site preparation method, to improve wildlife habitat, and to reduce the hazard of wildfires. According to the SCFC BMP Manual, a prescribed burn, conducted in compliance with all applicable BMPs should not have an adverse effect on water quality. Any potential issues stem from poor planning, execution, and changing weather conditions.

Example of a prescribed burn.

Source: SCFC

20.2.2) Stream Crossings

In order for landowners, foresters and contractors to access forestland, it is sometimes necessary to cross streams. All crossing should be constructed in compliance with SC BMPs for Forestry to minimize disturbance and limit the amount of sediment and nutrients entering the stream. Applicable practices to minimize water quality impacts from stream crossings include; keeping the slope on crossing approaches as gentle as possible, crossing the stream at a right angle, using drainage structures such as waterbars and turnouts to prevent road and ditch runoff from entering streams, adequately stabilizing any exposed soil, using portable bridges, and ensuring proper sizing, installation and stabilization of culverts.[110]

[110] (South Carolina Forestry Commission (SCFC), 1994)

Examples of stream crossing types by forested land use, access, and topography [111] .

20.2.3) Forest Road Construction

Forest access roads, both permanent main access and temporary limited use roads, are used for forest land management as well as recreational activities. Historically, forest access roads have been the largest contributor of sediment to streams during forestry operations. In order to protect water quality and minimize sediment from entering stream channels, these roads should be designed and planned in advance utilizing sediment control techniques such as filter strips and waterbars. In addition, the roads need to be properly maintained during any silvicultural activity and adequately stabilized when the activity is complete.

Forested Wetland Road Construction

"Road construction for silvicultural purposes in jurisdictional wetlands does not require a permit because of the silvicultural exemption under Section 404 of the Clean Water Act. However, to qualify for the silvicultural exemption, the road construction must comply with BMPs from the Clean Water Section 404 Program Definition and Permit Exemption, Part 232.3".[112] Due to the regulatory nature of wetland roads, contacting local BMP Foresters for guidance on construction and maintenance is encouraged.

[111] https://www.mdpi.com/2073-4441/7/12/6668/htm
[112] (South Carolina Forestry Commission (SCFC), 1994)

20.2.4) Timber Harvesting

Landowners are encouraged to seek the advice of a licensed forester or the SCFC to plan and execute timber harvests that are both environmentally responsible and economically efficient. Timber harvests should be conducted in compliance with SC BMPs for Forestry and account for SMZs, road locations, stream crossings, and forest regeneration methods before logging begins.[113] Proper planning and execution of timber harvests can prevent excess flooding and runoff, therefore avoiding large amounts of sediment from entering the water system.

20.2.5) Forestry Easements

Based on the language of a conservation easement, forested lands placed under conservation easements can still be utilized as working forests and are protected from future development. Working with existing land trusts such as UF, NLT, and TNC can help to identify priority lands for conservation.

20.2.6) Streamside Management Zones (SMZs)

Forest lands including or adjacent to perennial, intermittent, and ephemeral streams, as well as ponds and lakes, have the potential to contribute higher nutrient and sediment loads to the water systems and require additional attention during forestry operations. Once a forest land's water characteristics (e.g., type of stream, stream flow, behavior during storms) are identified by the landowner or licensed forest manager, the SMZ is broken into two parts (primary and secondary) ranging from 40-80 feet.

Specific BMPs within an SMZ are dependent on the forest land's characteristics (i.e. slope and land cover) as well as the types of streams on the land, but can include minimum overstory basal areas, keeping streams cleared of fell trees, handling toxic/hazardous materials outside of the SMZ, and minimizing disturbances to the forest floor.

20.2.7) Site Preparation

Before artificial or natural regeneration, site preparation is important to ensure seedling survival and prevent onsite erosion. Site preparation techniques can vary depending on the slope, natural conditions of land, crop tree species, and cost, but can also include mechanical (e.g., chopping, disking, and bedding), chemical (e.g. herbicides), or prescribed fire methods.

20.2.8) Reforestation

Reforestation can be accomplished either naturally or artificially, but is best started as soon after logging operations as possible to prevent erosion from occurring and sediment entering streams. Methods of reforestation are dependent on factors such as slope of land, crop tree species, and cost.

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[113] (South Carolina Forestry Commission (SCFC), 1994)

20.2.9) Fertilization and Pesticides

Pesticide, herbicide, and insecticide use can help to control unwanted vegetation and insects while protecting water quality, especially on erodible piedmont and mountain sites.[114] Safe use of these products includes delineation of treatment areas, riparian buffers to protect nearby waterways, and specifications of use (e.g. wind speeds, nearby sensitive areas, method of treatment).

Fertilization can help replace missing soil nutrients and enhance tree growth. According to the SCFC BMP Manual, fertilizers in prescribed amounts and properly placed pose no additional risk to water quality.[115] Protecting open waters from fertilizer applications and proper use of riparian buffers prevents additional nutrient loads from reaching waterways.

20.2.10) Minor Drainage

Minor drainage can be used to remove excess surface water from forest lands, which helps to facilitate land access and forest regeneration. Proper site design and compliance with wetland regulations are required to mitigate impacts to water quality. Coordination with a BMP Forester is recommended prior to initiating any minor drainage project.

20.2.11) SCFC Courtesy BMP Exams

The SCFC has BMP Foresters who conduct BMP Courtesy Exams to identify potential environmental impacts before, during, or after a forestry operation, suggest BMPs for pollutant mitigation, and assist with site design. Utilizing this service ensures compliance with state and federal cost-share requirements, which can cover a portion of landowners' expenses.

20.3) Forestry BMP Funding Options

Funding for forestry BMPs is limited. Cost share assistance may be available through the NRCS EQIP Program; however, foresters are encouraged to contact their local NRCS office and/or BMP Forester to learn more about possible funding sources.

20.3.1) Environmental Quality Incentive Program (EQIP)

The NRCS EQIP program promotes agricultural production while maintaining or improving environmental quality. Typically, up to a 75 % cost-share assistance is offered for project costs and forgone income. Historically underserved farmers can receive up to a 90 % cost share. The specific priorities to be addressed on the property are:

- Improvement of water quality in impaired waterways;
- Conservation of ground and surface water resources;
- Improvement of air quality;

[114] (South Carolina Forestry Commission (SCFC), 1994)
[115] (South Carolina Forestry Commission (SCFC), 1994)

- Reduction of soil erosion and sedimentation; and
    - Improvement or creation of wildlife habitat for at-risk species.

20.3.2) Forest Renewal Program

Encouraging the planting of trees on private lands, this cost-share program is funded jointly through the South Carolina State Legislature and industries that produce primary wood products. The program is designed to help landowners increase the productivity of their woodlands, stimulate the economy, and provide environmental benefits such as clean air, clean water, and wildlife habitat. The program is available to eligible landowners as approved by the SCFC; eligible landowners include private individuals, groups, partnerships, associations, trusts or corporations not engaged in the manufacture of wood products, or any other legal entity owning non-industrial forestland capable of producing wood products.

Figure 25: Ownership of Forested Lands

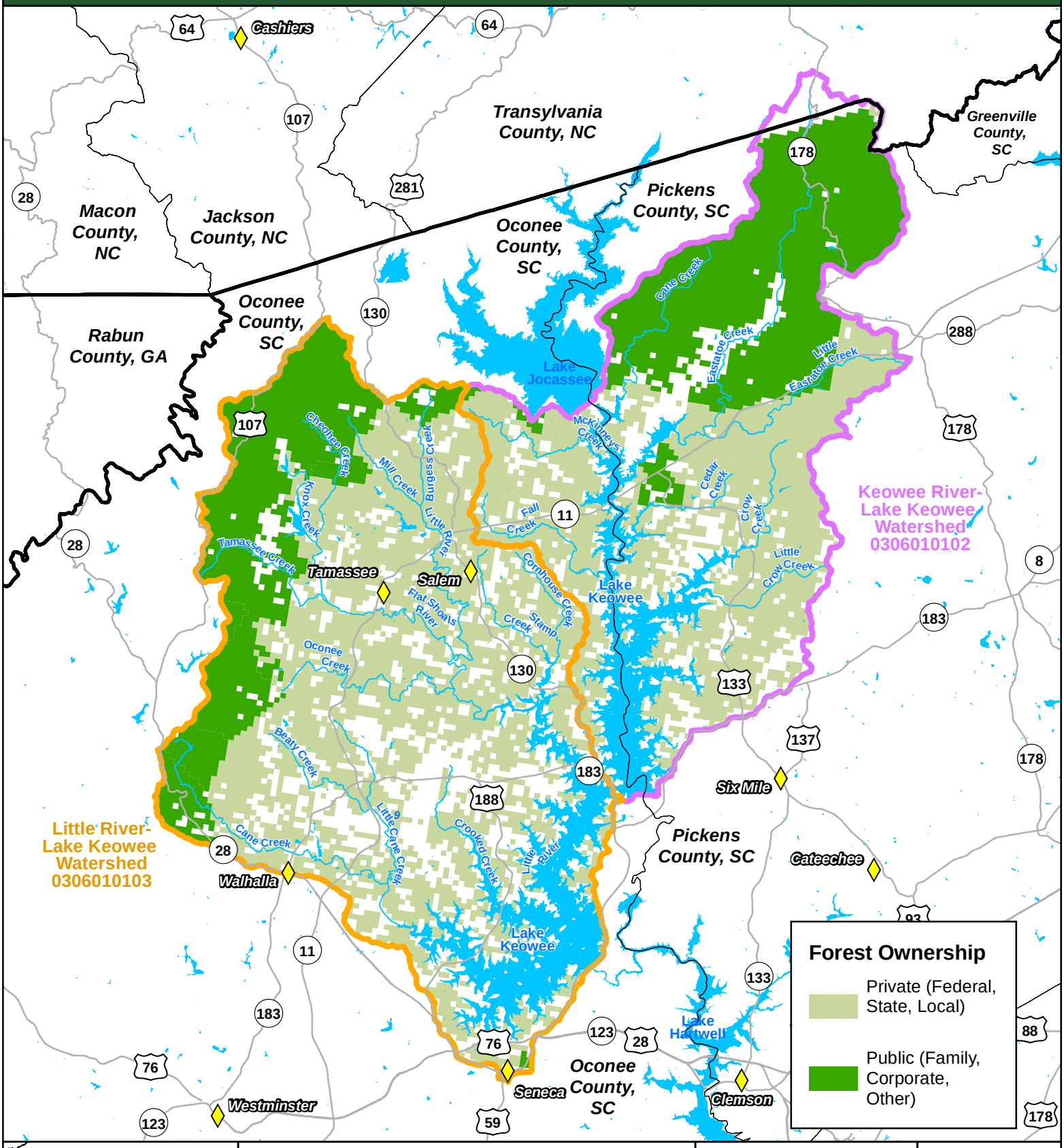

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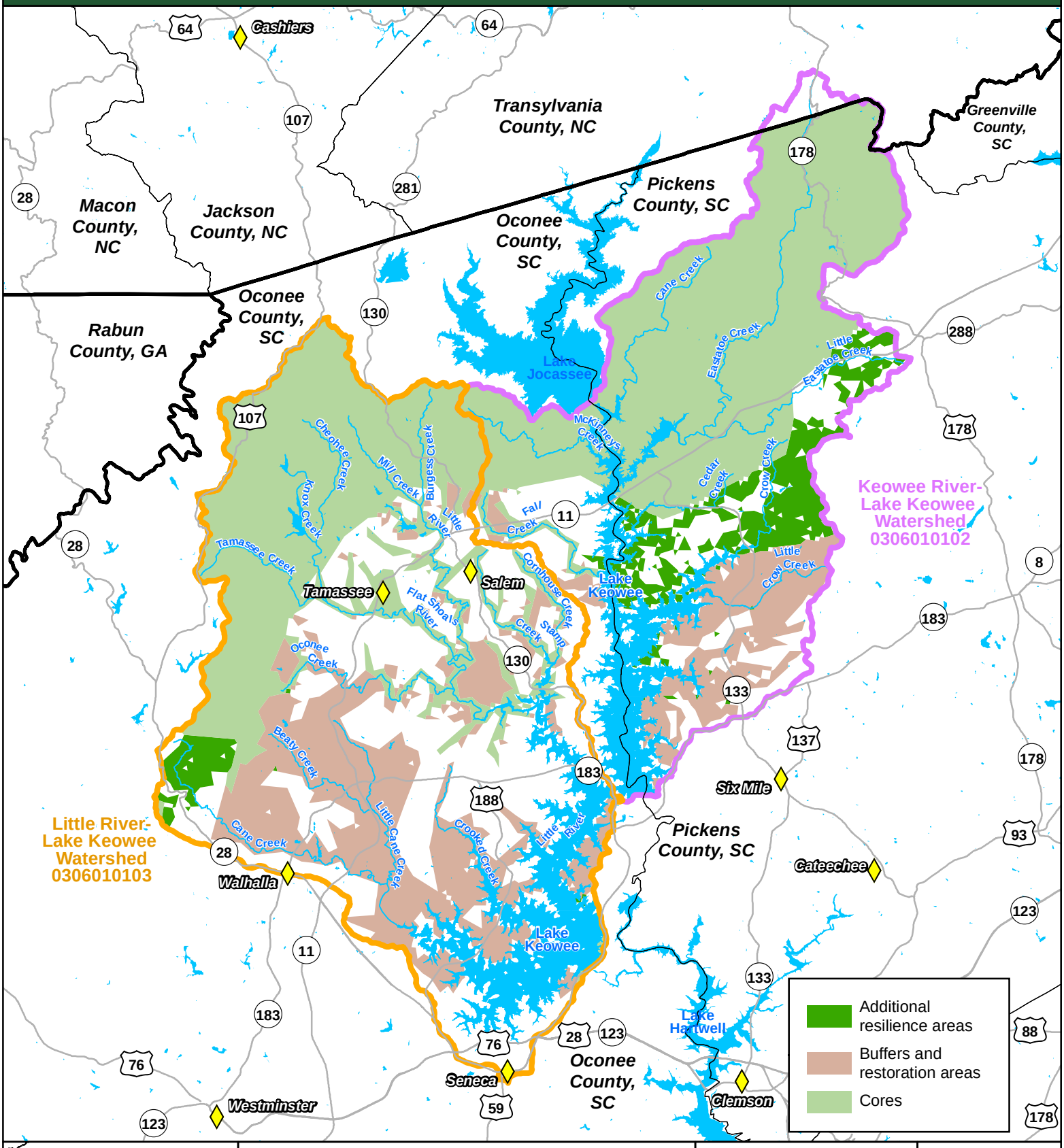
Figure 26. TNC Conservation Vision Areas (2018)



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21) Summary of BMP Recommendations

Table 45 presents a summary of the recommendations described in Sections 10-20, and provides a guide to where BMP implementation will best achieve load reductions.

Table 45. Summary of Parcel Prioritization Recommendations

Parcel Prioritization Category	Summary of Recommendations
Land Protection	Concentrate land protection efforts along the existing protected lands corridor in the northern region of the focus area to expand acreage of protected lands, protect sensitive headwater streams, and prevent urban encroachment from nearby developing towns and cities.
Agricultural BMPs	Target landowners in the Little River-Lake Keowee Watershed (HUC-0306010103), concentrating near the SC-183 and SC-11 corridors, to install 11 agricultural BMP projects.
Septic Repairs/Replacements	Conduct a pilot "Find and Fix" septic repair program in the Cane and Little Cane Creek subwatersheds. Then expand the program to the full watershed scale, first focusing on the high priority areas along the Eastatoe, Little Eastatoe, Fall, and Crow Creeks in the Keowee River-Lake Keowee Watershed and Cane Creek, Flat Shoals River, and Little River in the Little River-Lake Keowee watershed. Work specifically with Mile Creek Park to fix failing septic systems and RV dump stations.
Wetland Restoration/ Enhancement	Coordinate with developers in need of wetlands mitigation credits to provide funding to restore these wetland areas, specifically along Knox Creek near Tamassee, SC and Cedar Creek near SC-133.
Riparian Buffer Restoration/ Enhancement	Focus riparian buffer strategies along the northern rim of already protected lands and at the headwaters of several streams including Cane Creek, Oconee Creek, Cheohee and Knox Creeks, Burgess Creek, as well as along Eastatoe/Little Eastatoe Creek(s). Work with local governments to advocate for more stringent riparian buffer requirements.
Voluntary Dam Removal	Further evaluate the two medium-priority dams for potential voluntary dam removal. If dams are on agricultural properties, coordinate EQIP or Section 319 funds in combination with Agricultural BMPs.
Shoreline Management	Ensure compliance with Lake Keowee's Shoreline Management Plan, specifically focusing on restoring/maintaining natural lawns along the shoreline. Clarify the riparian buffer requirements or recommendations from cities and counties to develop a comprehensive riparian buffer recommendation.
Stormwater BMPs	Analyze the high priority parcels for placement of Stormwater BMPs and select 1-2 as demonstration sites. Advocate for Oconee County to hire a Watershed Planner or Stormwater Manager to help take a proactive approach to stormwater management in the county. Distribute educational materials to landowners in the watershed, especially directly around the lake.
Pet Waste Stations	Analyze the viability and placement of pet waste stations on 6 of the 14 identified high priority parcels, which include 8 parks, 4 veterinary facilities, and 2 pet groomers/boarding facilities. Work with local City/County partners to place pet waste stations first at public parks followed by the other identified locations.

Wildlife BMPs	Advocate for the maintenance of natural riparian buffers, especially at parks and along shorelines. Work with local governments to advocate for more stringent riparian buffer requirements. Work with partners to conduct public outreach about wildlife prevention.
Forestry BMPs	Encourage foresters to work with the SCFC and utilize the agency's courtesy exams and suite of BMP strategies and design. Focus outreach in the "Forest Core" areas first.

22) Public Outreach and Education

During the development of this WBP, LKSWPT engaged with the public in an effort to gain knowledge of the watershed, potential sources of pollutants, areas of concern, and what residents, business owners, and visitors' value most about the region. This engagement provided valuable insight and helped to inform a detailed public outreach strategy to address all nonpoint sources of bacteria, sediment, and nutrient impairments (Appendix G). This comprehensive public outreach strategy includes information on target audiences, messaging, outreach methods used, and recommended project partners for each pollution source.

22.1) Public Engagement during the WBP's Development

Public engagement was an important component in the development of this WBP. This section details the various ways LKSWPT solicited input from residents, visitors, and stakeholders within the focus area.

22.1.1) Public Meeting

LKSWPT hosted a public meeting on October 24, 2019 from 6:00-7:30 PM at the Seneca Water Filter Plant. Approximately 30 people were in attendance and the agenda included a general presentation on the LKSWPT along with an overview of the WBP process. Following the presentation, an open-ended question and answer session yielded many suggestions including areas of concern and questions about water quality in general. See Appendix H for the flyer distributed to advertise the public meeting. An overview of questions and comments received from participants are as follows:

- Areas of Concern:
  - Golf courses
  - Cane Creek
  - Keowee Key
  - Septic systems in disrepair directly around the lake
- Questions and Comments:
  - How do algal blooms and algae play a role in water quality and aquatic habitats of the lake?

- How does the current state of water quality affect recreation in the lake?
- What are the major sources of pollution within the focus area?
- What TMDLs are currently in place and how to they limit future development?
- There is a lack of continuity of riparian buffer requirements between Counties, Duke Energy (lake management), and SCDHEC.

22.1.2) Summary of Public Survey Results

LKSWPT hosted a 45-day online survey to gather additional information from people who live in, operate a business, or frequently visit the Lake Keowee Watersheds. The primary goals of the public survey were to gain an understanding of current baseline conditions, areas of concern, and to give the public the opportunity to weigh in on what should be the top priorities of this WBP. During the 45-day period, 275 people submitted responses to the public survey. An informative aspect of the public survey was the open-ended question posed at the end asking "*Do you have any concerns with water quality in the Lake Keowee Watersheds? Are there any problem areas we should be aware of?"*. The responses to this question are summarized in Table 46.

Table 46. Summary of Public Survey Results: Areas of Concern

Concern	# of Mentions	Concern	# of Mentions
Development	20	Foul Odor	5
None	17	Public Education	3
Water Quality	16	Invasive Species	3
Cane Creek	12	Water Clarity	3
Sediment	10	Gas/Diesel/Oil	3
Runoff	10	Protect Land	2
Riparian Buffers	10	Nuclear Plant	2
Shoreline Erosion	9	Wildlife	2
Septic Systems	9	Sewer Plants	2
Wake Boats	7	Water Taste	2
Duke Enforcement	7	Algae	2
Trash	6	Lake Level	2
Water's Edge subdivision	5		

Development, water quality (specifically in Cane Creek and the Water's Edge subdivision), and shoreline erosion (particularly from wake boats) were some of the most common responses to this question. The results of this survey informed BMP recommendations in Sections 10-21 as well as the detailed public outreach strategies in Appendix G.

22.1.3) External Stakeholder Meeting

LKSWPT convened an external stakeholder meeting on December 11, 2019. This meeting gathered government agencies, utility representatives, government officials, and conservation

groups to discuss the development of this WBP and solicit feedback for future engagement as we work towards the implementation of this WBP.

Questions, recommendations, and comments made during the meeting are summarized below:

- The lack of water quality monitoring is a concern. Stakeholders would like to see where gaps in water quality monitoring are geographically and encourage the use of the SC AAS program to fill those gaps.
- Is the goal of this plan to lobby for regulatory changes to meet necessary load reductions? Will gaps in policies be addressed?
- Septic tanks are a major issue in this area, is there anything that can be done to encourage better record-keeping practices for installations, repairs, or inspections?
- Because this watershed is primarily forested, including forestry management recommendations and BMPs is important to capture the land utilization of this watershed. Education and outreach on forestry BMPs should be a large consideration for future implementation projects.
- Is there a way to form a source water protection fund that would assist with the placement of conservation easements on high priority lands? Are there other sources of funding that might assist with land protection as it relates to protecting drinking water quality?

22.1.4) Website Development

The LKSWPT developed a website (www.lakekeoweewatershed.org) which will serve as the home for data and information related to the plan's development and future implementation opportunities, as well as other LKSWPT background, initiatives, and contact information.

22.2) Recommended Public Outreach and Education Strategies

The public outreach and education strategies detailed below will be the most effective strategies to employ during the implementation phase(s) of this WBP to assist with the completion of BMP projects and public education.

22.2.1) Mailings and Displays

Mailing lists will be compiled to facilitate communication with watershed residents regarding events, opportunities for potential projects, and general education. These lists can be used to send mailings that could include postcard invitations to meetings, workshops, information on conservation easements, agricultural and septic system BMP projects, and other nonpoint source pollution outreach events.

Including inserts with local utility providers' bills is also recommended to be utilized when possible. Because some utility providers mail water bills in postcard format, bill stuffers will not be feasible for all locations. However, placement of outreach materials (e.g., land protection, septic system maintenance, and agricultural BMP programs) at community gathering spots, such as city halls or community centers, is an alternative way to provide information to homeowners.

22.2.2) Community Meetings, Workshops, and Festivals

Community outreach meetings should be conducted as needed to discuss plan implementation, identify specific locations for BMP and land protection projects, and encourage landowner participation and engagement. Potential topics of discussion may include:

- Overview of Watershed Plan
- Watershed Plan goals
- Priority land protection areas
- Priority agricultural BMP and septic system projects
- Shoreline Management
- Possible funding sources for individual projects
- Workshop on suite of forestry BMPs

Schools, community groups, and public library patrons within the focus area would benefit from a variety of water quality educational publications and community workshops. Presentations to local landowners and community groups are an effective way to introduce groups to source water protection and nonpoint source pollution issues. Workshop topics could include conservation easements, agricultural BMPs, septic system maintenance and repair, pet waste, and nuisance wildlife. Storm drain stenciling and stream cleanups are excellent opportunities to engage the public, including youth organizations, while educating them about water quality issues.

Table 47. Community Groups, Municipalities, Libraries, and Schools for Public Outreach

Schools	
• Keowee Elementary School • Oconee Academy • Tamassee Salem Elementary School	• Walhalla Elementary School • Walhalla Middle School • Walhalla High School
Community Colleges and Universities:	**Community Centers**
• Clemson University • Fred P. Hamilton Career Center • Southern Wesleyan University	• Seneca's Gignilliat Community Center • Shave Recreation Center • Walhalla City Recreation Department
Libraries	**Community Groups**
• Oconee County Library • Salem Library • Pickens County Library	• Friends of Lake Keowee Society • South Carolina Forestry Commission • Homeowners Associations
Scout Troops	
• Boy Scout of America – Blue Ridge Council • Girl Scouts of South Carolina – Mountain to Midlands	
Local News Sources	
• Oconee Enterprise • Pickens County Courier • Upstate Today	• The Sentinel-Progress • Lake Living magazine • Keowee Key Scuttlebutt magazine

23) WBP Implementation, Milestones, and Measurable Goals

Up until this point, this WBP has detailed current watershed baseline conditions (Sections 2-3), pollutants of concern and possible sources of pollutants (Sections 4-8), and analysis of BMP implementation strategies (Sections 9-21). This section outlines how a plan to implement recommendations in order to meet water quality standards for bacteria, nutrients, and sediment. Due to the size of the focus area and the number of high priority projects identified, the implementation plan is divided into three phases: Phase 1 (years 1-3); Phase 2 (years 4-6), and Phase 3 (years 7-10). Although total restoration of the focus area would be ideal, the plan focuses on incremental improvements in water quality over a 10-year time frame (Tables 49-51).

Table 48. Summary of Implementation Recommendations

Pollutant Reduction Strategy	**Phase 1 (3 years)**		**Phase 2 (3 years)**		**Phase 3 (4 years)**	
	# of Projects	Estimated Cost	# of Projects	Estimated Cost	# of Projects	Estimated Cost
Land Protection	3	$69,750	3	$69,750	4	$93,000
Septic Repairs	180	$810,000	180	$810,000	185	$832,500
Agricultural BMPs	4	$90,157	4	$90,157	3	$67,617
Riparian Buffer Restoration	--	--	1	$19,831	1	$19,831
Pet Waste Station	6	$1,800	--	--	--	--
Total Estimated Cost	**$971,707**		**$989,737**		**$1,012,948**	

Implementation of BMPs is dependent upon landowner participation and available funding sources. As it is difficult to predict landowner preferences and participation rates, it is suggested to periodically reassess project goals to make sure load reductions are on target. For example, adjustments to the Public Outreach and Education Strategy may be needed if participation is lower than desired. It will also be important to evaluate the individual BMP projects themselves, making note of any problems that occurred before, during, and after construction to streamline the process for future participants.

Table 49. Project Milestones Phase 1: Years 1-3					
Action Items			Years (1-3)		
			1	2	3
Required BMPs to meet load reductions	Land Protection	Conduct outreach and education to priority landowners			
		Protect 165+ acres of land through 3 Conservation Easements or other land protection strategies			
	Agricultural BMPs	Conduct outreach and education to landowners through cooperating agencies			
		Send out targeted mailings to high priority landowners			
		Complete 4 agricultural BMP projects			
	Septic BMPs	Conduct outreach to homeowners through targeted mailings, social media, local contractors, and public displays			
		Complete 180 septic repairs/replacements			
	Riparian Buffers	Work with local governments on strengthening riparian buffer ordinances			
	Pet Waste Stations	Install 6 pet waste stations			
Supplemental BMPs, as funding and resources allow	Shoreline Management	Coordinate with utility/lake owner to collect data on the current state of shoreline landowner properties			
	Wetland Restoration	Monitor development impacts to wetlands and recommend mitigation options			
	Stormwater BMPs	Review current stormwater regulations and recommend strengthened regulations outside of MS4 requirements			
		Work with project partners to identify stormwater hotspots and recommend 1-2 demonstration sites			
	Wildlife BMPs	Pinpoint problem areas and collect cost information for identified best solutions			
	Forestry BMPs	Encourage foresters to coordinate with the South Carolina Forestry Commission to utilize the SCFC's courtesy exams and suite of BMP strategies and design			
	Send out surveys to participating landowners				
	Revise outreach and implementation strategies as needed				
	Complete quarterly updates on project website				
	Provide quarterly email and updates to stakeholders				

Table 50. Project Milestones Phase 2: Years 4-6

Action Items			Years (4-6)		
			4	5	6
Required BMPs to meet load reductions	*Land Protection*	Conduct outreach and education to priority landowners; continue to build relationships			
		Protect 165+ acres of land through 3 Conservation Easements or other land protection strategies			
	Agricultural BMPs	Conduct outreach and education to landowners through cooperating agencies			
		Send out targeted mailings to high priority landowners			
		Complete 4 agricultural BMP projects			
	Septic BMPs	Conduct outreach to homeowners through targeted mailings, social media, local contractors, and public displays			
		Complete 180 septic repairs/replacements			
	Riparian Buffers	Conduct outreach and education to landowners, including targeted mailings to high priority landowners			
		Complete 2 riparian buffer enhancement/restoration projects			
	Pet Waste Stations	Monitor effectiveness of installed pet waste stations			
Supplemental BMPs, as funding and resources allow	*Shoreline Management*	Coordinate with utility/lake owner to conduct landowner outreach, ensuring compliance with the SMP			
	Wetland Restoration	Monitor development impacts to wetlands and recommend mitigation options			
	Stormwater BMPs	If needed, recommend strengthened regulations outside of MS4 requirements			
		BMP demonstration site(s) identification, design, cost evaluation, and installation			
	Wildlife BMPs	Send out targeted mailings to landowners about wildlife management; coordinate with SCDNR			
	Forestry BMPs	Encourage foresters to utilize the SCFC's courtesy exams and suite of BMP strategies and design. Conduct landowner outreach and host a forestry workshop.			
	Send out surveys to participating landowners				
	Revise outreach and implementation strategies as needed				
	Complete quarterly updates on project website				
	Provide quarterly email and updates to stakeholders				

Table 51. Project Milestones Phase 3: Years 7-10

Action Items			Years (7-10)			
			7	8	9	10
Required BMPs to meet load reductions	*Land Protection*	Protect 220+ acres of land through 4 Conservation Easements or other land protection strategies				
	Agricultural BMPs	Conduct outreach and education to landowners through cooperating agencies				
		Send out targeted mailings to high priority landowners				
		Complete 3 agricultural BMP projects				
	Septic BMPs	Conduct outreach to homeowners through targeted mailings, social media, local contractors, and public displays				
		Complete 185 septic repairs/replacements				
	Riparian Buffers	Conduct outreach and education to landowners, including targeted mailings to high priority landowners				
		Complete 2 riparian buffer enhancement/restoration projects				
	Pet Waste Stations	Monitor effectiveness of installed pet waste stations				
Supplemental BMPs, as funding and resources allow	*Shoreline Management*	Coordinate with utility/lake owner to conduct landowner outreach, ensuring compliance with the SMP				
	Wetland Restoration	Monitor development impacts to wetlands and recommend mitigation options				
	Stormwater BMPs	Review current stormwater regulations and recommend strengthened regulations outside of MS4 requirements				
		Continue educational/outreach to landowners regarding proper stormwater management practices				
	Wildlife BMPs	Send out targeted mailings to landowners about wildlife management; coordinate with SCDNR				
	Forestry BMPs	Encourage foresters to utilize the SCFC's courtesy exams and suite of BMP strategies and design. Conduct landowner outreach and host a forestry workshop.				
	Send out surveys to participating landowners					
	Revise outreach and implementation strategies as needed					
	Complete quarterly updates on project website					
	Provide quarterly email and updates to stakeholders					
	Project wrap-up and final summary of projects/results					

24) Water Quality Monitoring Plan

Currently, water quality monitoring in the focus area is intermittent both geographically and periodically. Prior to project implementation it is extremely important that baseline water quality data is collected before and after projects are installed to measure changes in bacteria levels in relation to watershed improvements. Water quality monitoring should continue throughout the implementation period and should continue for up to one year after projects are installed. The water quality monitoring plan proposed below includes suggested sampling locations, parameters to be monitored, sample collection protocol, recommended microbial detection techniques, and potential individuals and/or organizations to conduct water sampling.

24.1) Proposed Water Quality Monitoring

24.1.1) Gaps in Current Water Quality Monitoring

Currently, water quality monitoring data collection is concentrated along specific streams in the focus area. For example, along Cane Creek and Little Cane Creek, there are 19 water quality sampling sites by SCDHEC, AAS, and FOLKS, however, other important feeder streams have no water quality monitoring nearby.

In the case of impaired streams, additional water samples should be taken upstream of current TMDL sites in areas where land use activities have the potential to contribute bacteria to waterways (e.g., agricultural land near streams, urban areas, and residential properties). If the samples collected indicate high bacteria or turbidity levels, additional samples should be collected further upstream until the source area is identified. Furthermore, prior to the installation of any BMP projects is it suggested that sampling take place at the nearest feasible downstream location so that changes in water quality can be documented over time.

24.1.2) Water Quality Monitoring Recommendations

LKSWPT recommends focusing on the following priority water quality monitoring:

1. **Encourage FOLKS and SC AAS** Integration – FOLKS, as an active member of LKSWPT, has committed its resources going forward to monitor critical areas using SC AAS monitoring methods and submit data to the SC AAS database. This ensures that data is publicly available for use and analysis, as well as facilitates expanding the monitoring network and ensuring consistency and continuity in data.
2. **Continued Monitoring of Bacteria on Cane and Little Cane Creeks** – LKSWPT recommends encouraging FOLKS to continue to monitor the status of bacteria in Cane and Little Cane Creeks.
3. **Monitoring for Bacteria on Crooked Creek** – because of its proximity to Cane Creek and Little Cane Creek, this stream will be important to monitor for potential bacteria problems. This could be accomplished by volunteer groups such as SC AAS or FOLKS.

4. **Additional Location Proposed below confluence of Eastatoe and Little Eastatoe Creek** – LKSWPT recommends the addition of a second monitoring location to site ER-0042. The proposed location of the new site is below the confluence of Eastatoe and Little Eastatoe Creeks. The addition of a monitoring station below the confluence will ensure data collection for both streams.
5. **Additional Location Proposed on Crow or Little Crow Creek** – LKSWPT recommends the placement of a water quality monitoring station, either regulatory (SCDHEC) or volunteer (SC AAS or FOLKS), on Crow and/or Little Crow Creek. There is currently a gap in water quality monitoring in this area and placement here would evenly distribute sampling locations.

24.2) Water Quality Monitoring Frequency and Techniques

Ideally, monitoring should occur on a monthly basis during a variety of hydrological conditions, and water samples should be taken before and after a project is installed. It is highly recommended that water samples continue to be collected on a monthly basis downstream of project sites for at least a year after installation. Monitoring data should be analyzed on a quarterly basis to identify trends, sources of pollution, and any changes in quality as a result of completed projects. Evaluating monitoring results by *E. coli* bacteria standards can determine percent attainment relating to water quality goals.

24.2.1) Microbial Source Detection Techniques

There are a variety of methods for analyzing bacteria in source waters. For the purposes of this project, we will focus on the most common methods: Most Probable Number (MPN) Method and Microbial Source Tracking.

Most Probable Number (MPN) Method

Water samples will be processed for *E. coli* using the MPN method of detection. Water samples will be processed using the EPA approved standard for detection of total coliforms and E. coli, the IDEXX Colilert method for Coliform/*E. coli*.[116]

Microbial Source Tracking

Microbial Source Tracking (MST), also known as Bacterial Source Tracking, is a method used to discern sources of fecal contamination in surface waters. This method is capable of determining if the source of fecal contamination is human, wildlife, domestic livestock, pets, or a combination of sources. MST could prove to be a useful tool for bacterial source detection in the focus area if funding and resources are available. Currently, Clemson University is piloting a technical service, using qPCR, quantitative polymerase chain reaction, to quantify bacteria loading from warm-blooded mammals (e.g., swine, bovine, human, and dog) in surface waters. The cost per sample is $350. Tests are being conducted in partnership with the Clemson

[116] (IDEXX Laboratories, 2013)

University Molecular Plant Pathogen Detection Lab and will provide valuable information to SC water resource managers.[117]

24.3) Volunteer Water Quality Monitoring

Voluntary monitoring programs are an excellent way to engage citizens in enriching activities while assessing water quality in a region. SC AAS (www.scadoptastsream.org) is an ideal program to involve local citizens in monitoring water quality in the Lake Keowee Watersheds. Schools, community groups, and interested citizens are great candidates for voluntary monitoring programs. The SC AAS Program offers trainings and monitoring resources under four protocols - Stream habitat, Assessment, Physical/Chemical Monitoring, and Macro-invertebrate Monitoring.[118] The information obtained through voluntary monitoring programs is valuable as it increases our understanding of water quality in areas that SCDHEC is unable to monitor. Anderson and Pickens County Stormwater Partners and UF are both certified SC AAS trainers with years of sampling and teaching experience.

Example of a volunteer monitoring water quality

(Source: SC AAS)

[117] (Clemson University, 2019)
[118] (South Carolina Department of Health and Environmental Control (SCDHEC), 2019)

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Appendix A. Standard Numbers from SCDHEC

This document was provided to UF by SCDHEC for utilization in load reduction calculations.

Standard Numbers (12/11/2015)
(#s in parentheses are reference #s!)

Loading

Septic: (*1, load from one septic tank per the StepL septic input page, 2, from Septic tab in WCS per Horsley and Whitten 1999*)
Bacteria: 2.76 x10E6/hr*24*365=2.4176 E10 per household
Nitrogen: 31.1lb/yr (1)
Phosphorus: 12.2 lb/yr

Cattle: (Beef) in Streams=Direct Input to Stream: (Ref 5, assumes year round spring deposition rate)
Bacteria 5.4xE8(5) bacteria/day/cow(5) * 365=1.97 x E11/yr/cow
Phosphorus: 0.004lbsP/day/cow(5) * 365=0.73 lbs/yr/cow
Nitrogen: 0.005lbsN/day/cow (5) * 365= 1.83 lbs/yr/cow

Fecal Colonies (#/animal/day) (4)

Chicken (layers)	1.36 x 10E8
Turkey	9.3 x 10E7
Hogs	1.08 x 10E10
Horse	4.20 x 10E8

Dog Waste Bacteria Loading
Dog 4.09x E09 bacteria/day

Livestock Equivalents (Mass of Waste produced per day, in PBCE (pasture beef cow equivalents).

Beef Cow	1
Dairy Cow	2.6
Horse	1.1
Hog	0.24
Sheep	0.04
Goat	0.04
Camel	0.5
Llama	0.5
Dog	0.01

Table below is the amount of FC bacteria available for deposit on the watershed per individual animal per year (100 % does **not** wash off)

Table 3. Annual Fecal Coliform Bacterial Loading (cfu/year) for Livestock Animals

Livestock	cfu/year	Reference
Cow	1.97×10^{12}	Metcalf and Eddy, 1991
Horse	1.53×10^{11}	ASAE, 1998
Hog	3.63×10^{12}	Metcalf and Eddy, 1991 ASAE, 1998
Sheep	1.10×10^{13}	Metcalf and Eddy, 1991 ASAE, 1998
Hen	4.61×10^{10}	Calculated from fecal waste of chicken (cfu/year) multiplied by hen:chicken mass ratio
Goat	1.10×10^{13}	(Assumed same as sheep)
Chicken	1.39×10^{11}	Metcalf and Eddy, 1991 ASAE, 1998

citation:
http://www.crwr.utexas.edu/gis/gishydro05/Modeling/WaterQualityModeling/BacteriaModel.htm

Land Use-Annual pollutant loadings from landuse per unit area

Annual Pollutant Loads by Land use (kg/ha-yr) Pounds multiply by 2.2, acres multiply by .404,

LANDUSE		TSS	TP	TN	Pb	In	Cu	FC
ROAD	MINIMUM	281	0.59	1.3	0.49	0.18	0.03	7.10E+07
	MAXIMUM	723	1.5	3.5	1.1	0.45	0.09	2.80E+08
	MEDIAN	502	1.1	2.4	0.78	0.31	0.06	1.80E+08
Commercial	MINIMUM	242	0.69	1.6	1.6	1.7	1.1	l.7E+09
	MAXIMUM	1,369	0.91	8.8	4.7	4.9	3.2	9.50E+09
	MEDIAN	805	0.8	5.2	3.1	3.3	2.1	5.60E+09
Single Fam	MINIMUM	60	0.46	3.3	0.03	0.07	0.09	2.80E+09
Residential	MAXIMUM	340	0.64	4.7	0.09	0.2	0.27	1.6E+l0
Low density	MEDIAN	200	0.55	4	0.06	0.13	0.18	9.30E+09
Single Fam	MINIMUM	97	0.54	4	0.05	0.11	0.15	4.50E+09

Residential	MAXIMUM	547	0.76	5.6	0.15	0.33.	0.45	2.6E+l0
HighDensity	MEDIAN	322	0.65	5.8	0.1	0.22	0.3	1.5E+l0
Multi Fam	MINIMUM	133	0.59	4.7	0.35	0.17	0.17	6.30E+09
Residential	MAXIMUM	755	0.81	6.6	1.05	0.51	0.34	3.6E+l0
	MEDIAN	444	0.7	5.6	0.7	0.34	0.51	2.1E+l0
Forest	MINIMUM	26	0.1	1.1	0.01	0.01	0.02	1.20E+09
	MAXIMUM	146	0.13	2.8	0.03	0.03	0.03	6.80E+09
	MEDIAN	86	0.11	2	0.02	0.02	0.03	4.00E+09
Grass	MINIMUM	80	0.01	1.2	0.03	0.02	0.02	4.80E+09
	MAXIMUM	588	0.25	7.1	0.1	0.17	0.04	2.7E+l0
	MEDIAN	346	0.13	4.2	0.07	0.1	0.03	1.60E+10
Pasture	MINIMUM	103	0.01	1.2	0.004	0.02	0.02	4.80E+09
	MAXIMUM	583	0.25	7.1	0.015	0.17	0.04	2.70E+10
	MEDIAN	343	0.13	4.2	0.01	0.1	0.03	1.60E+10

From Shaver, Ed, et al "Fundamentals of Urban Runoff: Technical and institutional issues: 2nd edition, 2007

Conversions: Multiply above by 0.45 then 0404 to get number for lb/ac/yr
Just for bacteria Multiply above by 0.404 to get number of bacteria/acre-year
Cropland (9) FC loading per unit area (#/ha)
No manure 9.50E+10
Poultry litter applied 6.50E+12
Dairy litter applied 1.75E+12

Concentrations

Average Concentration of Bacteria in runoff by landuse (per 100 ml)
FC E-Coli(8)
Urban 2.40E+04 8429
Forest 204
AgCrop (surface) (9)
No manure applied 1.30E+04

Poultry litter applied 5.70E+05
Dairy manure applied 2.30E+05
AgPasture 2375

References

-1 STEP_L model
-2 Watershed Characterization System References Tab, Septics Tab
-3 USEPA July 2003 National Management Measures for the Control of Nonpoint Pollution from Agriculture
EPA-841-B-03-004
-4 ASAE 1998 ASAE Standards 45 edition Standards Engineering Practices Data pp 646 (With EPA Region IV input)
-5 University of California Extension Fact Sheet No 25. Manure Loading into Streams from Direct Fecal Deposits
-6 http://dnrweb.dnr.state.md.us/watersheds/surf/bmp/swbmp.asp
-7 http://rpitt.eng.ua.edu/Publications/4_Stormwater_Characteristics_Pollutant_Sources_and_Land_Development_Characteristics/Stormwater_characteristics_and_the_NSQD/NSQD%203.1%20summary%20for%20EPA%20Cadmus.pdf
-8 : Mednick A. C. "Development of a Tool for Predicting and Reducing Bacterial Contamination at Great Lakes Beaches." Wisconsin DNR, Oct 20011.
-9 Mishra A. et al. "Bacterial Transport from Agricultural Lands Fertilized with Animal Manure". Water Air and Soil Pollution 189:127-134. (2008)

Appendix B. Typical Agricultural BMP Bundle and Bacteria Removal Calculations

Typical Agricultural BMP Bundle: Agricultural BMPs are most often installed in packages, or combinations of multiple BMPs. The SC DHEC Nonpoint Source Management Program 2012 Annual Report outlines several current and past 319 projects for both agriculture and septic BMPs.

Within the Upstate region of South Carolina, there have been five completed 319 projects that have focused predominantly on either septic or agricultural BMPs. The five projects completed various combinations of agricultural and/or septic BMPs, shown in the table below.

TMDL/ 319 Project	Total Fecal Coliform Removal (CFU)	Alternative Water Sources (units)	Controlled Stream Access for Livestock Watering (ft)	Fence (ft)	Water Well (units)	Heavy Use Area Protection (sq. ft)	Pipeline (ft)	Watering Facilities (units)	Vegetated Riparian Buffers (ac)	Onsite Wastewater Treatment System (units)	Streambank and Shoreline Protection (ft)
Rabon Creek	3.87E+13	2	152	3,143		10,918		1	2	43	
Cane/ Little Cane Creek	6.22E+11									17	2,644
Long Cane Creek	2.87E+12	5		3,735		23,491				9	41,916
Twelve Mile Creek	1.34E+14	4		57,122	14	55,391	14,135	44	10		29,267
Tyger River	3.14E+12	19		27,385	5	14,994	15,193			57	27,385
Total	***1.79E+14***	***30***	***152***	***91,385***	***19***	***104,794***	***29,328***	***45***	***12***	***126***	***101,212***

Looking only at the agricultural BMPs, which would include all but the onsite wastewater treatment system projects, there are only a few BMPs that are measured in units: watering facilities, water wells and alternative watering sources. Out of these three BMPs, water wells have the lowest total number of installations. Using this, we can assume that for every one waste well that is installed, there is an average of 1868 feet of fencing, 2138 square feet of heavy use area protection, 599 feet of pipeline, 2 watering facilities, and 0.23 acres of riparian buffer installed. An average agricultural BMP bundle therefore looks like this:

Average Agricultural BMP Bundle:

- 1 well with pump
- 1,686 feet of fencing
- 2,138 square feet of Heavy Use Area protection
- 599 linear feet of waterline
- 1 watering facility
- 0.23 acres of riparian buffer area

Average Bacteria Removal: The SC DHEC Nonpoint Source Management Program 2012 Annual Report contains total fecal coliform removed from all septic and agricultural BMP project combined. To determine the average fecal coliform bacteria one BMP bundle removes it is necessary to separate fecal reductions from septic and agricultural BMPs.

Since the Cane/Little Cane Creek project dealt exclusively with septic projects, we can determine the average bacteria reductions from a septic project.

$$\text{Average Septic Project Fecal Coliform Reductions} = \frac{\text{Total \# Septic Projects Completed}}{\text{Total Fecal Coliform Reduction}}$$

TMDL/319 Project	Total Fecal Coliform Removal (CFU)	Onsite Wastewater Treatment System Projects (units)	Average Fecal Coliform Removed by 1 Septic Project
Cane/Little Cane Creek	6.22E+11	17	3.66E+10

The average septic project fecal coliform reduction can then be used to calculate the average reduction of an agriculture BMP bundle. Since the Rabon Creek 319 project had both septic and agricultural BMPs, we can determine the agricultural reduction by removing the total bacteria removed from septic.

TMDL/ 319 Project	Total Fecal Coliform Removal (CFU)	Alternative Water Sources (units)	Controlled Stream Access for Livestock Watering (ft)	Fence (ft)	Water Well (units)	Heavy Use Area Protection (sq. ft)	Pipeline (ft)	Watering Facilities (units)	Vegetated Riparian Buffers (ac)	Onsite Wastewater Treatment System (units)	Streambank and Shoreline Protection (ft)
Rabon Creek	3.87E+13	2	152	3,143		10,918		1	2	43	

The table above shows all of the projects installed during the Rabon Creek 319 project. Using the calculated average septic reduction, the 43 septic projects removed 1.57E+12 CFU of fecal

coliform. Subtracting this number from the total fecal coliform removal gives us the remaining reductions, 3.71E+13 CFU that resulted from agricultural BMPs.

Using the average agriculture BMP bundle calculations from earlier, we can assume that the Rabon Creek 319 funds installed about 2 average agricultural BMP bundles.

TMDL/319 Project	Fecal Coliform Removal from Septic Projects	Remaining Fecal Coliform Removal (total septic removal)	Number of Agricultural BMP Bundles Installed	Average Fecal Coliform Removal from Agricultural BMP Bundles
Rabon Creek	(43*3.66E+10)=1.57E+12	(3.87E+13-1.57E+12) = 3.71E+13	2	(3.71E+13/2) = 1.86E+13

Dividing the total agricultural BMP removal by the 2 installed agricultural BMPs results in an average fecal coliform reduction of 1.86E+13 CFU per agricultural BMP bundle.

Appendix C. Calculating Sediment and Nutrient Load Reductions using STEPL

Calculating Estimated Total Watershed Sediment and Nutrient Load Reductions

- Open STEPL and choose the number of HUC-10 watersheds
- Once the spreadsheet opens, choose the following inputs:
    - DO NOT check "Treat all subwatersheds as parts of a single watershed"
    - Choose your weather station based on the county with most acreage in the watersheds
    - 1. Input all acreages
        - Urban – all developed lands
        - Cropland – Cultivated Crops
        - Pastureland – Pasture/Hay + Grasslands
        - Forest – all forested lands
        - User Defined – leave blank
        - Feedlots – leave blank
    - 2. Use the total number of estimated animals and divide evenly among the watersheds.
        - Using the cattle total, divide by 2 (half beef, half dairy) before dividing evenly among the watersheds. For example, if you have 2 watersheds, you would divide the cattle total by 4.
    - 3. Estimate the number of septic systems for each watershed; do not modify population per septic system (2.43 is the national average).Change the septic failure rate to 20%
    - 8. You can change the percentages of urban areas if needed, but not necessary
        - Commercial = medium and high intensity development
        - Single Fam = low intensity development
- Hit Export Data button at the top of the spreadsheet input page (input and output with graphs)
- Total Loads for TSS, TN, TP, and BOD will be calculated and found on the "Total Load" tab of the spreadsheet

Finding the Average Load Reductions for Typical Agricultural BMP "Packages"

- Open a new STEPL spreadsheet
    - The number of BMPs in your typical agricultural BMP "package" is the number you will enter in for "watersheds".
    - Choose your weather station based on the county with most acreage in the watersheds
        - In a typical BMP package we used 4 BMPs
            - Livestock Exclusion Fencing
            - Alternative Water Sources
            - Heavy Use Area
            - 35 m Improved Buffer

    - Enter in "1" for impaired streambank to consider the need for an alternative watering source
- Once the spreadsheet opens, choose the following inputs:
    - DO NOT check "Treat all subwatersheds as parts of a single watershed"
    - Choose your weather station based on the county with most acreage in the watersheds
- Inputs
    - 1. Enter "1" for all watersheds under pastureland; leave everything else empty
    - Under the BMP tab:
        - 2. Choose one type of BMP (of your agricultural package) per "Watershed" and enter 100% Area BMP applied for each one
            - Alternative Water Supply
            - Heavy Use Area Protection
            - Grass Buffer (minimum 35 feet wide)
            - Livestock Exclusion Fencing
    - Unhide the Gully and Erosion Tab if needed
        - Choose the watershed with the Alternate Watering Source listed as the BMP
        - Length (ft) used is the average length of fencing in a typical agricultural BMP package (we used 1,686)
        - Height is 3 ft (recommended height from SCDHEC)
        - Lateral Recession – Moderate (recommended from SCDHEC)
        - Soil Texture Class – predominant soil type in the watersheds overall
    - Under the Total Load tab, use the total loads for Sediment, N and P for the amount of reduction estimated per agricultural BMP package

Finding the Average Load Reductions for Riparian Buffers

- Open STEPL and choose the number of HUC-10 watersheds
- Once the spreadsheet opens, choose the following inputs:
    - DO NOT check "Treat all subwatersheds as parts of a single watershed"
    - Choose your weather station based on the county with most acreage in the watersheds
    - 1. Under urban lands, enter the total amount of urban lands for each watershed that is on high priority buffer parcels
    - 8. Modify urban acreage percentages to reflect [for each watershed]:
        - Commercial = medium and high intensity development
        - Single Family = low intensity development
        - Open Space = open space
        - Every other urban land use should be zero, and the total % area should equal 100
- Under the BMPs tab, select the Urban BMP tool
    - For each watershed:
        - Click commercial and choose "LID/Filter/Buffer Strips"; the BMP drainage area will automatically populate based on the percentages you entered in. Click apply. Click OK on the confirmation window.

        - Repeat the same process for each of the urban land use types you've entered for each watershed; so if you entered commercial, single family, and open space for two watersheds, you would do this a total of 6 times (3 for each type of urban land use for each watershed).
        - Exit when done
- Go to total load tab and get your loads for sediment and nutrients. This will give you the average amount of sediment and nutrients expected for each riparian buffer BMP project installed.

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Appendix D: Land Prioritization Analysis Criteria

Parcel Prioritization for Land Protection Criteria

1) Critical Watershed Area (CWA)

The Critical Watershed Area study was completed by Furman University using the InVEST model. The results of this analysis identified areas that, if developed, would have the biggest (negative) impact to water quality. Highest valued areas, if developed, would have significant negative impact to water quality, and are therefore the most important to protect.

Scoring: The Critical Watershed Area raster file created by Furman University was used to assign points to individual parcels based on higher potential water quality impacts. The average value per parcel was calculated; then the range of averaged values was separated into high, medium, and low priority categories. Because the results had a non-normal distribution, geometric intervals were used to divide them into three categories (high, medium, and low priority). Parcels designated high priority areas received "4" points; parcels designated medium priority areas were received "3" points; other parcels received "0" points

Critical Watershed Area Priority Ranges

Range	CWA Values
Low Priority Range	0 – 0.000004
Medium Priority Range	0.000005 – 0.000261
High Priority Range	0.000265 – 0.014961

GIS Layers Used: Parcel, Critical Watershed Area (Furman University, 2017).

2) Stream Order

First order, or headwater, streams are the smallest stream channels in a river network and are of increased importance to river/watershed health due to their ability to retain floodwater, store nutrients, reduce sediment, maintain base flow of rivers, and provide critical habitat. Loss of headwater streams can have significant negative impacts to water quality and watershed health, and are therefore very important to protect.[119]

Scoring: Using the National Hydrology Dataset, parcels containing headwater (1st order) streams received "4" points. All other parcels received "0" points.

GIS Layers Used: Parcel, National Hydrology Dataset

[119] (The Nature Conservancy (TNC), 2018)

3) Stream Classification

Streams that are in the most pristine condition are the most important to protect; once impacted they are difficult and expensive to restore. SCDHEC classifies streams throughout South Carolina; Outstanding Resource Waters are of "exceptional recreational or ecological importance or of unusual value" and Trout Waters Natural (TN) support natural populations and a "cold water balanced indigenous aquatic community of flora and fauna". Therefore, the ORW and TN waters are most important to protect from an ecological standpoint.

Scoring: Parcels that contained a stream, or portion thereof, were assigned points based on stream's classification. Parcels with streams classified as ORW or TN (i.e., highest quality streams that are a priority for protection) received "4" points; parcels with streams classified as Trout Waters Grow Put Take (TGPT) received "3" points; parcels with streams classified as Freshwater (FW) and no stream impairments received "2" points. Parcels with streams classified as FW and at least one impairment received "1" point. Parcels without streams along/within their boundaries received "0" points.

GIS Layers Used: Parcel, Stream Classification

4) Highly Sensitive Riparian Buffer Areas

Riparian, or vegetated, stream buffers provide water quality benefits including slowing and filtering stormwater runoff, reducing flooding, preventing stream channelization, stabilizing streambanks, and minimizing erosion.[120] Protecting the most sensitive riparian buffers ensures that lands continue to provide valuable water quality benefits. For water quality protection, riparian buffer zones should be a minimum of 100 feet wide on each side of the waterbody.[121]

Scoring: UF identified highly sensitive riparian areas by combining the results from the USFS Riparian Buffer Delineation Model v.5.2 (www.riparian.solutions, run by UF) with a 100-foot buffer around all waterways.[122] Parcels were assigned points according to acreage of highly sensitive riparian buffer areas within each parcel, based on the "natural breaks" in the resulting acreage data (partitioning data into classes based on natural groups in the data distribution). Parcels with 43 acres or more of highly sensitive riparian buffer acreage received "4" points; parcels with 20-42.99 acres of highly sensitive riparian buffer acreage received "3" points; parcels with 8-19.99 acres of highly sensitive riparian buffer acreage received "2" points; parcels with 2-7.99 acres of highly sensitive riparian buffer acreage received "1" point; parcels with <2 acres of highly sensitive riparian buffer acreage received "0" points.

GIS Layers Used: Parcel, Variable Width Riparian Buffer Model Results Layer (Inputs: DEM Raster Files, NLCD Land Cover 2011, National Wetlands Inventory, State Soil Survey Geographical Database, National Hydrography Dataset), 100-foot Waterway Buffer Layer

[120] (Pennsylvania Land Trust Association, 2014)
[121] (Fischer, 2000)
[122] (Abood, 2012)

5) Forested Riparian Buffer Areas

Forested riparian buffers provide increased benefits to water resources and provide habitat benefits to terrestrial and aquatic species. Protecting forested areas within highly sensitive riparian buffer areas will ensure that forest cover and water quality benefits are not lost.

Scoring: Parcels that have overlap with both forested land cover (mixed, evergreen, and deciduous) and the Highly Sensitive Riparian Buffer Areas layer (8.1.4) received "1" point; all other parcels received "0" points.

GIS Layers Used: Parcel, Highly Sensitive Riparian Buffer Areas Layer (8.1.4), Forest Land Cover

6) Wetlands Classifications

A wetland is an area that is permanently or seasonally saturated with water, supports predominately hydric vegetation, and contains hydric soils. The ecological and environmental benefits of wetlands include flood control, water purification, shoreline stabilization, groundwater recharge, and streamflow maintenance. Fresh Water (FW)-Forested/Shrub, FW-Emergent, and Riverine wetlands are the highest functioning types of wetlands, providing the most water quality benefits.

Scoring: Parcels containing wetlands were assigned points based on the type of wetland present. Parcels with FW Forested/Shrub, FW Emergent, and Riverine wetlands (i.e., the classifications of higher value wetlands) received "3" points; parcels with FW pond and lake wetlands received "2" points; remaining parcels received "0" points.

GIS Layers Used: Parcel, National Wetlands Inventory

7) Hydric Soils

Hydric soils are defined by federal law as "soil that, in its undrained condition, is saturated, flooded, or ponded long enough during a growing season to develop an anaerobic condition that supports the growth and regeneration of hydrophytic vegetation".[123] While wetlands must have hydric soils, presence of hydric soil does not necessarily indicate presence of wetlands. Hydric soils favor the formation of wetlands, support groundwater recharge, help identify the presence and boundary of wetlands, and support the growth of important vegetation that can help with pollution dissipation.[124] Presence of hydric soils within parcels indicates the current/potential for ecological services that are important to protecting water quality.

Scoring: Point values were assigned based on the acreage of the parcel that contains hydric soils. Parcels with 50 or more acres hydric soils received "3" points. Parcels with 30-49.99 acres of hydric soils received "2" points. Parcels with 5-29.99 acres of hydric soils received "1" point. Parcels with 4.99 acres or less of hydric soils received "0" points.

GIS Layers Used**:** Parcel, State Soil Survey Geographical Database

[123] (United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS), n.d.)
[124] (Mid-Atlantic Hydric Soil Committee, 2011)

8) 100-Year Floodplain

Floodplains help protect people and infrastructure from flooding and also benefit water quality by acting as natural filters as well as recharging aquifers.[125] By protecting existing undeveloped floodplains, the ecological benefits provided to the river system can continue. Flooding can be increased by land development, which may increase stormwater runoff and velocity.

Scoring: The National Flood Hazard Layer represents the current effective flood risk within an area, depicting which areas have a 1% probability of occurring in any given year. Parcels that fall within the 100-year floodplain approved by the Federal Emergency Management Agency (FEMA) without any urban/developed land received "2" points; parcels within the 100-year floodplain with urban/developed land received "1" point; all other parcels received "0" points.

GIS Layers Used: Parcel, National Flood Hazard (FEMA), NLCD Land Cover (2011)

9) Source Water Protection Areas

The Safe Drinking Water Act of 1996 was amended to provide a greater focus on pollution prevention to ensure surface water and groundwater are protected from pollution. These amendments require states to provide Source Water Assessment Reports (SWAR) that contain important information about drinking water sources and their susceptibility to contamination and identify the areas that contribute to a surface-water intake, or Source Water Protection Areas (SWPA) (SCDHEC, 2018). Protecting SWPAs is crucial to protecting drinking water sources.

Scoring: Parcels within source water protection areas received "2" points; parcels outside source water protection areas received "0" points.

GIS Layers Used: Parcel, Source Water Protection Areas

10) Stream Length

Parcels containing more linear feet of streams offer the opportunity to better protect water quality.

Scoring: Parcels with streams along/within their boundary were analyzed to determine the average length of streams within parcels throughout the watershed. In the Three and Twenty Creek Watershed, the average stream length within/adjacent to a parcel is 0.013 miles. Parcels with above average stream length received "2" points; other parcels received "0" points.

GIS Layers Used: Parcel, National Hydrography Dataset

11) Adjacent to Existing Protected Land

Protecting larger areas can enhance the environmental benefits provided by existing protected lands. Examples of existing protected lands include national and state parks, conservation easements, heritage preserves, and water utility-owned properties. Environmental benefits can include reduced flooding and soil erosion, streambank stabilization, improved water and air

[125] (The Nature Conservancy, 2018)

quality, and habitat protection.[126] Existing protected land can be seen in Figure 9.

Scoring: Parcels that were adjacent to existing protected land received "1" point; parcels not adjacent to existing protected land received "0" points.

GIS Layers Used: Parcel, National Conservation Easement Database, UF Conservation Easements, County Parks, National Heritage Preserves.

11) Parcel Size

Some land protection costs remain constant whether protecting a 200-acre or a 20-acre parcel. Since larger parcels generally provide increased environmental benefits, in many cases focusing on larger parcels will provide the most cost-effective option for protecting water quality.

Scoring: Parcels that meet UF's standard minimum acreage for conservation easements (50 acres) received "1" point; all other parcels received "0" points.

GIS Layers Used: Parcel, HUC-12 Watershed

Parcel Prioritization for Restoration BMPs

1) Current Water Quality Impairments

Parcels including, directly adjacent to, or upstream of an existing known bacterial impairment could be contributing to the problem.

Scoring: Parcels including, adjacent to, or upstream of streams with existing bacteria water quality impairments received "3" points. All other parcels received "0" points.

GIS Layers Used: Parcel, 303(d) List of Impaired Waters (2016), National Hydrography Dataset

Restoration Categories: Wetland Restoration/ Enhancement, Riparian Buffer Restoration/Enhancement, Voluntary Dam Removal, Stormwater BMPs

2) Land Cover

- Agricultural lands directly adjacent to waterways are more likely to contribute bacteria, nutrients, and sediment when stormwater runoff carries fertilizer and animal waste directly into streams. This criterion is a prerequisite to further analysis within the Agricultural BMP category; parcels that do not have agricultural land cover are not eligible for agricultural BMPs and are excluded from further analysis. Parcels must either have 50% or greater agricultural land cover or have any percentage of agricultural land cover adjacent to streams; parcels must meet one or both of these criteria to be considered for further analysis.
- Various land activities, such as logging and urban development, can negatively impact water quality through increased stormwater runoff, pollutant loads, stream

[126] (Stolton, 2015)

channelization, and increased flooding.[127] This factor identifies parcels with urban lands or known logging operations that are likely contributing higher pollutant loads and where BMP implementation may provide water quality benefits.

Scoring:

- *Agricultural BMPs:* Parcels with 50% or more agricultural land cover (identified as pasture/hay and cultivated crops) received "2" points. Parcels with agricultural lands that are adjacent to streams or include a water impoundment received "2" points. Parcels with 50% or greater agricultural land that are adjacent to streams or include a water impoundment received "4" total points. All other parcels received "0" points.
- *Stormwater BMP's*: Parcels within urban/developed land areas received "2" points. Parcels with known logging operations received "1" point; all other parcels received "0" points.

GIS Layers Used: Parcel, National Land Cover Dataset (2011), Landowner Database

Restoration Categories: Agricultural BMPs, Stormwater BMPs

3) Current Pollutant Export

This criterion prioritizes parcels likely to have high levels of nitrogen, phosphorus, and sediment export by using the results from Furman University's InVEST Model results.

Scoring: For each pollutant (nitrogen, phosphorus, and sediment) the average value of exports within each parcel was calculated; the range of averaged values was then separated into high, medium, and low export categories. For each pollutant, parcels within the highest average range of export received "3" points; parcels within the medium range of export received "2" points; parcels within the low range/no export received "0" points.

Current Pollutant Export Priority Ranges

Pollutant	Units	Low Priority	Medium Priority	High Priority
Nitrogen	Kg/pixel/year	0 – 0.032488	0.0324489 – 0.128093	0.128094 – 0.409430
Phosphorus	Kg/pixel/year	0 – 0.001163	0.001164 – 0.036652	0.036653 – 1.119240
Sediment	tons/pixel/year	0	0.000001 – 0.000004	0.000005 – 0.001241

GIS Layers Used: Parcel, Furman University's Current Pollutant Export Layers for Nitrogen, Phosphorus, and Sediment (results from the InVEST Model)

Restoration Categories: Agricultural BMPs, Wetland Restoration/Enhancement, Riparian Buffer Restoration/Enhancement, Shoreline Management, Stormwater BMPs

4) Unpermitted Point Source Pollutants

Although under the threshold for a permit, some point source activities may contribute to water quality pollution through stormwater runoff, such as existing agricultural operations (i.e., use of

[127] (Frankenberger, n.d.)

fertilizers, chemicals, or land applications of manure or waste).

Scoring: Parcels identified as including agricultural operations (farms) below the NPDES permit threshold received "1" point; all other parcels received "0" points.

GIS Layers Used: Parcel, Google searches: Farms, Golf Courses, Car Lots/Washes, Gas Stations, and Dry Cleaners

Restoration Categories: Agricultural BMPs, Stormwater BMPs

5) Permitted Point Source Pollutants

Permitted agricultural point sources could be contributors to bacteria, nutrient, or sediment pollution and may benefit from installation of agricultural BMPs.

Scoring:

- *Agricultural BMPs:* Parcels with agricultural points source permits (e.g., CAFOs, Animal Management Areas, biosolid application areas, known farms) received "1" point. All other parcels received "0" points.
- *Stormwater BMPs:* Parcels with NPDES (non-agricultural), mines/gravel pits, landfills, etc. received "1" point. All other parcels received "0" points.

GIS Layers Used: Parcel, Agricultural and Non-Agricultural NPDES, Land Applications, Animal Management Areas, Biosolid Application Areas, known farms (Google Search), Landfills, Mines/Gravel Pits

Restoration Categories: Agricultural BMPs, Stormwater BMPs

6) Restorable Wetlands

A wetland is an area that is permanently or seasonally saturated with water, supports predominately hydric plants, and contains hydric soils. The ecological and environmental benefits of wetlands include flood control, water purification, shoreline stabilization, groundwater recharge, and streamflow maintenance.[128] Restoring inundated and modified wetlands to their natural states would provide significant environmental and water quality benefit.[129]

Scoring: Parcels with wetlands with special modifiers (excavated, spoil, artificial substrate, diked/impounded, managed, farmed, partially drained/ditched, beaver) received "2" points. Additionally, parcels with historic wetlands received an additional "2" points.

GIS Layers Used: Parcel, National Wetland Inventory (Current and Historical)

Restoration Categories: Wetland Restoration/Enhancement

[128] (Washington State Department of Ecology, n.d.)
[129] (United States Environmental Protection Agency (EPA), 2005)

7) Water Impoundments and Dams

Dams physically alter the aquatic ecology and often convert natural wetlands into open water, reducing ecological benefits. Removal of obsolete dams can restore natural wetlands and stream flow, improve aquatic habitat, and renew natural sedimentation levels. Removing dams is not always a viable, or preferred, option depending on the dam's use, condition, and owner's interests.

Scoring: Parcels with dams received "2" points; all other parcels received "0" points.

GIS Layers Used: Parcel, National Inventory of Dams
Restoration Categories: Voluntary Dam Removal, Wetland Restoration/Enhancement

8) Highly Sensitive Riparian Buffer Areas

Riparian, or vegetated, stream buffers provide water quality benefits including slowing and filtering stormwater runoff, reducing flooding, preventing stream channelization, stabilizing streambanks, shading streams, and minimizing erosion.[130] This criterion places priority on parcels with highly sensitive riparian buffers that, if enhanced or restored, would provide significant water quality benefits.

Scoring: UF identified highly sensitive riparian areas by combining the results from the USFS Riparian Buffer Delineation Model v.5.2 (www.riparian.solutions, run by UF) with a 100-foot buffer around all waterways.[131] Parcels were assigned points according to acreage of highly sensitive riparian buffer areas within each parcel, based on the "natural breaks" in the resulting acreage data (partitioning data into classes based on natural groups in the data distribution). Parcels that fell fully or partially within this layer were assigned "4" points; all other parcels were assigned "0" points.[132] This criterion is a prerequisite for further analysis.

GIS Layers Used: Parcel, Variable Width Riparian Buffer Model Results Layer (Inputs: DEM Raster Files, NLCD Land Cover 2011, National Wetlands Inventory, State Soil Survey Geographical Database, National Hydrography Dataset), 100-foot Waterway Buffer Layer

Restoration Categories: Riparian Buffer Restoration/Enhancement, Shoreline Management

9) Stream Order

Priority was given to parcels along first and second order streams to account for the enhanced benefits riparian buffers provide on smaller, higher order streams.

Scoring: Using the National Hydrology Dataset, parcels containing headwater (first or second order) streams received "4" points. All other parcels received "0" points.

GIS Layers Used: Parcel, National Hydrology Dataset

[130] (Pennsylvania Land Trust Association, 2014)
[131] (Abood, 2012)
[132] (Fischer, 2000)

Restoration Categories: Riparian Buffer Restoration/Enhancement

10) Adjacency to Drinking Water Reservoirs or Drinking Water Intakes

Parcels directly adjacent to waterways and drinking water sources are more likely to contribute to pollutant loading, as there is less opportunity for filtration or removal before reaching surface and groundwater.

Scoring: Parcels adjacent to drinking water intakes or reservoirs received "4" points. Parcels adjacent to any waterways (other than drinking water intakes or reservoirs) received "2" points; all other parcels received "0" points.

GIS Layers Used: Parcel, National Hydrography Dataset, Drinking Water Intakes

Restoration Categories: Riparian Buffer Restoration/Enhancement, Shoreline Management

11) 100-Year Floodplain

Floodplains help protect people and infrastructure from flooding and also benefit water quality by acting as natural filters and recharging aquifers.[133] Impacts from flooding events are exacerbated by land development, which increases stormwater runoff volume and velocity. Restoring existing undeveloped floodplains return ecological benefits to the river system and downstream communities.

Scoring: The National Flood Hazard Layer represents the current effective flood risk within an area, depicting which areas have a 1% probability of flooding in any given year. Parcels that contain areas within the 100-year floodplain approved by the Federal Emergency Management Agency (FEMA) received "2" points; all other parcels received "0" points.

GIS Layers Used: Parcel, National Flood Hazard (FEMA), NLCD Land Cover (2011)

Restoration Categories: Riparian Buffer Restoration/Enhancement

12) Private Boat Ramps and Docks

Existing private boat ramps and docks can cause increased stormwater runoff, increased pollutants from boat fuel, sedimentation, and more.

Scoring: Parcels with private boat ramps along drinking water reservoirs received "2" points; parcels with private docks along drinking water reservoirs received "1" point. All other parcels received "0" points. A parcel with both a private boat ramp and a private dock received "3" total points: "2" for a private boat ramp and "1" for a private dock.

GIS Layers Used: Parcel, Private Boat Ramps and Docks

Restoration Categories: Shoreline Management

[133] (The Nature Conservancy, 2018)

13) High Traffic Commercial Pet Locations – Some locations are more likely to have more dog traffic; if pet waste is not properly disposed of, these areas are at increased likelihood of contributing to water quality pollution through stormwater runoff that includes concentrated levels of pet waste.

Scoring: Parcels containing veterinary hospitals, pet stores, pet grooming or boarding facilities, or humane societies/animal shelters received "1" point; all other parcels received "0" points.

GIS Layers Used: Parcel, Google searches: Veterinary Hospitals, Pet Stores, Pet Grooming and/or Boarding Facilities, Animal Shelters.

Restoration Categories: Pet Waste Stations

14) Parks – Existing public land where people may take their dogs include parks and heritage preserves. If not properly disposed of, pet waste negatively impacts water quality by increasing bacteria levels.

Scoring: Parcels categorized as existing public land (National/State/County/City Parks, Heritage Preserves, other lands open to the public) received "1" point. All other parcels received "0" points.

GIS Layers Used: Parcel, National/State/County/City Parks, Heritage Preserves

Restoration Categories: Pet Waste Stations

Appendix E

SEPTIC SUITABILITY GEOSPATIAL ANALYSIS

Prepared for the Lake Keowee Source Water Protection Team

Authored by Katie Callahan and Hamdi Zurqani, Clemson University

November 2019

CENTER for WATERSHED EXCELLENCE
Clemson Public Service and Agriculture

SEPTIC SYSTEM GEOSPATIAL ANALYSIS AND SOIL SUITABILITY

BACKGROUND

To better evaluate the potential impact of septic systems, failures, and bacteria pollution to surface waters and prioritize action on behalf of the watershed, a geospatial analysis was conducted. All figures and data were developed on the spatial scale of HUC-10, subdividing the project area to two major watersheds:

- 0306010102 Keowee River – Lake Keowee Watershed, residing mostly within Pickens County, SC and extending into North Carolina (Fig. 1);
- 0306010103 Little River - Lake Keowee Watershed, residing entirely within Oconee County, SC (Fig. 1b).

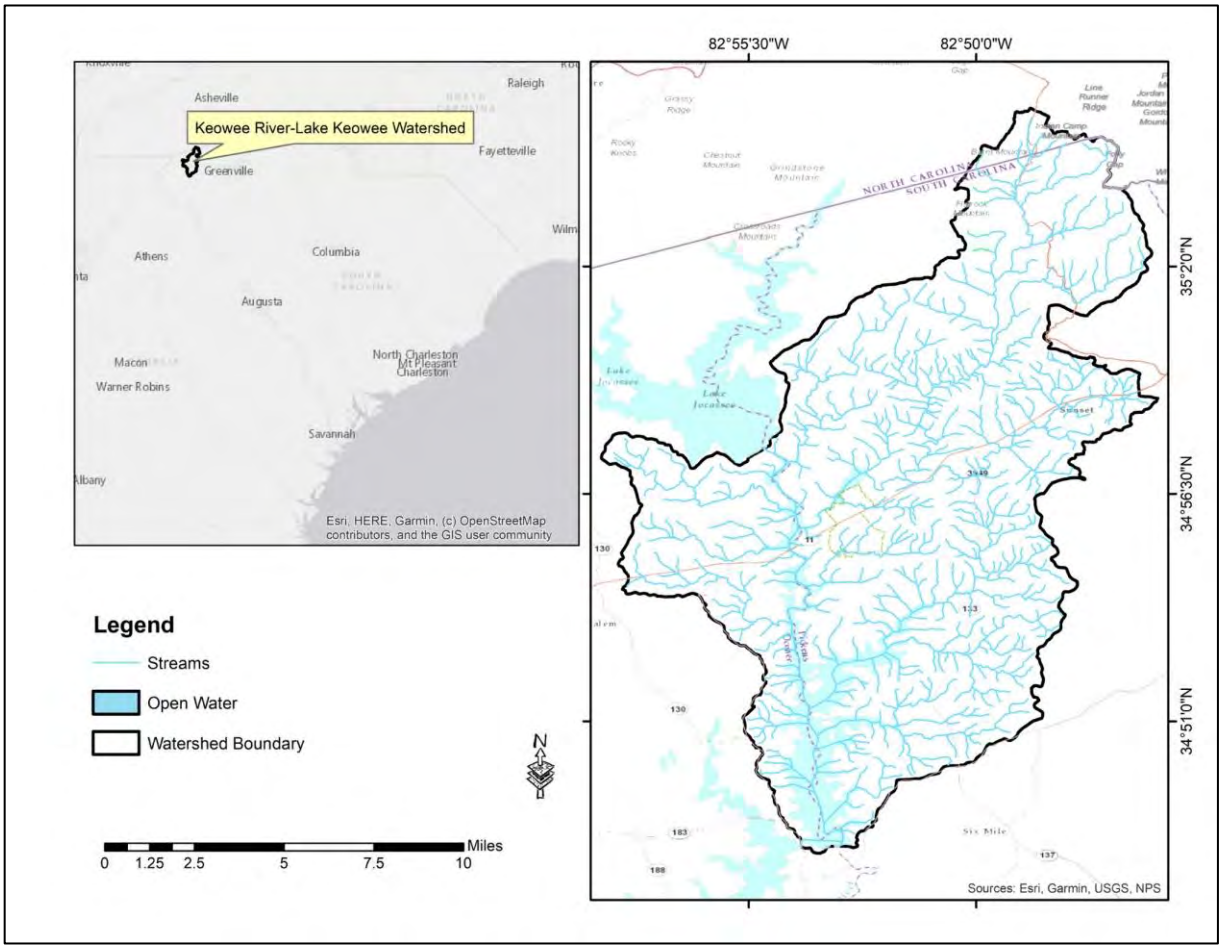


Fig. 1a. Project area and HUC-10 boundary for Keowee River Watershed.

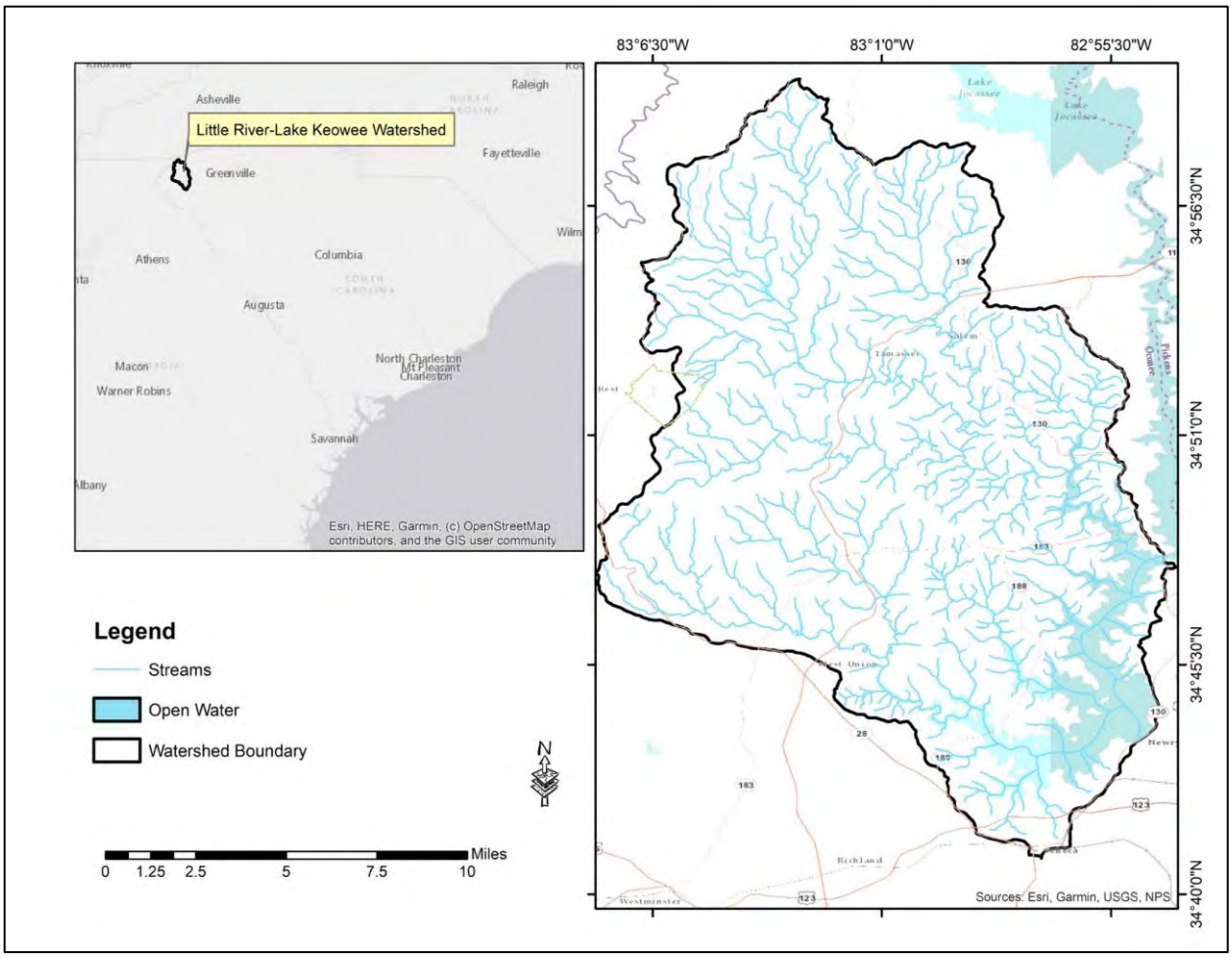


Fig. 1b. Project area and HUC-10 boundary for Little River Watershed.

Data was collected by LKSWPB partners and provided for this analysis where data was available.

Table 1. Date description and source.

No	Name	Date type	Sources
1	Sewer system lines	Polyline	Oconee County, Walhalla Water and Sewer
2	Streams data	Polyline	National Hydrography Dataset
3	911 data	Point	Oconee County
4	Building outlines	Polygon	Pickens Counties
5	Parcels polygon	Polygon	Oconee and Pickens Counties
6	Year built	Excel sheets	Oconee and Pickens Counties
7	Watersheds boundaries	Polygon (HUC-10)	Google Earth Engine (GEE)

ASSESSING PRIORITIES BASED ON AGE OF SYSTEM

Septic systems are a potential source of bacteria and nutrient pollution to groundwater and surface waters when the wastewater treatment system is failing. Failure to properly treat wastewaters occurs when the system is improperly sized, not sited appropriately, not maintained, disrupted by roots and heavy items that impact the drainfield (such as driving large vehicles over the adsorption field or placement of an above ground pool), and other factors. Septic system operations are reliant on soil suitability, characterized by the soil layer's ability to infiltrate; the separation between system and high water table; and presence of bedrock.

Several assumptions were made so that a data layer of homes served by septic systems within 300' of open water could be developed.

1. All homes within 500' of sewer line were labeled as being served by sewer.
2. Lots with more than one home were assigned the age of the oldest residence on the property.
3. All homes within 300' of open water were assumed to have the greatest potential impact on local water quality, if their system was failing.

Age of septic system was categorized as follows:

- 2001-2019
- 1971-2000
- Pre-1970
- No Information.

Within 300' of surface waters, the analysis identified 3,608 homes served by septic systems (1,707 in Keowee River Watershed and 1,901 in Little River Watershed). There are 786 septic systems within 300' of open water built in this century, and far more built before the year 2000 (1,982). More than 800 homes lacked year built between the two county data sets (23% of data points for this analysis). Figure 2a and 2b depict these categories across the two watersheds.

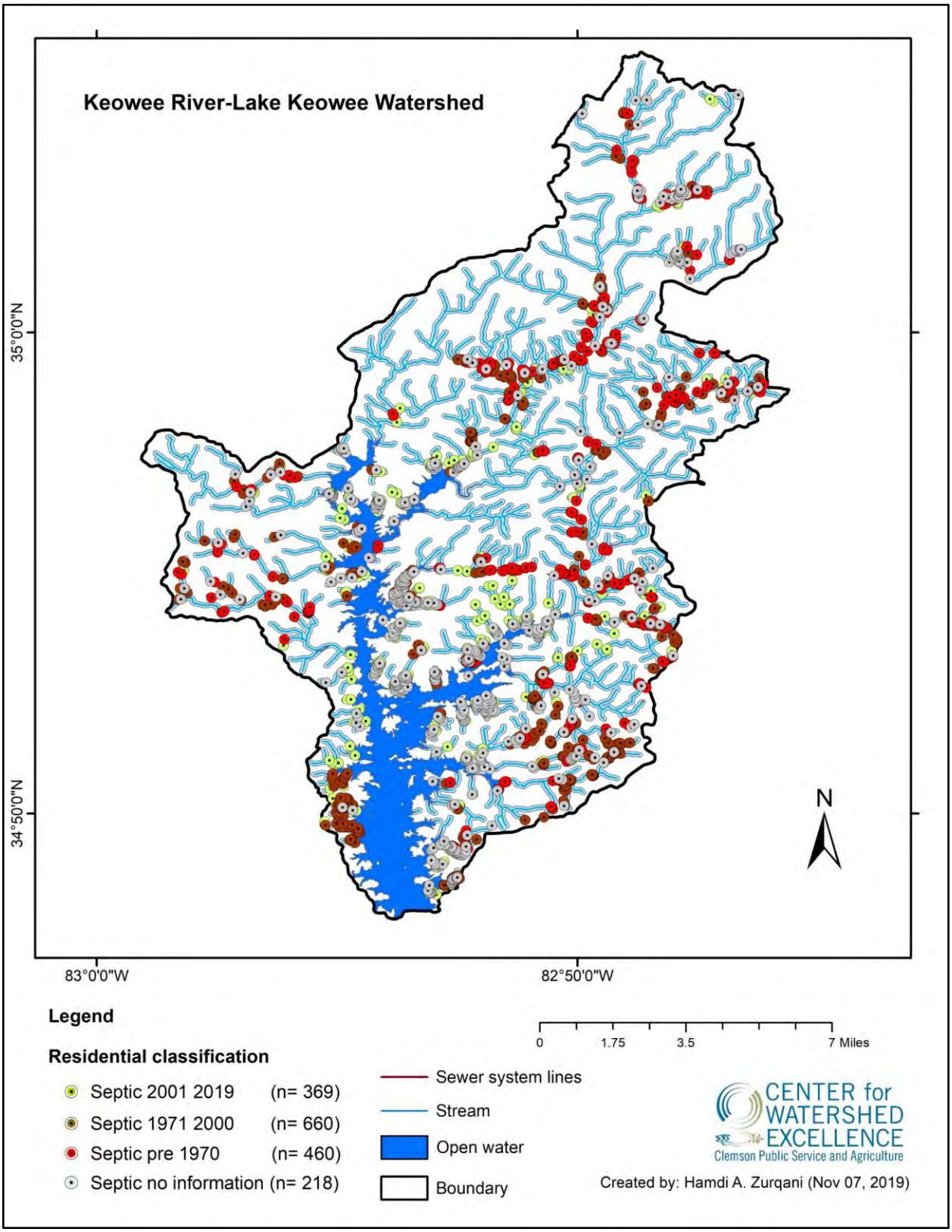


Fig. 2a. Categorized homes served by septic system and within 300' buffered zone area within 0306010102 Keowee River Watershed.

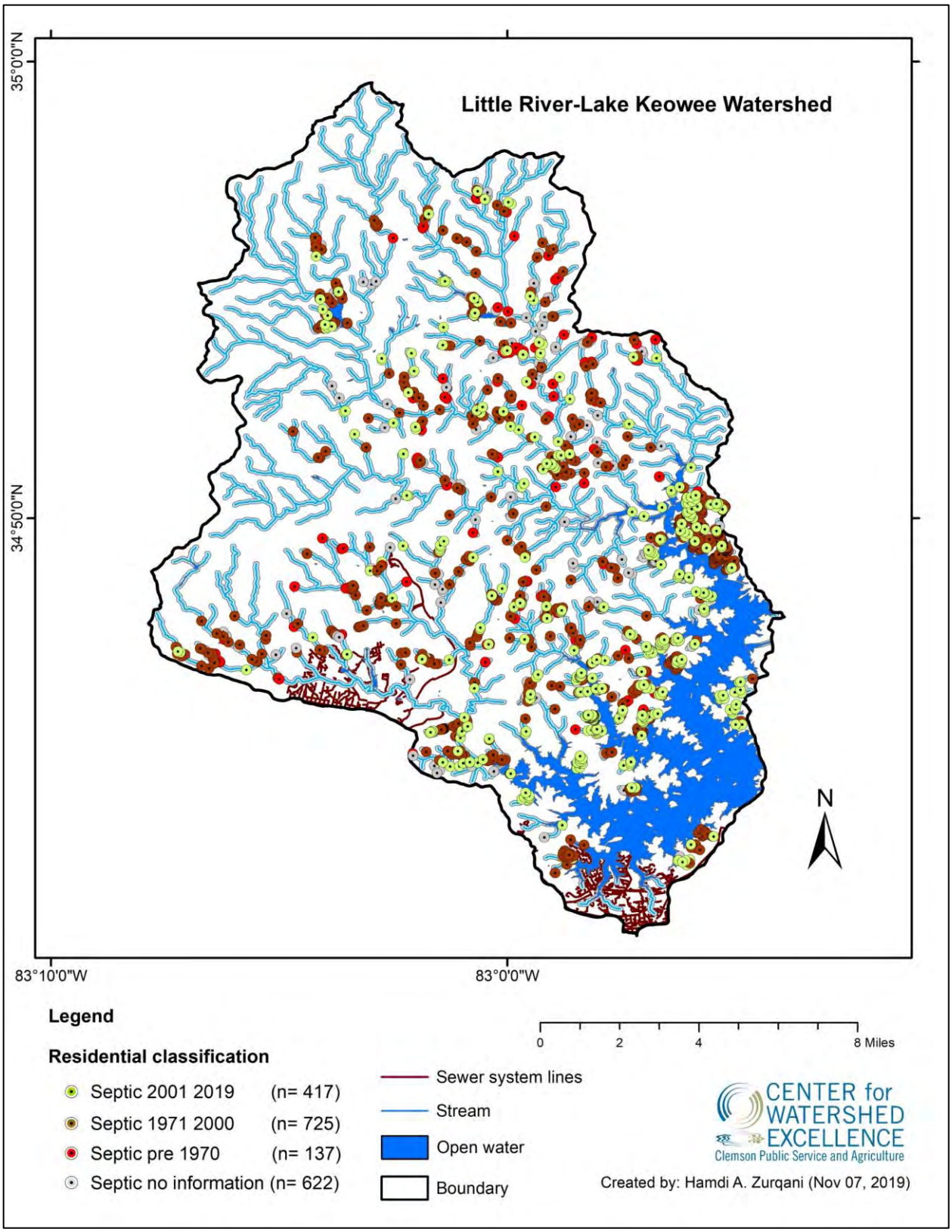


Fig. 2b. Categorized homes served by septic system and within 300' buffered zone area within 0306010103 Little River Watershed.

ASSESSING PRIORITIES BASED ON SOIL SUITABILITY RANKING

The traditional septic tank system consists of three major components: the septic tank, a distribution device, and an absorption field. After initial treatment in the septic tank, the liquid effluent passes through the distribution device, which ensures that equal quantities of effluent go to each pipe in the absorption field. The absorption field is a subsurface leaching area within the soil that receives the liquid effluent from the distribution device and distributes it over a specified area, where it is allowed to seep into the soil.

The Natural Resource Conservation Service (NRCS) is charged by the federal government to manage the National Cooperative Soil Survey and collect, store, maintain, and distribute soils information of privately-owned lands in the United States. As such, the agency produced three data bases – the Soil Survey Geographic Data Base (SSURGO), the State Soil Geographic Data Base (STATSGO), and the National Soil Geographic Data Base (NATSGO). Of these, SSURGO holds the most detailed level of information, created by field methods, using observations along soil delineation boundaries and traverses, and developing data based on field transects. Maps are made at scales ranging from 1:12,000 to 1:31,680 on mapping bases of orthophotoquads or 7.5' topoquads. According to the NRCS, SSURGO data is primarily used for farm and ranch conservation planning, silviculture, and county, city, and watershed planning and management (NRCS, accessed Nov. 2019).

For our analysis, the SSURGO Data Base was imported into ESRI ArcGIS and applied to the two watersheds of study. The "septic suitability" rating is applied to the watershed and more specifically, to the homes prioritized within the 300' of water buffered zone. Based on the NRCS SSURGO database, the rating classes of septic tank absorption fields are:

- "*Not limited*" - the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected.
- "*Somewhat limited*" - the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected.
- "*Very limited*" - the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Figures 3a and 3b show the SSURGO Septic Suitability rating across the two watersheds of study.

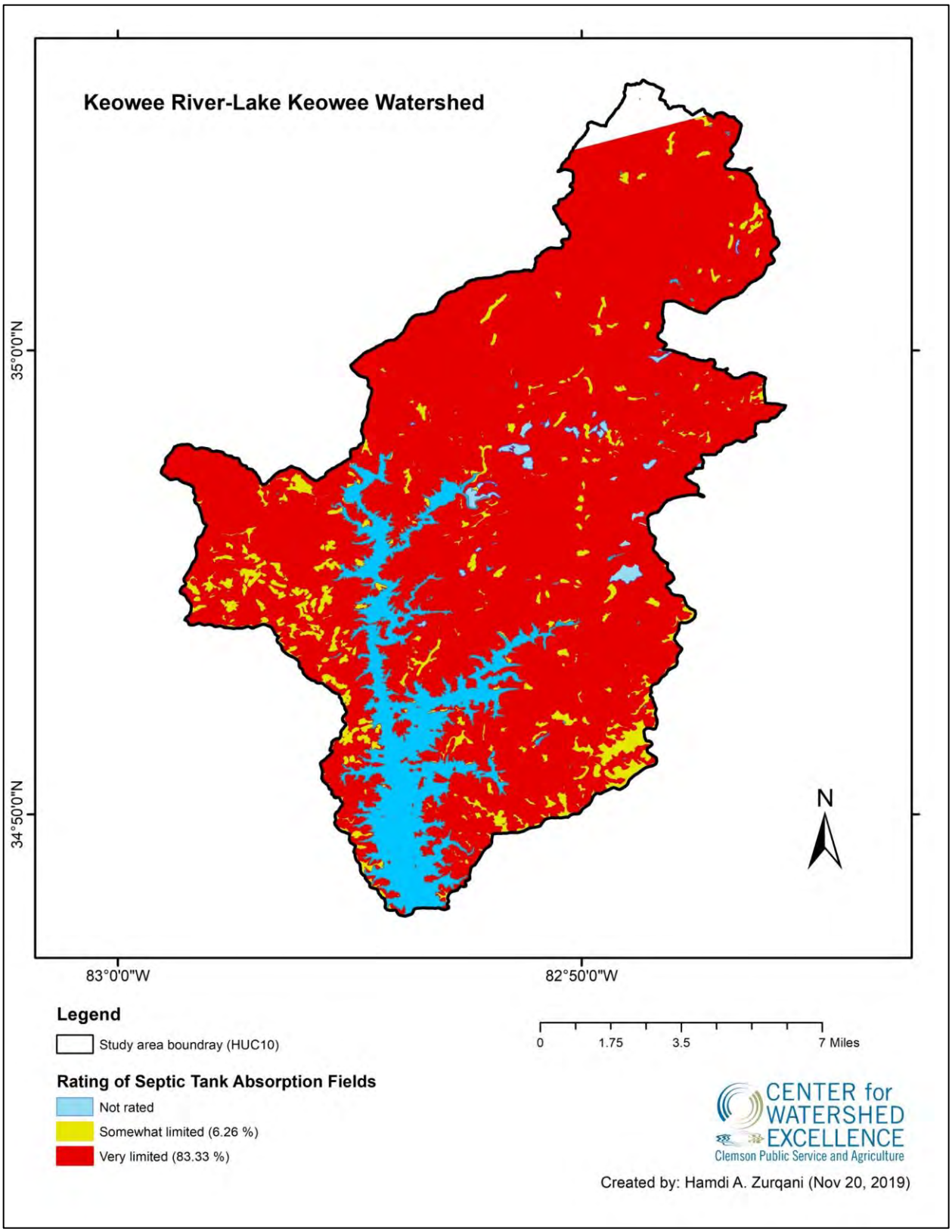


Fig. 3a. Septic Suitability Rating in 0306010102 Keowee River Watershed.

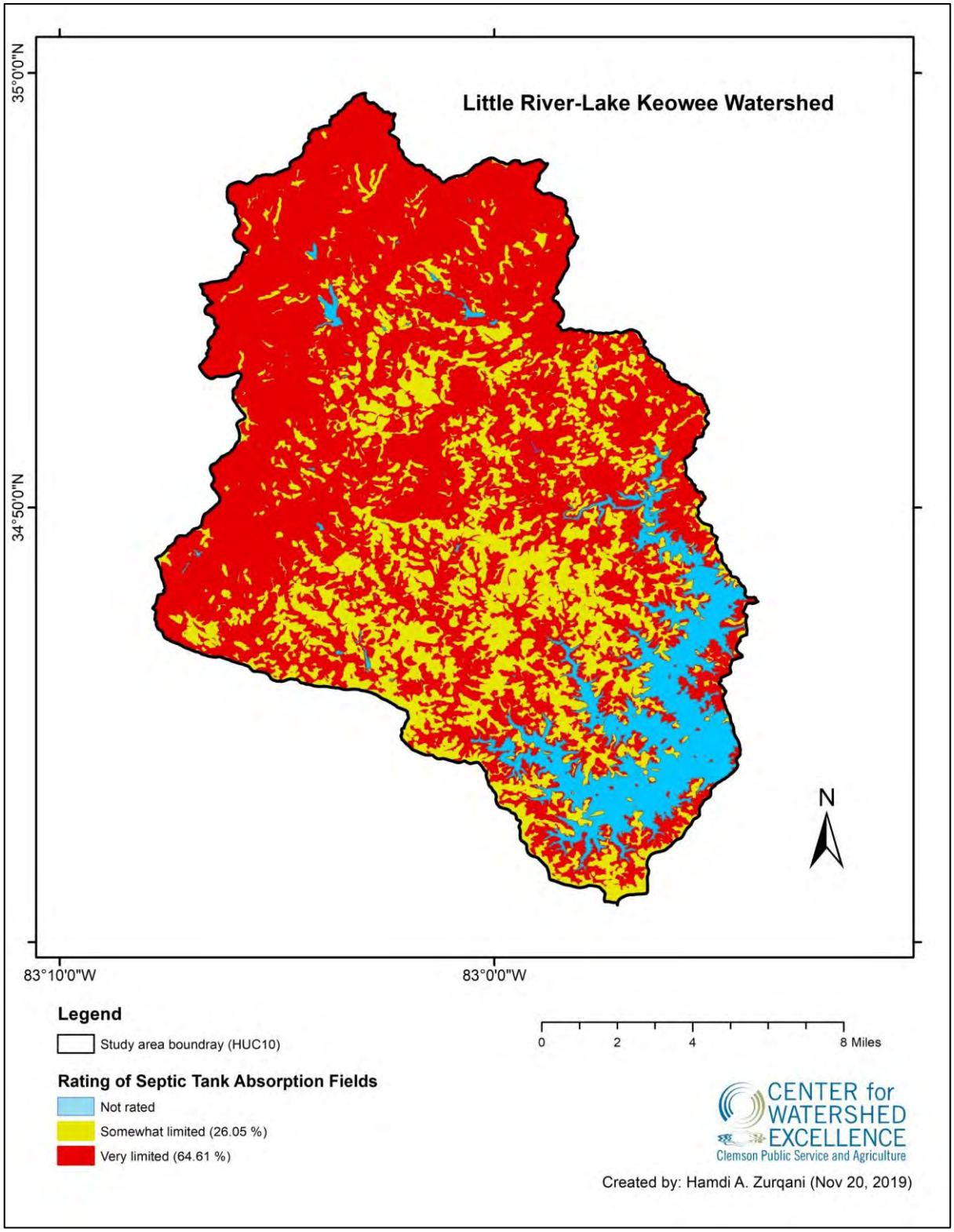


Fig. 3b. Septic Suitability Rating in 0306010103 Little River Watershed.

In this evaluation, only the soil layer between depths of 24 and 60 inches is evaluated. The septic suitability rating is based on soil properties that affect absorption of effluent. These include soil texture, stones and boulders, depth to bedrock, water movement, depth to saturated zone, flooding, slope, and the maintenance required of the owner for expected performance. The numerical ratings indicate the severity of individual limitations. Within the data set, ratings are shown as decimal fractions ranging from 0.01 to 1.00, indicating gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00). The analysis found that 83% of study area mostly in Pickens County (the Keowee River Watershed) rated as very limited, and nearly 65% of the Little River Watershed (Oconee County) also very limited.

PRIORITIZING SEPTIC SYSTEM FAILURES AND POLLUTION SOURCES

Overall, greater than 65% of land area across the entire watershed is rated as very limited for septic suitability. Further, it was identified that 54% of homes with year built data, served by septic systems, and within 300’ of water were installed before the year 2000. By grouping the age of septic systems near waterways by mean, a high risk-high priority analysis was conducted (Fig. 4a and 4b).

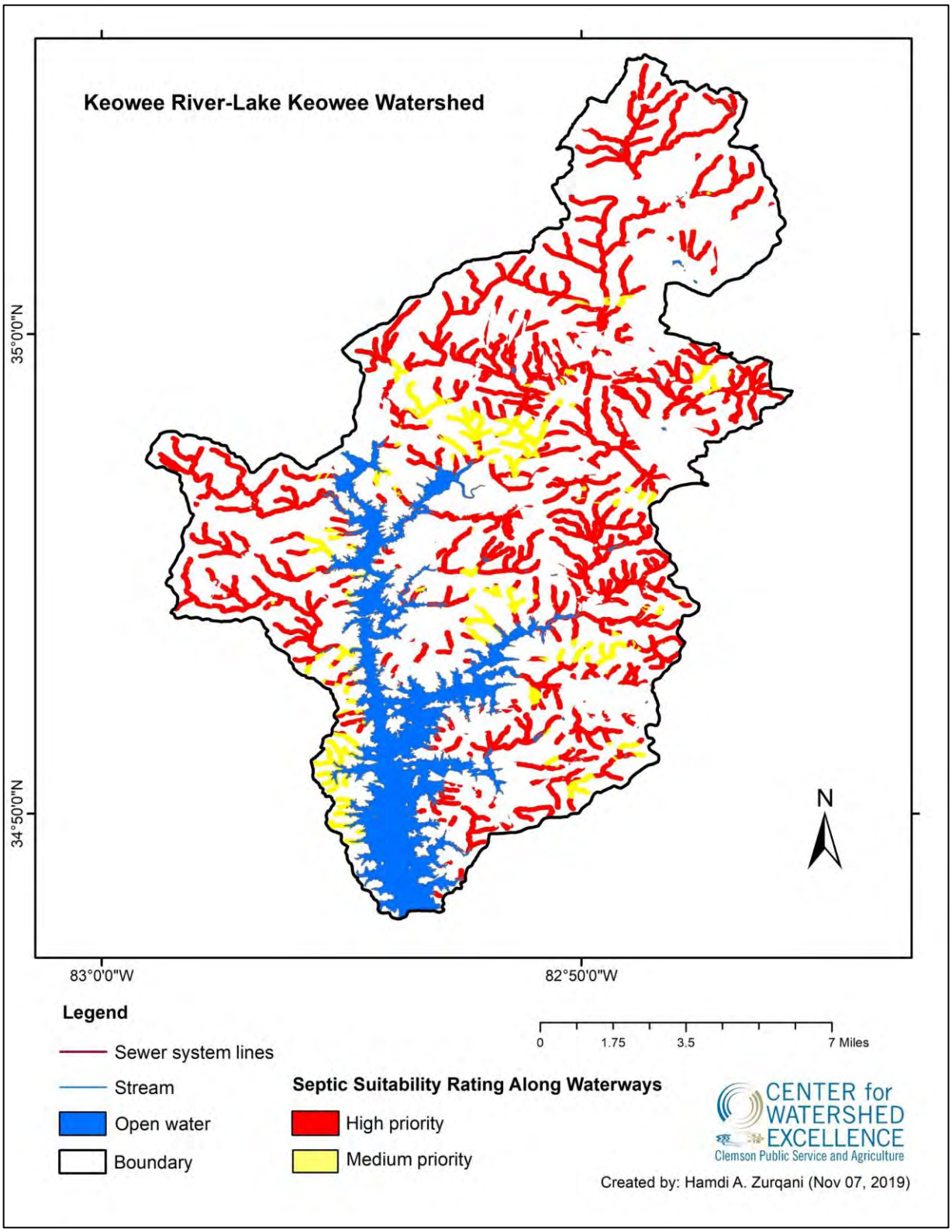
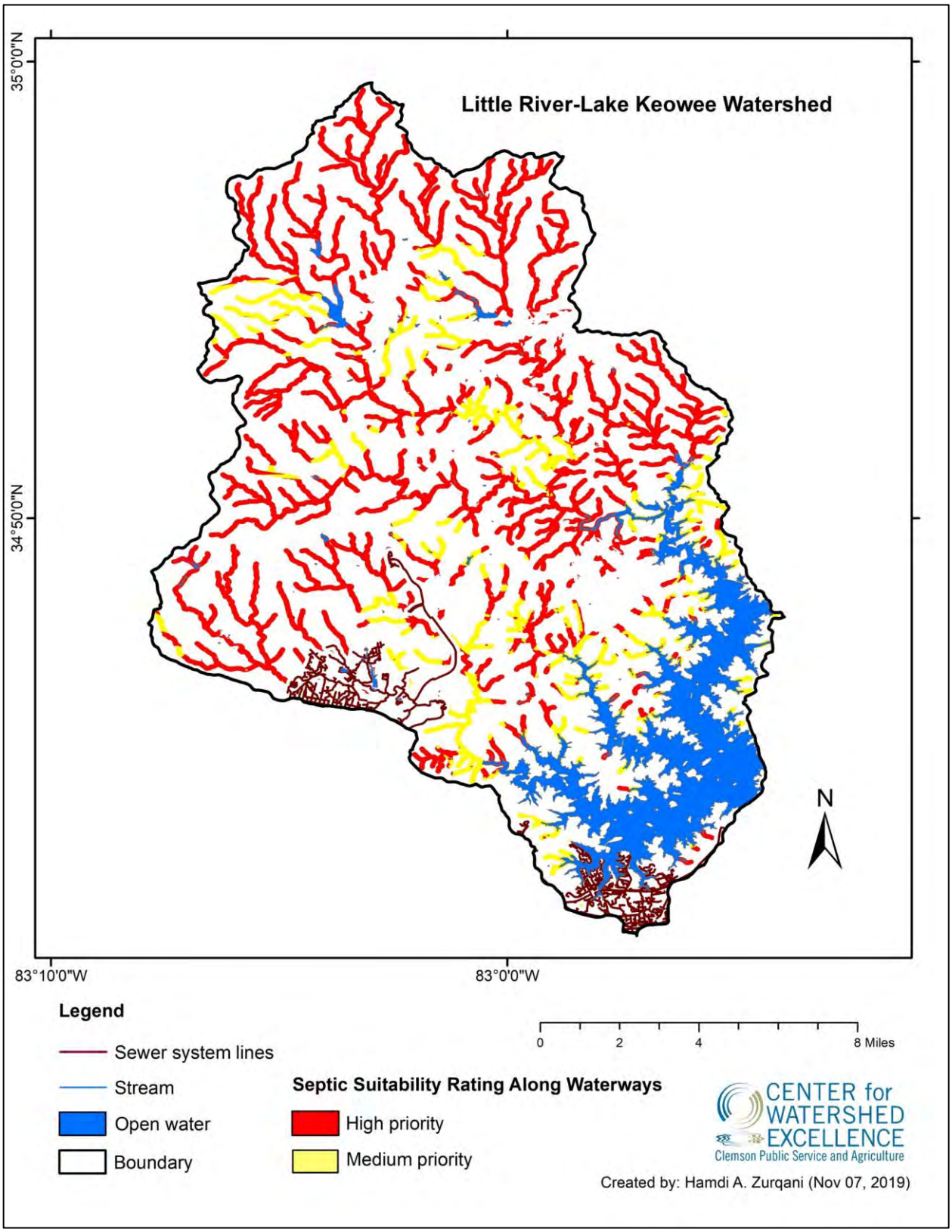


Fig. 4a. Prioritized buffered areas relating septic system failures and sources of pollution in the Keowee River Watershed.


Little River-Lake Keowee Watershed
35°0'0"N
34°50'0"N
83°10'0"W
83°0'0"W
N
0
2
4
8 Miles
Legend
Sewer system lines
Stream
Open water
Boundary
Septic Suitability Rating Along Waterways
High priority
Medium priority
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Clemson Public Service and Agriculture
Created by: Hamdi A. Zurqani (Nov 07, 2019)

Fig. 4b. Prioritized buffered areas relating septic system failures and sources of pollution in the Little River Watershed.

Septic system replacement or discontinuation and tie-in to sewer system improved bacteria loading to Horse Creek, a watershed of the Savannah River basin. Horse Creek was identified as impaired for bacteria from 1998 through 2006. Tie-in to sewer service infrastructure, septic system repairs, and education was implemented by 2009. In 2014, the waterway fully attained its use in regards and no longer was impaired for bacteria contamination (US EPA, 2016).

In order to condense data into an approach for addressing limitations of traditional septic systems to function successfully with average maintenance, all developed data was evaluated together. Within the 300' buffered zone around waterways, clusters of septic systems with age data were averaged and overlaid with septic suitability rating. Should an effort to educated homeowners, repair and replace systems, or extend sewer to address water quality impairments, Figures 5a and 5b show the areas of greatest anticipated priority.

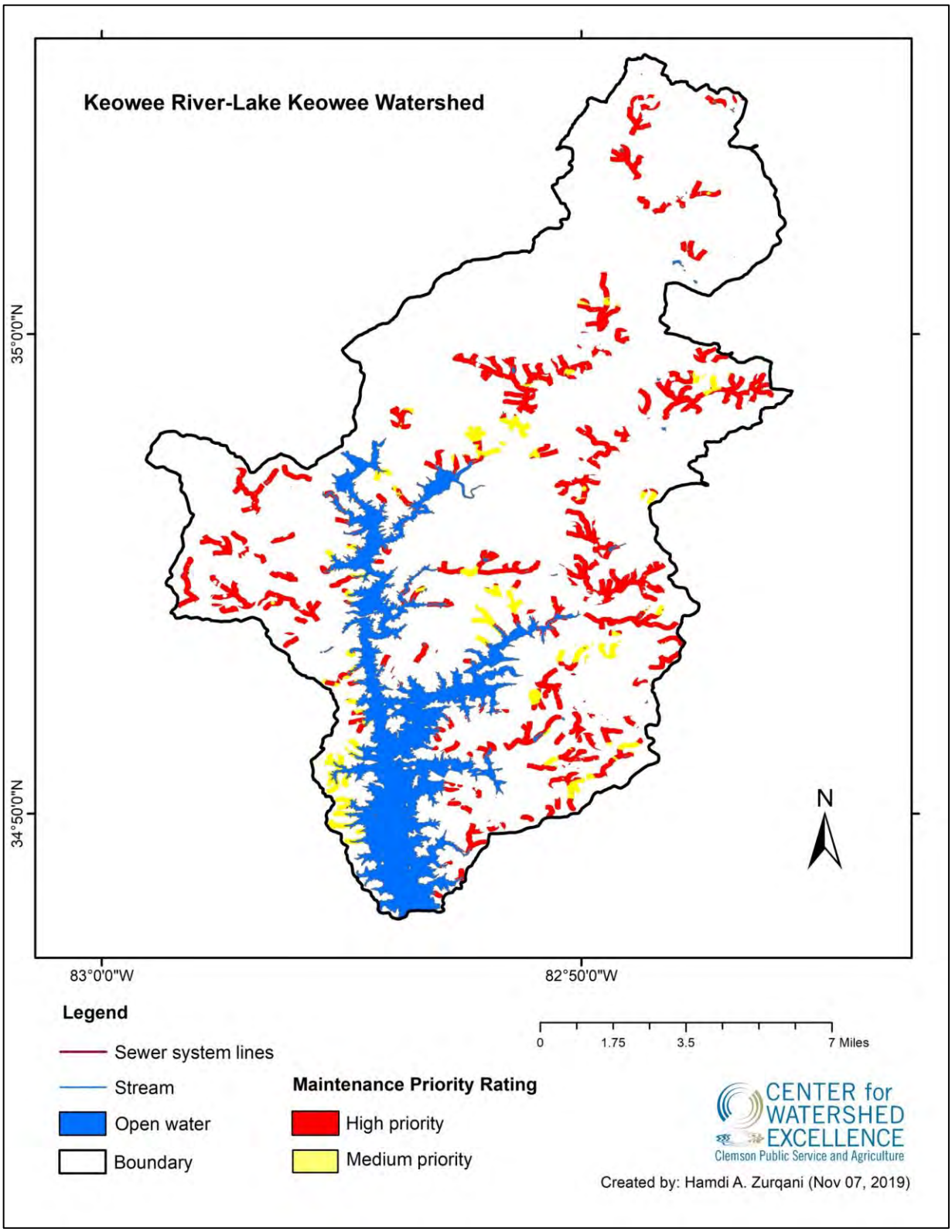

Fig. 5a. Priority reaches for a Septic System Repair and Replacement Program based on clusters of septic systems near streams and average age of septic systems in the Keowee River Watershed.

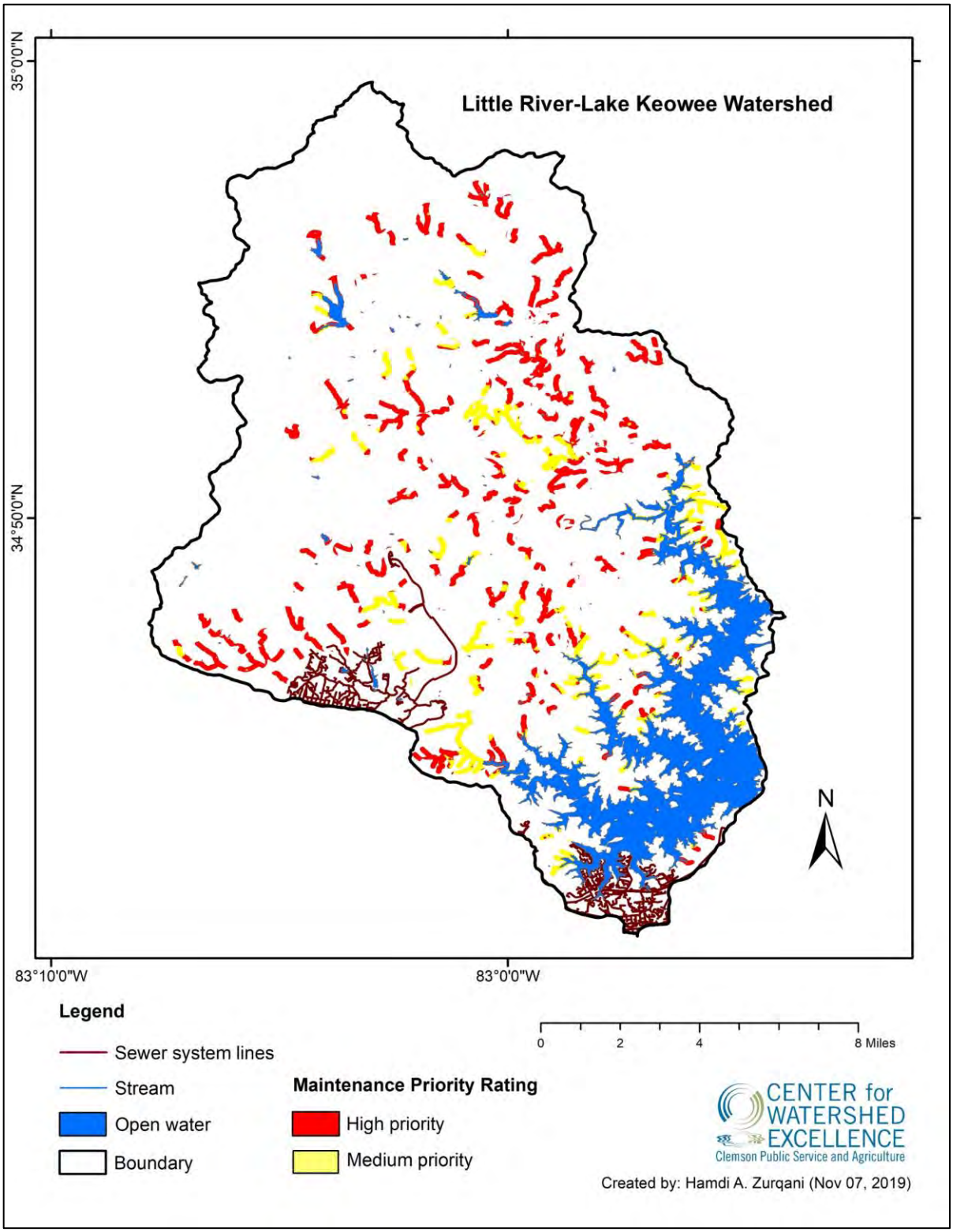

Fig. 5b. Priority reaches for a Septic System Repair and Replacement Program based on clusters of septic systems near streams and average age of septic systems in the Little River Watershed.

REFERENCES

National Resource Conservation Service.

United States Environmental Protection Agency. 2016. *Septic System Repairs Improve Water Quality in Horse Creek* 841-F-016-001M. Washington, D.C.

Appendix F. Parks and Pet-Related Businesses

Table 52. List of Parks and Pet-Related Businesses

Location Name	Type	County	Watershed
Oconee State Park	Park	Oconee	Little River-Lake Keowee
Oconee Station State Historic Site	Park	Oconee	Little River-Lake Keowee
Jocassee Gorges Management Area	Park	Pickens	Keowee River-Lake Keowee
South Cove County Park	Park	Oconee	Little River-Lake Keowee
High Falls County Park	Park	Oconee	Little River-Lake Keowee
Mile Creek Park	Park	Pickens	Keowee River-Lake Keowee
Sertoma Field	Park	Oconee	Little River-Lake Keowee
West Union Town Park	Park	Oconee	Little River-Lake Keowee
Keowee Toxaway State Park	Park	Pickens	Keowee River-Lake Keowee
Keowee Falls RV Park	Park	Oconee	Little River-Lake Keowee
The Pet Spa	Pet-Related Business	Oconee	Little River-Lake Keowee
Walhalla Veterinary Clinic	Pet-Related Business	Oconee	Little River-Lake Keowee
Oconee Veterinary Clinic	Pet-Related Business	Oconee	Little River-Lake Keowee
June’s Topknotch Pet Stylz	Pet-Related Business	Pickens	Keowee River-Lake Keowee

Appendix G. Public Meeting Flyers

LAKE KEOWEE
SOURCE WATER PROTECTION TEAM
Our Water. Our Future. Our Responsibility.

PUBLIC MEETING NOTICE

Protecting the Lake Keowee Watersheds

Thursday, October 24, 6:00 PM - 7:30 PM
at the Seneca Water Filter Plant

630 Northampton Road, Seneca SC 29672

**Limited parking available, please carpool if possible*

Please join us for a public meeting to discuss water quality in the Lake Keowee watersheds. The Lake Keowee Source Water Protection team is creating a "Lake Keowee Watershed-Based Plan", a grant-funded project focused on managing bacterial, sediment, and nutrient levels throughout the rivers and streams draining into Lake Keowee.

LAKE KEOWEE SOURCE WATER PROTECTION TEAM PARTNERS

Seneca Light & Water · FOLKS · GreenvilleWater · Oconee · Upstate Forever · Pickens County South Carolina 1868 · Advocates for Quality Development

This project is funded wholly or in part by the US EPA under a Capitalization Grant for Drinking Water State Revolving Funds through the SC Department of Health and Environmental Control (SC DHEC).

LAKE KEOWEE
SOURCE WATER PROTECTION TEAM
Our Water. Our Future. Our Responsibility.

STAKEHOLDER MEETING

to discuss protecting the Lake Keowee watersheds

Wednesday, December 11 from 10-11:30 AM
at the Seneca Water Filter Plant

630 Northampton Road, Seneca SC 29672

**Limited parking available, please carpool if possible*

Please join us for a stakeholder meeting to discuss water quality in the Lake Keowee watersheds. The Lake Keowee Source Water Protection team is creating a "Lake Keowee Watershed-Based Plan", a grant-funded project focused on managing bacterial, sediment, and nutrient levels throughout the rivers and streams draining into Lake Keowee.

LAKE KEOWEE SOURCE WATER PROTECTION TEAM PARTNERS

SENECA LIGHT & WATER
FOLKS
GreenvilleWater
OCONEE
UPSTATE FOREVER
PICKENS COUNTY SOUTH CAROLINA 1868
Advocates for Quality Development

This project is funded wholly or in part by the US EPA under a Capitalization Grant for Drinking Water State Revolving Funds through the SC Department of Health and Environmental Control (SC DHEC).

Appendix H. Public Outreach Strategy

Appendix H: Lake Keowee Watersheds Public Outreach Plan

BMP	Impairments Addressed	Sources of Pollution	Target Audience(s)	Messages	Methods of Outreach	Potential Project Partners
Septic System Repair/Replacement	• Bacteria • Nutrients	• Leaking/failing septic systems	• Homeowners • Home Owner Associations (HOAs) • Certified Septic System Contractors • Local Wastewater Providers • Municipal staff	• Septic systems can pollute waterways and are a threat to human health. Damaged or failing septic systems can expose citizens to harmful bacteria and viruses through contaminated drinking water and sewage backups in a home's indoor plumbing. • Faulty septic systems can cause untreated wastewater to rise to the surface of leach fields and drain into nearby waterways, polluting surface waters. • Septic systems should be inspected and serviced every three years to ensure they are operating properly.	• Send targeted mailing to homeowners • Information displays and/or brochures at public libraries, City/Town Halls, FOLKS office, Clemson Extension offices, County Buildings, and public recreational facilities • Utility bill stuffers • Social media, websites	• Advocates for Quality Development (AQD) • Anderson Pickens County Stormwater Partners (APCSP) • Clemson University Center for Watershed Excellence (CU-CWE) • Friend of Lake Keowee (FOLKS) • Greenville Water (CW) Seneca Light & Water (SL&W) • Oconee County • Pickens County • Oconee Joint Regional Sewer Authority (OJRSA) • Upstate Forever (UF)
Agricultural BMPs	• Bacteria • Nutrients • Sediment	• Livestock with access to streams • Agricultural runoff • Croplands	• Landowners • Agricultural Operators/ Livestock Owners • Farm Bureaus • SC Cattlemen's Association • Carolina Farm Stewardship Association	• It is important to keep animals out of waterways because it improves herd health while also protecting water quality. • Riparian buffers are effective at reducing the amount of soil, bacteria, sediments, and nutrients from entering streams and keeping animals out of waterways. • Proper use of fertilizers is important to protect water quality (in appropriate amounts and not before or during rain events). • Livestock can contribute to streambanks erosion and contribute to the sedimentation of waterways.	• Mail letters to landowners • Informational displays and/or brochures about proper agricultural practices at City Halls, water utility, offices, county buildings, NRCS and SWCD offices. • Provide information on BMP cost share programs for inclusion in SWCD and Cattlemen's Association webpages, and newsletters.	• Clemson Extension CU Ext.) • NRCS • Oconee County • Pickens County • Pickens County Soil and Water Conservation District (PCSWCD) • Oconee County Conservation District (OCSD) • UF
Wetland and Riparian Buffer Restoration and Enhancement	• Nutrients • Sediment	• Impacted, low quality, or inundated wetlands • Eroded streambanks	• Homeowners • HOAs • Municipal Staff • Mitigation Projects	• Plant native vegetation along creeks/streams to prevent erosion. • Buffers are the most cost-effective ways to protect water quality.	• Utility bill stuffers • Informational brochures and posters at local public offices. • Host a public tree or native plant giveaway for homeowners. • Establish support for a county-wide riparian buffer ordinance.	• CU Ext. • ADQ • APCSP • SL&W, GW, ORJWS • FOLKS • Municipal and County Staff • County Soil and Water Conservation District • UF

Appendix H: Lake Keowee Watersheds Public Outreach Plan

BMP	Impairments Addressed	Sources of Pollution	Target Audience	Messages	Methods of Outreach	Potential Project Partners
Stormwater BMPs	• Bacteria • Nutrients • Sediment	• Stormwater Runoff • Land clearing • Road building • Residential construction • Commercial construction	• Homeowners • HOAs • Schools • Local community groups (e.g. YMCAs) • Local governments • Home Builder Associations • Engineers • Contractors	• Routinely sweep off sidewalks and driveways. • Use weed-free mulch when reseeding bare spots on lawns, and use erosion control blankets if restarting or tilling a lawn. • Notify local government officials when you see sediment entering streets or streams near construction sites. • Avoid mowing within 10 to 25 feet from the edge of a stream or creek. • Wash your car at a commercial car wash or on a surface that absorbs water, such as grass or gravel. • Do not dump waste down storm drains because water flowing into storm sewers usually drains directly into local waterways without treatment. • Riparian buffers protect streams by reducing erosion and prevents pollutants from entering streams. • Contractors should install sediment control devices according to specifications. • Contractors should abide by local stormwater regulations. • Large tracts of cleared lands should be stabilized to prevent erosion.	• Do PSAs about stormwater runoff and water quality on local radio stations • Maintain a presence at local festivals • Help promote watershed education in the public-school system. • Promote online educations resources related to water quality (Clemson Ext, City and County websites, and local SWCDs) • Informational brochures and posters at local public offices (e.g., Clemson Ext., NRCS, SWCDs)	• APCSP • CU-Ext. • CU-CWE • FOLKS • Municipal and County Staff (Public Works, Parks, Stormwater) • Municipal Staff • UF
Pet Waste Stations	• Bacteria	• Improper disposal of pet waste	• Homeowners • HOAs • Apartment complexes • Veterinary offices • Animal shelters • Animal groomers	• It is important to dispose of pet waste properly! The incorrect disposal of pet waste is a major threat to water quality and human health because pet waste contains high levels of bacteria, parasites, and viruses. • Pet waste also contains nutrients and can contribute to algae growth in waterways. • Pet waste washed into lakes or streams can use of oxygen and release ammonia, which can cause fish kills.	• Pet waste station and signage installations • Informational posters at veterinary offices, groomers, kennels, animal shelters, libraries, city halls, and local schools. • Provide dog waste bag holders to veterinary offices, groomers, kennels, and animal shelters. • Advocate for the adoption of pet waste ordinances in local municipalities and counties.	• APCSP • CU Ext. • FOLKS • Pickens/Oconee County Parks Depts. • Pickens/Oconee County Soil and Water Conservation Districts • UF
Shoreline Management	• Nutrients • Sediment	• Eroded shorelines • Improper boat dock maintenance	• Homeowners • HOAs • Water utilities • Reservoir Operators	• Plant native plants along shorelines to prevent erosion. • Avoid mowing lawns to water's edge to reduce runoff into local waterways. • Establish a 10-30 foot no fertilizer or pesticide zone along shorelines on rivers, streams, and lakes. • Avoid pruning vegetation along shoreline without seeking proper guidelines and permits. • Obtain proper permits and abide by permit requirements when working within shoreline management area. .	• Utility bill stuffers • Informational brochures and posters at local public offices. • Host trainings and workshops on shoreline management for homeowners.	• APCSP • CU Ext. & CU CWE • UF • FOLKS • Oconee/Pickens County Soil and Water Conservation Districts • Municipal and County Staff • Utilities - GW, SL&W, ORJWS

Appendix H: Lake Keowee Watersheds Public Outreach Plan

BMP	Impairments Addressed	Sources of Pollution	Target Audience	Messages	Methods of Outreach	Potential Project Partners
Wildlife BMPs	• Bacteria • Nutrients • Sediment	• Canada Geese • Beavers • Deer • Coyotes • Feral Hogs	• Homeowners • HOAs • Apartment complexes • Land owners • Municipal staff • Hunt Clubs • Sporting Goods Stores	• Animal waste from wildlife contributes to bacteria pollution in rivers, lakes, and streams. • Discourage nuisance wildlife species from congregating in areas near impaired waters by planting riparian vegetation and posting not feeding signage.	• Host workshops on methods for controlling Canada Geese, beaver, deer, and feral hogs populations. • Promote signage in public areas with message “Don’t Feed the Geese”. • Create informational flyers on nuisance wildlife for displays in public places.	• Anderson and Pickens Counties Parks Dept • CU Ext. • FOLKS • NRCS • Soil and Water Conservation Districts • SCDNR
Land Protection Strategies	• Bacteria • Nutrients • Sediment	• Conservation Easement • Deed Restriction • Fee Simple Purchase • Land Donation	• Landowners • Homeowners • SC Cattlemen’s Association • Carolina Farm Stewardship Association	• Voluntary conservation easements can protect the land you love while you continue to own and manage it for traditional uses; you may also realize significant tax benefits. • Conservation agreements typically prevent land uses such as residential subdivisions, commercial or industrial operations, and mining, while allowing traditional rural land uses, such as farming, grazing, hunting, and timbering to continue.	• Send letters to high priority landowners with information about conservation easements. • Provide information on conservation easements for inclusion in SWCD and Cattlemen’s Association webpages, and newsletters. • Host public outreach meetings with Land Trust staff targeting landowners with large tracts of land, working farms, etc.	• Clemson Extension • SC Farm Bureau • SC USDA • SC Cattlemen’s Association • SCDNR
Forestry	• Sediment	• Improper forest management • Streamside timber harvesting • Poorly placed and managed access roads	• Landowners • Foresters	• Improper forestry practices degrade water quality. • Avoid any forestry activities in streamside management zones. • Harvesting operations should be planned and executed with the goal to protect the site. • Roads should be constructed in a manner to prevent stream crossings and steep slopes to the best extent possible. • Sites should be prepped and restored to prevent erosion.	• Provide information to landowners with forestry operations. • Put informational brochures at local public offices. • Send letters to private and public forest landowners with information about SCFC’s classes and informational resources.	• South Carolina Forestry Commission (SCFC) • Clemson Extension • Anderson & Pickens Counties Public Works • Anderson & Pickens Counties Stormwater Partners