CITY OF LAKE CITY

LAKE SWAMP WATERSHED PLAN

PREPARED FOR

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ACRONYMS AND DEFINITIONS

BMP	Best Management Practice
BOD_5	Biochemical Oxygen Demand, 5-day
CCC	Criterion Continuous Concentration
CCTV	Closed Circuit Television
CMC	Criterion Maximum Concentration
COD	Chemical Oxygen Demand
col/100mL	Unit measuring number of colonies of bacteria per 100 mL sample
DO	Dissolved Oxygen
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency
FC	Fecal Coliform
FSA	Farm Service Agency
HSG	Hydrologic Soil Group
HUC	Hydrologic Unit Code
LID	Low Impact Development
mg/L	Milligrams per liter
MLRA	Major Land Resource Area
MPN/100mL	Most Probable Number for estimating bacteria per 100 mL sample
NH_3	Ammonia
$NO_2 + NO_3$	Nitrite + Nitrate; fraction of nitrogen in the sample
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NTU	Nephaloturbidimetric Units
pH	Acidity or alkalinity of a sample
PHF	Pesticides, Herbicides, Fertilizers
PIS	Pathogen Indicator Study
PQL	Practical Quantification Limit
QAPP	Quality Assurance Project Plan
SC	South Carolina
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SMZ	Streamside Management Zone
SSO	Sanitary Sewer Overflow
STORET	Storage and Retrieval Data Warehouse
SWCD	Soil and Water Conservation District
TKN	Total Kjeldahl Nitrogen; fraction of nitrogen in the sample
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSS	Total Suspended Solids
WQM	Water Quality Monitoring
WQS	Water Quality Standard
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

The City of Lake City, South Carolina, has placed a priority on maintaining and upgrading infrastructure, preserving environmental resources, and improving quality of life for their residents. This includes a focus on community gathering areas and providing access for outdoor and aquatic recreation in the watershed. A new City park and recreation area are planned in order to provide access for area residents to the natural resources of Lake Swamp. Lake Swamp and its tributaries have been listed by the state of SC as impaired for dissolved oxygen (DO) and bacteria (*E. coli*), requiring further investigation in order to ensure Lake Swamp meets SC water quality standards for recreational access. In late 2015, Lake City was awarded a §319 grant from SCDHEC and US EPA to develop a watershed-based plan for the Lake Swamp Watershed. A stakeholder group was established, and stakeholder input was sought and incorporated into the watershed assessment and management plan. The overall goal of the Lake Swamp Watershed Plan was to evaluate current water quality conditions within the watershed, and to develop a plan to manage the watershed.

In order to accomplish this, a field survey was conducted in May 2016 according to standard SCDHEC and US EPA watershed assessment protocol. Field observations were recorded regarding existing land use activities and practices and any identifiable or potential issues which might impact water quality. These field observations, in combination with existing data, were used to analyze the watershed and form as complete a picture as possible of current conditions. Existing data included hydrologic maps, soil survey data, rainfall data, geologic, topographic and other natural features typical to the region, population demographics, land uses and activities within the watershed, including potential point and nonpoint sources of pollution which could contribute to the listed DO and *E. coli* impairments. Additionally, a literature review of academic sources and other South Carolina watersheds was completed in order to compare Lake Swamp to other similar watersheds.

Lake Swamp was identified as a blackwater system, with typical characteristics of low dissolved oxygen, lower pH, higher oxygen demand, low turbidity and tea-colored water. Water quality sampling data from up to (6) monitoring stations in the watershed was available for three timeframes: historical data (1999-2008), transition years (2009, 2010) and recent data (2009-2014). The monitoring stations are: PD-085, PD-086A, PD-087, PD-314, PD-346 and RS-10397. Of these, PD-085 has a limited number of samples, with two single year sampling periods separated by an 8 year window. Additionally, RS-10397 was a temporary station and was only monitored for a single year. A substantial amount of data was available for the other (4) stations, with nearly continuous operation conducted at PD-087, the station located at the watershed outlet. Recent data is only available for PD-087; all other stations were discontinued as of 2010. Hydrology data was not available for stormwater flows or in-stream flows.

In 2013, SC adopted a new pathogen indicator standard, and all data previously collected as Fecal Coliform were converted to *E. coli* values using a standard conversion factor of 0.8725 established by SCDHEC. This factor represents the ratio of 349/400, with 349 the WQS for *E. coli* and 400 formerly the

WQS for Fecal Coliform. Geomean values were calculated as these are more representative of the central tendency of bacteria data than a traditional average value.

Water quality data were analyzed according to average value and compared to the SC water quality standard in order to determine the percent exceedance. Impairment listings were evaluated. Dissolved oxygen results demonstrated a clear seasonal trend, with DO levels increasing in cooler months and decreasing in warm and hot months. Temperature data was highly correlated with peaking temperatures in the summer aligning with depleted DO. This seasonal fluctuation is expected in a blackwater system such as Lake Swamp. In most years, the DO levels began decreasing in April, reached their lowest concentrations in late summer/early fall, and then began to rebound in October. At some stations in some years, the DO concentration recovered and then fell again during the hot months, but for the most part, once the DO levels were depleted, the concentrations remained low until the weather cooled off, allowing the DO to be replenished in the water. The WQS for DO in a blackwater system was established at 4 mg/L. This standard was violated about 50% of the time throughout Lake Swamp. Values of pH are typically lower in blackwater systems than in other freshwater bodies. pH readings were very consistent across all monitoring stations and time periods at Lake Swamp, with average pH hovering right around 6.0 at all stations. The DO, temperature and pH results all provided clear evidence of natural processes expected in a blackwater system.

Historical bacteria monitoring data (1999-2008) showed Lake Swamp monitoring stations to be in compliance with state standards, and scattered exceedances less than 10%. During the transition monitoring period (2009-2010), intensive monitoring was conducted at two stations, RS-10397, a temporary station, and PD-346. Station PD-346 recorded 12% exceedance from the FC samples (converted to *E. coli* values) and 25% exceedance from the *E. coli* samples, compared to the SC *E. coli* WQS. Considering the entire history at PD-346, the percent exceedance was only 9%. In 2010, temporary station RS-10397 was established, and 3 out of 6 samples exceeded the WQS (50% exceedance). On the basis of this data, these two stations were listed as impaired. These two monitoring stations do not appear to meet SCDHEC's 5-yr/10% exceedance listing criteria and may or may not actually be impaired according to the SC listing standard. As the station located at the bottom of the watershed, PD-087 has the longest monitoring record in the watershed, with a total of 14 years of data. PD-087 is not impaired for bacteria. While there are potential bacteria pollutant sources in both the urban and rural land use areas upstream, it does not appear that Lake Swamp Watershed is a significant contributor of bacteria downstream.

It is fair to assume that many of the natural processes in Lake Swamp remain in-tact, including seasonal fluctuations in DO concentration and bacteria inputs from wildlife. Based on the analysis presented in this report, the majority of the influences upon dissolved oxygen and bacteria concentrations in Lake Swamp appear to be ambient and expected for a blackwater system. Lake Swamp is, however, populated by humans, and therefore it is likely that human activities do contribute pollutants which may influence DO and bacteria concentrations. Without knowing for certain how much of the depressed DO or bacteria concentrations can be attributed to natural conditions and how much can be attributed to human activities, it is difficult to fully assess the impact of human activities. The watershed management plan was designed to target activities which are likely to improve DO and bacteria conditions, but exact pollutant load reductions cannot be calculated due to lack of hydrology data. More intensive and current monitoring data is needed in order to determine the extent of human influence on DO concentrations in Lake Swamp Watershed.

The City of Lake City will continue to implement infrastructure improvement projects currently planned or underway, and will supplement their efforts with tasks identified in the watershed management plan. Key components of the plan are: (1) Public Outreach and Education; (2) Sanitary Sewer Rehabilitation and Illicit Discharge Detection and Elimination; (3) Septic System Maintenance and Rehabilitation; (4) Best Management Practices (BMP) for Agriculture; (5) BMPs for Timber Harvesting; (6) Conservation Easements in Riparian Areas; (7) Structural BMPs; and (8) Water Quality Monitoring Plan. A 10-year implementation schedule is included in the watershed management plan. Successful implementation will require stakeholder involvement and support.

SECTION 1

BACKGROUND

1.1 INTRODUCTION

A watershed can be defined as the area of land around a river, or group of rivers, which drains to a common point. A watershed can also be defined as the interconnected land and water within a topographic area, and defined by ridge lines at the boundaries. A watershed is characterized according to its physical and natural features, the characteristics of the population that resides there, and the land uses and activities which occur within the watershed. All of these characteristics combine to form a unique set of circumstances within each watershed. These watershed characteristics influence the human population that lives in the watershed, and in turn, the human population influences the watershed characteristics.

Water quality is regulated under the Clean Water Act. Authority is delegated by the US EPA to the states (in this case, to South Carolina) to set standards, determine appropriate beneficial uses for water bodies, and ensure that programs are in place to properly manage water resources at the state level. This includes regulating certain major pollutant sources under permits, monitoring water quality, and reporting to the EPA every 2 years on the status of the waters under the state's jurisdiction. Sampling data is used to identify impaired waters, and certain actions must be taken to improve the quality of waters which have been identified as impaired.

The Section 319 grant program was established by the EPA to provide a means for watershed managers, municipalities and stakeholders to assess conditions in the watershed, and develop a site-specific and appropriate implementation plan with specific tasks identified for improving water quality, particularly for impaired waters. The state (SCDHEC) oversees the grant program administration. Grant funds must be used initially to complete a watershed assessment.

A watershed assessment is a background investigation, which combines field survey observations and analysis of existing data, in order to evaluate the overall conditions in the watershed. After evaluating conditions in the watershed, the stakeholder group can identify key issues in the watershed, set goals, and develop a management strategy to accomplish the goals. Goals typically focus on water quality improvement, and implementation tasks typically involve specific pollutant sources, land and water resource management practices, infrastructure projects and public involvement.

Once the assessment has been completed and approved by EPA and SCDHEC, the watershed group is eligible to compete for additional grant funds to implement the watershed management plan, in the form of specific projects, measures, or outreach activities. Most importantly, the watershed assessment and management plan is a living document, which evolves as the stakeholder group matures, tasks are completed, conditions change, new information becomes available or new goals emerge.

1.2 LAKE SWAMP WATERSHED

The Lake Swamp watershed is a predominantly rural watershed in southeastern Florence County extending into northeastern Williamsburg County. There are three municipalities within the Lake Swamp watershed. The City of Lake City is located in the center of the watershed; the Town of Scranton and the City of Johnsonville are located at the periphery. Scranton is upstream of Lake City, while Johnsonville is the furthest municipality downstream at the outlet of the watershed.

The watershed encompasses approximately 164 square miles and has multiple headwater streams forming four subwatersheds. Originating northwest of Lake City, Camp Branch and Twomile Branch merge near Lake City to form Lake Swamp. Southeast of Lake City, Long Branch flows into Singleton Swamp. Flowing eastward, Singleton Swamp and Lake Swamp converge before flowing into the Lynches River north of Johnsonville. The Lake Swamp watershed collects stormwater runoff primarily from forested and agricultural areas, but also receives runoff from roads and neighborhoods within Lake City, Scranton and Johnsonville. The Lake Swamp watershed is outside of the regulated limits of the Florence County MS4. The watershed is sparsely populated in the rural areas, and consists primarily of forested swamp, small farms and timber lands.

The City of Lake City has placed a priority on maintaining and upgrading infrastructure, preserving environmental resources, and improving quality of life for their residents. This includes a focus on community gathering areas and providing access for outdoor and aquatic recreation in the watershed. A new City park and recreation area are planned in order to provide access for area residents to the natural resources of Lake Swamp. The Lake City Park and City Lake will be a focal point for recreation and serve as the head of a trail for kayaking and canoeing in Lake Swamp. This new amenity is intended to draw the community together, providing an ideal opportunity for community outreach on watershed restoration. Located near the geographic center of the watershed, the park can serve as a key element for watershed plan implementation including water quality BMPs, educational outreach and an emphasis on the importance of improving water quality for community benefit.

In late 2015, Lake City was awarded a §319 grant from SCDHEC to develop a watershed-based plan for the Lake Swamp Watershed. The overall goal of the Lake Swamp Watershed Plan is to evaluate current water quality conditions within the watershed, and to develop a plan to manage the watershed. The Lake Swamp Watershed Plan will provide Lake City and Florence County with a comprehensive watershed management strategy that can be implemented to improve water quality for all citizens of the region.

1.3 PREVIOUS WORK IN THE WATERSHED

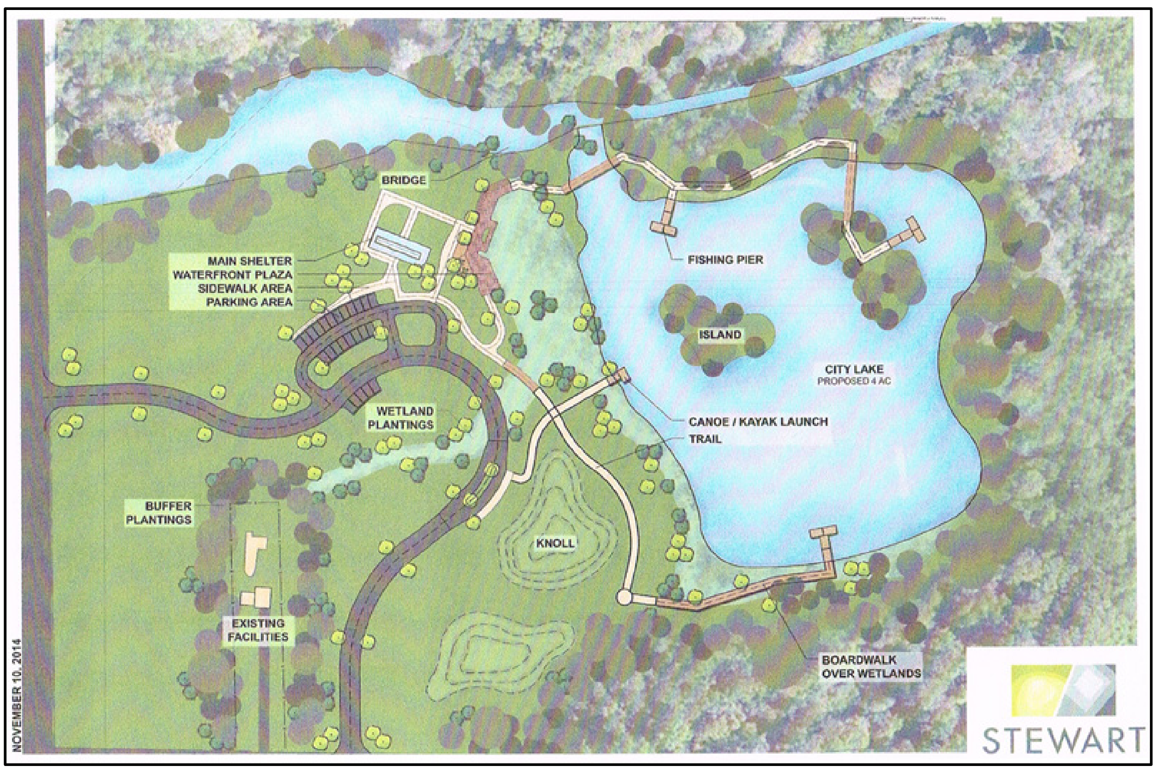
Lake City actively addresses stormwater concerns presented by the community. The City recently focused substantial resources toward maintaining and improving its stormwater system, beginning with adopting a penny tax and establishing a stormwater utility. Recent efforts include: completion of a

$250,000 stormwater outfall investigation and infrastructure mapping project; purchase of a vacuum truck; establishing a program for storm drain cleanouts and ditch maintenance; cleaning and conducting inspections of the entire stormwater system using closed circuit television (CCTV) equipment; and initiating an effort to replace catch basin lids to enable easy access and cleaning of catch basins. Additional efforts underway or complete include in-depth stormwater drainage study of the stormwater system in the Martha Law neighborhood, and re-design of the drainage system in the Carvers-Matthew neighborhood.

In addition to stormwater utility work, the City has undertaken numerous efforts to upgrade aging sanitary sewer infrastructure in order to address potential stormwater contamination from sanitary sewer overflows, exfiltration and cross-connections. The City conducted smoke testing, cleaning and CCTV inspections of the sanitary sewer and future rehabilitation of the sanitary sewer will be based on a system-wide assessment.

The City constructed a new lake in conjunction with the Lake City Park project (Figure 1-1). The park and lake will have a focus on natural resources and recreation and provide a focal point for implementation of watershed and water quality initiatives and outreach.

Figure 1-1: Conceptual Plan Schematic for Lake City Park and City Lake



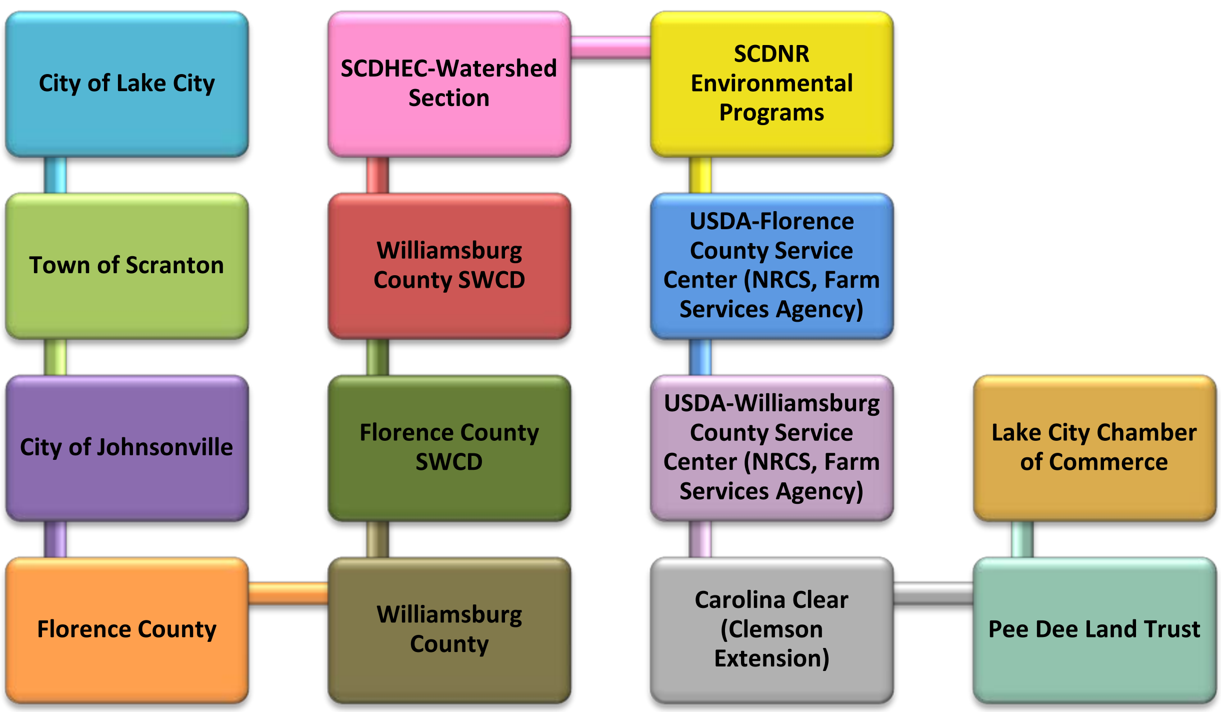
In addition to the City's efforts, the Florence County Soil and Water Conservation District actively promotes farming practices that help prevent soil erosion and protect water resources, and BMPs for the use of pesticides, herbicides, and fertilizers (PHF) to aid in reducing the discharge of pollutants related to the storage and application of PHFs by farmers.

All of the aforementioned efforts and projects should help to address stormwater and water quality in the Lake Swamp Watershed.

1.4 COOPERATING ORGANIZATIONS/STAKEHOLDERS

The success of a watershed plan depends on the commitment and involvement of community members and organizations that have a stake in its outcome. The stakeholder group for the Lake Swamp Watershed Plan consists of members of local governments, community organizations and citizens who have an interest in, or may be impacted by, activities in the Lake Swamp watershed. Stakeholders are shown in Figure 1-2.

Figure 1-2: Lake Swamp Watershed Overview Map



The City of Lake City invited all of the above stakeholders to the initial stakeholder meeting held on July 12, 2016 to discuss the current conditions in Lake Swamp, potential solutions, and ways for stakeholders to get involved. Representatives from Lake City, Johnsonville, Florence County SWCD, Clemson Extension, SCDHEC and SCDNR were in attendance at the meeting. Stakeholder input was a key component in evaluating conditions in the watershed, as well as in developing an appropriate management strategy which can be implemented in Lake Swamp Watershed.

Following is a synopsis of the issues that were discussed at the Stakeholder Meeting:

- Watershed Boundary: The SWCD watershed conservation district boundaries are not the same as the Lake Swamp Watershed boundary, which is based on the USGS Hydrologic Unit Code (HUC) system. The purpose of the watershed conservation districts is to control flooding and drainage, not water quality. They hold easements on both sides of the ditches, and are responsible for the channels and keeping them clean.
- Agricultural Producer Programs: Farmers are bound to the Farm Service Agency (FSA) requirements. Any large farmer that has applied for the Farm Bill has a conservation plan, including PHFs, for which the federal government helps to provide funding for BMPs. There is great awareness by agricultural producers concerning the use of approved PHFs from reputable companies.
- Livestock: There is minimal livestock production in Florence County. The Florence SWCD has previously sponsored a program to keep livestock out of the streams.
- Wildlife: Beaver dams and other wildlife have potential impacts on the watershed.
- Litter: Stakeholders agreed it is a problem throughout the watershed. Florence has begun to use cameras to help crack down on litter. Stakeholders are interested in starting Keep SC Beautiful and Keep Florence Beautiful campaigns in the watershed.
- Illegal Dumping: There are no known or observed instances of waste dumping in the watershed.
- Septic Tanks/Waste Haulers: Failing septic tanks may be contributing to bacterial pollution in the watershed. In the past, septic tank grants have been provided in the Big Swamp/Singleton Swamp watershed. Another grant program may help to garner interest in septic tank cleanout and rehab. The Lake City WWTP accepts septage waste.
- Potential Outreach:
  - Agricultural agencies
  - Septage waste haulers
  - Keep Florence County Beautiful
  - Private businesses and citizens
- Future Stakeholder Efforts: It was suggested to use the Lake City library as a place to gather and disseminate information.

1.5 PROJECT STAFF EXPERTISE

The City of Lake City is the lead organization for development of the Lake Swamp Watershed Plan. It has increased attention and efforts towards identifying and correcting problems within the existing stormwater system and sanitary sewer system which should lead to improvements in the watershed.

Lake Swamp Watershed extends beyond Lake City limits and is comprised of a mixture of urban, suburban and agricultural land uses. In order to develop a more comprehensive Watershed Plan to benefit all users within the watershed, the City enlisted the help of stakeholders with the expertise to address the rural and agricultural nature of the watershed, as well as the urban areas. This experience, along with the expertise provided by USDA, local Soil and Water Conservation agencies, Clemson extension and other local professionals operating in the watershed, was utilized to develop a comprehensive watershed management plan that addresses both urban and rural water quality impairment contributions.

At the time of publication, AECOM was serving as the City of Lake City's engineer of record, providing technical expertise in the areas of stormwater management, sanitary sewer and septic system rehabilitation, stream and wetland assessment and restoration, vegetative buffer establishment, and implementation of water quality BMPs.

By utilizing a diverse group of agencies as part of the project team, the City has developed a watershed plan that can meet its goals of water quality improvement and provide guidance for rural water quality improvements that, once fully implemented, will meet water quality standards for the entire watershed.

SECTION 2

WATERSHED CHARACTERIZATION

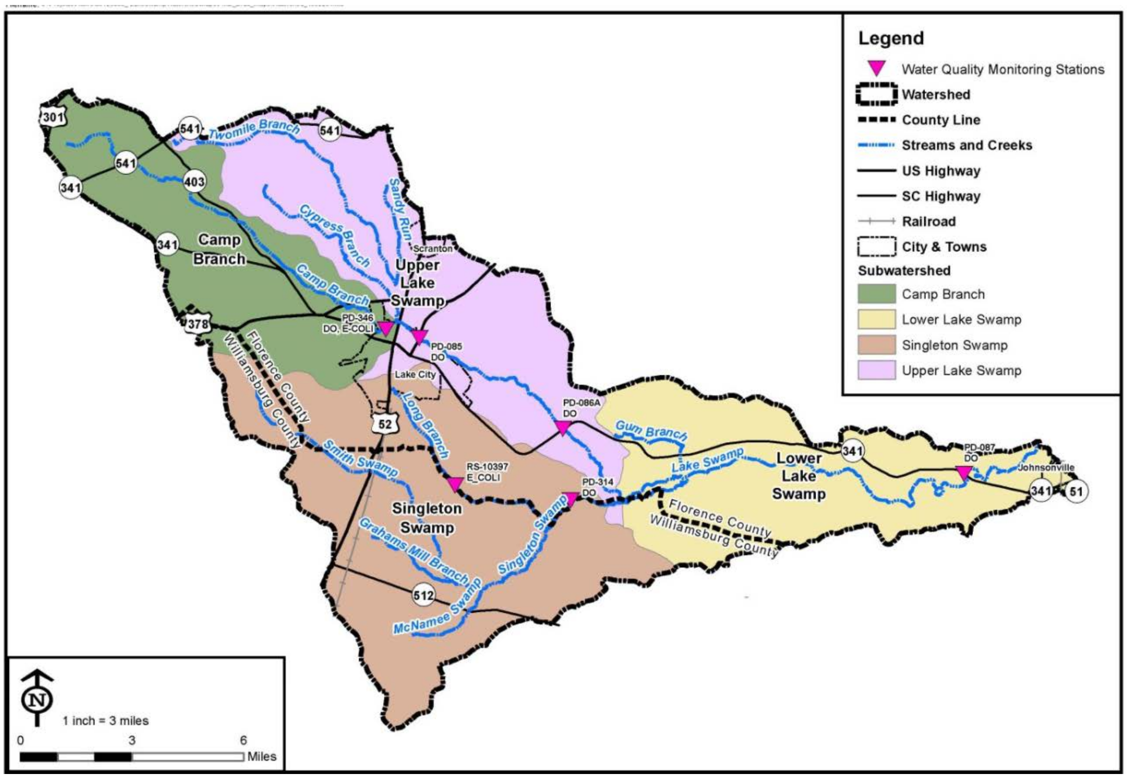
This section contains a detailed breakdown of the people and places that make up Lake Swamp Watershed. Section 2.1 describes the physical and natural features, including geography, geology and soils, hydrology, climate and weather. Section 2.2 describes the land uses and population demographics found in Lake Swamp Watershed. Section 2.3 describes the water quality standards, the water quality monitoring program, and conditions of similar watersheds. Section 2.4 contains a discussion of pollutant sources and findings from the field assessment conducted during development of this plan.

2.1 PHYSICAL AND NATURAL FEATURES

2.1.1 Geography

Lake City is located near the geographic center of the watershed. The Town of Scranton is at the northern watershed boundary, and Johnsonville is at the eastern boundary near the watershed outfall (Figure 2-1 and Appendix A, Lake Swamp Watershed Overview Map). The remainder of the watershed is rural. The watershed bridges both Florence County and Williamsburg County and is accessed by U.S. Highway 52, running north-south through Lake City, and Highway 341, running east-west through Lake City and Johnsonville.

Figure 2-1: Lake Swamp Watershed Overview Map



2.1.2 Topography

Lake Swamp Watershed is a blackwater system. These systems are characterized by low elevation, wide floodplains and minimal changes in topographic relief. The municipalities within Lake Swamp are primarily located on higher ground, however this is relative, with the entire watershed less than 100 feet above sea level. Minimal change in elevation from upstream to downstream produces large areas of inundation and very slow moving water. These characteristics in turn influence the quality or chemistry of the water.

2.1.3 Natural Processes

Blackwater swamps are forested wetlands, predominantly found in the coastal southeastern United States. These ecosystems provide an ideal habitat for a great amount of biodiversity and wildlife and these systems are naturally productive. Wide inundation areas of shallow, slow moving water provide space for floodwaters to attenuate and organic matter to decay. Decaying matter consumes oxygen during decomposition, therefore these systems typically are characterized by higher biochemical oxygen demand and lower dissolved oxygen. The decaying organic matter also produces a slightly more acidic (lower pH) water chemistry than other freshwaters. Dissolved oxygen is naturally replenished by oxygen dissolving from the atmosphere into the surface water, however this process is temperature-dependent. Oxygen saturation is typically higher in the winter, during cooler temperatures. Despite the extensive tree cover, the shallow water is subjected to high temperatures during summer in the southeastern US, and the combination of oxygen demand from decomposition and decreased oxygen saturation from the atmosphere results in less oxygen able to be replenished in these blackwater ecosystems during summer months. Finally, due to the ability of these swamps to attenuate floodwaters and settle out organic matter, the water clarity tends to be very high, with little turbidity in the water column. The water is typically tea-colored, resulting from the tannins released from decaying organic matter. This tea-coloration is natural for these systems.

2.1.4 Hydrology

The USGS uses a hierarchical classification of hydrologic drainage basins in the United States. Each major geographic area is divided and subdivided into successively smaller hydrologic units, identified by a unique Hydrologic Unit Code (HUC). Each state has adopted this classification system as a uniform way of identifying hydrologic areas. The Lake Swamp watershed (HUC 03040202-06) encompasses 105,066 acres (164 square miles) in Florence and Williamsburg Counties. It is one of 7 watersheds of the Lynches River Basin (HUC 03040202) which lies within the Pee Dee River Basin of northeastern South Carolina (Figure 2-2).

Figure 2-2: Map of Pee Dee River Basin

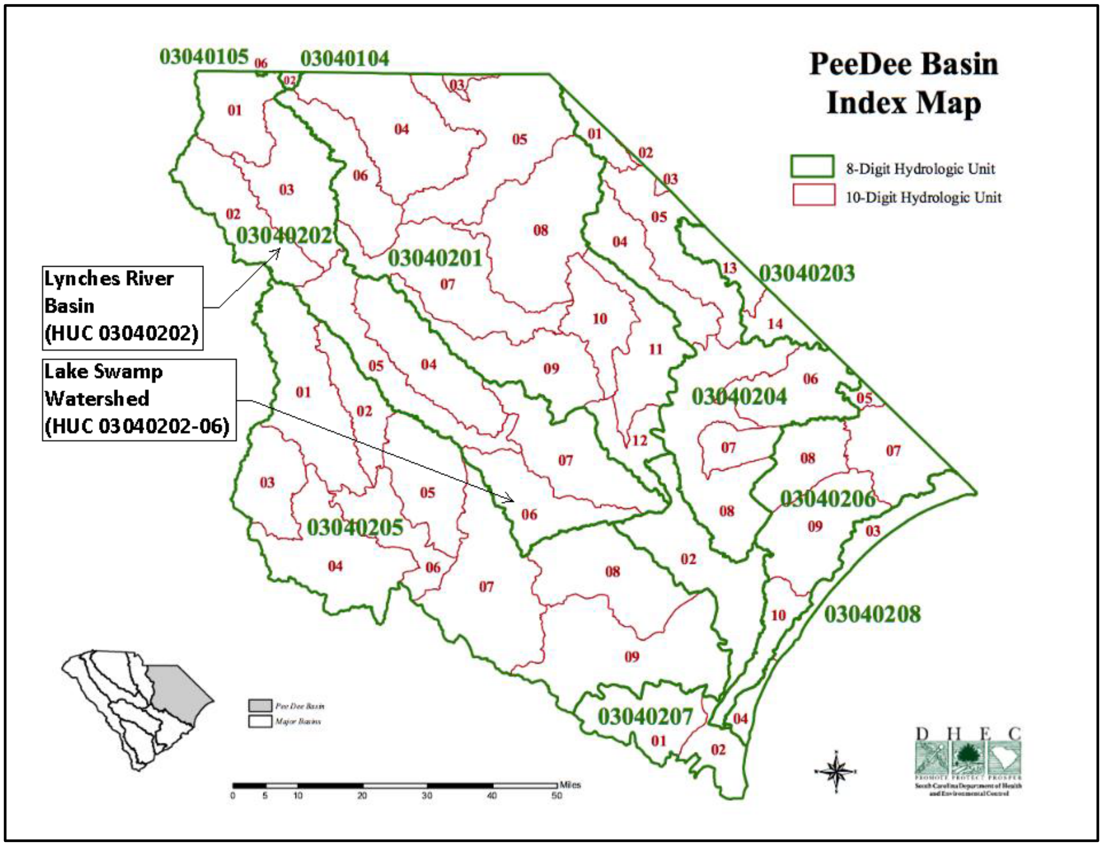


Table 2-1 identifies the subwatersheds, HUCs and land areas that make up Lake Swamp Watershed. The watershed primarily consists of Lake Swamp and its tributaries, and is made up of four (4) subwatersheds varying in size from 19,850 to 35,762 acres, and with a total of over 100,000 acres (approximately 164 sq mi). Lake Swamp Watershed is shown on Figure 2-1 and Appendix B Subwatershed Maps.

Table 2-1: Lake Swamp Subwatersheds, HUC and Area

Subwatershed	Hydrologic Unit Code (HUC)	Area (Acres)
Camp Branch	03040202-0601	19,850
Singleton Swamp	03040202-0602	35,762
Upper Lake Swamp	03040202-0603	25,972
Lower Lake Swamp	03040202-0604	23,482
	Total	**105,066**

The hydrology of Lake Swamp Watershed can be described as follows:

- Camp Branch Subwatershed: Camp Branch is the primary named water body in this subwatershed. Camp Branch originates near the Sumter-Florence County line, approximately 10 miles northwest of Lake City. Western portions of Lake City are located in this subwatershed.

- Upper Lake Swamp Subwatershed: Cypress Branch, Sandy Run Branch and Twomile Branch form the major water bodies in this subwatershed. Twomile Branch originates approximately 8 miles north northwest of Lake City, and merges with Camp Branch west of Lake City to form Lake Swamp. Stormwater from the northern half of Lake City drains north into Lake Swamp. The town of Scranton is also located in this subwatershed.

- Singleton Swamp Subwatershed: Smith Swamp, Grahams Mill Branch and McNamee Swamp join to form Singleton Swamp, which accepts drainage from Long Branch before draining into Lake Swamp. Long Branch receives drainage from the south side of Lake City, however Singleton Swamp is located primarily in Williamsburg County.

- Lower Lake Swamp Subwatershed: Lake Swamp and Singleton Swamp converge in this subwatershed. Lake Swamp accepts drainage from Gum Branch before flowing westerly towards the City of Johnsonville. Johnsonville is located near the downstream boundary (watershed outlet) of this subwatershed. From this point, Lake Swamp flows into the Lynches River .

2.1.5 Climate/Precipitation

Maximum precipitation in the Atlantic Coast Flatwoods occurs in summer. Rainfall usually occurs as moderate-intensity storms that can produce large amounts of rain and inundation.

Rainfall data compiled from the National Oceanic & Atmospheric Administration at the Lake City WWTP (Station Lake City 2 SE, SC US Coop: 384886) for the period 1995 through 2014 indicates an average annual rainfall of approximately 45 inches. The highest seasonal rainfall occurred in the summer, averaging approximately 15.3 inches. However, as shown in Table 2-2 below, the data for this weather station is incomplete. Furthermore, the historic rainfall event of October 2015 is not reflected in the data. During October 2015, the Florence Regional Airport, approximately 25 miles north of Lake City, recorded 14.71 inches of precipitation for the month of October 2015 (dnr.sc.gov/flood2015), or approximately 58% more than the average Fall precipitation for Lake City.

Table 2-2: Precipitation (in.), Station Lake City 2 SE, SC US Coop: 384886, 1995-2014

Year	Summer (June-Aug.)	Fall (Sept.-Nov.)	Winter (Dec.-Feb.)	Spring (Mar.-May)	Annual
2014	12.61	7.33	8.98	14.47	43.39
2013	21.20	5.89	8.81	12.95	48.85
2012	16.25	7.50	6.24	10.82	40.81
2011	10.51	5.14	*	11.36	*
2010	19.13	7.69	7.17	4.45	38.44 *
2009	*	8.32	7.38	*	*
2008	11.35	11.66	5.44	8.17	36.62
2007	13.41	5.70	9.65	5.22	33.98
2006	16.35	9.29	10.99	7.26	43.89 *
2005	14.88	*	7.02	*	*
2004	22.66	*	8.74	4.77	*
2003	*	8.25	*	17.73	*
2002	14.24	*	*	5.68	*
2001	*	*	7.34	8.27	*
2000	11.75	10.74	7.53	10.93	40.95
1999	8.58	14.89	11.67	8.54	43.68
1998	11.44	4.41	19.53	17.29	52.67
1997	18.85	14.75	15.72	7.76	57.08 *
1996	15.03	15.37	7.04	9.58	47.02
1995	21.85	12.26	17.25	5.94	57.30
Annual Avg.	15.30 *	9.32 *	9.79 *	9.51 *	44.98 *

* *Incomplete data.*

As shown in Table 2-3, the average annual daily temperature for the previously referenced weather station for the period 2000 through 2014 was 63.5° F. Seasonal mean temperatures ranged from approximately 46.6° F in winter to 79.6° F in summer.

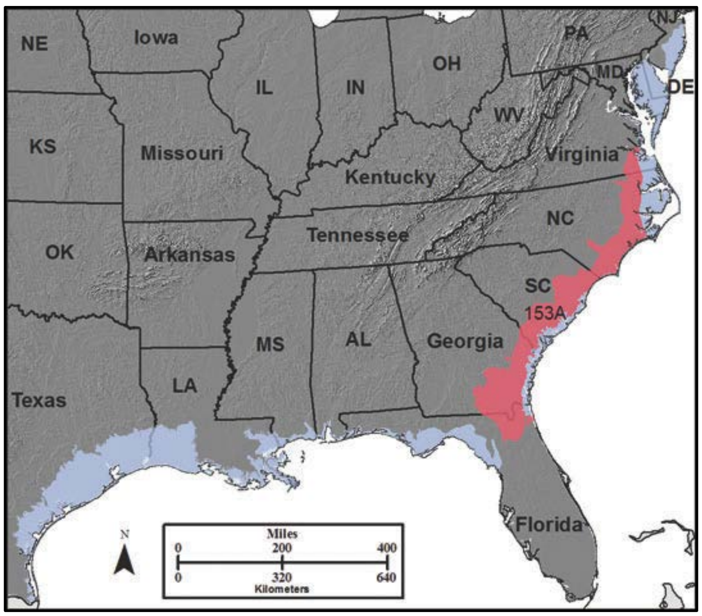
Table 2-3: Mean Temperatures (°F), Station Lake City 2 SE, SC US Coop: 384886, 2000-2014

Period	Summer (June, July, August)			Winter (December, January, February)			Annual		
	Mean Max.	*Mean Min.*	*Mean*	*Mean Max.*	*Mean Min.*	*Mean*	*Mean Max.*	*Mean Min.*	*Mean*
2000-2014	90.0°	69.3°	79.6°	58.9°	34.2°	46.6°	75.4°	51.5°	63.5°

2.1.6 Geology

The Lake Swamp watershed is situated within the Atlantic Coast Flatwoods Major Land Resource Area, MLRA 153A, as shown in Figure 2-3 below. MLRA 153A is a relatively flat coastal plain crossed by many broad, shallow valleys with widely meandering stream channels. The surface in this area consists of mostly unconsolidated Coastal Plain sediments. They are a mixture of river-laid sediments in old riverbeds and on terraces, flood plains, and deltas, consisting of combinations of clay, silt, sand, and gravel. Cretaceous marine, near-shore shale, sandstone, and limestone deposits occur beneath the surface. The present-day river valleys are extensive and are flat near the coast. The water table typically is close to the surface in these river valleys, and soils having restricted drainage are common throughout the area.

Figure 2-3: Map of Atlantic Coast Flatwoods Region



2.1.7 Soils

A wide range of soil types have been identified throughout the Lake Swamp Watershed (see Appendix C, Soils Maps for each subwatershed). For purposes of the Lake Swamp Watershed Plan, the soils are organized by Hydrologic Soil Group (HSG), as identified by USDA NRCS Web Soil Survey, based on estimates of runoff potential. Soils are assigned to one of four HSGs according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms. Table 2-4 provides a description of the four HSGs.

Table 2-4: Hydrologic Soil Groups

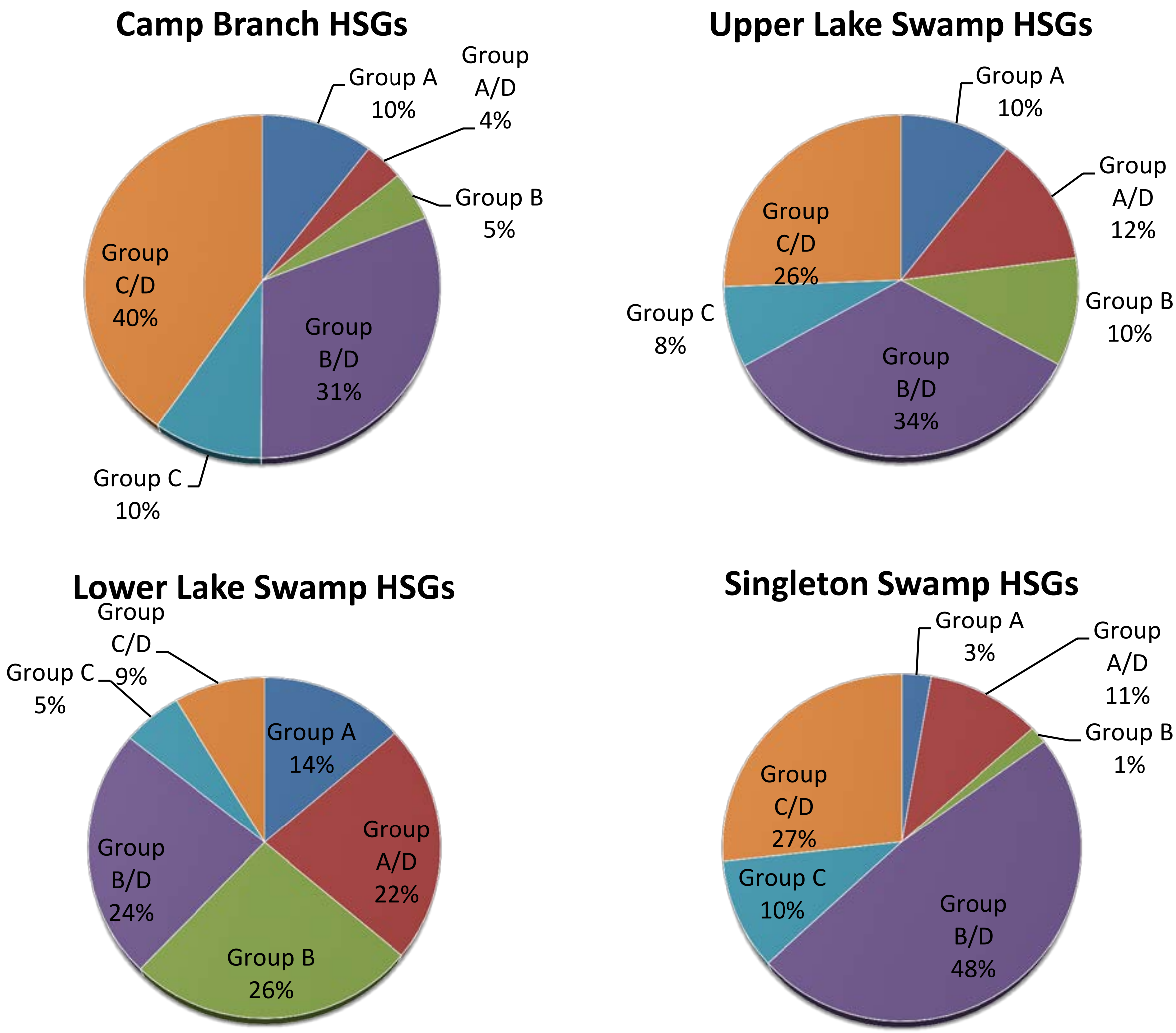
Hydrologic Soil Group	Description	Infiltration Rate (when thoroughly wet)
Group A	Consist mainly of deep, well drained to excessively drained sands or gravelly sands.	High (Low Runoff Potential)
Group B	Consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture.	Moderate
Group C	Consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture.	Slow
Group D	Consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material.	Very Slow (High Runoff Potential)
Dual HSGs (A/D, B/D, C/D): If a soil is assigned to a dual hydrologic group, the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in Group D are assigned to dual classes.		

Each subwatershed has a unique soil composition. As shown in Table 2-5 and Figure 2-4, the predominant soils for all but Lower Lake Swamp Subwatershed are Group B/D and Group C/D. Lower Lake Swamp contains relatively greater percentages of Group A and Group A/D soils than the remaining subwatersheds. Group A are well-drained soils suitable for infiltration BMPs; however, for Group A/D soils, an evaluation of runoff potential may need to be performed on a site by site basis. Lower Lake Swamp also has the lowest percentage of Dual HSG soils (55%), while the remaining subwatersheds are comprised of 72% to 86% Dual HSG soils. Infiltration rates impact the ability for the installation of structural BMPs. Thus, the potential for Low Impact Development (LID) implementation projects is limited for areas with Group C, D or Dual HSGs.

Table 2-5: Summary of Subwatershed Hydrologic Soil Groups

HSG	Camp Branch	Upper Lake Swamp	Lower Lake Swamp	Singleton Swamp
Group A	10%	10%	14%	3%
Group A/D	4%	12%	22%	11%
Group B	5%	10%	26%	1%
Group B/D	31%	34%	24%	48%
Group C	10%	8%	5%	10%
Group C/D	40%	26%	9%	27%
Group D	0%	0%	0%	0%
Dual HSGs	**75%**	**72%**	**55%**	**86%**

Figure 2-4: Chart of Subwatershed Hydrologic Soil Groups



Soil erodibility in the Lynches River Basin is low to moderate, with K values ranging from 0.10 to 0.38. In general, clay soils have low K values (about 0.05 to 0.15) because the particles are resistant to detachment. Sandy soils also have low K values (about 0.05 to 0.20) because they have high infiltration rates resulting in low runoff, and although soil particles are easily detached, sediment eroded from these soils are not easily transported. Silt loams have moderate K values (about 0.25 to 0.45) because they are moderately susceptible to particle detachment, infiltration is moderate and sediment is moderate to easily transported. Silt soils are susceptible to erosion and have high K values, which can exceed 0.45. Soil particles in silt soils are easily detached, sediment is easily transported, and silt soils readily crust producing high runoff rates and amounts.

The dominant soil orders in the Atlantic Coast Flatwoods MLRA are Spodosols and Ultisols. The soils dominantly have a thermic soil temperature regime, an aquic or udic soil moisture regime, and siliceous or kaolinitic mineralogy. They generally are very deep, well drained to very poorly drained, and loamy or clayey. Paleaquults formed in marine sediments on flats and in depressions on the coastal plain (Coxville, Lynchburg, Pantego, and Pelham series) and on marine terraces (Rains series). Paleudults (Goldsboro series) and Kandiudults (Norfolk series) formed in marine sediments on uplands. Albaquults (Leaf series) formed in mixed alluvium and marine sediments on flats and terraces. Alaquods (Leon and Mascotte series) formed in marine sediments on flats and terraces and in depressions. Haplosaprists (Croatan series) formed in organic deposits over mixed marine and fluvial deposits on the coastal plain.

2.2 LAND USE AND POPULATION CHARACTERISTICS

2.2.1 Land Use and Land Cover Data

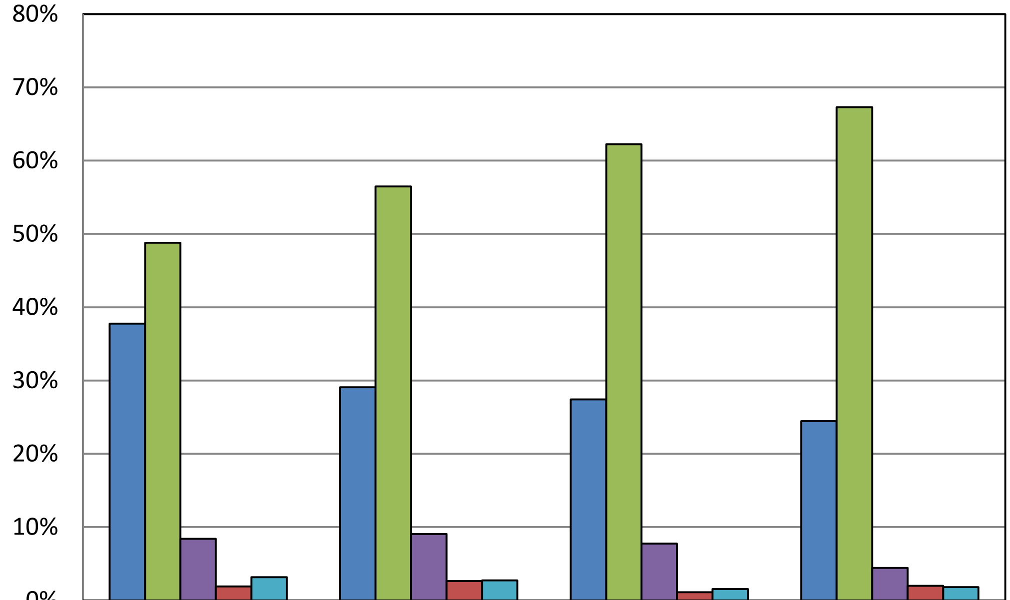
Land uses in Lake Swamp Watershed are shown in Table 2-6. The largest land use in Lake Swamp is forested blackwater swamp. The watershed is rural in nature, except for the urbanized areas of Lake City, Scranton and Johnsonville. Agriculture consists primarily of small family farms, although there are some larger commercial farms and timber activities.

Table 2-6 : Lake Swamp Watershed Existing Land Use

Land Use	Percentage
Forest/Wooded	60.0%
Agriculture	28.8%
Residential	7.0%
Commercial	2.0%
Vacant/Other	2.2%

Existing land uses for each the four subwatersheds is compared in Figure 2-5 below, and are shown in Appendix B, Lake Swamp subwatershed maps. Camp Branch has the greatest percentage of agriculture. Upper Lake Swamp includes most of Lake City and Scranton, which is reflected in the Commercial and Residential land use categories. The Vacant/Other land referenced in Figure 2-5 includes rights-of-way for power and gas lines, and other non-field/pasture land.

Figure 2-5: Chart of Existing Land Uses by Subwatershed



	Camp Branch	Upper Lake Swamp	Lower Lake Swamp	Singleton Swamp
Agriculture	38%	29%	27%	24%
Forest/Wooded	49%	56%	62%	67%
Residential	8%	9%	8%	4%
Commercial	2%	3%	1%	2%
Vacant /Other	3%	3%	2%	2%

2.2.2 Future Growth and Land Use Changes

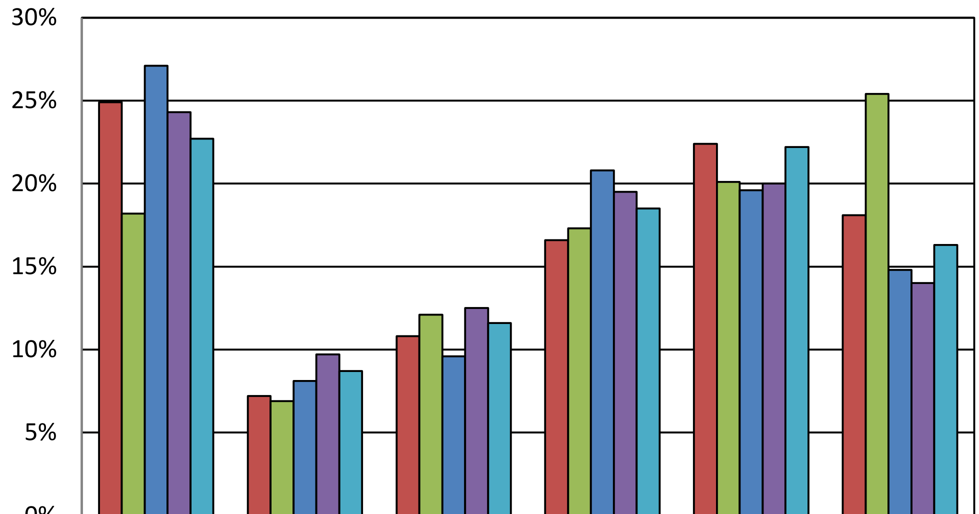
The population of Florence County has grown an average of 9.6% per decade over the last 60 years, which is less than the growth rate for the State of South Carolina (14.0%) and the United States (12.7%). The data for Florence County indicates an average increase in urban population of 18.5% from 1990 to 2010, while the rural population decreased by 1.5% over the same time period. Historically, Lake City has not seen significant growth; therefore, land uses within the Lake Swamp watershed are expected to remain mostly unchanged for the foreseeable future.

2.2.3 Demographics

Florence and Williamsburg Counties are predominantly rural counties. Similarly, the majority of the Lake Swamp watershed is rural. Florence County has a population of approximately 138,000, of which only 52,000 (38%) reside in the City of Florence and other small municipalities. Within the Lake Swamp watershed, the municipalities of Lake City (population 6,720), Scranton (population 772) and Johnsonville (population 1,602), make up 6.6% of Florence County's population. Williamsburg County has a population of 33,560. There are no Williamsburg County municipalities in the Lake Swamp watershed.

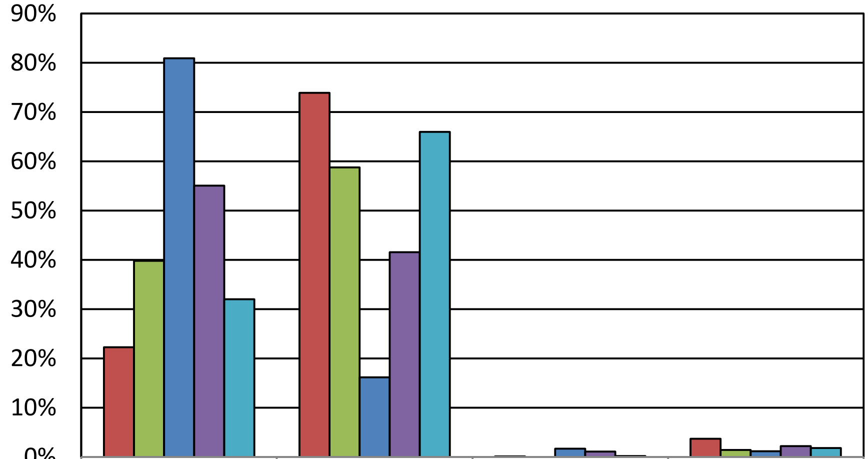
The City and County demographics are shown in Figures 2-6 through 2-8 below. In general, age demographics for these areas are similar. Approximately 60% are between 18 and 64 years old, the typical working age range; although the population of Scranton is skewed toward age 65 and older and the population of Johnsonville consists of a slightly higher percentage of children. The racial demographics and median household income show a greater variance, especially between Lake City (73.9% black, median household income $29,431) and Johnsonville (80.9% white, median household income $37,500). The County data also shows a disparity in income.

Figure 2-6: Chart of Population by Age



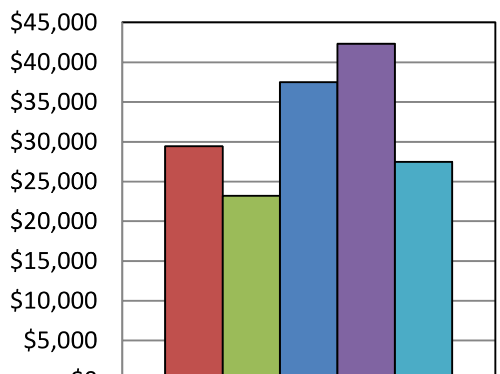
	Under 18	18-24	25-34	35-49	50-64	65 & Older
Lake City	24.9%	7.2%	10.8%	16.6%	22.4%	18.1%
Scranton	18.2%	6.9%	12.1%	17.3%	20.1%	25.4%
Johnsonville	27.1%	8.1%	9.6%	20.8%	19.6%	14.8%
Florence County	24.3%	9.7%	12.5%	19.5%	20.0%	14.0%
Williamsburg County	22.7%	8.7%	11.6%	18.5%	22.2%	16.3%

Figure 2-7: Chart of Population by Race



	White	Black	Asian	Other
Lake City	22.3%	73.9%	0.1%	3.7%
Scranton	39.8%	58.8%	0.0%	1.4%
Johnsonville	80.9%	16.2%	1.7%	1.2%
Florence County	55.1%	41.6%	1.1%	2.2%
Williamsburg County	32.0%	66.0%	0.2%	1.8%

Figure 2-8: Chart of Median Household Income



	Median Income
Lake City	$29,431
Scranton	$23,214
Johnsonville	$37,500
Florence County	$42,321
Williamsburg County	$27,485

2.3 WATER QUALITY

This section focuses on the primary water quality parameters of interest in Lake Swamp Watershed, namely dissolved oxygen and bacteria. Water quality standards are presented for these parameters, as well as for other parameters that are monitored in this watershed.

2.3.1 Water Quality Standards (WQS)

The Lake Swamp watershed is a blackwater system, characterized by naturally low dissolved oxygen concentration and lowered pH. SCDHEC has classified streams within the system that have naturally low DO as FW* (or FW sp, freshwaters with site-specific standards).

Under South Carolina R.61-68, Water Classification and Standards, the designated uses of freshwaters are as follows:

> *Freshwaters (FW) are freshwaters suitable for primary and secondary contact recreation and as a source for drinking water supply, after conventional treatment, in accordance with the requirements of the Department. Suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora. Suitable also for industrial and agricultural uses.*

2.3.1.1 Dissolved Oxygen

Dissolved oxygen (DO) is essential for aquatic life, including fish, invertebrates, plants, and aerobic bacteria. The DO concentration is a key indicator of the health of a stream. The current State standard criteria for DO to protect for aquatic life uses in freshwater is as follows:

> *Daily average not less than 5.0 mg/l with a low of 4.0 mg/l.*
> *(SC R.61-68, Water Classification and Standards)*

However, in South Carolina, waters that do not meet numeric criteria for DO due to natural conditions are covered by anti-degradation requirements provided in S.C. R.61-68, Section D.4. Due to the naturally low DO conditions in Lake Swamp, SCDHEC has established the following site-specific standards:

> *D.O. not less than 4 mg/L*
> *(SC R. 61-69, Classified Waters)*

For purposes of the Lake Swamp Watershed Plan, Camp Branch and Singleton Swamp are assumed to be part of the Lake Swamp blackwater system and therefore subject to the same site-specific DO standards.

2.3.1.2 Bacteria

Bacteria are commonly monitored in freshwaters as an indicator of potential health risks for individuals exposed to recreational waters. Indicator bacteria are generally not harmful, but indicate the presence of a health risk. Fecal coliform (FC) bacteria are commonly monitored in freshwaters as an indicator of potential health risks for individuals exposed to recreational waters. Until recently, SCDHEC considered a monitoring station impaired if greater than 10 percent of samples collected and analyzed for fecal coliform bacteria exceeded 400 cfu/100mL. During 2012, SCDHEC adopted a change of its pathogen indicator bacteria from FC to *Escherichia coli* (*E. coli,* or EC). Since June 2012, *E. coli* has been the indicator bacteria for freshwater recreational standards in the State of South Carolina. *E. coli* bacteria are members of the fecal coliform group of bacteria that normally live in the intestines of warm-blooded animals, including humans. Most strains of *E. coli* are harmless, and are an important part of a healthy intestinal tract. However, *E. coli* in surface waters are indicators of recent human or animal waste contamination and the quantity of disease-causing organisms potentially present.

The current State standard criteria for *E. coli* to protect for primary contact recreation use in freshwater is as follows:

> *Not to exceed a geometric mean of 126 MPN/100mL based on at least four samples collected from a given sampling site over a 30-day period, nor shall a single sample maximum exceed 349 MPN/100mL.*
> *(SC R.61-68, Water Classification and Standards)*

Prior to February 28, 2013, the State standard criteria for fecal coliform for recreational use in freshwaters in South Carolina, was:

> *Not to exceed a geometric mean of 200/100mL, based on five consecutive samples during any 30 day period; nor shall more than 10% of the total samples during any 30 day period exceed 400/100mL.*
> *(SC R.61-68, Water Classification and Standards)*

The assessment of enterococci and *E. coli* for purposes of Section 303(d) listing determinations for recreational uses shall be based on the geometric mean with an allowable 10% exceedance, where sufficient data exists to calculate a geometric mean (at least 4 samples). In the absence of sufficient data to calculate a geometric mean, the assessment shall be based on the single sample maximum with an allowable 10% exceedance.

In the absence of sufficient sampling data for *E. coli* under the new standard, SCDHEC's policy is to include all stations impaired for fecal coliform on current South Carolina §303(d) lists for *E. coli* exceedances. The §303(d) list is comprised of waters of the State that do not meet water quality standards, and for which a Total Maximum Daily Load (TMDL) must be developed for the pollutant of concern. Until sufficient data are collected, SCDHEC will calculate TMDLs for currently FC-impaired stations and then convert FC TMDLs to *E. coli* TMDLs using the conversion factor 0.8725. This ratio was derived by dividing the current single sample WQS for *E. coli*, 349 MPN/100mL by the former single sample maximum WQS for FC, 400 cfu/100mL.

2.3.1.3 Other Relevant WQS

SCDHEC monitors for a variety of water quality parameters at its monitoring stations across the state. Other parameters monitored at Lake Swamp Watershed are listed in Table 2-7. These parameters can be grouped as: dissolved oxygen and biochemical oxygen demand; physical parameters (temperature, pH, alkalinity, turbidity); bacteria (FC and *E. coli*); nutrients (ammonia, nitrite-nitrate, total kjeldahl nitrogen and total phosphorus); and metals (cadmium, chromium, copper, iron, manganese, mercury, nickel and zinc).

Table 2-7: Water Quality Parameters Monitored at Lake Swamp

Dissolved Oxygen (DO)	Nitrite -Nitrate (NO_2-NO_3)
Biochemical Oxygen Demand, 5-day (BOD)	Total Kjeldahl Nitrogen (TKN)
	Total Phosphorus (TP)
Air Temperature	Cadmium (Cd)
Water Temperature	Chromium (Cr)
pH	Copper (Cu)
Alkalinity	Iron (Fe)
Turbidity	Manganese (Mn)
Fecal Coliform (FC)	Mercury (Hg)
E. coli (EC)	Nickel (Ni)
Ammonia (NH_3)	Zinc (Zn)

Water Quality Standards for these additional parameters are also specified in SC R.61-68, Water Classification and Standards. Not all parameters have a numeric standard; some parameters have a narrative standard. WQS for pH, turbidity and nutrients are described below.

The current State standard criteria for pH in a blackwater swamp is as follows:

pH range 5.0 to 8.5

The current State standard criteria for Turbidity in freshwaters is as follows:

Turbidity not to exceed 50 NTUs, provided existing uses are maintained

The current State standard criteria for Nutrients is as follows:

Discharges of nutrients from all sources, including point and nonpoint, to waters of the State shall be prohibited or limited if the discharge would result in or if the waters experience growths of microscopic or macroscopic vegetation such that the water quality standards would be violated or the existing or classified uses of the waters would be impaired. Loading of nutrients shall be addressed on an individual basis as necessary to ensure compliance with the narrative and numeric criteria.

WQS for metals are specified in SC R. 61-68 and are presented in Table 2-8. Metals WQS are divided into criteria for aquatic life, human health (consumption) and organoleptic (taste and odor). Aquatic life criteria are further divided into Criterion maximum concentration (CMC) and Criterion continuous concentration (CCC). These define the highest instream concentration of a toxicant or an effluent to which organisms can be exposed. CMC allows a maximum acute exposure of 48 to 96 hours, while CCC allows a longer-term exposure (average over 28 days).

Table 2-8: Water Quality Standards for Metals

	FW Aquatic Life Criteria		Human Health Criteria			Organoleptic Criteria
	CMC	CCC	Consumption			Taste and Odor
	(~max) (ug/L)	(~avg) (ug/L)	Water+ Organism (ug/L)	Organism only (ug/L)	MCL only (ug/L)	(ug/L)
Cadmium	0.53	0.1	--	--	5	--
Chromium III	580	28	--	--	100	--
Chromium VI	16	11	--	--	100	--
Copper	3.8	2.9	1300	none	none	1000
Mercury	1.6	0.91	0.050	0.051	2	--
Nickel	150	16	610	4600	none	--
Zinc	37	37	7400	26,000	none	5000
Iron	*not listed in numeric criteria*					
Manganese	*not listed in numeric criteria*					

Lake Swamp monitoring data was compared to these WQS in order to evaluate current water quality conditions in the watershed. This analysis is presented in Chapter 3.

2.3.2 Water Quality Monitoring Stations

The Lake Swamp Watershed has been monitored by SCDHEC at six (6) Water Quality Monitoring (WQM) Stations, and these stations and their respective subwatersheds and location description are given in Table 2-9. As discussed in Section 2.3.1.1, all of these stations are assumed to be located within the Lake Swamp blackwater system, characterized by naturally low pH and dissolved oxygen concentration conditions. Currently, only WQM Station PD-087 is actively monitored by SCDHEC. WQM Stations PD-085, PD-086A, PD-314 and PD-346 were last monitored in 2009. WQM Station RS-10397 was monitored during 2010 only. A more detailed description of each monitoring station is provided after Table 2-9, including a statement as to the impairment at each location. Further information regarding impaired waters can be found in Section 2.3.3.

Table 2-9: Water Quality Monitoring Stations

Station	Subwatershed	Location
PD-085	Upper Lake Swamp	Lake Swamp at US 378
PD-086A	Upper Lake Swamp	Lake Swamp on SC 341
PD-087	Lower Lake Swamp	Lake Swamp at SC 341 2.6 Mi. W. of Johnsonville
PD-314	Singleton Swamp	Singleton Swamp at S-21-67
PD-346	Camp Branch	Camp Branch at S-21-278
RS-10397	Singleton Swamp	Long Branch at culvert at Moulds Rd. (at the end of pavement coming from Beulah Rd.)

2.3.2.1 WQM Station PD-346 Camp Branch at S-21-278 (North Matthews Road)

Station PD-346, located on Camp Branch at North Matthews Rd. in Lake City, monitors the Camp Branch subwatershed, covering a 31 sq mi drainage area that flows into Upper Lake Swamp. Land use for this subwatershed is primarily forest (49%) and agriculture (38%); however, approximately 8% is residential and 2% is commercial. The monitoring data for Station PD-346 indicates impairment for DO (aquatic life use) and bacteria (recreational use).

2.3.2.2 WQM Stations PD-085 Lake Swamp at US 378 (North Church Street) and PD-086A Lake Swamp on SC 341

Together, Stations PD-085 and PD-086A (RS-02318) monitor portions of the Upper Lake Swamp subwatershed, a 41 sq mi drainage area that flows into Lower Lake Swamp. PD-085 is located in Lake Swamp at North Church St. in Lake City, approximately 1 mile downstream of PD-346. PD-086A is located downstream of Lake City at Lake Swamp on SC 341, approximately 1 mile northeast of Jones Road. Portions of the City of Lake City and Town of Scranton lie within the subwatershed; however, the land use over this area is primarily forest (56%) and agriculture (29%); with, approximately 9% residential and 3% commercial. Monitoring data for Stations PD-085 and PD-086A indicates impairment for DO (aquatic life use).

2.3.2.3 WQM Stations PD-314 Singleton Swamp at S-21-67 and RS-10397 (Long Branch at Moulds Road)

Stations PD-314 and RS-10397 monitor portions of the Singleton Swamp subwatershed, a 56-sq. mile watershed that drains to Lake Swamp. PD-314 is located in Singleton Swamp at S-21-67, near the discharge to Lake Swamp. RS-10397 is located on Long Branch at a culvert at Moulds Road, at the end of the pavement, approximately 0.3 miles northeast of Beulah Rd. This subwatershed accepts drainage from the south side of Lake City; however, the land use for Singleton Swamp is primarily forest (67%) and agriculture (24%), with 4% residential and 2% commercial. Monitoring data for these stations indicates impairment for DO (aquatic life use) at Station PD-314, and bacteria (recreational use) at Station RS-10397.

2.3.2.4 PD-087 Lake Swamp at SC 341

Station PD-087), which monitors the majority of the Lower Lake Swamp subwatershed, is located in Lake Swamp at SC 341, approximately 2.6 miles west of Johnsonville. This 37-sq. mile subwatershed is the lowest point of the Lake Swamp Watershed. Camp Branch, Singleton Swamp and Upper Lake Swamp ultimately flow into the Lower Lake Swamp subwatershed, which discharges to the Lynches River near Johnsonville. Land use for this subwatershed is forest (62%), agriculture (27%), residential (8%) and commercial (1%). Monitoring data for Station PD-087 indicates impairment for DO (aquatic life use).

2.3.3 South Carolina §303(d) List of Impaired Waters

Every two years, SCDHEC develops a list of impaired waters as mandated by the EPA under Section 303(d) of the Clean Water Act. The purpose of the list is to identify waterbodies that do not meet the state's WQS so that corrective actions can be implemented to improve water quality. All six of the Water Quality Monitoring Stations in Lake Swamp are on the 2014 South Carolina 303(d) list, as shown in Table 2-10.

Once a site is included on the 303(d) list, SCDHEC must develop a TMDL within two to thirteen years of the initial listing. TMDLs for specific pollutants are developed by calculating the maximum amount of the pollutant a waterbody can assimilate and still meet water quality standards. Currently, there are no TMDLs established for the Lake Swamp Watershed; however, target dates for TMDL development have been published on the 2014 SC list of Impaired Waters and are included in the table.

Table 2-10: Lake Swamp Impairment Listings

Station	Subwatershed	Impairment	TMDL Target Date
PD-085	Upper Lake Swamp	DO	2019
PD-086A	Upper Lake Swamp	DO	2019
PD-087	Lower Lake Swamp	DO	2019
PD-314	Singleton Swamp	DO	2016
PD-346	Camp Branch	DO, *E. coli*	2016, 2017
RS-10397	Singleton Swamp	*E. coli*	2016

A primary goal of the Lake Swamp Watershed Plan is to evaluate current water quality conditions and to lay the groundwork for management of the watershed so as to avoid the need for TMDLs. In the event that TMDLs for DO or *E. coli* are necessary, the information in this plan may be useful in the development of these TMDLs.

2.3.4 Literature Review of Existing Coliform Bacteria Studies

A literature review was conducted in order to locate similar watersheds which could serve as a comparison to Lake Swamp Watershed. The literature reviewed is presented in Table 2-11. While there are numerous studies of coliform bacteria concentrations in surface waters, minimal information is available that is appropriate for use in evaluating bacterial loading to the Lake Swamp watershed. The issues are twofold: (i) the bacterial units are not compatible with the SCDHEC-collected data, and (ii) the study locations and land uses are dissimilar from the 105,000-acre, mostly rural, blackwater Lake Swamp watershed. Some of the studies present bacteria export rates, while some present bacteria concentrations, either in stormwater discharge, or in-stream (wet weather or dry weather). Data collected by SCDHEC at Lake Swamp Watershed consists of in-stream bacteria concentrations, therefore the export rates and stormwater discharge concentrations are not directly comparable to Lake Swamp bacteria data.

Table 2-11: Literature Review of Coliform Bacteria in Surface Waters

Study Name, Authors, Date	Location	Watershed Size (acres)	Description/Land Use	Bacterial Units Reported
***Escherichia coli* and fecal coliform export rates in two agricultural watersheds of the U.S. Midwest** Vidon and Campbell, 2009	U.S. Midwest, near Indianapolis, IN	3,284	Watershed FB8: 82.2% Agriculture 4.3% Urban 5.9% Forest 8.4% Herbaceous	FC MPN/km^2/yr EC MPN/km^2/yr
		3,378	Watershed SB4: 87.0% Agriculture 3.4% Urban 3.2% Forest 6.2% Herbaceous	
Faecal indicator organism concentrations and catchment export coefficients in the UK Kay, et al., 2008	15 catchments, England, Scotland, Wales	Majority: 1,236 - 24,710	Degree of Urbanization (Urban, Semi-Urban, Rural Overall) Rural (≥75% Improved Pasture, ≥75% Rough Grazing, ≥75% Woodland)	FC cfu km^{-2}h^{-1}
Fecal coliform export from four coastal North Carolina areas Line, et al., 2008	Eastern North Carolina	161 351 79 2,792	Primarily industrial Primarily residential Primarily residential Low-lying coastal forest	FC million MPN/ha-year
Cumulative Impacts of Landuse on Water Quality in a Southern Appalachian Watershed Bolstad and Swank, 1997	Western North Carolina	3,966 – 11,010	Mostly Forest; also includes Agricultural, Developed (residential and recreational)	FC cfu/100 mL

Study Name, Authors, Date	Location	Watershed Size (acres)	Description/Land Use	Bacterial Units Reported
Evaluation of Indicator Bacteria Export from an Urban Watershed Hathaway and Hunt, 2010	Raleigh, NC	12.5	Medium density residential neighborhood	EC MPN/100 mL FC MPN/100 mL
Fecal Coliform Source Assessment in a Small, Mixed Land Use Watershed Tufford and Marshall, 2002	Rawls Creek, near Columbia, SC	6,632	43.8% Residential 35% Forest 5.7% Mixed Urban 4.9% Commercial 4.8% Agriculture	FC cfu/100 mL
Changes in a Stream's Physical and Biological Conditions Following Livestock Exclusion Line, 2003	Long Creek watershed, southwestern North Carolina Piedmont	140	Primarily dairy cow pasture	FC cfu/100 mL
Land cover impacts on stream nutrients and fecal coliform in the lower Piedmont of West Georgia Schoonover and Lockaby, 2006	3 counties in west-central Georgia	Not stated	Dominant land cover categories: Unmanaged forests Managed forests Pasture Developing Urban	FC MPN 100 ml^{-1}
Loading at or Near Base Flow in a Mixed-Use Watershed Gentry, et al., 2006	Stock Creek Watershed south of Knoxville, TN	12,180	Mixed land use	EC cfu/d

Only two of the above-referenced studies, Vidon and Campbell, 2009, and Kay, et al., 2008, provided results in units comparable to data collected in the Lake Swamp watershed (FC cfu or *E. coli* MPN) and with similar land uses. Other studies provided useful references, but the numbers were not directly comparable. In addition to the academic literature reviewed, a number of SC TMDL documents and watershed plans were also reviewed in order to compare and evaluate Lake Swamp Watershed. The results of this comparative analysis are presented in Section 3. All sources cited in Table 2-11 and throughout the report, as well as additional sources used in development of this watershed assessment and plan, are listed in Section 6, References.

2.4 POLLUTANT SOURCES AND WATERSHED CONDITIONS

Pollutants can enter waterbodies from various point and nonpoint sources. Point source pollution arises from discrete locations, such as a pipe, outfall or ditch. Municipal and industrial wastewater discharges, urban stormwater systems and large livestock feedlots are examples of pollutant point sources. Nonpoint source pollution comes from many diffuse sources, and generally results from stormwater runoff. Common nonpoint sources include agricultural sources (livestock and crops), urban stormwater runoff, and malfunctioning septic systems. The primary water quality concerns in the Lake Swamp watershed are Dissolved Oxygen and Coliform Bacteria.

2.4.1 Dissolved Oxygen

Dissolved oxygen (DO) in surface waters is essential for the survival of aquatic life and is typically measured to assess the health of lakes and streams. Much of the DO in water comes from the atmosphere, dissolving at the water surface and mixing into the water by currents and turbulence, or entering a stream through groundwater recharge. DO is also delivered through photosynthesis by algae and aquatic plants. If the amount of oxygen dissolved in water falls below the minimum requirements for survival, aquatic organisms may die. The main factor contributing to declines in the DO level is the buildup of organic wastes, which consume oxygen when they decay.

The amount of oxygen that can dissolve in water is limited by physical conditions such as temperature, atmospheric pressure, low flow and excess nutrients and organic materials. The amount of available DO is dependent upon temperature, in an inverse relationship: DO decreases when temperatures increase, and DO increases when temperatures decrease. Low flow conditions limit the oxygen supply within the stream by limiting the reaeration rate. When excess nutrients and organic materials settle to the sediments, the increased oxygen demand from microbial degradation contributes to a reduction in DO.

Under South Carolina Regulation 61-68, Water Classifications & Standards, SCDHEC accepts that "Certain natural conditions may cause a depression of dissolved oxygen in surface waters while existing and classified uses are still maintained." SCDHEC allows a dissolved oxygen depression in these naturally low dissolved oxygen waterbodies.

The Lake Swamp watershed is largely a blackwater system, which is naturally low in DO. During the summer months, high temperatures and low stream flows contribute to a seasonal reduction in DO.

Sources of pollutants that contribute to DO depression include municipal wastewater treatment plants, industrial point sources, agricultural and urban overland stormwater runoff and failing septic systems.

2.4.2 Coliform Bacteria

Fecal coliform bacteria and *E. coli*, both coliform bacteria, live in the intestines of warm-blooded animals. Although generally not harmful, these coliform bacteria may indicate the presence of disease-carrying organisms, which live in the same environment as the coliform bacteria. Water samples with high concentrations of fecal coliform or *E. coli* bacteria are indicators of recent human or animal waste contamination. Studies of coliform bacteria are inconsistent, showing a wide variation in concentrations based on seasonal variability, hydrologic variability, land use and other factors. Some studies indicate that concentrations tend to increase in the summer and during stormwater events.

2.4.3 Point Sources

Typically, the two types of point sources that discharge pollutants into streams are continuous point sources (e.g., wastewater treatment plants) and urban stormwater systems.

There are no continuous point sources discharging to the Lake Swamp Watershed; however, there are two active permitted landfill facilities, one closed landfill, and three minor industrial dischargers in the Lake Swamp Watershed, as shown in Tables 2-12 and 2-13.

Table 2-12 : List of Permitted Landfill Facilities

Subwatershed	Landfill Facilities
Upper Lake Swamp	City of Lake City Landfill, 1228 East Main Street (Active)
Upper Lake Swamp	City of Lake City Municipal Dump (Closed)
Singleton Swamp	City of Lake City Construction & Demolition Waste Landfill, Twin Ponds Rd. (Active)

Table 2-13: List of Minor Industrial NPDES Permits

Subwatershed	NPDES Facilities – Minor Industrial Permits
Singleton Swamp (Long Branch)	Nan Ya Plastics Corp. America
Upper Lake Swamp (Twomile Branch)	L&B Developers/Woodberry Lake Mine
Upper Lake Swamp (Twomile Branch)	DDC LLC/Oshay Pit Mine

2.4.3.1 Urban Runoff

In addition, portions of the Lake Swamp watershed are within the urbanized areas of the City of Lake City, Town of Scranton and City of Johnsonville. Urban stormwater runoff can contain high coliform bacteria concentrations due to leaking sewers, sanitary sewer overflows (SSOs) and pet waste. Depressed DO from urban areas is typically related to higher temperature runoff from paved surfaces. Urban runoff may also contribute nutrients which further deplete oxygen from an already stressed system.

2.4.4 Non-Point Sources

Potential nonpoint-sources contributing to decreased in-stream DO include decomposing leaf litter, grass clippings, sewage and runoff from feedlots. Logging removes riparian cover which can contribute to increased runoff and siltation. Poor farming practices can discharge excess nutrients to waterways, leading to algae growth.

Potential nonpoint sources of coliform bacteria within the Lake Swamp watershed include wildlife, agricultural activities and livestock, urban runoff, failing septic systems, and pet waste. Very few livestock operations are believed to exist in the watershed. However, in urban areas, domestic pets are likely one of the primary sources of coliform bacteria.

Human sources also likely play a major role in coliform bacteria loadings and decreased DO in the Lake Swamp watershed. Aging sanitary sewer infrastructure and potential illicit connections from the sanitary sewer system to the stormwater system are common culprits for bacteria contamination. Infiltration and inflow occurs when groundwater seeps into sewer pipes through cracks, leaky pipe joints and/or deteriorated manholes. The sanitary sewer system in Lake City is currently susceptible to a high rate of infiltration and inflow during wet weather events, which increases the potential for overloading the system and causing sewer backups and overflows.

Outside of the City's sanitary sewer service area, in the rural areas of Florence County and Williamsburg County, failing septic systems are a potentially significant source of coliform bacteria. Septic systems are designed to have a lifetime of 20 to 30 years if properly maintained. Failure can occur when soils are saturated by stormwater, pipes become blocked by roots, and soil around the absorption field becomes clogged with organic material. Coliform bacteria from sanitary sewer overflows and failing septic systems can enter streams in stormwater runoff or through groundwater springs and seeps.

2.4.5 Field Survey

A field survey of the Lake Swamp watershed was conducted by AECOM in May 2016 to identify and map key pollutant sources and areas. In preparation for the survey, AECOM engineers reviewed public records for industrial discharge permits and landfills, and identified commercial, industrial and agricultural facilities to include in the survey, along with City properties for location of potential future BMPs. Two field teams used a standard protocol checklist based on SCDHEC and EPA guidance, in order to ensure consistent data collection. Photos were taken and observations were recorded.

General observations from the field survey of the 164-square mile watershed revealed minor issues in some areas of the watershed, are summarized below:

- Rip-rap and bricks placed around culverts and ditches for erosion control
- Drainage channels clogged with vegetation
- Drainage ditches with discolored soil and water
- Drainage ditches with vegetation burned by pesticides
- Eroding ditches
- Trash at outfalls and in ditches
- Presence of livestock (horses, cows and goats)
- Commercial kennel and stables

- Fuel pumps in close proximity to a stormwater ditch
- Agricultural field drainage routed directly to waterway
- Agricultural fields with no streambank buffer
- Construction debris
- Trash/junk in yards
- Open dumpster
- Muddy or stagnant water in ditch
- Timber harvesting and burning

Based on the field survey, there was no evidence of a major pollutant point source in the watershed. Field observations were as expected and are considered typical for a rural watershed in this region. Results from this field assessment formed much of the basis for the recommendations contained with the watershed management plan, which is presented in Sections 4 and 5. Improvements in land management, trash and litter control, public education and outreach, and agricultural/timber practices can help improve some of the areas observed during the field survey.

SECTION 3

WATERSHED ANALYSIS

This section describes the components of the watershed analysis for Lake Swamp, and the major findings.

3.1 SUMMARY OF AVAILABLE DATA

3.1.1 Water Quality Data

Historical water quality data for the Lake Swamp Watershed was obtained from EPA's STORET database for monitoring years 1999-2008. More recent water quality data was obtained directly from SCDHEC for monitoring years 2009-2014. 2015 data was excluded from this report because only a partial year of data had been vetted and made available at the time of plan development. Depending upon the timeframe, data is available for up to (6) monitoring stations within the watershed. This includes: PD-085, PD-086A, PD-087, PD-314, PD-346 and RS-10397. Of these, PD-085 has a limited number of samples, with two single year sampling periods separated by an 8 year window. Additionally, RS-10397 was a temporary station and was only monitored for a single year. A substantial amount of data is available for the other (4) stations, with nearly continuous operation conducted at PD-087, the station located at the watershed outlet. Table 3-1 shows the Lake Swamp monitoring stations and the various timeframes each has been monitored since 1999.

As shown in Table 3-1, Lake Swamp water quality monitoring data generally falls into three timeframes: historical data collected from 1999-2008, a transition period from 2009-2010, and more recent data collected only at PD-087, from 2009-2014. As a result of budget cuts, SCDHEC discontinued data collection at all of the monitoring stations in Lake Swamp Watershed except the watershed outlet (PD-087) during the 2009-2010 transition period. In 2009, the main (4) stations were operational. Also during this year, SCDHEC collected two sets of bacteria data at PD-346, as part of the SC Pathogen Indicator Study (PIS). This additional data was used with other bacteria data collected across the state, in order to evaluate and establish a new *E. coli* WQS to replace the Fecal Coliform WQS (SCDHEC, 2016). In 2010, only PD-087 and the temporary station (RS-10397) were operational. From 2011 to present, only PD-087 has remained operational with sampling occurring approximately bi-monthly.

Table 3-1: Lake Swamp Monitoring Stations and Monitoring Timeframes

Station	Sampling Dates
PD-085	August 1999 - October 2000 + 2008 (7 months)
PD-086A	August 1999 - July 2007 + 2009 (7 months)
PD-087	August 1999 - August 2007 *no sampling in 2003 or 2008* January 2009 - November 2014
PD-314	January 2001 - July 2007 + 2009 (7 months)
PD-346	January 2001 - July 2007 + 2009 (all 12 months)
RS-10397	2010 only (7 months)

A number of water quality parameters have been monitored in Lake Swamp Watershed, and this list of parameters has remained fairly consistent throughout the years. The primary monitored parameters of interest include: Dissolved Oxygen; Biochemical Oxygen Demand; Fecal Coliform and *E. coli* bacteria; physical parameters (Temperature, pH, Alkalinity, Turbidity); nutrients (Ammonia, Nitrate-Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus); and heavy metals (Cadmium, Chromium, Copper, Iron, Manganese, Mercury, Nickel, Zinc). These parameters are listed in Table 2-7.

All water quality samples were collected by SCDHEC staff as grab samples, from a depth of 0.3 ft. Samples were not composited or flow weighted. Dissolved Oxygen, Temperature and pH readings were collected in the field; the remaining parameters were analyzed in the laboratory.

3.1.2 Hydrology Data

Hydrology data is not available for Lake Swamp Watershed. There are no USGS gaging stations in this watershed to monitor stream flow in the main stem of Lake Swamp, or its tributaries. Neither end-of-pipe discharge nor in-stream flow data have been collected in Lake Swamp Watershed. Rainfall data is available from NOAA and is presented in Table 2-2.

3.2 WATER QUALITY DATA ANALYSIS

3.2.1 Data Processing

For the historical data period (1999-2008) and transition years (2009, 2010), this report focuses on the primary parameters of concern, namely dissolved oxygen and bacteria, with supporting pH, temperature and BOD data. For the recent monitoring period, 2009-2014, all monitored parameters were analyzed and are presented in this report, in order to give a snapshot of current water quality conditions in Lake Swamp Watershed. All source data was pre-processed for quality control purposes, with erroneous or duplicate data corrected or deleted.

Some laboratory results were reported as less than the Practical Quantitation Limit (PQL). SCDHEC defines PQL as the concentration at which the entire analytical system must give a recognizable signal and acceptable calibration point. It is the concentration in a sample that is equivalent to concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method-specific sample weights, volumes, and processing steps have been followed. For data points less than PQL, the PQL was used as the value for graphing data and performing calculations. Use of the PQL is a conservative approach which may produce higher than actual averages but which assures all samples are accounted for. Use of the PQL was rarely necessary with the fecal coliform data, occasionally necessary with the nutrients data, and frequently necessary with the BOD and metals data.

3.2.2 Bacteria Standard and Data Conversion

In addition to the three monitoring timeframes, an additional complication was brought about by the state of South Carolina's change of pathogen indicator from Fecal Coliform to *E. coli*. Historical monitoring data was collected and analyzed as Fecal Coliform (col/100mL). Once the new *E. coli* WQS was adopted in 2013, all bacteria samples were collected and analyzed directly for *E. coli* (MPN/100mL). This change necessitated all Fecal Coliform results collected prior to 2013 to be converted to *E. coli* for this report. The PIS established a conversion factor of 0.8725 to be used in converting Fecal Coliform to *E. coli* (SCDHEC, 2016). This factor represents the ratio of 349/400, with 349 the WQS for *E. coli* and 400 formerly the WQS for Fecal Coliform.

$$Fecal\ Coliform\ \left(\frac{\#\ col}{100mL}\right)\ x\ 0.8725 = E.Coli\ \left(\frac{\#\ MPN}{100mL}\right)$$

All Fecal Coliform concentration values in the Lake Swamp data were converted to *E. coli* concentrations before performing calculations or preparing graphs. Combining the various timeframes and the converted data produced a number of smaller subsets which were then combined. Both Fecal Coliform and *E. coli* values are presented in this report, with all final results presented as *E. coli*. ("Calc" identifies *E. coli* results which were calculated using the above equation; "Lab" identifies the original sample value, whether analyzed as Fecal Coliform or as *E. coli*.) Water bodies on the SC 303(d) list which were previously listed for Fecal Coliform have been revised to *E. coli* listings, as shown on Table 2-10. Any future bacteria TMDLs in SC will be issued as *E. coli* limits rather than Fecal Coliform limits.

3.2.3 Presentation of Results

Water Quality results are presented in three sections: Dissolved Oxygen (including BOD, pH and Temperature), Bacteria (Fecal Coliform and *E. coli*), and Other Parameters. For DO and Bacteria, these sections are further divided into the three timeframes previously described: historical data (1999-2008), transition years (2009, 2010) and recent data (2009-2014). Other Parameters (physical parameters, nutrients and heavy metals) are only presented for recent data. Within each section, average values were calculated for each parameter. Geomean was calculated for bacteria data, which gives a more representative value for the central tendency of highly variable bacteria data than can be obtained via a traditional Average calculation. Data is presented as a series of graphs and summary tables.

Each individual sample value, as well as the average value for each parameter during each timeframe, was compared to the SC WQS in order to determine the number of times the standard was violated out of the group of samples. This is reported as the "percent exceedance". This terminology can be confusing, since "exceeding the standard" in common terminology often indicates a positive outcome, but in water quality terminology, exceeding the standard equates to violating a state WQS. For all parameters monitored at Lake Swamp, a WQS was violated, or exceeded, when the sample result was lower than the minimum allowable concentration, or higher than the maximum allowable concentration, as specified in the state regulations. For pH, sample results should be within a range (5.0 to 8.5) in order to meet the SC WQS. If a pH sample was less than the minimum of 5.0, or greater than the maximum of 8.5, it violated the standard. For DO, the WQS specifies a minimum concentration of 4 mg/L. Any time a sample was less than this minimum value, the WQS was violated. In short, "exceeding the standard" may refer to a sample concentration which is too high, or too low, compared to the WQS. These percent exceedance values were also compared to the SC 303(d) impairment list, in order to validate the impairment listings.

Pollutant load calculations are not presented for Lake Swamp Watershed. With no available hydrology data (other than rainfall), it is not possible to accurately quantify streamflow or stormflow. In the event that SCDHEC initiates a TMDL process for Lake Swamp Watershed, additional data collection and modeling will be needed in order to accurately determine pollutant loads in the watershed. As such, the water quality analysis in this report focuses on existing in-stream concentrations of monitored pollutants, and evaluates land uses, potential pollutant sources, impairments and trends in the water quality data.

In order to evaluate the information presented in the following sections, please refer to Table 2-9, Water Quality Monitoring Stations, Figure 2-1, Map of Lake Swamp and Subwatersheds, and the watershed and subwatershed maps found in the Appendices.

3.3 DISSOLVED OXYGEN, BIOCHEMICAL OXYGEN DEMAND, TEMPERATURE AND PH

Dissolved oxygen results are presented in a series of graphs and tables, below. These graphs and tables follow the three timeframes previously discussed. Figures 3-1 through 3-3 focus solely on DO, while Figures 3-4 through 3-6 add in the parameters of pH and temperature to depict their relationship to DO. Tables 3-2 through 3-5 present DO results. Tables 3-6 through 3-9 present results for BOD, temperature and pH, respectively.

3.3.1 Results for Dissolved Oxygen

During all of the monitoring periods and at all of the stations in Lake Swamp Watershed, Figures 3-1, 3-2 and 3-3 clearly demonstrate a seasonal trend of dissolved oxygen concentrations, with DO levels increasing in cooler months and decreasing in warm and hot months. This seasonal fluctuation is expected in a blackwater system such as Lake Swamp and its tributaries. In most years, the DO levels began decreasing in April, reached their lowest concentrations in late summer/early fall, and then began to rebound in October. At some stations in some years, the DO concentration recovered and then fell again during the hot months, but for the most part, once the DO levels were depleted, the concentrations remained low until the weather cooled off, allowing the DO to be replenished in the water. Figure 3-3 in particular is a very clear presentation of the recurring cycle of seasons and dissolved oxygen, and this graph represents the most recent DO monitoring data for the watershed (PD-087, 2009-2014). This graph also clearly shows that this natural process results in DO concentrations falling below 4 mg/L during the hot months, and therefore violating the state's WQS.

3.3.2 Water Quality Standard for Dissolved Oxygen

The WQS for DO in a blackwater system was established at 4 mg/L. This standard was violated about 50% of the time, with DO concentrations falling below 4 mg/L during late spring, summer and fall. During the historical monitoring period (1999-2008), stations PD-087, PD-314 and PD-346 hovered at approximately 50% exceedance, which aligns with seasonally lower DO approximately 6 months out of the year. During the 2009 monitoring year, these three stations demonstrated slightly higher DO concentrations, with percent exceedance of 33%, 43% and 44%, out of 9, 7 and 9 samples taken, respectively. This outcome may have resulted from the particular months which were sampled in 2009.

Both stations PD-085 and PD-086A demonstrated the expected seasonal trend, but with exceedance percentages greater than 50%. Station PD-085 had the highest percent exceedance of any station in Lake Swamp (69%), however with a limited sample size of 16 samples, and the sampling periods separated by eight years (1999-2000, 2008), it is difficult to determine whether this percent exceedance is representative of actual conditions without additional sampling. Station PD-086A recorded 59% exceedance during the historical monitoring period (1999-2008) and 57% exceedance during 2009. Additionally, PD-086A recorded an overall average DO of 3.77 mg/L for the life of that station (Table 3-4), and this was the only station where the overall average DO was less than the SC WQS of 4 mg/L.

During transition year 2010, only PD-087 and temporary station RS-10397 were operational. Both stations demonstrated seasonal fluctuation of DO. As shown in Figure 3-2, DO concentrations at PD-087 fell below 4 mg/L during the summer samples and maintained 50% exceedance for the year (two out of four samples in 2010), while DO concentrations at RS-10397 remained slightly above 4 mg/L during the summer months and therefore recorded 0% exceedance for 2010. This was the only station in Lake Swamp Watershed with DO levels fully meeting the SC WQS, however this result was produced from only 7 samples.

3.3.3 Relationship of DO, Temperature, pH and BOD

Figures 3-4, 3-5 and 3-6 present Lake Swamp DO data for the three monitoring timeframes, and with the added components of temperature and pH. These graphs further demonstrate the seasonal fluctuation of DO, with temperatures peaking in the summer almost perfectly correlated with DO levels falling during the hot months. Figure 3-6 in particular is a very clear presentation of the inverse relationship between temperature and DO. Temperature results are presented in Tables 3-6 and 3-9. During the more recent monitoring period (2009-2014), both air and water temperature are presented, and the two temperature datasets are well correlated, with air temperature consistently a few degrees higher than water temperature, throughout the year. Air temperature readings taken in the field during the sampling events were on average higher than the temperature values reported by NOAA. This is assumed to be due to location, time of day, or possibly an instrument calibration or data processing issue.

Values of pH are typically lower in blackwater systems than in other freshwater bodies. Figures 3-4, 3-5 and 3-6 show the pH readings were very consistent across all monitoring stations and time periods at Lake Swamp. Tables 3-7 and 3-9 present Lake Swamp pH results. Average pH hovered right around 6.0 at all stations. Values for pH remained consistently within the state's WQS range (5.5 to 8.0) for all but a few samples, with the highest percent exceedance 5.7% at PD-087 during the recent monitoring period (2009-2014).

BOD is presented in Tables 3-8 and 3-9. Average BOD concentrations at all stations hovered just above the PQL (2.0 mg/L) and less than 3.0 throughout the monitoring periods. It is likely that these concentrations are over-estimated due to the use of PQL to calculate the average. Certainly there are plenty of sources of decaying organic matter in any swamp which exert oxygen demand, and in the data, samples with moderate oxygen demand did correlate to samples with lower DO, however there was not a distinctive inverse relationship observed between BOD and DO in this watershed.

3.3.4 Evaluation of Results for Dissolved Oxygen

Lake Swamp Watershed appears to be a good case study for seasonal dissolved oxygen fluctuation in a blackwater swamp. This seasonal relationship to temperature, and natural occurrence of low DO and pH has been observed in blackwater swamps in South Carolina and throughout the southeastern United States. Despite this apparently functioning natural process, the fact remains that all of the monitoring stations in this watershed, except for the temporary station RS-10397, are listed as impaired for DO. Over the history of monitoring in Lake Swamp Watershed, all of the stations (except RS-10397) exhibited approximately 50% exceedance, however only one station (PD-086A) had an overall average less than 4 mg/L for the history of monitoring. The other stations maintained overall average DO concentrations above 4 mg/L, as shown in Table 3-4. This may provide evidence that seasonally violating the numeric WQS for DO does not negatively impact the overall health of the blackwater system as negative impacts to aquatic life have not been observed or documented as a result of low DO in Lake Swamp.

Stations PD-085 and PD-086A demonstrated percent exceedance greater than 50%. PD-085 was based on a small sample size which does not seem to meet the SC standard for listing impaired waters. Regardless, the location of these two stations may be significant. Station PD-085 is located in Lake City, and receives flows from Camp Branch, Upper Lake Swamp, and approximately half of the urban/suburban areas within Lake City's jurisdiction. Station PD-086A is located further downstream of Lake City. If assuming that approximately 50% exceedance, or that DO concentrations falling below 4 mg/L approximately 6 months per year, is due to natural conditions in a blackwater system, then perhaps the greater than 50% exceedance at stations PD-085 and PD-086A represents human influences. In other words, the additional roughly 10-20% exceedance at these stations may represent roughly 10-20% pollutant contributions in these areas, whereby pollutants entering Lake Swamp from adjacent urban, suburban and rural land use activities may produce conditions which depress DO further than the already naturally low DO condition. Neither of these stations have been sampled since 2008/2009, therefore it is impossible to determine if this hypothesis represents current conditions. Notably, PD-087 at the bottom of the watershed has highest overall average DO concentration and the lowest percent exceedance (other than the temporary station). This may indicate the watershed is able to recover some of the depleted DO as the water travels downstream to the outlet.

Table 3-2: Summary of Dissolved Oxygen at Stations PD-085, PD-086A, PD-087, PD-314 and PD-346 (1999-2008)

Station	Average (mg/L)	# Samples	% Exceed
PD-085	4.14	16	**69%**
PD-086A	**3.72**	71	**59%**
PD-087	4.94	69	**48%**
PD-314	4.40	63	**51%**
PD-346	4.61	66	**52%**

Table 3-3: Summary of Dissolved Oxygen at Stations PD-086A, PD-087, PD-314, PD-346 and RS-10397 (2009, 2010)

Station	2009			2010		
	Average (mg/L)	# Samples	% Exceed	Average (mg/L)	# Samples	% Exceed
PD-086A	4.24	7	**57%**	--	--	--
PD-087	5.06	9	**33%**	7.01	4	**50%**
PD-314	4.64	7	**43%**	--	--	--
PD-346	4.80	9	**44%**	--	--	--
RS-10397	--	--	--	6.70	7	**0%**

-- indicates parameter was not sampled at this station during this timeframe

Table 3-4: Summary of Dissolved Oxygen at Stations PD-085, PD-086A, PD-087, PD-314, PD-346 and RS-10397 (1999-2014)

Station	Sampling Dates	Average	# Samples	% Exceed
PD-085	1999-2000; 2008	4.14	16	**69%**
PD-086A	1999-2007; 2009	**3.77**	78	**59%**
PD-087	1999-2014 (not 2003, 2008) *	4.87	105	**49.5%**
PD-314	2001-2007; 2009	4.42	70	**50%**
PD-346	2001-2007; 2009	4.63	75	**51%**
RS-10397	2010	6.70	7	**0%**

* *See following table for breakdown of monitoring periods at PD-087.*

Table 3-5: Summary of Dissolved Oxygen at Monitoring Station PD-087 (1999-2014)

Sampling Dates	Units	Average	# Samples	% Exceed
1999-2007	mg/L	4.94	69	48%
2009-2014	mg/L	4.74	36	53%
1999-2014	mg/L	**4.87**	**105**	**49.5%**

Figure 3-1: Graph of Dissolved Oxygen at Stations PD-085, PD-086A, PD-087, PD-314 and PD-346 (1999-2008)

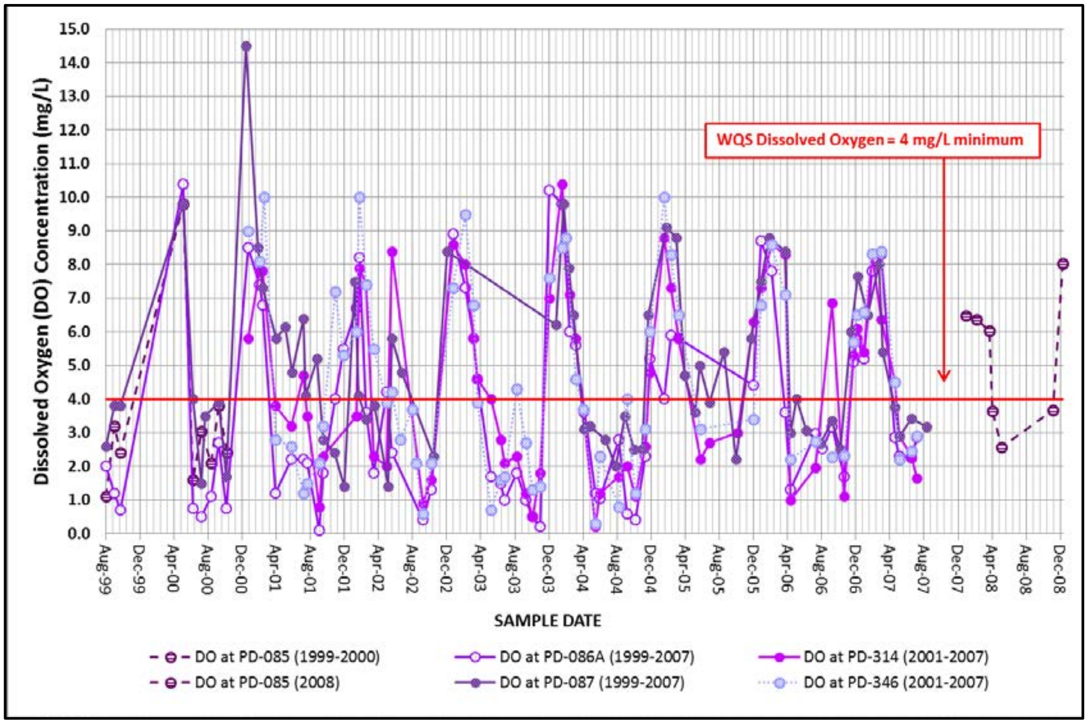


Figure 3-2: Graph of Dissolved Oxygen at Stations PD-086A, PD-087, PD-314, PD-346 and RS-10397 (2009, 2010)

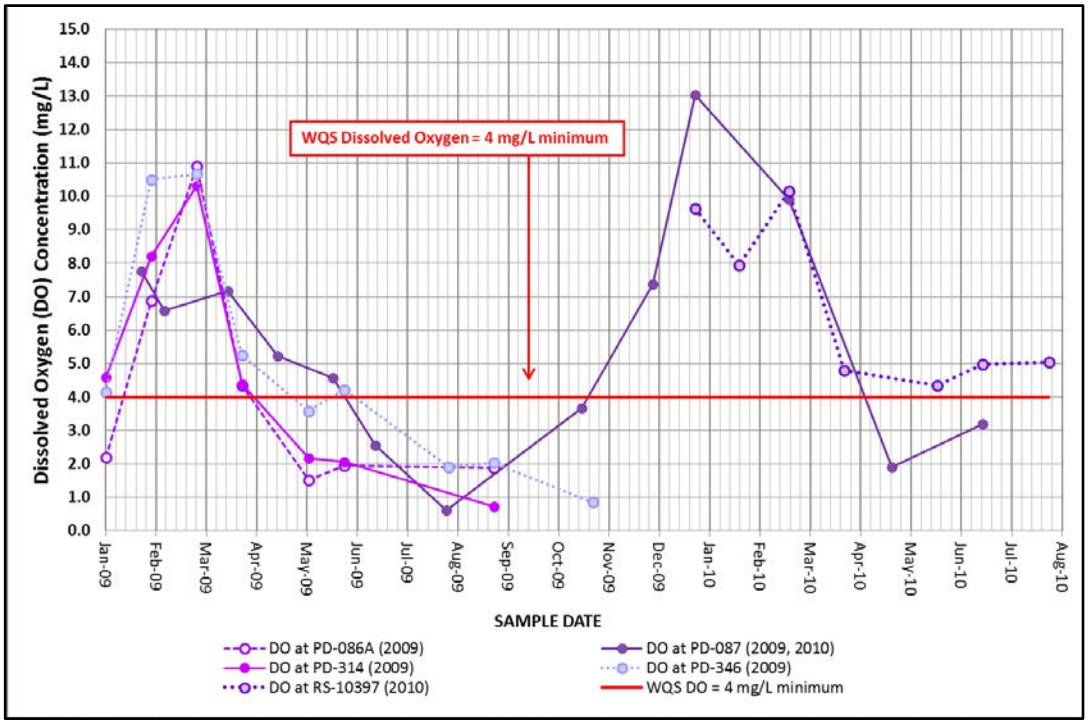


Figure 3-3: Graph of Dissolved Oxygen at Station PD-087 (2009-2014)

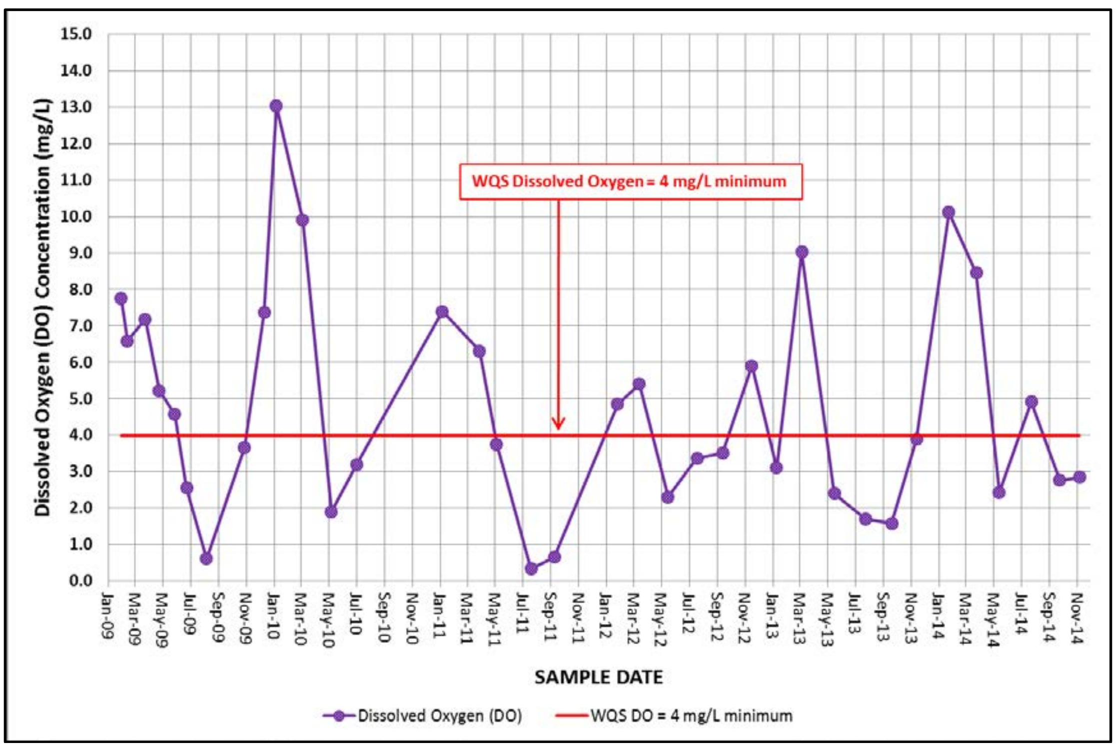


Figure 3-4: Graph of Dissolved Oxygen, Water Temperature and pH at Stations PD-085, PD-086A, PD-087, PD-314 and PD-346 (1999-2008)

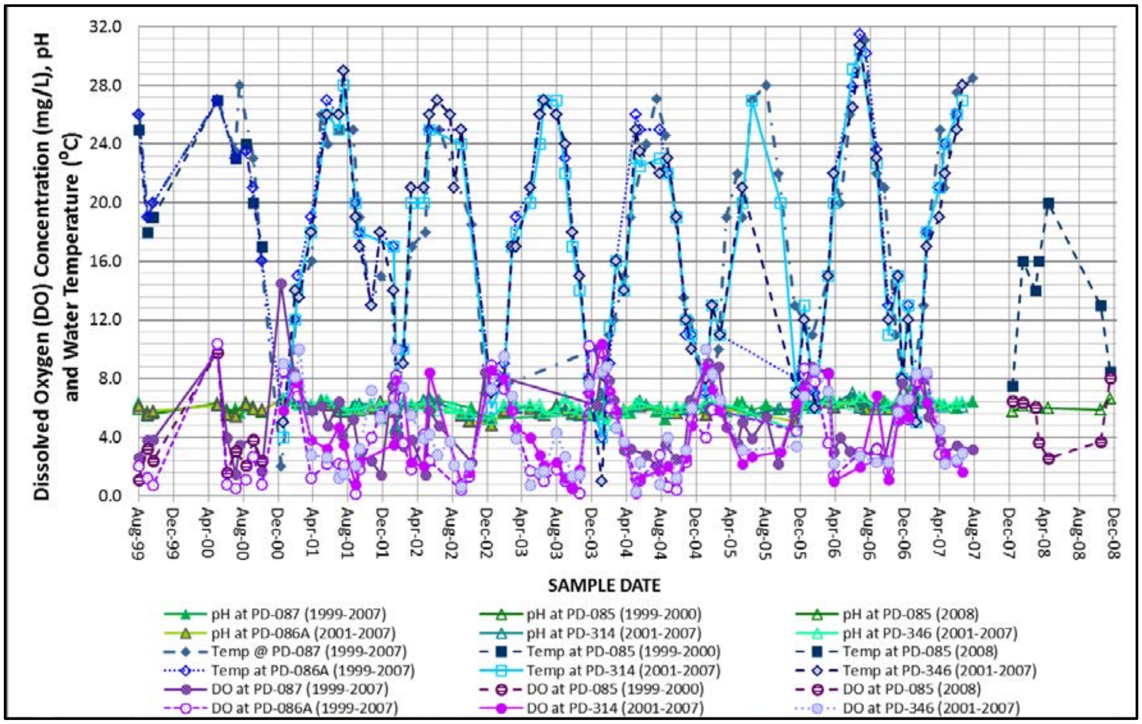


Figure 3-5: Graph of Dissolved Oxygen, Water Temperature and pH at Stations PD-086A, PD-087, PD-314, PD-346 and RS-10397 (2009, 2010)

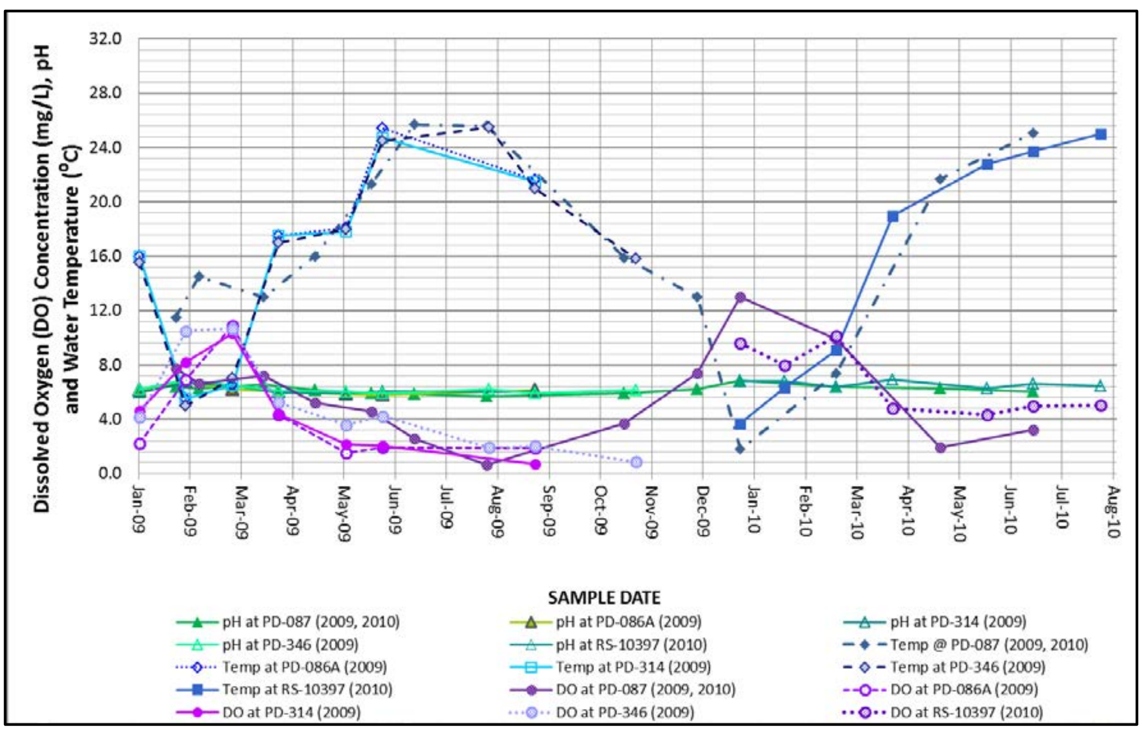


Figure 3-6: Graph of Dissolved Oxygen, Temperature and pH at Station PD-087 (2009-2014)

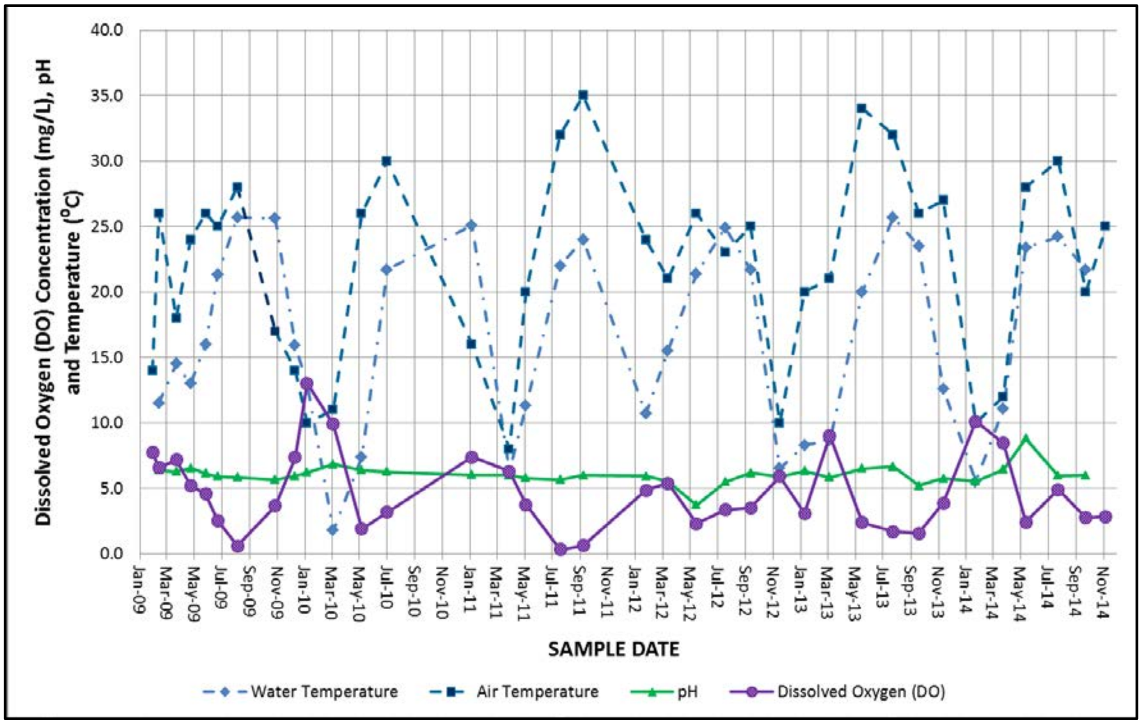


Table 3-6: Summary of Water Temperature at Stations PD-085, PD-086A, PD-087, PD-314, PD-346 and RS-10397 (1999-2014)

Station	1999-2008		2009		2010		1999-2014	
	Average (°C)	# Samples	Average (°C)	# Samples	Average (°C)	# Samples	Average (°C)	# Samples
PD-085	17.9	15	--	--	--	--	17.9	15
PD-086A	18.1	70	15.8	7	--	--	17.9	77
PD-087	18.2	68	17.4	9	14.0	4	17.5	103
PD-314	17.2	63	15.6	7	--	--	17.1	70
PD-346	17.3	66	16.6	9	--	--	17.2	75
RS-10397	--	--	--	--	15.7	7	15.7	7

Table 3-7: Summary of pH at Stations PD-085, PD-086A, PD-087, PD-314, PD-346 and RS-10397 (1999-2014)

Station	1999-2008		2009		2010		1999-2014	
	Average	# Samples	Average	# Samples	Average	# Samples	Average	# Samples
PD-085	5.99	16	--	--	--	--	5.99	16
PD-086A	5.99	72	6.12	7	--	--	6.01	79
PD-087	6.08	69	6.11	9	6.39	4	6.07	104
PD-314	6.09	64	6.17	7	--	--	6.10	71
PD-346	6.10	67	6.22	9	--	--	6.12	76
RS-10397	--	--	--	--	6.60	7	6.60	7

Table 3-8: Summary of Biochemical Oxygen Demand at Stations PD-085, PD-086A, PD-087, PD-314, PD-346 and RS-10397 (1999-2014)

Station	1999-2008		2009		2010		1999-2014	
	Average (mg/L)	# Samples	Average (mg/L)	# Samples	Average (mg/L)	# Samples	Average (mg/L)	# Samples
PD-085	2.58	9	--	--	--	--	2.58	9
PD-086A	2.79	56	2.05	6	--	--	2.72	62
PD-087	2.56	58	2.09	9	2.00	4	2.39	93
PD-314	2.51	55	2.23	7	--	--	2.48	62
PD-346	2.74	58	2.46	9	--	--	2.70	67
RS-10397	--	--	--	--	2.37	7	2.37	7

Table 3-9: Summary of BOD, pH, Water Temperature and Air Temperature at Station PD-087 (2009-2014)

Parameter	Sampling Dates	Units	Average	# Samples	% Exceed
BOD	2000-2007	mg/L	2.56	58	--
	2009-2014	mg/L	2.11	35	--
	2000-2014	**mg/L**	**2.39**	**93**	**--**
pH	1999-2007	--	6.08	69	1%
	2009-2014	--	6.05	35	5.7%
	1999-2014	**--**	**6.07**	**104**	**3%**
Water Temperature	1999-2007	^{o} Celsius	18.2	68	--
	2009-2014	^{o} Celsius	16.2	35	--
	1999-2014	**^{o} Celsius**	**17.5**	**103**	**--**
Air Temperature	2009-2014	^{o} Celsius	22.1	36	--

3.4 FECAL COLIFORM AND E. COLI BACTERIA

Bacteria results are presented in a series of graphs and tables, below. These graphs follow the three timeframes previously discussed. The graphs present *E. coli* data, while the Tables present both FC and *E. coli* values.

3.4.1 Historical Results for E. coli

Historical results are shown in Figure 3-7 and Table 3-10. During the historic monitoring period (1999-2008), the majority of individual samples across all monitoring stations were below the WQS (349 MPN/100mL). Similarly, the geomean values shown in Table 3-9 for all stations were well below the WQS. Table 3-9 does show exceedances at PD-085 for 2 out of 15 samples (13% exceedance), however with such a limited sample size and a seven year gap between the exceedances, it is difficult to determine whether this location has a bacteria problem without further sampling.

3.4.2 Transition Period Results for E. coli

Results for the transition period (2009-2010) are shown on Figure 3-8 and Table 3-11. In 2009, stations PD-086A, PD-087 and PD-314 had zero percent exceedance out of 7, 10 and 7 samples, respectively. Station PD-346, however, underwent intensive sampling, with 57 FC samples and 51 *E. coli* samples during that year. (The FC samples were converted to *E. coli* values and compared to the *E. coli* WQS.) For the most part these sampling events were paired, with both FC and *E. coli* sampled on the same day at each station, although there were a few exceptions. It is worthy to note that for the paired sampling events, for the most part exceedances were observed for both the FC and *E. coli* samples on the same dates, although there were 3 events where the *E. coli* sample exceeded the *E. coli* WQS while the FC sample (converted to *E. coli* value) did not exceed the *E. coli* WQS.

Station PD-346 recorded 12% exceedance from the FC samples (converted to *E. coli* values) and 25% exceedance from the *E. coli* samples, compared to the SC *E. coli* WQS. In 2010, temporary station RS-10397 was established, and 3 out of 6 samples exceeded the WQS (50% exceedance), compared to zero out of 4 samples (0% exceedance) at PD-087 in 2010.

3.4.3 Recent Results for E. coli

Recent monitoring results at PD-087 are shown in Figure 3-9 and Table 3-12. Only three samples exceeded the WQS at PD-087 during the recent five years of monitoring (2009-2014). Overall, from 1999-2014, 100 bacteria samples (combination of converted FC and actual *E. coli* samples) were taken at PD-087. Of these, there were 7% exceedances, with an overall geomean of 102 MPN/100mL. During each of the subset monitoring periods shown in Table 3-13, PD-087 maintained a geomean between 98 and 122 MPN/100mL and exceedance rate from 6% to 8%. These average geomean values are well below the *E. coli* WQS.

3.4.4 Evaluation of Results for E. coli

According to the 2014 SC 303(d) list, Lake Swamp is impaired for bacteria at PD-346 and RS-10397. PD-346 is the most upstream monitoring station along the main stem of Lake Swamp; RS-10397 is the most upstream station from Singleton Swamp subwatershed. None of the downstream stations are listed as impaired or demonstrate a clear problem with bacteria. Notably, the majority of exceedances for both PD-346 and RS-10397 occurred during intensive one-year sampling in 2009 and 2010, respectively. PD-346 only had 5% exceedance rate from 2001-2007. The exceedance rate jumped up to between 12% and 25% during the intensive sampling in 2009. Over the entire monitoring history at PD-346 (2001-2007, 2009), the geomean is 103 MPN/100mL, well below the WQS, and the overall exceedance rate is only 9%. RS-10397 was listed as impaired as a result of 3 exceedances out of only 6 samples, during 2010. These two monitoring stations do not appear to meet SCDHEC's 5-yr/10% exceedance listing criteria and may or may not actually be impaired according to the SC listing standard.

As the station located at the bottom of the watershed, PD-087 has the longest monitoring record in the watershed, with a total of 14 years of data (1999-2014, excluding 2003 and 2008). This station shows the water quality which is discharged downstream. While there are potential bacteria pollutant sources in both the urban and rural land use areas upstream, it does not appear that Lake Swamp Watershed is a significant contributor of bacteria downstream. With the currently available bacteria data, it is impossible to determine whether the bacteria are from human or ambient (wildlife) sources. Any bacterial problems in the upper reaches of the subwatersheds appear to be attenuated by the time Lake Swamp flows to the watershed outlet at PD-087.

Figure 3-7: Graph of *E. coli* Bacteria at Stations PD-085, PD-086A, PD-087, PD-314 and PD-346 (1999-2008)

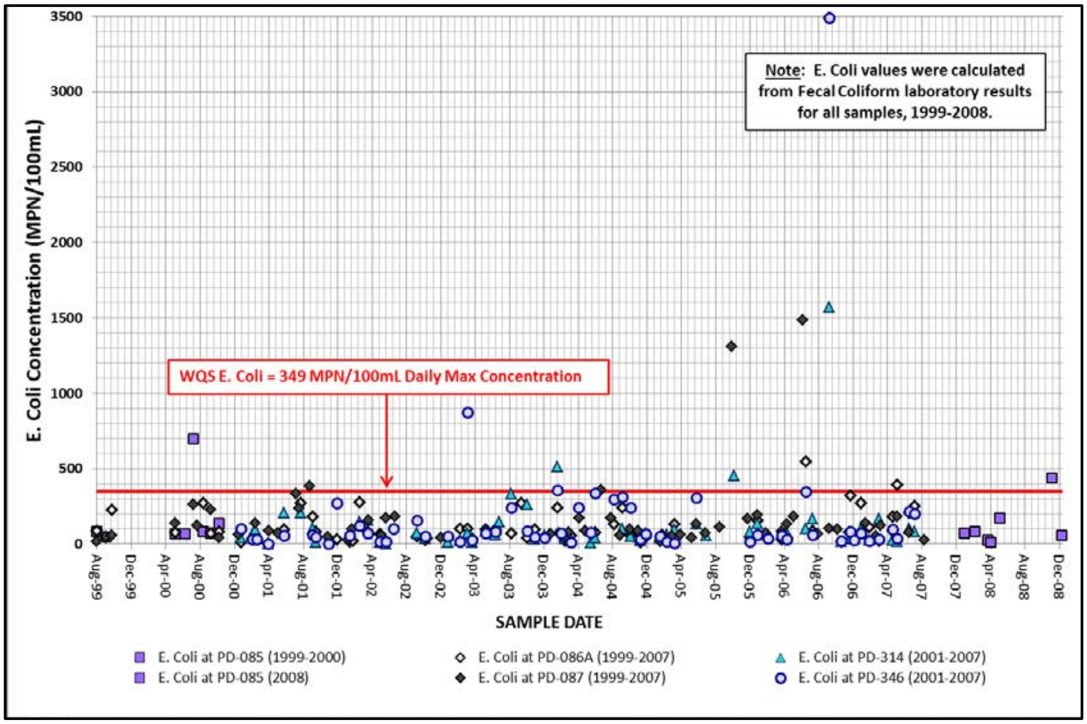


Figure 3-8: Graph of *E. coli* Bacteria at Stations PD-086A, PD-087, PD-314, PD-346 and RS-10397 (2009, 2010)

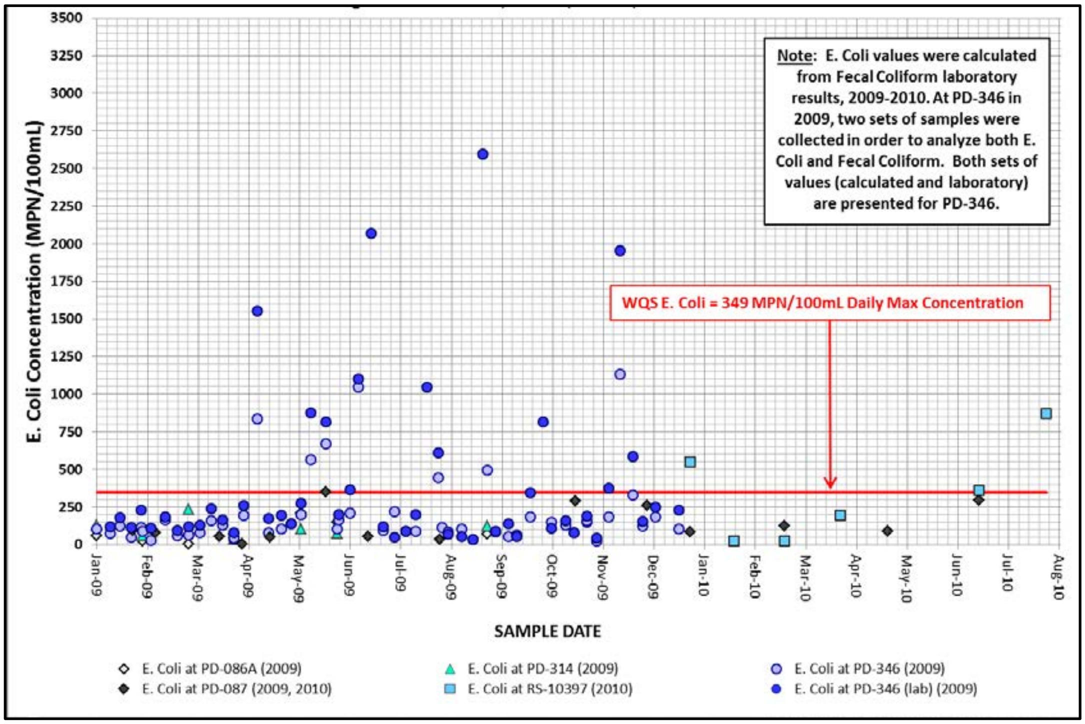


Figure 3-9: Graph of *E. coli* Bacteria at Station PD-087 (2009-2014)

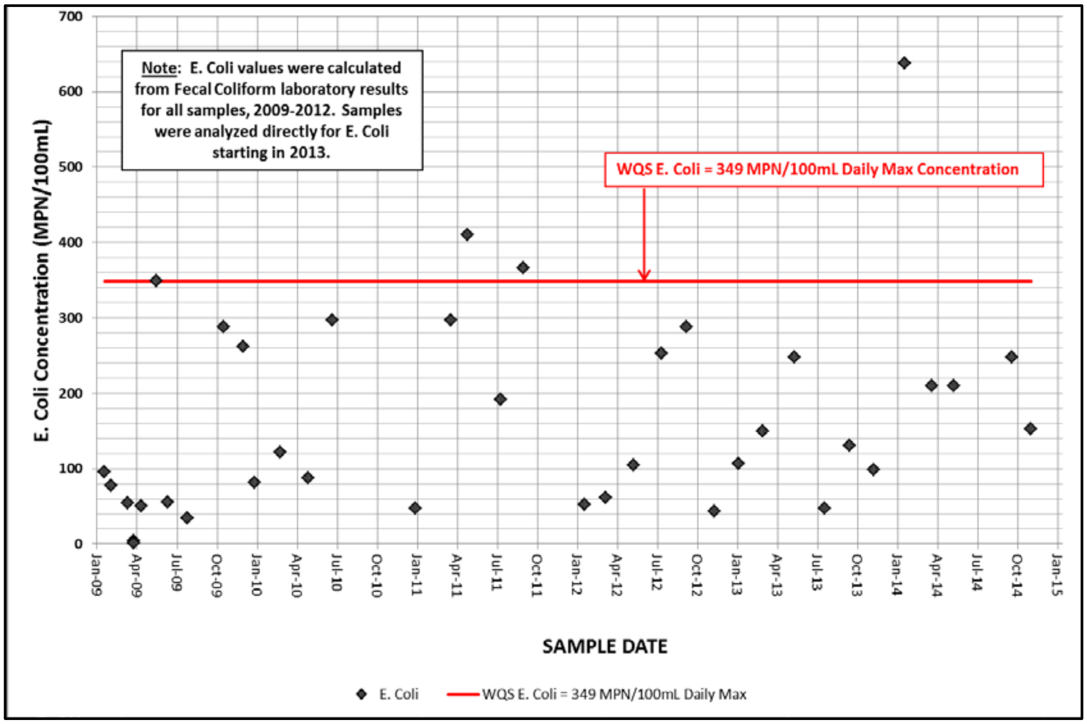


Table 3-10: Summary of Fecal Coliform and *E. coli* Bacteria Results at Stations PD-085, PD-086A, PD-087, PD-314 and PD-346 (1999-2008)

Station	Fecal Coliform Geomean (col/100mL)	*E. coli* (calc) * Geomean (MPN/100mL)	# Samples	% Exceed
PD-085	98	85.83	15	**13%**
PD-086A	84	73.09	66	5%
PD-087	112	97.73	63	6%
PD-314	66	57.98	59	5%
PD-346	75	65.27	60	5%

** Conversion from Fecal Coliform to E. coli: FC (col/100mL) X 0.8725 = E. coli (MPN/100mL)*

Table 3-11: Summary of Fecal Coliform and *E. coli* Bacteria Results at Stations PD-086A, PD-087, PD-314, PD-346 and RS-10397 (2009, 2010)

Station	2009				2010			
	Fecal Coliform Geomean (col/100mL)	*E. coli* (calc) * Geomean (MPN/100mL)	# Samples	% Exceed	Fecal Coliform Geomean (col/100mL)	*E. coli* (calc) * Geomean (MPN/100mL)	# Samples	% Exceed
PD-086A	62	54.34	7	0%	--	--	--	--
PD-087	77	67.11	10	0%	145	126.9	4	0%
PD-314	106	92.07	7	0%	--	--	--	--
PD-346	145	126.55 *	57	**12%**	--	--	--	--
	--	215.51 **	51	**25%**	--	--	--	--
RS-10397	--	--	--	--	187	163.28	6	**50%**

** Conversion from Fecal Coliform to E. coli: FC (col/100mL) X 0.8725 = E. coli (MPN/100mL)*
*** PD-346 – In 2009, two sets of samples were collected and analyzed for both FC and E. coli. Thus E. coli is presented both as result calculated from FC (first row) and as lab result (second row).*

Table 3-12: Summary of Fecal Coliform and *E. coli* Bacteria Results at Stations PD-085, PD-086A, PD-087, PD-314, PD-346 and RS-10397 (1999-2014)

Station	Monitoring Period	Fecal Coliform Geomean (col/100mL)	*E. coli* (calc) * Geomean (MPN/100mL)	# Samples	% Exceed
PD-085	1999-2000; 2008	98	85.83	15	**13%**
PD-086A	1999-2007; 2009	81	71.04	73	4%
PD-087	1999-2014 (not 2003, 2008)	**	101.68	100	7%
PD-314	2001-2007; 2009	70	60.89	66	5%
PD-346	2001-2007; 2009	103	90.12	117	9%
RS-10397	2010	187	163.28	6	**50%**

** Conversion from Fecal Coliform to E. coli: FC (col/100mL) X 0.8725 = E. coli (MPN/100mL)*
*** See following table for breakdown of monitoring periods at PD-087.*

Table 3-13: Summary of *E. coli* Bacteria Results at Station PD-087

Monitoring Periods	Fecal Coliform Geomean (col/100mL)	*E. coli* Geomean (MPN/100mL)	# Samples	% Exceed
1999-2007 (not 2003)	112	97.73	63	6%
2009-2012	118	103.00	25	8%
2013-2014 *	--	121.87	12	8%
2009-2014	--	108.77	37	8%
1999-2014 (not 2003, 2008)	**--**	**101.68**	**100**	**7%**

** 2013-2014 dataset also includes one confirmatory E. coli sample taken in 2009.*

3.5 OTHER WATER QUALITY PARAMETERS

Results for all of the other parameters monitored at PD-087 during the recent monitoring period (2009-2014) are shown in Table 3-14. Average alkalinity was low, and while the sample date with the lowest pH correlated well with a sample of zero alkalinity, this relationship was not consistent at higher alkalinity and pH concentrations. All turbidity samples were well below the WQS, showing the watershed to be fairly undisturbed from the standpoint of erosion and sediment flows. Average nutrient concentrations were low, and unremarkable. Average concentrations for heavy metals were also low, with many of the metals barely or not at all detected above the PQL. Chromium, Copper, Mercury and Nickel all had 0% exceedance. One exceedance was found for Cadmium. Zinc had a higher rate of detection, with 15.8% exceedance when comparing to the more stringent aquatic life WQS. All zinc samples were well below the human health WQS. A similar trend for zinc is found in the historic data as well (not shown in this report). Without any observable or likely source of zinc, it is assumed to be from naturally occurring sources.

Table 3-14: Other Water Quality Parameters at Station PD-087 (2009-2014)

Parameter	Units	Average	# Samples	% Exceed
Sampling Dates	--	January 2009 - November 2014		
Alkalinity	mg/L	14.2	36	--
Turbidity	NTU	5.24	35	0%
Ammonia (NH_3)	mg/L	0.154	35	--
Nitrite-Nitrate (NO_2-NO_3)	mg/L	0.195	35	--
Total Kjeldahl Nitrogen (TKN)	mg/L	0.802	34	--
Total Phosphorus (TP)	mg/L	0.067	36	--
Cadmium (Cd)	ug/L	0.7	19	5.3%
Chromium (Cr)	ug/L	5.4	19	0%
Copper (Cu)	ug/L	10	19	0%
Iron (Fe)	mg/L	1.15	19	--
Manganese (Mn)	mg/L	0.118	19	--
Mercury (Hg)	ug/L	0.20	20	0%
Nickel (Ni)	ug/L	20	19	0%
Zinc (Zn)	ug/L	20.3	19	15.8%

-- indicates no numeric standard for this watershed

3.6 COMPARISON OF LAKE SWAMP TO OTHER WATERSHEDS

3.6.1 Dissolved Oxygen Comparison to Other Watersheds

A study of Dissolved Oxygen in Singleton Swamp and the nearby Big Swamp watershed was completed in 2006 (Santee-Wateree Resource Conservation and Development Council, March 2006). The study assessed whether there was sufficient evidence to conclude that DO conditions in these swamps are natural, or whether controllable human sources have important effects on the DO concentration. The results supported the assertion that critical summer conditions (high temperatures and low flows) increase bacterial activity, increase in-stream residence time, and decrease stream re-aeration rates and DO concentrations. Under critical summer conditions, in-stream DO concentrations drop due to BOD decay from microbial activity, which is worsened by decreased re-aeration. Background modeling scenarios also suggested that complete removal of human influences would have little effect on what appear to be naturally low dissolved oxygen conditions in these swamps. The results of this study are highly relevant to the Lake Swamp watershed due to the proximity of the study area. DO values were comparable to Lake Swamp DO data, however BOD values in Singleton Swamp and Big Swamp were considerably higher than BOD values in the Lake Swamp data.

3.6.2 Bacteria Comparison to Other Watersheds

As discussed in Section 2.3.4, the available research on coliform bacteria loading in surface waters is highly variable, inconsistent and for the most part not compatible with the variables in Lake Swamp watershed. Different watershed areas, land uses, geographic locations, rainfall, bacteria type (fecal coliform vs. *E. coli*), analytical methods and reporting units (cfu vs. MPN) complicate a comparison to the Lake Swamp watershed. However, two studies, Vidon and Campbell, 2009, and Kay, et al., 2008, provided bacteria export rates and land uses that are comparable to the Lake Swamp watershed. In terms of these studies, an export rate is a bacteria count that was determined for a stated land use, or land use combination, over a period of time. For instance, Vidon and Campbell reported export rates for annual *E. coli* loading for two watersheds with approximately 96% non-urban land use. The Lake Swamp watershed is approximately 91% non-urban. In addition, Kay, et al. reported export rates for Fecal Coliform based on degree of urbanization. Using data from these two studies, an *E. coli* loading estimate for Lake Swamp watershed was estimated to range from 1.13E+15 MPN/year to 2.79E+15 MPN/year. Flow data paired with *E. coli* sampling was conducted in these other watersheds in order to determine these export rates, and flow data is not available for Lake Swamp Watershed.

The 2006 Fecal Coliform TMDL and Load Reduction Management Plan for Big Swamp, SC (Santee-Wateree Resource Conservation and Development Council, May 2006) reviewed the seasonal variability of fecal coliform data collected from ambient WQS stations in the Big Swamp watershed. Big Swamp is located northeast and immediately adjacent to Lake Swamp, and sections of the watershed are impaired due to fecal coliform. The study focused on non-point fecal coliform sources, including wildlife, grazing, livestock, and malfunctioning or “straight-pipe” septic systems. The results of the study showed that generally, the warmer months of the year (May-October) had higher mean fecal coliform bacteria concentrations, although there were exceptions. The study area included a WWTP outfall that experienced chronic summer NPDES coliform permit exceedances. The study also reviewed hydrologic variability of FC in the watershed by estimating the flow based on data from a similar watershed. The results indicated higher bacteria concentrations tend to occur at low flow. The study results from this TMDL have relevance to the Lake Swamp watershed due to their proximity; however, unlike the Big Swamp watershed, there is no WWTP outfall in the Lake Swamp watershed. Actual streamflow data from the watershed may yield different hydrologic results than reported.

3.7 ASSESSING THE HUMAN IMPACTS

Lake Swamp is a minimally developed watershed, with a large percentage of the land use remaining as forested swamp. It is fair to assume that many of the natural processes in the swamp remain in-tact, including seasonal fluctuations in DO concentration. Lake Swamp is, however, populated by humans, and therefore it is likely that human activities do contribute pollutants which may influence DO concentrations. Similarly, due to the large tracts of in-tact forested swamp, it is fair to assume that wildlife serve as a natural source of bacteria measured in Lake Swamp samples. Even with a significant wildlife population, it is likely that human activities are a source of bacteria in the watershed.

Without knowing for certain how much of the depressed DO can be attributed to natural conditions and how much can be attributed to human activities, it is difficult to assess the impact of human activities. Similarly, it is difficult to determine how much bacteria may be coming from natural wildlife sources compared to human sources. More intensive and current monitoring data is needed in order to determine the extent of human influence on DO concentrations in Lake Swamp Watershed.

Without hydrology data, existing pollutant loads or potential pollutant load reductions cannot be accurately quantified. Considering the overall concentration of pollutants, affects to water quality appear to be minimal, although difficult to quantify beyond simple concentration and frequency of exceeding the WQS. reductions which might be possible via implementing this watershed plan. Improvements in BMP implementation as recommended in this watershed plan should further improve water quality in Lake Swamp Watershed.

SECTION 4

WATERSHED GOALS AND OBJECTIVES

The goals of the Lake Swamp Watershed Plan are:

- Establish a Stakeholder Group;
- Characterize the land uses, activities and potential pollution sources;
- Evaluate current water quality conditions and determine whether low DO conditions are due to natural blackwater conditions and/or pollutant sources;
- Create a plan to proactively monitor, mitigate and manage the watershed to meet SC Water Quality Standards;
- Avoid impairment listings and TMDLs, if possible.

The results of this watershed evaluation have been used to identify the types of management strategies and BMPs that will be the most effective in improving water quality within the Lake Swamp Watershed.

Each Stakeholder will be responsible for implementation of projects under its own jurisdiction. Projects will be prioritized and implemented according to funding availability. All Stakeholders should engage in the implementation planning and scheduling process so that their combined efforts will maximize results.

SECTION 5

RECOMMENDED MANAGEMENT STRATEGIES

The Lake Swamp Watershed Plan is intended to be a living document. The Plan should be updated as conditions or goals change, as tasks are accomplished, as additional strategies are developed, or as new information is obtained.

A variety of management strategies and Best Management Practices (BMPs) can be implemented to help reduce the amount of pollutants contaminating surface waters. A BMP may be structural, such as a detention pond or bioretention area, or non-structural. Non-structural BMPs are institutional, educational or pollution prevention practices that help reduce stormwater runoff and pollutant transport to receiving waters. BMPs may address urban, suburban and rural areas and activities. BMPs may be targeted to a specific pollutant, or more general to improve stormwater quality overall.

BMPs help to reduce coliform bacteria and DO impairments and sources of other pollutants in the watershed. While the overall reduction in pollutant loading associated with educational outreach activities cannot be quantified as part of this plan, the ability to educate and change behaviors can have a significant impact within the community. A future long-term water quality monitoring plan associated with this watershed project will monitor the water quality and may be able to provide conclusive results with regards to educational impact.

The primary water quality parameters of concern in the Lake Swamp Watershed are coliform bacteria and Dissolved Oxygen (DO). Dissolved Oxygen is not a pollutant; however, declines in DO can be caused by pollutants. The main factor contributing to changes in the DO level is the buildup of organic wastes, which consume oxygen when they decay.

The Lake Swamp watershed is largely a blackwater system which is naturally low in DO due to high summertime temperatures, low slopes and slow moving water. The use of BMPs may help increase DO levels in some applications. Examples of BMPs to address low DO include: sanitary sewer system rehab, septic system maintenance/rehab, pet waste management, composting and management of grass clippings and yard wastes, reduction and management of pesticides, herbicides, and fertilizers (PHF), reduction of soil erosion, including construction site erosion and sediment control practices, pond maintenance (waterfowl management, aerator/fountain installation, vegetative buffer maintenance, agricultural BMPs (vegetative buffers, exclusion fencing), and streambank restoration.

Coliform bacteria from animals (both domestic and wild), and humans (primarily from septic tanks and sanitary sewer overflows and pet waste in urban areas), are transported to surface waters during rainfall events, and can survive in stream sediments for months. Many of the same BMPs for DO are effective in treating coliform bacteria.

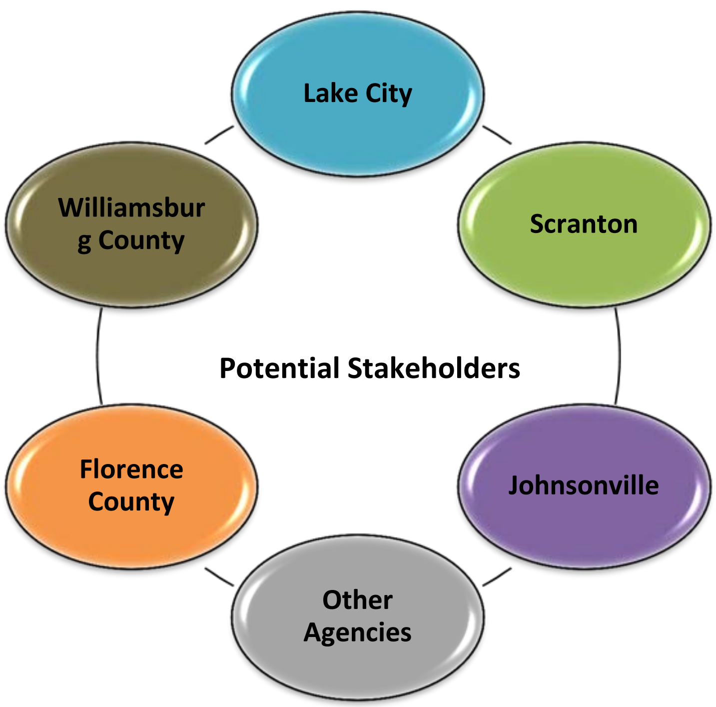
The following strategies are recommended for management of dissolved oxygen and reduction of coliform bacteria loading in the Lake Swamp Watershed:

1) Public Outreach and Education
2) Sanitary Sewer Rehabilitation and Illicit Discharge Detection and Elimination
3) Septic System Maintenance and Rehabilitation
4) Best Management Practices for Agriculture
5) Best Management Practices for Timber Harvesting
6) Conservation Easements in Riparian Areas
7) Structural BMPs

Relevant Stakeholders should collaborate and develop plans for implementation of BMPs to reduce impacts to surface waters that may contribute to depressed DO and elevated coliform bacteria concentrations.

5.1 PUBLIC OUTREACH AND EDUCATION

Stakeholders should implement a public awareness campaign as a first step toward improving the condition of the Lake Swamp watershed. Many people are unaware of the various activities that can adversely impact the quality of stormwater runoff. Public outreach and education builds support from citizens and allows for more successful implementation of all BMPs. Public outreach and education is an umbrella to be applied to all BMPs and continue throughout the entirety of the Plan. All Stakeholders should have involvement in this effort.



Direct outreach can include distribution of printed informational fliers, information presented on the Stakeholder websites and in print media, and educational distribution on the local television public access channel. To reduce coliform bacteria in stormwater runoff from domestic pets, education and outreach programs should focus on local residents in an effort to encourage proper disposal of pet waste.

Informational signs should be installed in the watershed. Signage may include road signs ("Now entering Lake Swamp Watershed"), interpretive/graphical signs at parks or other public places, instructional signs, or signs for specific BMP installations or stormwater project sites. Signage allows for visual information to be disseminated to the public with regards to the importance to water quality and pollutant removal. Since stakeholders have a vested interest in the projects, it will be important to include them in the decision making process with regards to how information is presented and how signage will be integrated into the projects.

In addition to direct Stakeholder outreach, Carolina Clear provides assistance with educating and involving the public in waterway protection and pollution prevention. Carolina Clear, developed by Clemson University, uses a comprehensive approach to inform and educate communities about water quality, water quantity, and the cumulative effects of stormwater. Carolina Clear currently works with Florence County, which is a member of the Florence Darlington Stormwater Consortium. Information on the Florence Darlington Stormwater Consortium is available to the public on the Carolina Clear website at: http://www.clemson.edu/public/carolinaclear/consortiums/flodar_home/about.html. Carolina Clear uses numerous types of media and other means, such as workshops and presentations, to educate, inform and encourage community involvement in stormwater pollution prevention.

5.2 SANITARY SEWER REHABILITATION AND ILLICIT DISCHARGE DETECTION & ELIMINATION

5.2.1 Sanitary Sewer Rehabilitation

Wastewater collection systems can experience inflow and infiltration during rain events which may be attributed to the deterioration of gravity sanitary sewer system infrastructure. Excessive inflow and infiltration can cause sewer backups and overflows that potentially discharge untreated wastewater to surface waters. Exfiltration of sewage into groundwater may occur where a damaged sewer pipe is above the water table. Discharges to groundwater eventually reach surface water. Rehabilitation of the gravity sanitary sewer will reduce infiltration, inflow and overload during wet weather events, and potential exfiltration of coliform bacteria into the groundwater.

Sanitary sewer rehabilitation projects may include smoke testing and inspections to identify likely sources of infiltration and inflow, followed by cleaning, televising and rehabilitation to seal the gravity sanitary sewer lines and manholes. Appendix D is a map showing the sanitary sewer service area for the City of Lake City, and Town of Scranton.

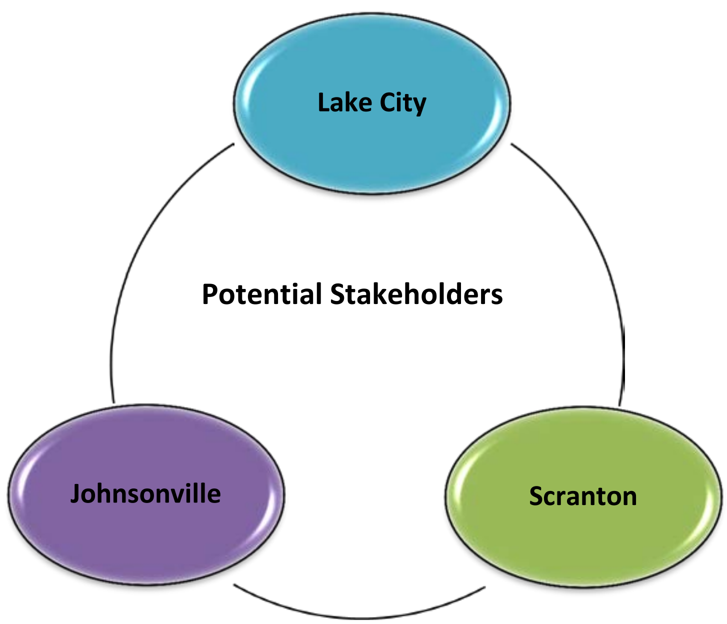
5.2.2 Illicit Discharge Detection and Elimination (IDDE)

An illicit discharge is defined as any discharge that is not entirely composed of stormwater, except for discharges resulting from firefighting activities. Typical illicit discharges include such things as sanitary wastewater, effluent from septic tanks, car wash wastewaters, improper oil disposal, radiator flushing disposal, laundry wastewaters, spills from roadway accidents, improper disposal of automobile fluids and household chemicals. Illicit connections are illegal and/or improper connections to storm drainage systems and receiving waters.

The elimination of pollutants before they are introduced to stormwater runoff is the most effective means of dealing with pollutants in urban stormwater. Illicit discharges may occur inadvertently or intentionally. In either case, the identification and removal of illicit discharges and illicit connections is a means for reducing stormwater pollution. The implementation of an IDDE program is a positive step towards elimination of pollutants at their source and can have a significant positive impact on water quality. Appendix E is a map showing the location of the stormwater system and outfalls for the City of Lake City.

5.2.3 Recommended Stakeholder Actions

The relevant Stakeholders should conduct an overall evaluation of their wastewater collection systems during wet weather and dry weather to determine potential locations which might have sewer discharge, illicit connections, or dry weather flows, all of which might contribute to *E. coli* and DO impairments in the Lake Swamp watershed.



Lake City is in the process of obtaining funding from USDA Rural Development for wastewater collection system improvements. Funding for sanitary sewer system rehabilitation may also be available through:

- SC Community Development Block Grant Program (CDBG) – grants to improve community infrastructure, etc.
- SC Rural Infrastructure Authority (RIA) – grants for qualified infrastructure projects
- State Revolving Fund (SRF) – federally capitalized loan programs for water and waste water infrastructure projects.
- U.S. Economic Development Administration (EDA) – grants for water and sewer improvements, etc.

The Sanitary Sewer Rehabilitation and IDDE BMP will reduce both *E. coli* and DO impairments in the watershed.

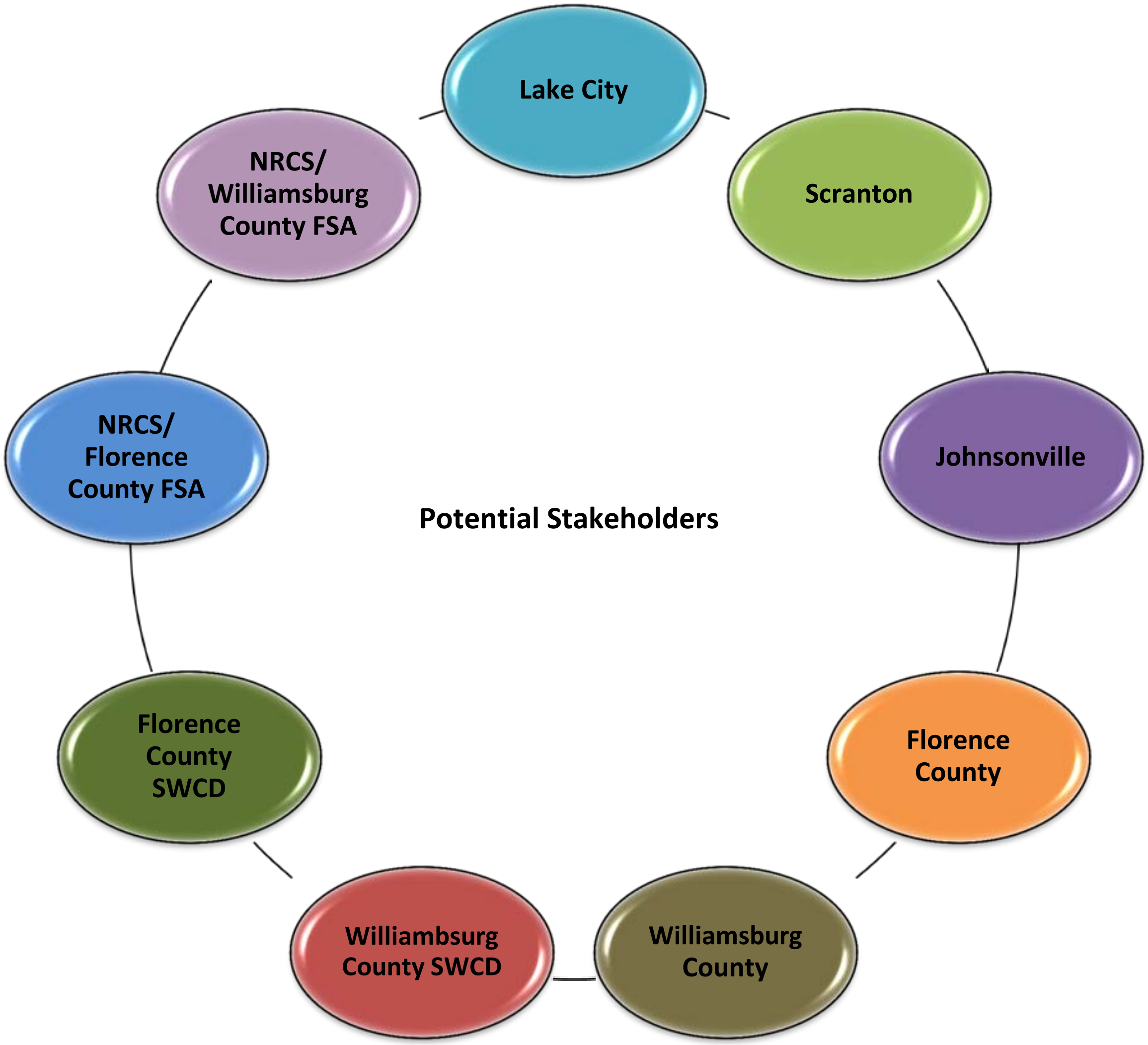
5.3 SEPTIC SYSTEM MAINTENANCE AND REHABILITATION

The majority of the Lake Swamp watershed is outside of areas where sanitary sewer service is provided. Appendix E shows the sanitary sewer service area for the City of Lake City, and Town of Scranton. Households outside of the Lake City, Scranton and Johnsonville sanitary sewer service areas rely on septic systems for wastewater treatment. According to SCDHEC, in an average year, 10 to 30 percent of septic systems fail to work properly, usually because of poor maintenance. This results in the discharge of partially treated or untreated human waste to groundwater or surface waters. Additionally, some old septic tank systems have straight-pipe discharges into a ditch with no treatment at all.

Relevant Stakeholders should develop a plan to encourage septic system maintenance and rehabilitation to eliminate surface water contamination from failing septic systems. Stakeholders should work together with each other and local septage waste haulers to conduct a septic system inventory and locate areas with a high density of septic systems. A maintenance and repair program should be developed, and sources of low interest loans or grants identified to help homeowners in need of financial assistance to bring their systems into compliance. Grants may be available to homeowners for septic tank rehabilitation.

Based on the septic system inventory, the City of Lake City, Town of Scranton and City of Johnsonville should evaluate the feasibility of extending sewerage to high density problem areas and developing areas.

Although malfunctioning septic tanks are a likely source of coliform bacteria, a DNA matching technique could be utilized to confirm whether the source of *E. coli* in a water sample is human or animal. By identifying the primary source, a more targeted management plan can be developed.



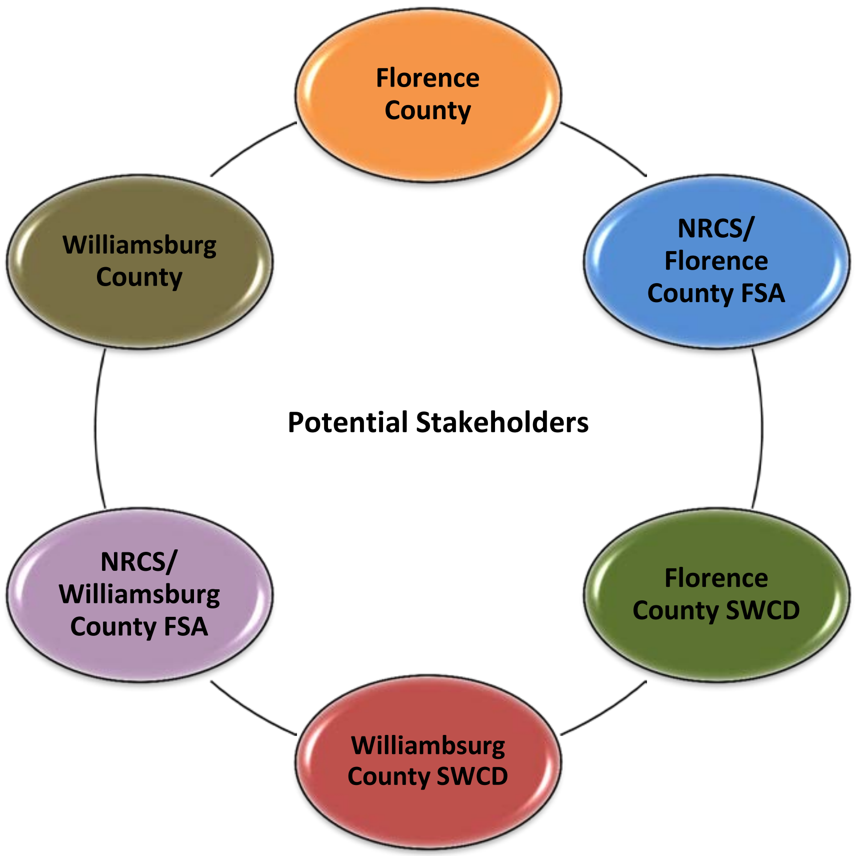
State and Federal grants and loans for wastewater infrastructure projects may be available from multiple agencies:

- SC Community Development Block Grant Program (CDBG) – grants to improve community infrastructure, etc.
- SC Rural Infrastructure Authority (RIA) – grants for qualified infrastructure projects
- State Revolving Fund (SRF) – federally capitalized loan programs for water and waste water infrastructure projects.
- USDA Rural Development (RD) – loans, grants and loan guarantees for infrastructure
- U.S. Economic Development Administration (EDA) – grants for water and sewer improvements, etc.

The Septic System Maintenance and Rehabilitation BMP will reduce both *E. coli* and DO impairments in the watershed.

5.4 BEST MANAGEMENT PRACTICES FOR AGRICULTURE

Agriculture comprises nearly 30% of land use in Lake Swamp watershed. Pesticides, fertilizers, livestock waste and sediment from agricultural activities are potential nonpoint sources of pollutants that impact water quality. These pollutants may contribute bacteria, or cause DO to become reduced as the surface water consumes oxygen while attempting to assimilate other pollutants. The use of agricultural BMPs can reduce the amount of pollutants entering streams, benefiting water quality while maintaining or even enhancing agricultural production. Stakeholders should include agricultural BMPs in their outreach and education efforts and develop a plan for monitoring and enforcement.



The Natural Resources Conservation Service (NRCS) provides technical information for conservation practices through its National Conservation Practice Standards technical guides. These standards are for informational purposes, and should not be used to plan, design or install a conservation practice. Instead, conservation practice standards must be developed by the State of South Carolina to insure that all State and local criteria are met. Table 5-1 is a partial list of NRCS Conservation Practice Standards that can be used for protecting water quality. A full list of standards is provided on the NRCS website, http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/cp/ncps. Selecting and implementing practices that work together to reduce pollutant transport is more effective than using a single practice.

Table 5-1 : Example NRCS Agricultural BMPs

BMP Type	Example	NRCS Conservation Practice Standard	Description
Sediment and Erosion Control	Cover Crop	340	Seasonal protection against soil erosion; increases infiltration.
	Field Border	386	Permanently vegetated borders established around fields and pastures to reduce soil erosion.
	Riparian Cover/Buffers	390, 391	Establishment of grasses, trees and/or shrubs adjacent to water bodies to protect water quality, provide wildlife habitats and to stabilize stream banks and channels.
	Surface Drain, Field Ditch	607	A graded ditch for collecting or intercepting excess surface, such as sheet flow from natural and graded land surfaces or channel flow from furrows, and carry it to an outlet.
Coliform Bacteria Control	Exclusion Fence	382	Barriers installed to limit animal, human and wildlife entry into specified areas and surface waters.
	Access control	472	Restriction of animals, people or vehicles from areas to improve and protect natural resources in the area.
	Watering Facility	614	Installed to keep livestock out of streams and other surface water areas where water quality is a concern.
Agrichemical Control	Integrated Pest Management	595	A site-specific pest management plan to prevent or mitigate off-site pesticide risks to water quality, soil, water, air, plants, animals and humans.
Nutrient Control	Nutrient Management	590	Management of amount, placement and timing of plant nutrients to obtain optimum yields and minimize the risk of surface and groundwater pollution.

Figure 5-1: Photo Example of a Field Border

Figure 5-2: Photo of a Cattle Exclusion Fence

Figure 5-3: Photo of a Watering Facility

These NRCS BMPs for Agriculture and other agricultural BMPs will reduce both *E. coli* and DO impairments in the watershed.

5.5 BEST MANAGEMENT PRACTICES FOR TIMBER HARVESTING

Approximately 60% of the Lake Swamp watershed consists of forest or woods. Recent timber harvesting and burning in some areas of the watershed was evident from the field survey. Road access, harvesting, burning and regeneration of timber are activities that have the potential to contribute to nonpoint source pollution by adding sediment, nutrients, organics, pesticides and elevated temperatures to streams. The South Carolina Forestry Commission provides a BMP Manual for Forestry (http://www.state.sc.us/forest/bmpmanual.pdf) with guidelines designed to minimize impacts on water quality.

Stakeholders should include Timber Harvesting BMPs in their outreach and education efforts and develop a plan for monitoring and enforcement.

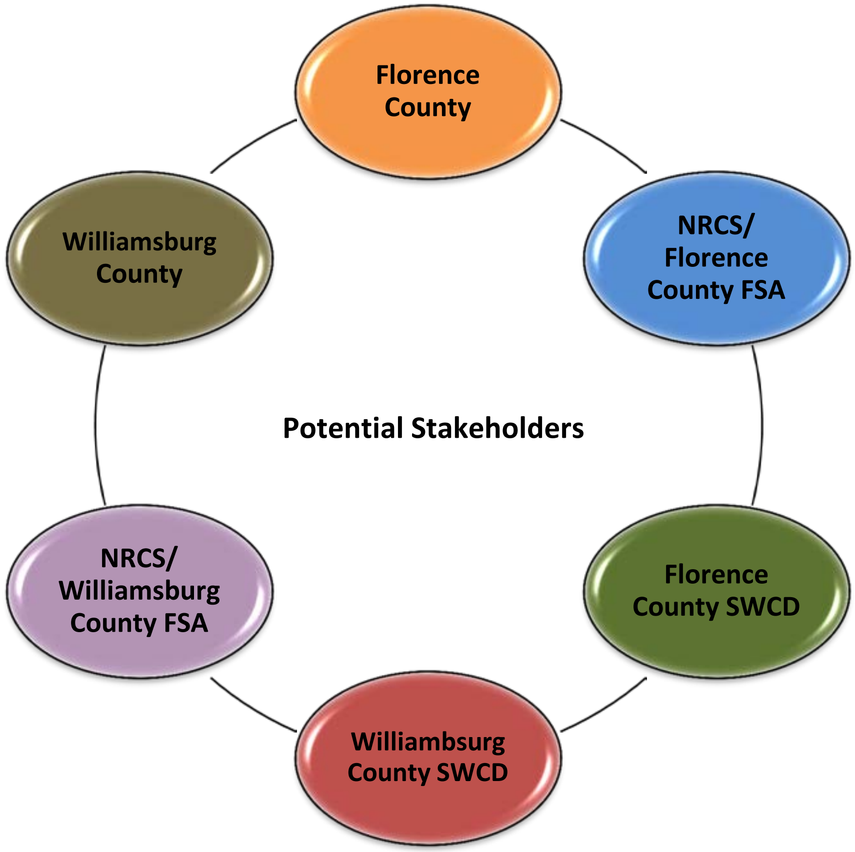
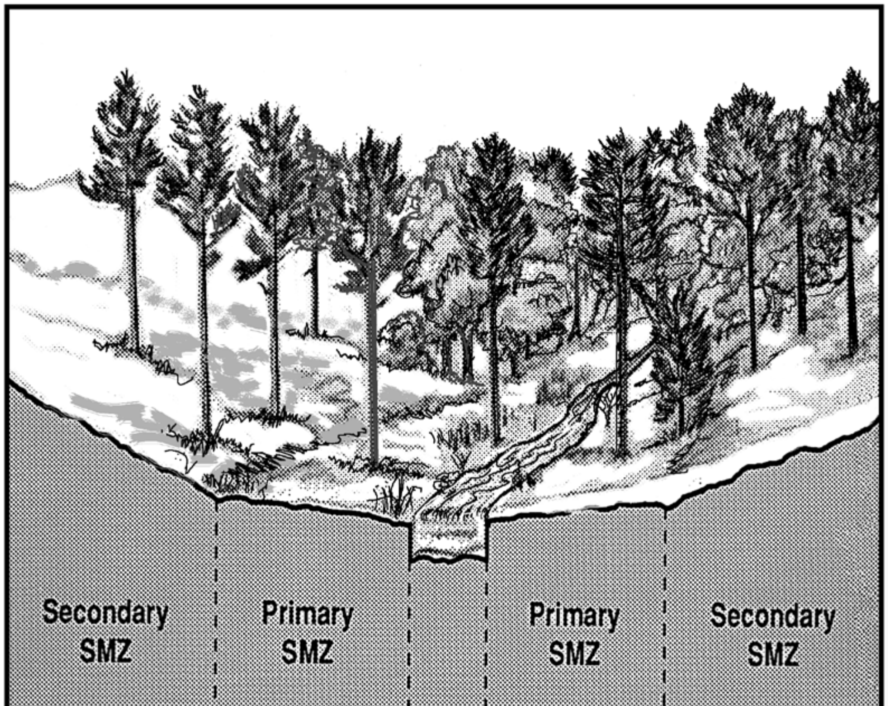


Table 5-2 : Example BMPs for Timber Harvesting

BMP	Description
Streamside Management Zones (SMZs)	Forest management activities are restricted within the Primary and Secondary SMZs (Figure 5-4). (Similar to Riparian Buffers listed in previous table.)
Stream Crossings	Recommendations for stream crossings to assure minimum impacts on water flow and aquatic organisms.
Forest Road Construction	Guidelines for designing roads to minimize the amount of sediment entering stream channels.
Timber Harvesting	Promotes proper planning, execution and follow up to minimize water quality impacts of harvesting.
Reforestation	Recommendations for regeneration of harvested site to decrease erosion, water yield, and storm flow.
Prescribed Burning	Guidance for planning and conducting prescribed burning to reduce impact on water quality.
Herbicides and Insecticides	Guidance for the use of herbicides and insecticides to protect water quality.

Figure 5-4: Diagram of Recommended SMZ widths for perennial and intermittent streams*



Percent Slope Perpendicular to Stream	Width of SMZ on each side (feet)		
	Primary	Primary (TROUT)	Secondary
Less than 5%	40	40	0
5% - 20%	40	80	40
21% - 40%	40	80	80
Greater than 40%	40	80	120

* *Perennial streams are identified by well-defined banks and natural channels, and have continuously flowing water most years. Intermittent streams also have well-defined banks and natural channels, but typically have flowing water from a headwater source for only a portion of the year.*

These BMPs for Timber Harvesting and other BMPs provided in the South Carolina Forestry Commission BMP Manual will reduce both *E. coli* and DO impairments in the watershed.

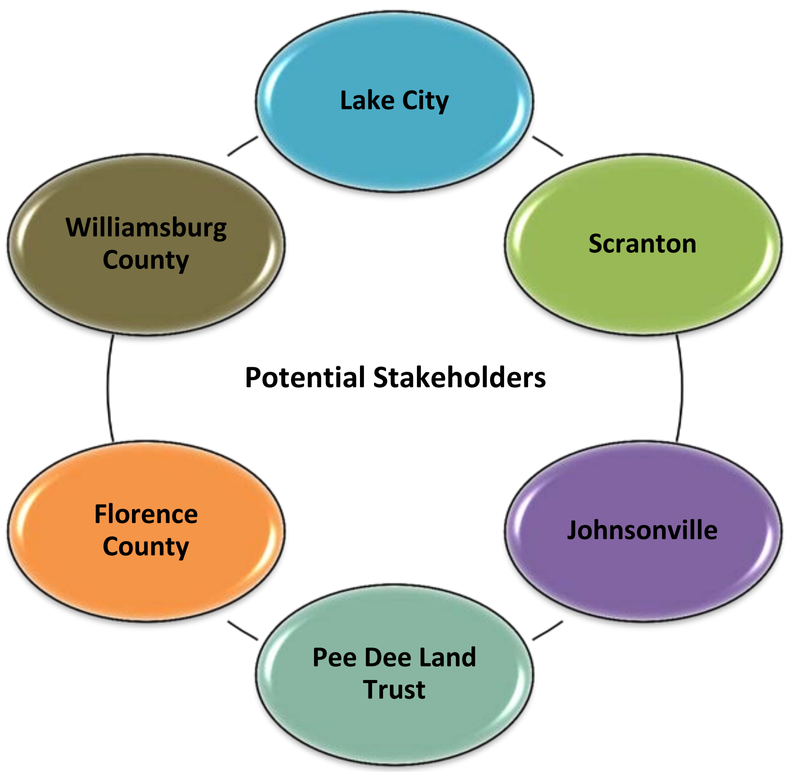
5.6 CONSERVATION EASEMENTS IN RIPARIAN AREAS

Riparian areas are lands immediately adjacent to streams, lakes or other surface waters. Riparian vegetation provides water quality protection by filtering runoff and groundwater before it enters surface waters. This watershed plan focuses on placing riparian areas in conservation easements for the purposes of protecting water quality; however, other lands are also eligible for conservation easements.

Conservation easements are legal agreements between a landowner and a land trust that restricts certain uses on a piece of property in order to protect specific conservation values. In return for donation of a conservation easement, the landowner may be eligible for substantial tax benefits through the reduction of federal income and estate taxes and South Carolina income and property taxes.

Under a conservation easement, landowners typically retain the right to engage in agricultural activities, hunting, fishing, managing ponds, and other low-impact recreational activities, but may forfeit commercial timber harvesting in a wide vegetated buffer along a stream. The easement is intended to protect the conservation values (e.g., riparian buffer for water quality) while allowing a landowner to generate revenue from the land in a compatible way, and maintain land in the family for future generations.

Lake Swamp watershed Stakeholders should investigate opportunities to promote the conservation, preservation and restoration of riparian buffers.



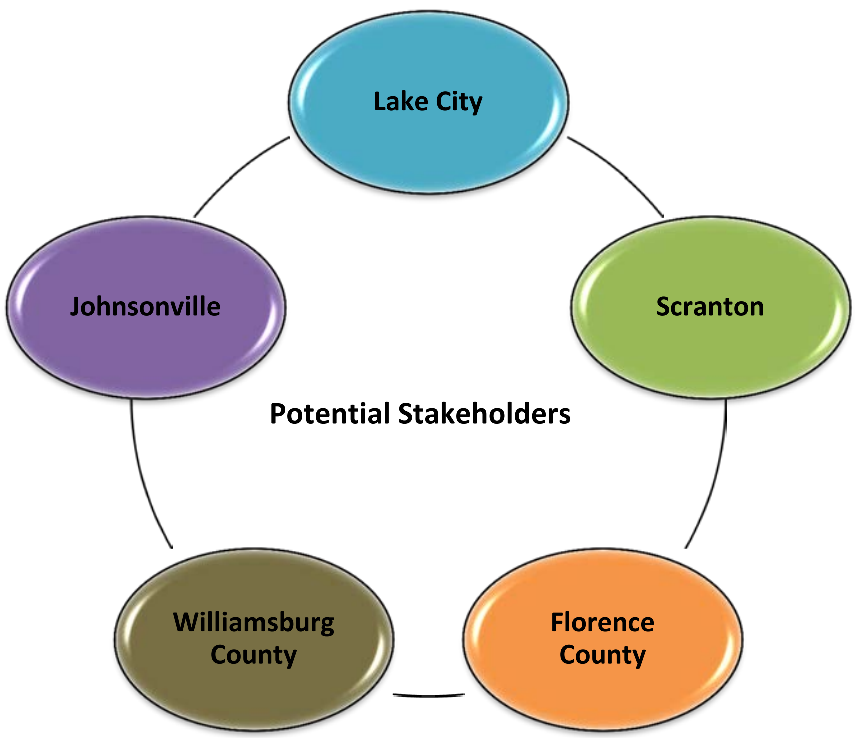
Private landowners holding riparian tracts with bottomland hardwoods or cypress/tupelo swamps should be provided information concerning placing these lands into conservation easements to maintain the riparian buffer in its natural state in perpetuity, thereby protecting the water quality in the Lake Swamp watershed. Additional information on Conservation Easements can be found in Appendix F, 2015 Pee Dee Land Trust Guide to Land Protection and Conservation Easements. A list of land trusts serving South Carolina can be found at the South Carolina Conservation Bank website: http://sccbank.sc.gov/Application/Pages/QualifiedEntities.aspx. Implementing Conservation Easements in Riparian Areas will help reduce both *E. coli* and DO impairments in the watershed.

5.7 STRUCTURAL BMPS

Unlike conventional stormwater pollutants, bacteria are living organisms that can be inactivated without being removed. They can be inactivated or removed through sorption (binding or attachment to a substance), sedimentation, filtration, predation and UV light. Bacteria may survive in sediments that can become re-suspended by turbulent water, resulting in increased bacterial concentrations during storm events. In effect, all BMPs that prevent erosion and/or reduce runoff volume and sediment will reduce bacteria loads to the receiving water.

BMPs should be designed to maximize exposure to sunlight, provide habitat for predation by other microbes, provide surfaces for sorption, provide filtration and/or allow sedimentation.

Structural BMPs will help remove bacteria from pet waste and assist with other pollutants typically found in urban runoff (Section 2.4.3.1). Municipal Stakeholders should establish urban design guidelines and standards applicable to development and redevelopment projects to encourage the use of structural BMPs to treat stormwater runoff for bacteria. (See Table 5-3 below.)



Numerous published studies of BMPs indicate that wet ponds, wetlands and infiltration practices provide the highest bacterial removal rates. Stormwater BMPs are often used in combination, creating a treatment train for enhanced performance. For example, a vegetated swale or grass strip may provide pretreatment for a bioretention system by reducing sediment loading to the bioretention area.

No single stormwater BMP will be applicable for all situations. The BMP selection process takes into account numerous factors, including size of the drainage area, and the surface area required for the BMP. Some BMPs are ideal for microscale use in urban areas. Bioretention areas, commonly known as a rain garden, can be worked into most landscaping plans. Along with bacteria removal, they provide good aesthetic value and also contribute to groundwater recharge, stormwater peak flow and volume control.

Table 5-3: Structural BMPs for Bacterial Removal

BMP	Description	Bacteria Removal Mechanism
Detention (Dry) Pond	Designed to receive stormwater from a drainage area and discharge it at a reduced flow rate over a determined period of time, allowing particles and associated pollutants to settle.	Settling and sedimentation.
Retention (Wet) Pond	Open water ponds constructed to store and treat stormwater runoff.	Settling and sedimentation, solar irradiation, and natural predation.
Constructed Wetlands	Designed to receive stormwater runoff for treatment, and to replicate natural wetland ecosystems for efficient and reliable pollutant removal.	Settling and sedimentation, solar irradiation, and natural predation.
Bioretention Areas (Rain Gardens)	Excavated shallow surface depressions that utilize engineered soils and vegetation to capture and treat stormwater runoff.	Sedimentation, sorption and filtration.
Infiltration Systems	Designed to capture and temporarily store stormwater runoff in a rock-filled chamber with no outlet, allowing for infiltration into the underlying soil.	Soil adsorption and filtration.
Filtering Practices	Designed to capture and temporarily store stormwater runoff, and treat it by passing runoff through an engineered filter media of sand, compost, soil or a combination to filter out sediment.	Settling, sedimentation, straining, sorption and filtration.
Enhanced Dry Swales	Vegetated open channels designed to attenuate and treat stormwater runoff within cells formed by check dams or other means.	Settling and filtering by vegetation and soils.

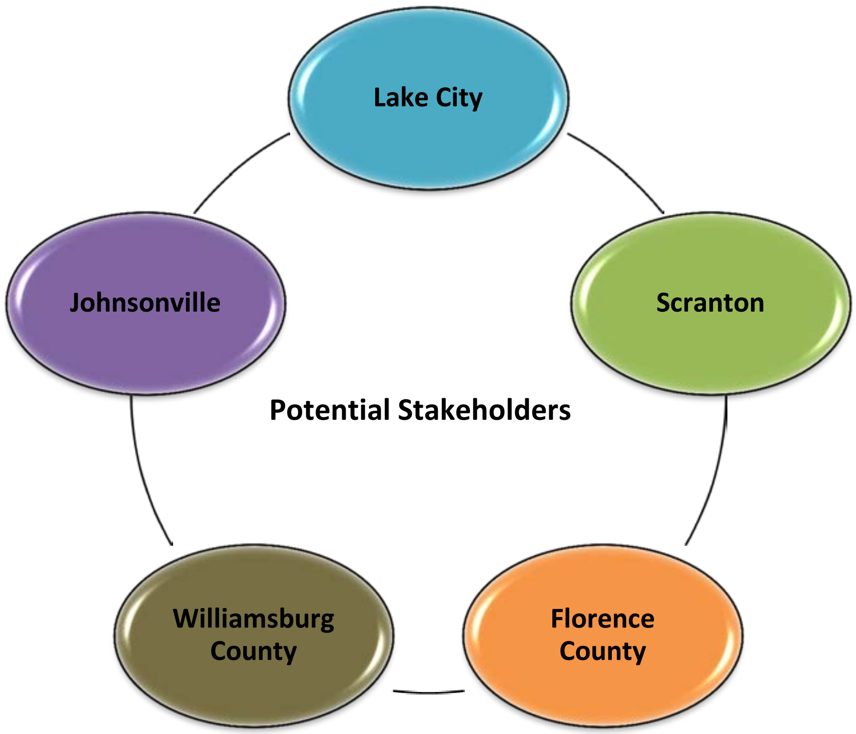
Figure 5-5: Bioretention at Ronald E. McNair Memorial Park, Lake City, SC

5.8 WATER QUALITY MONITORING PLAN

SCDHEC water quality monitoring data for the Lake Swamp Watershed is available since 1999, but not all stations were sampled each year (see Section 3.1.1). Beginning in 2011, monitoring was discontinued at all but one WQM station. SCDHEC currently collects data at PD-087 on Lake Swamp at SC 341, 2.6 Mi. W. of Johnsonville. This WQM station is in the Lower Lake Swamp subwatershed, which collects discharge from Camp Branch, Singleton Swamp and Upper Lake Swamp subwatersheds and is the outlet for the Lake Swamp watershed.

This watershed assessment has been provided as an evaluation of data currently available and has identified limited conclusions based on incomplete data. This report has recommended that further monitoring is needed in order to fill in data gaps and determine with certainty whether or not these waters are actually impaired.

Additional water quality monitoring for *E. coli* and Dissolved Oxygen should be conducted to characterize water quality conditions in each subwatershed to document long-term water quality trends, and eventually BMP progress. The Lake Swamp Stakeholders should develop a Water Quality Monitoring Plan to re-implement monitoring at all six (6) of the SCDHEC-monitored WQM stations in the watershed. The plan should include a Quality Assurance Project Plan (QAPP) for collecting and analyzing the data to meet SCDHEC and EPA standards. The Water Quality Monitoring Plan should be designed to provide sufficient data for the Lake Swamp watershed which can be validated by SCDHEC to determine if the WQM stations should be delisted from the SC 303(d) list or, if impaired, to further define the level of impairment.



5.9 MILESTONE IMPLEMENTATION SCHEDULE

The City of Lake City will have the primary role in the Lake Swamp Watershed Plan. The City will be responsible for projects under its ownership and within its boundaries and will take the lead in coordinating Stakeholder involvement. Each Stakeholder should take part in the Plan based on its area of influence. The following implementation schedule is dependent on Stakeholder input and participation. If a Stakeholder should determine that the proposed plan is not feasible, the schedule may be adjusted. To achieve the full goals of the Lake Swamp Watershed Plan, every effort should be made to implement as much of the proposed plan as possible.

The schedule of implementation will be variable, based on Stakeholder participation, funding sources, and additional monitoring results. This plan provides an overall goal for implementation, but several key factors, including grant cycles, the economy, design development timelines and Stakeholder involvement, may influence the ability to implement the plan as recommended. In addition, the schedule should be revisited annually to determine the practicality of the schedule and revisions based on changes to the overall plan.

There are numerous opportunities for implementation of the BMPs proposed in this plan. The minimum goals of the Watershed Plan are shown in the table below, designated either as Overall Stakeholder Goals, which depend on involvement of multiple Stakeholders, or Lake City Goals. As funding sources become available for work in the watershed, the BMPs identified in this plan should be implemented and completed as soon as possible.

Table 5-4: Implementation Schedule

Year 1	
Overall Stakeholder Goals	**Lake City Goals**
- Conduct Stakeholder collaboration meeting. - Conduct education and outreach. - Begin septic system inventory and investigate funding sources. - Develop a plan for identifying potential areas for conservation easements. - Begin development of comprehensive Water Quality Monitoring Plan.	- Begin stormwater outfall inventory and investigations for IDDE. - Begin sanitary sewer system inspections . - Identify City-owned properties/parks for potential stormwater BMP implementation. - Review upcoming drainage projects for water quality opportunities. - Investigate funding sources.
Years 2-4	
Overall Stakeholder Goals	**Lake City Goals**
- Conduct annual Stakeholder meetings. - Continue education and outreach. - Stormwater outfall investigations for IDDE. - Sanitary sewer system inspections. - Complete septic system inventory and develop outreach plan for maintenance. - Identify agricultural areas for potential BMPs and develop outreach plan. - Identify poor timber harvesting activities and develop outreach plan. - Identify potential areas for buffer preservation and conservation easements. - Identify municipally-owned properties for potential stormwater BMP implementation. - Finalize comprehensive Water Quality Monitoring Plan. - Begin implementation of Water Quality Monitoring Plan	- Continue stormwater outfall inventory and investigations for IDDE. - Continue sanitary sewer system inspections . - Develop sanitary sewer system rehab plan. - Develop structural BMP design guidelines and standards for urban development. - Identify potential structural BMPs for City-owned properties/parks. - Implement water quality improvements for upcoming drainage and flood mitigation projects. - Identify funding requirements and secure funding.

Years 5-7	
Overall Stakeholder Goals	**Lake City Goals**
- Conduct annual Stakeholder meetings. - Continue education and outreach. - Sanitary sewer system rehab. - Complete stormwater outfall investigations for IDDE. - Conduct outreach for septic system for maintenance and rehab. - Implement outreach plan for Agricultural and Timber Harvesting BMPs. - Pursue conservation easements for buffer preservation. - Develop designs for structural BMPs on municipally-owned property. - Continue implementation of Water Quality Monitoring Plan. - Review results of Water Quality Monitoring Plan and update as required.	- Complete stormwater outfall inventory and investigations for IDDE. - Develop a schedule for ongoing stormwater outfall investigations. - Begin sanitary sewer system rehab. - Develop designs for structural BMPs on City-owned properties/parks. - Continue to implement water quality improvements for upcoming drainage and flood mitigation projects. - Begin implementation of structural BMP design guidelines and standards for urban development.

Years 8-10	
Overall Stakeholder Goals	**Lake City Goals**
- Conduct annual Stakeholder meetings. - Continue education and outreach. - Continue scheduled stormwater outfall investigations. - Continue outreach for septic system for maintenance and rehab. - Continue implementation of outreach plan for Agricultural and Timber Harvesting BMPs. - Continue to pursue conservation easements for buffer preservation. - Begin construction of structural BMPs on municipally-owned property. - Continue implementation and review of Water Quality Monitoring Plan. - Re-evaluate management priorities.	- Continue scheduled stormwater outfall investigations. - Continue sanitary sewer system rehab. - Complete construction of structural BMPs on City-owned properties/parks. - Begin BMP performance monitoring of completed BMPs. - Continue to implement water quality improvements for upcoming drainage and flood mitigation projects. - Re-evaluate management priorities.

SECTION 6

REFERENCES

Bolstad and Swank. “Cumulative Impacts of Landuse on Water Quality in a Southern Appalachian Watershed,” 1997

Florence County Comprehensive Plan 2007, Natural Resources Element http://files.florenceco.org/public/Planning/natural_resources_element.pdf

Florence/Darlington Stormwater Consortium (October 12, 2016) http://www.clemson.edu/public/carolinaclear/consortiums/flodar_home/index.html

Gentry, et al. “Loading at or Near Base Flow in a Mixed-Use Watershed.” 2006

Hathaway and Hunt. “Evaluation of Indicator Bacteria Export from an Urban Watershed.” 2010

Kay, D., et al. “Faecal Indicator Organism Concentrations and Catchment Export Coefficients in the UK.” 2008

Line, D.E. “Changes in a Stream’s Physical and Biological Conditions Following Livestock Exclusion,” 2003

Line, et al. “Fecal Coliform Export from Four Coastal North Carolina Areas.” 2008

Pee Dee Land Trust. “2015 Pee Dee Land Trust Guide to Land Protection and Conservation Easements.” http://www.peedeelandtrust.org/images/pdfs/2015_PeeDeeLandTrust_Booklet_webFINAL.pdf

Riggin, et al. South Carolina Department of Natural Resources. “Little Pee Dee-Lumber Focus Area Conservation Plan.” March 2016.

Santee-Wateree Resource Conservation and Development Council. “Dissolved Oxygen Assessment.” March 2006.

Santee-Wateree Resource Conservation and Development Council. “Fecal Coliform TMDL and Load Reduction Management Plan, Big Swamp, South Carolina.” May 2006. http://www.scdhec.gov/HomeAndEnvironment/Docs/tmdl_bgswmp_fc.pdf

Schoonover and Lockaby. “Land Cover Impacts on Stream Nutrients and Fecal Coliform in the Lower Piedmont of West Georgia.” 2006

South Carolina Department of Health and Environmental Control. “Regulation 61-68, Water Classifications & Standards, effective June 27, 2014.” http://www.scdhec.gov/Agency/docs/water-regs/R.61-68.pdf

South Carolina Department of Health and Environmental Control. "Regulation 61-69, Classified Waters, effective June 22, 2012." http://www.scdhec.gov/Agency/docs/water-regs/R.61-69.pdf

South Carolina Department of Health and Environmental Control. "Total Maximum Daily Loads for Fecal Coliform for Hills Creek, Lynches River, North and South Branch of Wildcat Creek, Flat Creek, Turkey Creek, Nasty Branch, Gulley Branch, Smith Swamp, Little Pee Dee River, Maple Swamp, White Oak Creek, and Chinners Swamp of the Pee Dee River Basin, South Carolina." SCDHEC Technical Report Number: 029-05. September 2005. http://www.scdhec.gov/HomeAndEnvironment/Docs/tmdl_pd_fc.pdf

South Carolina Department of Health and Environmental Control. "Total Maximum Daily Load Document, Jeffries Creek and Tributaries, *Escherichia coli* Bacteria, Indicator for Pathogens." June 2016. http://www.scdhec.gov/HomeAndEnvironment/Docs/Jeffries_Crk_Tribs_ECOLI_TMDL_NODD.pdf

South Carolina Department of Health and Environmental Control. "Total Maximum Daily Load Document, Pocotaligo River and Tributaries, *Escherichia coli* Bacteria, Indicator for Pathogens." September 2013. http://www.scdhec.gov/HomeAndEnvironment/Docs/Pocotaligo_Ecoli.pdf

South Carolina Department of Health and Environmental Control. "Watershed Water Quality Assessment, Pee Dee River Basin." December 2007. http://www.scdhec.gov/HomeAndEnvironment/Docs/pd-005-07.pdf

South Carolina Forestry Commission. "Best Management Practices for Forestry." Undated. http://www.state.sc.us/forest/refbmp.htm September 26, 2016.

South Carolina Statistical Abstracts. http://abstract.sc.gov/chapter14.html

Todd. "Instream Swamps and their Effect on Dissolved Oxygen Dynamics within Blackwater Streams of the Georgia Coastal Plain: Role of Hydrology and Sediment Oxygen Demand." 2001

Tufford and Marshall. "Fecal Coliform Source Assessment in a Small, Mixed Land Use Watershed." 2002

United States Census Bureau. http://www.census.gov/ July 6, 2016.

USDA Natural Resources Conservation Service, MLRA Explorer, MLRA 153A – Atlantic Coast Flatwoods. http://apps.cei.psu.edu/mlra/ April 18, 2016.

USDA Natural Resources Conservation Service, National Conservation Practice Standards. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/cp/ncps/ October 4, 2016.

USDA Natural Resources Conservation Service, Web Soil Survey. http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm July 1, 2016.

Vidon and Campbell. "*Escherichia coli* and Fecal Coliform Export Rates in Two Agricultural Watersheds of the U.S. Midwest." 2009

References for GIS Data:

AECOM, Lake City, Storm Sewer Survey, 3/24/2016. *(Stormwater Map)*

Florence County SC parcels data, 2009 and Williamsburg County SC parcels data, sorted by municipal name and county names. *(Municipal and County Owned Property)*

National Wetlands Inventory, Wetlands Mapper, https://www.fws.gov/wetlands/Data/Mapper.html, 2016 and Federal Emergency Management Agency, FEMA Flood Map Service Center, https://msc.fema.gov/portal, Titles: 45041C_20141216, Publication Date 12/16/2014 and 45089C_20121116, Publication Date 11/16/2012. *(Hydrology)*

National Wetlands Inventory, Wetlands Mapper, https://www.fws.gov/wetlands/Data/Mapper.html Publication Data 2016. *(Wetlands)*

South Carolina Department of Health and Environmental Control. GIS Data Clearinghouse, http://www.scdhec.gov/HomeAndEnvironment/maps/GIS/GISDataClearinghouse/
- GIS Data Layers
- NPDES Points – Title: NPDES. Publication Date 2001
- Landfills – Title: swaste. Publication Date 2006
- Water Quality Monitoring Stations – Title: Approved TMDL Sites. Publication Date 2016

South Carolina Department of Natural Resources. http://www.dnr.sc.gov/pls/gisdata/download_data.login,GIS Data Clearinghouse, Wetlands (Land Use/Land Cover) data for Olanta, Mill Bay, Scranton, Lake City West, Lake City East, Prospect Crossroads, Johnsonville, Hebron Crossroads, Workman, Kingstree, Fowler and Indiantown Quads, dated 2002. After the GIS data was downloaded and compiled it was visually checked and revised using the most recent available aerial photography. *(Existing Land Use)*

URS, Lake City Infrastructure Assessment. *(Sanitary Sewer Map)*

USDA, Geospatial Data Gateway, Title: 10 digit Watershed Boundary Dataset in HUC8, https://gdg.sc.egov.usda.gov/

USDA, Web Soil Survey, http://www.dnr.sc.gov/pls/gisdata/download_data.login, 2016. *(Hydrologic Soil Groups)*

APPENDIX A

Lake Swamp Watershed Overview Map

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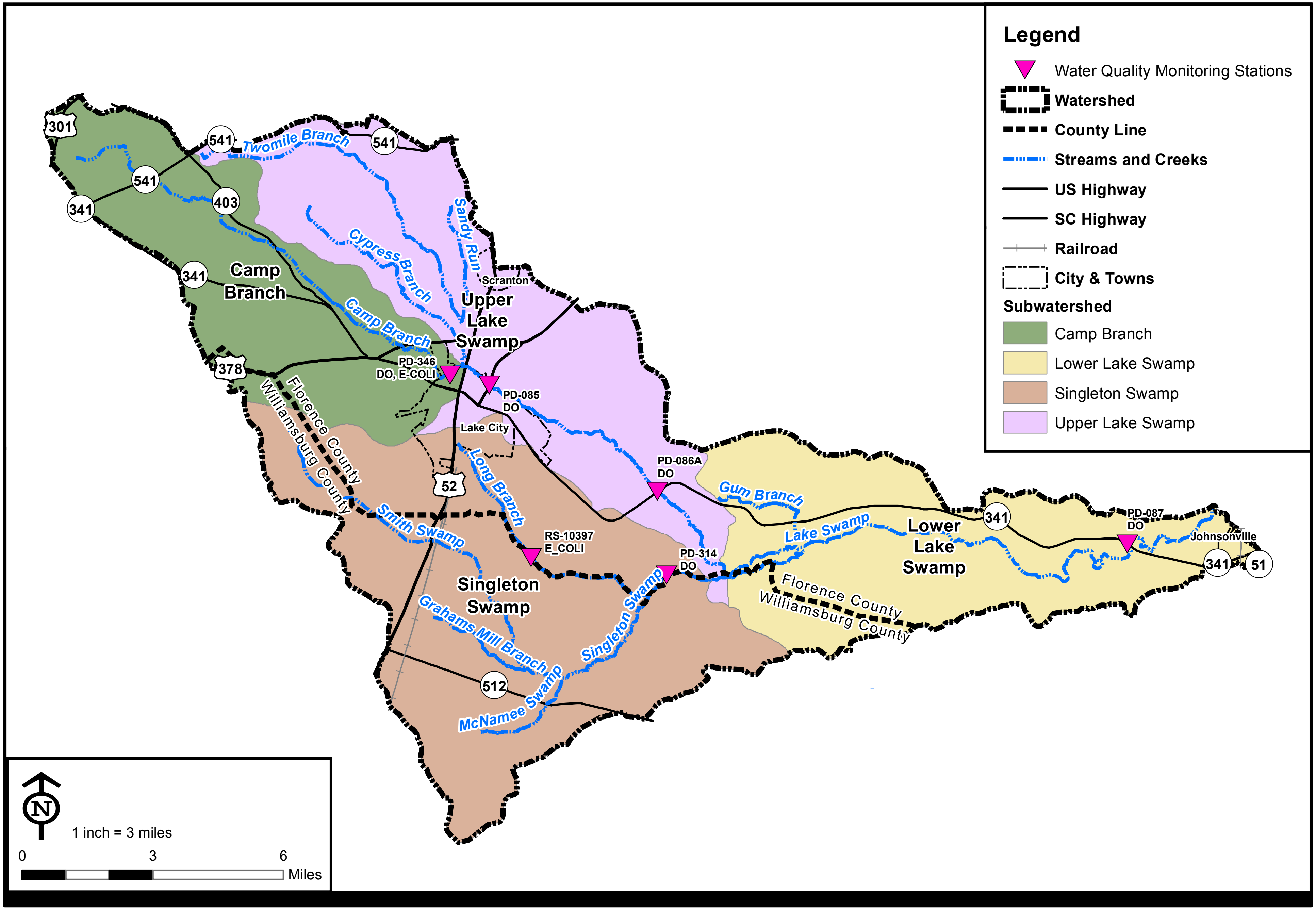

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LAKE SWAMP WATERSHED OVERVIEW MAP

Lake Swamp Watershed Plan
CITY OF LAKE CITY
Project No.: 60492884
Date: 2016-10-04

APPENDIX B

Lake Swamp
Subwatershed Maps

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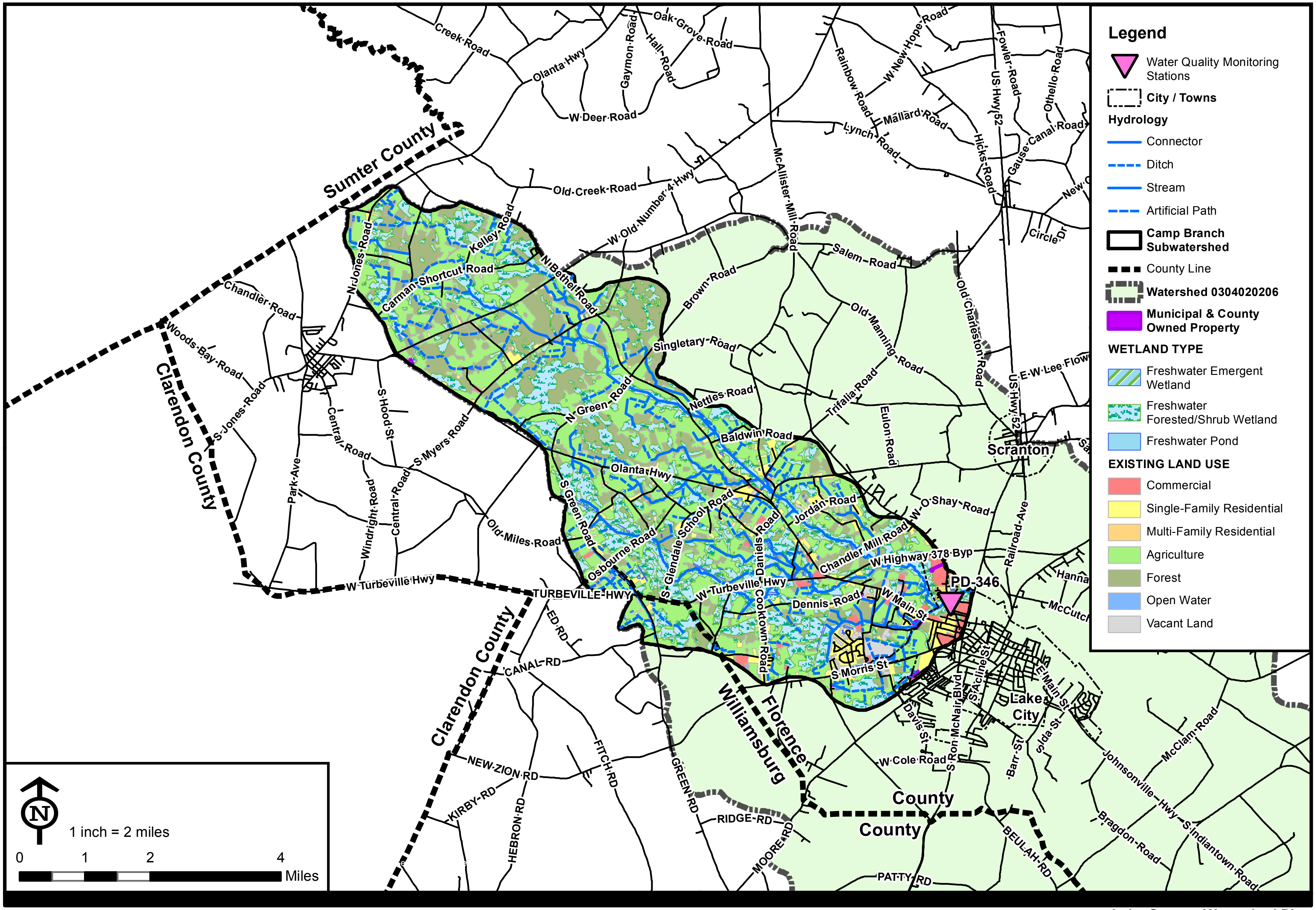

CAMP BRANCH SUBWATERSHED MAP

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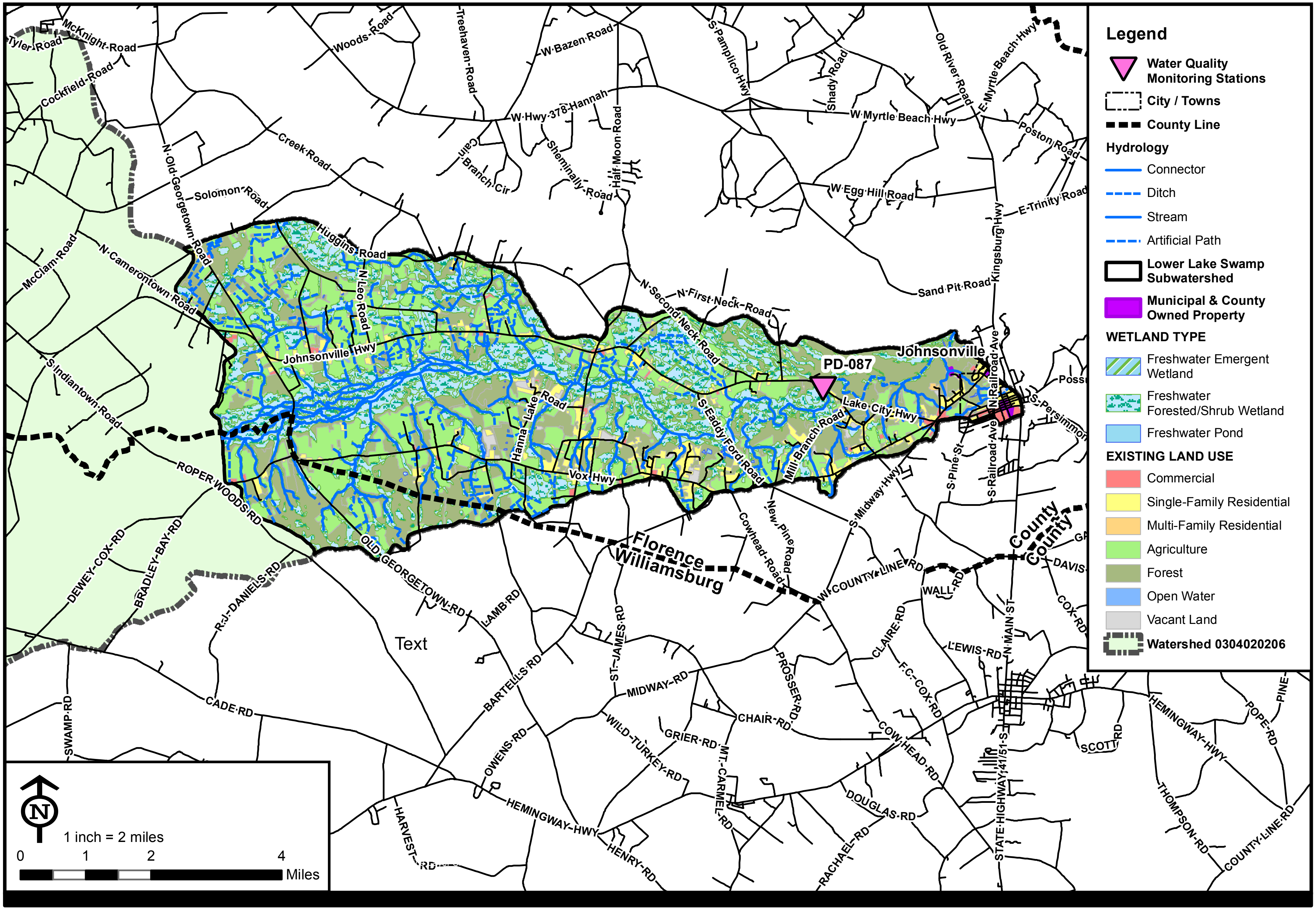

LOWER LAKE SWAMP SUBWATERSHED MAP

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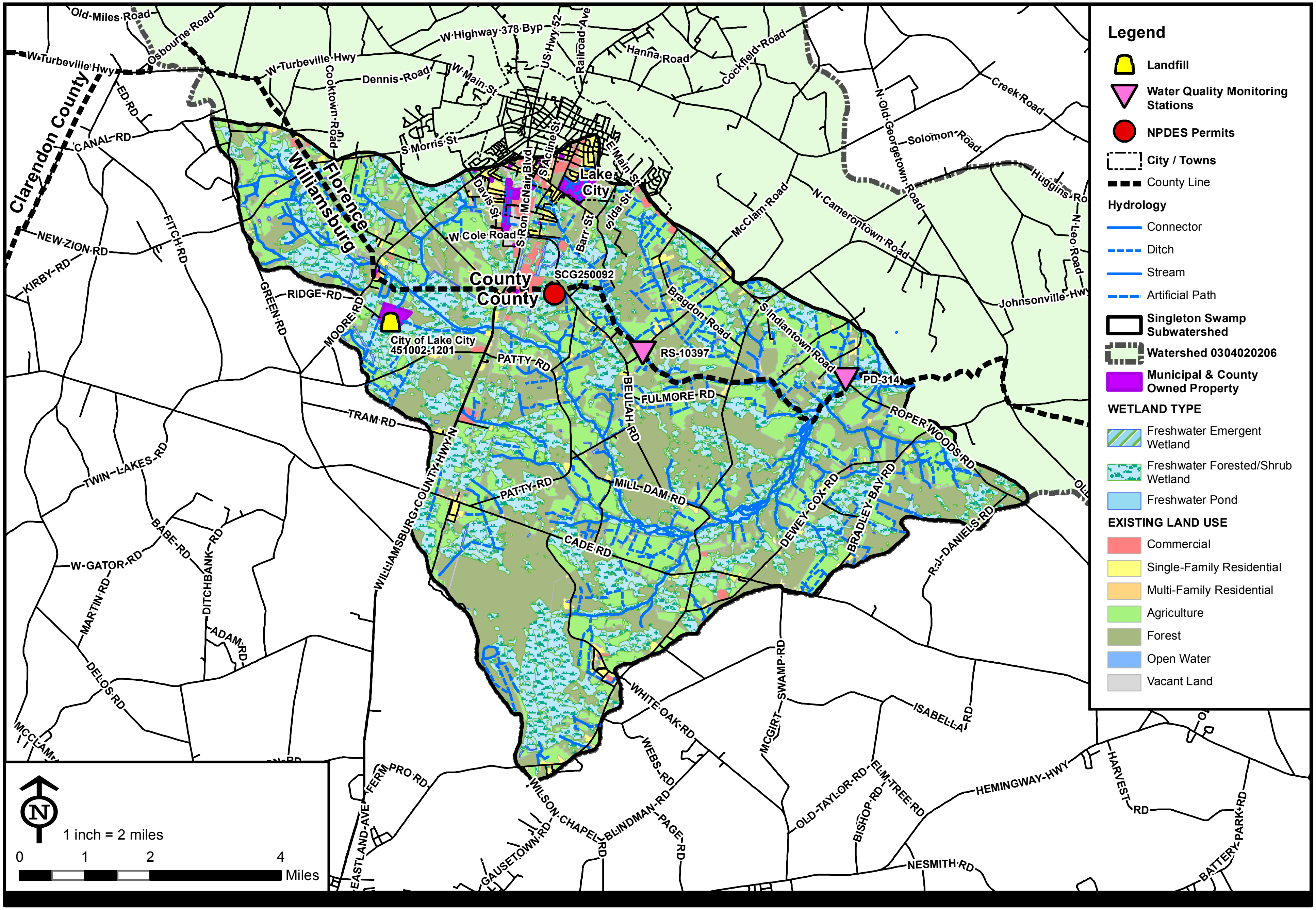

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SINGLETON SWAMP SUBWATERSHED MAP

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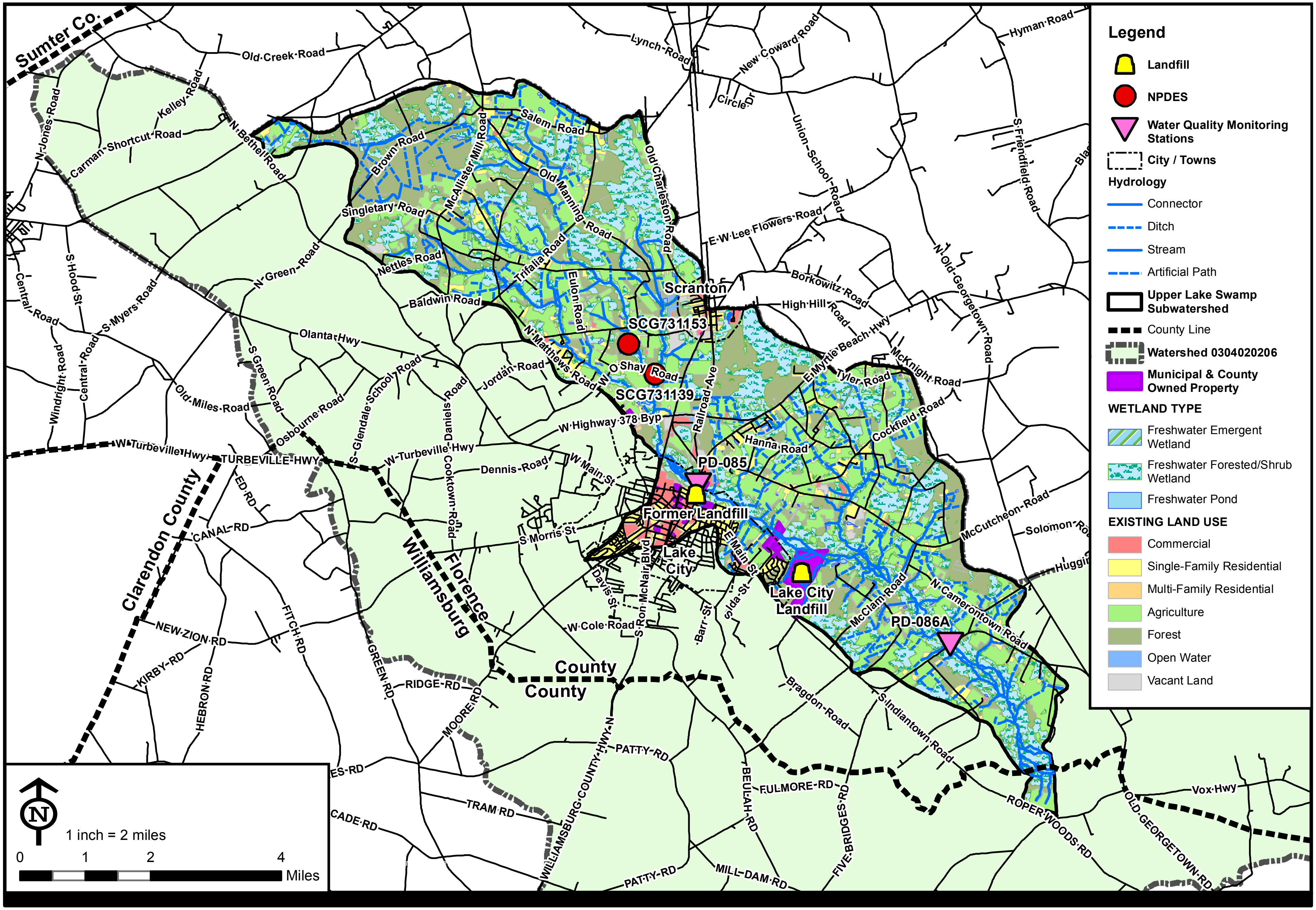

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UPPER LAKE SWAMP SUBWATERSHED MAP

Lake Swamp Watershed Plan
CITY OF LAKE CITY
Project No.: 60492884
Date: 2016-10-04

APPENDIX C

Lake Swamp Watershed
Soils Maps

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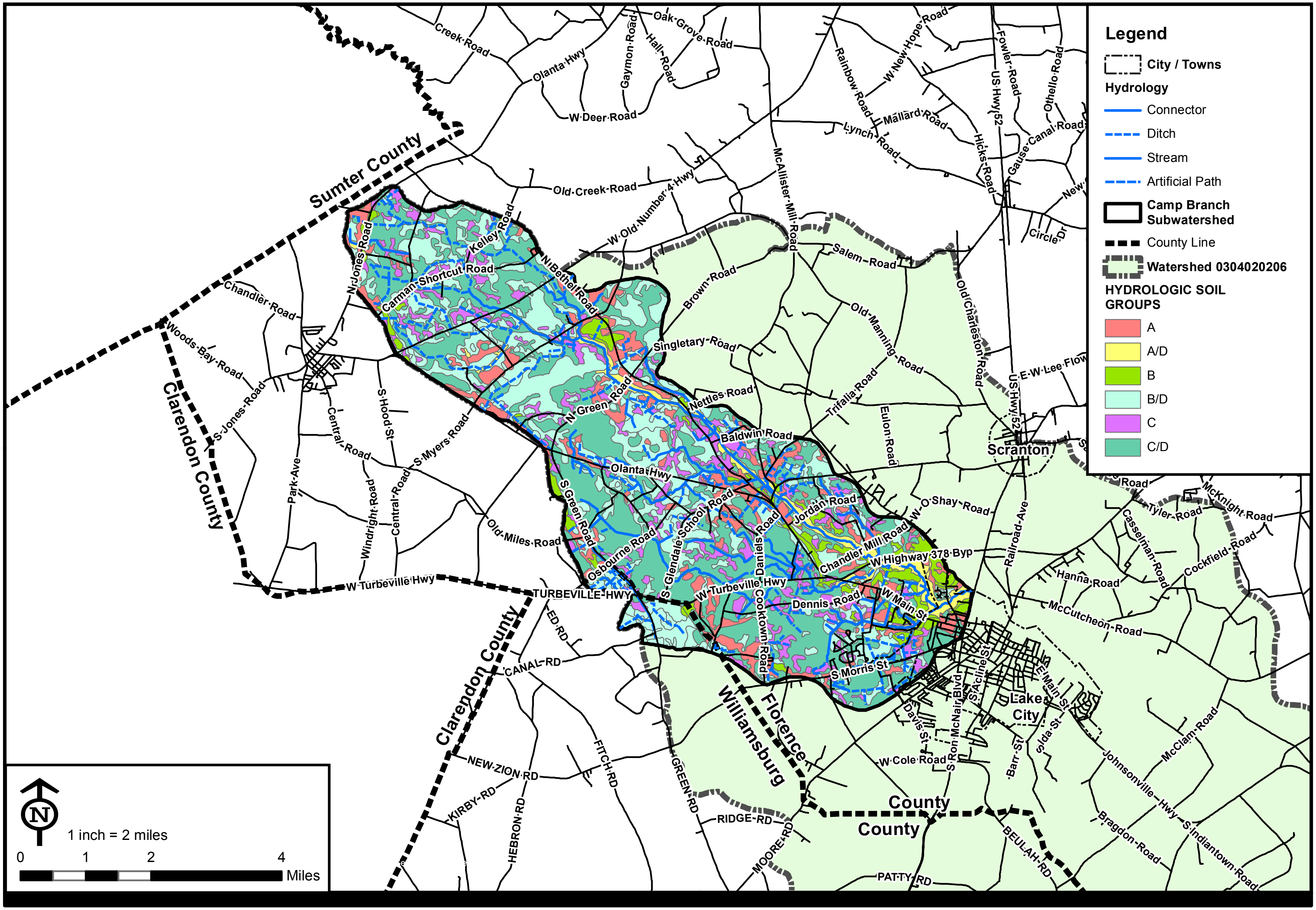

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CAMP BRANCH SUBWATERSHED SOILS MAP

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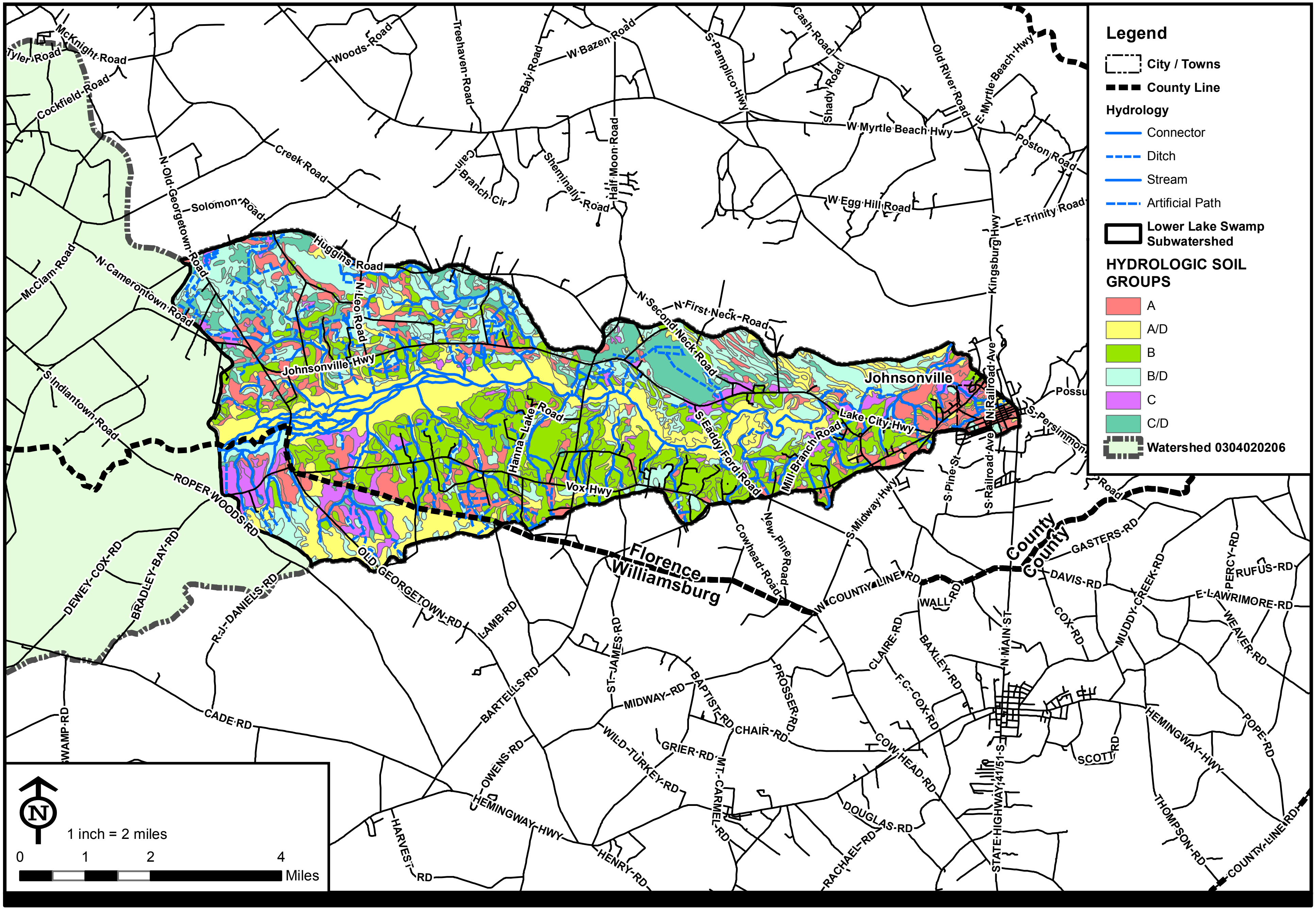

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LOWER LAKE SWAMP SUBWATERSHED SOILS MAP

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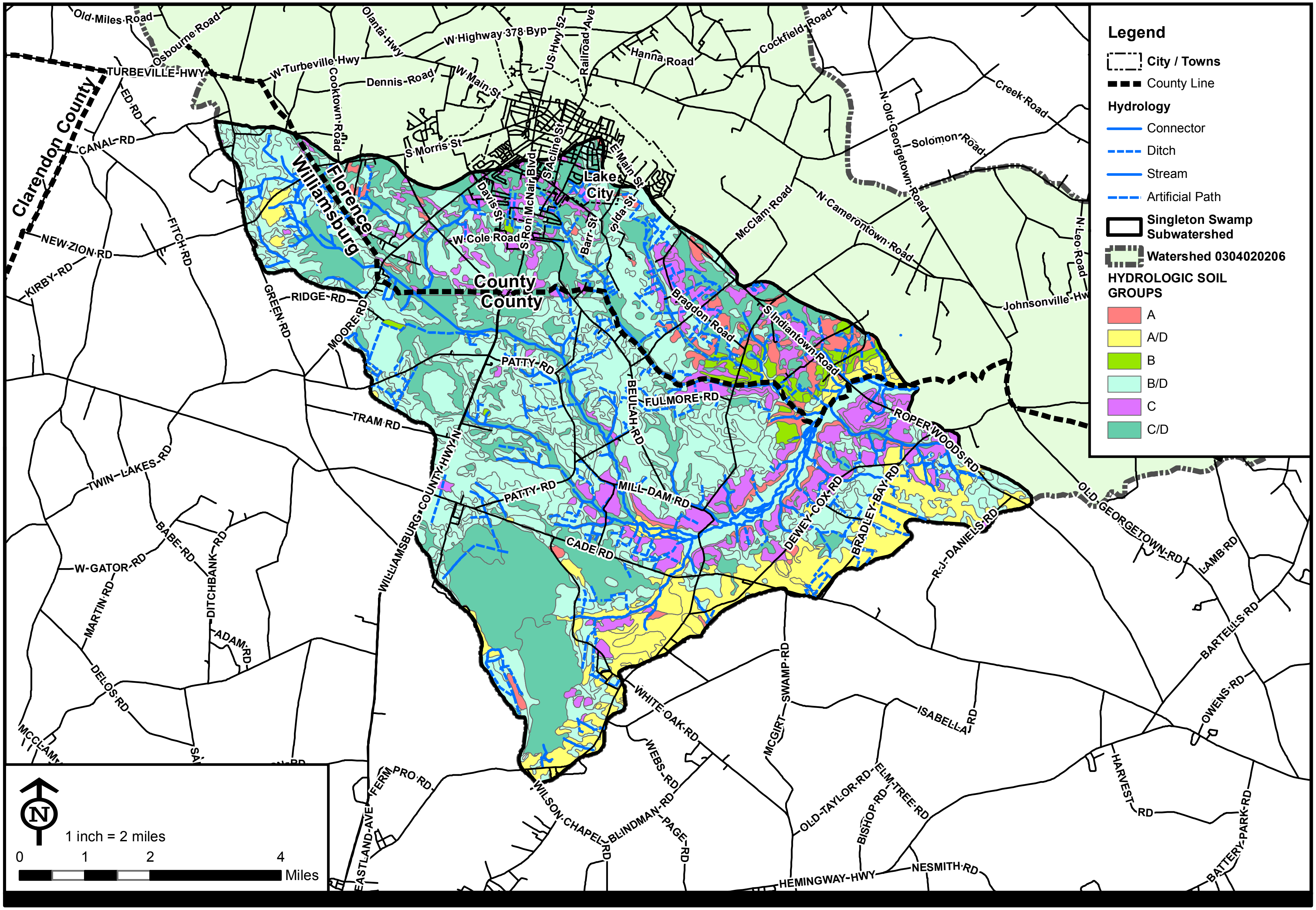

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SINGLETON SWAMP SUBWATERSHED SOILS MAP

Lake Swamp Watershed Plan
CITY OF LAKE CITY
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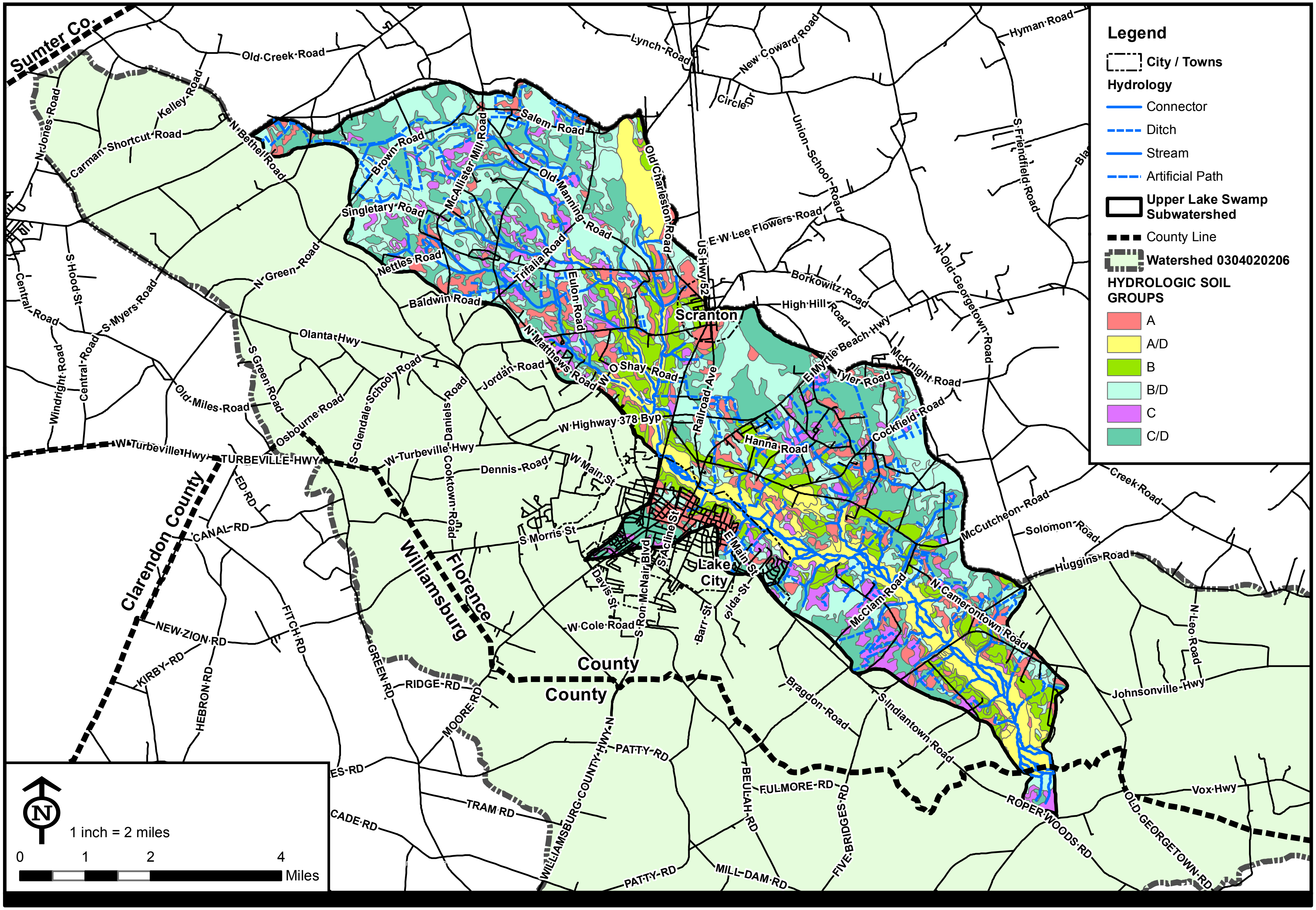

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UPPER LAKE SWAMP SUBWATERSHED SOILS MAP

Lake Swamp Watershed Plan
CITY OF LAKE CITY
Project No.: 60492884
Date: 2016-10-04

APPENDIX D

Lake City
Sanitary Sewer System Map

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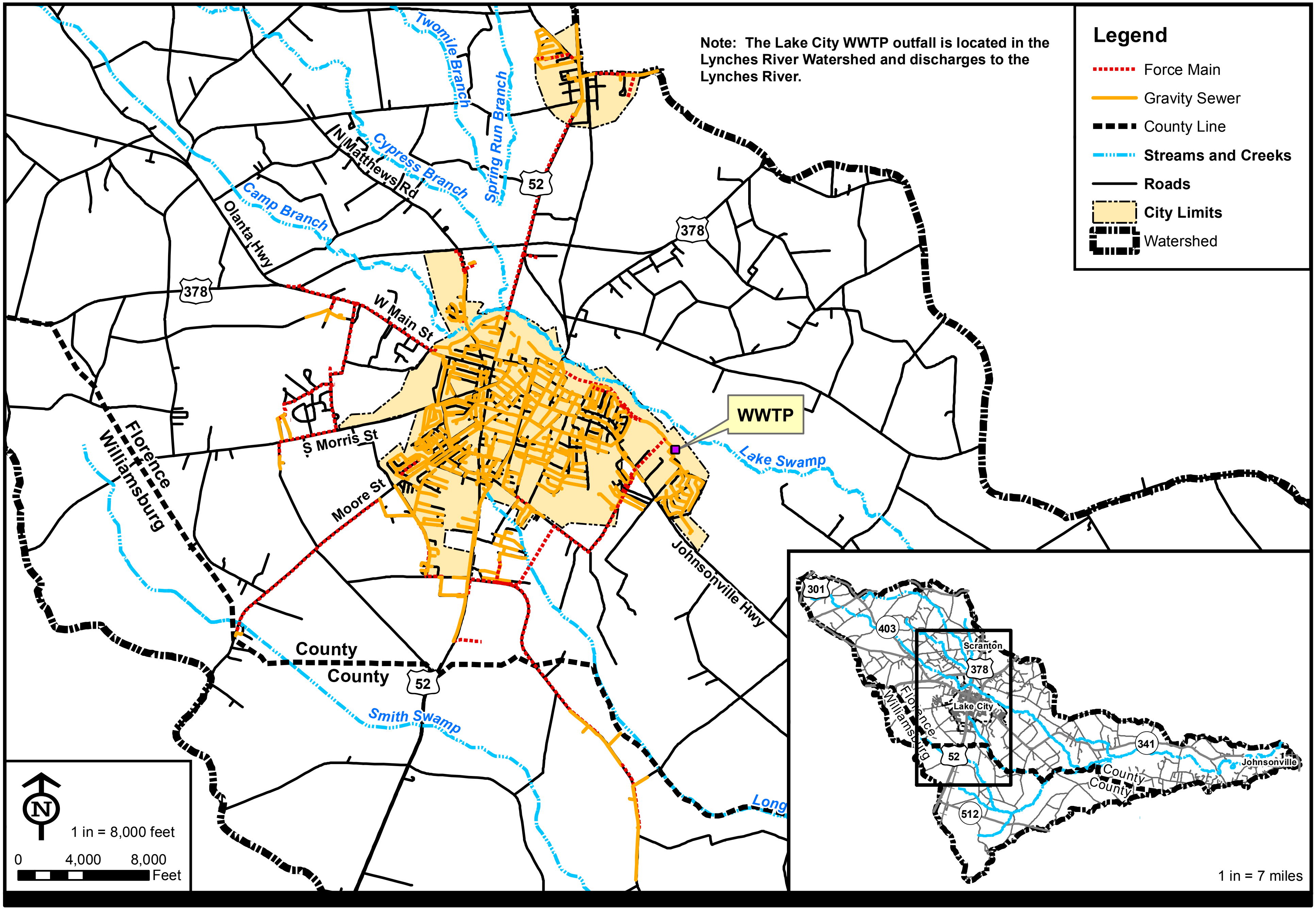

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LAKE CITY SEWER SYSTEM MAP

Lake Swamp Watershed Plan
CITY OF LAKE CITY
Project No.: 60492884
Date: 2016-10-04

APPENDIX E

Lake City
Stormwater System and Outfalls Map

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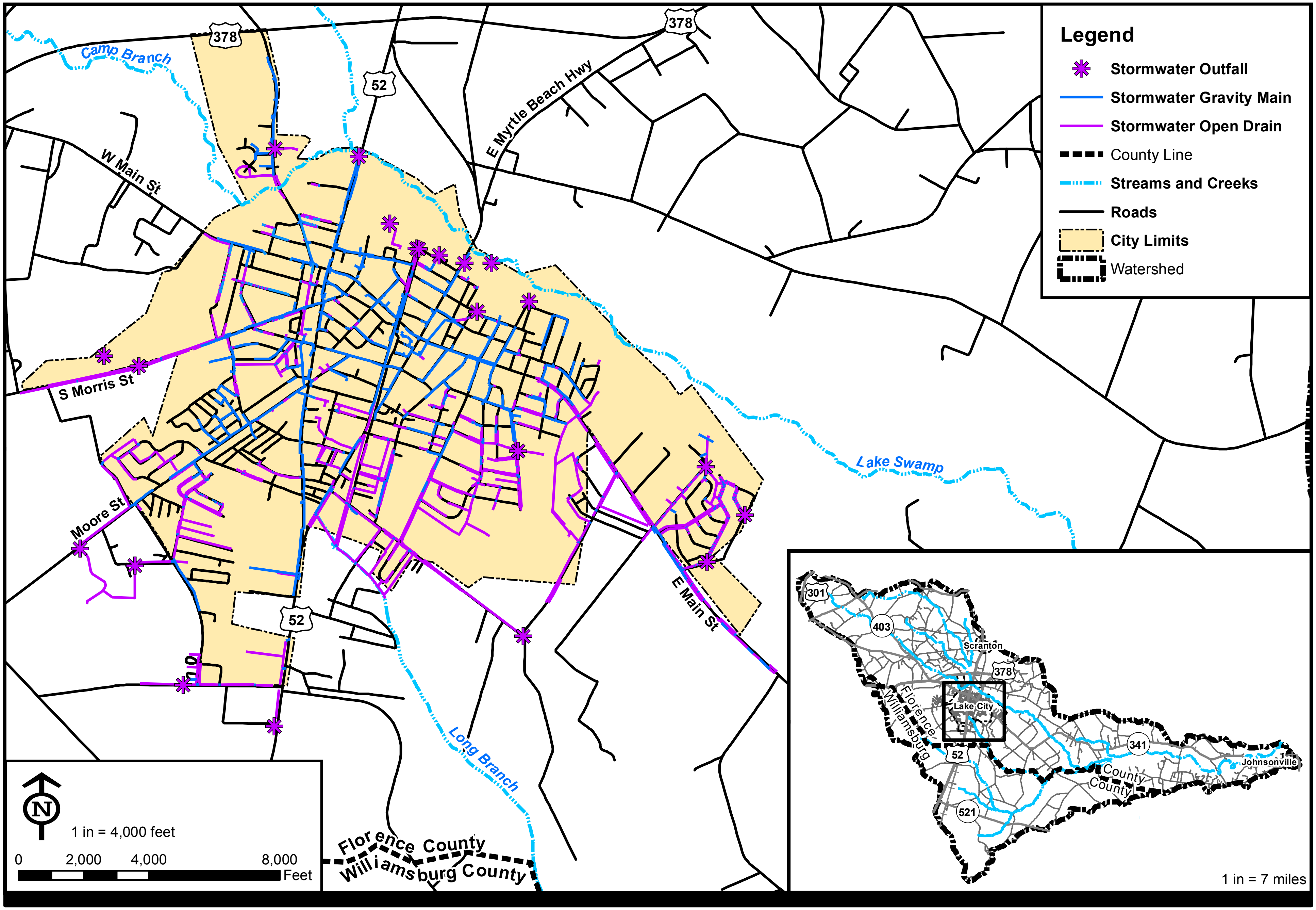

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LAKE CITY STORMWATER SYSTEM AND OUTFALLS MAP

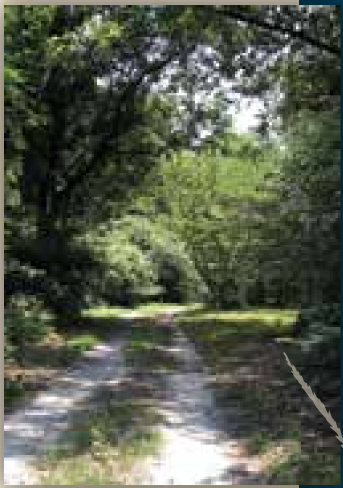
Lake Swamp Watershed Plan
CITY OF LAKE CITY
Project No.: 60492884
Date: 2016-10-04

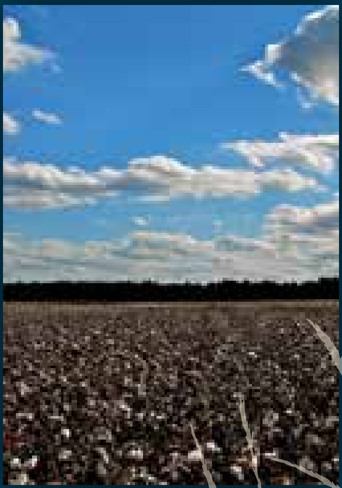
APPENDIX F

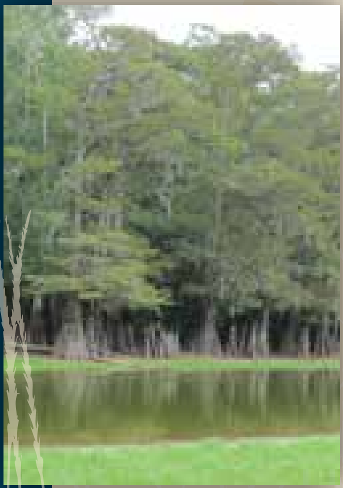
2015 Pee Dee Land Trust Guide to Land Protection and Conservation Easements

Pee Dee Land Trust

PROTECTING THE PAST, ENSURING THE FUTURE







A guide to land protection and conservation easements

Pee Dee Land Trust

Pee Dee Land Trust

Established in 1999 as a wetlands mitigation service project of the Pee Dee Resource Conservation and Development Council, the organization expanded its efforts and its geographic reach, growing into an independent organization with precedent-setting success in land protection. Its impact as an organization will be visible for generations to come.

Mission

The mission of the Pee Dee Land Trust is to conserve, and to promote an appreciation of, the significant natural, agricultural, and historical resources of the Pee Dee Region in South Carolina.

We work toward this mission through education and outreach and through voluntary land protection projects. The organization – its board, staff, and supporters – is dedicated to maintaining the interconnectedness of people and the land.

Through protecting the past, we help ensure the future.

Identifying the Pee Dee

The Pee Dee has continued to be one of the most productive agricultural areas in the state, even as farming has evolved over time. It is also a region with subtle geographic variations, places that intrigue botanists and expanses that entice outdoorsmen for hunting or exploring the black-water swamps and creeks that intermingle with red rivers and high bluffs. Travelers are intrigued by the crossroads communities and the tree-lined roads. They trace their ancestry back to the region – counting among their kin Revolutionary War soldiers who fought with General Francis Marion, leaders and laborers in driving the economy of the region and state.

The long-time farming operations have kept intact some of the most notable areas of the Pee Dee. Hundreds of thousands of acres are still in crop or forest land in the region. Private ownership has enabled those who love the land to continue to live on and work it.

Rural populations and the layout of farm upon farm depend on the similarity of surrounding land uses in order to continue traditional lifestyles, protect the clean air, reduce pressure on the water bodies, alleviate the congestion on roads, and sustain the distinctiveness of the region.

This region encompasses nine counties that border the Great Pee Dee River and Pee Dee Land Trust (PDLT) currently works in all of them.

By the close of 2014, PDLT had directly protected more than 20,875 acres with conservation easements and taken ownership of two nature preserves totaling 267 acres. From small farms to large plantations to significant historical sites and extensive riverbottom forests, important places are being voluntarily protected by their owners. However, significant farms and forests are being irrevocably converted every year so conserving land now is crucial.

PDLT provides an opportunity for those who have long been interested in preservation of the land and for those who are enthusiastic new converts to the concept. Through PDLT, conservation easements on private land can do more for our region than we ever could before.

For their generosity in helping protect special places, and while still serving as stewards of the land, there are often tax benefits for families and corporations. This booklet is designed to answer basic questions about our organization and about conservation easements. Before initiating any easement transaction, a landowner should first consult his or her legal and tax advisors, then discuss with the land trust the characteristics of their property that make it appropriate for permanent protection.

Protecting the Right Places

Tailoring conservation to the place and the people

Conservation easements are very flexible documents within the confines of appropriate conservation values (such as significant wildlife habitat, scenic open space, and high-quality farmland, among others). Once the conservation values have been identified, those values and the landowner's needs will guide the restrictions placed on a property.

What is a Conservation Easement or Conservation Agreement?

A "Conservation Easement" or a "Conservation Agreement" is an umbrella term for any sort of easement document between a landowner and a land trust that protects natural or historical areas, farms, or forestland. It may also protect scenic vistas, water quality, wildlife habitat, or some outdoor recreation locations.

It is the legal agreement between a landowner and a designated nonprofit that restricts certain uses on a piece of property in order to protect specific conservation values identified in the easement. It transfers certain legal rights in the property itself so that future sale or transfer of the property takes the easement along with it.

The landowner retains ownership of the property, but the land trust is the keeper of those specifically designated property rights and agrees to enforce the terms of the easement over time. Typically, these are voluntary but permanent.

Most conservation easements do not convey public access but they may if the landowner wishes. Although easements are designed to protect land against inappropriate development, they do not usually protect a property against condemnation by governmental or other authorized entities. In addition, Pee Dee Land Trust is not an advocacy organization, but does have a vested interest in lands on which it holds conservation easements. Because of that, PDLT will act to preserve the conservation values of the easement.

Easements can be highly flexible and tailored neatly to a particular piece of property and the particular needs of the owner within the conservation mission of PDLT.

"My sisters and I are proud and pleased to have placed our family property in a conservation easement with the Pee Dee Land Trust. Not only does this easement honor the legacy of our mother and father's love of the land but it will protect the property in perpetuity for our children and their children. It is our hope that they will be able to enjoy the sights and sounds of nature as we have. Whether a swallowtail kite soaring along cypress tree tops, the deep blue of an indigo bunting reflecting in the bright sunlight, or the gobble of a wild turkey on an early spring morning, these rhythms of nature bring peace to us in our ever increasing urban and commercial world."

Steve Jones

and his family placed a conservation easement on their property on the scenic Black River protecting more than 2.5 miles of river frontage and habitat for the endangered Swallowtail kite.

When might you use a Conservation Easement?

Conservation easements appeal to private property owners who understand that the quality of life of our region is intertwined with the Pee Dee's history and our unspoiled natural resources, rivers, swamps, and rich soils. As landowners recognize the importance of a property's features or location and the difficulty of holding onto family land in the face of rising land values and taxes, conservation easements become a more attractive option.

Easements enable landowners to make decisions about the future of their special places and not leave the fate of their property up to changing government policies and market forces. An easement can reduce the potential for dispute among heirs by taking some options off the table, such as development or fragmentation of a farm, thus leaving a legacy for their descendents and all people who love the land.

The donation of an easement may provide significant financial benefits to the donor. These financial benefits can help keep a particular piece of property intact and productive for farming, forestry, or wildlife habitat uses where estate tax expenses might otherwise force sale and development.

By donating an easement in perpetuity, the landowner guarantees that his or her property will be protected in the future no matter who owns the property. It does not hinder the ability to sell or transfer it to others, though it does, by design, reduce the appraised property value to varying degrees.

What rights does the landowner maintain?

The landowner retains all the customary rights and responsibilities of land ownership that are not specifically prohibited or restricted by the conservation easement. For example, the easement does not allow public access onto the property unless it is granted by the landowner. A landowner may retain the right to partition, or subdivide, the property into a limited number of parcels at some future date. He or she may, for example, retain the right to build two houses and associated outbuildings such as barns or garages; or, the landowner may retain the right to run a small business out of his or her home.

Typically, landowners retain the right to engage in agricultural activities, including selling their crops onsite and harvesting timber. Hunting, fishing, managing ponds, and pursuing other low-impact recreational activities are normally allowed, as well. Some conservation easements identify certain areas within the property as a whole for additional protections, such as a wide vegetated buffer along a stream where the landowner elects to give up commercial timber harvesting.

The reserved rights are intended to protect the conservation values while allowing a landowner to generate revenue from the land in a compatible way.

Landowners retain all responsibilities for paying taxes on their land and for the liabilities traditionally associated with land ownership.

"Wildwood Farms, where our family lived for many years was dear to my late husband's heart. Jim farmed the land and grew tobacco, cotton, soybeans, corn, wheat, and wonderful vegetables. He also raised hogs, beef cattle, German Shepherd dogs and four sons. After his death our family decided the best way to honor him and protect the farm as well as to ensure its continued use for farming, forestry, and a natural habitat for animals was to place it in the Pee Dee Land Trust conservation easement.

I once read in Gone with the Wind a quote from Gerald O'Hara, Scarlett's father. "Land is the only thing in the world worth working for because it's the only thing that lasts."

Sarah K. Wilds

donated an easement on 574 acres of working farm and forest land in Darlington County providing a scenic view for those driving in to Hartsville.

A BRIEF HISTORY OF THE PEE DEE LAND TRUST

1998	Pee Dee Resource Conservation and Development Council (PDRC&D) creates a land trust and wetland mitigation bank for 5 upper-Pee Dee counties.
2001	PDLT accepts first conservation easement – 13 acres.
2002	Florence is added to PDLT focus area.
2003	Georgetown and Williamsburg Counties are added to focus area.
2004	Land Trust develops Strategic Plan for land conservation, focusing on land protection, education, and resource assessment.
2005	Land Trust hires first full time director and joins the Francis Marion University Regional Nonprofit Consortium.
2006	Land Trust dramatically expands membership, education, and land protection efforts, to conserve 1,300 acres and increase membership from 40 to nearly 300.
2007	Land Trust creates education and outreach program; quadruples land protection to nearly 8,000 acres. Membership exceeds 400 households.
2008	Director of Education and Outreach hired. Land protection exceeds 10,000 acres. Attendance at events hits record highs.
2009	10th Anniversary of the Land Trust. First Horry County easement. Part time land protection staff position created.
2010	Full time Director of Land Conservation is hired. 12,000+ acres protected land.
2012	Awarded National Accreditation from The Land Trust Alliance
2014	Consolidated with Black Creek Land Trust (3,000+ acres). Surpassed 20,000 acre milestone and took on the stewardship of our first two nature preserves.
2015	Launched Our Places Endowment Campaign

"Our family has farmed this land for generations. Over the years many cousins have inherited the family property. In order for my son to continue the farming business, we had to consolidate ownership. The tax benefits of a conservation easement in conjunction with Conservation Bank funding made this possible, and we were so relieved that there was an option that makes sense for farmers."

L. H. "Buddy" Calhoun, Jr.
and his family protected the 2,000+ acre Donoho Plantation in Marlboro and Dillon Counties, guaranteeing the availability of high-quality farmland and a scenic view along nearly 3 miles of the "Cotton Trail". Their property also protects significant plant and animal habitat in Donoho Bay, a historically significant Carolina Bay.

What are the easement holder's responsibilities?

First, the organization must be considered "qualified". A qualified organization can be a nonprofit, non-governmental organization, which meets and maintains the standards required by law. An organization that accepts conservation easements must be fiscally able to enforce them over time and it must monitor them each year. To do so, PDLT has a limited right to access the property at a time agreed upon with the landowner in order to complete annual monitoring. Additionally, if a landowner agrees, the Land Trust may coordinate scientific or historical research on a property. The donation of an easement typically conveys no right of access onto the land by the public.

Can an easement be changed?

Easements are permanent legal agreements. Although voluntary, they are irreversible. PDLT includes in its easement documents an explanation of how minor modifications and amendments may be handled, consistent with the easement's conservation purposes. When properly designed, easements are not so restrictive that they prohibit changes in agricultural, forestry, and low-impact recreational activities.

“As a bird hunter and an outdoorsman, I have watched with regret as rural tract after rural tract of land gets dotted with houses. I enjoy seeing the trees and saving the habitat for the animals, and I know people passing by on the road or paddling down the river do, too. By placing a conservation easement on my property, I can help set the tone for land protection around my farm.”

Jim Crawford

a Pee Dee Land Trust former board member, donated a conservation easement on more than 450 acres in Marlboro County. His savings from the tax incentives will enable him to purchase more land for protection.

What about forestry practices or changes in agricultural uses?

Conservation easements which include agricultural and forestry activity as part of the conservation values of the property, are designed to allow for changes in agricultural land uses from one type of farm practice to another and to allow for changes in acceptable agricultural technology over time. They require best management practices for timber harvests and accommodate a landowner's preferences for wildlife management. For example, a farm which has traditionally been cultivated for tobacco or cotton could be converted to pasture for livestock or planted in pines for timber or used for other agricultural purposes.

Who is responsible for managing the property?

The landowner remains responsible for all land management activities. As the easement holder, PDLT's interest and responsibility is only to ensure protection of the conservation values that have been identified in the easement.

The landowner pays taxes as he or she normally would; maintains appropriate liability insurance, leases land or hunting rights, and carries out any other ordinary responsibilities of land ownership.

Your land - your legacy - our community

Why grant a conservation easement?

Landowners donate conservation easements for a variety of reasons. Foremost are a love of their land and a strong desire to protect it for their families and future generations. Conservation easements are powerful estate planning tools that provide families the opportunity to plan together for the future of their land. Neighboring landowners in the Pee Dee who donate conservation easements on contiguous properties provide mutual protection against unwanted or unplanned development while sharing the benefits of conserving larger resource areas for wildlife, scenic landscapes, and recreational uses.

The donation of a conservation easement may provide substantial tax benefits through the reduction of federal income and estate taxes and South Carolina income and property taxes.

The Following tax analysis was prepared by Frank Cureton and Will Johnson at Haynsworth Sinkler Boyd, P.A. (Contact information is provided on page 15.)

What are the tax benefits of donating an easement?

Federal Income Tax Benefits

Federal tax laws allow the donor of a qualified easement to claim the value of the easement as a charitable contribution for income tax purposes. A landowner gets no deduction for selling the easement for fair market value.

For charitable contribution purposes, the easement value is generally based on the difference between the fair market value of the property before the easement and the value of the property after donation of the easement (except in instances where there is a substantial record of sales of easements comparable to the donated easement). The difference between the "before" value and the "after" value is the amount that can be treated as a charitable contribution for income tax purposes.

For example, suppose that an individual who owns a 1,000-acre Pee Dee property valued at $2 million places a qualified easement on the property, precluding future development. Suppose further that the easement reduces the value of the property to $800,000. The charitable donation would be valued at $1.2 million.

For donations made in 2014, the landowner could deduct the charitable contribution up to 50% of the landowner's adjusted gross income for that year. A qualifying farmer or rancher could deduct charitable contributions up to 100% of the landowner's adjusted gross income. The landowner could deduct the unused portion of the contribution in the 15 succeeding years (subject to the applicable percentage limit of AGI). The 50% and 100% limitations and 15-year carry- forward provisions expired and have not been extended beyond December 31, 2014 as of the date of printing this publication, meaning that current law provides for a 30% limitation and 5-year carry-forward period. However, Congress has extended the more favorable provisions for many years, often at the end of or even beyond the end of the relevant tax year. We are optimistic that proposed legislation approved by the Senate Finance Committee in July 2015 will make these changes in the near future, at least for 2015 and 2016. Please consult your tax or legal advisor to determine the status of this law.

Assuming that Congress extends the application of the more favorable provisions described above, the following chart illustrates the approximate tax savings for the landowner in the above example (assuming the levels of AGI set forth in the chart and an estimated 40% combined federal and state income tax burden):

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	...YEAR 15
Landowner's adjusted gross income	$500,000	$500,000	$400,000	$400,000	$600,000	...
50% of AGI	$250,000	$250,000	$200,000	$200,000	$300,000	...
Tax savings	$100,000	$100,000	$80,000	$80,000	$120,000	...

"We have been interested in land protection options for many years. When the opportunity to work with a local land trust came available, we moved quickly and encouraged our neighboring landowners to do the same. Since the easement has been in place, we have been able to tell still more people about this option."

Tim Dargan

The farm known as Woodfield is protected by Tim Dargan and his family. Their easement fits into a mosaic of protected properties that creates a significant area of farm, forest, wildlife habitat, and scenic vista protection on S. Charleston Road in Darlington County.

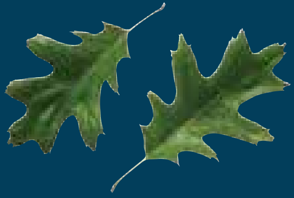
Protecting the land you love for generations to come.

"Three generations of my family have enjoyed this special paradise on the Black River. My family is pleased that this beautiful river front property and piece of American history will be preserved by PDLT."

Don Montgomery

and his family pulled together to protect a historic property along the scenic Black River. Their property is the site of the Battle of the Lower Bridge where Francis Marion and his troops fought back the British.

Saving our natural habitats, scenic open spaces and farms.



Our experience shows that easement values typically vary from a 30% to a 90% reduction in the value of the land, based on the size and location of the parcel and other factors. The highest easement values typically are associated with properties that are under intense development pressure. The nature and extent of the restrictions placed on the property by the easement also impact the easement value.

By law, the easement value must be determined by a qualified appraiser, and the appraisal must satisfy numerous requirements. It is the responsibility of the donor to hire a qualified appraiser who is familiar with the property, conservation easements and local growth trends. Pee Dee Land Trust has a list of appraisers who have been involved with conservation easements in the region.

To qualify for a federal income tax deduction, an easement must provide a public benefit through permanent protection of at least one of the following important conservation resources:

1. The protection of a relatively natural habitat of fish, wildlife or plants, or a similar ecosystem;
2. The preservation of open space, including farm and forestland, for the scenic enjoyment of the general public or pursuant to an adopted governmental conservation policy;
3. The preservation of an historically significant land or building; or
4. The preservation of land for public outdoor recreation or education.

An easement may restrict only a portion of a donor's entire contiguous parcel, permit certain development and other uses (as long as they do not interfere with the protection of conservation resources), and prohibit physical access by the public (except when the purpose of the easement is to preserve land for public recreation or education).

South Carolina Income Tax Benefits*

South Carolina allows a deduction for South Carolina income tax purposes for the donation of a qualified easement. The calculation of the easement value and the requirements for a qualified easement for South Carolina deduction purposes are the same as they are for federal income tax purposes. The 40% income tax rate assumed in our chart on page 6 is designed to approximate the combined effect of the federal and South Carolina income tax deductions.

In addition to the federal and South Carolina income tax deductions, a donor of an easement (on property in South Carolina) that qualifies for a federal income tax deduction is also entitled to a credit against South Carolina income taxes equal to 25% of the total amount of the deduction (subject to certain caps). Remember that a tax credit (unlike a deduction) constitutes a dollar-for-dollar decrease in the taxpayer's bottom-line tax liability. The caps are that (1) the credit may not exceed $250 per acre of restricted property and (2) the credit used in any one year may not exceed $52,500 (though unused credits may be carried forward). The taxpayer may also sell the state income tax credits, subject to generally applicable income tax principles.

Applying the facts of the example described above, the total deduction was $1.2 million, and 25% of that amount is $300,000. The per-acre cap would mean that the maximum credit for a 1,000 acre parcel is $250,000. The taxpayer earns $250,000 in tax credits and can use up to $52,500 each year. Any unused credits can be carried forward or sold.

"We wanted to preserve the Highland Farm's beautiful trees, land, and wildlife which my family had cultivated for agricultural improvement and enjoyed for fishing and hunting for more than a century. The Pee Dee Land Trust has enabled us to plant, timber, and preserve majestic long leaf pines while receiving the additional tax benefits of a conservation easement. We are pleased that the easement now provides permanent green space around Hartsville."

IONE COKER LEE

decided to leave a legacy by placing a conservation easement on her farm outside of Hartsville where she is working diligently to restore longleaf pine forest across the property.

"The way swamp timber is harvested is to clear cut till there's nothing left bigger than a buggy whip. I just hated seeing that; I enjoy the swamp ecology as it is and would like to see future generations have the same opportunity to learn about the woods. An easement was something I could do to help."

Austin Gilbert

protected more than 4 miles along the Lynches River in Florence County, preserving more than 800 acres of bottomland hardwood as a forest and several hundred acres of high ground for continued farm and forestry activity.

Estate Tax Benefits*

Conservation easements can significantly reduce the value of an estate, making estate taxes more affordable to heirs. Unlike limits it places on deductions for federal income taxes, the Internal Revenue Code allows unlimited charitable contributions for the purpose of reducing estate and gift taxes. Essentially, the value of the property is frozen at the lower "after" value for estate and gift tax purposes. In addition to the above tax benefits, up to 40 percent of the value of land covered by a conservation easement may be exempted from estate and gift taxation, as long as the total dollar value excluded does not exceed $500,000. The full 40 percent benefit is available for easements that reduce the fair market value of a property by at least 30 percent. Smaller deductions are available for easements that reduce the value by less than this amount. Also, heirs can donate post-mortem conservation easements to reduce estate taxes under the above provisions if the easement is completed within nine months.

Under current law, the unified credit (amount of an estate that is not subject to tax) is $5.43 million for tax year 2015 and is adjusted for inflation each year going forward.

Using the same example for estate or gift tax purposes, assuming a marginal estate tax rate of 40%, without a conservation easement, the property valued at $2,000,000 would have a marginal estate tax burden of $800,000 (assuming that the unified credit is already fully utilized). The table below illustrates the tax savings that would result from granting a conservation easement valued at $1,200,000.

	Value Before	Value After	Value After "Easement" Exclusion
Value	$2,000,000	$800,000	$480,000
Estate Tax	$800,000	$320,000	$172,000
Tax Savings	$0	$480,000	$628,000

With the uncertainty surrounding the estate tax and the possibility that these benefits may be of differing values based on the size of each taxpayer's total, taxable estate, property owners considering the donation of a conservation easement for estate tax benefits should consult their tax or legal advisor regarding recent tax law changes and implications.

Property Tax Benefits*

As a conservation easement restricts various development rights and diminishes the fair market value of the property, it has the potential to provide ad valorem tax relief. South Carolina law explicitly requires that the valuation of property for ad valorem tax purposes take into account the existence of any conservation easements.

In addition, South Carolina law provides that unimproved real property that is subject to a conservation easement is agricultural real property if the property otherwise qualifies as such. This provision ensures that the granting of a conservation easement will not jeopardize the special 4% assessment ratio applicable to agricultural real property.

Pee Dee Land Trust Criteria for Accepting Easements.

Pee Dee Land Trust will consider accepting easements that further the mission of the organization – to conserve the significant natural, agricultural, and historical resources of the Pee Dee region. More specifically, PDLT seeks easements that are:

- located within the Pee Dee region
- likely to qualify under the IRS regulations
- of sufficient size and appropriate restrictions so as to protect the conservation values associated with it

Preference is given to those easements that protect land

- with important concentrations of natural, historic, agricultural resources, especially if the property is at risk for conversion to uses that would destroy those characteristics
- adjacent to existing easements or other protected open space areas
- containing a low level of existing development
- with lower potential for future issues in monitoring, liability, and enforcement

"Conservation easements preserve family land but more importantly they preserve family ties. The history of stewardship can live on through the generations and in many cases, easements make it possible for a family farm to remain in the family."

William Howard, III

and his family protected a 946 acre farm they inherited in Williamsburg County. The property continues to be actively managed as working farm and forest land.

"I remember growing up visiting the farm near McColl, captivated by stories of our family's history. Generations have lived and worked on the farm and now we are working to restore it. I couldn't image visiting the farm with anything but the beautiful natural surroundings. It means so much to me to preserve our historic home and farm for my family and future generations. This conservation easement does just that."
-Kathryn McColl

"Broad Oaks"

The descendants of Eulah Roper McColl, including Kathryn McColl, and neighbor Allan McDonald have protected the core of the historic "Broad Oaks" farm and united the landscape despite divided ownership.

What is the process for planning a conservation easement?

If or when you decide to protect your property with a conservation easement, please call Pee Dee Land Trust staff to discuss your decision.

PDLT provides a questionnaire for you to review and complete with staff. You will need to provide plats of the property and PDLT staff will schedule a visit to the site.

PDLT staff will present the proposed project to the Land Protection Committee for review and a vote as to whether to proceed. PDLT staff will then draw up a first draft of the easement fashioned after the needs expressed by the landowners. The drafts are revised until the landowner is satisfied. Depending on how long this activity takes, the easement process can take less than a year to complete. Further, the easement must be voted on by PDLT's Board.

Other primary documents involved in the process include a survey of the easement area as it fits into the overall tract of land, updated title verification, and subordination of any mortgages on the property.

For the landowner's tax benefit purposes, an appraisal is necessary. PDLT does not guarantee tax deductibility of easements; however, the relevant tax laws are used as an important part of deciding whether to accept an easement. For appraisals, it is important to find an appraiser who meets the Federal criteria and has experience working with conservation easements. The appraiser generally does "before and after" appraisals based on the restrictions the landowner has laid out.

Through protecting the past, we help ensure our future.

PDLT then prepares a baseline documentation report as a baseline for future monitoring of the easement area. PDLT will also (as will most land trusts) ask for an endowment contribution to our stewardship fund (further described below) to allow us to monitor this protected property long term, as required by law. In some cases, PDLT must impose a fee for the transaction.

The easement is recorded in the county land records; it runs with the land. If you give away or sell the land, PDLT then works with the new owner, who is bound by the same easement terms as the original owner.

What is the cost of preparing an easement?

The Pee Dee Land Trust works hard to keep the complex process of a conservation easement project as streamlined as possible. Our organization works jointly with the landowner to complete the baseline documentation report, in most cases, and provides the first draft of the conservation easement document.

There are, of course, a few costs for which the landowner is responsible. Those include one's own legal and financial counsel, the appraisal, title work or property surveys when they are needed.

PDLT asks easement donors for a modest contribution to its Stewardship Fund. The fund works like an endowment, supporting the monitoring and enforcement of all the organization's land protection projects. This donation is typically a deductible gift for income tax purposes. Landowners should, of course, consult their financial advisors for information about reducing their tax liability.

"An easement provides a flexible approach to protecting a working farm while ensuring us, and future farmers on this place, that we can get the job done. We put heavy restrictions on most development potential but were able to ensure that the farm operation could grow as it needs to."

Edwin Dargan

and his son Ned have protected the family's 730+ acre farm on both sides of S. Charleston Road in Darlington County.

PHOTO: Ashley Waddell, News and Press, Darlington, SC.

Our heritage deserves to be protected.

Other Conservation Options for protecting the Pee Dee's distinctive natural, historical, and agricultural heritage...

For individuals and corporations dedicated to preserving this area for future generations, Pee Dee Land Trust staff is glad to discuss a full range of other land conservation options.

These could include donations of land, gifts of land by will, bargain sales, purchased easements, and other conservation strategies.

We can also provide planned giving opportunities for those interested in supporting the present and future programs of PDLT. Opportunities to increase the organization's effectiveness and sustainability could include participating in a trade-lands program, making gifts of stock or long-term pledges to support operations.

With the benefits of tax incentives, making a charitable gift to PDLT may provide significant benefits to you and your family while helping you to conserve our Pee Dee Region.

Sources for Additional Information

For more about PDLT, our land protection and education projects, see our website www.peedeelandtrust.org or call us directly at 843.667.3229.

To find a list of land trusts working in South Carolina, please see the list provided on the website for the South Carolina Conservation Bank. That website is http://sccbank.sc.gov.

For information on land trusts generally across the U.S., contact the Land Trust Alliance which is the national clearinghouse for this information and the umbrella professional organization for land trusts across the country. That website is www.lta.org.

To read more about conservation generally, how it helps individuals and improves communities, see the collection of land protection books at any Pee Dee area library. In 2006, PDLT donated 10 books on the subject to each branch library in an effort to make this information more accessible.

Tax Benefit Analysis (August 2015):
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Columbia, SC 29201
fcureton@hsblawfirm.com 803.540.7824
wjohnson@hsblawfirm.com 803.540.7945

Haynsworth Sinkler Boyd, P.A.
ATTORNEYS AND COUNSELORS AT LAW

*PDLT does not give tax or legal advice. It is recommended that you consult your own accountant or tax attorney for advice on these matters.

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David Harper, Executive Director
Phone: 843.667.3229
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Mailing: P.O. Box 2134, Florence, SC 29503
Governance: board with 2 representatives per county.
Focus Area: Chesterfield, Darlington, Dillon, Florence, Georgetown, Horry, Marion, Marlboro, and Williamsburg Counties

Preserving beautiful trees, land, and wildlife.

Pee Dee
Land Trust

PROTECTING THE PAST, ENSURING THE FUTURE

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DUKE ENERGY.