Watershed Based Plan
for the
South, Middle, and North Tyger Subwatersheds

An Action Plan for Protection and Restoration Activities

Prepared by

UPSTATE FOREVER

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for SCDHEC

www.scdhec.gov

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Project Stakeholders

- City of Greer Stormwater Department
- Clemson University Extension
- Greenville County Land Development
- Greenville County Soil and Water Conservation District
- Greer Commission of Public Works
- SC Department of Natural Resources
- Spartanburg County Parks Department
- Spartanburg County Soil and Water Conservation District
- Spartanburg County Stormwater Department
- Startex-Jackson-Wellford-Duncan Water District
- Town of Duncan
- Tyger River Foundation
- USC Upstate Watershed Ecology Center
- Woodruff Roebuck Watershed District

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SJWD WATER DISTRICT

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1) INTRODUCTION

Upstate Forever (UF), in collaboration with project partners, developed this Watershed Based Plan (WBP) for three subwatersheds in the Tyger River Basin (HUC 03050107) to reduce bacteria levels and sediment pollution to meet state water quality standards. The three subwatersheds include the South Tyger River (HUC 0305010701), Middle Tyger River (HUC 0305010702), and North Tyger River (HUC 0305010703). This portion of the greater Tyger River Watershed (HUC 03050107) includes source water intakes and protection areas for Greer Commission of Public Works (Greer CPW), Startex-Jackson-Wellford-Duncan Water District (SJWD), and Woodruff Roebuck Watershed District (WRWD). Together Greer CPW, SJWD, and WRWD provide drinking water to roughly 127,000 residents living in Greenville and Spartanburg Counties.

In 2004 a Fecal Coliform Bacteria TMDL for the Tyger River Basin was approved by the U.S. Environmental Protection Agency (US EPA); unfortunately, water quality standards for many of these sites have not been attained. According to the TMDL, the suspected sources of bacteria in the region include failing septic systems, leaking sewer pipes, stormwater runoff, domestic pets, and wildlife (SCDHEC, 2007). Excessive sedimentation is also a concern in the region because it can degrade the quality of drinking water resources while adversely impacting aquatic organisms by destroying habitat and clogging fish gills. In a recent SC Department of Natural Resources (SCDNR) study of the Broad River Basin, sediment loading in the greater Broad River Basin is 965,000 tons/year, of which up to 88% is stored within the basin (SC DNR, 2016). Subsequently, multiple South Carolina Department of Environmental Control (SCDHEC) monitoring stations in this area are impaired for Biological Criteria.

This WBP provides a comprehensive overview of the sources of bacteria and sediment pollution in these three watersheds and identifies critical areas for protection and restoration. This plan also provides strategies to reduce or eliminate pollution loads, suggests potential funding opportunities and technical resources for pollution mitigation practices, and outlines a public outreach strategy to increase public awareness about water quality issues as it relates to bacteria and sediment. Project partners for this WBP include: Clemson University Extension (CU-Ext), Greenville County Land Development, Greenville County Soil and Water Conservation District (GCSWCD), City of Greer Stormwater Department, Greer Commission of Public Works (Greer CPW), SC Department of Natural Resources (SCDNR), Spartanburg County Stormwater Department, Spartanburg County Parks, Startex-Jackson-Wellford-Duncan Water District (SJWD), Town of Duncan, Tyger River Foundation, USC Upstate Watershed Ecology Center (WEC), and Woodruff Roebuck Water District (WRWD).

2) GENERAL WATERSHED INFORMATION

2.1) Basin Summary

This WBP focuses on three subwatersheds of the Tyger River Basin (HUC 03050107), the North Tyger River, Middle Tyger River, and South Tyger River (Table 1). Together these three subwatersheds comprise approximately 416 miles of streams, 2,331 acres of lake, and over 220,900 acres of land (SC Watershed Atlas, 2017). These three subwatersheds are situated within the greater Broad River Basin with all streams within these subwatersheds classified as freshwaters, according to South Carolina state stream classification criteria (SC Watershed Atlas, 2017).

Table 1. HUC Codes and Sizes of South, Middle, and North Tyger River Subwatersheds (SCDHEC, 2007, NLCD, 2011)

Subwatersheds	10-digit Hydrological Unit Codes (HUC)	Acreage	Stream Miles	Lake Acreage
South Tyger	03050107-03	111,755	205	1,504
Middle Tyger	03050107-02	52,581	98	579
North Tyger	03050107-01	56,590	114	249
Total (all 3)		220,925	417	2,332

2.2) Location and Hydrology

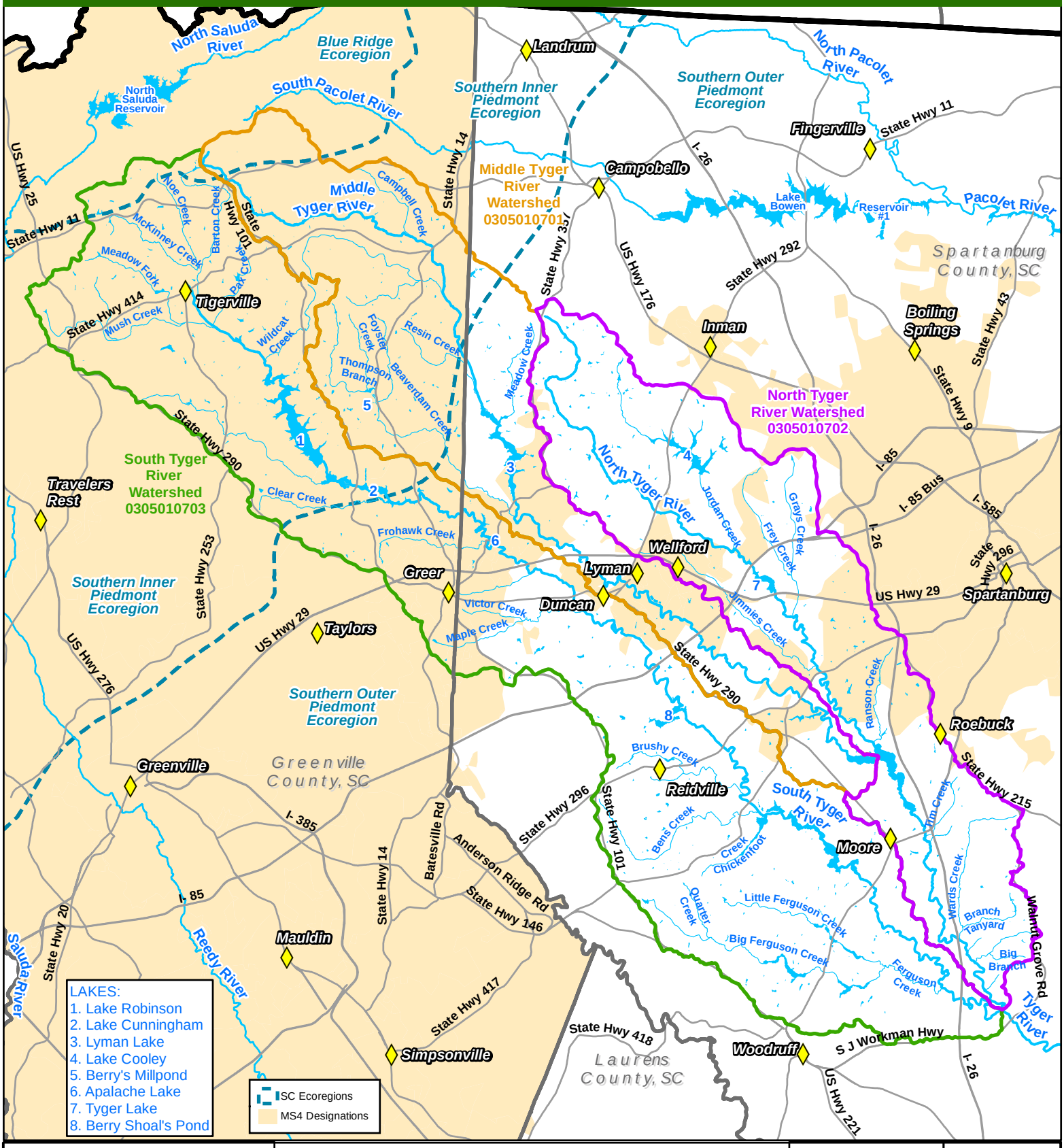
The South and Middle Tyger River watersheds are located within both Greenville and Spartanburg Counties and are mostly within the Piedmont Ecoregion, with a portion extending into the Blue Ridge Ecoregion of South Carolina. The North Tyger River subwatershed is found solely within Spartanburg County and the Piedmont Ecoregion of South Carolina (Figure 1).

The South Tyger River is formed near Chestnut and Glassy Mountains, from the joining of Mush Creek, Barton Creek, and Pax Creek near Pax Mountain in Northern Greenville County. The river is impounded downstream of the confluence to form Lake Robinson. Further downstream the South Tyger River joins Beaverdam Creek to form Lake Cunningham. Downstream of Lake Cunningham, Frohawk Creek, Wards Creek, and Maple Creek flow from the City of Greer into the South Tyger River. The river then flows through Berry's Pond while accepting flow from Silver Lake, Brushy Creek, Bens Creek, Chickenfoot Creek, and Ferguson Creek. The South Tyger River subwatershed includes portions of the City of Greer, as well as the towns of Reidville and Woodruff.

The Middle Tyger River originates near Highway 11 in Northern Greenville County and after being joined by Barnes, Beaverdam, and Campbell Creeks, it is impounded to form Lyman Lake. Below Lyman Lake, flow from Foyster Creek, Thompson Branch, and Berry's Millpond joins the river via another Beaverdam Creek, before flowing southeast through the towns of Lyman and Duncan and continuing to its confluence with the North Tyger River.

The North Tyger River begins just north of Farms Bridge Road in Spartanburg County. Jordon Creek begins above the former location of Hollywild Animal Park (Hampton Road, Wellford, SC) and flows southeast into Lake Cooley before joining with the North Tyger River just above Tyger Lake. As the river continues it is joined by Frey, Grays, and Jimmies Creek, which drains from the town of Lyman and Wellford. The river continues to flow southeast and is joined by Ranson Creek, the Middle Tyger River, Tim Creek, Stillhouse Branch, Wards Creek, and Johnson Creek before joining with the South Tyger to form the mainstem Tyger River.

Figure 1: North, Middle, and South Tyger River Watersheds



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2.3) Population

The three subwatersheds include the communities of Tigerville, Greer, Lyman, Duncan, Wellford, Reidville, Roebuck, and Moore (Figure 1). Population estimates for the area were calculated by identifying the U.S. Census Tracts within each subwatershed, and the total number of occupied homes data within the Census Tracts as provided by the U.S. Census. The estimated cumulative population of all three subwatersheds is 121,845, based on the number of occupied homes (46,505) and the average household size per US Census block group from the 2010 U.S. Census. The majority of the population are concentrated around the cities and towns and along the major transportation corridors in the region.

Estimated Population in Subwatersheds	=	Number of Occupied Homes	X	Average Household Size

2.4) Climate

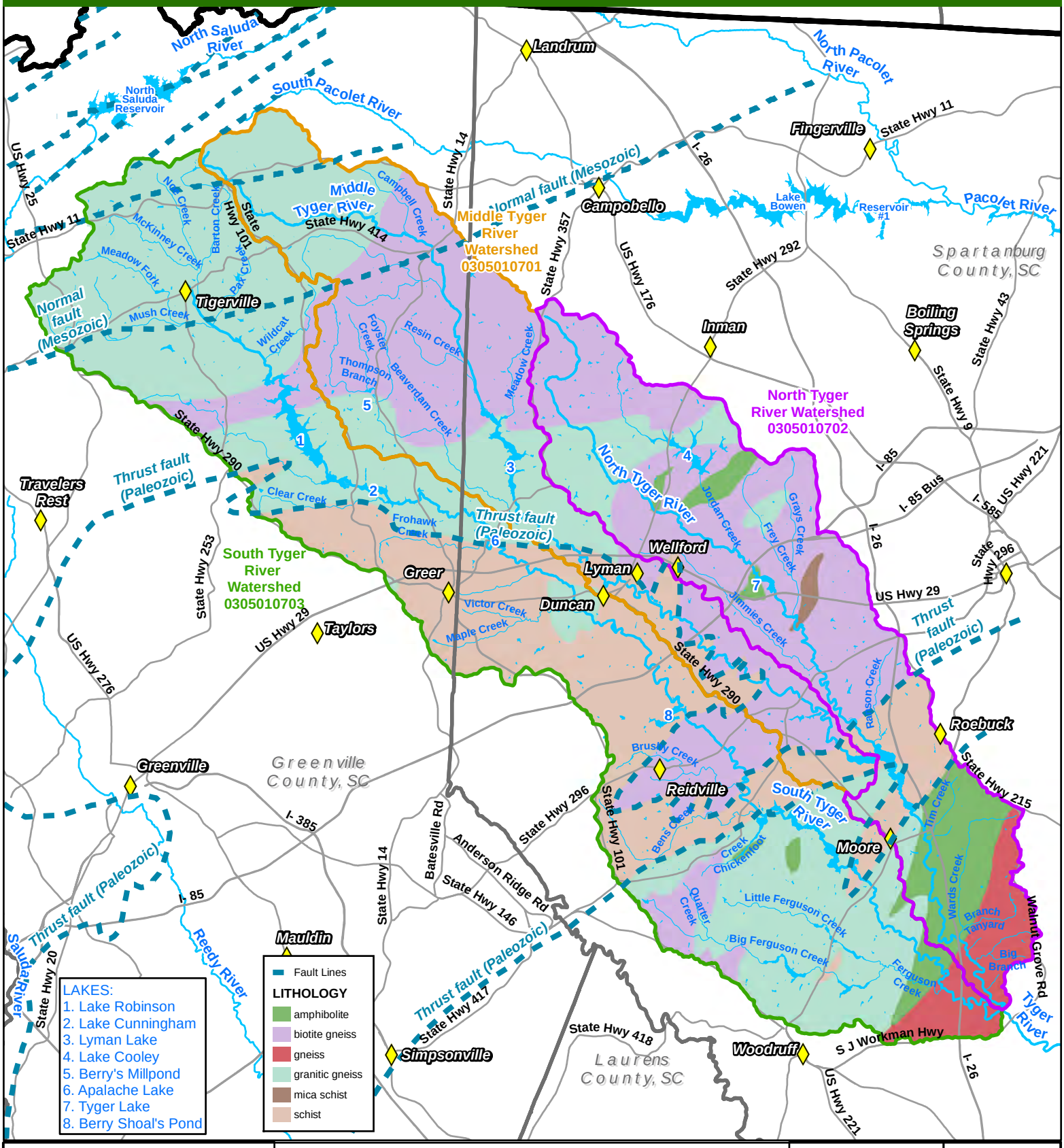
The three subwatersheds enjoy a moderate climate and are situated between 34–35°N latitude. The annual mean temperature for the region is 60.2°F, with average temperatures ranging from 29°F–91°F (U.S. Climate Data, 2017). Yet, temperatures in the state have increased 0.5°F since the beginning of the 20th century (NOAA, 2018). Average annual rainfall throughout the watershed is 48.45 inches, while annual precipitation for the state of South Carolina has been below average during most of the 2000s (12 of 16 years during 2000 –2015) (U.S. Climate Data, 2017). In fact, since the start of the 21st century, the state has experienced a below normal number of extreme precipitation events (NOAA, 2018). The average length of the freeze-free period for this area is approximately 220 days, with the last freezing temperatures occurring around late March and the first happening in early November (Farmers' Almanac, 2017). As development and emissions in the region continue to rise, historically unprecedented warming is projected by the end of the 21st century, including increases in extreme heat events, and increased intensity of naturally occurring droughts (NOAA, 2018).

2.5) Geology and Soils

The two primary geological features of the watersheds include the Six Mile thrust sheet and the Laurens thrust stack (SCNDR, 2017) (Figure 2). The Six Mile thrust sheet is made up of number of rock types (e.g., mica, schist, red-weathering biotite schist, gneiss) and are commonly deeply weathered. The rocks were formed from sediments deposited in an environment containing volcanic materials (Nelson, 1998). The Laurens thrust stack is the easternmost portion of the Inner Piedmont Block. The primary rock type in this formation is layered biotite gneiss. Other rock types found in the Laurens Thrust include biotite schist, sillimanite-mica schist, amphibolite, and small bodies of marble. The Laurens Thrust stack lies on top of the Six Mile thrust sheet (Nelson, 1998).

The principal soils within the focus area include Cecil, Davidson, Madison, Pacolet and Wilkes type soils with Soil K-factor sin the basin ranges from 0.25 to 0.27 (SCDNR, 2016). These soils, with the exception of the Wilkes soils, are deep, well-drained, moderately permeable soils. The Wilkes soil is a shallow, well-drained soil, with moderate to moderately slow soil permeability.

Figure 2: Lithology



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2.6) Land Use and Land Cover

Sourced from the 2011 National Land Cover Dataset (NLCD), land cover in the focus area has been divided into seven categories, as shown in Table 2. Combined, the top three land cover classes are forest, agricultural, and developed land. Forestland is the predominant land cover type across the basin, covering 44% of the total subwatersheds' area (Figures 3 and 4). Developed land accounts for 23% of the subwatersheds' land cover and is concentrated around the cities and major transportation corridors (e.g., Hwy 29, I-85, Hwy 101, Hwy 290, Hwy 296). In this plan grassland/herbaceous, pasture/hay, and cultivated crops are all considered agricultural lands, and account for 28% of the land area in all three basins. The South Tyger River subwatershed contains the highest amount of agricultural land, almost double the amount compared with the other basins, with the North Tyger having the least.

Table 2. Primary Land Cover Classes in the South, Middle, and North Tyger Subwatersheds

Land Cover Type	South Tyger (Acres)	Middle Tyger (Acres)	North Tyger (Acres)	Total (Acres)
Open Water	1,791	670	747	3,208
Developed Land	24,440	10,777	14,760	49,977
Barren Land	568	207	426	1,201
Forest	50,844	22,525	22,997	96,366
Shrub/Scrubland	1,485	555	837	2,877
Grassland/Herbaceous	8,917	4,695	4,165	17,777
Pasture/Hay	21,601	11,949	10,847	44,397
Cultivated Crops	117	30	98	245
Wetlands	1,991	1,173	1,712	4,877

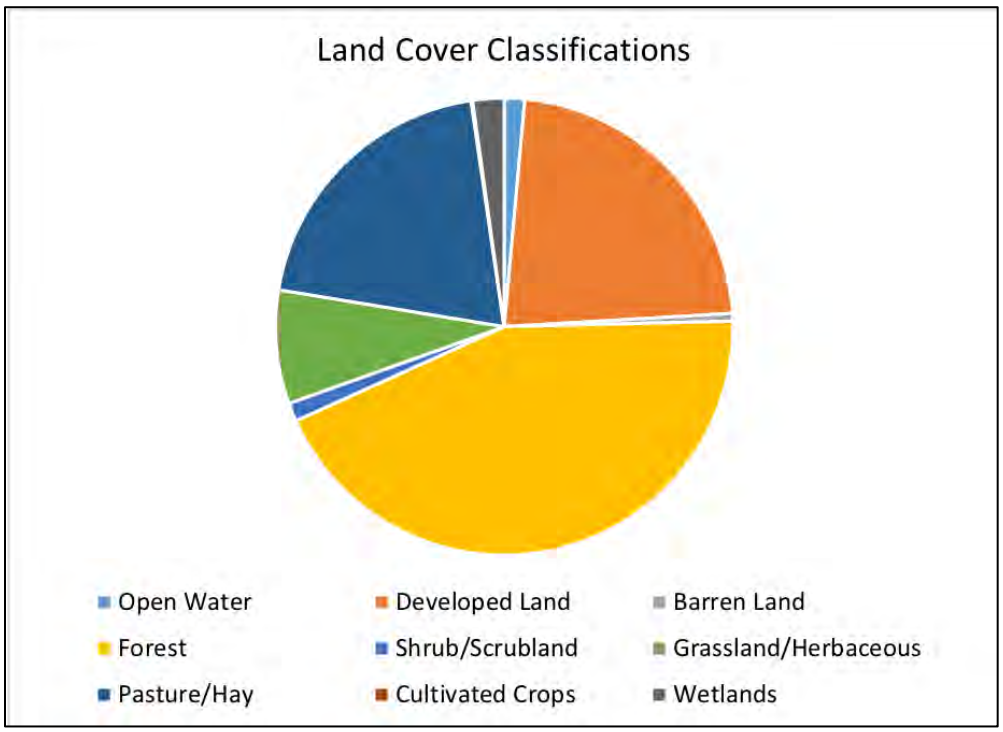
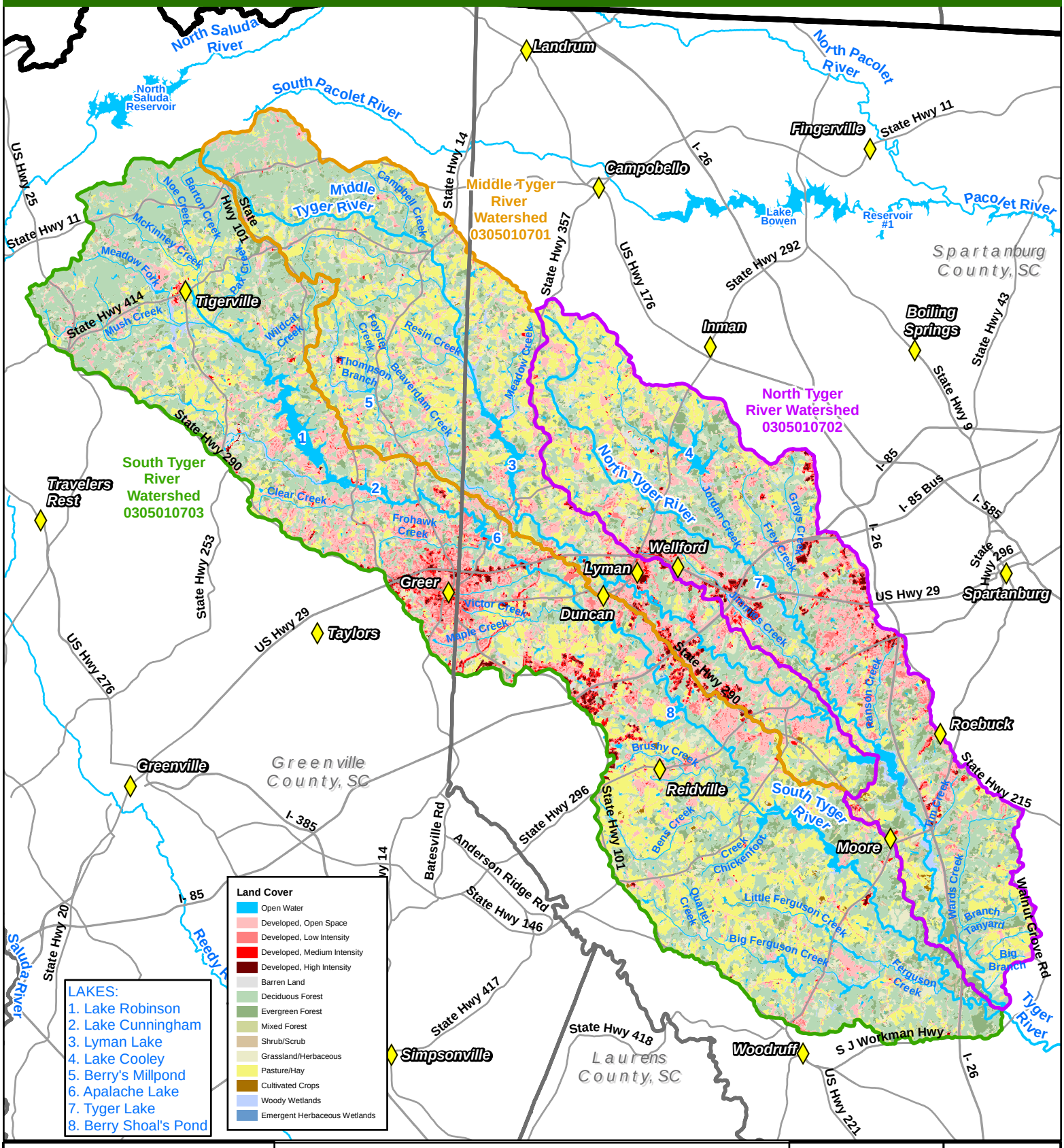


Figure 3. Land Cover Classifications for Tyger River Subwatersheds

Figure 4: Land Cover



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2.7) Source Water Intakes

Multiple utilities provide drinking water to residents within the focus area. Three utilities have intakes within the focus area and include Greer CPW, SJWD, and WRWD (Figure 5). Combined, these utilities serve roughly 127,000 residents living in both Greenville and Spartanburg Counties. SJWD currently has three surface water intakes permitted for withdrawal. One is located on the Middle Tyger River, the second is located on the North Tyger Reservoir, and the third is located on Lake Cooley in Wellford, SC, also in the North Tyger subwatershed (SJWD, 2016). This water is treated at the filtration plant in Lyman, SC, located in the Middle Tyger watershed. Greer CPW has one permitted surface water intake on Lake Cunningham. This intakes feeds into Greer CPW's treatment plant located north of Greer, SC. Finally, WRWD holds two permitted surface water intakes. The first intake is located on the South Tyger River and the second is on the North Tyger River just before the two rivers come together to form the Tyger River. These two surface water intakes supply water to the treatment plant located in the South Tyger subwatershed. Source water protection areas have also been designated for each of these utility providers to provide additional protection to these important drinking water sources (SC Watershed Atlas, 2017). Watershed based plans enhance source water protection planning efforts by delineating all potential impacts to source waters within an entire watershed. Through a variety of strategies (e.g., land protection, agricultural BMPs, septic system repairs, riparian buffers) it is possible to reduce and/or prevent nonpoint source pollutants from washing off lands and contaminating our waterways and drinking water resources. This not only improves water quality, but also reduces treatment costs for utilities and ultimately their customers. Watershed based plans outlines specific actions and strategies for water quality protection and improvement that will help to ensure sustainable and safe drinking water supplies for our communities.

3) WATER QUALITY MONITORING & ASSESSMENT

3.1) Water Quality Impairments and Sources

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 SC's surface and groundwater resources. The purpose of this rule is to establish general rules and specific numeric and narrative criteria and anti-degradation rules, for the protection of classified and existing water uses. This rule also serves to establish procedure to classify waters of the State (SCDHEC, 2014).

3.2) Water Quality Monitoring Stations

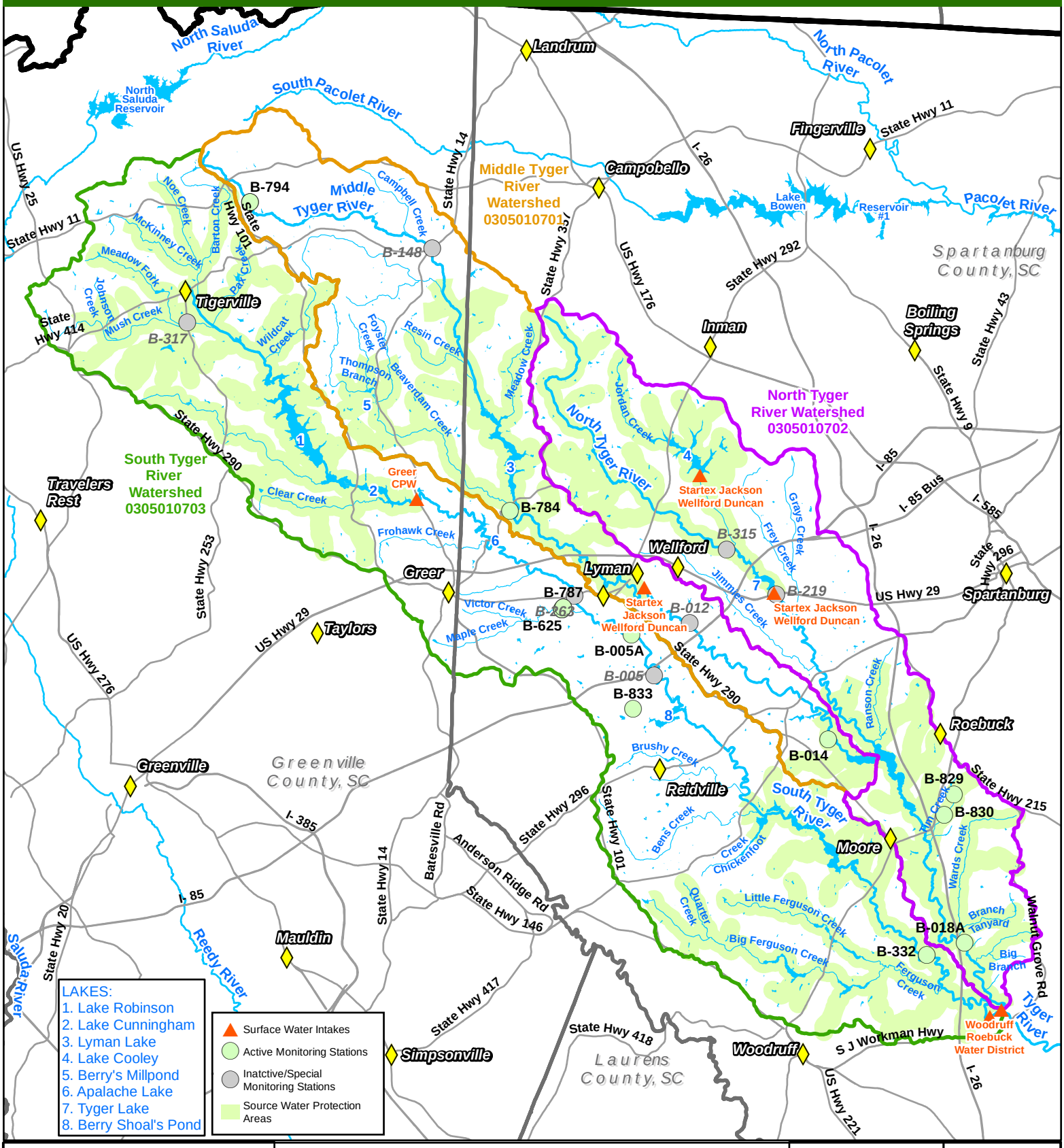
SCDHEC strategically places water quality monitoring stations across the state of South Carolina to evaluate surface and groundwater water quality. Within these three Tyger River subwatersheds there are a total of 18, both active and inactive, SCDHEC water quality-monitoring stations (Table 3). Currently, there are three regularly monitored stations, eight stations that are sampled periodically, and seven inactive stations in the region. The data for these stations have been collected and analyzed by SCDHEC from 1999 – 2017. These sites are sampled for a combination of water quality parameters including ambient monitoring, macroinvertebrate sampling, and special study sites (Figure 5).

Table 3. SCDHEC Water Quality Monitoring Station Locations and Monitoring Status

WQMS*	WQMS Location	Subwatershed	Type	Status
B-005	South Tyger at S-42-73	South Tyger	Ambient	Inactive
B-005A	South Tyger at 293	South Tyger	Macro	95,99**
B-012	Middle Tyger at S-42-63	Middle Tyger	Ambient	Inactive
B-014	Middle Tyger at S-42-64	Middle Tyger	Ambient	Current
B-018A	North Tyger at S-42-231	North Tyger	Ambient	Current
B-148	Middle Tyger at SC 14	Middle Tyger	Ambient	Inactive
B-219	North Tyger at US 29	North Tyger	Ambient	Inactive
B-263	South Tyger at SC 290	South Tyger	Ambient	Inactive
B-315	Trib to North Tyger at UN# Rd	North Tyger	Ambient	Inactive
B-317	Mush Creek at SC 253	South Tyger	Ambient	Inactive
B-332	South Tyger at S-42-86	South Tyger	Ambient	Current
B-625	Maple Creek at SR 644	South Tyger	Macro	99,04,09**
B-784	Beaverdam Creek at SC 357	Middle Tyger	Macro	99,04,09**
B-787	Ferguson Creek at SR 86	South Tyger	Macro	99,04,09**
B-794	Middle Tyger at Red Turner Rd	Middle Tyger	Macro	99**
B-829	Unnamed Trib. to Timms Creek	North Tyger	SSS	03**
B-830	Timms Creek	North Tyger	SSS	03**
B-833	Unnamed Trib. to South Tyger	South Tyger	SSS	03**

SSS is Special Study Site
**Water Quality Monitoring Stations*
***Years macroinvertebrates sampling was conducted*

Figure 5: Monitoring Stations, Intakes, and Source Water Protection



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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. In 2013 SCDHEC switched to the *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 (US EPA, 1986).

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 recorded as FC. Consequently, in this watershed plan the bacteria load reductions were calculated using FC data and are referred to generically as "bacteria". Also, the monitoring plan in this Watershed Based Plan is designed specifically to address *E. coli* bacteria.

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 (SCDHEC, 2014). 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.

3.5) History of Water Quality

As shown in Figure 6, several tributaries within the focus area are listed as impaired due to high levels of bacteria, based on the 2016 Section 303(d) of the Clean Water Act list of impaired or threatened waters. The 303(d) lists are compiled biannually by SCDHEC and provide information on waterbodies regarding their impairment status. An impaired water body can be taken off of the 303(d) list by either attaining water quality standards, or by the approval of a TMDL. It is important to note that the approval of a TMDL does not ensure that water quality standards will be achieved. SCDHEC provides a status update of the TMDL sites every two years in a biennial report.

Two TMDLs for fecal coliform bacteria have been approved for the Tyger River Basin. The first was approved for the Middle Tyger River (Station B-148) in August 1999, and the second for 25 stations in the greater Tyger River Basin in September of 2004 (SCDHEC, 1999 & 2004). The 1999 TMDL consists of the drainage area to Station B-148, located on Middle Tyger River, at SC Hwy 14 in Greenville County. This area includes 11,438 acres and drains to station B-148 (SCDHEC, 1999). At the time of publication, land area in this region consisted of forest (90.9%), agriculture (7.9%), and other (1.3%). No point sources were present at the time of TMDL publication, thus bacteria contributions were attributed to nonpoint loading from agricultural sources, septic, and wildlife (SCDHEC, 1999). SCDHEC Station B-148 is now inactive.

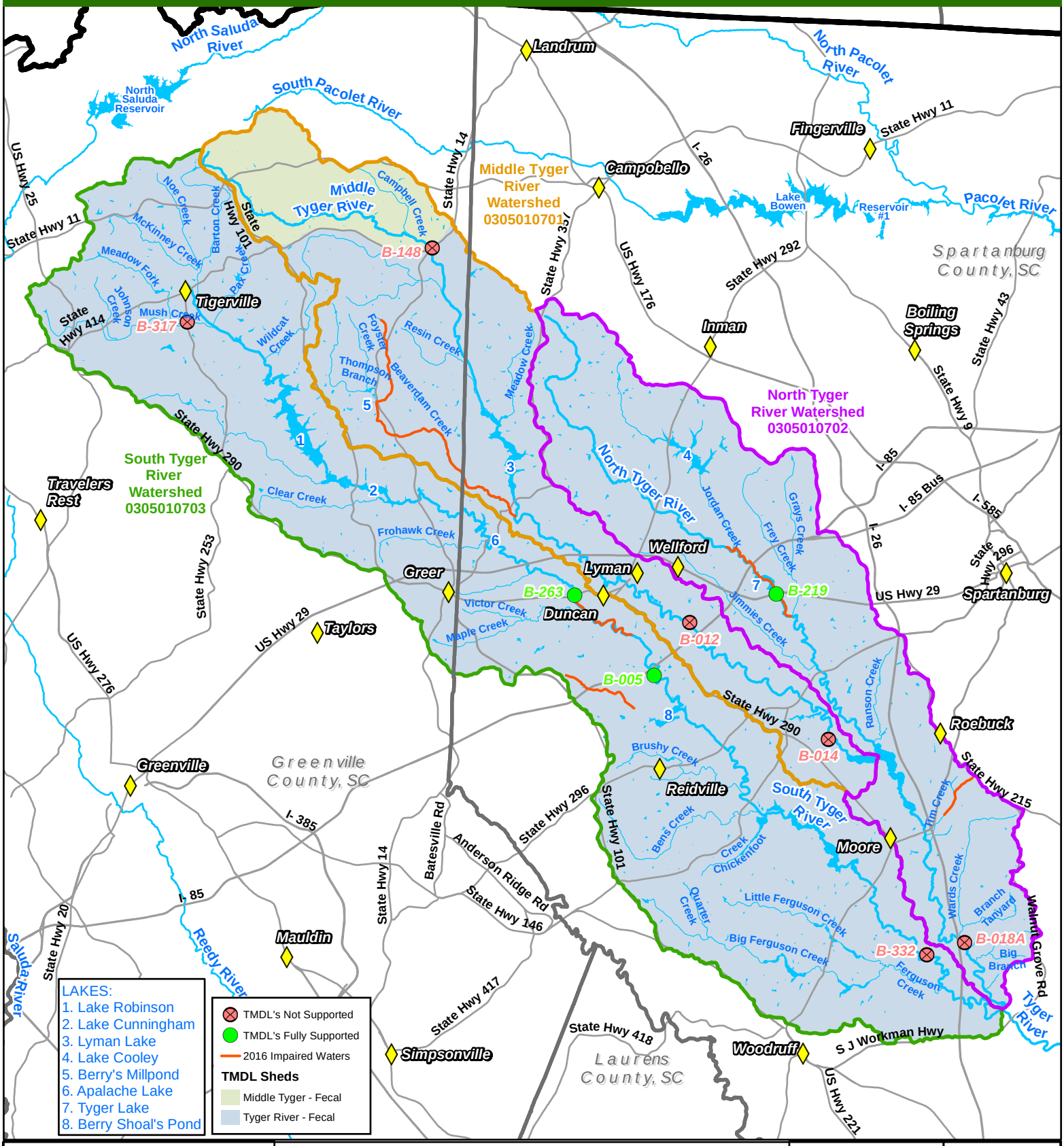
The 2004 TMDL for the greater Tyger River Basin (HUC 03050107) encompassed the 820 square mile basin and included 25 water quality-monitoring stations that were impaired due to violations of the State's fecal coliform standard. Ten of these 25 monitoring stations are located within the three HUC 10 basins included in this watershed plan (Table 4). According to the TMDL, the major sources of fecal bacteria in this HUC 8 basin included agriculture, failing septic systems, urban runoff, and wildlife (SCDHEC, 2004). In 2006, several project partners including Clemson Extension and the US Department of Agriculture Natural Resources Conservation Service (NRCS), coordinated with local landowners to implement a combination of agricultural Best Management Practices (BMPs) throughout the region (e.g., fencing, alternative watering sources, wells, heavy use areas) as well as the repair and or replacement of failing septic systems to address the bacteria problem. As a result of this work, four sites (sites B-219, B-149, B-263, and B-332) were listed as restored in the state's 2012 Integrated Report (US EPA, 2012). Despite these significant efforts and on the ground improvements five stations in the focus area are still impaired for bacteria according to the 2016 Section 303(d) list, including site B-332 (SCDHEC, 2016). Additionally, seven other sites were shown to partially support the recreational designated use standard for bacteria. A partially supported use indicates that the percentage of standard excursions is greater than 10% but equal to or less than 25%. Sites that are not supported have a percentage of excursions greater than 25%.

Table 4. Water Quality Impairments (SCDHEC 303(d) Lists From 1998-2016)

WQMS	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016
B-005	FC	FC	FC	CU FC	CU*	--	TMDL NS	TMDL NS	TMDL FS	TMDL FS
B-012	--	--	FC	FC	*	--	TMDL NS	TMDL NS	TMDL NS	TMDL NS
B-014	--	--	FC	FC	*	CU	TMDL NS	TMDL NS	TMDL NS	TMDL NS
B-018A	--	--	FC	FC	CU*	CU	TMDL NS	TMDL NS	TMDL NS	TMDL NS
B-148	FC	--	--	--	--	--	TMDL NS	TMDL NS	TMDL NS	TMDL NS
B-219	FC	FC	FC	FC	*	--	TMDL FS	TMDL FS	TMDL FS	TMDL FS
B-263	FC	FC	FC	FC	*	--	TMDL FS	TMDL FS	TMDL FS	TMDL FS
B-315	FC	FC	FC	FC	*	--	TMDL NS	TMDL NS	TMDL NS	TMDL NS
B-317	FC	FC	FC	FC	*	--	TMDL NS	TMDL NS	TMDL NS	TMDL FS
B-332	--	--	FC	FC	*	CU	TMDL FS	TMDL FS	TMDL FS	TMDL NS

*Key: FC = Fecal Coliform, CU = copper, TMDL NS = TMDL not supported, TMDL FS = TMDL fully supported, - - = no data listed, and * = Fecal Coliform TMDL approved in 2004)*

Figure 6: Impaired Waters



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As shown in Table 5, the highest fecal coliform sample was detected at site B-018A in the North Tyger subwatershed with a value of 28,000 CFU/100 ml. This site also reported the highest percent exceedance, of 46%, which indicates that this site was over the state standard 46% of the time. Sites B-012 and B-0148 also exceeded the state standard for bacteria 46% of the time. Percent Exceedance was based on the FC standard of 400 CFU/100 ml, meaning sites in excess of 400 CFU/100 ml were classified as an exceedance. Site B-005 has the second highest average value at 22,000 CFU/100 ml and is located in the South Tyger subwatershed. Interestingly, this site had a much lower percent exceedance rate at 17%. The maximum bacteria values for sites B-005 and B-018A were significantly higher than the other remaining sites ranging from 15,900–19,000 CFU/100 ml.

Table 5. FC Results from SCDHEC Water Quality Monitoring Stations (USEPA STORET)

WQMS	Total Samples	Years	Average Sample*	Max Value*	Samples in Compliance	Exceedances	Percent Exceedances
B-005	108	1999-2008	560	22,000	90	18	17
B-012	24	1999-2004	559	4,600	13	11	46
B-014	122	1999-2017	299	5,000	98	24	20
B-018A	128	1999-2012	1,213	28,000	69	59	46
B-148	59	1999-2008	468	2,200	32	27	46
B-219	121	1999-2009	107	3,400	108	13	11
B-263	24	1999-2004	239	2,100	19	5	21
B-317	96	1999-2009	462	7,000	67	29	30
B-332	122	1999-2012	262	5,000	103	19	16

**Average result and Maximum Value in CFU/100 ml.*

SCDHEC began collecting *E. coli* data in 2013 from four sites within the focus area (Table 6). The state standard for *E. coli* is a daily maximum of 349 MPN/100 ml. Based on this information, 61% of the samples from B-018A continue to exceed state bacteria standards with a maximum value of 3,147 MPN/100 ml. Site B-332, was previously delisted from the Section 303 (d) lists for the years 2010, 2012, and 2014, was again listed as impaired in the 2016-303(d) list with a percent exceedance rate of 63%. Although the average samples for sites B-014 and B-332 were below the state standard, their percent exceedances where higher than 10%, thus leading to these sites being added to the 2016 303(d) list.

Table 6. *E. coli* Results from SCDHEC Water Quality Monitoring Stations (US EPA STORET)

WQMS	Total Samples	Sample Years	Average Result*	Max Value*	Samples in Compliance	Number of Exceedances	Percent Exceedances
B-014	31	2013-2017	273	2,420	25	6	19
B-018A	31	2013-2017	651	3,147	12	19	61
B-317	64	2009-2016	439	2,318	40	24	38
B-332	64	2013-2017	309	1,203	24	40	63

**Average result and Maximum value measured in MPN/100 ml.*

Multiple water quality monitoring stations in the focus area have also been listed as impaired for biological criteria according to the State 303(d) lists (Table 7). Sites are added to the 303(d) list if they do not meet the Aquatic Life Use Support (AL) criteria designated by the State. According to SCDHEC, AL Use Support is determined by comparing important water quality characteristics to specific biological criteria. Support of AL is determined based on the percentage of criteria excursion and, where data are available, the composition functional integrity of the biological community. Parameters assessed include: dissolved oxygen (DO), pH, toxicants (priority pollutant, heavy metals, ammonia), nutrients, and turbidity. If it is determined that for any one parameter that the criterion is not met, then it is deemed that the AL use is not supported and the location is listed as impaired for AL (SCDHEC, 2018).

Table 7. Biological Water Quality Impairments as Reported by SCDHEC 303(d) Lists

WQMS	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016
B-005A	BIO	--	BIO	BIO	BIO	BIO	BIO	BIO	BIO	BIO
B-219	--	--	--	--	BIO	BIO	BIO	BIO	BIO	BIO
B-784	--	--	BIO	--	BIO	BIO	BIO	BIO	BIO	BIO
B-829	--	--	--	--	--	--	BIO	BIO	BIO	BIO
B-830	--	--	--	--	--	--	BIO	BIO	BIO	BIO
B-833	--	--	--	--	--	--	BIO	BIO	BIO	BIO

4) POLLUTION SOURCES

4.1) Bacteria Pollution

Bacterial pollution can be attributed to both point and nonpoint sources within each of the subwatersheds. Potential sources of bacteria pollution in the focus area include agriculture land uses, wastewater effluent, urban runoff, and wildlife (Table 8).

Table 8: Potential Sources of Bacteria Pollution in the Focus Area

Agriculture	Wastewater	Urban	Wildlife
• Cattle • Horses • Sheep & Goats • Poultry • Cropland	• Septic Tanks • WWTPs	• Stormwater Runoff • Domestic Pets	• Deer • Feral Hogs • Waterfowls • Beavers

4.1.1) Point Sources of Bacteria Pollution

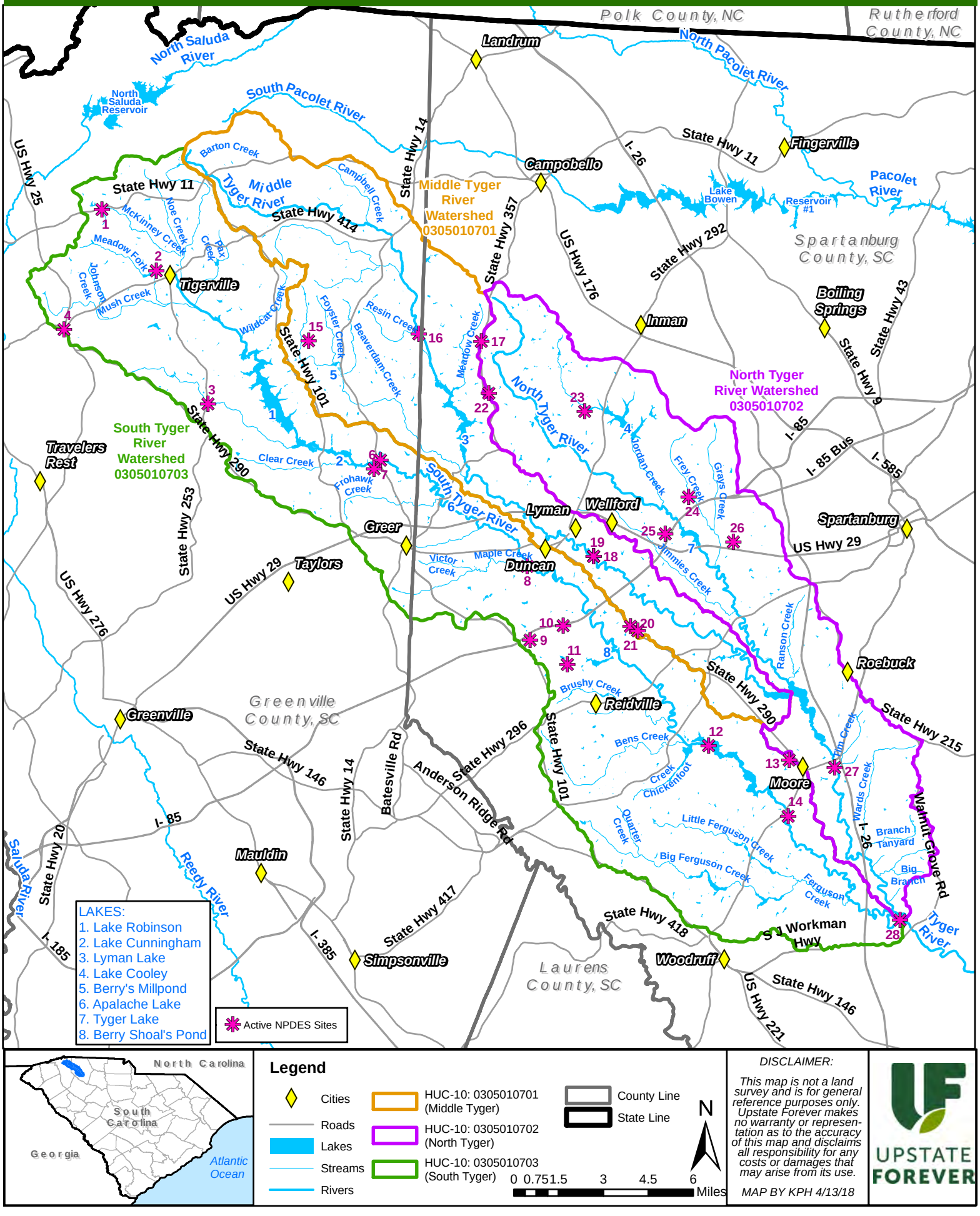
A point source pollutant is one that can be identified as a single or definite source. The National Pollution Discharge and Elimination System (NPDES) controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Major municipal dischargers include all facilities with design flows greater than one million gallons per day, while minor dischargers are less than one million gallons per day (US EPA, 2017). There are 28 NPDES permits in the region, one of which is inactive (ND006439), and 9 that are permitted to discharge bacteria into the subwatersheds. These sites are listed below in Table 9. (Table 9 & Figure 6). While no specific bacteria exceedances are noted, several facilities permitted to discharge bacteria have had compliance issues in the past 12 quarters. Look Up Forest Homes Association (SC0026379) has a history of Significant Noncompliance for the past 12 quarters. Reported violations include exceedances in Biological Oxygen Demand (BOD) and Nitrogen (Total Ammonia). The most recent Violation/Warning Letter for this facility was issued on January 12, 2018. The North Greenville College (SC0026565) has two reported quarters of noncompliance in the past 12 for exceedance of total suspended solids (TSS). Midway Park Inc., otherwise known as Wellford Estates Trailer Park, (SD0030571) also has had issues with noncompliance. This facility was reported to have violations during 4 of the past 12 quarters, for total residual Chlorine, and Fecal Coliform. The Fecal Coliform violations occurred in Quarter 8 (10/01/2016 - 12/31/2016) and Quarter 12 (10/01/2017 - 12/31/2017) for exceedances of 200% and 589%, respectively. The Greer CPW Water Treatment Plant also has reported noncompliance during 2 of the past 12 quarters. Specific violation information for this facility was not available (USEPA ECHO, 2018).

Table 9. NPDES Sites in South, Middle, and North Tyger Subwatersheds

Map Id	NPDES Permit #	Facility Name	Subwatershed	Facility Type	Permitted to Discharge Bacteria
1	SC0026379	Look Up Forest Homes Association	South	Domestic	Yes
2	SC0026565	United Utilities/N Greenville College*	South	Domestic	Yes
3	SCG730079	Hanson Aggr SE/Sandy Flats	South	Industrial	No
4	SCG731142	Enigma Corp. Spinx #249 Mine	South	Industrial	No
5	ND0082917	Faith Printing Co Inc.	South	Industrial	No
6	SCG645020	Greer CPW Water Treatment Plant	South	Municipal	Yes
7	SC0030465	Lakeview Steak House	South	Domestic	Yes
8	SC0046345	Greer/Maple Creek Plant	South	Municipal	Yes
9	SCG731165	Sloan Construction/Plemmons Rd Mine	South	Industrial	No
10	SCG730567	Jerry N Smith/JerryCo Mine	South	Industrial	No
11	SC0043982	AFL Telecommunications LLC	South	Industrial	No
12	SC0047732	SSSD/S. Tyger RV Regional WWTP	South	Municipal	Yes
13	ND0067351	RD Anderson Applied Tech. CTR.	South	Domestic	No
14	SC0036145	Midland Capital LLC/Moore Plant	South	Industrial	No
15	ND0064629	Blue Ridge High School	Middle	Domestic	Yes (Inactive)
16	SCG730214	Clark Const/Clark-Tyger Sand M	Middle	Industrial	No
17	SCG731127	Larry Green Grading/#2 Hwy 292 Mine	Middle	Industrial	No
18	SC0021300	Lyman, City of	Middle	Municipal	Yes
19	SCG643003	SJWD Water Treatment Plant	Middle	Municipal	No
20	SCG750029	Goldsmith Floors and More LLC	Middle	Industrial	No
21	SCG250257	Draexllmaier Auto LLC/Duncan	Middle	Industrial	No
22	SCG731128	Larry Green Grading/#3 Hwy 292 Mine	North	Industrial	No
23	SCG730056	Vulcan Const Mat/Lyman Quarry	North	Industrial	No
24	SD0030571	Wellford Estates Trailer Park	North	Domestic	Yes
25	SCG250170	Leigh Fibers Inc	North	Industrial	No
26	SCG730371	Fairforest Venture/Cedar Cres	North	Industrial	No
27	SC0048143	SSSD/Lower N Tyger River WWTP	North	Municipal	Yes
28	SCG646065	Woodruff Roebuck Water District WTP	North	Municipal	No

*The SC Public Service Commission approved the sale of this facility to ReWa in February 2018. (https://dms.psc.sc.gov/Web/Dockets/Detail/116545)

Figure 7: Active NPDES Sites



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Wastewater Treatment Plants - Wastewater treatment plants (WWTPs) are considered a point source of bacteria pollution in this plan. There are seven WWTPs with NPDES permits in the focus area (Figure 7 & Table 9). Unfortunately, problems with wastewater treatment plants can occur, which may lead to sanitary sewer overflows (SSOs) that result in untreated sewage discharge into local waterways. 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 waterbody, or are estimated to exceed 500 gallons (http://www.scdhec.gov/Environment/WaterQuality/SanitarySewers/SewerForms/). SSOs are reported by SCDHEC as the net volume of wastewater lost to the environment (SCDHEC, 2018). According to SCDHEC there have been a total of 262 SSOs with an estimated cumulative volume of 4.8 million gallons since 2015 in both Greenville and Spartanburg County with a portion of these SSOs occurring in the focus area (SCDHEC, 2017). In the past 90 days there have been a 54 SSO events totaling 26,945 gallons reported in Greenville and Spartanburg Counties (http://www.scdhec.gov/apps/environment/SSO/).

4.1.2) Nonpoint Sources of Bacteria Pollution

Nonpoint source pollution is caused by rainfall moving over and through the ground, picking up and carrying 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), stormwater runoff, domestic pets, and wildlife. Approximately a third of the land in these subwatersheds is rural in nature, so in this case the emphasis is placed on addressing bacterial inputs from agriculture, failing septic tanks, and domestic pets. Addressing wildlife populations directly is difficult therefore this plan focuses on public informational sessions to discourage the congregation of nuisance wildlife populations in an effort to reduce their bacteria contributions.

Agriculture - Livestock are the primary agricultural concern for increasing the concentration of bacteria in waterways. 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 (e.g., manure, sludge) applied to cultivated crops can also cause increased bacteria levels if applied in excess amounts or before rain events.

Agricultural land, comprised of pasture/hay and cultivated crops, is most heavily concentrated in the South Tyger subwatershed with approximately 21,761 acres consumed with these land uses. The Middle and North Tyger subwatersheds are smaller in comparison to the South Tyger subwatershed and contain less agricultural land overall at 11,903 acres and 10,914 acres, respectively. Livestock activity in the subwatersheds was confirmed via aerial imagery and/or windshield surveys.

The number of animals in each subwatershed was estimated by combining information from the USDA Census of Agriculture with a GIS analysis of the acreage of farmland in each subwatershed. The acreage of farmland within each subwatershed is based on an analysis of the 2011 National Land Cover Database Land Cover 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 each county was calculated. This ratio was then applied to the acreage of farmland within each subwatershed to estimate the total number of farm animals living within the boundaries of each subwatershed area. An example formula is shown below.

$$\text{Number of (Cattle) in the Subwatershed Area} = \left(\frac{\text{Total Number of (Cattle) within the County}}{\text{Total Acreage of Farmland within the County}} \right) \times \text{Acreage of Farmland within a Subwatershed Area}$$

Based on these calculations, approximately 2,956 cattle live in the subwatersheds, with the South Tyger River subwatershed having the largest population. Other farm animals with the potential to impact surface water bacteria levels include horses, goats, and sheep, hog and poultry (Table 10).

Table 10: Livestock Estimations per Subwatershed

Subwatershed	Type of Livestock					
	Cattle	Horses	Goats	Sheep	Hog	Poultry
South Tyger River	1,420	589	542	73	664	1,249
Middle Tyger River	923	335	319	57	237	385
North Tyger River	613	290	259	25	430	853
TOTAL	**2,956**	**1,214**	**1,120**	**155**	**1,311**	**2,487**

The total amount of bacteria loading from livestock was calculated using the annual pollutant load per land use. Runoff from pastureland was considered the primary land use associated with livestock and accordingly the source of bacteria to waterways in the region. For the purposes of this plan pasture lands are considered those lands where livestock may graze (i.e., grassland/herbaceous and pasture/hay land use categories). Using the median annual pollutant load rate of 1.60E+10 FC/year/hectare, it was possible to estimate the total annual loading per subwatershed (Shaver, Ed. et al., 2007). From this it was determined that the South Tyger subwatershed has the highest bacteria loading from livestock, followed by the Middle Tyger and North Tyger (Table 11). Annual pollutant loads based on acreage were obtained by multiplying the annual load by 0.404 (the conversion rate hectare and acres; 1 acre = 0.404 hectares) (Shaver, et al., 2007).

Table 11. Annual FC Loading from Livestock per Subwatershed

Subwatershed	Pasture/Grassland (Acres)	Livestock Annual FC Loading
South Tyger River	30,518	1.95E+14
Middle Tyger River	16,644	1.08E+14
North Tyger River	15,012	9.70E+13
TOTAL	**62,174**	**4.00E+14**

Croplands can also contribute to bacteria levels in waterways. Manure applications contain bacteria that may wash into nearby waterways during rain events. Severely eroded soils may also contribute fertilizers, pesticides, sediments and other toxins to the surface waters in the area. Additionally, there are three sites with permits for wet spray irrigation located in the Middle Tyger subwatershed (SC Watershed Atlas, 2017). These sites can influence surface waters if runoff is mismanaged. However, based on overall acreage cropland, cultivated crops, does not appear to be a major source of bacterial loading in the focus area, as there are roughly 245 acres of cropland in the entire region.

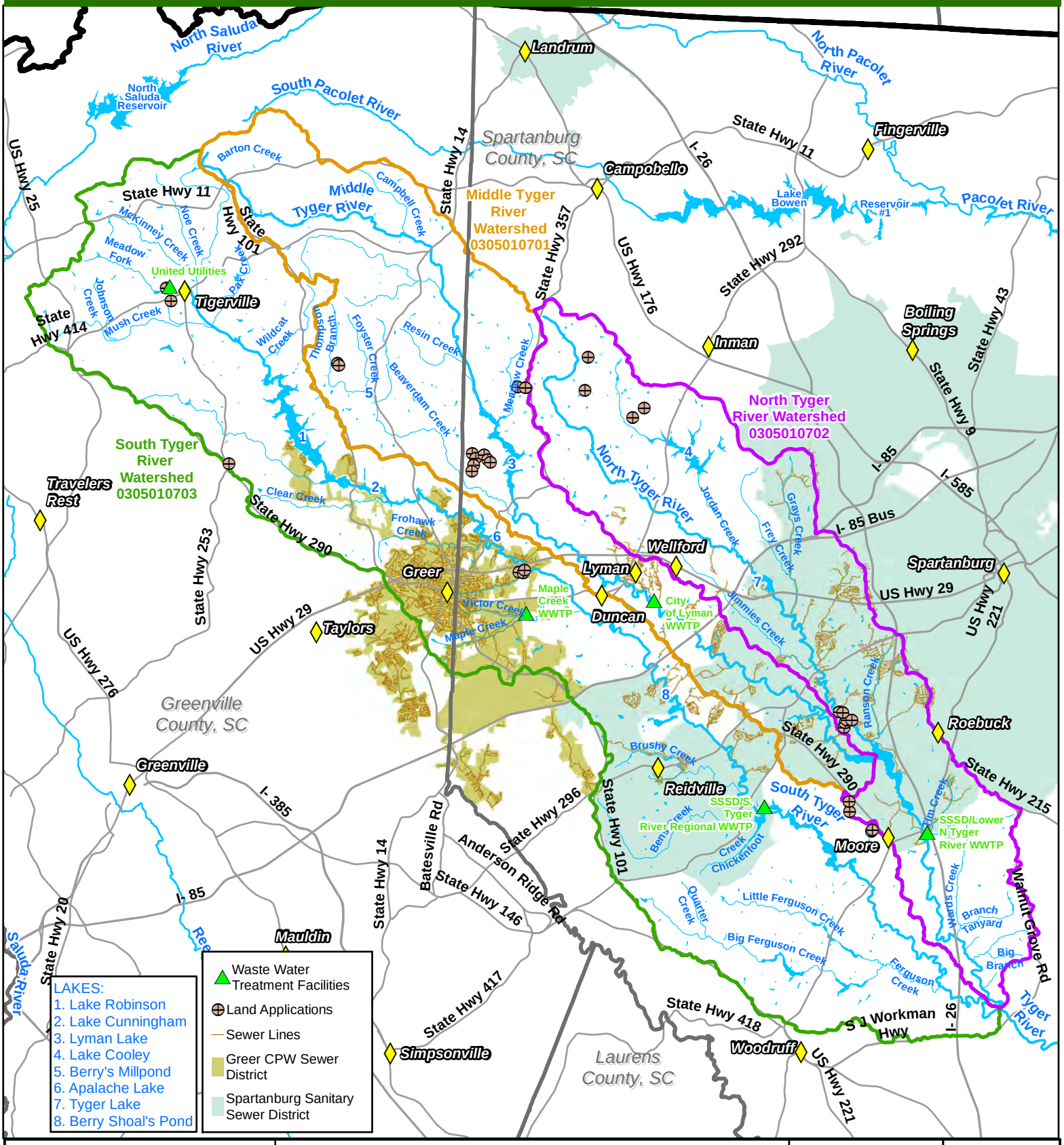
Septic Systems - Damaged or improperly maintained septic systems can be a significant nonpoint source of bacteria to surface and groundwater resources. Septic systems typically have four main parts: an exit pipe that transports the wastewater out of the home to the septic tank, a septic tank where waste 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.

A large portion of the approximately 46,505 homes in the focus area do not have access to sanitary sewer and thereby must rely on septic tanks to treat domestic wastewater. Greer CPW provides sewer service to 6,727 homes in these watersheds. Spartanburg Sanitary Sewer District (SSSD) serves 42,223 customers total, of which roughly14,104 customers live in these subwatersheds. SJWD bills 8,085 customers for various utilities (i.e., Spartanburg Water, Greer CPW, City of Wellford, Town of Lyman, Town of Duncan, and the City of Inman) for sewer service in the focus area. Based on this information it was estimated that there are 17,589 homes using septic systems in these three watersheds combined. The majority of septic systems in these subwatersheds are located where there is restricted access to sewer, such as the northern portion of the Middle Tyger subwatershed, the southern and northern parts of the South Tyger subwatershed, and the northern part of the North Tyger River subwatershed. It is estimated that 10-30% of these septic systems are failing due to improper maintenance, age, or misuse. The anticipated number of failures in the focus area was determined by multiplying the mean failure rate of 20% by total number of septic systems in the region. Using this information, there are approximately 3,518 failing septic systems in the three subwatersheds combined. Figure 7 shows the sewer service areas and lines within the subwatersheds, giving an idea of those regions that should be targeted for septic repair programs.

Table 12. Estimated Number of Septic Systems per Subwatershed

Subwatershed	# Households	# Households on Sewer	# Households with Onsite Septic Systems	# Households with Failing Septic Systems
South Tyger	23,189	12,713	10,476	2,095
Middle Tyger	10,761	6,996	3,765	753
North Tyger	12,555	9,207	3,348	670
Total	46,505	28,916	17,589	3,518

Figure 8: Wastewater Services



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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 and is especially a problem in developed areas containing a higher density of impervious surfaces. Developed land accounts for 23% of total land cover in the focus area and is concentrated along the major transportation corridors, around the cities of Greer, Lyman, Duncan, Wellford, and along the eastern border of the North Tyger subwatershed near the City of Spartanburg. Overall, there is not much high intensity development in the focus area; most of the development in the developed land category is considered medium to low intensity.

According to the US EPA a single dog can produce approximately 274 pounds of waste each year. Pet waste can contain harmful organisms such as bacteria, viruses, and parasites. Using the total number of households within a subwatershed area (as calculated in Section 2 using data from the U.S. Census) and a formula prepared by the American Veterinary Medical Foundation shown below, it was determined that roughly 26,054 dogs live within the planning area.

Number of Dog Owning Households	=	National Percentage of Dog Owning Homes*	x	Total Number of Households
17,486 Homes with Dogs	=	0.376	x	46,505 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*

Number of Dogs	=	National Average of Dogs in Homes*	x	Total Number of Dog-Owning Households
26,054	=	1.49	x	17,486 Dog-Owning Households

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

Based on the calculated number of dogs within the subwatersheds and the US EPA dog waste statistic (dog can produce 274 lbs./year), dogs living within the subwatersheds produce approximately 7.1 million pounds of waste annually.

Public outreach campaigns on proper pet waste disposal will be necessary to reduce bacterial loading in the subwatersheds. For this reason, the location and number of pet stores, feed and seed stores, animal shelters, and pet groomers have been identified in the subwatersheds. Such businesses and organizations may prove helpful in sharing information on the environmental and human health risks of pet waste in waterways. In addition, community parks have been identified

as places where pet waste stations would be effective. Both pet stores and community parks will be effective in the distribution of pet waste information as well as pet waste station installations. For a full list of pet stores, animal hospitals and community parks, please see Appendix A.

Wildlife - Wildlife have the potential of impacting the bacteria levels in water and do appear to be a contributor to elevated levels of bacteria in the three subwatersheds. However, bacterial impacts from wildlife on forested lands are often reduced due to the undisturbed state of the soils and vegetation. Because forested land accounts for over 44% of land cover in the focus area, it is assumed that wildlife in these areas do not have a major effect on bacteria levels in the subwatersheds. For example, SCDHEC site B-317, located in the South Tyger subwatershed, north of Lake Robinson, is listed as in Full Support (FS) of *E. coli* standards in the 2016 303(d) list (SC Watershed Atlas, 2018). Forested land density is most dense in the northern portion of the South and Middle Tyger subwatersheds. The predominant forest type across the focus area is deciduous, accounting for 35% of the forest cover. Evergreen forests make up 8% of the forest cover, and mixed forest accounts for just 1% of total forest acreage.

Within the planning area nuisance wildlife populations are increasing in numbers. Examples of nuisance species include deer, geese, beavers, and feral hogs. There are a few areas with open waters, such as Lake Lyman Park, where Canada geese populations have become problematic. A single Canadian goose can produce an average of 82 grams (2.6 ounces) of waste a day (Lake Access, 2017) thereby leading to water quality problems in areas with high populations. Also, feral hogs are moving into Spartanburg County and the focus area (SCDNR, 2017). Feral hogs 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 (Miller, 2016).

4.2) Sediment Pollution

According to the US EPA, sediment is the considered the most common pollutant in rivers, streams, lakes, and reservoirs in the country (MARC, n.d.). The greater Broad River basin has is a large dynamic fluvial system (13,792 km^2), which has experienced significant changes in sediment erosion and deposition from of historical land use practices, dam construction, in-stream modifications, and current-day land development (SCDNR, 2016). Human activities have altered sedimentation patterns, leading to habitat degradation as a result of elevated turbidity and increased sediment deposition. Sediment can come from both natural sources (e.g., erosion) and human induced activities (e.g., construction and agriculture). Excess sediment can 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 (MARC, n.d.).

According to a recent SCDNR study of the Broad River Basin, sediment loading in the greater Broad River Basin is 965,000 tons/year of which up to 88% is stored within the basin (SCDNR, 2106). This study also concluded that the Tyger River watershed, HUC 03050107, is the largest subwatershed within the Broad River Basin (HUC 03050105), 2080 km^2, and contributes 66.8 tons/ km^2/year to the greater Broad Basin (SCDNR, 2016). In comparison, Lawson's Fork Creek is the second smallest subwatershed in the Broad Basin, 217 km^2, but has the highest sediment yield at 201.2 tons/km^2/year.

Sedimentation has the potential to impact reservoirs in the focus area. Lyman Lake became operational in 1954 and is owned and managed by SJWD. Since 1954, three bathymetric surveys have been conducted on the reservoir in 1998, 2007, and 2017. According to these surveys, Lyman Lake has lost a total of 71.4 acres of surface area and 131-acre feet of capacity from sedimentation in its 63 years of operation which is roughly 3% of the lakes storage capacity (USDA, 2017). This accumulation of sediment can be problematic for source water providers who rely on reservoir capacity to provide a reliable water source for their customers.

Annual sediment loading for the subwatersheds was calculated using the Spreadsheet Tool for Estimating Pollutant Load (STEPL). The STEPL model estimates annual sediment loading based on the Universal Soil Loss Equation (USLE) and takes into account sediment loading from land uses (e.g., urban, cropland, pasture land, and forest lands) (US EPA, 2018). Using this tool, it is estimated that cumulatively, the three subwatersheds contribute 27,122 tons of sediment per year to the region with the majority of the loading attributed to pasturelands. The breakdown of sediment loading per subwatershed is shown in Table 13 and land use is found in Figure 9. Although the SCDNR data could not be used to estimate sediment loading from the North, Middle, and South Tyger Rivers (due to the watershed scale used to collect the data), it was used to benchmark the STEPL results and seems in relative agreement as this plan includes only 43% of the greater Tyger River subbasin included the SCDNR analysis.

Table 13. Annual Sediment Loading Per Subwatershed

Subwatershed	Sediment Load (Tons/year)
South Tyger	12,379
Middle Tyger	7,178
North Tyger	7,565
Total	**27,122**

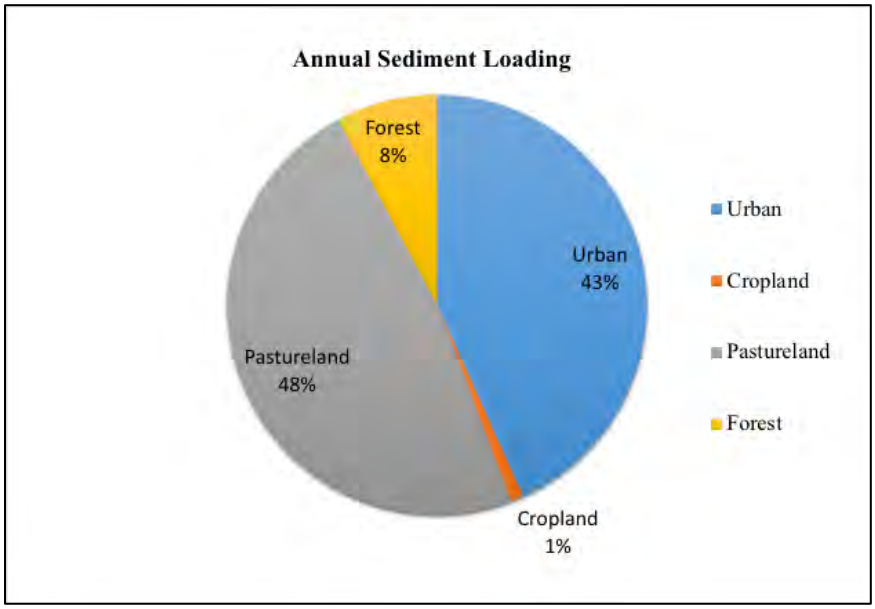


Figure 9. Annual Sediment Loading per Land Use

4.2.1) Point Sources of Sediment Pollution

As stated in Section 4.1.1 above, the NPDES permit system protects water quality by regulating point sources of pollution from being discharged into Waters of the United States (US EPA, 2018). SCDHEC operates the NPDES program in the state of South Carolina. Sediment is regulated from stormwater point sources within the Municipal Separate Storm Sewer System (MS4) program area, stormwater from construction sites, and stormwater associated with industrial permits (SCDHEC, 2018). Portions of the subwatersheds fall under both Phase 1 (Medium) and Phase 2 (Small) MS4 designations and are as follows: Greenville County - Medium, City of Greer -Small, Spartanburg County -Small, City of Duncan - Small, City of Lyman - Small, and the City of Wellford –Small (SC Watershed Atlas, 2018). See Table 9 for a complete list of NPDES permits in the subwatersheds.

4.2.2) 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 agriculture (e.g., livestock operations, cropland), stormwater runoff, construction sites, and forestry practices. Sediment is considered a nonpoint source pollutant outside of MS4 boundaries (Table 14).

Table 14. Sources of Sediment Pollution in Subwatersheds

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

Agriculture - The most common source of pollution from agriculture is soil that is washed off fields during rain events (US EPA, 2005). This sediment often carries with it other contaminants including fertilizers, pesticides, and heavy metals into waterways, which attach themselves to sediment particles. Agricultural practices that enhance 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 stream banks.

Urban - The urbanization of watersheds often has negative impacts on water quality. Activities most associated with urbanization are land disturbances; channelization of streams, the expansion of impervious surfaces, and increases in the stormwater runoff (SC AAS, 2018). Sediment pollution from urban areas is usually linked to mismanaged construction sites but can also come from streets, yards, and the stream itself. In Spartanburg County all construction sites, both within and outside of MS4 boundaries, are permitted and inspected by the County to ensure compliance with the Spartanburg County Stormwater Ordinance (https://www.spartanburgcounty.org/DocumentCenter/View/100).

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 (US EPA, 2018). This is a concern in the focus area because according to SCDNR, runoff volume and annual suspended sediment loads are projected to increase in these

watersheds by 64% and 614%, respectively, with the conversion of forests into low-density developments (SCDNR, 2016).

5) BACTERIA LOAD REDUCTIONS

The bacteria load reductions included in this plan were based on the Tyger River Basins Fecal Coliform Bacteria TMDL and the Middle Tyger River (B-148) Fecal Coliform Bacteria TMDL (SCDHEC, 1999, 2004). The TMDLs include both point and nonpoint sources in the bacteria load calculations. This information was used to calculate specific nonpoint source bacteria load reductions for each of the subwatersheds. Seven wastewater treatment plants (WWTPs) are currently operating in the focus area. These WWTPs discharge into the South, Middle, and North Tyger subwatersheds. See Section 4.1.1, Table 9, for list of WWTPs and locations. Point sources with current NPDES permits were not included in the load reduction calculations in this watershed-based plan.

5.1) Bacteria Load Reduction Calculations

Table 15 shows reductions needed in the focus area, based on the 1999 and 2004 TMDLs (Refer to the 2004 TMDL, Table 5-3, page 29 and page 9 in the 1999 TMDL). The Nonpoint Load Reduction Needed was calculated using information from this document and represents the bacteria reduction needed from nonpoint sources per day and year in each subwatershed in order to meet water quality standards. FC values have been converted to *E. coli* values by multiplying by 0.8725 (SCDHEC, 2013).

Table 15: *E. coli* Target Bacteria Reductions Needed Per TMDL*

WQMS	TMDL Existing Load (Counts/Day)	TMDL Existing Waste Load Continuous (Counts/Day)	Existing Nonpoint Load (Counts/Day)	TMDL Nonpoint % Reduction Needed	Nonpoint Load Reduction Needed (Counts/Day)	Nonpoint Load Reduction Needed (Counts/Year)
B-005	4.77E+12	6.25E+10	4.71E+12	83%	3.91E+12	1.43E+15
B-012	1.07E+12	6.47E+10	1.01E+12	40%	4.03E+11	1.47E+14
B-014	1.95E+12	6.47E+10	1.89E+12	63%	1.19E+12	4.35E+14
B-018A	6.09E+12	7.93E+10	6.01E+12	75%	4.51E+12	1.64E+15
B-148	2.92E+11	NA	2.92E+11	64%	1.87E+11	6.83E+13
B-219	5.66E+11	6.60E+08	5.66E+11	46%	2.60E+11	9.50E+13
B-263	7.66E+11	3.04E+09	7.63E+11	13%	9.92E+10	3.62E+13
B-315	3.46E+11	NA	N/A	52%	N/A	N/A
B-317	1.06E+11	NA	N/A	31%	N/A	N/A
B-332	1.87E+12	7.63E+10	1.79E+12	33%	5.91E+11	2.16E+14

TMDL Existing Load - This represents the total bacteria load from both point and nonpoint sources and comes directly from the 2004 Tyger River Basin TMDLs for Fecal Coliform Bacteria. See "Existing Load" column in Table 5-3 on page 29. For B-148 this information is from the 1999 TMDL for the Middle Tyger. The loading information for B-148 is from pg. 9 under the section *Allocation of Load.* Results are shown in counts/day, as per the TMDL.

TMDL Existing Waste Load Continuous - This column represents the bacteria load from point sources and comes directly from the 2004 Tyger River Basin TMDL for Fecal Coliform Bacteria See "Existing Waste Load Continuous" column in Table 5-3 on page 29. Results are shown in counts/day, as per the TMDL.

Existing Nonpoint Load - Existing Nonpoint Load represents the bacteria load from nonpoint sources and is calculated, as shown below. Results are shown in counts/day, following the TMDL example.

Existing Nonpoint Load	=	TMDL Existing Load	-	TMDL Existing Waste Load Continuous

TMDL Nonpoint Percent Reduction Needed - This represents the percent reduction needed from nonpoint sources to achieve water quality standards. The information comes directly from the 2004 Tyger River Basin TMDL for Fecal Coliform Bacteria. See "Percent Reduction[4]" column in Table 5-3 on page 29 and pg. 9 in the 1999 Middle Tyger TMDL.

Nonpoint Load Reduction Needed (counts/day) - This represents the bacteria load reduction needed from nonpoint sources and is calculated, as shown below. Results are shown in counts/day, following the TMDL example.

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

Nonpoint Load Reduction Needed (counts/year) - This represents the bacteria load reduction needed from nonpoint sources and is calculated, as shown below. Results are shown in counts/year, to facilitate calculations for recommended BMP installations per year.

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

Table 16 summarizes the nonpoint load reductions needed per subwatersheds. This information was derived from Table 15 above and is used to calculate the BMP load reductions needed.

Table 16. Estimating *E. Coli* Load Reductions Needed per Subwatershed

***E. coli* Load Reductions**	**South Tyger**	**Middle Tyger**	**North Tyger**
Counts/day	4.60E+12	1.78E+12	4.77E+12
Counts/year	1.68E+15	6.50E+14	1.74E+15

5.2) Bacterial Loading and Reductions by BMP

Bacterial loading and reductions were estimated for the three BMP categories: septic, agricultural, and pet waste. These recommendations were calculated per basin and based on the estimated actual number of failing septic systems, pasture land within a ¼ mile of streams, and approximate number of pets in each subwatershed.

Total possible septic reductions refers to what is needed annually to repair all estimated malfunctioning septic sytems based on an average 20% estimated failure rate per basin. This number is found by multiplying the approximate number of homes on septic systems in each basin by the 20% estimated septic system failure rate, and the standard bacteria load per household/per year (2.42E+10 bacteria). Please see below for example of South Tyger River subwatershed, which has around 10,476 homes on septic systems.

Total Possible Reductions for Septic in Subwatershed	=	Estimated # of Homes on Septic in Subwatershed	x	Estimated Septic Failure Rate	x	Standard Contribution of Bacteria per Septic per Year
5.07E+13	=	10,476	x	20%	x	2.42E+10

Total possible agricultural reductions respresents the amount of bacteria that could potentially be removed annually by targeting livestock within a 0.25 mile of waterways by fencing livestock out of streams and/or improving riparian buffers. This information was derived using the standard FC loading rate from pasture lands and the number of acres of pasture lands within 0.25 miles of waterways. The following example is for the South Tyger subwatershed. For example, there 11,516 of agricultural acres within 0.25 miles of rivers in the South Tyger subbasin. Runoff from these agricultural lands would contribute roughly 7.44E+13 bacteria/year to local waterways.

Total Possible Reductions for Agriculture in Subwatershed	=	Acres of Pasture within 0.25 miles of Waterways in Subwatershed	x	Estimated Bacteria Loading per Acre of Pasture
1.84E+14	=	11,516	x	1.60E+10

Total possible pet waste reductions represent the annual bacteria reductions expected from the installation of pet waste stations in a basin, with an assumed 50% success rate. The standard annual bacteria load per dog is 1.49E+12 bacteria a year. The recommended pet waste reduction was calculated by multiplying the number of dogs in the area by the 50% success rate and the

annual standard bacteria load per dog. See eample calculation for South Tyger River subwatershed.

Total Possible Reductions for Pet Waste	=	Number of Pets in Subwatershed	x	Success Rate	x	Standard Bacteria Loading Per Dog/Year
9.68E+15	=	12,991	x	50%	x	1.49E+12

Table 17 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 per subwatershed to attain the necessary reductions. The standard bacteria equivalents used to estimate the loads for all sources are found in Appendix B. These standards are as follows: septic systems – 2.42E+10 bacteria/year; agricultural BMPs – 1.86E+13 bacteria/year, and a single pet waste station – 2.19E+12 bacteria a year.

Table 17. Total Recommended Bacteria Reductions and BMPs per Subwatershed

	South Tyger	**Middle Tyger**	**North Tyger**
Number of Septic BMPs	350	40	325
Septic Loading Reductions	8.47E+12	9.68E+11	7.87E+12
Number of Agricultural BMPs	90	35	92
Agricultural Loading Reductions	1.67E+15	6.51E+14	1.71E+15
Number of Pet Waste BMPs	4	2	11
Pet Waste Loading Reduction	8.76E+13	4.38E+12	2.41E+13
Total Loading Reductions	**1.69E+15**	**6.56E+14**	**1.74E+15**

6) SEDIMENT LOAD REDUCTIONS

Reducing sediment loading to streams can have substantial benefits to water quality. According to SCDNR's sediment transport study of the Broad River Basin there are significant relationships between land cover to suspended sediment concentrations in waterways as well as streambed particle size. As suspended sediment increases in a waterbody, the diversity and abundance of aquatic organisms decrease. In addition, as streambed particle size decreases there is a decrease in many sensitive aquatic species since smaller sediment sized particles (e.g., silt and mud) can smoother eggs and other macroinvertebrates (SCDNR, 2016). Using this information SCDNR's study identified land use targets for agriculture, forest cover, and urban lands in the Broad Basin that would protect the aquatic diversity and abundance within streams. These land use targets are 70% forestland, 20-25% agricultural lands, and 10% urban lands. Meaning, in areas where forest cover was less than 70%, agriculture more than 20-25%, and/or urban lands more than 10%, there are higher suspended sediment concentrations in water columns and finer bed particle

substrates (SCDNR, 2016). These recommended targets were incorporated into the land prioritization assessment to help identify priority subwatersheds for protection and restoration.

6.1) Sediment Load Reductions Per BMP

Sediment load reductions were estimated for three BMP categories: agricultural lands, protected lands, and riparian buffers. Each of these load reductions were based upon the high priority sites from the respective categories (See Sections 8, 10, and 12). Load reductions for agricultural and riparian buffer BMPs were calculated using the STEPL model. Land protection sediment reductions were derived based on standard land use annual pollutant loadings per unit area (Shaver et al., 2007).

Table 18. Estimated Annual Sediment Load Reductions per Subwatershed

	South Tyger (tons/year)	Middle Tyger (tons/year)	North Tyger (tons/year)
Agricultural Loading Reductions	968	1,592.8	910.8
Land Protection Loading Reductions	562.7	127.4	404.8
Riparian Buffer Load Reductions	6.6	49.3	7.3
Total Sediment Loading Reductions	**1,537.3**	**1,769.5**	**1,322.9**

Agricultural sediment load reductions respresent the amount of sediment projected to be removed annually through the use of agricultural BMPs installed on high priority agricultural sites within the three subwatersheds. For the purposes of this plan the typical agricultural BMP package includes exclusion fencing, heavy use areas, alternate water sources, and improvements within the riparian buffer area (e.g., grass, vegetation, other erosion control techniques). The combined sediment removal for a single agricultural BMP package was estimated using STEPL for a 1 acre parcel assuming exclusion fencing, alternate water source, heavy use are, and a basic grassed buffer and equaled 4.4 tons sediment/year. Total sediment reductions for each subwatershed using agricultural BMPs was calculated by multiplying the total removal per agricultural package by the number of high priority parcels for each subwatershed. Please see the following example for the South Tyger River subwatershed which contains 220 high priority agricultural properties.

Typical Agricultural BMP Package	=	▪ Livestock Exclusion Fencing ▪ Alternative Water Source ▪ Heavy Use Area ▪ 35 m Improved Buffer

Estimated Total Sediment Removal in Subwatershed	=	Sediment Removal Per Typical Agricultural BMP Package	x	Number of High Priority Agricultural Sites in Subwatershed
968 tons/year	=	4.4 tons/year	x	220

Sediment reductions from Land Protection represent the amount of sediment that is prevented 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 Total Suspended Solids (TSS) for the conversion of undeveloped land into single family low density residential (Shaver, et al, 2007). Refer to example below for South Tyger subwatershed for total estimated sediment removal rates using land protection BMPs.

Estimated TSS Removal From Land Protection (tons/acre/year)	=	TSS Load per Single Family Low Residential Land Use (tons/acre/year)	-	TSS Load per Current Land Use (tons/acre/year)
562.7	=	1,560.1	-	997.5

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. For this analysis, the high priority riparian buffer sites on non-agricultural lands within all three subwatersheds were determined in GIS by selecting all high priority riparian sites and then removing all properties that included agricultural lands to ensure that these parcels were not double counted for agricultural and riparian buffer sediment reductions. See Appendix G for more information on STEPL calculations for sediment removal using riparian buffers.

7) PARCEL PRIORIZATION METHODOLOGY

UF utilized weighted criteria to analyze each parcel within the watersheds in order to identify priority lands for protection, restoration/enhancement, and/or best management practices. Each criterion was assigned a total number of possible points based on its importance to water quality protection. 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, detailed throughout Section 7.

7.1) Preliminary Steps

Step 1: Parcel Layer Pre-conditioning in ArcGIS

Before beginning the analysis, it was important to normalize the parcel layers from each of the two counties within the subwatershed areas. After selecting all of the parcels that lay fully or partially within the subwatersheds, a new merged layer was created that combined the selected parcels from each county. If appropriate, parcel boundaries were clipped to eliminate areas outside the subwatersheds' boundaries and each parcel's acreage within the focus area was calculated.

- *Steps taken:*
    - Add parcel layers for each county within the watershed boundary.
    - Select all parcels fully/partially within the watersheds, creating new layers for each county.
    - Merge selected parcels from each county into one shapefile.
    - Clip merged parcel layer to the watersheds' boundaries.
    - In a new field, calculate geometry to find the area of each parcel.

This conditioned layer will be referred to as "parcel layer" or "parcel" through the remainder of this report.

Step 2: Parcel Layer Analysis in ArcGIS – The parcel layer was then analyzed to identify high priority parcels for protection, restoration/enhancement, or BMPs, based on various factors that are important to water quality; specific details are provided throughout the report.

Step 3: Analyzing Results in Excel – The results from the Protection, Restoration/Enhancement, and BMP analyses were exported from the parcel layer's ArcGIS attribute table into an Excel spreadsheet for further review and refinement.

7.2) 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 each category. A higher point value indicates increased importance to water quality within each category (Protection, Restoration/Enhancement, BMPs).

7.3) 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 actions will help protect and improve water quality. An overview of the actions analyzed is shown in Table 19. The results are presented in summary, condensed table, and map formats. Full spreadsheet data will be provided electronically for each category.

Table 19: Summary of Prioritization Results

Category	Number of Parcels in Results	Notes
Parcel Analysis Results	65,680	Score results for all parcels that were analyzed for protection or restoration activities
Land Protection	294	High priority parcels that, if developed, would have greatest impact on water quality
Septic System Repair or Replacement	3,226	High priority parcels for septic repair or replacements
Agricultural BMPs	4,057	High priority parcels for agricultural BMPs
Wetland Restoration/Enhancement	184	High priority parcels for wetland restoration/enhancement
Riparian Buffer Restoration/Enhancement	1,232	High priority parcels for riparian buffer restoration or enhancement
Voluntary Dam Removal	18	High priority parcels for Voluntary Dam Removal
Shoreline Management	291	High priority parcels for Shoreline Management restoration/enhancement
Stormwater BMPs	97	High priority parcels for stormwater BMPs, such as detention pond retrofits or rain gardens
Pet Waste Station(s)	53	High priority parcels for Pet Waste Stations

8.0) LAND PROTECTION

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. Examples includes parks, Heritage Preserves, utility owned properties, and properties already known to be protected by a conservation easement.

8.1) Land Protection Criteria

Table 20 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 (20-31 points), medium (10-19 points), and low (0-9 points) priority for protection (see Figure 9).

Table 20: 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	68+ Acres of Riparian Buffers	4	4
	23-67.99 Acres of Riparian Buffers	3	
	8-22.99 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**

8.1.1) 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

Table 21. Critical Watershed Area Priority Ranges

Range	CWA Values
Low Priority Range	0 – 0.00005
Medium Priority Range	0.000006 – 0.001008
High Priority Range	0.001009 – 0.203238

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

8.1.2) 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 (TNC, 2016).

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

8.1.3) Stream Classification

Streams that are in the most pristine condition are the most important to protect, since 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 a natural/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

8.1.4) 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 (Pennsylvania Land Trust Association, 2014). Protecting the most sensitive riparian buffers ensures that the benefits to water quality continue. For water

quality protection, riparian buffer zones should be a minimum of 100 feet wide on each side of the waterbody (Fischer, 2000).

Scoring: UF identified highly sensitive riparian areas by combining the results from the USFS Riparian Buffer Delineation Model v.3.5 (run by UF) with a 100-foot buffer around all waterways (Abood, 2015). 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 67 acres or more of highly sensitive riparian buffer acreage received "4" points; parcels with 22.7-66.9 acres of highly sensitive riparian buffer acreage received "3" points; parcels with 8.4-22.6 acres of highly sensitive riparian buffer acreage received "2" points; parcels with 2.1-8.3 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

8.1.5) Forested Riparian Buffer Areas

Forested riparian buffers provide increased benefits to water resources and provide habitat benefits to both terrestrial and aquatic species. Protecting forested areas within the Highly Sensitive Riparian Buffer Areas will ensure that forest cover and its 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

8.1.6) 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. 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

8.1.7) 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" (USDA, 2013). 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 (Mid Atlantic Hydric Soil Committee, 2011). 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

8.1.8) 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 (TNC, 2016). 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)

8.1.9) 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 this area 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

8.1.10) 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 North, Middle, and South Tyger River watersheds, the average stream length within/adjacent to a parcel is 0.1 miles. Parcels with above average stream length received "2" points; other parcels received "0" points.

GIS Layers Used: Parcel, National Hydrography Dataset

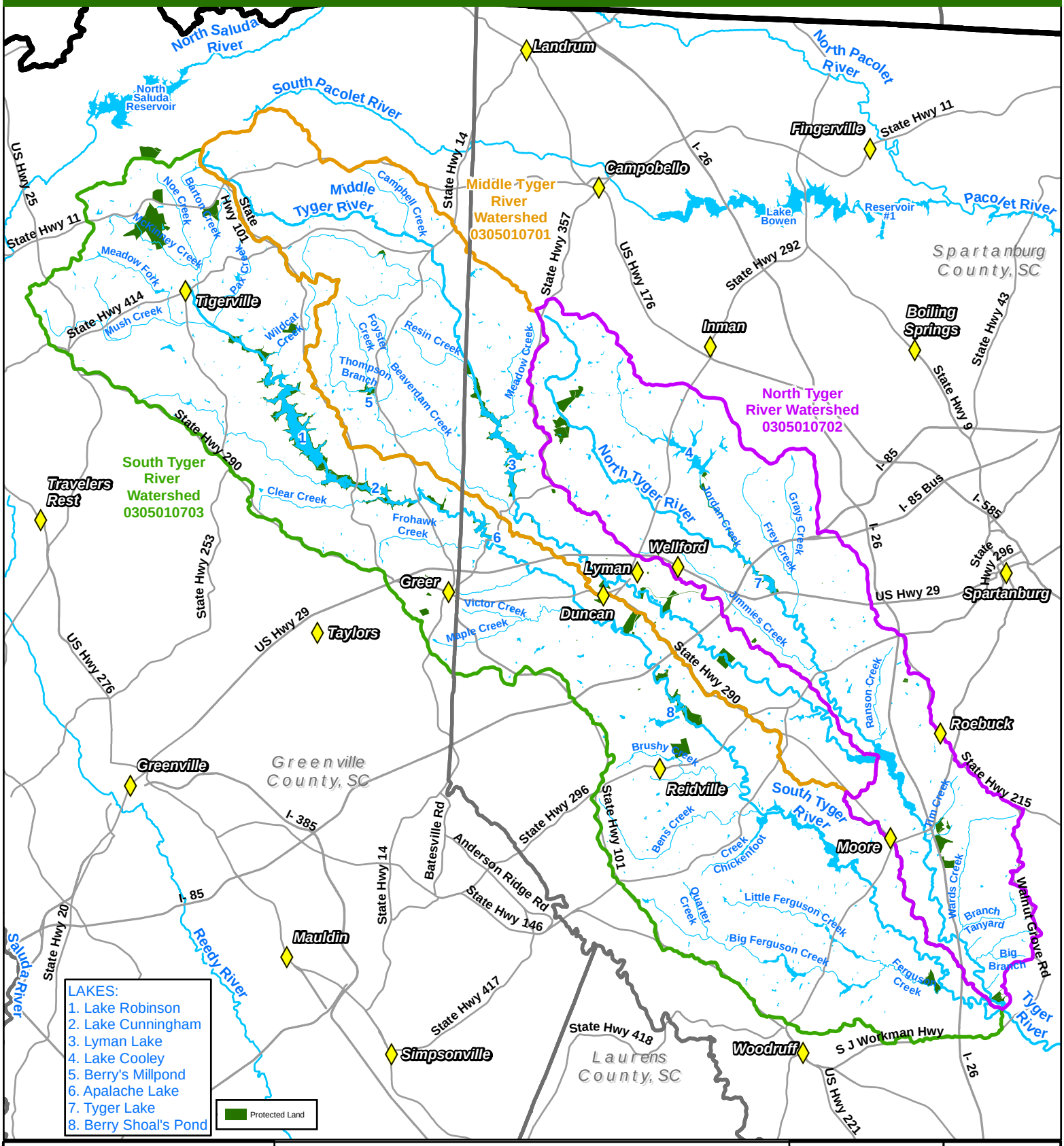
8.1.11) Adjacent to Existing Protected Land

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 quality, and habitat protection (Stolton, 2015). 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 (Source: NCED), UF Conservation Easements, County Parks, National Heritage Preserves.

Figure 10: Protected Land



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8.1.12) 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

8.2) Protection Results & Recommendations

Out of 31 points possible, the highest score a parcel achieved is 27. This analysis identified 631 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 that fall within Spartanburg's Special Places Inventory*
6. Parcels were REMOVED if: use is a golf course or university

*The Spartanburg Special Places Inventory was authored by Upstate Forever in 2010 to identify areas of the County with significant intact biological and historical resources (Upstate Forever, 2010). The results of this study helped shape the development of Conservation Focus Areas with the end goal of protecting land within these special places.

The refined results identified 296 parcels for initial protection efforts. These parcels are located throughout the North, Middle, and South Tyger watersheds and 44% of the high priority parcels are 100 acres or more (see Figure 11). A concentration of high priority parcels for protection can be seen near the Towns of Moore and Roebuck in the southern portion of the watersheds, specifically just south of the confluence of the Middle and North Tyger Rivers. General land protection strategies are outlined below and specific recommendations for each parcel are included in Table 21: High Priority Parcels for Protection.

8.3) Land Protection Strategies & 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 these Tyger subwatersheds to protect sensitive lands in the region.

8.3.1) 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 to date it has cost approximately $6,250 per easement on staff time and fees. Stewardship fees for the property,

which involve the annual monitoring of the property in perpetuity, typically have ranged between $9,500 - $17,000 depending upon numerous factors including size of tract and distance from office.

8.3.2) Deed Restriction

While this option is discouraged, the current property owner 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.

8.3.3) Fee Simple Purchase

Entities, such as SJWD, Greer CPW, or WRWD, could purchase priority parcels and voluntarily restrict certain undesirable land uses from occurring on their property. Restrictions could be permanent or temporary, depending on continued management and ownership decisions.

8.3.4) 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.

8.3.5) 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 (Tetra Tech, 2007). Because it has been well documented that what happens on the land impacts water quality, 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 to reduce both the amounts and impacts of nonpoint source pollution on drinking water sources, recharge streams and groundwater sources, reduce the risk from hazardous spills, and lower overall treatment costs for operators. Using this plan utilities can identify high priority lands for protection and/or restoration and then work with local communities and landowners to develop strategies to purchase the property and/or create a management plan for parcel.

Figure 11: Parcel Prioritization for Protection

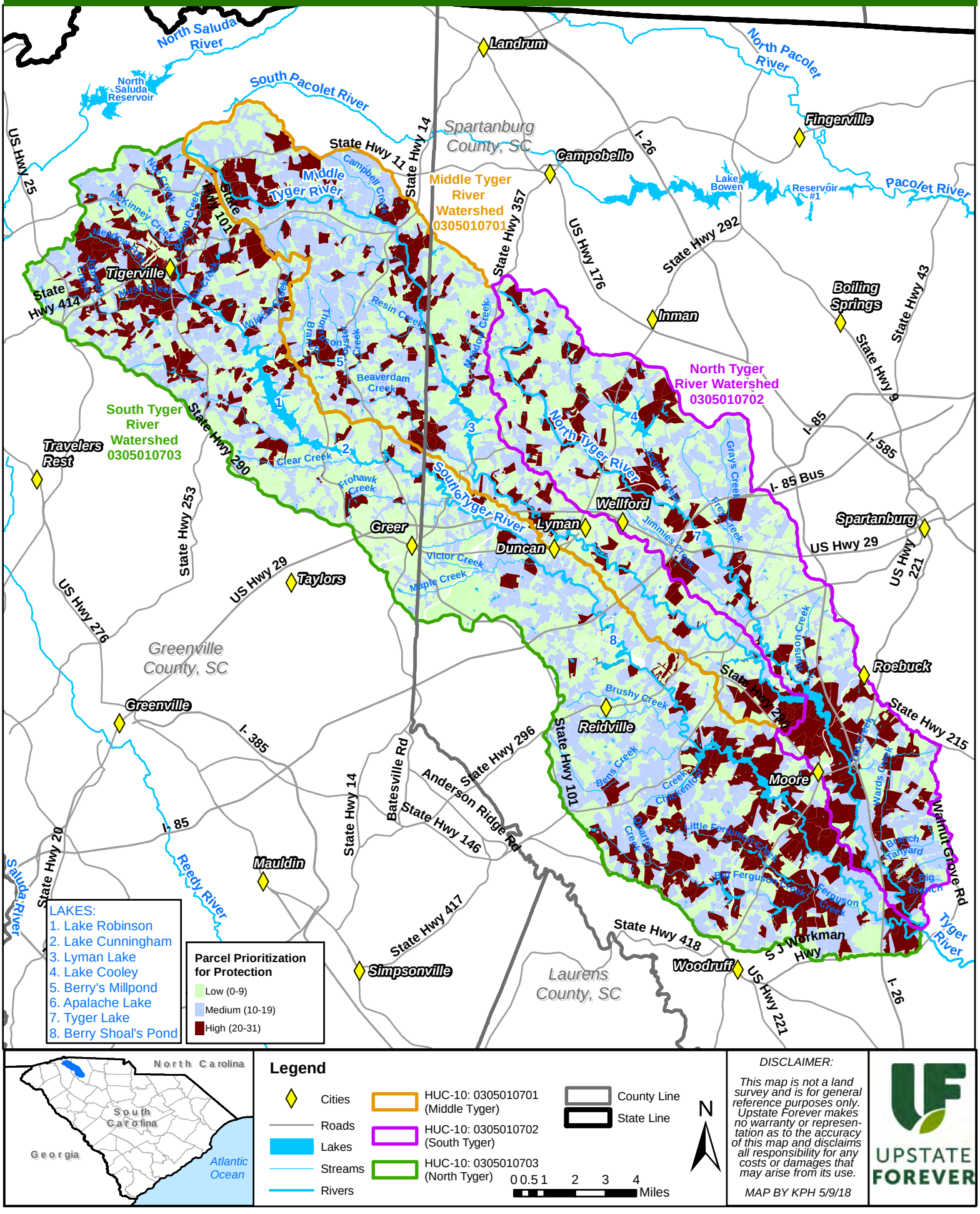

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Figure 12: High Priority Parcels for Protection

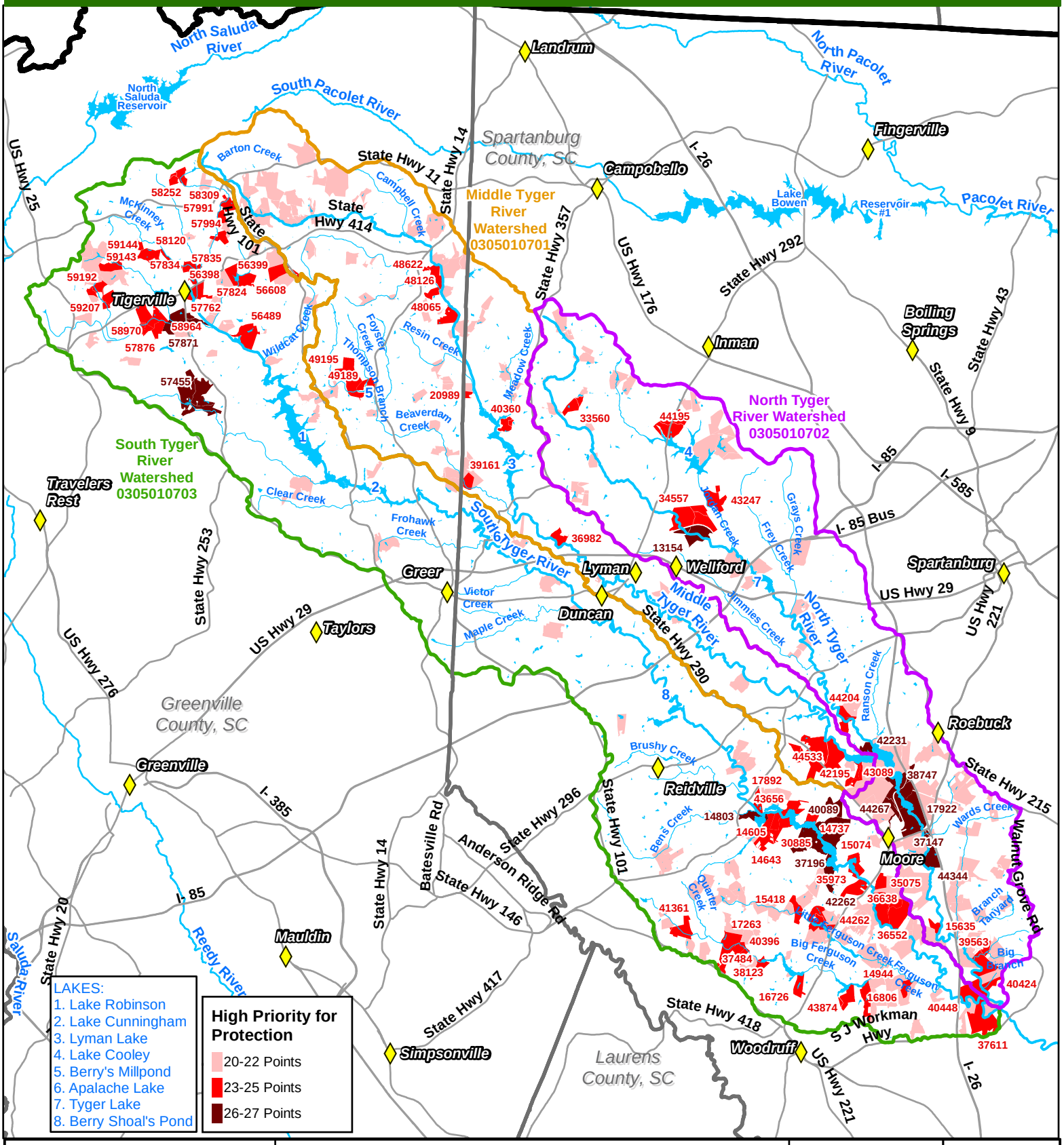

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Table 22: HIGH PRIORITY PARCELS FOR LAND PROTECTION

MapID	Acreage	TaxPin	County	State	PropertyLocation	LandUse	Prop_Type	Prot_Score	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	Acres100	WetProt	ACEP	Wetland
42231	105.658	6-32-00-003.08	Spartanburg	SC	0 MOORE DAIRY RD MOORE	Qualified Agricultural Farm Vacant (4AGL)	OTHER AGRICULTURE	27	x									x		x	
44344	212.13	6-40-00-006.00	Spartanburg	SC	0 HIGHWAY 221 ROEBUCK	Qualified Agricultural Farm Vacant (4AGL)	FARMS-GENERAL	27	x									x		x	
14803	124.642	4-03-00-008.00	Spartanburg	SC	1393 HIGHWAY 417 MOORE	Qualified Agricultural Farm Vacant (4AGL)	FARMS-GENERAL	26	x		x							x		x	
42262	191.519	4-09-00-001.00	Spartanburg	SC	290 WILDFLOWER LN MOORE	Non-Qualified Regular Farm Improved (6RGA)	RESIDENTIAL - SINGLE FAMILY	26	x	x								x		x	
17922	207.407	6-40-00-004.00	Spartanburg	SC	0 HIGHWAY 221 ROEBUCK	Qualified Agricultural Farm Vacant (4AGL)	FARMS-GENERAL	26	x									x			
38747	210.21	6-33-00-010.00	Spartanburg	SC	399 BREWTON RD ROEBUCK	Qualified Agricultural Farm Vacant (4AGL)	FARMS-GENERAL	26	x									x			
37147	229.788	6-40-00-001.01	Spartanburg	SC	0 HIGHWAY 221 ROEBUCK	Qualified Agricultural Farm Vacant (4AGL)	FARMS-GENERAL	26	x									x		x	
13154	234.214	5-12-00-018.00	Spartanburg	SC	0 FORT PRINCE BLVD WELLFORD	Qualified Agricultural Farm Vacant (4AGL)	NON-COMMERCIIAL FOREST DEVEL.	26	x	x								x		x	
57871	283.306	6.5005E+11	Greenville	SC	PO BOX 232	Agricultural Improved (9171)	OTHER	26	x									x		x	
44267	286.625	6-39-00-031.00	Spartanburg	SC	0 OLD ROEBUCK RD MOORE	Qualified Agricultural Farm Vacant (4AGL)	NON-COMMERCIIAL FOREST DEVEL.	26	x									x		x	
37196	351.551	4-08-00-042.00	Spartanburg	SC	306 RHODES RD WOODRUFF	Qualified Agricultural Farm Vacant (4AGL)		26	x	x								x		x	
57455	549.725	649040101100	Greenville	SC	230 SALLY GILREATH RD	Agricultural Improved (9171)	OTHER	26	x									x		x	
40089	552.237	6-39-00-010.00	Spartanburg	SC	341 PEARSON TOWN RD MOORE	Qualified Agricultural Farm Vacant (4AGL)	FARMS-GENERAL	26	x	x								x		x	
58120	52.6938	6.5102E+11	Greenville	SC	PO BOX 256	Agricultural Vacant (9170)	AGRICULTURAL	25	x											x	
57991	60.1157	6.5101E+11	Greenville	SC	349 HIGHWAY 8 E	Agricultural Vacant (9170)	AGRICULTURAL	25	x												
57834	60.5046	6.5003E+11	Greenville	SC	28 MOONSHINE FALLS TRL	Residential Vacant (1180)	RESIDENTIAL	25	x											x	
59144	128.581	656010100200	Greenville	SC	3 FOXWOOD LN	Agricultural Vacant (9170)	AGRICULTURAL	25	x									x			
15074	130.007	6-46-00-006.00	Spartanburg	SC	3770 OLD SPARTANBURG HWY MOORE	Qualified Owner Occupied Farm Improved (4OOA)	RESIDENTIAL - SINGLE FAMILY	25	x	x								x		x	
43656	148.865	5-44-00-006.00	Spartanburg	SC	0 KUHN RD MOORE	Qualified Agricultural Farm Vacant (4AGL)	OTHER AGRICULTURE	25	x	x								x		x	
56489	221.131	6.4303E+11	Greenville	SC	1032 CAMP CREEK RD	Agricultural Improved (9171)	OTHER	25	x	x								x		x	
14605	74.9223	4-04-00-001.03	Spartanburg	SC	0 ROGERS FARM RD WOODRUFF	Qualified Agricultural Farm Vacant (4AGL)	NON-COMMERCIIAL FOREST DEVEL.	24	x												
59143	79.8394	656010100100	Greenville	SC	PO BOX 282	Agricultural Improved (9171)	OTHER	24	x												
39161	81.2157	5-05-00-012.00	Spartanburg	SC	0 BURNETTE RD LYMAN	Qualified Agricultural Farm Vacant (4AGL)	NON-COMMERCIIAL FOREST DEVEL.	24	x												
14737	84.9552	5-44-00-008.00	Spartanburg	SC	0 PEARSON TOWN RD MOORE	Qualified Agricultural Farm Improved (4AGA)	FARMS-GENERAL	24	x	x										x	
57835	86.9019	650030100110	Greenville	SC	PO BOX 256	Agricultural Vacant (9170)	AGRICULTURAL	24	x											x	

Parcels sorted by Protection Score, highest to lowest. This table includes only the top 25 parcels.

9) SEPTIC SYSTEM REPAIR OR REPLACEMENT

Damaged or improperly maintained septic systems can be a significant source of bacteria to surface and groundwater resources. Improper connections, clogs, heavy use, or unmaintained systems can increase the chance that improperly treated wastewater will leak into surface and ground water, which can significantly increase pathogenic bacteria levels, leading to potential health effects in drinking water. Septic system repairs and replacements can reduce bacteria pollution in nearby streams by preventing bacteria leakage from faulty systems. The estimated failure rate for septic systems is 10-30%. For the purposes of this project the average failure rate of 20% was used. Septic systems that are not functioning properly need to be repaired or replaced to prevent bacteria from leaking into nearby rivers and streams. Septic tanks should be pumped every 5 years to maintain efficiency.

9.1) Septic Systems Repair/Replacement Criteria

Table 23 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 (7-10), medium (4-6), and low (0-3) priority for septic tank repair/replacement (see Figure 12).

Table 23. Criteria and Ranking System for Septic Repair/Replacement

Criteria	Ranking	Points	Total Possible Points per Category
Sewer Service Availability (prerequisite for further analysis)	Parcels without Sanitary Sewer Lines	1	1
Adjacency to Drinking Water Reservoirs or Intakes	Adjacent to Drinking Water Reservoirs or Intakes	4	4
	Adjacent to other Waterways	2	
Current Water Quality Impairments	Include, Adjacent to, or Upstream of Existing Impairments	3	3
Land Cover	Urban/Developed Land	2	2
TOTAL POSSIBLE SEPTIC POINTS PER PARCEL			**10**

9.1.1) Sewer Service Availability

Parcels without access to sanitary sewer lines are most likely to utilize septic tank systems to treat wastewater produced on site. This criterion is a prerequisite to further analysis within the Septic BMP category. Parcels that have sewer systems are not eligible for septic system repairs and replacements and thus are excluded from further analysis.

Scoring: Parcels without sewer lines received "1" point; all other parcels received "0" points.

GIS Layers Used: Parcel, Local Sewer System Lines (Provided by Water Districts)

9.1.2) Adjacency to Reservoirs and Drinking Water Intakes

Improperly operating septic systems directly adjacent to water, especially drinking water sources, are of the most concern because bacteria have less opportunity to settle or be naturally filtered before reaching a waterway. As such, parcels with septic systems that are directly adjacent to drinking water sources or other waterways were prioritized.

Scoring: Parcels (likely to have septic systems) that are adjacent to drinking water intakes or reservoirs received “4” points. Parcels that are 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

9.1.3) 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

9.1.4) Land Cover

Parcels within urban and developed lands are more likely to have the opportunity to connect to sewer systems and reduce the potential for bacterial contamination. While switching from septic to sewer is not always a viable option, the potential is greater in urban areas; this criterion helps to identify areas that could most benefit from such a switch.

Scoring: Parcels that fall within urban/developed land received “2” points; all other parcels received “0” points.

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

9.2) Septic System Results & Recommendations

This analysis identified 3,359 parcels as high priority for septic repair/replacement (Figure 13). Concentrations of high priority parcels can be seen in the upper portion of the Middle Tyger River Watershed (0305010701), along Lakes Robinson and Cunningham, and along the corridor between Reidville and Moore, in between State Highway 101 and Walnut Grove Road. There are 57 subdivisions in Spartanburg and 32 subdivisions in Greenville that fall within high priority areas for septic repair/replacement. Of these subdivisions, 34 are located within a mile of existing sewer lines in Lyman, Greer, and Wellford. UF recommends a public outreach campaign targeting the 55 subdivisions in high priority areas outside of the 1-mile radius of sewer lines. This will target homeowners that are likely unable to obtain sewer service and may have problematic septic tanks.

9.3) Septic System Strategies

According to the US EPA STEPL Model, a typical septic system generates 2.42E+10 bacteria a year (SCDHEC, 2015). The following BMPs are considered the most relevant and effective for residential areas in the subwatersheds for bacteria pollution relating to wastewater.

9.3.1) Replace/Repair Septic System

Replacing and/or repairing malfunctioning septic systems is recommended throughout these subwatersheds. Repairing these systems not only improves water quality but also improves quality of life for residents dealing with these failing septic systems.

9.3.2) 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.

9.4) Septic System BMP Unit Cost Estimates and Funding Options

Many homes are not within access points of municipal sanitary sewer lines and therefore onsite septic systems are the most appropriate wastewater treatment. Traditional septic systems and drain fields can 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 24).

Table 24. 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	$4,000 per system	• SCDHEC 319 Funds • USDA Rural Development • State Revolving Funds

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.

9.4.1) Section 319 Funding (SCDHEC)

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

9.4.2) Local Governments

Both Greenville and Spartanburg County may be able to assist homeowners by providing financial support for septic system improvements as funding becomes available. Additionally, local sewer authorities may be able to provide assistance for onsite septic system maintenance, repairs, or replacements.

9.4.3) USDA Rural Utilities Service – Water & 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. Technical assistance by state is given to non-profit organizations 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 through a lending program.

9.4.4) 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 U.S. 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" (USDA, 2017). The moderate-income limit for the subwatersheds is $78,200 for 1-4-person homes and $103,200 for 5-8+ person homes. The average median income for the subwatersheds is $51,743. Of the 69 census block groups in the subwatersheds, 91% 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. Homeowners over 62 years may be eligible for grant funds.

Figure 13: Parcel Prioritization for Septic Repair/Replacement

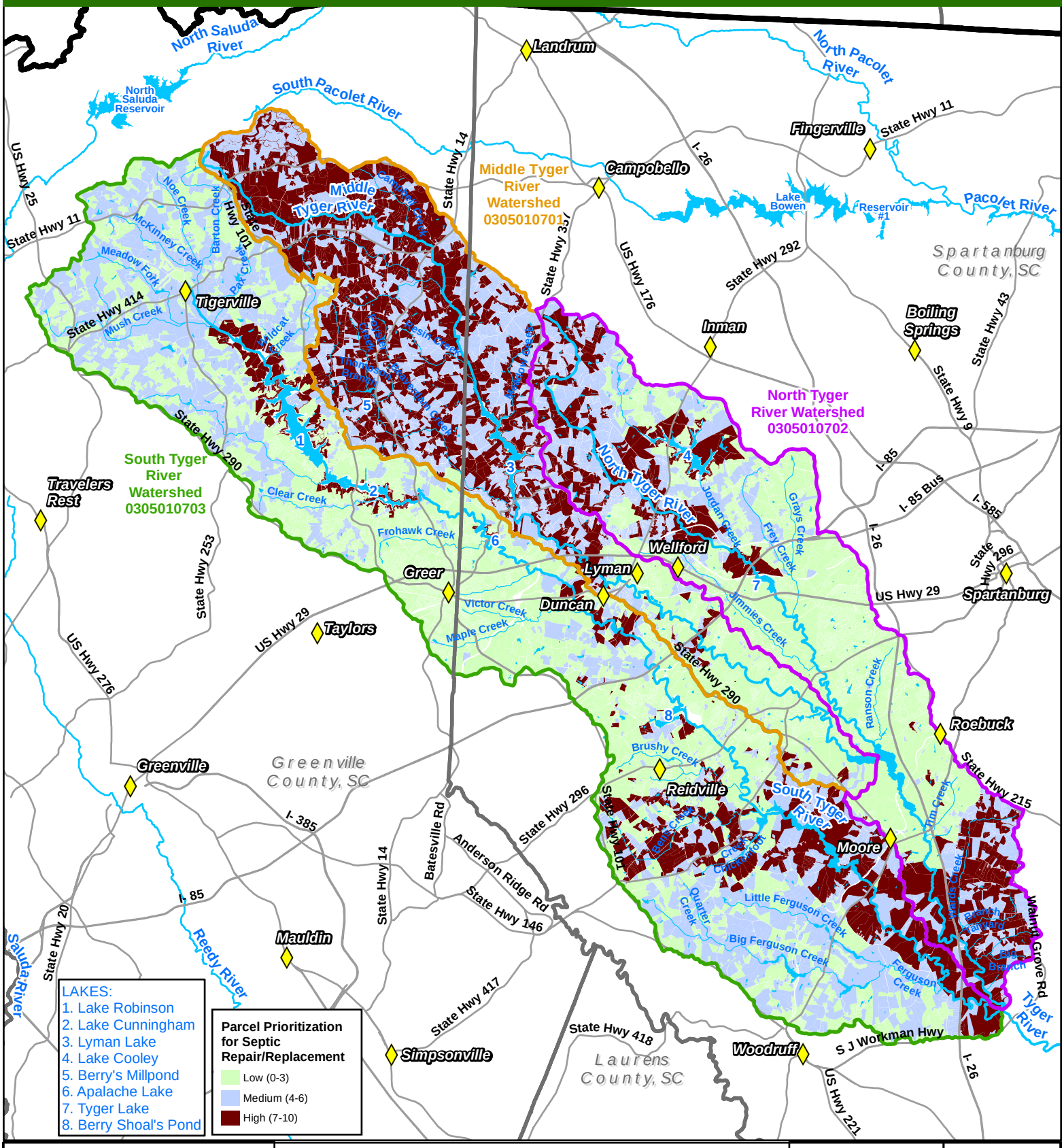

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Figure 14: High Priority Parcels for Septic Repair/Replacement

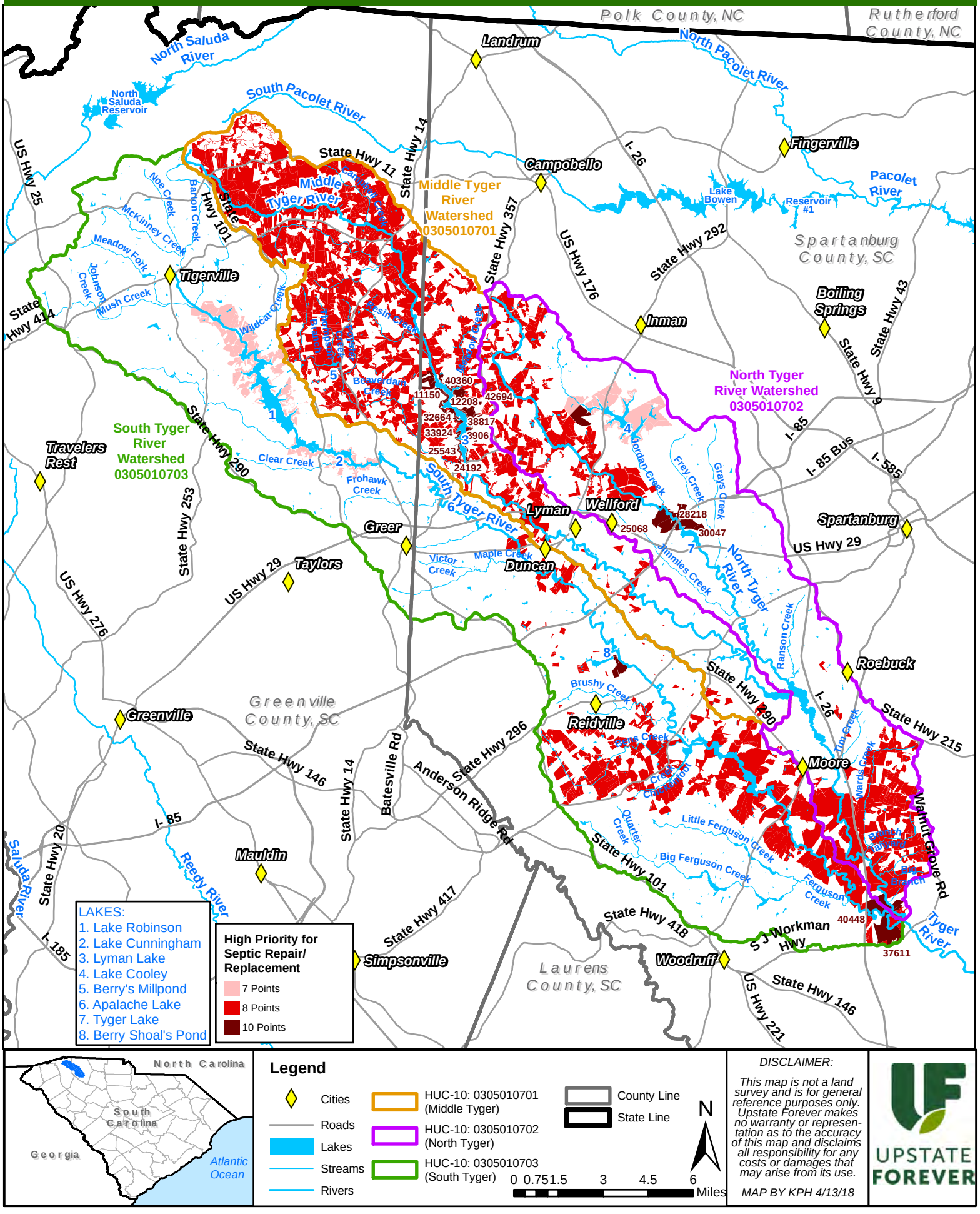

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Table 25: HIGH PRIORITY PARCELS FOR SEPTIC REPAIR/REPLACEMENT

	Property Location and Land Use							Score	High Priority Categories									Further Refinement		Funding	
MapID	Acreage	TaxPin	County	State	PropertyLocation	LandUse	Prop_Type	Septic_Score	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	100Acres+	HP Wetland/Protection	ACEP	Wetland
40360	84.08	1-46-00-027.00	Spartanburg	SC	370 CLEMENT LOOP RD INMAN	Non-Qualified Regular Farm Improved (6RGA)	FARMS-GENERAL	10	x	x	x	x	x		x				x	x	x
37611	365.982	4-28-00-010.00	Spartanburg	SC	4010 WALNUT GROVE RD ROEBUCK	Qualified Agricultural Farm Vacant (4AGL)	COMMERCIAL FOREST PRODUCTION	10	x	x			x	x				x			
25068	132.497	5-16-00-057.00	Spartanburg	SC	0 JOHN DODD RD WELLFORD	Qualified Agricultural Farm Vacant (4AGL)	FARMS-GENERAL	10	x	x			x					x			
28218	115.339	5-16-00-058.02	Spartanburg	SC	0 HILL ST EXT WELLFORD	Qualified Agricultural Farm Vacant (4AGL)	FARMS-GENERAL	10	x	x			x					x			
30047	111.288	5-17-00-007.00	Spartanburg	SC	0 FALLING CREEK RD SPARTANBURG	Qualified Agricultural Farm Vacant (4AGL)	NON-COMMERCIIAL FOREST DEVEL.	10	x	x			x					x			
40448	248.157	6-59-00-023.00	Spartanburg	SC	0 KITCHENS RD ROEBUCK	Exempt Government Vacant (EXV)	COMMERCIAL FOREST PRODUCTION	10	x	x			x					x			
38785	7.9032	5-05-00-038.08	Spartanburg	SC	130 LYMAN LAKE HTGS LYMAN	Qualified Agricultural Residential Vacant (4AGP)	FARMS-GENERAL	10		x	x	x	x		x					x	x
32664	0.916876	5-05-03-057.00	Spartanburg	SC	150 LAKE LYMAN HTS LYMAN	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	10		x	x	x	x		x					x	x
42157	0.665146	5-05-03-062.00	Spartanburg	SC	160 LAKE LYMAN HTS LYMAN	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	10		x	x	x	x		x					x	x
8807	1.32039	5-05-03-067.00	Spartanburg	SC	184 LAKE LYMAN HTS LYMAN	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	10		x	x	x	x		x					x	x
31984	0.745752	1-46-00-027.06	Spartanburg	SC	498 LYMAN LAKE RD LYMAN	Non-Qualified Regular Residential Vacant (6RGP)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	10		x	x	x	x		x					x	x
11947	0.161443	1-46-15-005.00	Spartanburg	SC	465 LYMAN LAKE RD LYMAN	Exempt Improved (EXE)	RESIDENTIAL - SINGLE FAMILY	10		x	x	x	x		x					x	x
9031	0.291502	5-05-03-058.01	Spartanburg	SC	0 LAKE LYMAN HTS LYMAN	Qualified Owner Occupied Residential Vacant (4OOP)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	10		x	x	x	x		x					x	x
39903	1.01062	5-05-03-063.00	Spartanburg	SC	170 LAKE LYMAN HTS LYMAN	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	10		x	x	x	x		x					x	x
7176	0.884242	5-05-03-065.00	Spartanburg	SC	180 LAKE LYMAN HTS LYMAN	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	10		x	x	x	x		x					x	x
33924	3.99524	5-05-12-002.00	Spartanburg	SC	200 LYMAN LODGE RD LYMAN	Exempt Government Improved (EXW)	RECREATIONALACTIVITIES	10		x	x	x	x		x					x	x
10968	1.09456	5-02-00-059.00	Spartanburg	SC	201 SHADOW LN LYMAN	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	10		x		x	x		x	x					x
12208	1.18772	5-02-00-061.00	Spartanburg	SC	181 SHADOW LN LYMAN	Non-Qualified Regular Residential Vacant (6RGP)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	10		x		x	x		x	x					x
11150	1.05936	5-02-00-062.00	Spartanburg	SC	171 SHADOW LN LYMAN	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	10		x		x	x		x	x					x
8906	0.319771	5-05-08-029.00	Spartanburg	SC	275 MARLOWE LN LYMAN	Qualified Owner Occupied Residential Vac MH (4OOJ)	RESIDENTIAL - SINGLE FAMILY	10		x		x	x		x						x
7840	0.313965	5-05-08-030.01	Spartanburg	SC	0 MARLOWE LN LYMAN	Non-Qualified Regular Residential Vacant (6RGP)	UNDEVELOPED LAND	10		x		x	x		x						x
42694	36.333	1-47-00-026.00	Spartanburg	SC	291 RECTOR RD INMAN	Qualified Owner Occupied Farm Vacant MH (4OOK)		10		x	x		x							x	
38817	5.13216	5-05-00-039.01	Spartanburg	SC	140 LAKE LYMAN HTS LYMAN	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	10		x	x		x		x					x	
24192	1.18571	5-05-00-142.00	Spartanburg	SC	102 CARSHALTON DR LYMAN	Non-Qualified Regular Residential Vacant (6RGP)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	10		x	x									x	
25543	0.615935	5-05-00-143.00	Spartanburg	SC	106 CARSHALTON DR LYMAN	Non-Qualified Regular Residential Vacant (6RGP)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	10		x	x									x	

Parcels sorted by Septic Score, highest to lowest. This table includes only the top 25 parcels.

10) AGRICULTURE

Implementing agricultural BMPs reduces both bacteria and sediment pollution in nearby streams while still maintaining, and often improving, conditions for livestock. For the purposes of this plan agricultural land includes pasture (livestock), hay, and cultivated crops. Livestock are the primary agricultural source of bacterial pollution throughout the planning area and can also contribute to sediment pollution. Therefore, to address bacteria inputs agricultural BMPs will focus on restricting animal access to streams across the region with the exception of the urban areas around the City of Greer and also along the major transportation corridors (I-85, US-29, SC-101, etc.). When fencing livestock out of streams it is often necessary to provide an alternative water source the animals, consequently agricultural BMPs often require several components, which also typically reduce sediment inputs to local waterways.

10.1) 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. Table 26 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 (12-17), medium (6-11), and low (0-5) priority for agricultural BMPs (see Figures 14 and 15).

Table 26: 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, bio-solid application areas, Animal Management Areas)	1	
TOTAL POSSIBLE AGRICULTURAL POINTS PER PARCEL			**17**

10.1.1) Agricultural Land

Agricultural lands directly adjacent to waterways are more likely to be sources of bacteria, nutrients, and sediment because of the potential for stormwater runoff carrying fertilizer or 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.

Scoring: 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.

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

10.1.2) Current Pollutant Export

Agricultural lands can be high contributors of nutrients and sediment if they are not managed properly. Common activities can cause discharge of various pollutants into nearby streams. Nutrients, such as nitrogen (N) and phosphorus (P), are known components of many fertilizers, compost, manures, or bio-solids commonly applied to agricultural fields. High nutrient levels can lead to excessive growth of algae, diminished dissolved oxygen levels, and an increase in toxins that may affect human health if ingested (NOAA, 2017). Agricultural lands can also be major contributors to sedimentation and erosion if land is improperly managed (US EPA, 2018). Allowing farm animals into nearby streams, farming on steep slopes, heavy tillage, removal of natural riparian buffers, and soil erodibility are all major factors that contribute to stream sedimentation and soil erosion. The effects of stream sedimentation can be diminished dissolved oxygen levels, degraded aquatic habitats, and increased stream bank erosion and channelization (USGS, 2016). Sedimentation impacts to drinking water utilities include reduced storage capacity as sediment fills in reservoirs, which affects the reliability of water supply; degradation of equipment and reservoir dams, including spillway clogging and turbine damage; and increased cost of water treatment for sediment filtration and additional contaminants (HydroWorld, 2017).

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.

Table 27: Current Pollutant Export Priority Ranges

Pollutant	Units	Low Priority	Medium Priority	High Priority
Nitrogen	Kg/pixel/year	0 – 0.040233	0.04.234 – 0.158627	0.158628 – 0.507028
Phosphorus	Kg/pixel/year	0 – 0.001292	0.001293 – 0.040692	0.040693 – 1.242620
Sediment	tons/pixel/year	0	0.000001 – 0.000004	0.000005 – 0.001243

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

10.1.3) Current Water Quality Impairments

Agricultural lands that include, are directly adjacent to, or upstream of known bacteria, nutrient, or bio water quality impairments could be a contributing factor.
Scoring: Parcels including, adjacent to, or upstream from streams with existing bacteria, nutrient, or bio 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

10.1.4) 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. These land uses may commonly use 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

10.1.5) 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: Parcels with agricultural points source permits (e.g., CAFOs, Animal Management Areas, bio-solid application areas, known farms) received "1" point. All other parcels received "0" points.

GIS Layers Used: Parcel, Agricultural NPDES, Land Applications, Animal Management Areas, Bio-Solid Application Areas, known farms (Google Search)

10.2) Agricultural BMP Results & Recommendations

This analysis identified 4,057 parcels as high priority for Agricultural BMPs. Concentrations of high priority parcels are located in the northern portions of the Middle and North Tyger River watersheds (03050107 -01/-03) and in the Reidville area of the South Tyger River watershed (0305010702). UF recommends targeting landowners in these areas for Agricultural BMP installations.

10.3) Agricultural BMP Strategies

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

10.3.1) Streambank Fencing

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

10.3.2) Armored Streambank Crossings /Culvert Crossing

When stream crossings are necessary to move livestock from one area to another, armored streambank crossings and/or culvert crossings provide protection to reduce erosion within the crossing area. The type of crossing needed will depend upon site conditions.

10.3.3) 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 support removal of livestock from waterways, therefore reduce

manure deposited directly into streams, protecting riparian vegetation, and reducing erosion along streambanks. Additionally, providing a clean reliable source of water for livestock improves livestock health and reduces risk of mortality from injury or disease stream improves their overall health by linear pipelines may be necessary to transport water from the well to the alternative watering sources.

10.3.4) Animal Heavy Use Areas

Heavy use areas, such as alternative water sources, experience high concentration of animals making it difficult to maintain vegetation. Installing a durable material (e.g., crush and run gravel) reduces erosion and pollutant loading of stormwater runoff.

10.3.5) Riparian Buffers

Riparian buffers are vegetated areas along waterways that stabilize soil, filter runoff, and provide wildlife habitat. Restoring riparian buffers will reduce manure, sediment, fertilizers, pesticides, and other pollutants from washing into streams, stabilize stream banks, and improve water quality.

10.4) Agricultural BMP Unit Costs Estimates and Funding Options

Agricultural BMP unit cost estimates are based on information provided by the USDA (SC EQIP, 2017). There are numerous cost share programs available to landowners at the federal, state, and local level. Potential funding sources for agricultural BMPs are provided below in Table 28. The US Department of Agriculture, 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. Additional details included below.

Table 28: Agricultural BMP Unit Costs (SC EQIP, 2017)

BMP	Estimated Cost Per Unit
Linear Streambank Fencing	$3.30/ft.
Well (500’ deep)	$9,546.25 each
Linear Pipeline	$4.92/ft.
Alternative Watering Source	$1066.40 each
Heavy Use Area	$1.67 sq. ft.
Riparian Buffer	$389.07/acre
Filter Strip	$167.37 ft.

10.4.1) Conservation Steward 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, nonindustrial 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 (NRCS SC, 2018).

10.4.2) Conservation Reserve Program (CRP)

The CRP is a land conservation program administered by the Farm Service Agency (FSA), a branch of the US Department of Agriculture. 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 (USDA, 2018).

10.4.3) 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 are 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.

10.4.4) 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 ground water and improve water quality. Examples of previously funded projects include high efficiency irrigation systems, nutrient and pest management plans, and agricultural BMPs.

10.4.5) Section 319 Funding

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

10.4.6) Partners for Fish and Wildlife

The US Fish and Wildlife Service sponsor 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, species that will benefit, etc. Cost share specifics will vary by site (USFWS, 2018). 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.

10.4.7) Wildlife Habitat Incentives Program (WHIP)

NRCS's WHIP program provides funding to landowners to devote some of their land to the development of wildlife habitat. Wildlife habitat may include upland, wetland, agricultural land, or aquatic habitat. The projects must target specific species for habitat improvement, and generally require an agreement of 5-10 years. Cost-share assistance is offered up to 75%, usually paid through reimbursements.

Figure 15: Parcel Prioritization for Agricultural BMP's

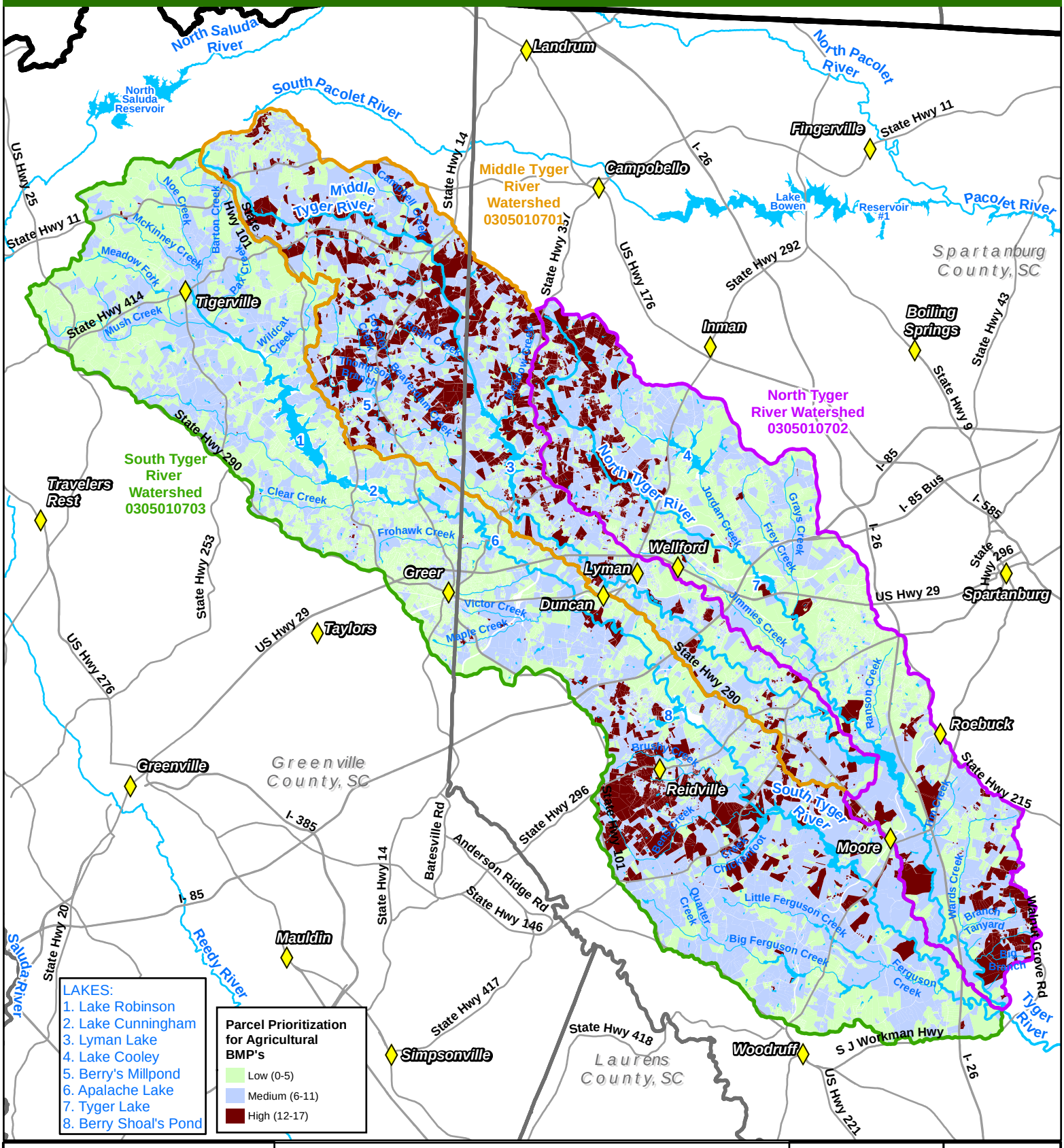

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Figure 16: High Priority Parcels for Agricultural BMP's

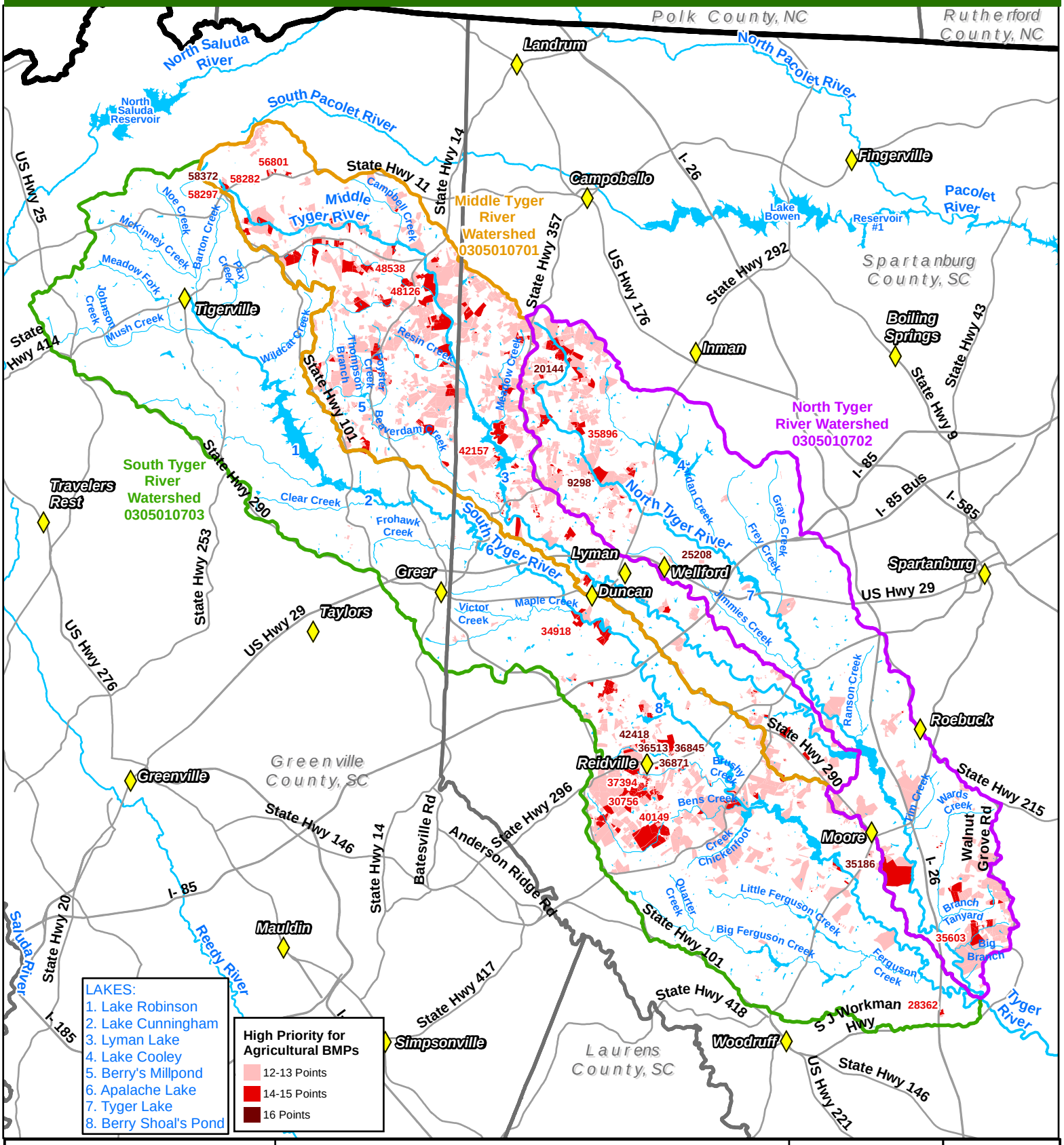

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Table 29: HIGH PRIORITY PARCELS FOR AGRICULTURAL BMP'S

	Property Location and Land Use							Score	High Priority Categories									Further Refinement		Funding	
MapID	Acreage	TaxPin	County	State	PropertyLocation	LandUse	Prop_Type	Ag_Score	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	100Acres+	HP Wetland/Protection	ACEP	Wetland
58372	1.37165	652030100801	Greenville	SC	210 PITTMAN RD	Residential Single Family (1100)	RESIDENTIAL	16		x	x		x							x	
58373	0.708765	652030100802	Greenville	SC	238 PITTMAN RD	Residential - Mobile Home on Mobile Home File (1171)	MOBILE HOME	16			x									x	
20144	1.81398	1-42-00-077.03	Spartanburg	SC	620 WILLIAMS BOTTOM RD INMAN	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	16			x									x	
9298	0.949233	5-07-00-006.01	Spartanburg	SC	115 MONTGOMERY RD LYMAN	Qualified Owner Occupied Residential Imp MH (4OOG)	MOBILE HOME COMBINED WIHT LAND	16			x									x	
25208	0.567479	5-16-00-021.00	Spartanburg	SC	859 NEIGHBORHOOD RD WELLFORD	Non-Qualified Regular Commercial Improved (6RGC)	GROCERIES-RETAIL	16			x									x	
42418	0.573929	5-36-00-041.10	Spartanburg	SC	233 CREEKSIDE FARMS WAY DUNCAN	Non-Qualified Regular Residential Vacant (6RGP)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	16			x									x	
36845	0.301797	5-37-00-367.00	Spartanburg	SC	501 W HOLLOWAY DR REIDVILLE	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	16			x									x	
36513	0.285264	5-37-00-368.00	Spartanburg	SC	505 W HOLLOWAY DR REIDVILLE	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	16			x									x	
36514	0.200638	5-37-00-370.00	Spartanburg	SC	513 W HOLLOWAY DR REIDVILLE	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	16			x									x	
36558	0.269367	5-37-00-382.00	Spartanburg	SC	506 W HOLLOWAY DR REIDVILLE	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	16			x									x	
36871	0.292332	5-37-00-383.00	Spartanburg	SC	502 W HOLLOWAY DR REIDVILLE	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	16			x									x	
35186	1.45031	6-46-00-040.02	Spartanburg	SC	6875 HIGHWAY 221 MOORE	Non-Qualified Regular Commercial Improved (6RGC)	AUTOMOBILE REPAIR & SERVICE	16			x									x	
48126	58.0946	620020102407	Greenville	SC	4736 COCKRELL RD	Agricultural Vacant (9170)	AGRICULTURAL	15	x	x	x	x	x						x	x	x
48538	12.5179	628010101804	Greenville	SC	1146 HIGHWAY 11	Agricultural Vacant (9170)	AGRICULTURAL	15	x	x	x		x							x	
42157	0.665146	5-05-03-062.00	Spartanburg	SC	160 LAKE LYMAN HTS LYMAN	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15		x	x	x	x		x					x	x
56801	8.1842	645020100410	Greenville	SC	1820 HIGHWAY 11	Residential Single Family (1100)	RESIDENTIAL	15		x	x		x							x	
58282	20.0138	652020100703	Greenville	SC	2126 HIGHWAY 11	Residential - Mobile Home with Land (1170)	MOBILE HOME	15		x	x		x							x	
35896	19.5652	1-47-00-101.00	Spartanburg	SC	1700 HAMPTON RD INMAN	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15		x	x		x							x	
28362	10.2317	4-27-00-032.02	Spartanburg	SC	180 FRONTAGE RD 35 ROEBUCK	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15		x	x		x							x	
30756	13.4448	5-42-00-043.00	Spartanburg	SC	1951 REIDVILLE SHARON RD GREER	Non-Qualified Regular Residential Improved (6RGR)	RESIDENTIAL - SINGLE FAMILY	15		x	x		x							x	
40149	38.4424	5-42-00-066.00	Spartanburg	SC	905 FOWLER RD WOODRUFF	Qualified Agricultural Farm Vacant (4AGL)	FARMS-FRUITS & VEGETABLES	15		x	x		x							x	
35603	82.3554	6-60-00-001.00	Spartanburg	SC	0 HATCHETT RD ROEBUCK	Non-Qualified Regular Residential Vacant (6RGP)	NON-COMMERCIIAL FOREST DEVEL.	15	x		x		x							x	
58297	3.71068	652020100721	Greenville	SC	2221 COAL PIT RD	Residential - Mobile Home on Mobile Home File (1171)	MOBILE HOME	15			x	x								x	x
34918	51.1906	5-19-00-141.00	Spartanburg	SC	0 WOODS CHAPEL RD DUNCAN	Qualified Agricultural Farm Improved (4AGA)		15			x	x	x							x	x
37394	30.776	5-36-00-061.00	Spartanburg	SC	301 LIGHTWOOD KNOT RD GREER	Qualified Agricultural Farm Vacant (4AGL)	FARMS-FRUITS & VEGETABLES	15			x	x	x							x	x

Parcels sorted by Agricultural Score, highest to lowest. This table includes only the top 25 parcels.

11) 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. 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.

11.1) Wetland Restoration/Enhancement Criteria

Table 30 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 (see Figure 17). These ranges were chosen based on the total available points and the highest scores parcels achieved from this analysis.

Table 30. 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**

11.1.1) 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 (WA Dept. of Ecology, 2017). Restoring inundated and modified wetlands to their natural states would provide significant environmental and water quality benefit (USEPA, 2002).

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)

11.1.2) Current Water Quality Impairments

Parcels including, directly adjacent to, or upstream of existing known water quality impairments 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

11.1.3) 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 export per parcel was calculated; then the range of averaged values was separated into high, medium, and low export categories. For each pollutant, parcels within the highest 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.

Table 27: Current Pollutant Export Priority Ranges

Pollutant	Units	Low Priority	Medium Priority	High Priority
Nitrogen	Kg/pixel/year	0 – 0.040233	0.04.234 – 0.158627	0.158628 – 0.507028
Phosphorus	Kg/pixel/year	0 – 0.001292	0.001293 – 0.040692	0.040693 – 1.242620
Sediment	tons/pixel/year	0	0.000001 – 0.000004	0.000005 – 0.001243

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

11.1.4) 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, renew natural sedimentation levels, etc. 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

11.2) Wetland Restoration/Enhancement Results & Recommendations

184 parcels fell within the high priority range, with the highest achieved score of 14 and concentrated along the northern portion of the Middle Tyger River just upstream of Lyman Lake (Figure 17). It is recommended to coordinate with developers in need of wetlands mitigation credit to provide funding to restore many of these wetland areas.

Figure 17: Parcel Prioritization for Wetland Restoration/Enhancement

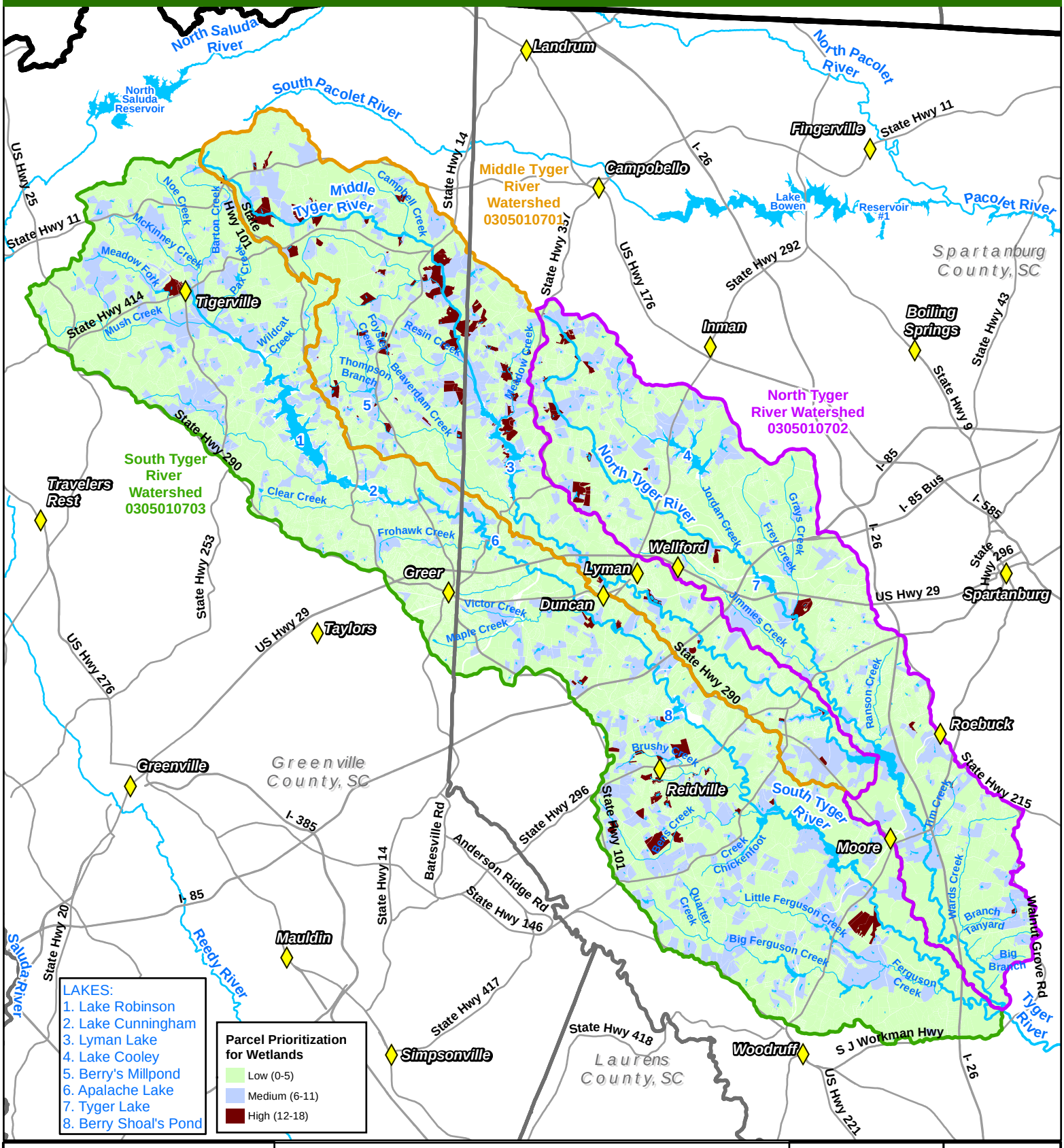

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Figure 18: High Priority Parcels for Wetland Restoration/Enhancement

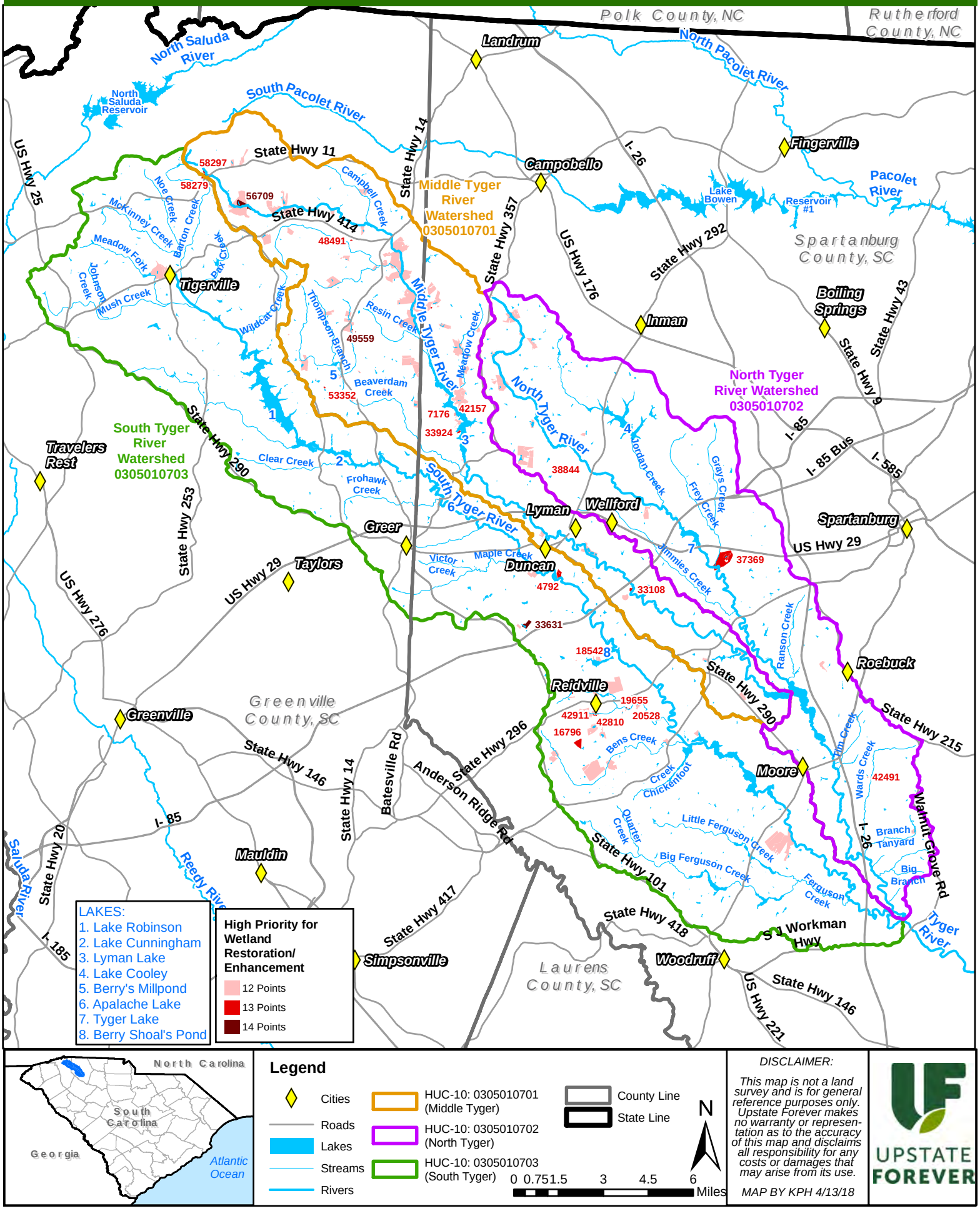

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Table 31: HIGH PRIORITY PARCELS FOR WETLAND RESTORATION/ENHANCEMENT

	Property Location and Land Use									High Priority Categories									Further Refinement		Funding	
MapID	Acreage	TaxPin	County	State	PropertyLocation	Neighborhood	LandUse	Prop_Type	Wetland	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	100Acres+	HP Wetland/Protection	ACEP	Wetland
56709	42.8865	644020100402	Greenville	SC	141 OLD BALLENGER MILL RD		Agricultural Improved (9171)	OTHER	14	x	x	x	x	x	x					x	x	x
33631	26.1795	5-24-00-132.00	Spartanburg	SC	1 TUNGSTEN WAY DUNCAN		Non-Qualified Regular Commercial Improved (6RGC)	MACHINERY (EXCEPT ELECTRICAL)	14		x	x	x	x	x						x	x
49559	1.1984	630060101800	Greenville	SC	PO BOX 87	CHAPEL HILL ESTATES	Residential - HOA Property (1181)	RESIDENTIAL	14			x	x								x	x
42157	0.665146	5-05-03-062.00	Spartanburg	SC	160 LAKE LYMAN HTS LYMAN		Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	13		x	x	x	x		x					x	x
7176	0.884242	5-05-03-065.00	Spartanburg	SC	180 LAKE LYMAN HTS LYMAN		Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	13		x	x	x	x		x					x	x
33924	3.99524	5-05-12-002.00	Spartanburg	SC	200 LYMAN LODGE RD LYMAN		Exempt Government Improved (EXW)	RECREATIONALACTIVITIES	13		x	x	x	x		x					x	x
37369	148.048	6-19-00-018.01	Spartanburg	SC	500 R AND D DR SPARTANBURG		SCDOR Industrial (State Assessed) (TIDI)	KNIT GOODS	13	x		x	x	x	x				x	x	x	x
58297	3.71068	652020100721	Greenville	SC	2221 COAL PIT RD		Residential - Mobile Home on Mobile Home File (1171)	MOBILE HOME	13			x	x								x	x
42911	0.38545	5-36-00-089.89	Spartanburg	SC	120 W LONGFIELD LN REIDVILLE		Non-Qualified Regular Residential Vacant (6RGP)		13			x	x								x	x
42810	0.3325	5-36-00-089.90	Spartanburg	SC	116 W LONGFIELD LN REIDVILLE		Non-Qualified Regular Residential Vacant (6RGP)		13			x	x								x	x
42809	0.323712	5-36-00-089.91	Spartanburg	SC	112 W LONGFIELD LN REIDVILLE		Non-Qualified Regular Residential Vacant (6RGP)		13			x	x								x	x
42816	0.265255	5-36-00-089.92	Spartanburg	SC	108 W LONGFIELD LN REIDVILLE		Non-Qualified Regular Residential Vacant (6RGP)		13			x	x								x	x
42881	0.284091	5-36-00-089.93	Spartanburg	SC	104 W LONGFIELD LN REIDVILLE		Non-Qualified Regular Residential Vacant (6RGP)		13			x	x								x	x
42797	0.280469	5-36-00-089.94	Spartanburg	SC	100 W LONGFIELD LN REIDVILLE		Non-Qualified Regular Residential Vacant (6RGP)		13			x	x								x	x
19655	0.49931	5-37-00-113.00	Spartanburg	SC	211 CHRIS LYN CT WOODRUFF		Non-Qualified Regular Residential Vacant (6RGP)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	13			x	x								x	x
20528	1.03232	5-37-00-117.00	Spartanburg	SC	159 MONIQUE LN WOODRUFF		Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	13			x	x								x	x
16796	32.8294	5-42-00-038.04	Spartanburg	SC	0 REIDVILLE SHARON RD GREER		Qualified Agricultural Farm Vacant (4AGL)	FARMS-GENERAL	13			x	x								x	x
42491	0.584642	6-47-00-019.11	Spartanburg	SC	151 JAMESON DR ROEBUCK		Non-Qualified Regular Residential Improved (6RGR)	RESIDENTIAL - SINGLE FAMILY	13			x	x								x	x
48491	1.67116	628010101115	Greenville	SC	1206 PLEASANT HILL RD		Residential Vacant (1180)	RESIDENTIAL	13			x	x								x	x
53352	1.83137	634030101500	Greenville	SC	RR 3		Religious - Church (810)	COMMERCIAL	13			x	x								x	x
58279	14.6983	652020100700	Greenville	SC	2134 HIGHWAY 11		Agricultural Improved (9171)	OTHER	13			x	x								x	x
38844	0.250258	5-11-00-021.22	Spartanburg	SC	469 BRENDA WAY LYMAN		Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	13			x	x								x	x
4792	21.0598	5-20-00-036.03	Spartanburg	SC	101 WILBURN AVE DUNCAN		Non-Qualified Regular Commercial Improved (6RGC)	MOBILE HOME PARKS	13			x	x	x							x	x
33108	10.2787	5-26-00-008.07	Spartanburg	SC	310 SPARTANGREEN BLVD DUNCAN		SCDOR Industrial (State Assessed) Industrial Vac (TIDD)		13			x	x	x							x	x
18542	0.257545	5-30-12-044.00	Spartanburg	SC	150 N LAKEVIEW DR DUNCAN		Qualified Owner Occupied Residential Vac MH (4OOJ)	MOBILE HOME LOT	13			x	x	x		x					x	x

Parcels sorted by Wetland Score, highest to lowest. This table includes only the top 25 parcels.

12) RIPARIAN BUFFER RESTORATION/ENHANCEMENT

This analysis identifies parcels that are high priority for riparian buffer restoration/enhancements with the end goal of improving current riparian buffer area, vegetation coverage, and adding riparian buffers to sensitive area. Riparian buffers provide many ecological benefits such as erosion and nonpoint source pollution control and filtration, wildlife habitat, streambank stabilization, and groundwater recharge. While the necessary width of a buffer to provide such ecosystem services depends on a number of factors, in general, wider widths of riparian buffer coverage provide a greater number of benefits (Conservation Tools, n.d.) . Increasing the coverage of riparian buffers, especially along impaired or sensitive streams, can reduce the cost of water treatment, help mitigate future impairments, and assist with erosion and flood control.

12.1) Riparian Buffer Restoration/Enhancement Criteria

Table 32 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 (18-26 points), medium (9-17 points), and low (0-8 points) priority for riparian buffer restoration/enhancement (see Figure 18).

Table 32: 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**

12.1.1) 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 (Pennsylvania Land Trust Association, 2014) . This criteria places priority on parcels that, if restored, would provide significant water quality benefits. Restoring or enhancing highly sensitive riparian buffers can provide significant water quality benefits.

Scoring: UF identified highly sensitive riparian areas by combining the results from the USFS

Riparian Buffer Delineation Model v.3 (run by UF) with a 100-foot buffer around all waterways. Parcels that fell fully or partially within this layer were assigned "4" points; all other parcels were assigned "0" points (Fischer, 2000). 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

12.1.2) Stream Order

Riparian buffers on headwater streams, in this case first and second order streams, have much greater influences on overall water quality within a watershed than those along downstream reaches (Fischer, 2000). 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 (1^{st} or 2^{nd} order) streams received "4" points. All other parcels received "0" points.

GIS Layers Used: Parcel, National Hydrology Dataset

12.1.3) Adjacency to Lakefront and 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 ground water.

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

12.1.4) Current Water Quality Impairments

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

Scoring: Parcels including, adjacent to, or upstream of streams with existing 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

12.1.5) 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.

Scoring: For each pollutant (nitrogen, phosphorus, and sediment) the average value of export within each parcel was calculated; then the range of averaged values was separated into high, medium, and low export categories. For each pollutant, parcels within the highest 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.

GIS Layers Used: Parcel, Furman University’s Current Pollutant Export Layers for Nitrogen, Phosphorus, and Sediment (results from the InVEST Model) (Natural Capital Project, 2017).

Table 27: Current Pollutant Export Priority Ranges

Pollutant	Units	Low Priority	Medium Priority	High Priority
Nitrogen	Kg/pixel/year	0 – 0.040233	0.04.234 – 0.158627	0.158628 – 0.507028
Phosphorus	Kg/pixel/year	0 – 0.001292	0.001293 – 0.040692	0.040693 – 1.242620
Sediment	tons/pixel/year	0	0.000001 – 0.000004	0.000005 – 0.001243

12.1.6) 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 (Natural Capital Project, 2017). By restoring 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 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)

12.2) Riparian Buffer Restoration/Enhancement Results & Recommendations

This analysis identified 2,044 parcels as high priority for riparian buffer restoration/enhancement. Out of a possible 26 points, 6 parcels achieved a total of 24 points. To further refine high priority results, parcels within urban floodplain areas were removed; these parcels will likely be covered under Stormwater BMP’s (see Section 15). The remaining 1,232 high priority parcels are highly concentrated in three HUC-12 subwatersheds: Upper Middle Tyger River (030501070101), Beaverdam Creek Middle Tyger River (030501070102), and Lower South Tyger River (030501070305), accounting for 64% (793 out of 1,232 high priority parcels). UF recommends focusing the Riparian Buffer Strategies listed below in these three subwatersheds.

12.3) Riparian Buffer Restoration/Enhancement Strategies

The following are recommendations for riparian buffer restoration and/or enhancement strategies for the South, Middle, and North Tyger River subwatersheds.

12.3.1) Develop a Buffer Management Plan

UF recommends the Development of Buffer Management Plans for Greer CPW’s drinking water reservoirs (Lakes Robinson and Cunningham) and SJWD’s drinking water reservoirs (Lakes Lyman, Apalache, Cooley, Tyger, Berry’s Millpond, Berry Shoals Pond).

12.3.2) 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 limit activities allowed within riparian buffers. This could protect the natural canopy, prevent clear-cutting to a waterway's edge, improve stormwater management in highly urban areas, and provide long-term water quality protection. It is recommended to collaborate with local governments to establish healthy buffer requirements. High priority governments include: Greenville and Spartanburg Counties, as well as the City of Greer. A recent study showed a significant loss in riparian buffers from the years 2001 to 2011 along the main stem of the Reedy River. Spurred by these findings and the well understood water quality benefits provided by buffers, Greenville County staff drafted a buffer ordinance, currently proposed as: a 100-foot total buffer zone for streams with drainage areas <50 acres, and a 200-foot total buffer zone for streams with drainage areas >50 acres. Since Spartanburg and Greenville are experiencing similarly rapid development, we can assume that similar loss of buffers is occurring along the Tyger Rivers within Spartanburg County and that a buffer ordinance would provide critical benefits.

12.3.3) Restoration/Enhancement

Restoring land adjacent to waterways, lakes, ponds, and wetlands to a natural wooded/vegetated state by improving the density and type of plants, stabilizing streambanks, and ensuring proper maintenance. Coordinating with developers in need of wetlands or stream mitigation in the area could direct mitigation projects to priority areas within the North, Middle and South Tyger River subwatersheds.

12.3.4) Tree Giveaways

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, like the North and South Pacolet subwatersheds, and can be used to encourage landowners to plant trees near streams/shorelines which will in turn provide water quality and riparian buffer benefits such as streambank stabilization, additional shade/vegetative cover, and erosion control.

Figure 19: Parcel Prioritization for Riparian Buffer Restoration/Enhancement

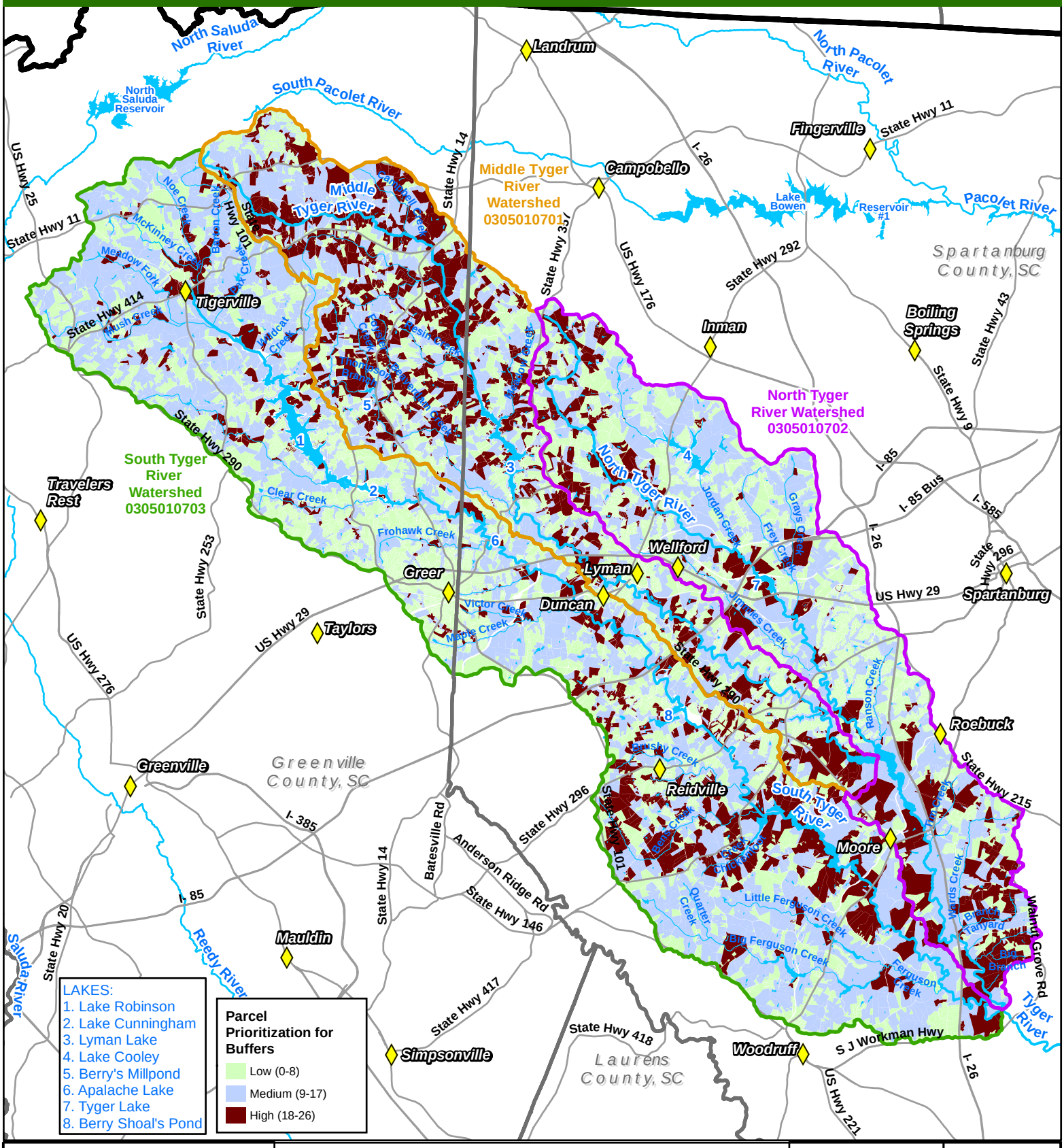

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Figure 20: High Priority Parcels for Riparian Buffer Restoration/Enhancement

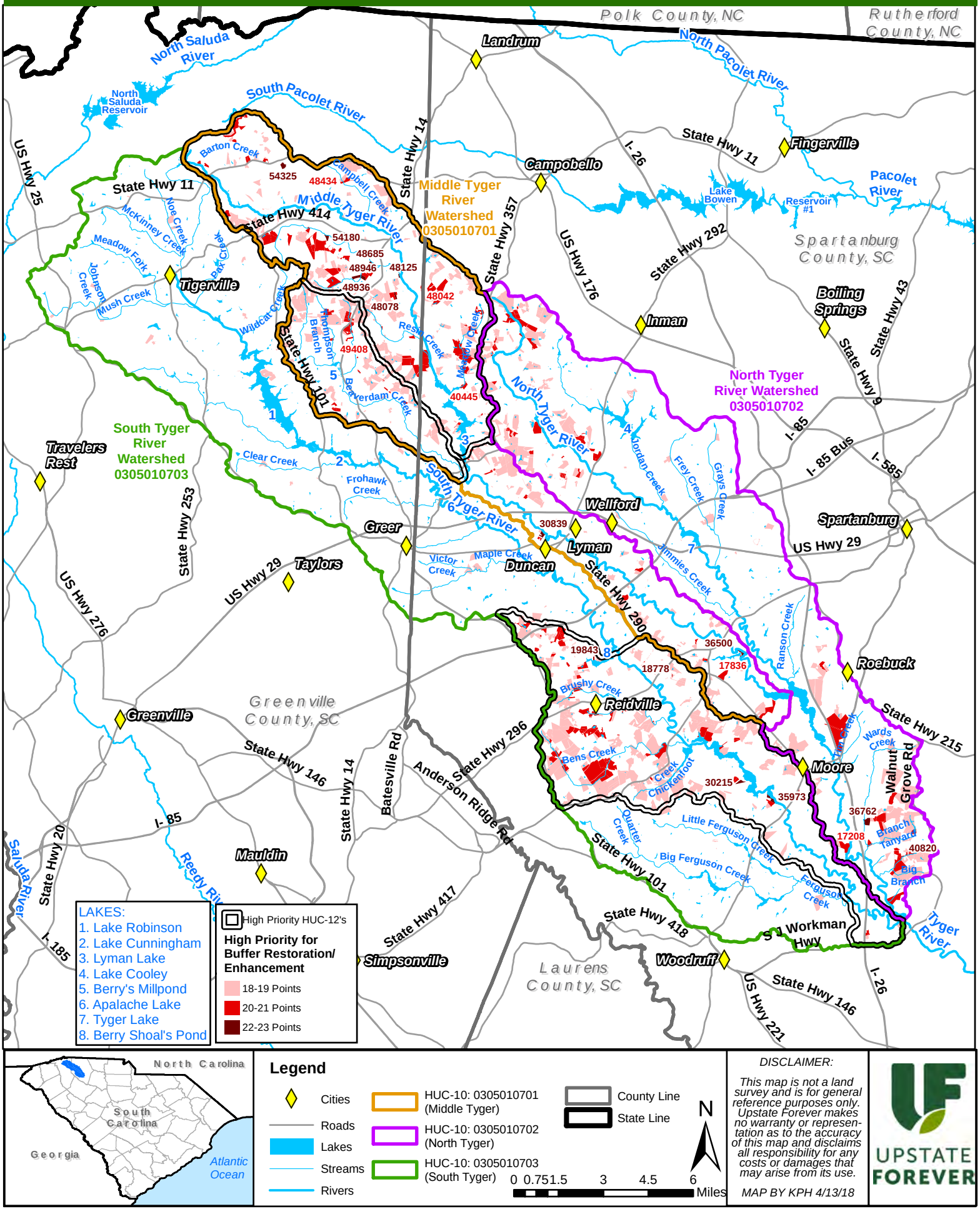

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Table 33: HIGH PRIORITY PARCELS FOR RIPARIAN BUFFER RESTORATION/ENHANCEMENT

	Property Location and Land Use								Score	High Priority Categories									Further Refinement		Funding	
MapID	Acreage	TaxPin	County	State	PropertyLocation	Neighborhood	LandUse	Prop_Type	Buffer	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	100Acres+	HP Wetland/Protection	ACEP	Wetland
48694	7.35583	628040101600	Greenville	SC	927 LAURELWOOD WAY	LAURELWOOD	Agricultural Vacant (9170)	AGRICULTURAL	23			x		x							x	
30839	17.571	5-15-13-021.00	Spartanburg	SC	0 VAUGHN RD DUNCAN		Qualified Agricultural Farm Vacant (4AGL)	FARMS-GENERAL	22	x		x	x	x						x	x	x
48125	3.77011	620020102405	Greenville	SC	4736 COCKRELL BRIDGE RD		Agricultural Vacant (9170)	AGRICULTURAL	22	x		x	x	x						x	x	x
48949	11.8241	629020102600	Greenville	SC	4879 N HIGHWAY 14		Agricultural Improved (9171)	OTHER	22			x	x	x							x	x
36500	20.2557	5-32-00-060.05	Spartanburg	SC	141 TWIN LAKES DR MOORE		Qualified Agricultural Farm Vacant (4AGL)	OTHER AGRICULTURE	22			x	x	x							x	x
35973	28.7382	4-09-00-011.00	Spartanburg	SC	0 OLD SPARTANBURG HWY MOORE		Qualified Agricultural Farm Vacant (4AGL)	FARMS-GENERAL	22	x		x		x							x	
48685	7.56335	628040100600	Greenville	SC	606 W POINSETT ST STE A	LAURELWOOD	Agricultural Improved (9171)	OTHER	22			x		x							x	
48691	5.67042	628040101300	Greenville	SC	927 LAURELWOOD WAY	LAURELWOOD	Agricultural Improved (9171)	OTHER	22			x		x							x	
48936	15.8145	629020102406	Greenville	SC	202 PINK DILL MILL RD		Agricultural Improved (9171)	OTHER	22			x		x							x	
48690	9.7838	628040101200	Greenville	SC	947 LAURELWOOD WAY	LAURELWOOD	Residential Single Family (1100)	RESIDENTIAL	22			x		x							x	
48946	11.9924	629020102510	Greenville	SC	190 DEWEY RD		Agricultural Improved (9171)	OTHER	22			x		x							x	
54180	10.5366	636040100201	Greenville	SC	4664 HOWE RD		Agricultural Improved (9171)	OTHER	22			x		x							x	
54325	16.2565	637020100602	Greenville	SC	1565 HIGHWAY 11		Agricultural Vacant (9170)	AGRICULTURAL	22			x		x							x	
30215	11.9903	4-08-00-049.23	Spartanburg	SC	0 BOBCAT LN WOODRUFF		Qualified Agricultural Farm Vacant (4AGL)	FARMS-GENERAL	22			x		x							x	
36762	26.5896	6-54-00-020.00	Spartanburg	SC	269 SHAMAN RD ROEBUCK		Qualified Owner Occupied Farm Improved (4OOA)	RESIDENTIAL - SINGLE FAMILY	22			x		x							x	
19843	2.06339	5-30-12-002.00	Spartanburg	SC	565 BERRY SHOALS RD DUNCAN		Qualified Owner Occupied Residential Imp MH (4OOG)	MOBILE HOME COMBINED WIHT LAND	22			x	x	x		x					x	x
48078	7.53768	620010101901	Greenville	SC	581 BARNETT RD		Residential Single Family (1100)	RESIDENTIAL	22		x	x		x							x	
40820	0.511378	6-55-00-088.00	Spartanburg	SC	0 JOHNSON RD ROEBUCK		Non-Qualified Regular Residential Vacant (6RGP)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	22		x	x		x							x	
18778	0.57157	5-31-00-250.00	Spartanburg	SC	257 GLEN CREST DR MOORE		Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	22			x		x			x					
40445	19.4552	1-46-00-025.00	Spartanburg	SC	0 CLEMENT LOOP RD INMAN		Qualified Agricultural Residential Vacant (4AGP)	UNDEVELOPED LAND	21		x			x							x	
48042	10.2667	620010100404	Greenville	SC	430 NODINE RD		Agricultural Improved (9171)	OTHER	21					x							x	
48434	20.2248	627030101000	Greenville	SC	400 EAST RUTHERFORD STREET	THE MEADOWS OF CAMPBELL CREEK	Agricultural Vacant (9170)	AGRICULTURAL	21					x								
49408	1.42078	630030104901	Greenville	SC	4078 CRIPPLE CREEK RD		Residential Single Family (1100)	RESIDENTIAL	21					x								
17836	2.54455	5-32-08-001.00	Spartanburg	SC	128 SORRENTO DR MOORE		Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	21					x								
17208	15.2827	6-54-00-023.04	Spartanburg	SC	0 JAMES RD ROEBUCK		Qualified Agricultural Residential Vacant (4AGP)	UNDEVELOPED LAND	21					x								

Parcels sorted by Riparian Buffer Score, highest to lowest. This table includes only the top 25 parcels.

13) 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 would restore natural flows to rivers and streams.

13.1) Voluntary Dam Removal Criteria

Table 34 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 (0 points) priority for dam removal (see Figure 20).

Table 34: Criteria and Ranking System for Voluntary Dam Removal

Category	Criteria	Points	Total Possible Points per Category
Water Impoundments & 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**

13.1.1) Water Impoundments and Dams

Dams physically alter the aquatic ecology and removal of obsolete dams can restore stream flow, improve aquatic habitat, renew natural sedimentation levels, etc. Removing dams is not always a viable – or preferred – option, depending on the dam's use, condition, and owner's wishes

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

GIS Layers Used: Parcel, National Inventory of Dams

13.1.2) Current Water Quality Impairments

Parcels including, directly adjacent to, or upstream of an existing known water quality 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

13.2) Voluntary Dam Removal Results, Recommendations & Funding Sources

This analysis identified 22 parcels as high priority for exploring if the landowner would be interested in a voluntary dam removal. To further identify parcels containing dams that are more likely candidates for removal, parcels meeting the following qualifications were selected for more in-depth analysis:

1. Agricultural Land Use
2. Dams on Small Ponds (impounding less than 50 acres of water)
3. Parcels were REMOVED if: Dam located in large subdivisions, gated communities, or with obvious recreational usage

The refined results identified 18 parcels (see Table 35: High Priority Parcels for Dam Removal) we recommend for further evaluation for potential voluntary dam removal (see Figure 22), given landowner approval. Most of these dams are located on farms, residential properties, or undeveloped lands. If a dam on agricultural land is providing water to livestock, we recommend coordinating EQIP or Section 319 funding to fence cattle out of streams and install an alternate water source to improve water quality. Dams that could be identified as providing an amenity within neighborhoods or golf courses (at the mapping scale) were removed, but a field analysis should be conducted to further evaluate remaining dams. The high priority parcels are spread throughout the North, Middle, and South Tyger River watersheds.

Figure 21: Parcel Prioritization for Voluntary Dam Removal

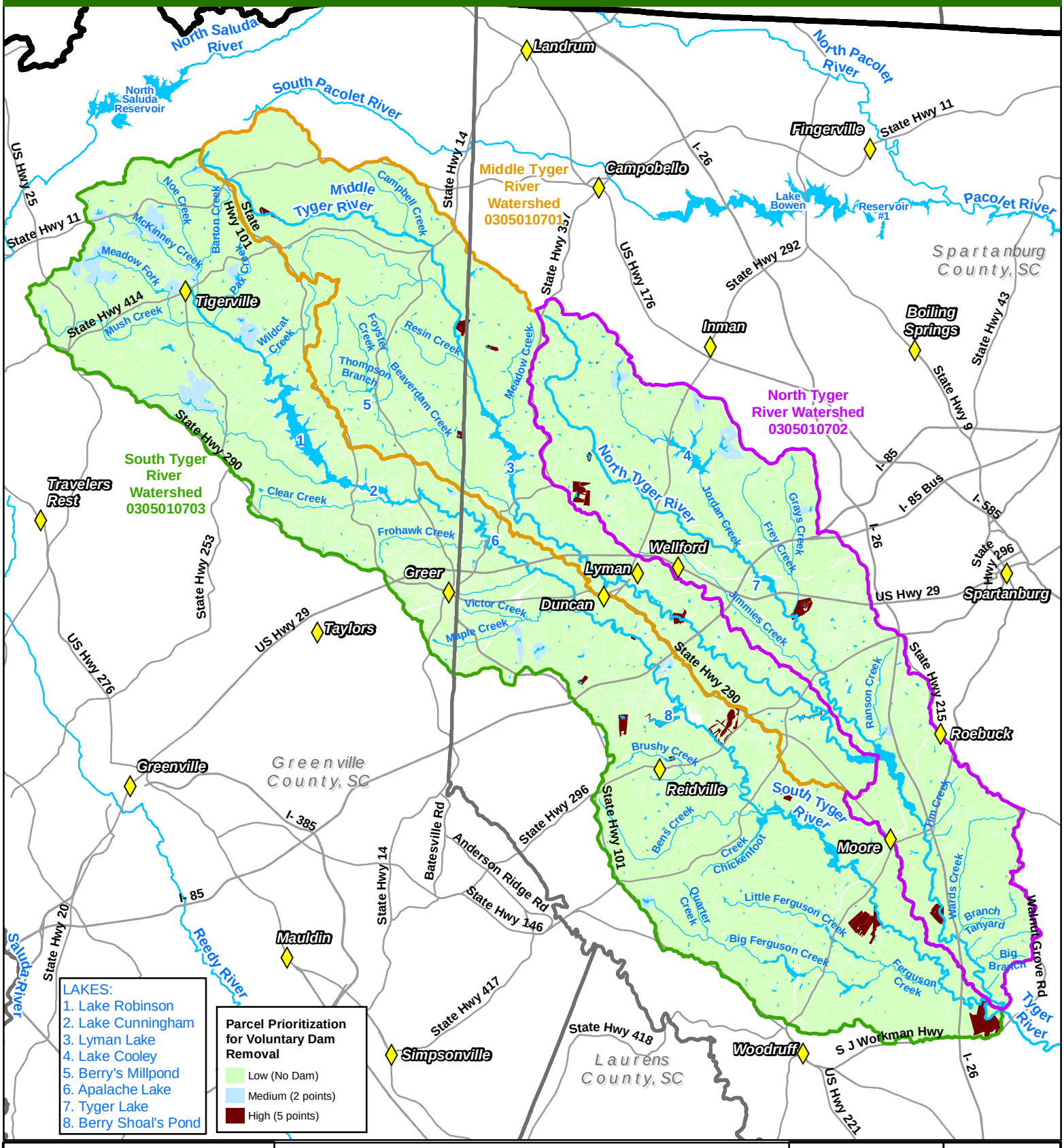

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Figure 22: High Priority Parcels for Voluntary Dam Removal

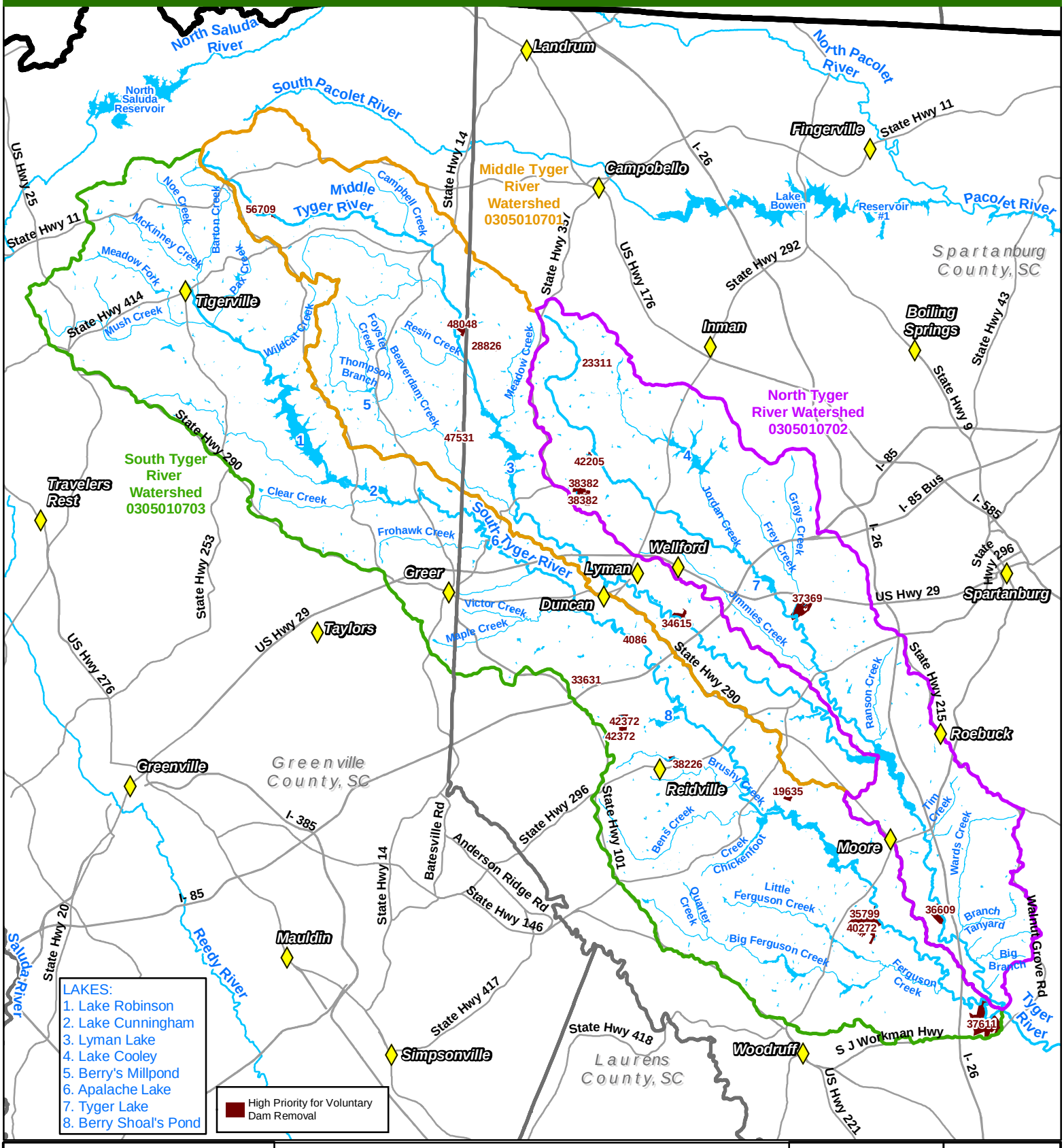

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Table 35: HIGH PRIORITY PARCELS FOR VOLUNTARY DAM REMOVAL

	Property Location and Land Use								High Priority Categories										Further Refinement		Funding	
MapID	**Acreage**	**TaxPin**	**County**	**State**	**PropertyLocation**	**LandUse**	**Prop_Type**	**Dam_Score**	**Protection**	**Septic**	**Ag**	**Wetlands**	**Buffers**	**Dams**	**Shoreline**	**Stormwater**	**PetWaste**	**100Acres+**	**HP Wetland/Protection**	**ACEP**	**Wetland**
56709	42.8865	644020100402	Greenville	SC	141 OLD BALLENGER MILL RD	Agricultural Improved (9171)	OTHER	5	x	x	x	x	x	x					x	x	x
35799	96.3295	4-14-00-035.00	Spartanburg	SC	1500 OLD SWITZER RD WOODRUFF	Non-Qualified Regular Residential Improved (6RGR)	RESIDENTIAL - SINGLE FAMILY	5	x	x	x	x	x	x					x	x	x
28826	27.391	1-41-00-017.05	Spartanburg	SC	340 MILL GIN RD CAMPOBELLO	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	5		x	x	x	x	x						x	x
33631	26.1795	5-24-00-132.00	Spartanburg	SC	1 TUNGSTEN WAY DUNCAN	Non-Qualified Regular Commercial Improved (6RGC)	MACHINERY (EXCEPT ELECTRICAL)	5		x	x	x	x	x						x	x
37369	148.048	6-19-00-018.01	Spartanburg	SC	500 R AND D DR SPARTANBURG	SCDOR Industrial (State Assessed) (TIDI)	KNIT GOODS	5	x		x	x	x	x				x	x	x	x
47531	25.5504	618020100500	Greenville	SC	1113 JORDAN RD	Agricultural Improved (9171)	OTHER	5			x	x	x	x						x	x
48048	84.226	620010100800	Greenville	SC	250 NODINE RD	Agricultural Vacant (9170)	AGRICULTURAL	5	x	x		x	x	x					x	x	x
40272	220.828	4-14-00-037.00	Spartanburg	SC	1480 OLD SWITZER RD WOODRUFF	Non-Qualified Regular Farm Vacant MH (6RGK)		5	x	x		x	x	x				x	x	x	x
38382	166.769	5-10-00-072.00	Spartanburg	SC	102 MURPHY RD LYMAN	Non-Qualified Regular Farm Improved (6RGA)	FARMS-GENERAL	5	x	x		x	x	x				x	x	x	x
42205	18.0288	5-06-00-138.00	Spartanburg	SC	668 ZIMMERMAN RD LYMAN	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	5		x		x	x	x						x	x
19635	71.9874	5-44-00-005.01	Spartanburg	SC	0 KUHN RD MOORE	Qualified Agricultural Farm Vacant (4AGL)	FARMS-GENERAL	5	x		x		x	x						x	
37611	365.982	4-28-00-010.00	Spartanburg	SC	4010 WALNUT GROVE RD ROEBUCK	Qualified Agricultural Farm Vacant (4AGL)	COMMERCIAL FOREST PRODUCTION	5	x	x			x	x				x			
34615	81.152	5-21-09-001.00	Spartanburg	SC	125 S MAIN ST STARTEX	Qualified Agricultural Farm Vacant (4AGL)	UNDEVELOPED LAND	5	x				x	x						x	
36609	114.793	6-54-00-013.00	Spartanburg	SC	150 JOHNSON LN ROEBUCK	Qualified Owner Occupied Farm Improved (4OOA)	FARMS-GENERAL	5		x				x				x		x	
4086	10.9735	5-20-00-047.00	Spartanburg	SC	501 S DANZLER RD DUNCAN	Non-Qualified Regular Farm Improved (6RGA)	RESIDENTIAL - SINGLE FAMILY	5		x				x							
42372	89.1625	5-30-00-097.02	Spartanburg	SC	0 BERRY SHOALS RD DUNCAN	Qualified Agricultural Farm Vacant (4AGL)	FARMS-GENERAL	5	x					x						x	
23311	2.9333	1-42-00-076.03	Spartanburg	SC	155 COLLINSDALE CT INMAN	Non-Qualified Regular Residential Vacant (6RGP)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	5						x						x	
38226	19.7891	5-36-00-042.00	Spartanburg	SC	0 DILLARD RD DUNCAN	Non-Qualified Regular Residential Improved (6RGR)	RESIDENTIAL - SINGLE FAMILY	5						x						x	

Parcels sorted by Dam Score, highest to lowest. This table includes all top 18 parcels.

14) 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 directly impact water quality just before the intake, with little opportunity for settling or filtration; hence, proper management of these properties can help to ensure drinking water stays clean. 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.

14.1) Shoreline Management Criteria

Table 36 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 (see Figure 22).

Table 36: 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**

14.1.1) Adjacency to Drinking Water Reservoirs or 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 ground water.

Scoring: Parcels adjacent to drinking water intakes or reservoirs received "4" points; all other parcels were excluded from further analysis.

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

14.1.2) 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 export per parcel was calculated; then the range of averaged values was separated into high, medium, and low export categories. For each pollutant, parcels within the highest 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.

Table 27: Current Pollutant Export Priority Ranges

Pollutant	Units	Low Priority	Medium Priority	High Priority
Nitrogen	Kg/pixel/year	0 – 0.040233	0.04.234 – 0.158627	0.158628 – 0.507028
Phosphorus	Kg/pixel/year	0 – 0.001292	0.001293 – 0.040692	0.040693 – 1.242620
Sediment	tons/pixel/year	0	0.000001 – 0.000004	0.000005 – 0.001243

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

14.1.3) 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 (Pennsylvania Land Trust Association, 2014). This criteria places priority on parcels that, if restored, would provide significant water quality benefits. Restoring or enhancing highly sensitive riparian buffers can provide significant water quality benefits.

Scoring: UF identified highly sensitive riparian areas by combining the results from the USFS Riparian Buffer Delineation Model v.3 (run by UF) with a 100-foot buffer around all waterways. Parcels that fell fully or partially within this layer were assigned "4" points; all other parcels were assigned "0" points (Fischer, 2000).

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

14.1.4) 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

14.2) Shoreline Management Results & Recommendations

This analysis identified 291 high priority parcels for all drinking water reservoirs combined (see Figures 22-27, and Tables 40-46) adjacent to the various reservoirs. No further refinement was conducted since shoreline management is specific to each reservoir.

14.2.1) Develop a Buffer Management Plan

Upstate Forever recommends developing a Buffer Management Plan for Greer CPW's drinking water reservoirs (Lakes Robinson and Cunningham) and SJWD's drinking water reservoirs (Lakes Lyman, Apalache, Cooley, Tyger, Berry's Millpond, Berry Shoals Pond).

14.2.2) Restore Lawns along Shorelines

Maintaining/improving natural riparian vegetation along the shorelines of drinking water reservoirs is important. UF encourages maintaining natural buffers along shorelines by encouraging landowners not to mow lawns down to the shoreline.

14.2.3) Private Boat Ramp Removal

Private boat ramps impact water quality while providing benefits to a limited number of people. Removing these ramps would reduce stormwater runoff impacts and, if replaced with a vegetated buffer, would provide water quality improvements. Prohibiting new private ramps and providing public boat ramps strategically around the lake(s) that are well managed would reduce direct impacts to the lake(s). Landowners with unused or unmaintained boat ramps may be most amenable to their removal.

14.2.4) Private Boat Dock Maintenance

UF recommends that water utilities work with 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. Additionally, utilities could consider requiring stormwater BMPs in order to permit a new boat dock and limiting the width and size of new docks (most importantly at the shoreline) to mitigation and minimize riparian buffer encroachment.

14.2.5) Data Collection

UF recommends that water utilities collect information on shoreline land uses that will provide information such as presence of docks or ramps and current status of shoreline management strategic planning.

Figure 23: Parcel Prioritization for Shoreline Management

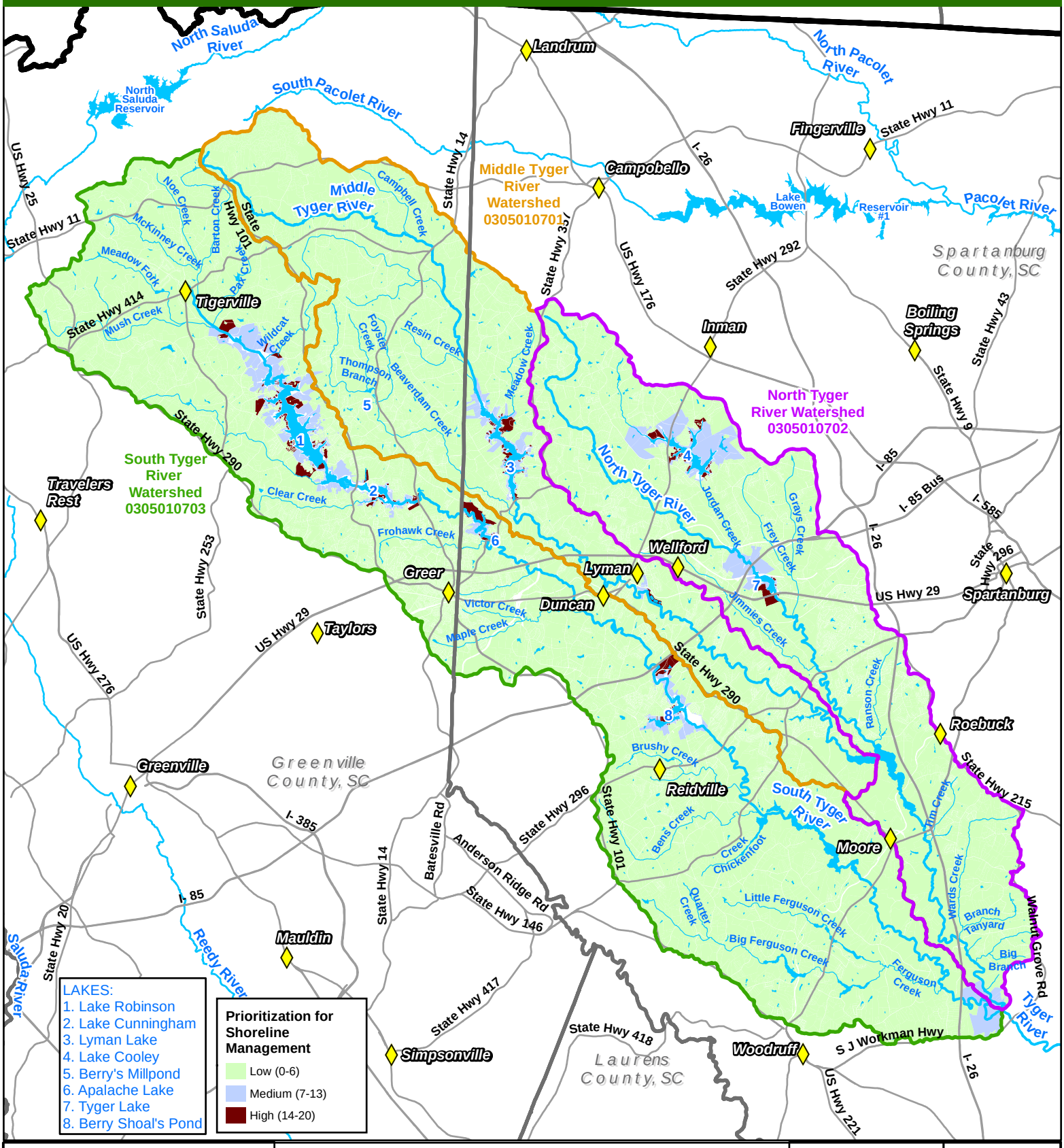

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Figure 24: High Priority Parcels for Shoreline Management - Lake Robinson

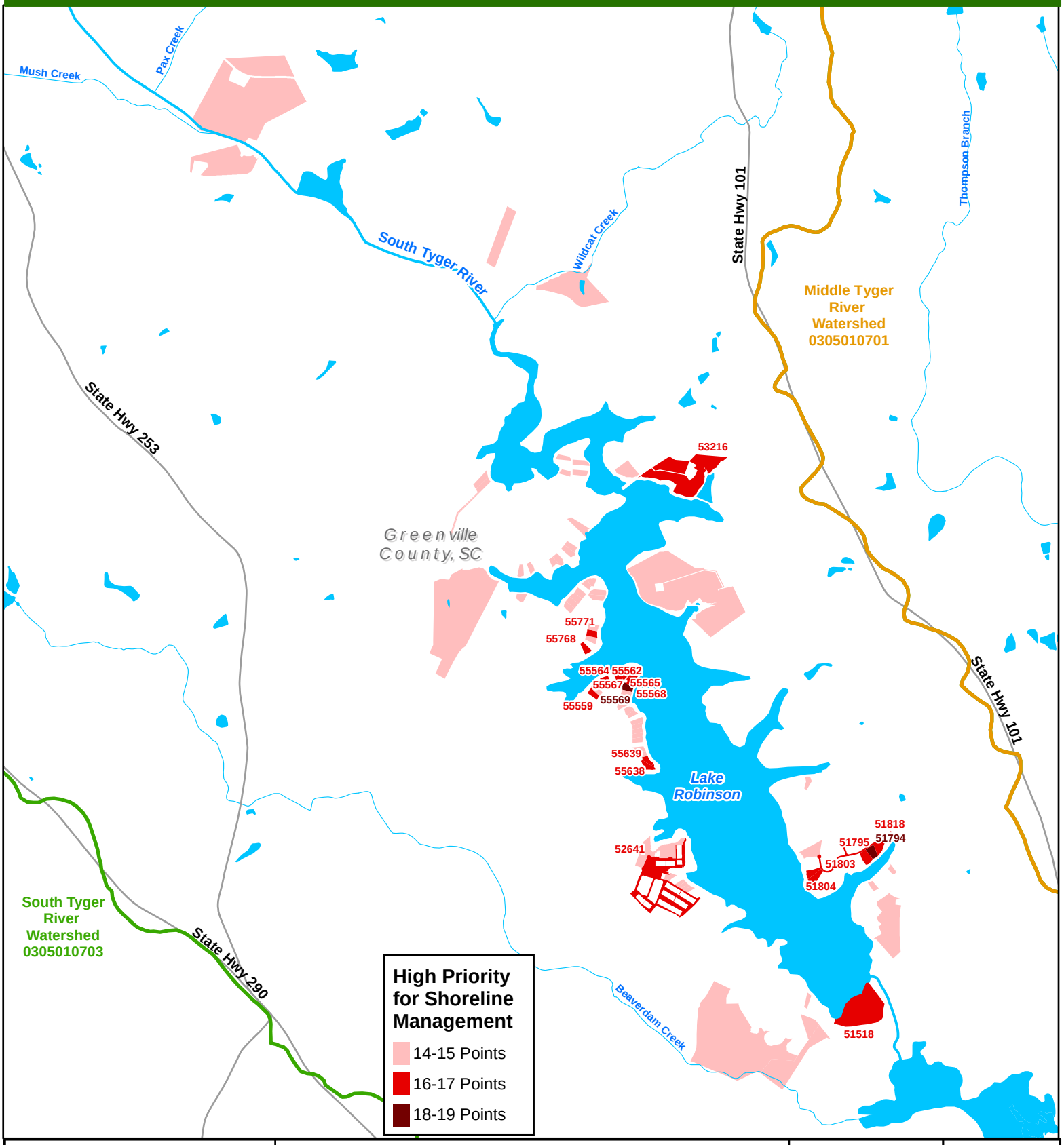

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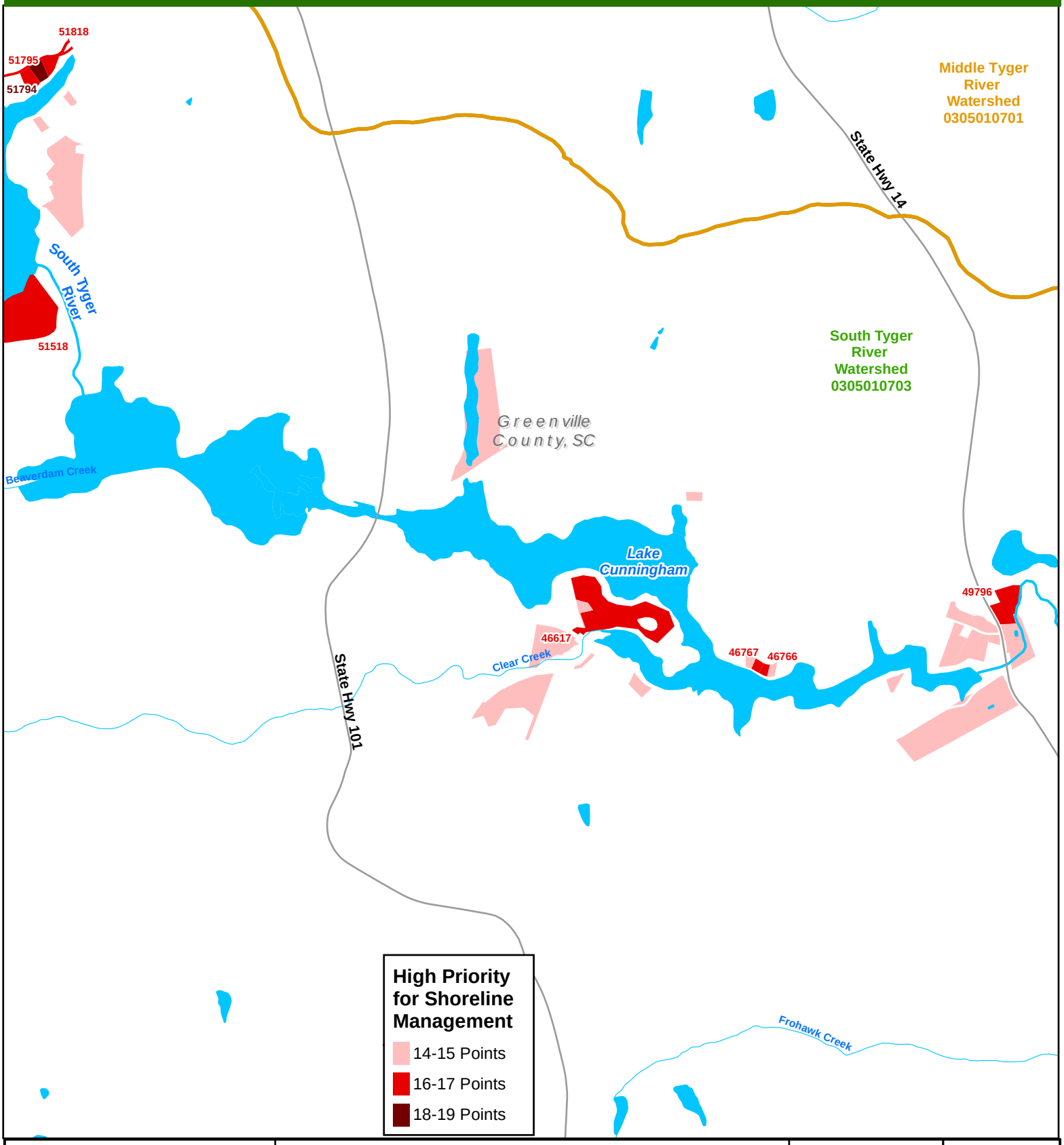
Table 37: HIGH PRIORITY PARCELS FOR SHORELINE MANAGEMENT - LAKE ROBINSON

	Property Location and Land Use							Score	High Priority Categories									Further Refinement		Funding	
MapID	Acreage	TaxPin	County	State	Neighborhood	LandUse	Prop_Type	Shoreline	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	100Acres+	HP_Wetlands_Protection	ACEP	Wetland
51794	1.30	633080100100	Greenville	SC	PENNINGTON POINTE	Residential Single Family (1100)	RESIDENTIAL	18							x						
55569	0.94	641060101200	Greenville	SC	ARROWHEAD	Residential Single Family (1100)	RESIDENTIAL	18							x						
51518	23.47	633020101600	Greenville	SC		Utility Facility (891)	COMMERCIAL	17							x						
51795	1.50	633080100200	Greenville	SC	PENNINGTON POINTE	Residential Single Family (1100)	RESIDENTIAL	17							x						
55559	0.83	641060100200	Greenville	SC	ARROWHEAD	Residential Single Family (1100)	RESIDENTIAL	17							x						
55564	0.92	641060100700	Greenville	SC	ARROWHEAD	Residential Single Family (1100)	RESIDENTIAL	17							x						
55568	0.82	641060101100	Greenville	SC	ARROWHEAD	Residential Single Family (1100)	RESIDENTIAL	17							x						
55771	0.88	641090103100	Greenville	SC	HAMMOND'S POINTE	Residential Single Family (1100)	RESIDENTIAL	17			x				x						
51803	1.50	633080101100	Greenville	SC	PENNINGTON POINTE	Residential Single Family (1100)	RESIDENTIAL	16							x						
51804	1.04	633080101200	Greenville	SC	PENNINGTON POINTE	Residential Vacant (1180)	RESIDENTIAL	16							x						
51818	4.17	633080102800	Greenville	SC	PENNINGTON POINTE	Residential - HOA Property (1181)	RESIDENTIAL	16							x					x	
52641	17.81	633150115600	Greenville	SC	STILLWATERS	Residential - HOA Property (1181)	RESIDENTIAL	16							x						
53216	21.72	634020105500	Greenville	SC		Agricultural Improved (9171)	OTHER	16							x						
55562	1.17	641060100500	Greenville	SC	ARROWHEAD	Residential Single Family (1100)	RESIDENTIAL	16							x						
55565	0.85	641060100800	Greenville	SC	ARROWHEAD	Residential Single Family (1100)	RESIDENTIAL	16							x						
55567	1.10	641060101000	Greenville	SC	ARROWHEAD	Residential Single Family (1100)	RESIDENTIAL	16							x						
55638	0.71	641060107600	Greenville	SC	LANFORD'S POINTE	Residential Single Family (1100)	RESIDENTIAL	16							x						
55639	0.98	641060107700	Greenville	SC	LANFORD'S POINTE	Residential Single Family (1100)	RESIDENTIAL	16							x						
55768	0.89	641090102800	Greenville	SC	HAMMOND'S POINTE	Residential Single Family (1100)	RESIDENTIAL	16							x						
51526	13.83	633020101901	Greenville	SC		Agricultural Improved (9171)	OTHER	15							x						
55377	57.08	641020101800	Greenville	SC		Residential Single Family (1100)	RESIDENTIAL	15	x						x						
55571	1.28	641060101400	Greenville	SC	ARROWHEAD	Residential Single Family (1100)	RESIDENTIAL	15							x						
55627	0.73	641060106500	Greenville	SC	LANFORD'S POINTE	Residential Single Family (1100)	RESIDENTIAL	15							x						
55628	0.54	641060106600	Greenville	SC	LANFORD'S POINTE	Residential Single Family (1100)	RESIDENTIAL	15							x						
55637	0.98	641060107500	Greenville	SC	LANFORD'S POINTE	Residential Single Family (1100)	RESIDENTIAL	15							x						

Parcels sorted by Shorline Score, highest to lowest. This table includes only the top 25 parcels.

Figure 25: High Priority Parcels for Shoreline Management - Lake Cunningham



Legend

- Cities
- Roads
- Lakes
- Streams
- Rivers
- HUC-10: 0305010701 (Middle Tyger)
- HUC-10: 0305010702 (North Tyger)
- HUC-10: 0305010703 (South Tyger)
- County Line
- State Line

N

0 0.05 0.1 0.2 0.3 0.4 Miles

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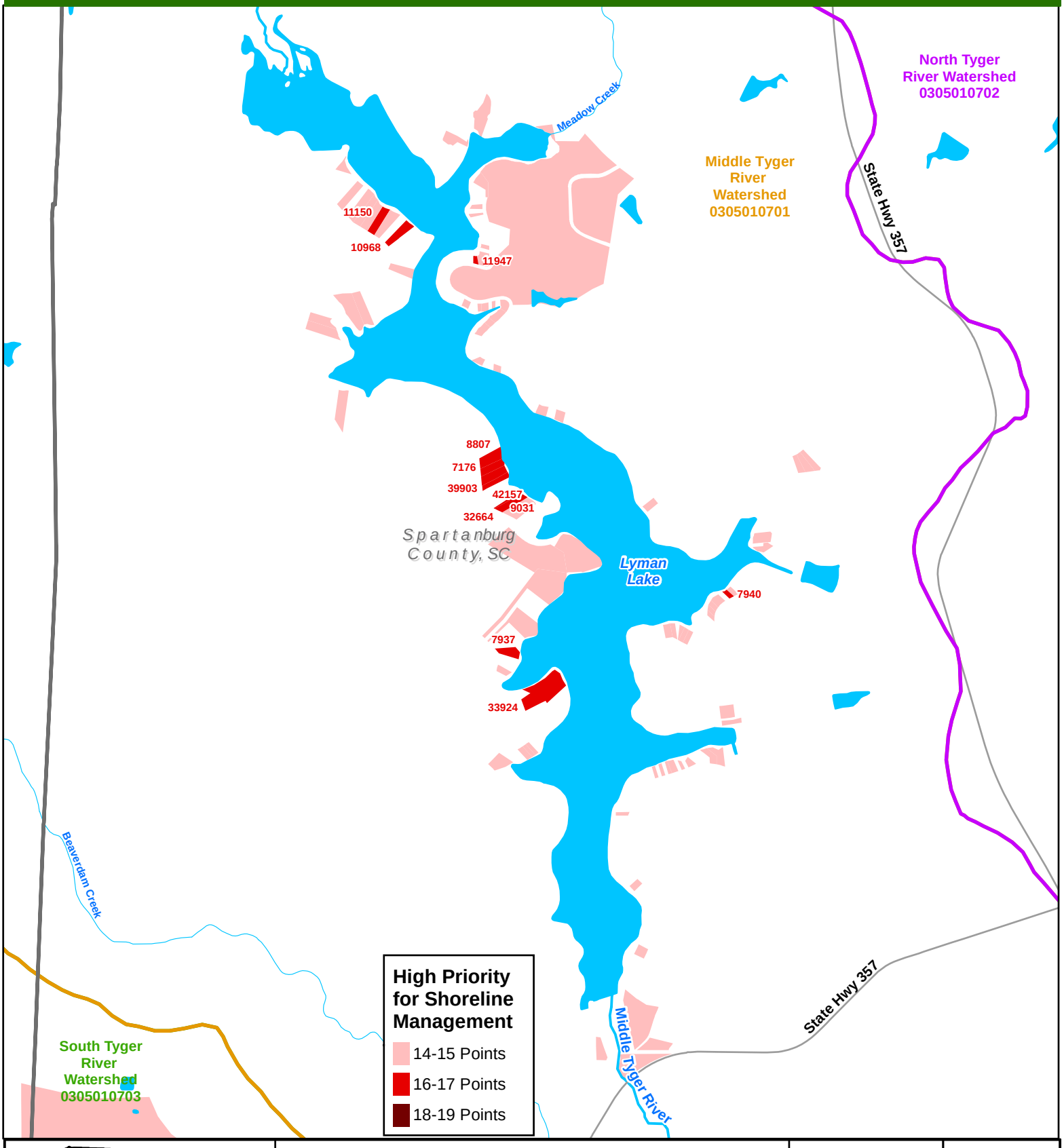
Table 38: HIGH PRIORITY PARCELS FOR SHORELINE MANAGEMENT - LAKE CUNNINGHAM

	Property Location and Land Use							Score	High Priority Categories									Further Refinement		Funding	
MapID	Acreage	TaxPin	County	State	Neighborhood	LandUse	Prop_Type	Shoreline	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	100Acres+	HP_Wetlands_Protection	ACEP	Wetland
46617	16.72	537060202100	Greenville	SC		Residential Vacant (1180)	RESIDENTIAL	17					x		x						
46766	0.47	537070104000	Greenville	SC		Residential Single Family (1100)	RESIDENTIAL	17							x						
46767	0.56	537070104400	Greenville	SC		Residential Single Family (1100)	RESIDENTIAL	17							x						
23906	7.48	9-02-00-076.00	Spartanburg	SC		Non-Qualified Regular Commercial Improved (6RGC)	TEXTILE MILL PRODUCTS	16							x						
49796	4.62	631040100800	Greenville	SC		Residential Single Family (1100)	RESIDENTIAL	16					x		x						
10678	0.42	9-02-10-018.00	Spartanburg	SC		Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						
11571	0.30	9-02-14-028.00	Spartanburg	SC		Non-Qualified Regular Residential Improved (6RGR)	RESIDENTIAL - SINGLE FAMILY	15							x						
45994	1.43	537030301900	Greenville	SC	VALLEY HAVEN ACRES	Residential Single Family (1100)	RESIDENTIAL	15							x						
46733	2.06	537070102905	Greenville	SC		Agricultural Improved (9171)	OTHER	15							x						
46735	3.44	537070103000	Greenville	SC		Residential Vacant (1180)	RESIDENTIAL	15							x						
46738	1.94	537070103004	Greenville	SC		Agricultural Improved (9171)	OTHER	15							x						
46742	3.90	537070103008	Greenville	SC		Residential Vacant (1180)	RESIDENTIAL	15							x						
46768	0.54	537070104600	Greenville	SC		Residential Single Family (1100)	RESIDENTIAL	15							x						
47092	0.90	537170101200	Greenville	SC	CUNNINGHAM POINT	Residential Single Family (1100)	RESIDENTIAL	15							x						
49995	0.80	631060101341	Greenville	SC	CANNON HILL	Residential - Mobile Home with Land (1170)	MOBILE HOME	15							x						
9307	0.55	9-02-06-053.00	Spartanburg	SC		Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	14							x						
9367	0.47	9-02-05-011.00	Spartanburg	SC		Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	14							x						
9406	0.42	9-02-10-006.00	Spartanburg	SC		Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	14							x						
9458	0.39	9-02-10-017.00	Spartanburg	SC		Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	14							x						
9459	0.35	9-02-10-007.00	Spartanburg	SC		Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	14							x						
9461	0.35	9-02-10-002.00	Spartanburg	SC		Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	14							x						
9524	0.40	9-02-10-003.00	Spartanburg	SC		Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	14							x						
10366	0.74	9-02-15-089.00	Spartanburg	SC		Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	14							x						
10598	0.37	9-02-10-004.00	Spartanburg	SC		Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	14							x						
10676	20.63	9-02-00-045.04	Spartanburg	SC		Non-Qualified Regular Farm Vacant (6RGL)	FARMS-GENERAL	14							x						

Parcels sorted by Shoreline Score, highest to lowest. This table includes only the top 25 parcels.

Figure 26: High Priority Parcels for Shoreline Management - Lyman Lake



Legend

- Cities
- Roads
- Lakes
- Streams
- Rivers
- HUC-10: 0305010701 (Middle Tyger)
- HUC-10: 0305010702 (North Tyger)
- HUC-10: 0305010703 (South Tyger)
- County Line
- State Line

N

0 0.05 0.1 0.2 0.3 0.4 Miles

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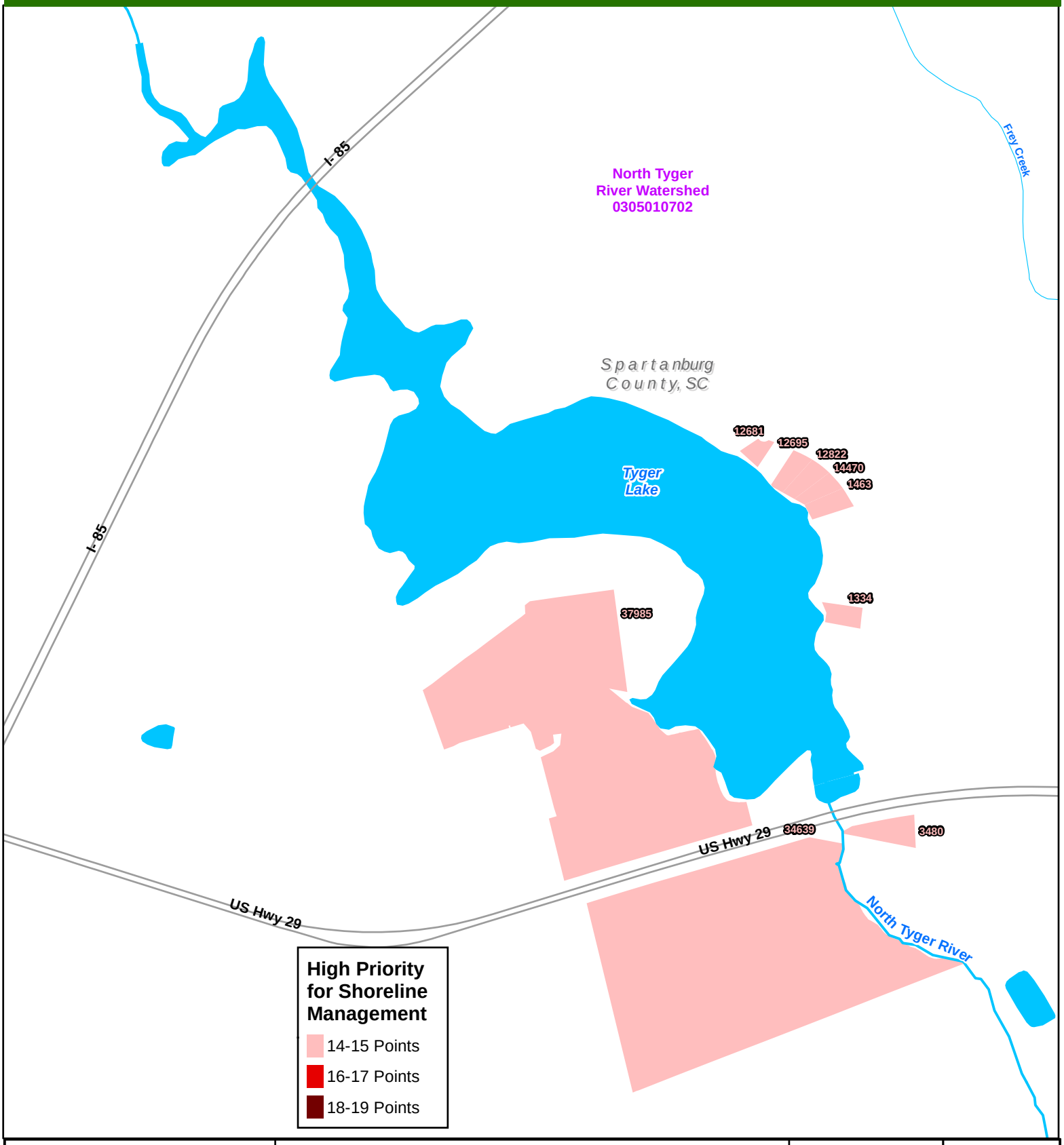
Table 39: HIGH PRIORITY PARCELS FOR SHORELINE MANAGEMENT - LYMAN LAKE

	Property Location and Land Use						Score	High Priority Categories									Further Refinement		Funding	
MapID	Acreage	TaxPin	County	State	LandUse	Prop_Type	Shoreline	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	100Acres+	HP_Wetlands_Protection	ACEP	Wetland
7176	0.88	5-05-03-065.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	17		x	x	x			x	x					x
33924	4.00	5-05-12-002.00	Spartanburg	SC	Exempt Government Improved (EXW)	RECREATIONALACTIVITIES	17		x	x	x			x	x	x				x
42157	0.67	5-05-03-062.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	17		x	x	x			x	x					x
8807	1.32	5-05-03-067.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	16		x	x	x			x	x					x
9031	0.29	5-05-03-058.01	Spartanburg	SC	Qualified Owner Occupied Residential Vacant (4OOP)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	16		x	x	x			x	x					x
10968	1.09	5-02-00-059.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	16		x		x			x	x					x
11150	1.06	5-02-00-062.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	16		x		x			x	x					x
11947	0.16	1-46-15-005.00	Spartanburg	SC	Exempt Improved (EXE)	RESIDENTIAL - SINGLE FAMILY	16		x	x	x			x	x					x
32664	0.92	5-05-03-057.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	16		x	x	x			x	x					x
39903	1.01	5-05-03-063.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	16		x	x	x			x	x					x
7795	0.43	5-05-08-039.00	Spartanburg	SC	Non-Qualified Regular Residential Improved (6RGR)	RESIDENTIAL - SINGLE FAMILY	15		x					x						
7826	0.23	5-06-05-003.00	Spartanburg	SC	Non-Qualified Regular Residential Improved (6RGR)	RESIDENTIAL - SINGLE FAMILY	15		x					x						
7840	0.31	5-05-08-030.01	Spartanburg	SC	Non-Qualified Regular Residential Vacant (6RGP)	UNDEVELOPED LAND	15		x		x			x	x					x
8055	0.15	5-05-12-052.00	Spartanburg	SC	Non-Qualified Regular Residential Vacant MH (6RGJ)	MOBILE HOME LOT	15		x					x						
8071	0.19	5-05-12-048.00	Spartanburg	SC	Qualified Owner Occupied Residential Vacant (4OOP)	MOBILE HOME LOT	15		x					x						
8080	0.25	5-05-12-053.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15		x					x						
8735	4.99	5-09-00-010.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15		x	x				x	x					
8880	0.22	5-05-08-038.00	Spartanburg	SC	Non-Qualified Regular Residential Improved (6RGR)	RESIDENTIAL - SINGLE FAMILY	15		x					x						
8906	0.32	5-05-08-029.00	Spartanburg	SC	Qualified Owner Occupied Residential Vac MH (4OOJ)	RESIDENTIAL - SINGLE FAMILY	15		x		x			x	x					x
8908	0.17	5-05-08-037.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15		x					x						
8940	0.19	5-05-08-038.01	Spartanburg	SC	Qualified Owner Occupied Residential Imp MH (4OOG)	MOBILE HOME COMBINED WIHT LAND	15		x					x						
9142	0.19	5-05-12-044.00	Spartanburg	SC	Non-Qualified Regular Residential Improved (6RGR)	RESIDENTIAL - SINGLE FAMILY	15		x					x						
9206	0.20	5-05-12-046.00	Spartanburg	SC	Non-Qualified Regular Residential Vacant MH (6RGJ)	MOBILE HOME LOT	15		x					x						
10457	0.31	5-05-00-053.05	Spartanburg	SC	Non-Qualified Regular Residential Improved (6RGR)	RESIDENTIAL - SINGLE FAMILY	15		x					x						
10957	0.18	1-46-11-005.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15		x					x						

Parcels sorted by Shoreline Score, highest to lowest. This table includes only the top 25 parcels.

Figure 27: High Priority Parcels for Shoreline Management - Tyger Lake



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- HUC-10: 0305010703 (South Tyger)
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- State Line

N

0 0.03 0.06 0.12 0.18 0.24 Miles

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Table 40: HIGH PRIORITY PARCELS FOR SHORELINE MANAGEMENT - TYGER LAKE

	Property Location and Land Use						Score	High Priority Categories									Further Refinement		Funding	
MapID	Acreage	TaxPin	County	State	LandUse	Prop_Type	Shoreline	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	100Acres+	HP_Wetlands_Protection	ACEP	Wetland
1463	0.94	5-17-14-026.01	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						
12681	0.56	5-17-10-002.00	Spartanburg	SC	Non-Qualified Regular Residential Vacant (6RGP)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	15							x						
12822	0.88	5-17-14-026.03	Spartanburg	SC	Non-Qualified Regular Residential Improved (6RGR)	RESIDENTIAL - SINGLE FAMILY	15							x						
14470	0.77	5-17-14-026.02	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						
37985	52.09	5-22-00-001.08	Spartanburg	SC	Exempt Improved (EXE)	SPORTS ACTIVITIES	15			x				x	x					
1334	0.88	5-17-14-005.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	14							x						
3480	1.68	5-22-00-010.03	Spartanburg	SC	Non-Qualified Regular Commercial Improved (6RGC)	WAREHOUSING & STORAGE SERV.	14							x						
12695	0.88	5-17-10-004.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	14							x						
34639	60.47	5-22-00-001.02	Spartanburg	SC	Qualified Agricultural Farm Vacant (4AGL)	NON-COMMERCIIAL FOREST DEVEL.	14	x						x						

Parcels sorted by Shoreline Score, highest to lowest. This table includes all high priority parcels for Tyger Lake.

Figure 28: High Priority Parcels for Shoreline Management - Lake Cooley

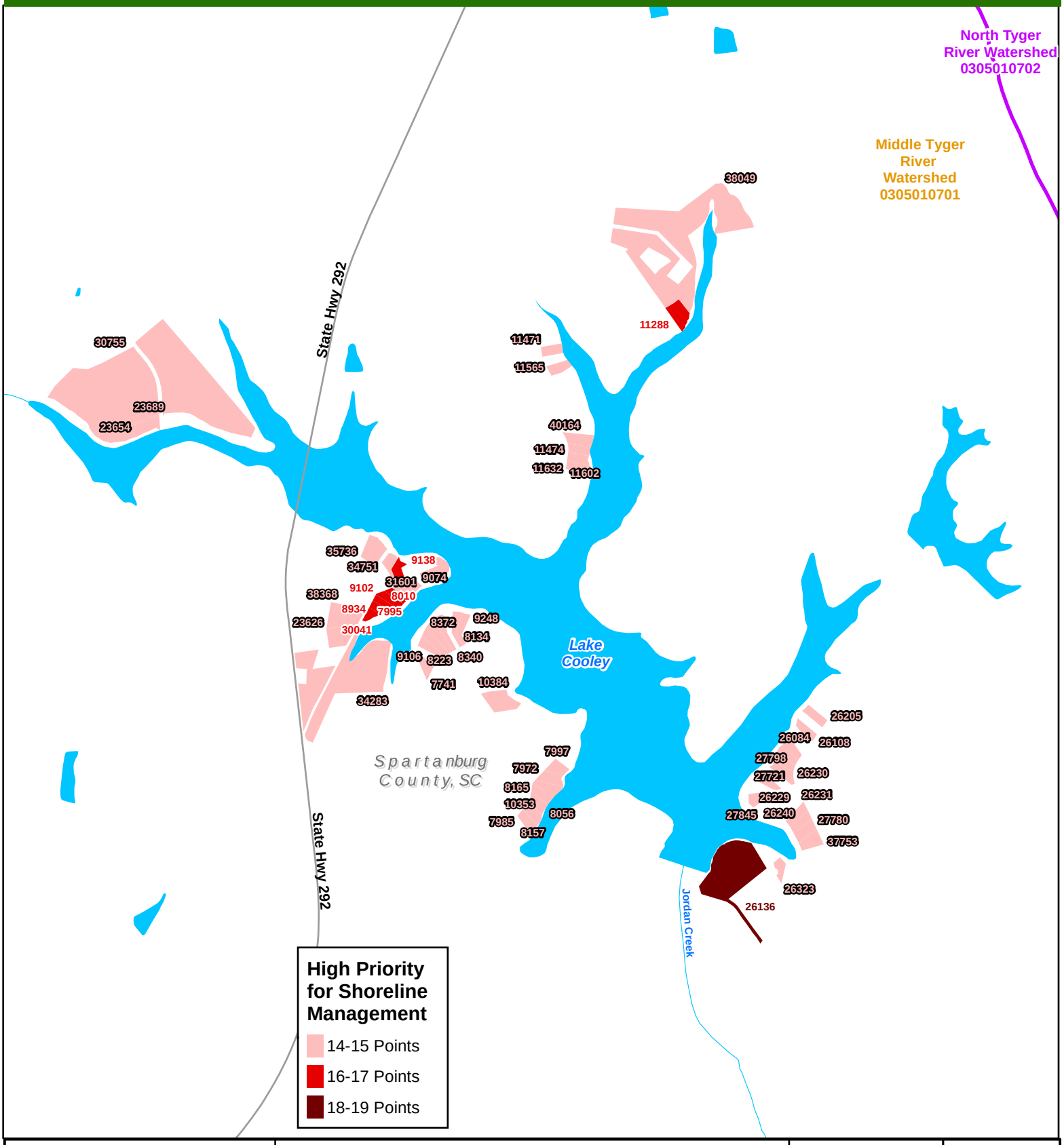

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Table 41: HIGH PRIORITY PARCELS FOR SHORELINE MANAGEMENT - LAKE COOLEY

	Property Location and Land Use						Score	High Priority Categories									Further Refinement		Funding	
MapID	Acreage	TaxPin	County	State	LandUse	Prop_Type	Wetland	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	100Acres+	HP_Wetlands_Protection	ACEP	Wetland
26136	10.61	6-05-00-003.03	Spartanburg	SC	Exempt Government Improved (EXW)	WATER UTILITIES & IRRIGATION	19							x		x				
7995	0.60	5-08-01-001.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	17			x				x						
8010	0.61	5-08-05-002.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	16							x						
8934	0.61	5-08-05-001.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	16							x						
9102	0.74	5-08-05-003.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	16							x						
9138	0.80	5-08-01-008.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	16							x						
11288	1.60	6-02-00-005.05	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	16							x						
30041	0.48	5-07-08-001.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	16							x						
7972	1.04	5-08-09-013.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						
7985	0.90	5-08-09-008.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						
7997	0.87	5-08-09-014.00	Spartanburg	SC	Non-Qualified Regular Residential Improved (6RGR)	RESIDENTIAL - SINGLE FAMILY	15							x						
8056	0.79	5-08-09-010.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						
8165	0.96	5-08-09-012.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						
8372	0.97	5-08-00-002.07	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						
9074	1.16	5-08-01-002.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						
10353	0.82	5-08-09-011.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						
10384	2.20	5-08-00-015.02	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						
11474	0.80	6-05-01-001.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						
11602	0.75	6-05-01-002.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						
11632	0.91	6-05-01-003.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						
23626	1.85	5-07-00-053.02	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						
23654	1.16	1-48-00-041.01	Spartanburg	SC	Non-Qualified Regular Residential Vacant MH (6RGJ)		15							x						
23689	1.96	1-48-00-041.02	Spartanburg	SC	Qualified Owner Occupied Residential Vac MH (4OOJ)	RESIDENTIAL SUBDIVISION UNDEVELOPED LOT	15							x					x	
26205	0.86	6-05-00-172.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						
26229	0.75	6-05-00-163.00	Spartanburg	SC	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	15							x						

Parcels sorted by Shoreline Score, highest to lowest. This table includes only the top 25 parcels.

15) STORMWATER BMPS

This analysis identifies parcels within developed areas that may be appropriate for installation of stormwater retrofits, which would reduce stormwater runoff and pollutant loading into nearby waterways. Urbanized areas, particularly those built prior to stormwater management requirements, are at an increased risk of negatively impacting nearby waterways due to increased impervious surfaces. Impacts such as increased surface water runoff, less time for stormwater to absorb into the ground, stream channelization, and heightened erosion and flooded areas can all attribute to impaired water quality and can be mitigated by the installation of stormwater BMPs.

15.1) Stormwater BMP 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 that are of high (12-16 points), medium (6-11 points), and low (0-5 points) importance for Stormwater BMPs (see Figure 28).

Table 42: 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 (see Section 15.1.4)	1	1
Permitted Point Source Pollutants	Permitted Point Source Pollutants (see Section 15.1.5)	1	1
TOTAL POSSIBLE STORMWATER BMP POINTS			**16**

15.1.1) Land Cover

Various land activities, such as logging and urban development, can negatively impact water quality through increased stormwater runoff, pollutant loads, stream channelization, and increased flooding (Frankenburger, n.d.). 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: 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, Urban/Developed Land Cover, Landowner Database

15.1.2) 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 export per parcel was calculated; then the range of averaged values was separated into high, medium, and low export categories. For each pollutant, parcels within the highest 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.

Table 27: Current Pollutant Export Priority Ranges

Pollutant	Units	*Low Priority*	*Medium Priority*	*High Priority*
Nitrogen	Kg/pixel/year	0 – 0.040233	0.04.234 – 0.158627	0.158628 - 0.507028
Phosphorus	Kg/pixel/year	0 – 0.001292	0.001293 –0.040692	0.040693 – 1.242620
Sediment	tons/pixel/year	0	0.000001 –0.000004	0.000005 – 0.001243

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

15.1.3) Current Water Quality Impairments

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

Scoring: Parcels including, adjacent to, or upstream of streams with existing 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

15.1.4) Unpermitted Point Source Pollutants

Although under the threshold for a permit, some point source activities may contribute to water quality pollution through stormwater runoff. Examples include: golf courses, car washes, car lots, auto repair shops, gas stations, and dry cleaners. These land uses may commonly use and store materials that could impact water quality if not properly managed (fertilizers, chemicals/soaps, hazardous waste, etc.).

Scoring: Parcels identified as including a: golf course, car wash, car lot, auto repair shop, gas station, or dry cleaners received "1" point; all other parcels received "0" points.

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

15.1.5) Permitted Point Source Pollutants

Various land activities requiring a permit for stormwater runoff may be impacting water quality. Examples include: NPDES (non-agricultural), landfills, mines, and gravel pits. This identifies and evaluates lands with known/potential pollution sources.

Scoring: Parcels with NPDES (non-agricultural), mines/gravel pits, landfills, etc. received "1" point. All other parcels received "0" points.

GIS Layers Used: Parcel, Non-Agricultural NPDES, Landfills, Mines/Gravel Pits

15.2) Stormwater BMP Results & Recommendations & Potential Funding Sources

This analysis identified 1,335 parcels as high priority for installation of stormwater BMPs. To further refine high priority results, parcels meeting the following qualifications were selected for more in-depth analysis:

1. Parcels outside of MS4 Designations, as these are less likely to have stormwater regulations and more likely benefit more highly from stormwater retrofits or installation
2. Parcels were REMOVED if: have agricultural land cover that is likely covered under agricultural BMP considerations

The refined results identified 97 parcels (see Figure 29 and Table 46: High Priority Parcels for Stormwater BMPs) for further analysis. Concentrations of parcels can be seen near Reidville, SC and along the North Tyger River.

15.2.1) Section 319 Funding (SCDHEC)

The US EPA provides annual funding to SCDHEC for projects that reduce or prevent nonpoint source water pollution by implementing an approved Watershed Based Plan. SCDHEC distributes these Section 319 funds through grants that may pay up to 60 percent of eligible project costs, with a 40 percent 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.

15.3) Stormwater BMP Strategies

UF recommends further analyzing the high priority parcels to determine which would have the highest impact in regards to stormwater management.

15.3.1) Stormwater BMP's

In areas built prior to stormwater control requirements, installation of detention/retention ponds, pervious pavement, rain gardens, or rain barrels could provide significant reduction of stormwater runoff and pollutants. Focusing on publicly owned parcels (e.g., schools, parks) or parcels upstream from known flooding problems may provide streamlined implementation.

15.3.2) Stormwater BMP Retrofits

In areas built prior to stormwater water quality requirements, existing detention ponds could be retrofitted to provide pollutant removal. Again, focusing on publicly owned parcels (e.g., schools, parks) may provide streamlined implementation.

Figure 29: Parcel Prioritization for Stormwater BMP's

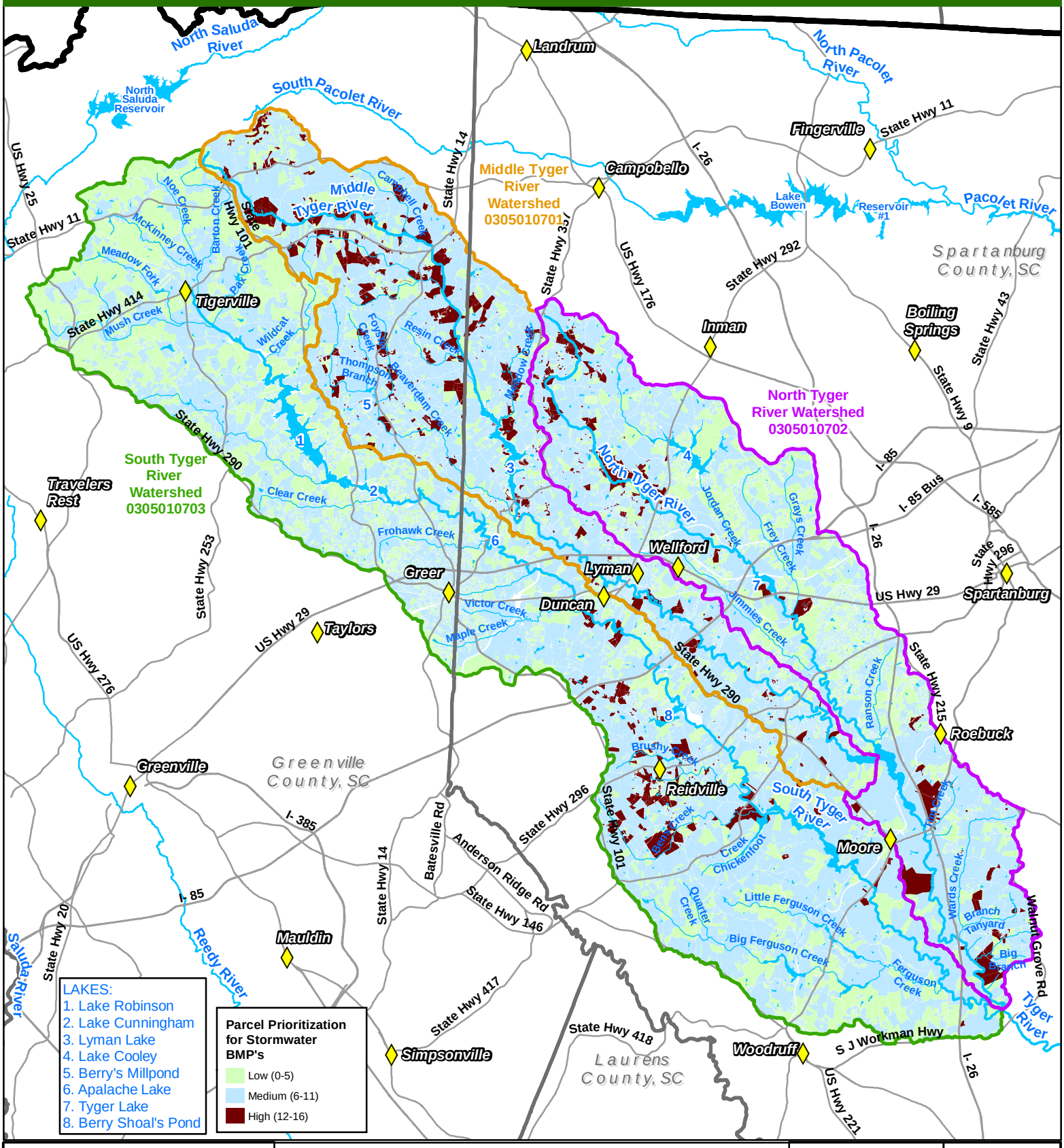

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Figure 30: High Priority Parcels for Stormwater BMP's

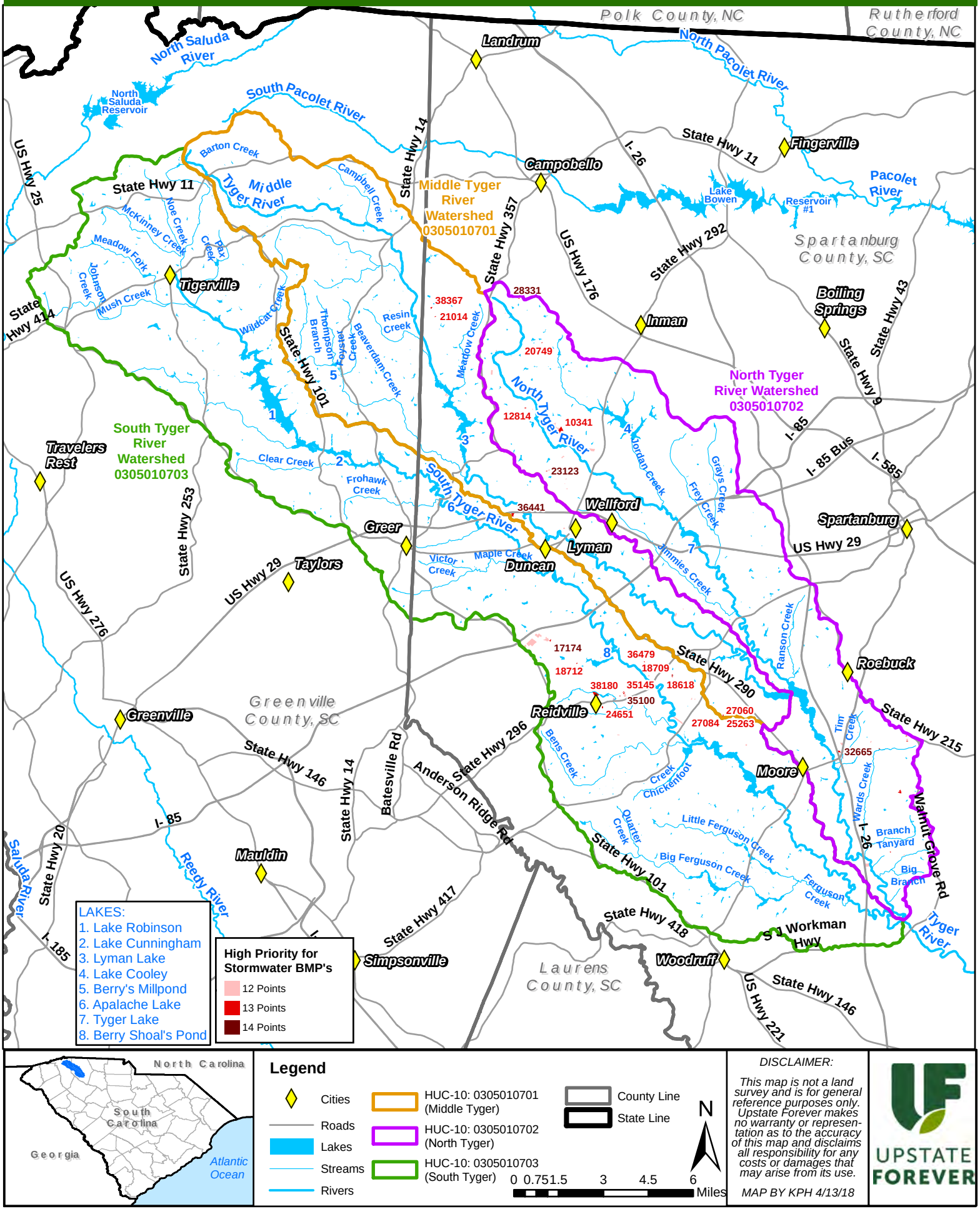

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Table 43: HIGH PRIORITY PARCELS FOR STORMWATER BMP'S

	Property Location and Land Use							Score	High Priority Categories									Further Refinement		Funding	
MapID	Acreage	TaxPin	County	State	PropertyLocation	LandUse	Prop_Type	Stormwater	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	100Acres+	HP Wetland/Protection	ACEP	Wetland
18778	0.57157	5-31-00-250.00	Spartanburg	SC	257 GLEN CREST DR MOORE	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	14			x		x			x					
36546	0.200757	5-37-00-004.69	Spartanburg	SC	709 E CAMELTON DR REIDVILLE	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	14			x					x					
36817	0.763414	6-40-00-054.00	Spartanburg	SC	346 LAWTONWOOD LN ROEBUCK	Non-Qualified Regular Residential Vacant (6RGP)	UNDEVELOPED LAND	14			x					x					
18709	0.506679	5-31-00-249.00	Spartanburg	SC	253 GLEN CREST DR MOORE	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	13					x			x					
18618	0.669313	5-31-00-252.00	Spartanburg	SC	265 GLEN CREST DR MOORE	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	13					x			x					
36479	0.453669	5-31-00-503.00	Spartanburg	SC	509 GREY OAKS TRL DUNCAN	Non-Qualified Regular Residential Improved (6RGR)	RESIDENTIAL - SINGLE FAMILY	13					x			x					
38367	1.58069	1-36-00-009.08	Spartanburg	SC	1870 SPENCER CREEK RD CAMPOBELLO	Non-Qualified Regular Residential Improved (6RGR)	RESIDENTIAL - SINGLE FAMILY	13				x				x					x
38180	13.6911	5-36-00-043.00	Spartanburg	SC	2085 DUNCAN REIDVILLE RD REIDVILLE	Non-Qualified Regular Commercial Improved (6RGC)	AUTOMOBILE REPAIR & SERVICE	13				x				x					x
21014	0.586056	1-36-00-047.16	Spartanburg	SC	2039 SPENCER CREEK RD CAMPOBELLO	Non-Qualified Regular Residential Vacant MH (6RGJ)	MOBILE HOME LOT	13								x					
28331	0.589155	1-37-00-055.08	Spartanburg	SC	317 GRANNY DORIS BLVD INMAN	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	13								x					
20749	0.640856	1-43-09-011.00	Spartanburg	SC	131 COLLINSDALE DR INMAN	Non-Qualified Regular Residential Improved (6RGR)	RESIDENTIAL - SINGLE FAMILY	13								x					
12814	0.763518	5-03-16-032.00	Spartanburg	SC	117 COOPER EST INMAN	Non-Qualified Regular Residential Vacant MH (6RGJ)	MOBILE HOME LOT	13								x					
10341	23.4	5-07-00-032.03	Spartanburg	SC	0 BUMBLEBEE LN WELLFORD	Exempt Government Vacant (EXV)	SOLID WASTE DISPOSAL	13								x					
23123	0.62196	5-11-00-259.00	Spartanburg	SC	604 SEA RAY DR LYMAN	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	13								x					
36441	5.57172	5-14-07-004.02	Spartanburg	SC	190 LEE JOYAL RD DUNCAN	Non-Qualified Regular Commercial Improved (6RGC)	ELECTRICAL MACHINERY	13								x					
17174	1.34205	5-30-00-058.00	Spartanburg	SC	1129 DUNCAN REIDVILLE RD DUNCAN	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	13								x					
18712	0.686588	5-30-11-060.00	Spartanburg	SC	1589 DUNCAN REIDVILLE RD DUNCAN	Qualified Owner Occupied Residential Vac MH (4OOJ)	MOBILE HOME LOT	13								x					
24651	1.01389	5-36-12-031.01	Spartanburg	SC	124 GASTON DR REIDVILLE	Qualified Owner Occupied Residential Vac MH (4OOJ)	MOBILE HOME LOT	13								x					
35773	0.246385	5-37-00-004.68	Spartanburg	SC	705 E CAMELTON DR REIDVILLE	Non-Qualified Regular Residential Improved (6RGR)	RESIDENTIAL - SINGLE FAMILY	13								x					
35145	0.602467	5-37-00-006.00	Spartanburg	SC	191 GANO DR WOODRUFF	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	13								x					
35100	1.25998	5-37-00-006.02	Spartanburg	SC	175 GANO DR WOODRUFF	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	13								x					
27084	1.30947	5-38-00-069.00	Spartanburg	SC	409 BETHANY CHURCH RD MOORE	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	13								x					
25263	0.515065	5-38-00-070.01	Spartanburg	SC	153 KUHN RD MOORE	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	13								x					
27060	0.953403	5-38-00-071.00	Spartanburg	SC	159 KUHN RD MOORE	Qualified Owner Occupied Residential Vac MH (4OOJ)	MOBILE HOME LOT	13								x					
32665	2.84914	6-40-00-012.01	Spartanburg	SC	6204 HIGHWAY 221 ROEBUCK	Non-Qualified Regular Commercial Improved (6RGC)		13								x					

Parcels sorted by Stormwater Score, highest to lowest. This table includes only the top 25 parcels.

16) PET WASTE STATIONS

This analysis identifies parcels that may be suited 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. Many people do not understand that pet waste - which can contain harmful organisms such as bacteria, viruses, and parasites - will be carried into, and pollute, nearby waterways during rain events. According to the US EPA a single dog can produce approximately 274 pounds of waste each year. 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 27,158 dogs in theses Tyger River Watersheds, producing a total of 7.4 million pounds of waste each year. Public outreach campaigns on proper pet waste disposal will be helpful to reduce this bacterial loading in the watersheds.

16.1) Pet Waste Station Criteria

Table 44 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 (see Figure 30). No medium priority range was included for this analysis as most parcels scoring in this category will receive 1 point at most.

Table 44: 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 (See Section 16.1.1)	1	1
Parks	Existing Public Land	1	1
TOTAL POSSIBLE PET WASTE POINTS			**2**

16.1.1) High Traffic Commercial Pet Locations – Some locations are more likely to have increased 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.

16.1.2) 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

16.2) Pet Waste Station Results & 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 51 parcels (see Table 46: High Priority Parcels for Pet Waste Station Installation) as high priority for installation of pet waste stations. These parcels include 17 parks, 5 veterinary facilities, 12 pet groomers/boarding facilities, and 3 other pet related businesses that would be frequented by pet owners and likely have elevated levels of pet waste (see Figure 30).

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

Cost estimates for urban BMPs are based on information provided by Greenville County and Anderson and Pickens County Stormwater Partners (APCSP). The following table outlines funding options and cost estimates for pet waste BMPs.

Table 45. 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)	• Greenville County SWCD • Spartanburg County SWCD • CU Extension • Local Governments
	Pet Bags	$60/2,000	

General stormwater education and outreach efforts could have significant benefits to local communities. Stormwater education and outreach is required as part of the Municipal Separate Storm Sewer System (MS4) Permit. A partnership with the Greenville County Soil and Water Conservation District, which is responsible for carrying out stormwater education in Greenville County, would help effectively conduct stormwater outreach in the northern portions of the South and Middle Tyger subwatersheds within Greenville County. The Spartanburg Water Quality Partners is groups made up of Clemson Extension, Spartanburg Soil and Water Conservation District, Spartanburg County's Stormwater Department, and USC Upstate Watershed Ecology Center. Together these agencies carry out stormwater outreach education throughout Spartanburg County. This group will be instrumental in carrying out the stormwater education component of this plan in the southern portion of all three subwatersheds.

Figure 31: High Priority for Pet Waste Station(s)

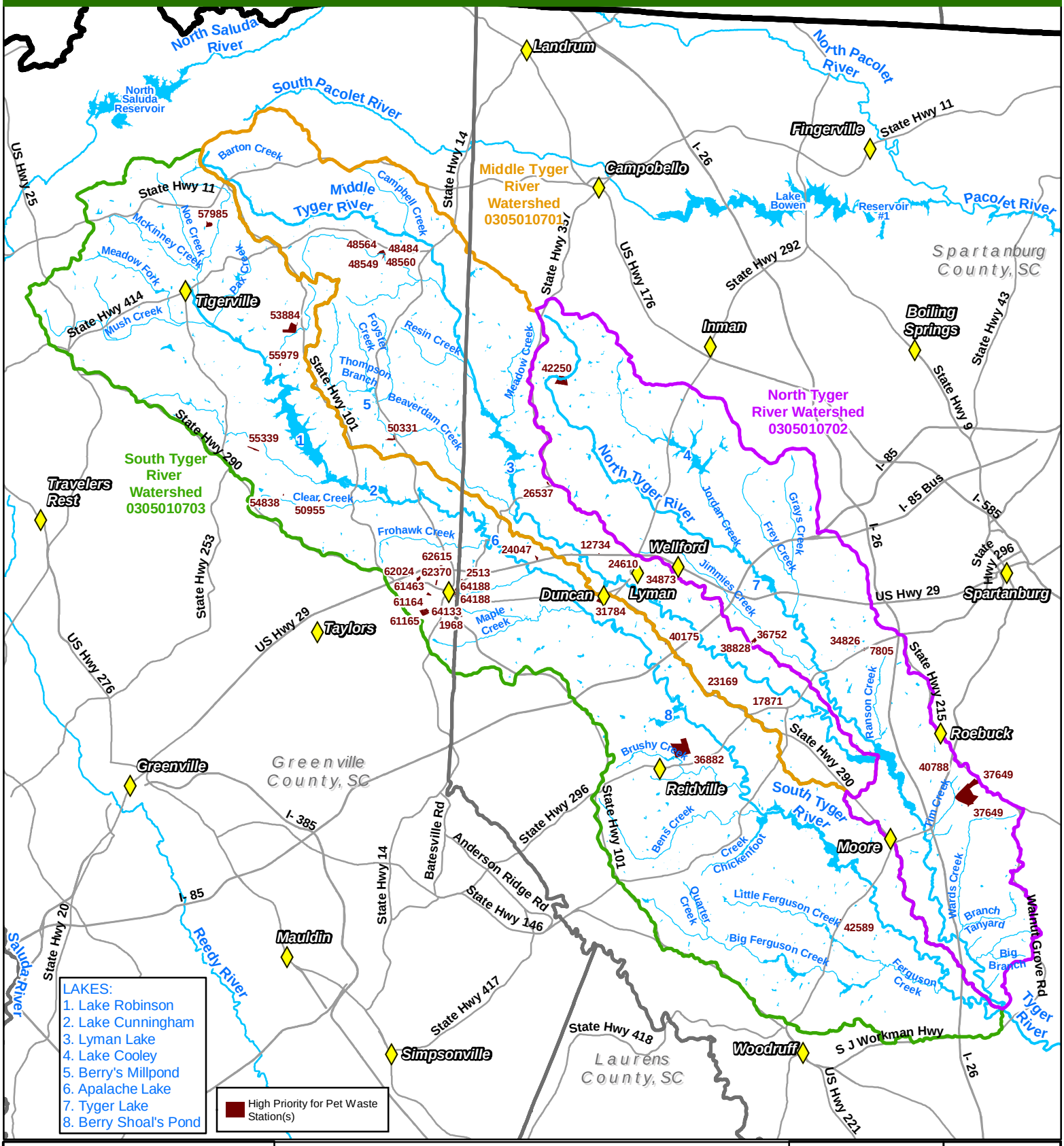

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Table 46: HIGH PRIORITY PARCELS FOR PET WASTE STATION(S)

	Property Location and Land Use								High Priority Categories									Further Refinement		Funding		High Traffic Commercial Pet
MapID	Acreage	TaxPin	County	State	PropertyLocation	LandUse	Prop_Type	Pet_Score	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	100Acres+	HP Wetland/Protection	ACEP	Wetland	Locations
61893	0.249491	G011000300900	Greenville	SC	1301 W POINSETT ST	Retail - General (520)	COMMERCIAL	1									x					Amanda's Pet Grooming
54838	1.02959	6.4002E+11	Greenville	SC	431 MILFORD CHURCH RD	Residential Single Family (1100)	RESIDENTIAL	1									x					Angel Clips Pet Grooming and Boarding
42589	0.92638	4-14-00-018.01	Spartanburg	SC	8272 HIGHWAY 221 WOODRUFF	Non-Qualified Regular Commercial Improved (6RGC)	ANIMAL SPECIALTY SERVICES	1									x			x		Animal Clinic of Woodruff
42250	49.3911	1-42-00-068.00	Spartanburg	SC	2430 HOLLY SPRINGS RD INMAN	Qualified Owner Occupied Residential Improved (4OOR)	RESIDENTIAL - SINGLE FAMILY	1		x							x			x		Bark N Beauty Pet Salon
1966	0.298083	9-04-02-002.01	Spartanburg	SC	0 OAK ST GREER	Exempt Government Improved (EXW)	UNDEVELOPED LAND	1									x					Ben Edward Park
2228	0.241208	9-04-02-005.00	Spartanburg	SC	0 WILL ST GREER	Exempt Government Improved (EXW)	UNDEVELOPED LAND	1									x					
62615	2.73696	G017000201701	Greenville	SC	505 GAIL AVE	Veterinary Clinic (411)	COMMERCIAL	1									x					Blue Ridge Animal Hospital
48484	1.13932	6.2801E+11	Greenville	SC	301 UNIVERSITY RDG STE 2400	Residential Vacant (1180)	RESIDENTIAL	1		x							x					Campbell Covered Bridge
48549	2.26538	6.2801E+11	Greenville	SC	301 UNIVERSITY RDG STE 200	Residential Vacant (1180)	RESIDENTIAL	1		x							x					
48559	0.905061	6.2801E+11	Greenville	SC	301 UNIVERSITY RDG STE 2400	Residential Vacant (1180)	RESIDENTIAL	1									x					
48560	2.6752	6.2801E+11	Greenville	SC	301 UNIVERSITY RDG STE 2400	Residential Vacant (1180)	RESIDENTIAL	1		x							x					
48564	9.85717	6.2801E+11	Greenville	SC	301 UNIVERSITY RDG STE 2400	Residential Vacant (1180)	RESIDENTIAL	1									x					
37649	183.457	6-40-00-020.00	Spartanburg	SC	109 OTTS SHOALS RD ROEBUCK	Non-Qualified Regular Commercial Improved (6RGC)	NURSERY, PRIMARY, SECONDARY ED	1	x				x				x	x		x		Carolina Pampered Pet Grooming
61164	0.799027	G005000100202	Greenville	SC	301 E POINSETT ST	Residential Vacant (1180)	RESIDENTIAL	1									x					Century Park
61165	11.7036	G005000100300	Greenville	SC	301 E POINSETT ST	Residential Vacant (1180)	RESIDENTIAL	1									x			x		
61166	3.52205	G005000100400	Greenville	SC	301 E POINSETT ST	Residential Vacant (1180)	RESIDENTIAL	1									x			x		
61167	9.22578	G005000100600	Greenville	SC	301 E POINSETT ST	Residential Vacant (1180)	RESIDENTIAL	1									x			x		
64188	12.2608	G029001000800	Greenville	SC	301 E POINSETT ST	Government (821)	COMMERCIAL	1									x					City Park / Horace McKown Center
53884	50.5805	6.3504E+11	Greenville	SC	301 UNIVERSITY RDG STE 2400	Recreation - Community Recreation (770)	COMMERCIAL	1									x					David Jackson Park
50955	1.73788	6.3201E+11	Greenville	SC	900 MILFORD CHURCH RD	Veterinary Clinic (411)	COMMERCIAL	1									x					Double Springs Veterinary Hospital
36752	3.7316	5-27-00-005.00	Spartanburg	SC	0 LARKIN PARK DR SPARTANBURG	Exempt Government Improved (EXW)		1									x					Fairmont Larkin Park
38828	5.96872	5-22-00-029.00	Spartanburg	SC	0 DRUMMOND CIR SPARTANBURG	Exempt Improved (EXE)	PARKS-GENERAL RECREATION	1									x					
2513	0.845182	9-03-13-019.00	Spartanburg	SC	0 E BEARDEN ST GREER	Exempt Government Improved (EXW)	UNDEVELOPED LAND	1									x					Greentown Park
62370	4.67975	G015000200900	Greenville	SC	301 E POINSETT ST	Residential Vacant (1180)	RESIDENTIAL	1									x					Greer City Stadium
61463	6.00252	G008000206400	Greenville	SC	301 E POINSETT ST	Recreation - Community Recreation (770)	COMMERCIAL	1									x					H.R. Turner Park
23169	1.01621	5-31-00-020.07	Spartanburg	SC	740 SHOALS RD DUNCAN	Non-Qualified Regular Commercial Improved (6RGC)	VETERANARIAN SERVICES	1									x					Health Pointe Veterinary Clinic
22055	5.68868	1-48-00-005.00	Spartanburg	SC	2300 HAMPTON RD WELLFORD	Non-Qualified Regular Commercial Improved (6RGC)	NATURE EXHIBITIONS	1									x			x		Hollywild Animal Park
40788	0.508363	6-33-07-026.00	Spartanburg	SC	5001 HIGHWAY 221 ROEBUCK	Non-Qualified Regular Commercial Improved (6RGC)	SPECIAL TRAINING & SCHOOLING	1									x					Inn the Dog House Pet Boarding
55339	9.33871	641010102704	Greenville	SC	12 LEXUS LN	Multi-Family Duplex (110)	MULTI-FAMILY	1									x					Kare for Me Pet Groomer
6991	7.71936	6-25-00-145.01	Spartanburg	SC	0 OLD ANDERSON MILL RD MOORE	Exempt Government Improved (EXW)	OTHER MISCELLANEOUS SERVICES	1									x					Linville Hills Park
24610	1.35622	5-15-11-084.01	Spartanburg	SC	0 PACIFIC ST LYMAN	Exempt Government Vacant (EXV)	PROTECTIVE SERVICES	1									x					Lyman Park
34873	1.14884	5-15-00-006.10	Spartanburg	SC	0 COMMUNITY ST LYMAN	Exempt Government Vacant (EXV)	OTHER UNDEVELOPED LAND/WATER	1									x					
62206	0.157411	G014000400500	Greenville	SC	301 E POINSETT ST	Residential Vacant (1180)	RESIDENTIAL	1									x					
62207	0.167476	G014000400600	Greenville	SC	301 E POINSETT ST	Residential Vacant (1180)	RESIDENTIAL	1									x					

Parcels sorted by High Traffic Commercial Pet Locations, A-Z. This table includes all high priority parcels.

17) WILDLIFE

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 the public outreach campaign. For example, educating landowners on the signs of nuisance wildlife activity, such as rooting damage by feral hogs, and asking them to help inventory locations of these wildlife populations can be completed simultaneously to improve efficiency. Once nuisance wildlife populations have been identified, the types and locations of BMPs can be prioritized accordingly.

17.1) Wildlife BMPs

There are a variety of BMPs which work to reduce the impacts of wildlife on water quality. The recommended BMPs focus on reducing erosion and the direct contribution of fecal matter into waterways. Examples can be found below.

17.1.1) Streambank Fencing

Streambank fencing can limit wildlife populations' access to streams, therefore protecting streams from both bacteria generated from waste as well as the damaging effects wildlife can have on landscapes, such as erosion.

17.1.2) Riparian Buffers

Vegetated riparian barriers remove bacteria from runoff. Wild hogs tend to be attracted to heavily vegetated areas near streams, so 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 waterfowls (e.g., Canada geese) from congregating. Creating a buffer strip of tall thick vegetation will 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 (INDNR, 2017).

17.1.3) Filter Strips

Filter strips, a "strip or area of vegetation for removing sediment, organic matter, and other pollutants from runoff and wastewater" (NRCS, 2018), can be used in combination with riparian areas to help maintain buffers, as well as to slow runoff, remove sediment and bacteria, increase soil aeration, and recycle plant nutrients.

17.1.4) Trapping

Particularly effective with feral hog populations, trapping can assist with the management of populations through harvest, relocation, or consumption. Box, swing, and corral traps are all effective in the trapping of feral hogs. This method can also be effective with beaver populations. Wildlife Control Operators (WCO's) perform wildlife control services on a contract-fee basis and can be hired by landowners who do not wish to directly deal with the animals themselves.

17.1.5) Hunting

Hunting is a common method used to control wildlife populations. Educating landowners and community members about the safety and training needed for this BMP method is important. Out of season permits for species such as deer and feral hogs can be attained through SCDNR if the populations become problematic in the subwatershed (SCDNR, 2017).

17.1.6) No Feeding Wildlife Signage

Feeding wildlife often contributes to increases in nuisance species (e.g., deer, 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 areas (e.g., parks).

17.2) 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. BMP unit cost estimates come from both the previously mentioned prices in the agricultural BMP section as well as estimates from NRCS. For a descriptive list of potential funding sources, please see Section 6. Table 47 provides an overview of wildlife BMP unit costs and possible sources of funding. The US Department of Agriculture, 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. Additional details included below (Table 47).

Table 47: 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	Linear Streambank Fencing	$3.50/foot	• WHIP • EQIP • AWEP • CSP • County Governments • US Fish and Wildlife • Section 319 Funds
	Filter Strips	$168/acre	
	Riparian Buffers	$390/acre	
	Box, Swing, and Corral Traps	$320-460 each	Private Landowners

17.2.1) Section 319 Funding

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

17.2.2) 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 WHIP, CSP, and EQIP. See Section 10.4 for more information on each of these federal cost share programs.

17.2.3) 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.

18) PUBLIC EDUCATION AND OUTREACH

A detailed public outreach strategy has been developed for the entire focus area that covers all nonpoint sources of bacteria impairments (e.g., wastewater, agricultural, urban stormwater, and wildlife). This table can be found in Appendix C. Detailed information includes the target audience to be addressed, messages to convey, outreach methods used, and recommended project partners are listed for each pollution source.

18.1) Mailings and Displays

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

Including inserts with local utility providers' bills can also 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., septic system maintenance, agricultural BMP programs, and pet waste stations) at community gathering spots, such as city halls or community centers, will be an alternative way to provide information to homeowners

18.2) Community Meetings, Workshops, and Festivals

Community outreach meetings should be conducted as needed to discuss the implementation plan, identify specific locations for BMP projects, make revisions to the plan based on community feedback, and generate landowner participation. Topics to be addressed include:

- Overview of watershed plan
- Subwatershed water quality issues & goals
- Priority agricultural BMP and septic system projects per basin
- Priority Urban Stormwater and Wildlife BMP projects per basin
- Shoreline Management
- Possible funding sources
- Community stormwater education opportunities

Schools, community groups, and public library patrons 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 nonpoint source pollution issues. Workshop topics could include 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. There are 9 schools in the focus area as well as several libraries and one community center (See Table 48). The Boy Scout and Girl Scout troops in the region have expressed interest in this initiative and will be contacted as appropriate projects become available. Finally, festivals are an excellent venue for reaching out to local residents. Some of the

relevant festivals in the area are Discover Your Watershed Day on Lyman Lake, and Fish The Tyger, in Roebuck SC. These events draw in people from across the region and provide ample opportunities to interact with public.

Table 48. Community Groups, Municipalities, Libraries, and Schools for Public Outreach

Schools:	
• Blue Ridge High School • Blue Ridge Middle School • Dorman High School • Florence Chapel Middle School • Greer Middle College Charter School • Holly Springs-Motlow Elementary School	• Mountain View Elementary School • Reidville Elementary School • Skyland Elementary School • Tigerville Elementary School
Cities and Towns:	
• City of Greer • Town of Duncan • Town of Lyman • Town of Wellford • Town of Reidville • Town of Roebuck • Town of Tigerville • Town of Moore	
Libraries:	
• Cyrill-Westside Library • Greer Library • Middle Tyger Library	
Community Centers	
• Middle Tyger Community Center	
Scout Troops	
• Boy Scout Palmetto Council Daniel Morgan District • Girl Scouts Mountains to Midlands Council	

18.3) Additional Public Outreach and Education Efforts

Watershed residents who wish to learn more about the watershed-based plan will be able to find project updates as well as general water quality information online through partner websites.

19) PROJECT IMPLEMENTATION, MILESTONES, AND MEASURABLE GOALS

This watershed-based plan implementation schedule will cover a span of 10 years with the intent of decreasing bacteria and sediment loads in the South, Middle, and North Tyger subwatersheds. The implementation strategy for this watershed plan will include the following stages: Project Identification, Implementation, Evaluation, and Refinement. Additionally, 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.

19.1) Project Identification Period

The project identification phase involves contacting landowners that have been identified through the prioritization process for the various BMP strategies and discussing BMP strategies and funding options. Building relationships with these landowners is a crucial component in the success of BMP implementation. Communicating with landowners from the beginning will enable project managers to gauge interest in these projects early on in the process and increase the likelihood of success.

19.1.1) Land Protection

As with all voluntary landowner projects, the success of this work is dependent upon landowner participation. Thus, the first step will be to cultivate relationships with local landowners with the assistance of local utilities and organizations to gauge interest in land protection opportunities. Targeting those landowners identified as high priority parcels for land protection through the GIS parcel prioritization analysis is recommended. For those landowners not interested in conservation easements, it will be important to work with these individuals to identify if there are other, more appealing land protection strategies for their properties.

19.1.2) Restoration BMPs

Initial efforts will focus on building relationships with local landowners to identify specific agricultural BMP projects and secure funding for such projects. Partnerships with NRCS and local Soil and Water Conservation Districts (Greenville County SWCD and Spartanburg County SCWD) would facilitate project identification, design, and funding procurement. Because these agencies already have experience working with local landowners and farmers, as well as designing agricultural related water quality BMPs, their knowledge and involvement is essential to the success of this effort.

In regards to septic system repair and/or replacement, a public outreach campaign should be conducted in each region with the help of the local stormwater outreach agencies including Spartanburg Water Quality Partners (Clemson University Cooperative Extension, Spartanburg County SWCD, Spartanburg County Stormwater, and USC Upstate Watershed Ecology Center), local utilities (Greer CPW, SJWD, and WRWD), as well as Greenville County SWCD to enroll homeowners in septic system replacement programs. Outreach methods will consist of general media advertisements, community meetings, bill stuffers, and displays at local government offices and public facilities (refer to Appendix C for more detailed information).

Preferred pet waste stations locations have already been identified as part of the planning process and these sites can be found in Table 46 (High Priority Parcels for Pet Waste Stations). However, it is important to gather additional input from residents to confirm these locations prior to installing the stations. It will be necessary to engage local park departments to finalize site locations and pet waste station maintenance schedules.

Finally, working with local residents, Clemson University Cooperative Extension (CU-Ext.), SC Department of Natural Resources (SC DNR), Greenville County Parks Recreation and Tourism

(GCPRT) and Spartanburg County Parks Department (SC Parks) would help to identify those regions of the entire focus area with nuisance wildlife populations. Deterrence or removal strategies of wildlife will vary depending upon the species of interest (e.g., waterfowl, feral hog, beaver, coyote, or deer).

19.2) Project Implementation Period

Prior to project implementation it is extremely important that baseline water quality data be collected before and after projects are installed so that it is possible to measure changes in bacteria levels in relation to watershed improvements. Water quality monitoring should continue throughout the implementation period and is recommended to continue for up to a year after projects are installed. Subwatersheds will be prioritized based on the types of projects that will be of most benefit as well as their potential to provide needed bacteria and sediment reductions. The final number of BMP projects installed will depend upon landowner participation and available funding sources.

19.3) Evaluation and Refinement Period

Since it is difficult to predict landowner preferences and participation rates it will be necessary to periodically reassess the project goals. 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. Consideration should also be given to new or revised stormwater management techniques as they become available.

To begin, relationships between project partners and landowners should be secured with general ideas of what BMPs or other implementation tasks are desired per landowner, which funding opportunities are specifically available for the desired implementation tasks, and the level of cooperation required to successfully achieving the installments and the proper management for continuous benefit. Therefore, an initial outreach-based plan should be introduced and implemented during the first two years.

Table 49. Project Milestones Years 1-3

Action Items	Subwatershed*	Years (1-3)		
Secure funding for Phase 1	S, M, N			
Land Protection – Conduct outreach and education to priority landowners	S, M, N			
Land Protection – Build relationships with landowners	S, M, N			
Land Protection – Facilitate the closing of 6 conservation easements and/or other land protection strategies	S, M, N			
Agricultural BMPs – Conduct outreach and education to landowners in subwatersheds through cooperating agencies	S, M, N			
Agricultural BMPs – Send out targeted mailings to high priority landowners	S, M, N			
Agricultural BMPs – Complete 7 agricultural BMP projects	S, M, N			
Septic BMPs – Conduct outreach to homeowners in subwatersheds through targeted mailings, social media, local contractors, and public displays	S, M, N			
Septic BMPs – Install 25 septic repairs	S, M, N			
Shoreline Management – work with utilities to develop shoreline management plans for all drinking water reservoirs	S, M, N			
Work with local governments on strengthening riparian buffer ordinances	S, M, N			
Promote proper shoreline management through outreach activities	S, M, N			
Wetland Restoration/Enhancement – Monitor development impacts to wetlands and recommend mitigation options	S, M, N			
Send out surveys to participating landowners	S, M, N			
Revise outreach and implementation strategies as needed	S, M, N			
Complete all active agricultural and septic system BMP projects	S, M, N			
Complete quarterly updates on project website	S, M, N			
Provide quarterly email and updates to stakeholders	S, M, N			

** S=South Tyger, M=Middle Tyger, and N=North Tyger*

Table 50. Project Milestones Years 4-10

Action Items	Subwatershed	Years (4-6)		
Secure funding for Phase 2	S, M, N			
Land Protection – Conduct outreach and education to priority landowners	S, M, N			
Land Protection –Build relationships with landowners	S, M, N			
Land Protection – Facilitate the closing of conservation easements and/or other land protection strategies	S, M, N			
Agricultural BMPs – Conduct outreach and education to landowners in subwatersheds through cooperating partners	S, M, N			
Agricultural BMPs – Send out targeted mailings to high priority landowners	S, M, N			
Agricultural BMPs – Complete agricultural BMPs projects	S, M, N			
Septic BMPs – Conduct outreach to homeowners in subwatersheds through targeted mailings, social media, local contractors, and public displays	S, M, N			
Shoreline Management – work with utilities to develop shoreline management plans for all drinking water reservoirs	S, M, N			
Promote proper shoreline management through outreach activities	S, M, N			
Riparian buffer restoration/enhancement – conduct outreach to landowners on riparian buffer functions and importance	S, M, N			
Continue work with local governments on strengthening riparian buffer ordinances, if needed	S, M, N			
Work with local parks and pet owned businesses to install pet waste stations	S, M, N			
Send out surveys to participating landowners	S, M, N			
Revise outreach strategy as needed	S, M, N			
Complete all active agricultural and septic BMP projects and pet waste stations	S, M, N			
Complete quarterly updates on project website	S, M, N			
Provide quarterly email and updates to stakeholders	S, M, N			

Table 51. Project Milestones Years 7-10

Action Items	Subwatershed*	Years (7-10)		
Secure funding for Phase 3	S, M, N			
Land Protection – Conduct outreach and education to priority landowners	S, M, N			
Land Protection – Build relationships with landowners	S, M, N			
Land Protection – Facilitate the closing of conservation easements and/or other land protection strategies	S, M, N			
Agricultural BMPs – Conduct outreach and education to landowners in subwatersheds through cooperating partners	S, M, N			
Agricultural BMPs – Send out targeted mailings to high priority landowners	S, M, N			
Agricultural BMPs – Complete agricultural BMPs projects	S, M, N			
Conduct outreach on nuisance wildlife BMPs throughout all basins	S, M, N			
Stormwater BMPs – work with local stormwater education partners to identify stormwater BMP projects	S, M, N			
Install stormwater BMP projects	S, M, N			
Volunteer Dam Removal – send targeted mailings on dam maintenance and operation to identified property owners	S, M, N			
Work with interested landowners of dams to pursue removal options	S, M, N			
Remove unnecessary and/or failing dams	S, M, N			
Send out surveys to participating landowners	S, M, N			
Revise outreach strategy as needed	S, M, N			
Complete quarterly updates on project website	S, M, N			
Provide quarterly email and updates to stakeholders	S, M, N			

20) WATER QUALITY MONITORING

Instream monitoring is used to assess baseline conditions of streams as well as changes or improvements in stream conditions after BMP projects have been 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.

20.1) Proposed Monitoring Locations

Instream water quality monitoring is important for measuring current conditions as well as gauging the recovery of the streams after BMP projects have been installed. In the focus area priority sample sites are the existing SCDHEC water quality monitoring locations (B-014, B-

018A, and B-332). There are seven inactive sites in the region, and eight special study sites. Many of the inactive stations are located in the South and North Tyger subwatersheds. It is recommended to reinstate monitoring at these inactive sites in order to gather a more comprehensive picture of water quality in the region.

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.

20.2) Monitoring Frequency

Instream monitoring should occur at each of the proposed sites in the all three subwatersheds. Ideally monitoring should occur on a monthly basis during a variety of hydrological conditions; 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 to bacteria standards can determine percent attainment relating to water quality goals.

20.3) 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.

20.3.1) Most Probable Number (MPN) Method

Water samples will be processed for *E. coli* using the Most Probable Number (MPN) method of detection. This type of analysis is based on the presence or absence of bacteria. Water samples will be processed using the US Environmental Protection Agency (US EPA) approved standard for detection of total coliforms and *E. coli*, the IDEXX Colilert method for Coliform/*E. coli* (IDEXX, 2013).

20.3.2) 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. These methods are capable of determining if the source of fecal contamination is human, wildlife, domestic livestock and pets. MST could prove to be a useful tool for bacterial source detection in the focus area if funding and resources allow. 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 University Molecular Plant Pathogen Detection Lab and will provide valuable information to SC water resource managers (http://www.clemson.edu/public/water/watershed/projects, 2018).

20.4) Voluntary Water Quality Monitoring

Voluntary monitoring programs are an excellent way to engage citizens in enriching activities while assessing water quality in a region. SC Adopt-A-Stream, www.SCadoptastsream.org, is an ideal program to involve local citizens in monitoring water quality in the Tyger watersheds. Schools, community groups, and interested citizens are great candidates for voluntary monitoring programs. Currently there are 12 active SC AAS sites in the focus area (SC AAS, 2018). The information obtained through voluntary monitoring programs is extremely valuable and increases our understanding of water quality in areas that SCDHEC is unable to monitor. USC Upstate Watershed Ecology Center and UF are both certified SC AAS trainers with years of sampling and teaching experience. These organizations will actively seek participants interested in monitoring water quality in these subwatersheds to sample in these subwatersheds.

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Appendix

List of City and County Parks:

Name	Address	Subwatershed
Campbells Covered Bridge	171 Campbell's Covered Bridge Rd. Landrum, SC 29356	Middle Tyger
Lake Lyman Lodge	200 Lyman Lodge Rd. Lyman, SC 29365	Middle Tyger
Lyman Park	81 Groce Rd. Lyman, SC 29365	Middle Tyger
Fairmont-Larkin Park	198 Larkin Park Dr. Spartanburg, SC 29301	North Tyger
Holston Creek Park	7560 New Cut Rd. Inman, SC 29359	North Tyger
Lake Cooley Park	100 Cooley Dock Rd. Inman, SC 29349	North Tyger
Linville Hills Park	1211 Old Anderson Mill Rd. Moore, SC 29369	North Tyger
Wadsworth Trail	501 Willis Rd. Spartanburg, SC 29301	North Tyger
BP Edwards Park	Sunnyside Dr. Greer, SC 29650	South Tyger
David Jackson Park	25 Fowler Rd. Taylors, SC 29687	South Tyger
Greentown Park	Moss St. Greer, SC 29651	South Tyger
Greer City Park	301 E. Poinsett St. Greer, SC 29651	South Tyger
Greer Veterans Park	17th St. Greer, SC 29650	South Tyger
Reidville/Academy Park	521 East Main St. Reidville, SC 29375	South Tyger
Springwood Park	Wood Ave. Greer, SC 29651	South Tyger
Stevens Ball Field	150 Ballpark St. Greer, SC 29650	South Tyger
Stone Ledge Park	119 S. Spencer St. Duncan SC 29334	South Tyger
Tyger River Park	195 Dillard Rd. Duncan, SC 29334	South Tyger
Victor Heights Park	Anita St. Greer, SC 29650	South Tyger
Wards Creek Park	1 Elmer St. Greer, SC 29650	South Tyger

Appendix A - Parks and Pet Related Businesses

List of Groomers, Kennels and Veterinarians

Name	Address	Subwatershed
Double Storm Kennel	4016 N Hwy 101 Greer, SC 29561	Middle Tyger
Grooming By Londa	4483 Jordan Rd. Greer, SC 29561	Middle Tyger
HealthPoint Vet Clinic	740 Shoals Rd. Duncan, SC 29334	Middle Tyger
Sirolye Pet Care	2737 S357 Lyman, SC 29365	Middle Tyger
Ultimate Pet Lodge	1691 S357 Lyman, SC, 29365	Middle Tyger
Bark'n Beauty Pet Salon	2430 Holly Spring Rd. Inman, SC 29349	North Tyger
The Fur Fairy	210 Morrow Ridge Rd. Lyman, SC 29365	North Tyger
Blue Ridge Animal Hospital	224 W Wade Hampton Blvd. Greer, SC, 29650	South Tyger
Dog Gone Beautiful	1301 W Poinsett St. Greer, SC 29650	South Tyger
Double Springs Animal Hospital	900 Millford Church Rd. Taylors, SC 29687	South Tyger
West Spartanburg County Animal Hospital	13220 E Wade Hampton Blvd. Greer, SC 29651	South Tyger
Woodlands Pet Resort	2556 Old Tyger Bridge Rd. Greer, SC 29561	South Tyger

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
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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)

Source of Bacteria Impairment	Target Audience	Message	General Outreach Methods	Potential Project Partners
Wastewater - • Septic Tanks • Wastewater Treatment Plant Operators	• 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 back ups 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. • Routine inspections and maintenance of septic systems are important to keep them operating safely and effectively.	• Send letters to all homes located within the three watersheds informing residents about malfunctioning septic system symptoms, cost share programs to repair or replace faulty systems, and routine septic tank maintenance. • Put septic system maintenance and repair information displays at the City Halls, Water District offices, County Buildings, and recreational facilities.	• Towns of Duncan, Lyman, Wellford, Reidville, and Greer • Greer CPW • SJWD • WRWD
Agriculture - • Livestock • Cropland	• Agricultural Operators o Livestock Owners • Landowners • Municipal staff	• It is important to keep animals out of waterways because it improves herd health while also protects water quality • Riparian buffers are effective at reducing soil erosion and the amount of bacteria entering streams from animal waste. • Proper use of fertilizers is important to protect water quality (in appropriate amounts and not before or during rain events).	• Provide information on cost share programs for agricultural practices that reduce bacteria inputs to surface waters through local NRCS offices, local feed and seed stores, Cattlemen's Association webpage and newsletters, and other relevant businesses. • Place informational displays at local municipal buildings, NRCS offices, and SWCD locations.	• Local NRCS Offices • Local Soil & Water Conservation Districts • Municipal Staff • Cattlemen's Association
Urban Runoff - • Stormwater Runoff • Domestic Pets	• Homeowners • HOAs • Apartment complexes • Veterinary offices • Animal shelters • Animal groomers • Local community groups (e.g. YMCAs) • Municipal staff • Public Schools	• It is important to properly dispose of pet waste! The improper disposal of pet waste is a major threat to water quality because it contains high levels of bacteria, parasites, and viruses. High levels of bacteria are a threat to human health if ingested. High bacteria levels are also more difficult to treat for drinking water providers. • 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 reducing pollutants entering streams.	• Place pet waste stations and signage at local parks, parking along rivers, and public buildings. • Hang 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. • Do Public Service Announcements about stormwater runoff and water quality on local radio stations. • Maintain a presence at local festivals. • Work to promote watershed education in public school system.	• Spartanburg County Public Works • Spartanburg County Parks Dept. • Greenville County Soil and Water District • Municipal Staff • Clemson Extension • USC Upstate Watershed Ecology Center • Tyger River Foundation
Wildlife animal populations - • Canadian 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 not feeding.	• Host workshops on how to control Canadian Geese, beaver, deer, and feral hogs populations. • Promote signage in public areas with message "Don't Feed the Geese". • Create informational flyers on wildlife for displays at local city halls, libraries, community centers, etc.	• Clemson Extension • Local NRCS offices • Local Soil and Water Conservation Districts • Spartanburg County Parks Dept. • Greenville County Recreation District

Source of Turbidity Impairment	Target Audience	Message	General Outreach Methods	Potential Project Partners
Agriculture - • Livestock with access to streams • Cropland	• Landowners • 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. • Livestock can cause streambanks to erode and contribute to the sedimentation of waterways. • Riparian buffers are effective at reducing soil erosion and the keeping sediment out from streams.	• Send letters to all homes located within the three watersheds informing residents about available cost share programs to install agricultural BMPs on properties. • Put informational displays at the City Halls, Water District offices, County Buildings, and recreational facilities about proper agricultural practices • Provide information on cost share programs for Soil and Water Conservation Districts to include in their newsletters. • Cattlemen's Association webpage, newsletter	• Clemson Extension • NRCS • Spartanburg County Soil and Water Conservation District • Greenville County Soil and Water Conservation District
Construction – • Land clearing • Road building • Residential construction • Commercial construction	• Home Builder Associations • Engineers • Contractors	• 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. • Conservation easements are tools that can be used to protect land in perpetuity while providing financial benefits to landowners and water quality benefits to the region.	• Provide information on proper stormwater protection to local contractors through stormwater permitting departments. • Host trainings and workshops on sediment control practices for construction sites. • Place informational displays at local municipal buildings where building permits are issued.	• Spartanburg County Public Works • Greenville County Stormwater • City of Greer Stormwater Department • Municipal and County Staff
Urban - • Stormwater Runoff	• Homeowners • HOAs • Apartment complexes • Public Schools	• Sweep sidewalks and driveways instead of hosing them off • Use weed-free mulch when reseeding bare spots on lawns, and use store erosion control blankets if restarting or tilling a lawn • Notify local government officials when you see sediment entering streets or streams near a construction site. • 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 Public Service Announcements (PSAs) about stormwater runoff and water quality on local radio stations. • Maintain a presence at local festivals. • Help promote watershed education in public school system. • Promote online educations resources related to water quality (Clemson Ext, City and County websites, and local Soil and Water Conservation Districts). • Put informational brochures and posters at local public offices (e.g., Clemson Ext., NRCS, SWCDs).	• Spartanburg and Greenville Soil and Water Conservation Departments • Municipal and County Staff • Clemson Extension • USC Upstate Watershed Ecology Center • Tyger River Foundation
Shoreline Management	• Homeowners • HOAs	• Plant native plants along shoreline to prevent erosion. • Avoid mowing to water's edge to reduce runoff into waterbody. • Establish a 10-30 foot no fertilizer or pesticide zone along shorelines. • Avoid pruning vegetation along shoreline without seeking proper guidelines and permits.	• Work with utilities to send out information with water bills. • Put informational brochures and posters at local public offices. • Host trainings and workshops on shoreline management for homeowners.	• Spartanburg and Greenville Soil and Water Conservation Departments • Municipal and County Staff • Clemson Extension • USC Upstate Watershed Ecology Center • Tyger River Foundation • Utilities - Greer CPW, SJWD

1) COOPERATING ORGANIZATIONS:

- **Clemson University Extension (CU Ext.)** – CU Ext. Spartanburg County Agents are committed to assisting Upstate Forever in the development of a watershed-based plan for the Middle, North, and South Tyger River Watersheds by attending meetings, providing input into the plan development, and assisting with public outreach.

- **City of Greer Stormwater Department** - The Stormwater Manager will provide available data, participate in the stakeholder group, assist in the identification of areas in need of Best Management Practices (BMPs), and provide input to watershed-based plan development.

- **Greenville County**
    - **Public Works** - The Stormwater Manager will provide available data, participate in the stakeholder group, identify actions and pollutant reductions needed within Greenville County, and provide input into plan development.
    - **Soil and Water Conservation District -** The Soil & Water Conservation District has committed to participate as a partner in this effort by attending meetings, providing data and relevant resources as needed and allowed, aiding in the identification of potential problem areas, and offering input to the watershed-based plan development.

- **Greer Commission of Public Works (Greer CPW) -** Greer CPW has committed to participate in the stakeholder group, provide available sanitary sewer and water quality information as needed, help with the identification of areas needing septic repair, and offer input in the development of the watershed-based plan.

- **SC Department of Natural Resources (SCDNR) -** SCDNR has extensive knowledge of the aquatic habitat and resources of the Tyger River watersheds and this information will be critical to the watershed planning process. Thus, SCDNR has committed to participate as a stakeholder in this effort by attending meetings, providing data and relevant resources as needed and allowed, aiding in the identification of potential problem areas, and offering input to plan development.

- **Startex-Jackson-Wellford-Duncan Water District (SJWD**) - SJWD has committed to engage in the stakeholder process by attending meetings, providing source water protection plans and water quality data as needed, assisting in the identification of potential problem areas, BMPs, and priority parcels for protection, watershed-based plan development, and aiding in public outreach efforts.

- **Spartanburg County**
    - **Parks Department -** The Parks Manager will provide recreation information and plans, participate in the stakeholder process, and assist with public education and outreach.

- **Stormwater Department** - The Stormwater Manager will provide available data, participate in the stakeholder group, aid in the identification of areas in need of BMP's, and assist with public outreach.
- **Soil and Water Conservation District -** The Soil & Water Conservation District is adept at conservation planning and land management in Spartanburg County. Their knowledge of water quality and land use (especially rural and agricultural) issues in the selected watersheds will be vital to the watershed planning process.

- **Town of Duncan -** The Town of Duncan, which is located within the South Tyger Watershed, has committed to participate in the stakeholder process by attending meetings, providing input to the development of the watershed-based plan, aiding in the identification of problem areas in the community, and possibly assisting with outreach to the local residents.

- **Tyger River Foundation -** The Tyger River Foundation has committed to participate in the stakeholder process by stakeholder process by attending meetings, providing input to the development of the watershed-based plan, aiding in the identification of problem areas in the community, and possibly assisting with outreach to the local residents.

- **USC Upstate Watershed Ecology Center** (WEC) **-** USC Upstate WEC will provide pertinent available data, participate in the stakeholder group process, assist in public outreach and education efforts, provide input to watershed-based plan development, and identify actions and pollutant reductions within these three Tyger River watersheds.

- **Woodruff Roebuck Watershed District (WRWD) -** WRWD has committed to participate in the stakeholder group, provide available water quality information as needed, help with the identification of areas needing BMPs, and offer input in the development of the watershed-based plan contingent upon approval by Board of Commissioners.

UPSTATE FOREVER

PUBLIC MEETING

Developing Watershed-based Plan for Tyger River Watershed

January 11, 2018, 6:30-8:00 pm at Lake Lyman Lodge

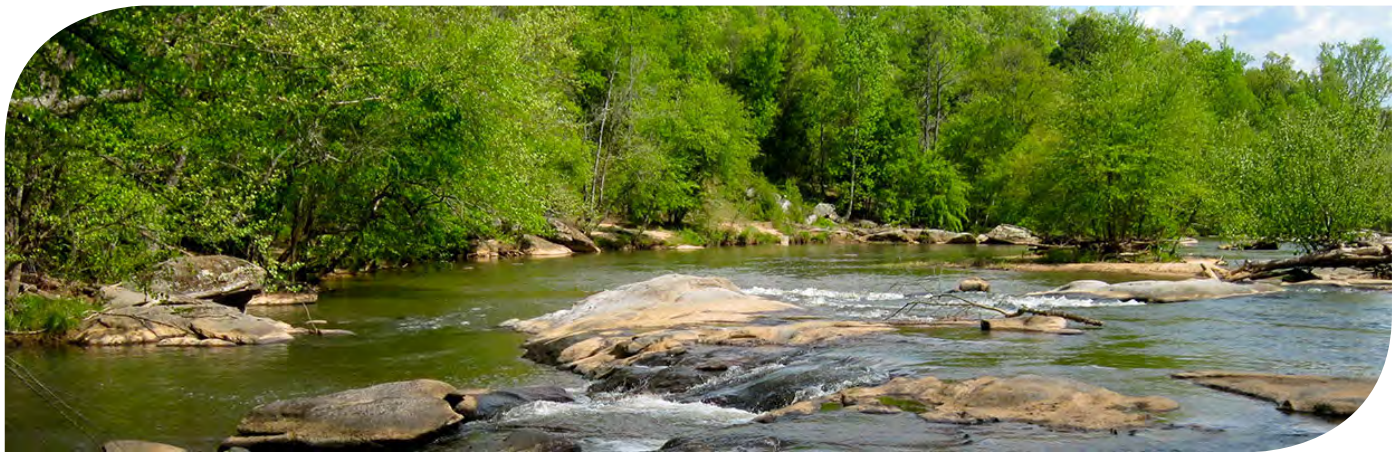
100 Lyman Lodge Rd, Lyman, South Carolina 29365

Agenda:

- Welcome and Introductions
- Watershed Planning Process Overview
- Middle, North, and South Tyger Watersheds
- Question and Answer Session

PARTNERS

This project is funded wholly or in party 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)



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 (sqft)	pipeline (ft)	watering facilities (units)	riparian buffers - vegetated (ac)	onsite wastewater treatment system projects (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 water 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 Agriculture BMP Bundle:

- **1 well with pump**
- **1,868 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.

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

MDL/319 Project	total fecal coliform removal (cfu)	onsite wastewater treatment system projects (units)	average fecal coliform removed by one 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 ofan agriculture BMP bundle. Since theRabon 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 (sqft)	pipeline (ft)	watering facilities (units)	riparian buffers - vegetated (ac)	onsite wastewater treatment system projects (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
RabonCreek	(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 G - STEPL Riparian Buffer Tool Screenshots

Buffer Input Tab – STEPL

8. Input or modify urban land use distribution

Watershed	Urban Area (ac.)	Commercial %	Industrial %	Institutional %	Transportation %	Multi-Family %	Single-Family %	Urban-Cultivated	Vacant (developed)	Open Space %	Total % Area
NthTyger-open space	37.88	0	0	0	0	0	0	0	0	48	48
NT-single fam	37.88	0	0	0	0	0	14	0	0	0	14
NT-commercial	37.88	38	0	0	0	0	0	0	0	0	38
MT-open space	260.21	0	0	0	0	0	0	0	0	36	36
MdlTyger-single fam	260.21	0	0	0	0	0	20	0	0	0	20
MT-commercial	260.21	44	0	0	0	0	0	0	0	0	44
SthTyger-open space	87.26	0	0	0	0	0	0	0	0	30	30
ST-single fam	87.26	0	0	0	0	0	30	0	0	0	30
ST-commercial	87.26	40	0	0	0	0	0	0	0	0	40
											300

Buffer Total Load Tab – STEPL

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)	N Reduction	P Reduction	BOD Reduction	Sediment Reduction	N Load (with BMP)	P Load (with BMP)	BOD (with BMP)	Sediment Load (with	%N Reduction	%P Reduction	%BOD Reduction	%Sed Reduction
	lb/year	lb/year	lb/year	t/year	lb/year	lb/year	lb/year	t/year	lb/year	lb/year	lb/year	t/year	%	%	%	%
W1	63.0	6.3	168.1	1.5	41.4	4.1	147.3	1.9	21.6	2.2	20.8	-0.5	65.7	65.7	87.6	131.5
W2	30.2	5.5	137.1	0.7	19.8	3.6	120.2	0.3	10.3	1.9	16.9	-0.2	65.7	65.7	87.6	131.5
W3	182.9	18.3	850.3	3.4	120.2	12.0	745.3	4.5	62.7	6.3	105.1	-1.1	65.7	65.7	87.6	131.5
W4	324.8	32.5	866.2	7.6	192.1	19.2	683.0	9.0	132.7	13.3	183.1	-1.4	59.1	59.1	78.9	118.3
W5	296.0	53.8	1345.6	6.7	175.1	31.8	1061.2	8.0	120.9	22.0	284.5	-1.2	59.1	59.1	78.9	118.3
W6	1454.5	145.4	6763.4	27.3	860.3	86.0	5333.6	32.3	594.2	59.4	1429.8	-5.0	59.1	59.1	78.9	118.3
W7	90.8	9.1	242.0	2.1	21.8	2.2	77.7	1.0	68.9	6.9	164.4	1.1	24.1	24.1	32.1	48.1
W8	148.9	27.1	676.9	3.4	35.8	6.5	217.2	1.6	113.1	20.6	459.7	1.8	24.1	24.1	32.1	48.1
W9	443.4	44.3	2061.9	8.3	106.7	10.7	661.6	4.0	336.7	33.7	1400.3	4.3	24.1	24.1	32.1	48.1
Total	3034.5	342.3	13111.6	61.0	1573.3	176.2	9047.1	63.2	1461.2	166.1	4064.5	-2.2	51.8	51.5	69.0	103.6

Buffer Urban Tab - STEPL

2. Urban landuse distribution

Landuse	Commerc	Industria	Institutio	Transpor	Multi-Fa	Single-F	Urban-C	Vacant (	Open Space
W1	0	0	0	0	0	0	0	0	18.1824
W2	0	0	0	0	0	5.3032	0	0	0
W3	14.3944	0	0	0	0	0	0	0	0
W4	0	0	0	0	0	0	0	0	93.6756
W5	0	0	0	0	0	52.042	0	0	0
W6	114.492	0	0	0	0	0	0	0	0
W7	0	0	0	0	0	0	0	0	26.178
W8	0	0	0	0	0	26.178	0	0	0
W9	34.904	0	0	0	0	0	0	0	0

2a. Effective BMP application area (ac)

Landuse	Commerc	Industria	Institutio	Transpor	Multi-Fa	Single-F	Urban-C	Vacant (	Open Spac
W1	0	0	0	0	0	51.46	0	0	33.64
W2	0	0	0	0	0	11.62	0	0	8.3
W3	31.54	0	0	0	0	0	23.24	0	0
W4	0	0	0	0	0	318.06	0	0	184.68
W5	0	0	0	0	0	102.6	0	0	0
W6	225.72	0	0	0	0	0	0	0	0
W7	0	0	0	0	0	0	0	0	21
W8	0	0	0	0	0	21	0	0	0
W9	28	0	0	0	0	0	0	0	0

3. Selected urban BMPs

Landuse	Commerc	Industria	Institutio	Transpor	Multi-Fa	Single-F	Urban-C	Vacant (	Open Space
W1	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	LID/Filter/B	0 No BMP	0 No BMP	LID/Filter/Buffer Strip
W2	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	LID/Filter/B	0 No BMP	0 No BMP	LID/Filter/Buffer Strip
W3	LID/Filter/B	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	LID/Filter/B	0 No BMP	0 No BMP
W4	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	LID/Filter/B	0 No BMP	0 No BMP	LID/Filter/Buffer Strip
W5	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	LID/Filter/B	0 No BMP	0 No BMP	0 No BMP
W6	LID/Filter/B	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP
W7	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	LID/Filter/Buffer Strip
W8	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	LID/Filter/B	0 No BMP	0 No BMP	0 No BMP
W9	LID/Filter/B	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP

3a. Percentage of BMP effective area (%)

Landuse	Commerc	Industria	Institutio	Transpor	Multi-Fa	Single-F	Urban-C	Vacant (	Open Spac
W1	0	0	0	0	0	0	0	0	213.113
W2	0	0	0	0	0	219.113	0	0	0
W3	219.113	0	0	0	0	0	0	0	0
W4	0	0	0	0	0	0	0	0	197.148
W5	0	0	0	0	0	197.148	0	0	0
W6	197.148	0	0	0	0	0	0	0	0
W7	0	0	0	0	0	0	0	0	80.22
W8	0	0	0	0	0	80.22	0	0	0
W9	80.22	0	0	0	0	0	0	0	0