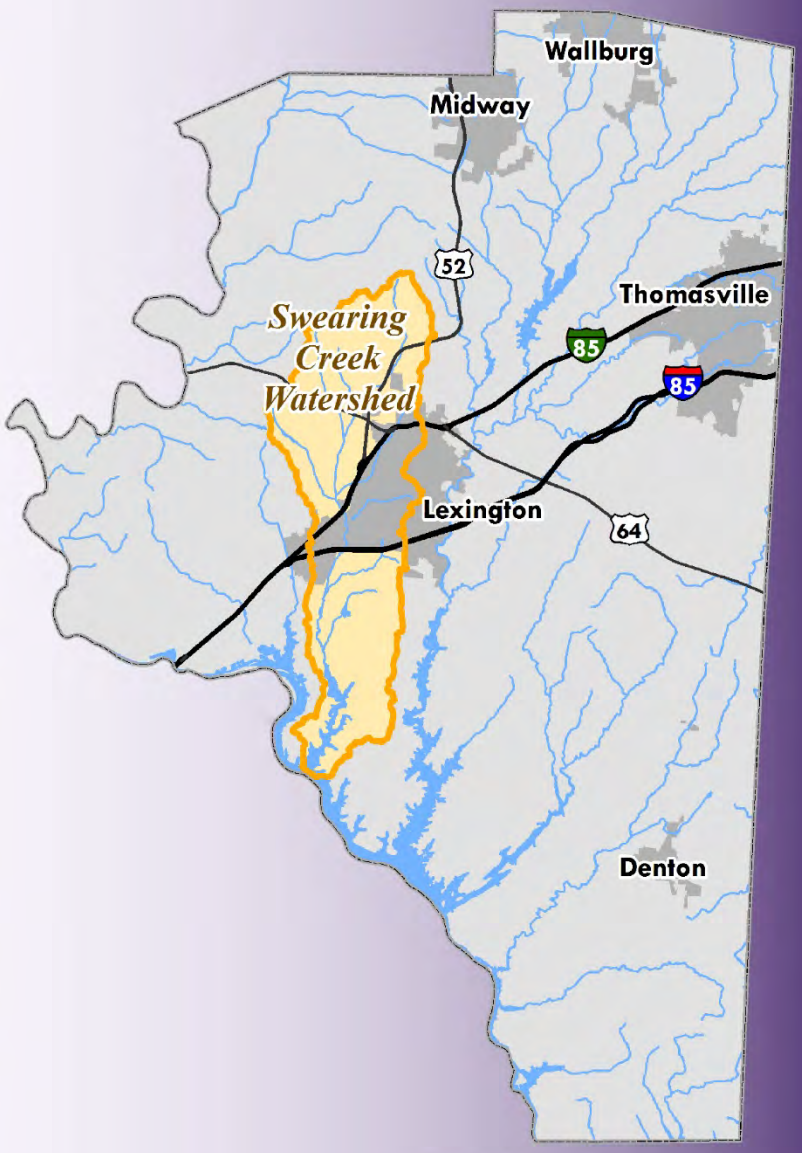
Swearing Creek Watershed

Assessment

January 2018



Davidson County, NC

PIEDMONT TRIAD
REGIONAL COUNCIL

Swearing Creek Watershed Assessment

Prepared By
Piedmont Triad Regional Council

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REGIONAL COUNCIL

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Introduction

Swearing Creek is a 49-square mile watershed in central Davidson County, North Carolina (see Figure 1). It includes the western half of the City of Lexington, NC, and drains directly to High Rock Lake, the first of the "chain of lakes" on the Yadkin River system. This watershed has a history primarily defined by an urban furniture industry and rural agriculture – largely smaller cattle and crop farms. It is not a water supply, nor does it receive wastewater discharges from the City of Lexington. The main impacts to the creek appear to be from rural and urban non-point sources of pollution.

Swearing Creek was listed as impaired in 2004 by the NC Department of Environmental Quality's (DEQ) Division of Water Resources (NC DWR) for failing to fulfill criteria for "supporting" biological conditions – benthic macroinvertebrate surveys conducted by the NC DWR have demonstrated that the ecosystems residing in the Creek are not those seen in healthy stream systems. High Rock Lake is also an impaired water body - listed in 2008 for violating water quality standards for chlorophyll-a; and in 2014 for turbidity (NC DWQ 2014a). NC DWR conducted a special study of the Lake's water quality to determine the sources of nutrient pollution. The study's modeling is finished. Current data shows consistent, weather dependent pollution levels, indicating the likeliest sources of pollution for Swearing Creek is non-point source pollution and/or intermixing with other parts of the lake that become more available due to weather conditions (e.g. heavy rains). Please visit https://deq.nc.gov/about/divisions/water-resources/planning/modeling-assessment/special-studies#HRL for detailed information. A stakeholder process to develop a nutrient management strategy that can be implemented by either state or federal regulatory authorities could be scheduled soon.

Davidson County has an agricultural heritage, with an emphasis on dairy cattle and hay and a history of subsistence agriculture and dairy and tobacco farms. Despite increasing urbanization from Winston-Salem to the north and growth along I-85, the county retains a strong rural identity. 64% (31 square miles) of the Swearing Creek watershed is outside of the City of Lexington, although 71% of the land is dedicated to non-urban uses. The Davidson County Soil & Water Conservation District (DCSWCD) offers many cost-sharing programs to protect open spaces and farmland and protect water quality. The county has made programmatic investments in agricultural heritage and farmland protection as important values, but limited financial resources leave these resources vulnerable to loss and degradation.

The City of Lexington was a hub of North Carolina's furniture and textile industries. The city's geography is largely defined by this history, with an industrial sector lying along the railroad tracks in the eastern part of town, and the Uptown District just a few block west, which is focused on a public town square and main street full of shops. Neighborhoods grow out in all directions from this social and economic hub of the city.

The city's furniture factories were the largest consumers of water in the area for decades. Due to globalization in the late twentieth century, this industry has suffered and Lexington's economy was not spared – as was the entire Piedmont Triad. These impacts were compounded by the Great Recession of 2008. The City is recovering, though, converting many of the former factories into brownfield redevelopment projects that can serve residential, commercial, and industrial growth and revitalize the city's urban core with jobs and homes.

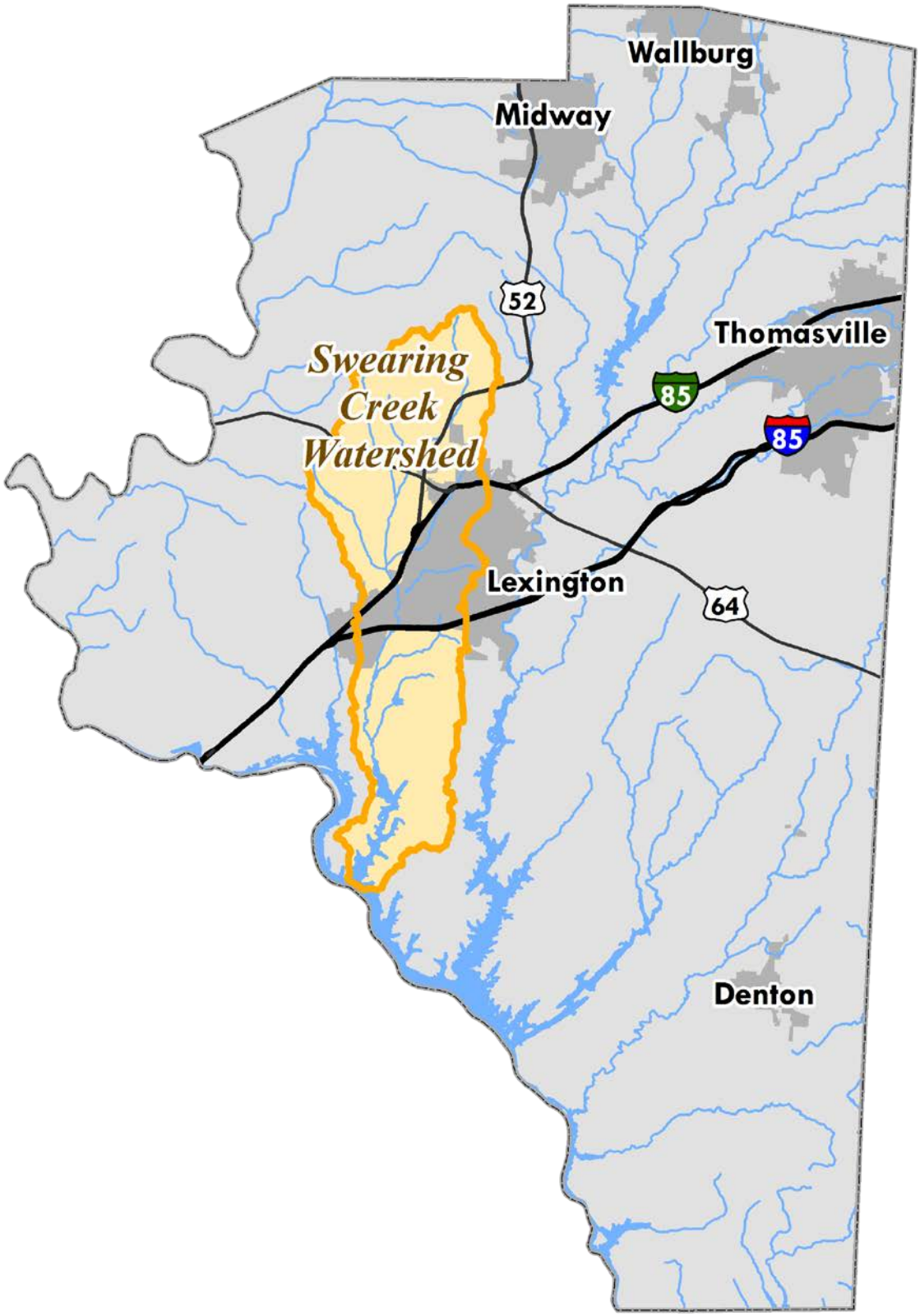


Figure 1: Swearing Creek Watershed

Swearing Creek has a relatively low population density except in Lexington's Uptown District, which features some of the city's densest residential and commercial districts (see Figure 2). The downstream communities of the watershed are sparsely populated, reflecting their use as farmland and/or vacation residences along High Rock Lake. The upstream rural communities are a little denser than these, reflecting their residential use by communities living just off US-52 and NC-8. Although the City of Lexington lost significant residents between 2000 and 2010, due to the Great Recession, this population generally has not changed much over decades. American Community Survey (ACS) data shows general small recent increases in population, indicating that both Lexington and central Davidson County are recovering from these economic and social obstacles (see Figure 3).

The land use of the watershed is varied, as would be expected from an area that includes farming communities and a sizable city. Nearly the entire area outside of the city is evenly split between residential (12.4 square miles) and agricultural lands (12.6 square miles). Generally speaking, these lands are not characteristically high concerns in watersheds, although individual behaviors can and do have devastating impacts upon local and downstream conditions. Of particular concern from prior watershed planning efforts is a lack of stream (aka "riparian") buffers on both farms and single-family lots. While the City of Lexington requires such streamside areas to be protected, Davidson County does not unless a landowner is enrolled in a cost-share program. Absent buffers contribute to stream erosion, loss of property, and a lack of filtration of pollutants, particularly fertilizers and pesticides.

Lack of riparian buffers are a concern on both farms and single-family lots.

The City of Lexington has relaxed some of the requirements of the land use designations shown in this map, working with developers to fill in the vacant residential, commercial, and industrial properties in the city by making mixed-uses of lands and buildings an attractive option. The concerns over potential negative impacts to adjacent landowners due to mixing uses has been less of a concern than in the past, as many of the businesses moving into the city do not have the significantly adverse impacts that many more individual businesses of the past have had upon neighbors and downstream communities.

A total of two square miles of industrial land is dispersed throughout the Swearing Creek watershed. This is a fairly large dedication of land for industrial purposes, and does not include the large amount of industrial area immediately outside the watershed boundary. Many of these properties are brownfields from Lexington's heyday as one of the world's furniture capitals; they are the sites of many exciting potential redevelopment projects. Consequently, many of these lands hug the interstate highways and the rail line.

GOAL - Outline strategies to support growth while minimizing adverse impacts to natural resources.

The proposed Davidson County Industrial Park is different, though, lying just outside of this watershed to the west, at the juncture of I-85 and I-85 BUS. When completed, the park is likely to fundamentally alter the growth patterns of both the city and the county, with farmland being sold to support residential and commercial growth around the park, and increased growth along all highways that will cross through it. This may have an impact upon local and downstream water quality conditions – the goal of this assessment and its following restoration report will be to outline strategies to support such growth while minimizing adverse impacts and ensure that the natural resources of the area thrive and persist for future generations.

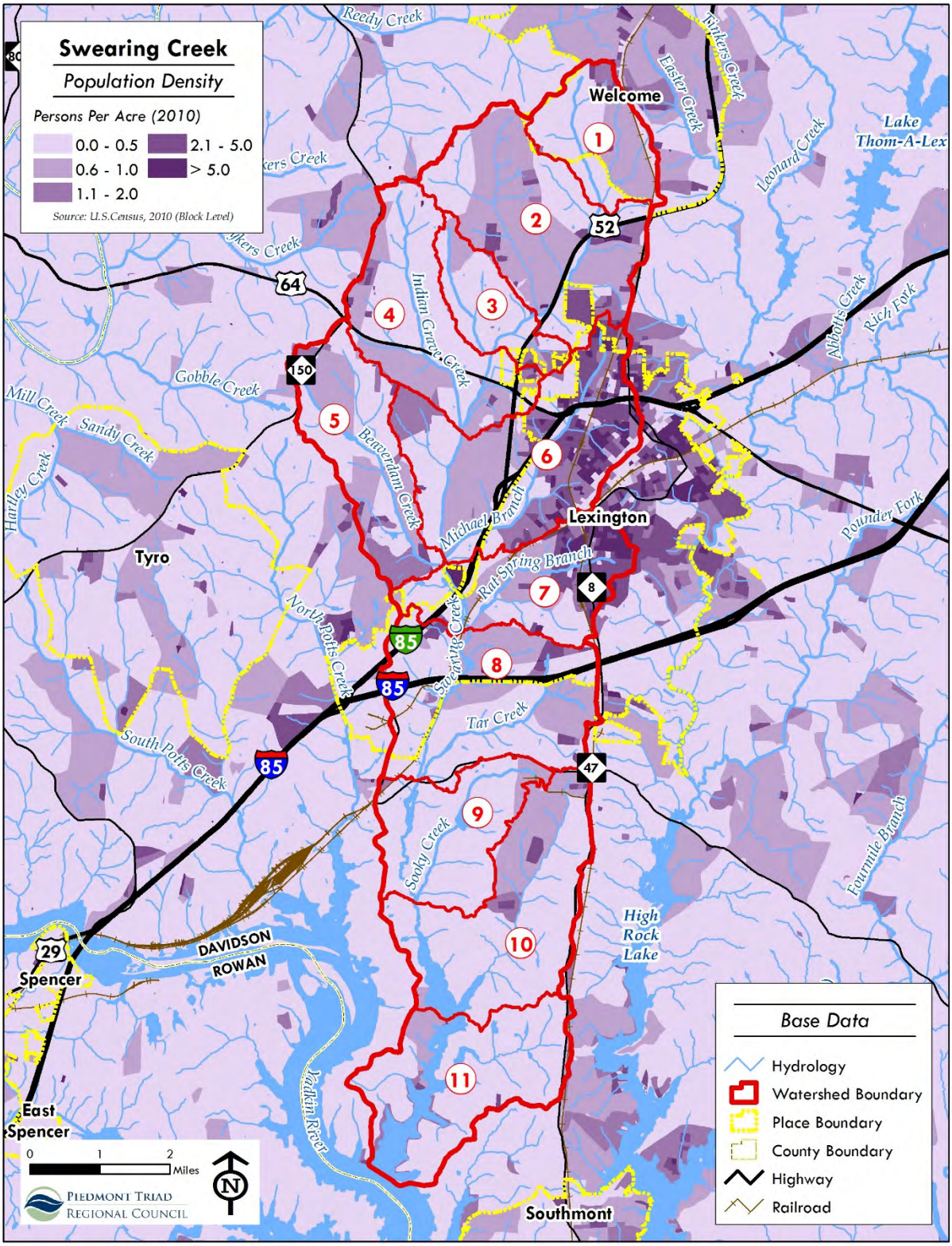


Figure 2: Swearing Creek Watershed Population Density

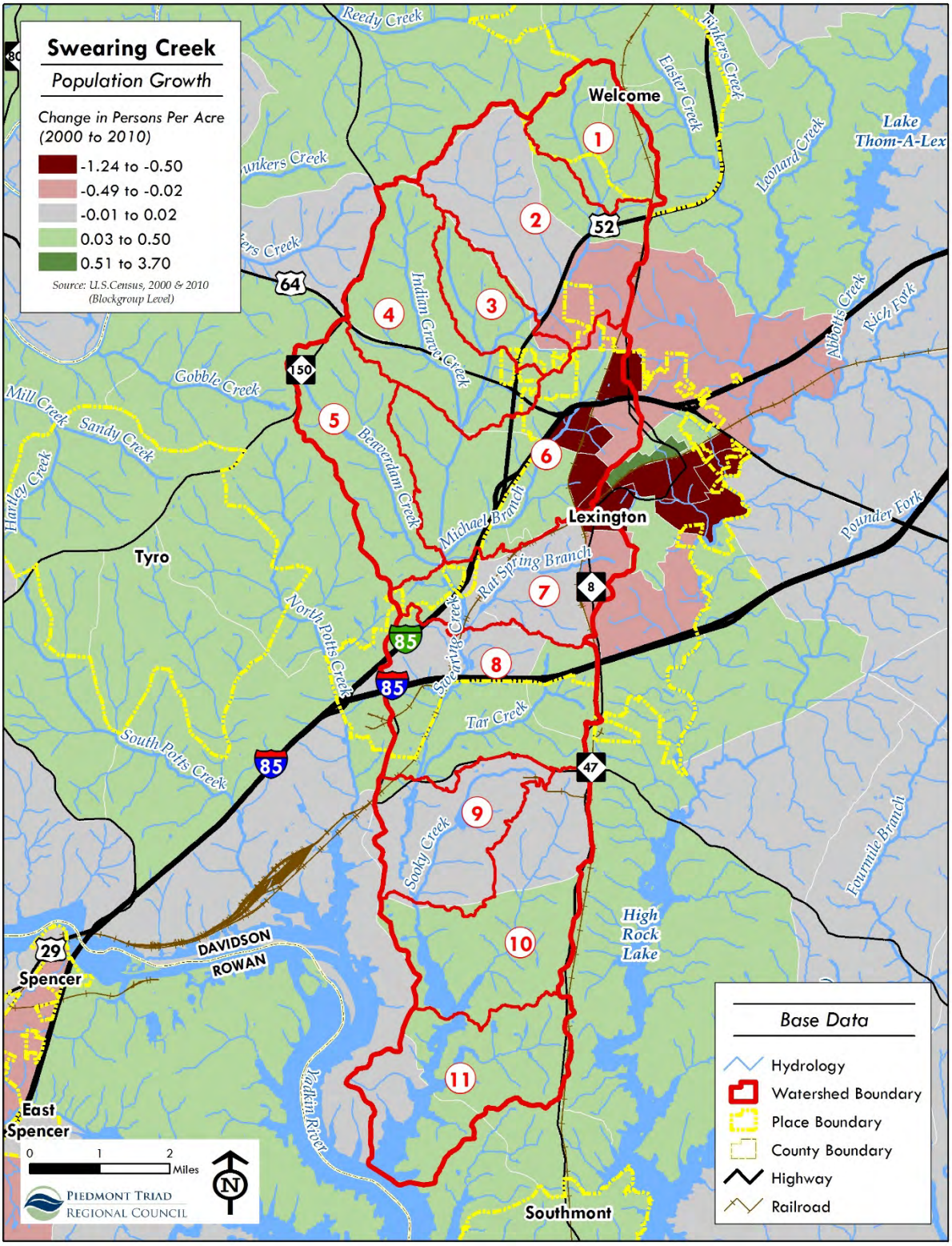


Figure 3: Swearing Creek Watershed Population Density Change

Section 1: Stakeholder Process

Watershed Stakeholder Committee

The Stakeholder Committee consists of members of the local community who are immediately affected by Swearing Creek watershed conditions. The Stakeholder Committee can include local landowners, members of environmental organizations, local government staff, environmental professionals, and others who are interested in improving the quality of the community's environment and welfare. The Stakeholders Committee guides the planning process, provides information and insight on local issues and concerns in the watershed and ensures that this watershed assessment and all future restoration planning efforts consider a broad, diverse range of community interests.

Stakeholder Committee		
City of Lexington	**Davidson County**	
Trey Cleaton, *Planning Manager*	Guy Cornman, *Planning Director*	
Giselle Comer, *Water Resources Lab Director*	Scott Leonard, *Planner*	
Josh Monk, *City Planner*	**Davidson County Tourism Recreation Investment Partnership (TRIP)**	
Wes Kimbrell, *Water Resources Engineer*	Chris Phelps, *Executive Director*	
Conservation Trust of North Carolina	**Davidson County Soil & Water Conservation District**	
Edgar Miller, *Director of Government Relations*	Andy Miller, *District Director & Agent*	
North Carolina Wildlife Resources Commission	Lloyd Phillips, *District Resources Specialist*	
Olivia Munzer, *Habitat Conservation Biologist*	**Piedmont Triad Regional Council**	
Brooke Massa, *Wildlife Biologist*	Malinda Ford, *GIS Manager*	Jesse Day, *Planning Director*
North Carolina Forest Service	Joy Fields, *Planner*	Cy Stober, *Planner*
Nancy Stairs, *Urban Forester*	Cameron Colvin, *Planner*	Elizabeth Jernigan, Assistant Planning Dir.
NC Department of Environmental Quality (DEQ)	Lindsey Lengyel, *Stormwater SMART Coordinator*	
Paul Clark, *Environmental Program Consultant*	**Yadkin Riverkeeper**	
Anjie Ackerman, *Planning Specialist*	Will Scott, *Yadkin Riverkeeper*	
Kirsten Ullman, *Planning Specialist*		

Technical Services

The Piedmont Triad Regional Council (PTRC) was awarded a NC Clean Water Management Trust Fund (CWMTF) grant to assess the Swearing Creek watershed for its sources of impairment and develop a local watershed plan that meets the US EPA's Nine Key Elements of Local Watershed Planning and delivers a strategic plan to the City of Lexington and Davidson County that empowers them to address the watershed's needs simultaneous to their other community development and growth concerns. PTRC retains a planning staff that has established a reputation as capable professional watershed planners, producing documents that can holistically serve watersheds and the communities that reside within them.

PTRC is the technical lead for all analytical services described in this assessment and its following restoration plan. Staff will be responsible for watershed modeling, water quality analysis, field assessments, and other tasks that acquire or develop data that inform the decisions made to protect and improve conditions in this watershed. Those decisions will be made by the stakeholders committee with the advisement of the technical team at PTRC. One exception to this approach will be the collection and laboratory analysis of water quality data, which is being done by the City of Lexington Public Works staff. In addition to the one site monitored by the Yadkin-Pee Dee River Basin Association (YPDRBA), the City staff are collecting and analyzing data from five other locations, including all major tributaries to Swearing Creek (see Figure 4). The goal is to account for the pollutant loads contributed by each subwatershed and direct investments and outreach to those places that most need it.

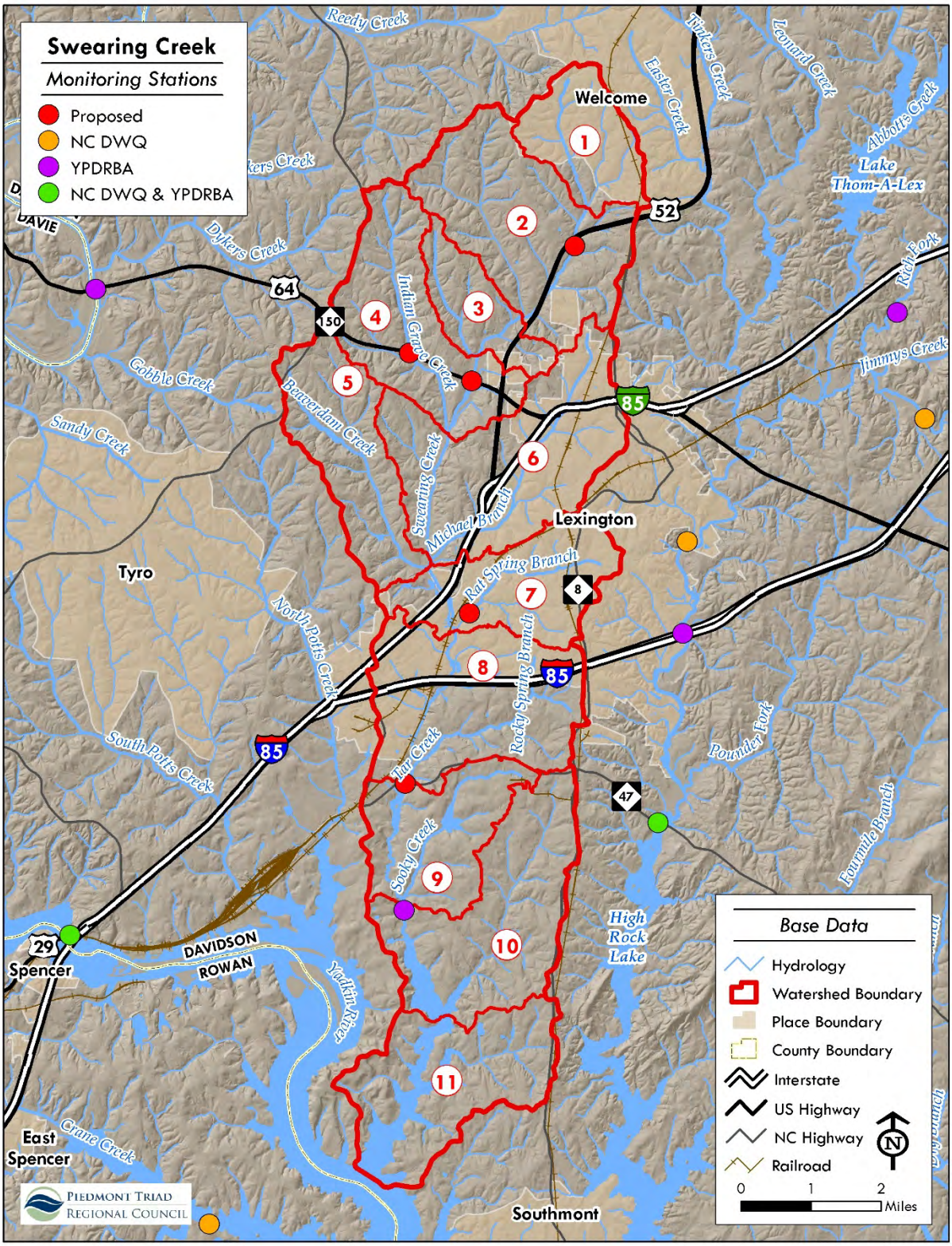


Figure 4: Swearing Creek Watershed Monitoring Stations Map

Section 2: Watershed Characterization

The Swearing Creek watershed is a fairly homogenous natural landscape. Though Lexington's industrial history contrasts with that of the surrounding countryside farms and residences, the environmental features of the watershed are generally similar and evenly distributed throughout this watershed. Characterizing watershed attributes (i.e. geography, geology, floodplains and wetlands, ecological habitat, etc.) allows watershed stakeholders to understand the current natural conditions in a watershed, and what steps can realistically and effectively be taken to remedy current water quality impairments and their sources. Having similar soils, geology, hydrology, and slopes throughout the watershed makes it simpler to recommend universal management practices for water quality improvements, as they will be relevant regardless of where they are applied in the watershed.

Watershed Delineation

GIS methodology was used to delineate Swearing Creek into 11 subwatersheds - using ESRI's ArcGIS software, Spatial Analyst extension and the ArcHydro toolset. The first step in delineating watersheds was obtaining the Digital Elevation Models (DEMs) for the area from the USGS National Map Viewer. The 1/9 arc-second DEM was downloaded for the area with a resolution of roughly 3 meters.

The DEM was reconditioned to impose the linear stream features onto the DEM, burning in stream slopes and filling in sinks. Next the "Flow Direction" tool calculated the flow direction for each grid cell in the DEM. This flow direction data was then used in the "Flow Accumulation" tool to calculate the number of cells that drain into an each individual grid cell. The flow accumulation output grid represents the drainage area measured in units of grid cells. Streams were then defined using a threshold drainage area (or flow accumulation value) of 2,000 – meaning that all cells whose flow accumulation was greater than 2,000 cells was classified as a stream cell and the remaining cells were considered the land surface draining to the streams. All stream cells were given a value of 1. Next, this stream network was divided into district stream segments (or links). Then a catchment grid was derived from the stream segmentations and converted into a polygon catchment file. Roughly 364 small catchments were derived, which were then manually dissolved into the 11 subwatersheds that gave stakeholders management units that will be used to summarize watershed data, characterize conditions, and develop recommendations in this assessment and the next phases of the planning process (see Figure 5).

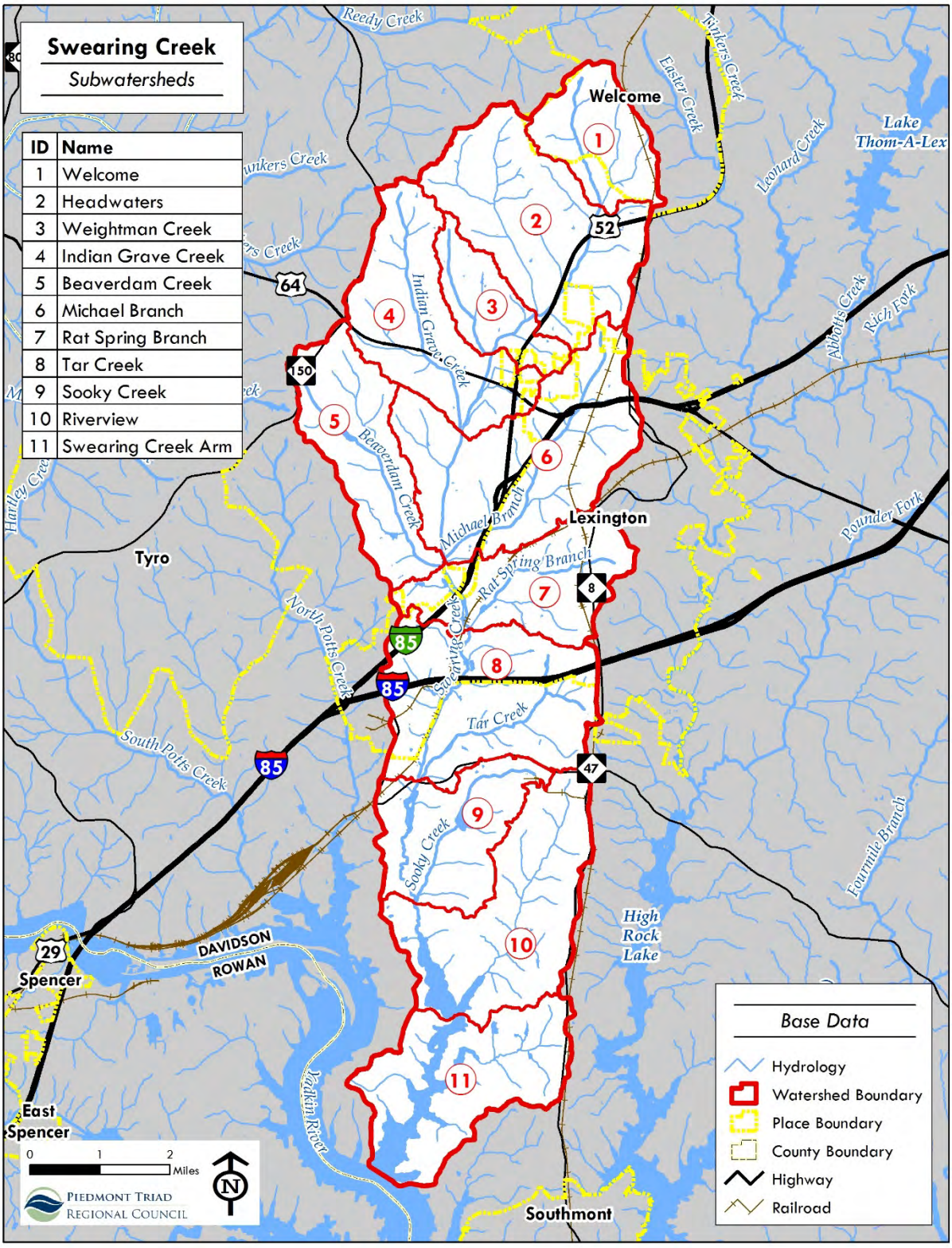


Figure 5: Swearing Creek Watershed Delineated Subwatersheds Map

Geography

Swearing Creek watershed is a 49 square mile watershed which contains over five significant tributaries (Indian Grave Creek, Beaverdam Creek, Tar Creek, Rat Spring Creek, and Sooky Creek), and has been delineated into eleven (11) subwatersheds. The land uses vary from the largely agricultural use in the headwater and downstream areas of the watershed to the urban core of Lexington and commercial corridors of I-85, I-85 BUS, US-52, NC-8, NC-47, and NC-150. The majority of the watershed is rural, with 71% of its land identified as non-urban. Even much of the land within the city limits of Lexington is sparsely populated and retains large areas of pervious (unpaved) surfaces.

The City of Lexington occupies a large area of the watershed, but the urbanized area of the watershed is much smaller, focused chiefly in Subwatersheds 6 & 7. The Center for Watershed Protection (CWP) has determined that all waters with <5% impervious cover are capable of achieving pristine stream habitat conditions; with 5 – 10% impervious cover are capable of fostering good stream habitat conditions; 10 – 15% impervious cover frequently are failing to support stream habitats; 15 – 20% impervious cover are in poor condition; and >20% impervious coverage are incapable of providing sustainable habitats for aquatic and benthic habitat due to stormwater impacts (Schueler & Holland 2000). The NC DWR has identified urban runoff as a likely source of impairment for Swearing Creek, but the localization of the watersheds impervious cover makes other non-point sources of stress to water quality conditions likely as well.

Geology

According to the NC Geological Survey (NCGS), in geological terms, NC "is best described in terms of geological belts; that is, areas with similar rock types and geologic history" (NCGS). The State of North Carolina is composed of eleven predominant geologic formations, known more commonly as "belts." Swearing Creek watershed lies almost entirely within the Charlotte Belt (see Figure 6). The NCGS describes the Charlotte Belt as consisting of "*igneous rocks such as granite, diorite and gabbro*…[that]…*are 300-500 million years old*." It differs greatly from the clayey Carolina Slate Belt, having sandier amendments and greater porosity.

Swearing Creek watershed is composed mainly of four geological types: Granitic Rock, Metamorphosed Granitic Rock, Metamorphosed Gabbro and Diorite, and Metavolcanic Rock (see Figure 7). The classifications are defined below, as found at the USGS website detailing metamorphic rock species (http://tin.er.usgs.gov/geology/state/sgmc-lith.php?code=5#North%20Carolina);

> ***Cid Formation*** – Like most of the rock in the Charlotte Belt, it dates from the Cambrian/Late Proterozoic Eras and is composed of felsic and mafic metavolcanic rock.
>
> ***Granite Rock*** - Dates from the Cambrian/Late Proterozoic Eras; found in the Carolina Slate Belt as megacrystic and well-foliated rock that has local instances of hornblende.
>
> ***Granite of Salisbury Plutonic Suite*** – This granite rock dates from the Devonian/Silurian Eras and is pink and massive to weakly foliated.
>
> ***Metavolcanic Rock*** – The volcanic metaconglomerate found in the Carolina Slate Belt dates from the Cambrian/Late Proterozoic Era, and includes metagraywacke and metamudstone.
>
> ***Metamorphosed Gabbro & Diorite*** - Dates from the Paleozoic/Late Proterozoic Eras; found in the Charlotte and Milton, or Carolina Slate Belts; foliated to massive.
>
> ***Metamorphosed Granitic Rock*** **–** Dates from the Cambrian/Late Proterozoic Eras; it is generally megacrystic and well foliated, with local presence of hornblende
>
> ***Metamorphosed Mafic Rock*** - Dates from the Paleozoic/Late Proterozoic Eras; found in the Charlotte and Milton, or Carolina Slate Belts; metagabbro, metadiorite, and mafic plutonic-volcanic complexes.

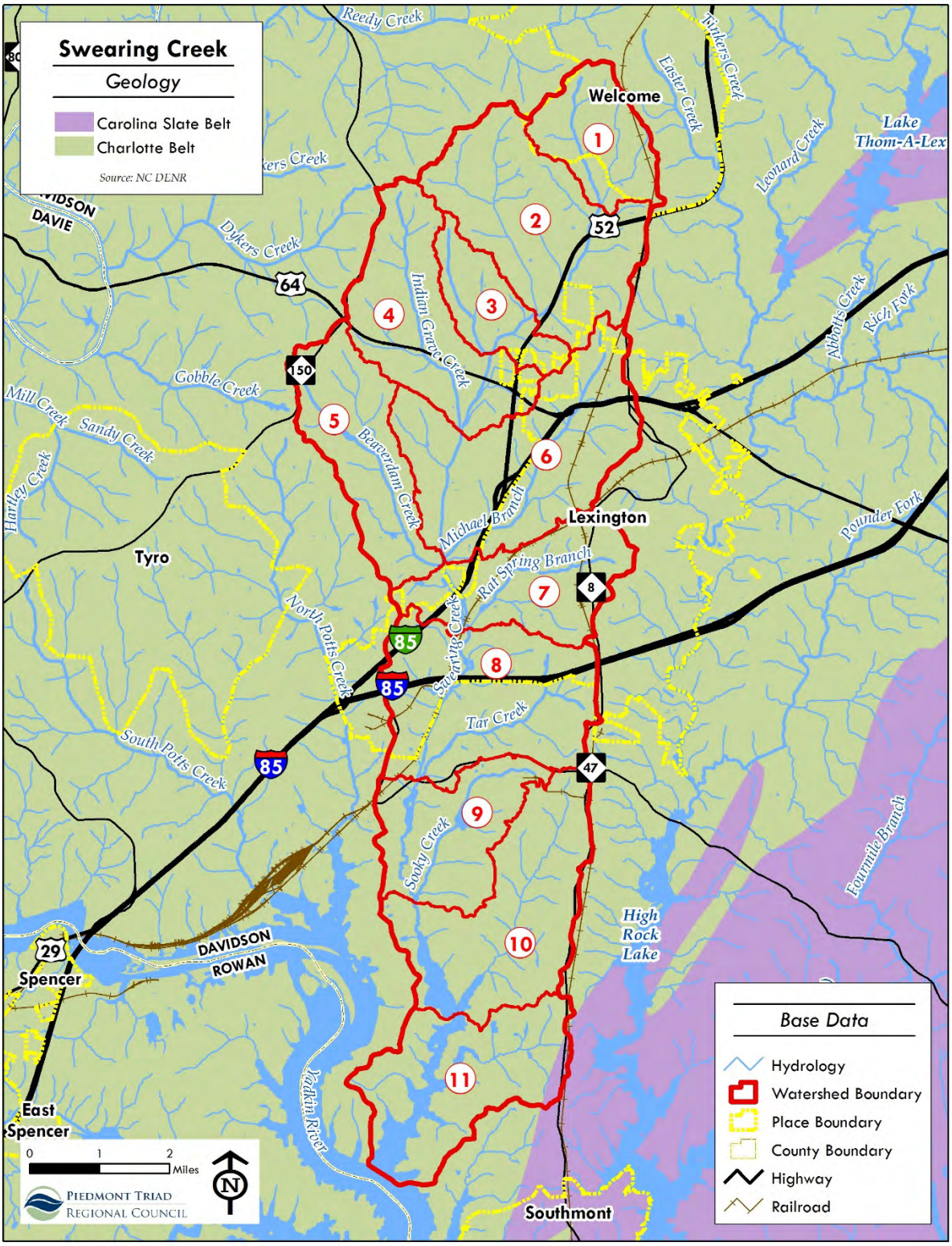


Figure 6: Swearing Creek Watershed Geologic Belt Map

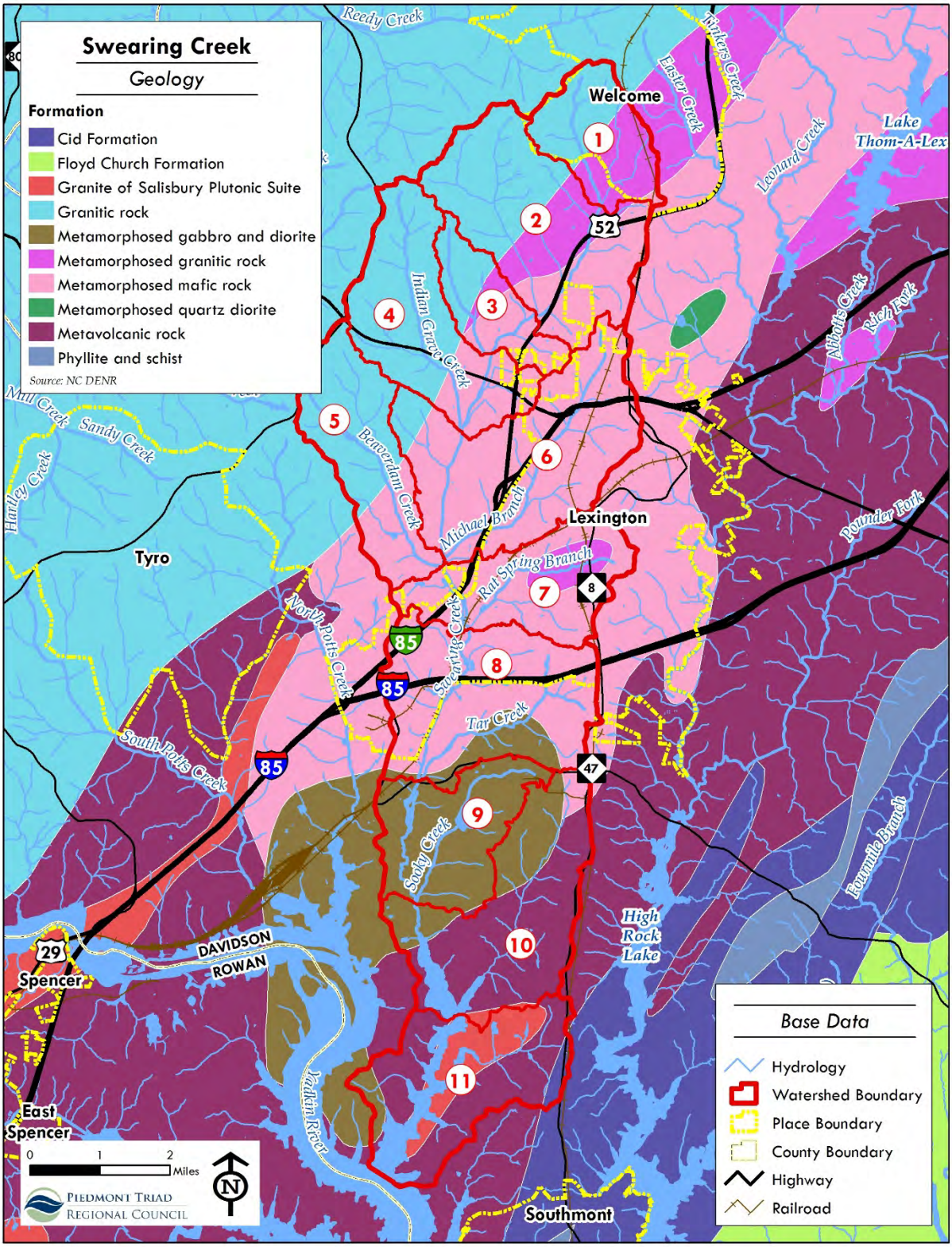
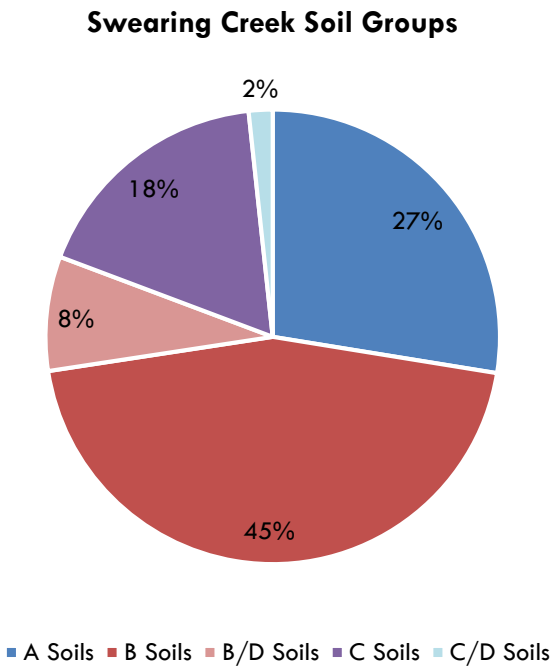


Figure 7: Swearing Creek Watershed Geologic Formations Map

Soils

The Swearing Creek watershed has over 1,000 distinct soils species. Over half of the watershed's soils are present at concentrations of 1% or less. They include soils of all classes, including 13 square miles of porous Class A soils in the headwaters. These soils are uniformly interspersed with Class B and C soils, both of which have somewhat fine textures, higher clay content, and slower drainage. Class B soils are predominant in this watershed, lying in 26 square miles of the watershed, while Class C soils occupy 10 square miles of the watershed (see Figure 8).

For a detailed profile of the soils in Davidson County and the Swearing Creek watershed, please consult with the NC Division of Soil & Water Conservation (NC DWSC)'s *Soil Survey of Davidson County, NC*, or the US Department of Agricultural Natural Resource Conservation Service's Soil *Map Unit Profile* for Davidson County (McCachren 1994; USDA NRCS 2007).



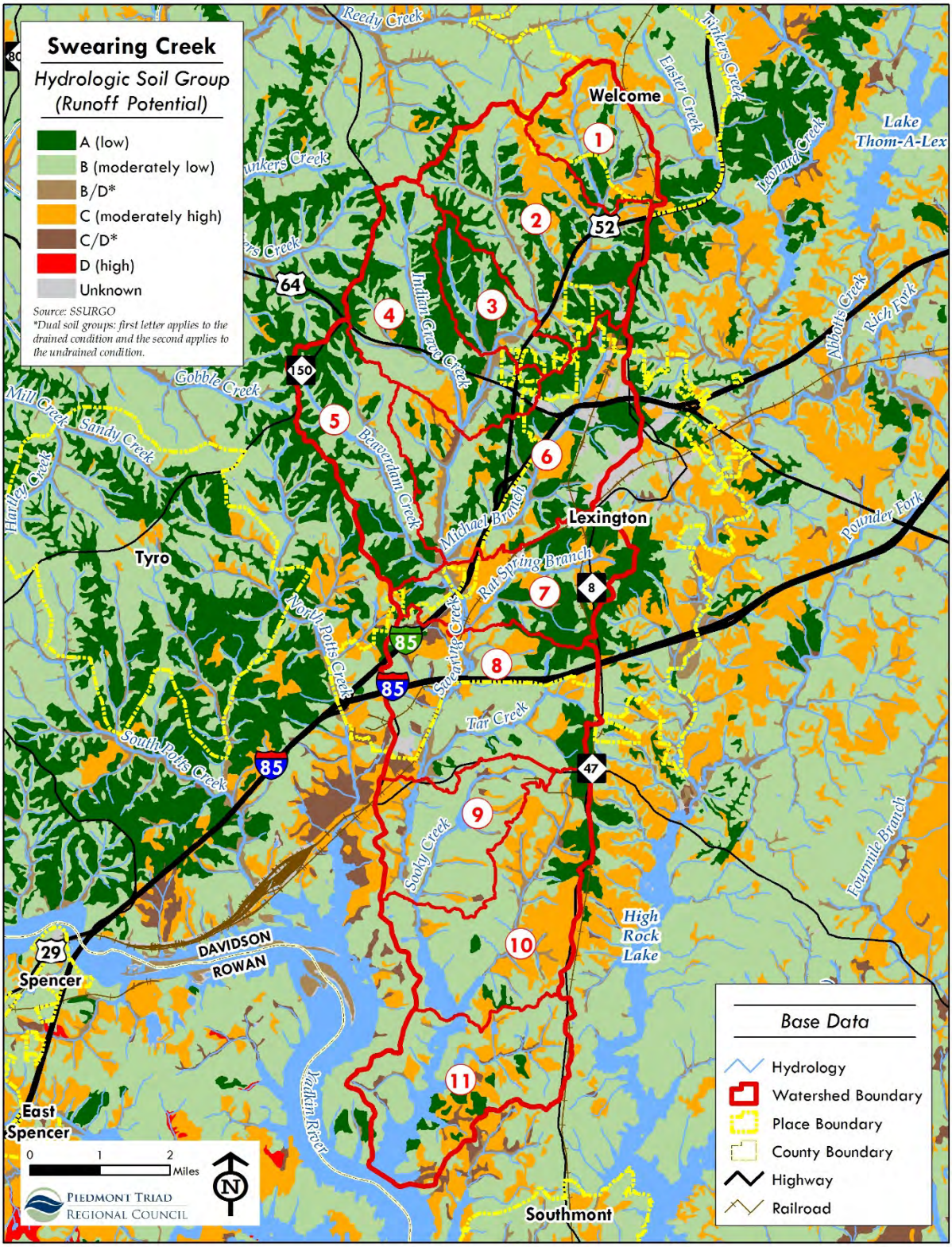


Figure 8: Swearing Creek Watershed Soil Groups Map

The predominant soil species comprising almost 67% of all soil in the Swearing Creek watershed are:

Cecil soil group (27%) - a loam that is found with varying levels of clay or organic material throughout the watershed. It drains very well, with water percolating freely up to 6 feet below the surface, and has a low shrink-swell potential. It has very low organic content, with no more than 1% found at the surface.

Davidson loam group (18%) – a well-draining soil usually found on ridgetops and slopes. It contains a 7-in. thick layer of reddish-brown loam and a deep (>65-in.) subsoil. It is an acidic soil that has moderate permeability with a low shrink-swell potential.

Pacolet sandy loam groups (15%) – a very dark grayish-brown sandy loam that is found on slopes. It has a subsoil that is about 30-in thick and differing variations of yellow and red sandy clay loams. It is an acidic soil with low shrink-swell potential and moderate permeability.

Chewacla loam group (8%) – a poorly draining soil that features a 9-in layer of brown loam and a 43-in subsoil. Its color is generally brown, yellowish brown, and light brownish gray. It has sandy loam surface and a sandy clay loam subsurface. It is an acidic soil with moderate permeability and is mostly found in floodplains.

Vance sandy loam group (6% - this soil is found almost exclusively in and around Welcome. It is a well-draining soil with low permeability found on broad ridges. It is an acidic soil, with a 9-in yellowish-brown sandy loam surface and a mottle of yellow, brown, red, and olive in its 34-in subsoil. There is a >60-in of underlying multihued saprolite with a loam texture.

Mecklenburg loam group (6%) – a well-draining soil found on ridgetops and slopes that has a reddish-brown loam surface over a yellowish red clay subsurface that extends >60 in down. It has low permeability and a moderate shrink-swell potential.

Generally, the Swearing Creek watershed's soils are sandier than many of the clayish soils of the Piedmont ecoregion, and consequently less stable. This is particularly true near High Rock Lake (see Figure 9). The soils almost all drain well, with water able to penetrate up to six feet below the soil surface. Class A soils drain extremely well, while Class C and B/D soils have much more clay content and drain more slowly. Class C soils are more prone to erode on the steeper slopes near High Rock Lake.

There are no hydric soils in the watershed, though the "partially hydric" Chewacla soil group makes up about 8% of the watershed's soils (see Figure **10**). Hydric soils are an indicator of saturated soils, and one of three attributes used to delineate and declare an area as a wetland. Chewacla is found almost exclusively within the riparian zone of Swearing Creek and its main tributaries, making it off-limits to development and potential degradation. These areas coincident with all documented wetlands, though field assessments may identify the need for a more detailed assessment for the presence of wetlands and hydric soils, as has been found elsewhere in Davidson County.

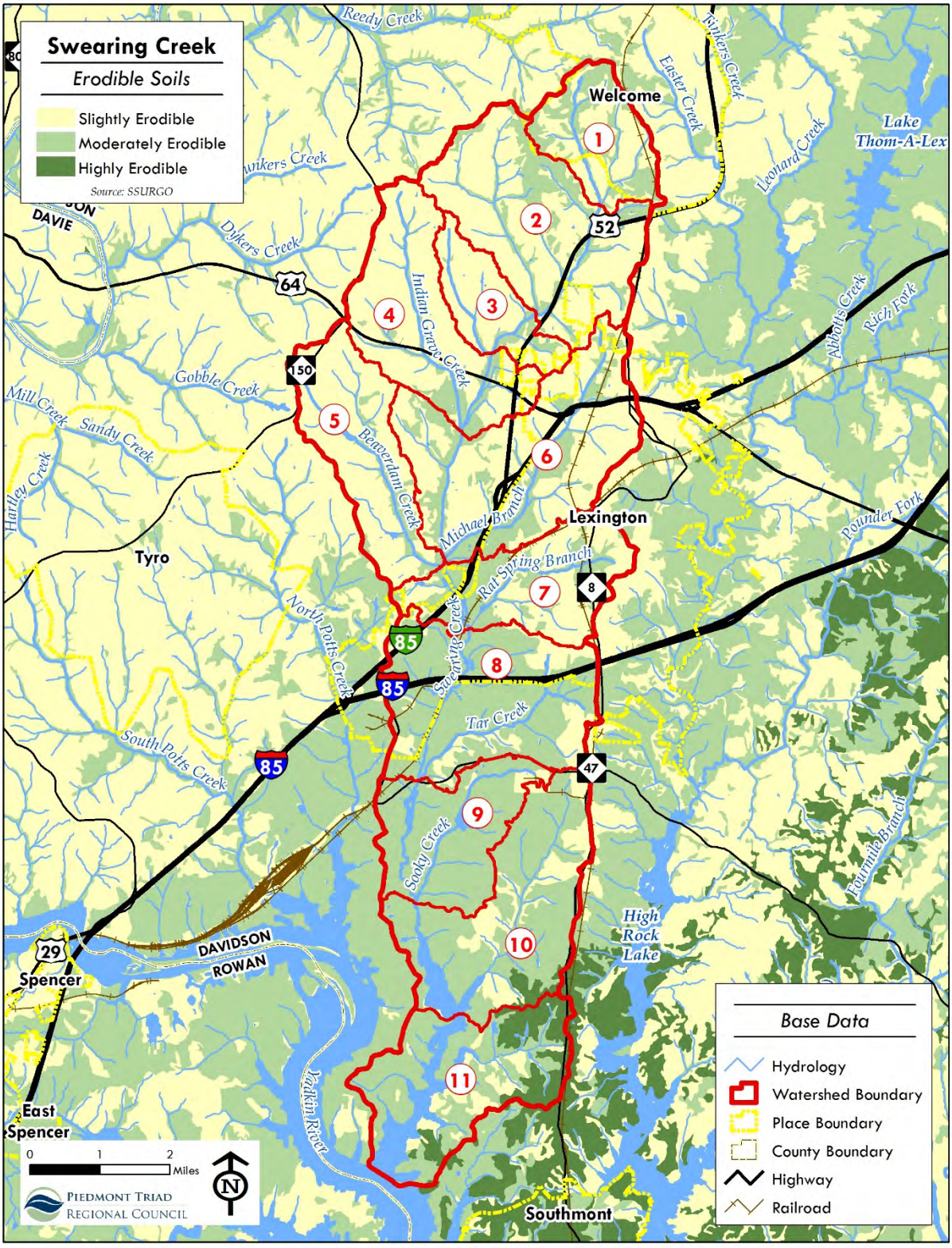


Figure 9: Swearing Creek Watershed Erodible Soils Map

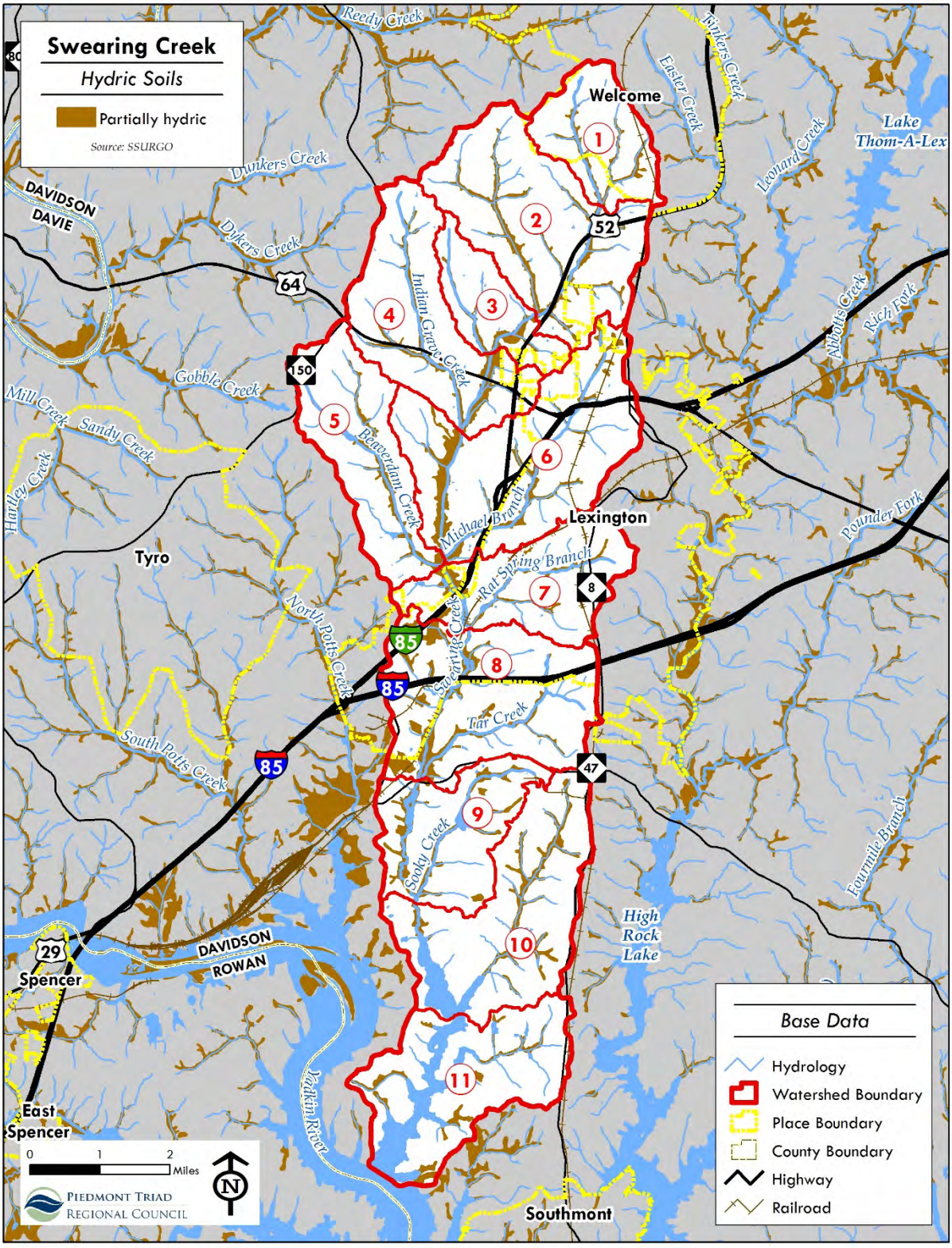


Figure 10: Swearing Creek Watershed Hydric Soils Map Topography

The Swearing Creek watershed falls 354 feet over ~17 miles from its headwaters in the community of Welcome to High Rock Lake south of Lexington (see Figure 11). The highest point in the watershed at 972 feet is found at the northernmost area in Welcome, and the lowest are at the confluence with High Rock Lake. The highest elevations are generally found in these more northern headwaters, with slopes and elevations moderating the closer the creek gets to the lake.

The Center for Watershed Protection (CWP) considers slopes over 15% to be a significant source of stormwater or agricultural runoff to catchment waters if they are cleared of vegetation. These slopes are steep enough that they contribute to runoff waters' velocity and how they impact catchment waters, their banks and beds, and the habitats they support. This usually results in large-scale erosion (Schueler & Holland 2000). Swearing Creek watershed has such slopes in 18% of its total area, which is equivalent to almost 9 square miles of land with slopes that should not be developed. They are found throughout the watershed, but largely in floodplains that are generally not developable for most uses (see Figure 12).

Swearing Creek does not have a USGS stream gauge to monitor water height and flows. Its immediate neighbor stream, Abbotts Creek, does have a gage immediately downstream of the City of Lexington, though its watershed is roughly four times the size of Swearing Creek when including its main tributary Rich Fork Creek. Without direct measurement, this data is the likeliest representation of hydraulic conditions in Swearing Creek. Historically, Abbotts Creek's mean streamflow ranges from 7.7 cubic feet per second (cfs) in 2002 to 628 cfs in 2003, and mean stream heights of 3.23 feet in 2015 and 6.94 feet in 2003. However, hurricanes and other violent weather has produced higher records in Abbotts Creek, including a velocity of 14,800 cfs in 1947 and an annual peak height of 13.48 feet in 2003 (USGS 2011).

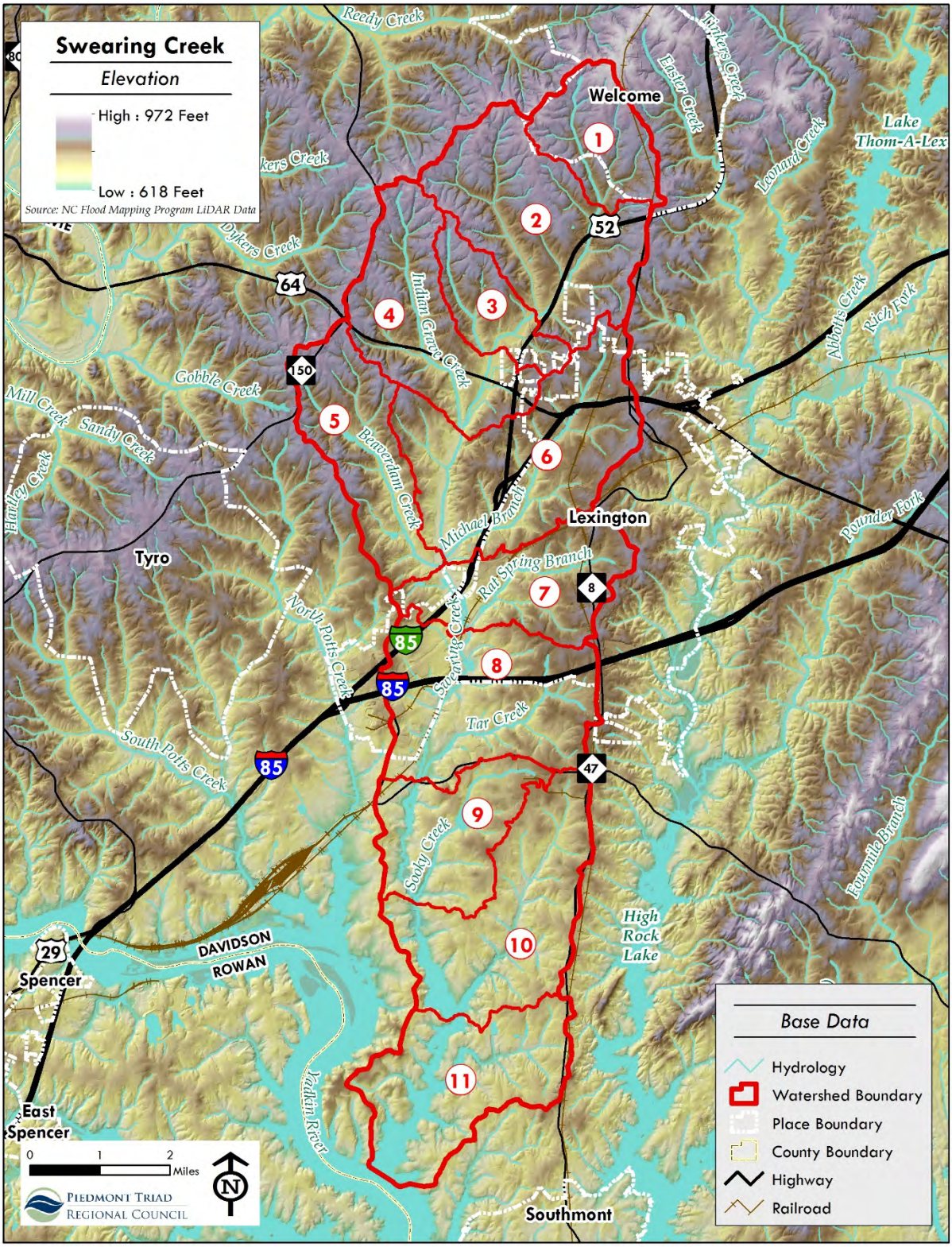


Figure 11: Swearing Creek Watershed Elevation Map

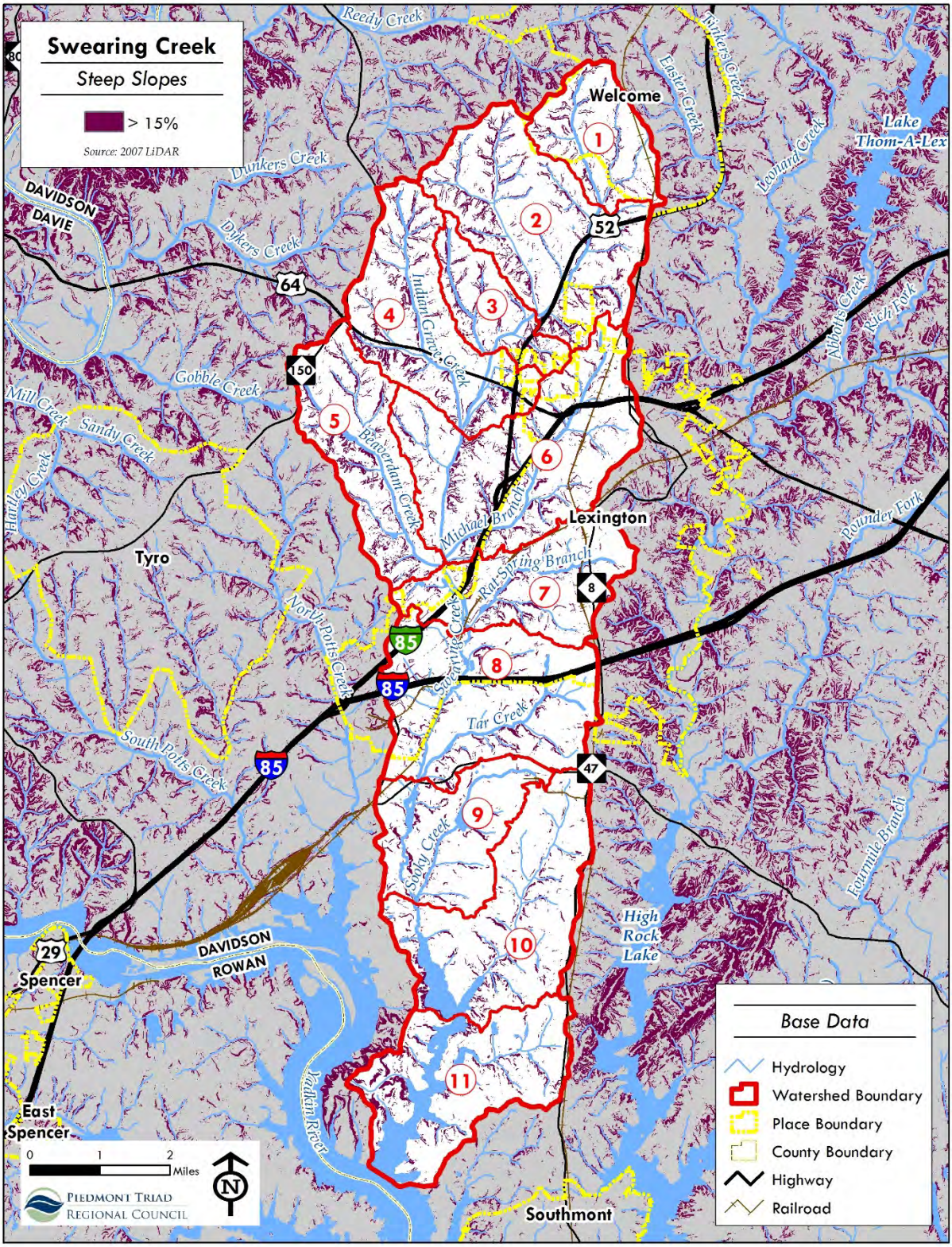


Figure 12: Swearing Creek Watershed Steep Slopes Map

Surface Hydrology

Davidson County has a temperate year-round climate with four seasonal changes. The average precipitation for the 18 months studied under this project was 1.85 inches/month (Weather Underground, Inc., 2011). Field data collection was conducted under ample precipitation conditions. The State Climate Office of North Carolina at NC State University reports that "summer precipitation is normally the greatest, and July is the wettest month. Summer rainfall is also the most variable, occurring mostly in connection with showers and thunderstorms. Daily showers are not uncommon, nor are periods of one to two weeks without rain. Autumn is the driest season, and November the driest month, except in the event of a hurricane. All North Carolina's rivers and streams commonly have a maximum flow in late spring, with low flow in fall. It is rare for any but the very smallest streams to be dry at any time. Floods covering a wider area and extending into the Piedmont are most likely in winter, when traveling weather systems bring prolonged rain to a large portion of the state" (State Climate Office of NC, 2008).

Figure 13: Class I - V Stream

Swearing Creek and its tributaries can be grouped into two groups of stream orders. The first is the Class I – V streams that compose the many small headwater tributaries and streams that originate due to natural springs and rainfall runoff. The small order urban streams within the City of Lexington are generally more incised due to the impacts of larger stormwater volumes than the rural tributaries.

The second type of tributary is the Class VI – X streams found primarily in Swearing Creek. The Creek and its largest tributaries carry large volumes and increase in volume and velocity briefly downstream of Lexington before these volumes and their high flows enter High Rock Lake. Downstream larger-order streams and creeks are more stable, but also more incised from cumulative stresses to the watershed. They generally have more difficulty accessing their floodplains in developed watersheds than smaller streams, depriving these areas of critical public safety and pollutant filtration services.

Figure 14: Class VI - X Stream

High Rock Lake is an artificial impoundment on the Yadkin River, and does not follow the River's natural hydrology. Built by the Aluminum Company Of America (ALCOA) in 1928 for energy generation at its production facilities on Badin Lake, it is now designated by NC DWR as a recreation water feature, and is permitted to be used for primary recreation (fishing, swimming, boating) but not for drinking water, by agreement with the ALCOA. It is currently owned and managed by the Cube Hydro, which regulates its surface levels in order to generate hydropowered electricity at the Badin Dam downstream. The Lake's security is managed by a Cube Hydro-employed security team, and the general water quality and safety of recreational users is their responsibility. While Cube Hydro likely maintains a dialogue with the High Rock

Lake Homeowners Association and other Lake stakeholders to ensure that the Lake serves residents' needs, they ultimately are the sole authority to maintain Lake levels and downstream hydrology on the Yadkin River. Consequently, Lake levels are generally lower in the summer, when electricity demands are higher in NC. Shallower lake levels increase water temperatures, enhancing the opportunity for eutrophication to cause algal blooms.

Due to the Lake's presence, flooding is not a significant problem in much of the watershed. However, the Lake is also the receptor of all the upstream pollutants, and many of the pollutants are concentrated at the confluence of Swearing Creek and High Rock Lake. The Lake's hydrodynamics appear to create an eddy at the creek's confluence that does not allow water entering from the creek to flow immediately downstream. Depending upon weather conditions and lake level, this eddy circulates the creek's pollutants (as well as other pollutants that enter High Rock Lake upstream) at this confluence, including upstream. This is further antagonized during drought conditions, which have been common and extreme in the last fifteen years (especially 2002 and 2007).

Figure 15: High Rock Lake at low levels, January 2011

Floodplains and Wetlands

Wetlands provide flood control, pollution mitigation, ecological habitat, and are natural water quality filters. Wetlands are delineated using three attributes: hydric soils, hydrophytic vegetation, and hydrology. The criteria basically fulfill the concept that soils must be saturated with water for at least 2 weeks out of an average year, and that these areas are supportive of plants that rely upon wetlands as habitat (NC DENR 2004).

National Wetlands Inventory (NWI) data, published originally in 1977, identifies 155 wetlands totaling 439 acres within the Swearing Creek watershed (see Figure 17). As stated on the NWI website,

"...the data are intended for use in publications, at a scale of 1:24,000 or smaller. Due to the scale, the primary intended use is for regional and watershed data display and analysis, rather than specific project data analysis. The map products were neither designed nor intended to represent legal or regulatory products," (US Fish and Wildlife Service, 2006).

Figure 16: Wetland in Lexington

More accurate local wetlands data is necessary to make a firm determination of location and number of wetlands in the watershed. For example, using this NWI data set, small farm ponds and lagoons are regularly labeled as wetlands, when, for the purposes of watershed analysis they fit the function of water features better. Updating and validating both the NWI and soil survey data should be NC DEQ and USGS priorities for the NC Piedmont region, as both are inaccurate and often misrepresentative of actual conditions. The County may want to explore wetlands protection and restoration as a potential investment for any future mitigation needs for development impacts and/or nutrient offset management in the context of a state-legislated nutrient reduction strategy for High Rock Lake.

Floodplain data was obtained from the NC Floodplain Mapping Program and accurately represents 100-year floodplains in the Swearing Creek watershed (see Figure 18). The 100-year floodplain is that area designated as having 1% chance of being flooded annually, given historical records, soil group, topography, and average rainfall for a region. The Federal Emergency Management Administration (FEMA) restricts the flood insurance coverage permitted to those who build within this 100-year floodplain. No hydric soils are listed within the 100-year floodplain, which is highly unusual, and highlights the need for a new Davidson County soil survey. The floodplains are sole location of the partially hydric Chewacla soils in this watershed.

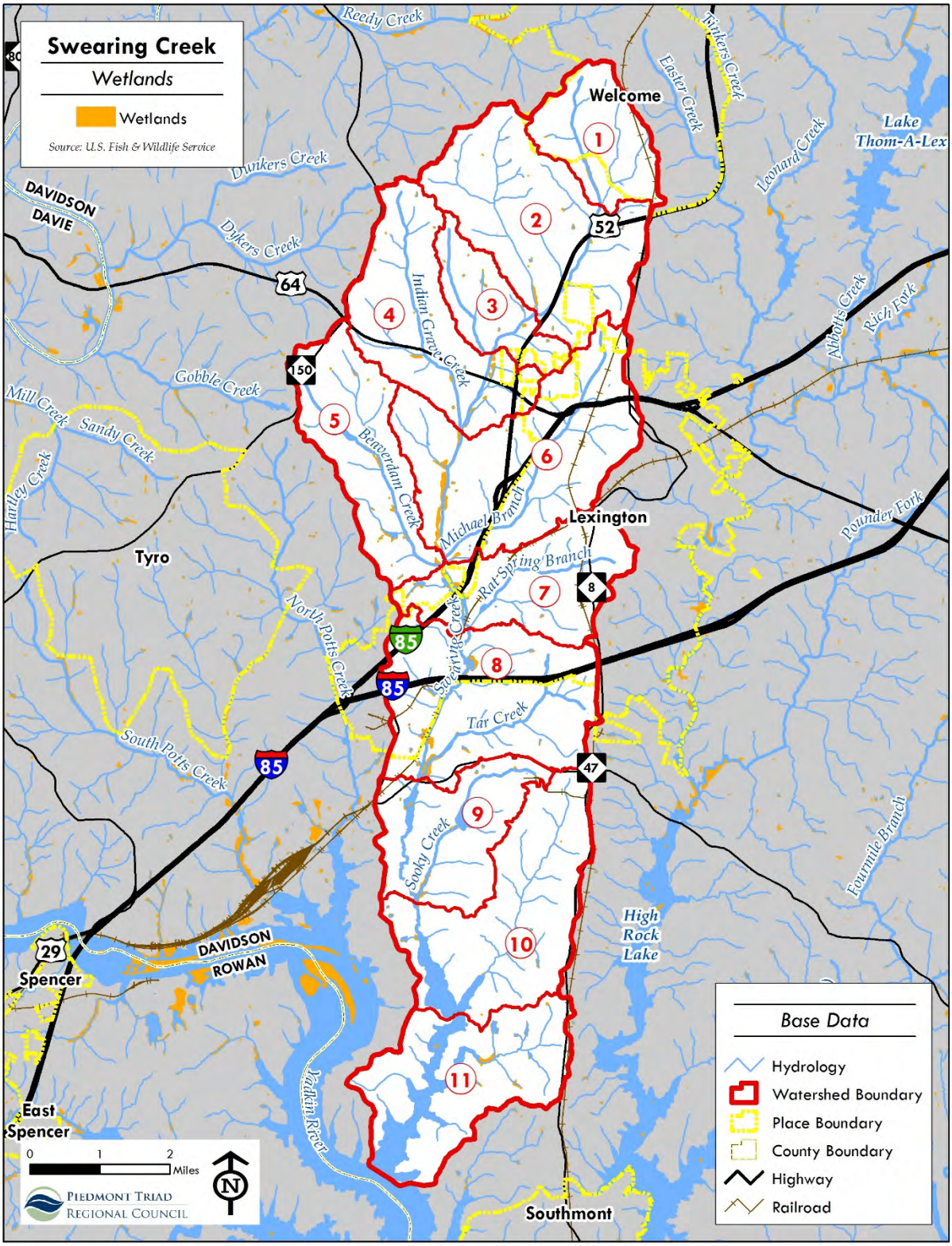


Figure 17: Swearing Creek NWI Wetlands Map

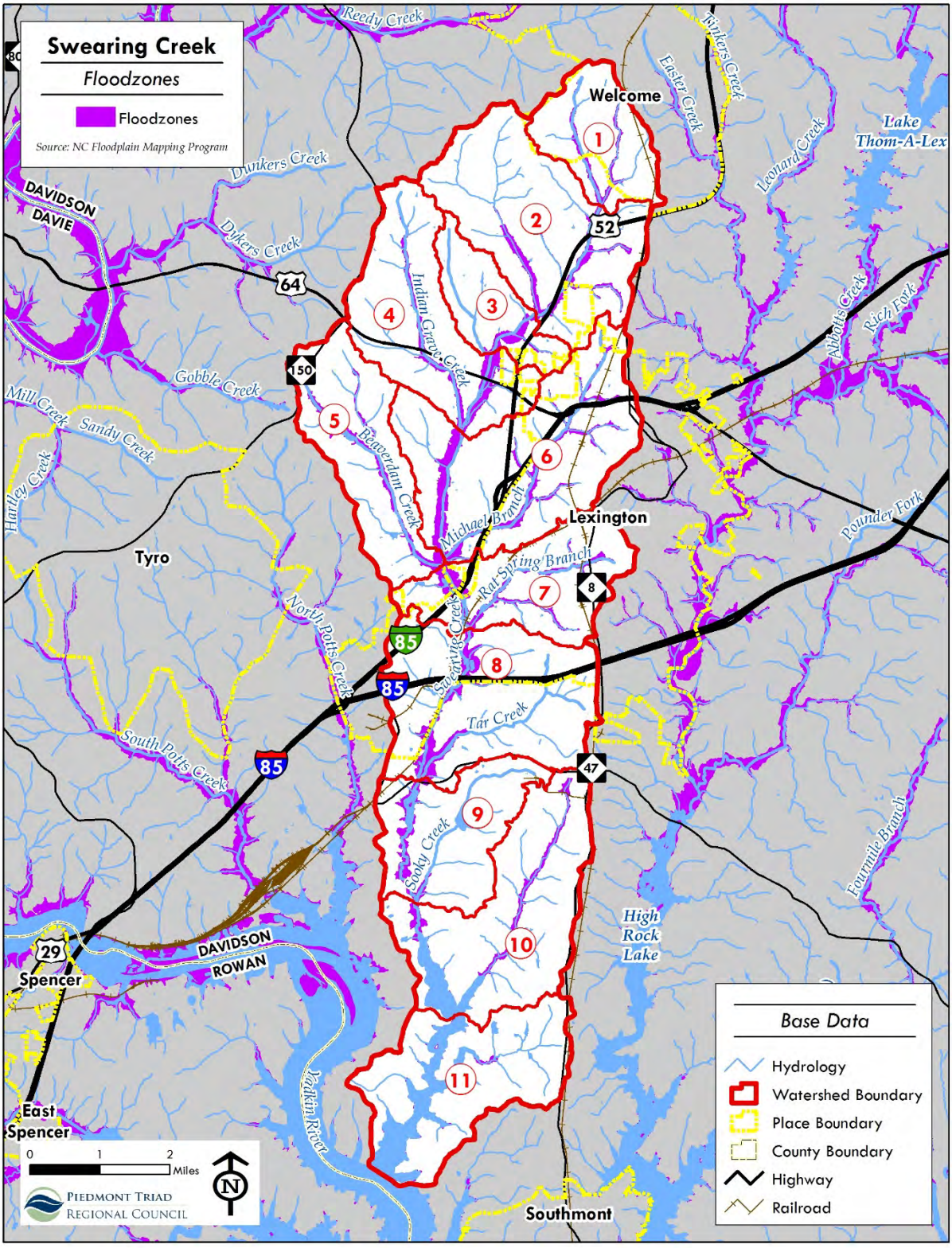


Figure 18: Swearing Creek Watershed FEMA Floodplains Map

Ecological Habitat

The NC Natural Heritage Inventory (NHI) lists two natural heritage areas for "moderate" ecological significance within the Swearing Creek watershed, as well as one for "general" ecological significance. However, these moderate sites – the Swearing Creek Swamp Forest and the Smith Grove Slopes - include the globally-imperiled Piedmont Bottomland Forest community. This habitat is a wetland ecosystem found only in a few places throughout the state and the world that "*…make it very vulnerable to extinction.*" Swearing Creek's watershed includes two other ecosystem types rare to North Carolina, including a wading bird colony. The watershed is surrounded by the rich ecological and recreational resources of High Rock Lake, which includes bald eagles and great blue herons nesting sites (see Figure 19).

From 2011 – 2014, the PTRC was the lead planning entity for a HUD Sustainable Communities project called Piedmont Together. This three-year planning effort identified a spectrum of challenges and assets the 12-county Piedmont Triad region must address to ensure a future with a reliably sustainable society, economy, and environment. Broken down into eight working groups, including teams focused on Green Infrastructure and Climate Adaptability, the project delivered numerous products to enhance the quality of life in the region.

One of these products was the Green Infrastructure Network, which has a hub in the Swearing Creek watershed. The hubs of the network were determined using a GIS-based method of evaluating the entire 12-county region's farmland, waters, and biodiversity. These evaluations were then synthesized so that the sites that best serve all three of these needs are identified as "hubs" that can be prioritized for restoration and protection efforts. These hubs were then interconnected using a "least-cost" tool that optimized utilizing high-value landscapes (e.g. riparian buffers) and avoiding ecological obstacles (e.g. roads). As can be seen in Figure 20, the Green Infrastructure Network prioritizes Swearing Creek's natural heritage area as a hub and links it to High Rock Lake and the wetlands of the Lake's Abbotts Creek Arm through the more erodible, flatter farmland of the watershed's downstream areas. These should be a priority for conservation efforts by environmental groups and the land trusts.

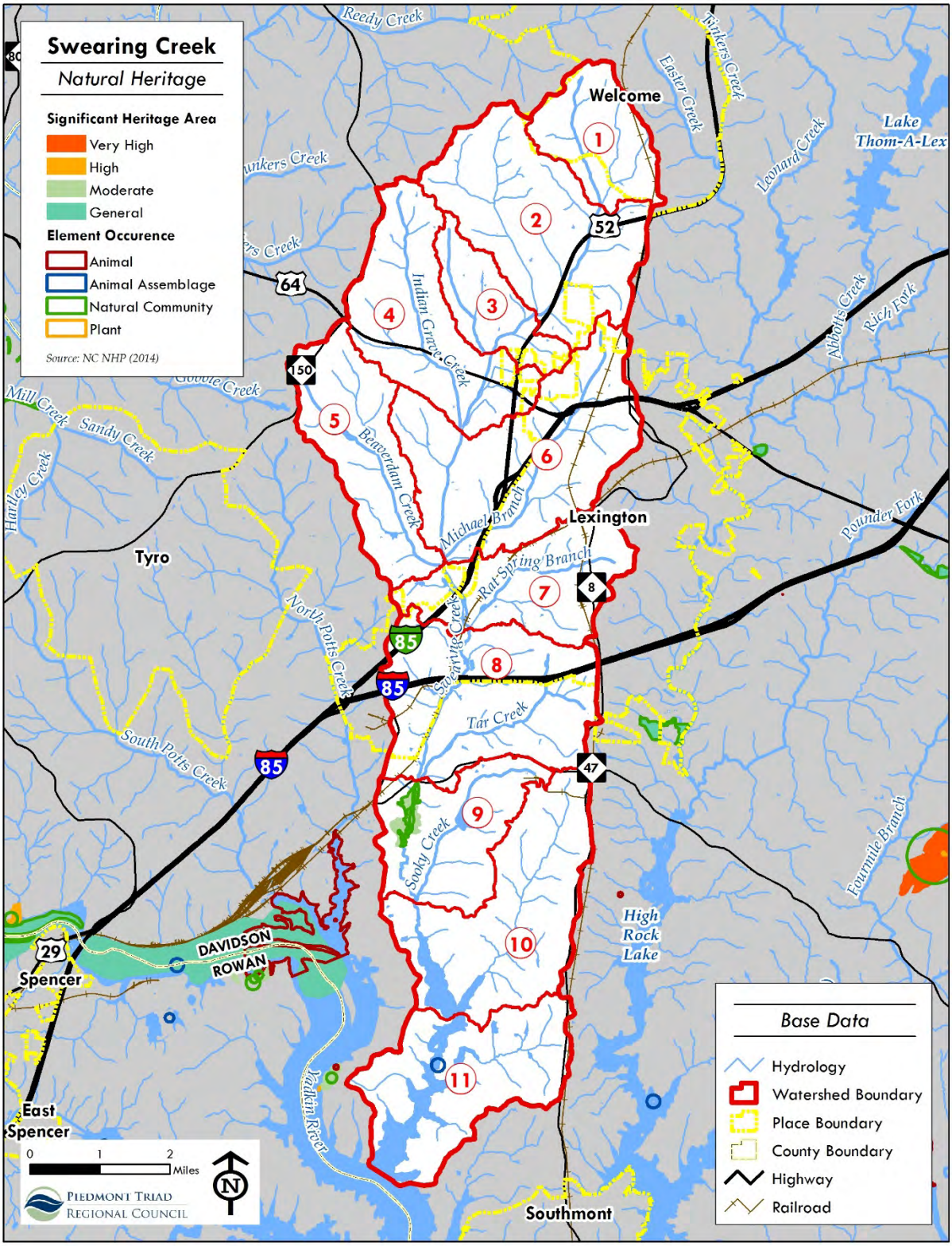


Figure 19: Swearing Creek NC NHP Natural Heritage Sites Map

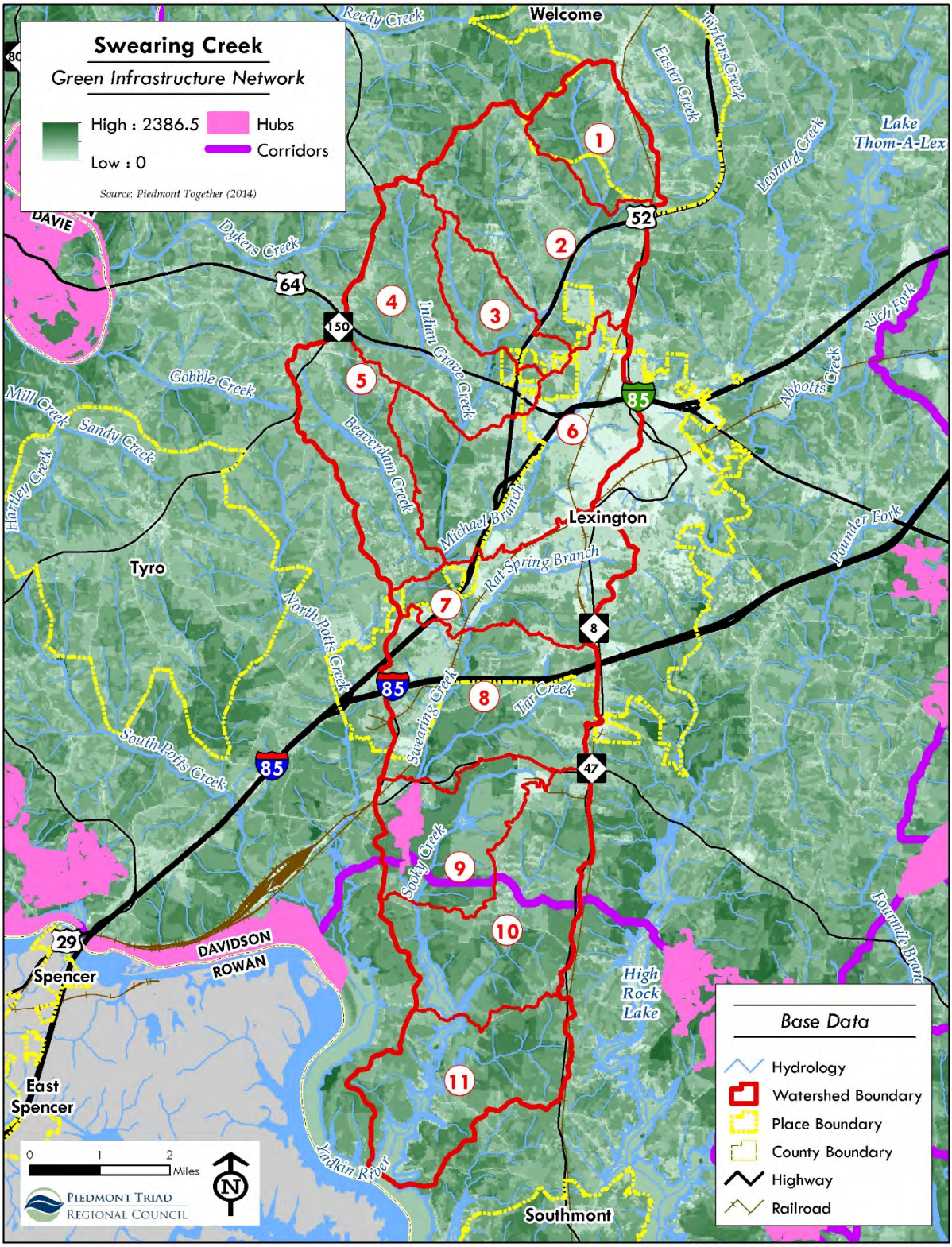


Figure 20: Swearing Creek Watershed Piedmont Together Green Infrastructure Network Map

Section 3: Water Quality Monitoring Data

Swearing Creek was first listed as an impaired waterbody in 2004 by NC DWR after fish community sampling revealed "Fair" conditions at one site just south of Old Linwood Rd. Benthic macroinvertebrate surveys conducted by NC DWR since that time have also demonstrated that biological conditions within the Creek are not representative of a healthy stream system. These degraded water quality conditions were speculated to be caused by non-point source pollution, likely stemming from urban stormwater runoff and/or agricultural practices within the surrounding watershed.

Swearing Creek is a direct tributary of High Rock Lake in Davidson County, which has also been listed as an impaired waterbody since 2004 for high chlorophyll-*a* concentrations. Since that time High Rock Lake has also been listed for high pH levels, high turbidity, and polychlorinated biphenyls (PCB) fish tissue advisories (NC DWR 2014a). NC DWR conducted a special study of the Lake's water quality to determine the sources of nutrient pollution. Their analysis of tributary water quality data suggested that stormwater impacts to the various tributaries are having a cumulative degrading effect on High Rock Lake (Tetra Tech 2004). This assessment supports initial speculation that the likeliest cause of pollution in Swearing Creek is non-point source pollution and/or intermixing with other parts of the lake. High Rock Lake is now undergoing a Total Maximum Daily Load (TMDL) stakeholder process to better assess the sources of these pollutants, set water quality standards, and develop a nutrient management strategy to reduce the amount of pollutants entering the system.

PTRC was awarded a grant in September 2014 from the NC CWMTF to assess present water quality impacts and watershed restoration needs for Swearing Creek in order to develop a strategic plan for the City of Lexington and Davidson County to better address water quality issues. As part of this assessment, biological and water chemistry data was monitored and collected in coordination with the City of Lexington, NC DEQ, and the YPDRBA. The results of these monitoring efforts are discussed below.

Biological Monitoring

Benthic macroinvertebrate monitoring has been conducted by the NC DWR Bioassessment Branch at four different sites along Swearing Creek since 1985 – at the base of Beaverdam Creek, at a site just south of Old Linwood Rd, at the convergence of Tar Creek near NC 47, and at a site just north of Jersey Church Road. However, only the sampling site at NC 47 has continued monitoring since 1987. In 2001 and 2002, habitat conditions at this site were listed as "Fair", which suggests impaired water quality conditions. Most recent samples from 2006 show that aquatic habitat has improved back to "Good-Fair" conditions for benthic macroinvertebrates.

Fish community data was collected by the NC DWR Bioassessment Branch in July 2004 at station QF24 just south of Old Linwood Road. This sample revealed "Fair" fish community conditions, which originally placed Swearing Creek on the 303(d) impaired waters list. A listing of "Poor," "Poor-Fair," or "Fair" for bioclassification will garner a stream an impaired rating (NC DWR 2014b). It is unclear if any fish community sampling has been conducted on Swearing Creek since this time. More up-to-date biological data would help the City of Lexington and Davidson County gauge how aquatic communities are being impacted by watershed conditions and if any improvements have been made since 2004, similar to the improvements made in the macroinvertebrate communities.

Water Chemistry Monitoring

Water chemistry parameters are regularly monitored at only one location in the Swearing Creek watershed, station Q5135000, which is located at Jersey Church Rd near Linwood and overseen by the YPDRBA. For the purposes of this project, the City of Lexington's water quality monitoring staff sampled and analyzed data from five additional sites within the watershed, one at NC 47, one near the Green Needles neighborhood, one at West Center, one near Tussey Rd, and one near the Northside neighborhood. Sampling at the five additional sites was conducted for a full year from October 2014 to October 2015. All available YPDRBA data for station Q5135000 was retrieved from NC DEQ's Monitoring Coalition database dating back to 1998. Only data from October 2014 to October 2015 was used for comparison to City of Lexington samples to ensure consistency. Water quality measurements from the YPDRBA site correlated fairly well with data collected by the City of Lexington, falling within similar data ranges. A complete spreadsheet of water quality data examined for this report is available from the PTRC upon request.

Water quality data measuring temperature, dissolved oxygen (DO), and pH within Swearing Creek showed little signs of concern. Temperatures were relatively stable, staying between 5 and 25 degrees Celsius, with typical increases during the warmer summer months. This is below the temperature criteria for the upper and lower Piedmont, which is 29° and 32°C respectively (NC DWR 2014b). Temperature in streams is usually only a concern if there are rapid increases or decreases in temperature due to urban runoff, which more frequent sampling could help reveal. DO levels from all six sites remained above the 5 mg/L threshold for healthy aquatic habits. Swearing Creek pH levels were also well within NC DEQ's standards for freshwater pH, between 6 and 9, suggesting that it is not one of the main tributaries contributing to High Rock Lake's high pH levels. The conductivity of Swearing Creek remained, primarily, between 50 and 200 µS/cm. There are currently no established thresholds for conductivity in NC. However, freshwater streams should ideally have a conductivity between 150 and 500 µS/cm to support "diverse aquatic life", which Swearing Creek fell within or below (Behar 1997).

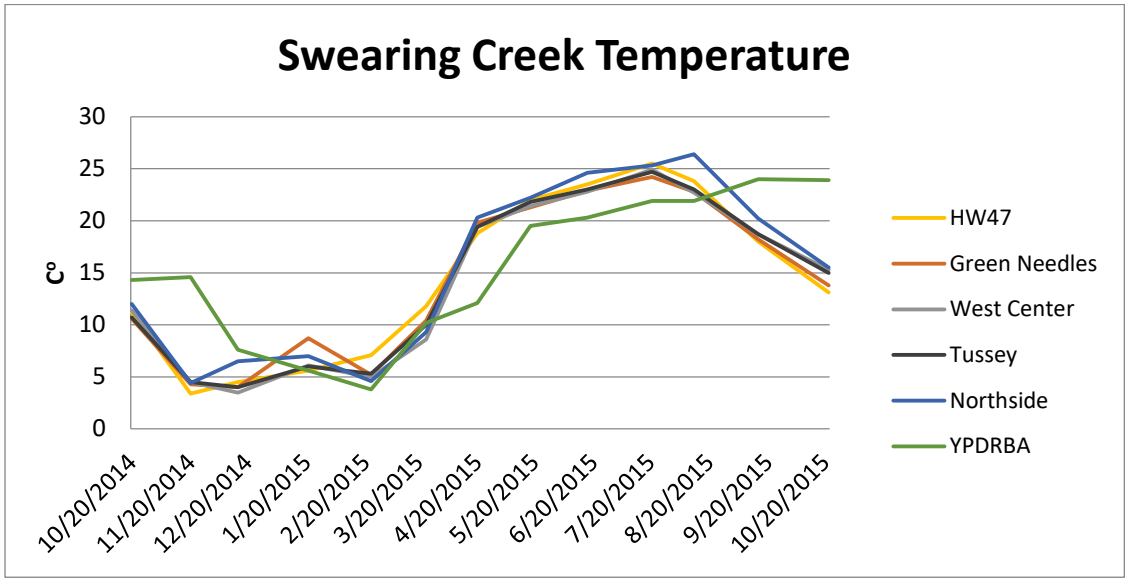


Figure 21: City of Lexington & YPDRBA Temperature Data for the Swearing Creek Watershed

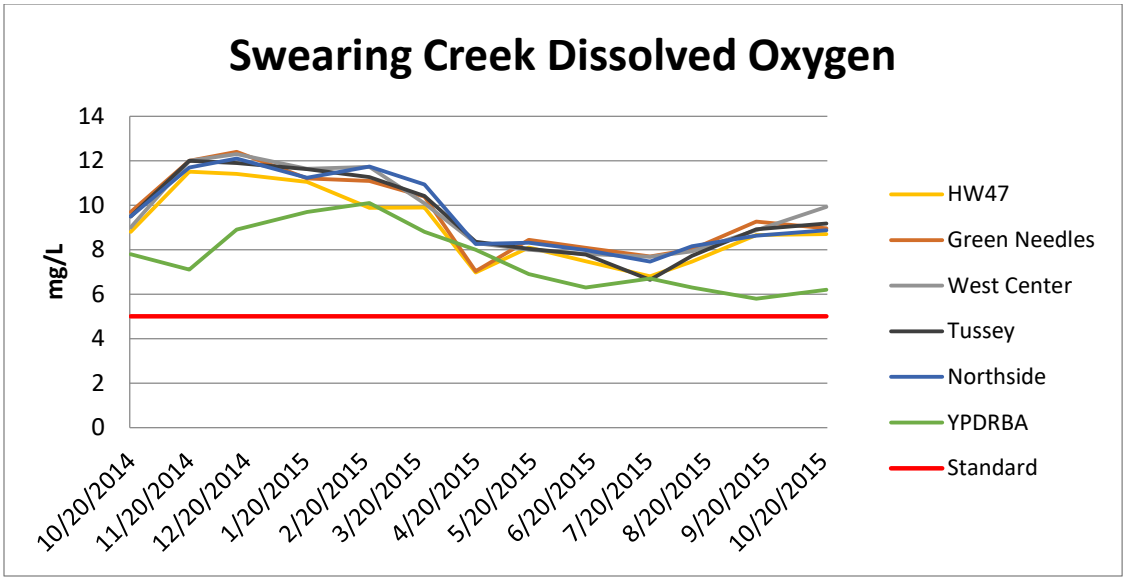


Figure 22: City of Lexington & YPDRBA DO Data for the Swearing Creek Watershed

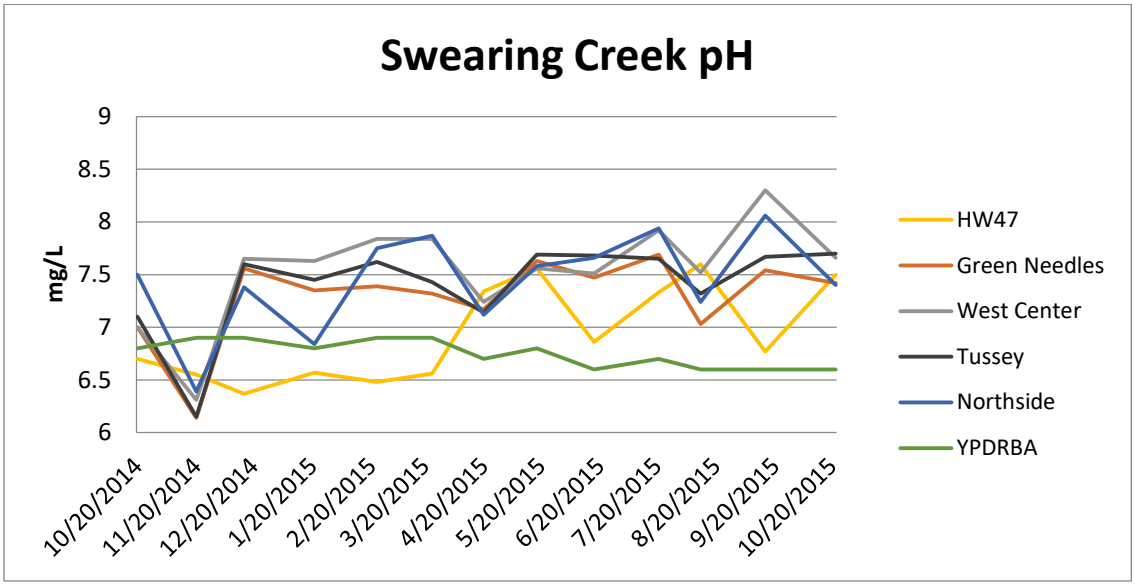


Figure 23: City of Lexington & YPDRBA pH Data for the Swearing Creek Watershed

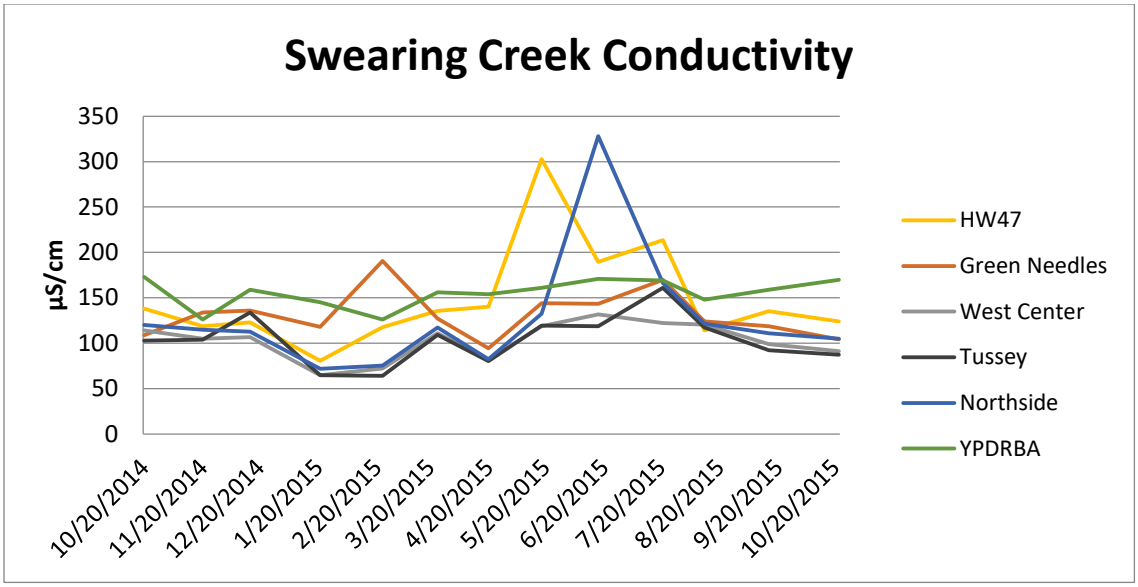


Figure 24: City of Lexington & YPDRBA Conductivity Data for the Swearing Creek Watershed

One of High Rock Lake's primary water quality concerns, as well as its tributaries, is high turbidity. For this study, the City of Lexington measured the amount of total suspended solids (TSS) in order to assess the water's cloudiness, see Figure 25. TSS levels remained consistently low throughout the sampling period with two spikes at the NC 47 and Northside site. Turbidity was, however, measured at the YPDRBA station. Figure 26 shows turbidity levels measured at this site since 2004, when Swearing Creek and High Rock Lake were first listed as impaired waterbodies. Turbidity within the Creek has remained fairly low throughout this period, with only ten instances surpassing NC DEQ's 50 NTU threshold over the past 12 years. Periodic spikes in turbidity are likely due to weather patterns, where heavy rains cause increased erosion and sediment loads to enter the stream.

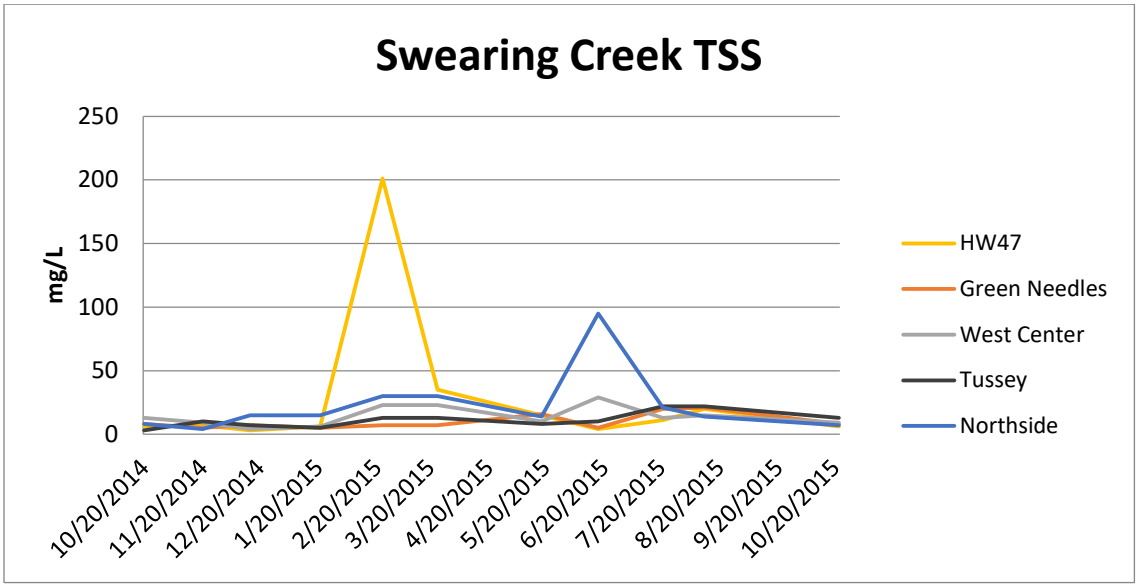


Figure 25: City of Lexington & YPDRBA TSS Data for the Swearing Creek Watershed

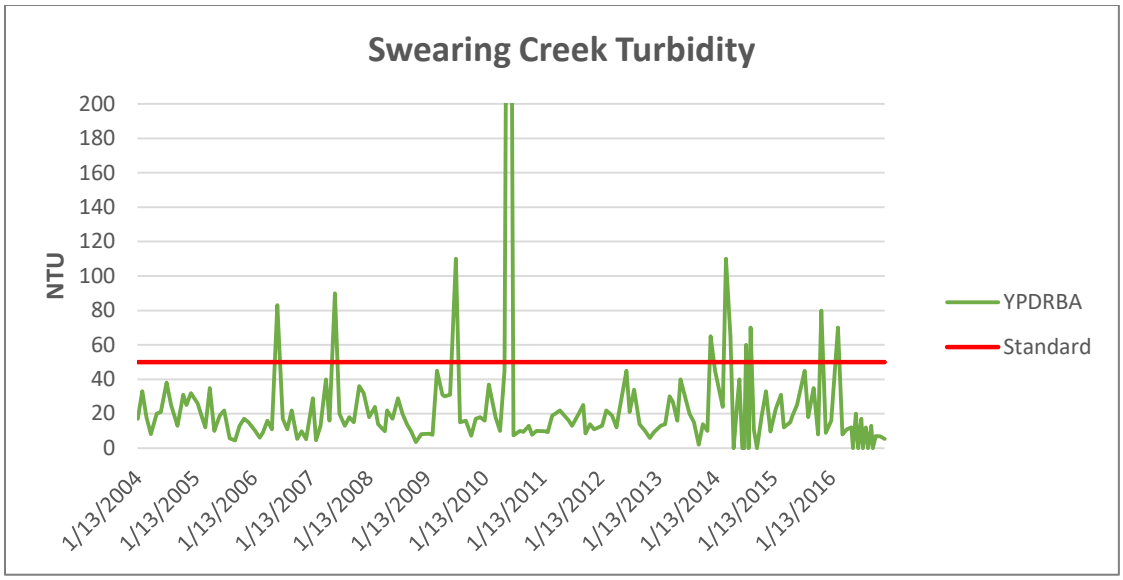


Figure 26: YPDRBA Turbidity Data for Swearing Creek near Jersey Church Rd

High chlorophyll-a concentrations are another concern for High Rock Lake and its tributaries, which is an indicator of algae growth. Algal blooms and other uncontrolled growth of plant life is often caused by an excess of nutrients, especially phosphorous and nitrogen. In order to monitor the amount of nutrients entering Swearing Creek, samples of total phosphorous (TP), nitrates (NO3), and total kjeldahl nitrogen (TKN) were taken at all six sample locations. There are currently no established thresholds for nutrients in NC, except for nitrates plus nitrites, which should not exceed levels of 10mg/L (NC DWR 2014b). From October to March 2014, phosphorus levels remained relatively low. In May, however, there were rises in phosphorus at all five of the sites tested by the City of Lexington, with the highest levels seen at the NC 47 and Northside sites. Phosphorus levels remained higher at the Northside site throughout the rest of the year. The West Center also saw higher levels of phosphorus in September of 2015. NO3 levels followed similar patterns, remaining fairly stable until May, when all five City of Lexington sites saw increased nitrate loads. There were two periods during the sampling period when TKN levels rose, once in January and again in June. The Northside sampling site saw the highest increases, followed by the YPDRBA station and West Center site. These spikes in TKN mimic the increases in total phosphorus during these times.

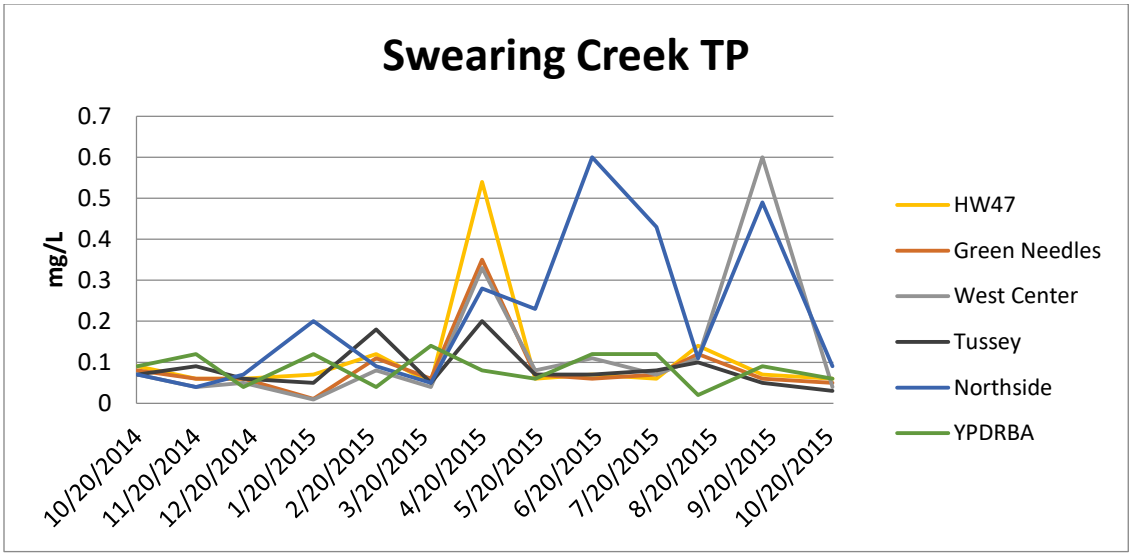


Figure 27: City of Lexington & YPDRBA TP Data for the Swearing Creek Watershed

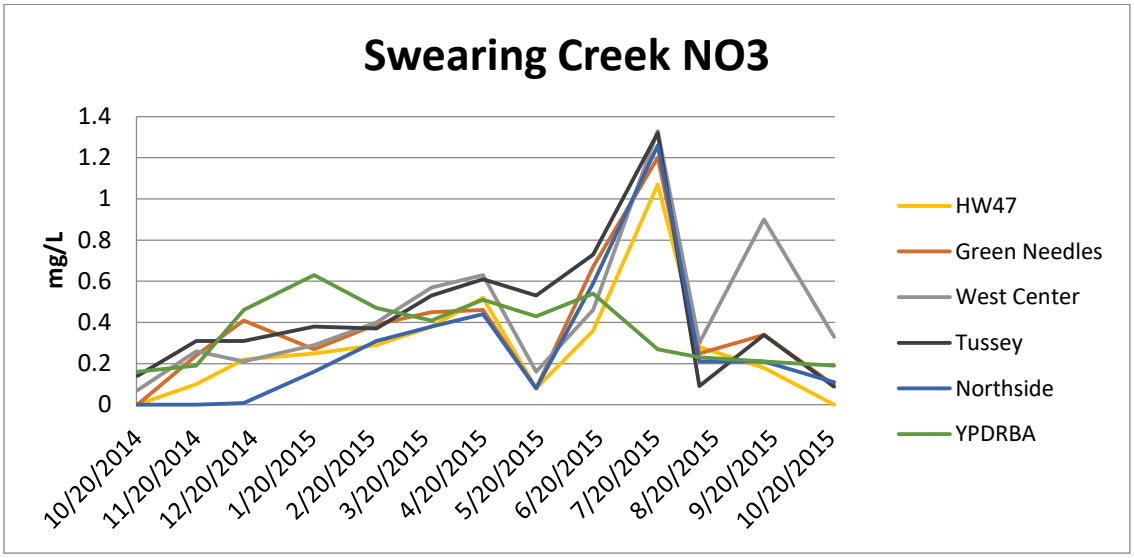


Figure 28: City of Lexington & YPDRBA NO3 Data for the Swearing Creek Watershed

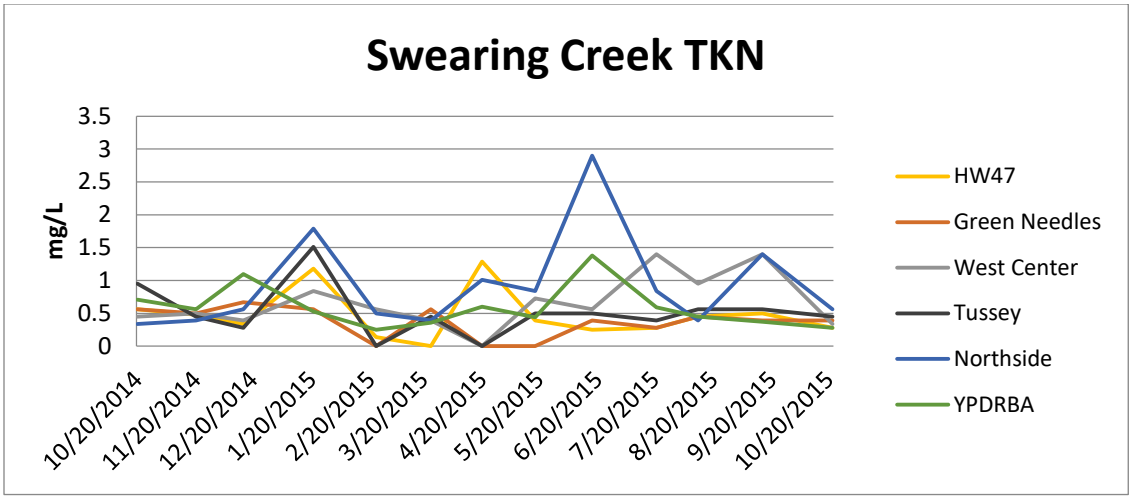


Figure 29: City of Lexington & YPDRBA TKN Data for the Swearing Creek Watershed

Another indicator of excess nutrients is fecal coliform, which is a bacteria found in human and animal fecal matter. However, fecal coliform can also pose significant health risks. Fecal coliform has been monitored at the YPDRBA station since 2010. As seen in Figure 30, levels of fecal coliform consistently stayed below NC DEQ's water quality standards of 200cfu/100ml for freshwater aquatic life between 2011 and 2013, with one sample in 2010 rising well above DEQ standards. However, since 2013, fecal coliform levels at the YPDRBA site have remained consistently above NC DEQ standards. The largest spike in fecal coliform occurred in July 2014, when levels reached 8600cfu/100ml, 43 times NC DEQ's limit. Acute violations of the 200 cfu/100mL water quality standard have not led to an impairment rating of these waters by NC DEQ due to the requirements that all fecal coliform bacteria impairments be declared only following a protocol that requires five samples within 30 days (NC DWR 2014b). However, clearly, fecal coliform is a potential concern for the Swearing Creek watershed. Swearing Creek does not receive treated wastewater from the City of Lexington, whose plant is located on the eastern side of the city in the Lower Abbotts Creek watershed. Thus, fecal coliform is likely entering the stream as a result of agricultural practices within the watershed and rural stormwater runoff.

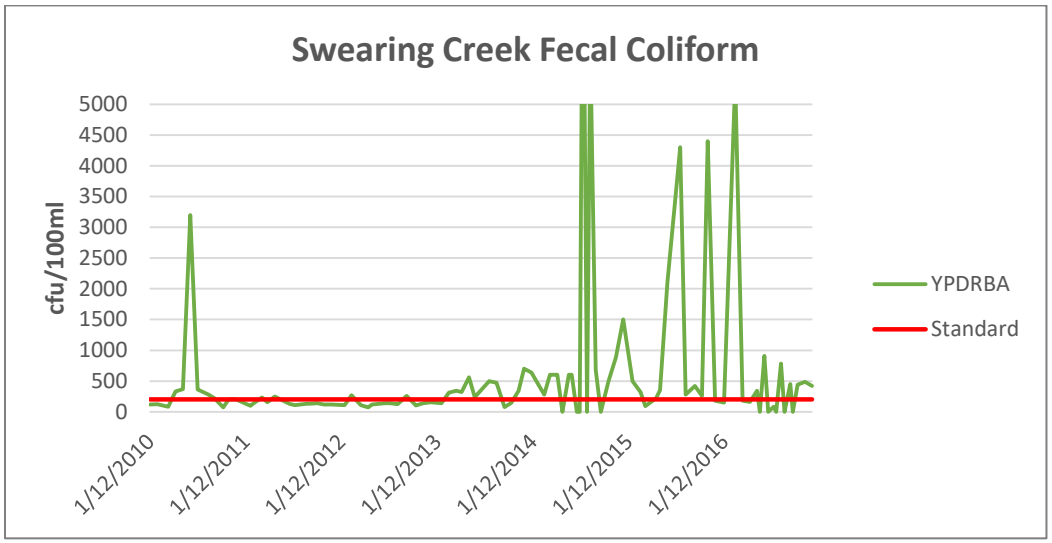


Figure 30: YPDRBA Fecal Coliform Data for Swearing Creek near Jersey Church Rd

Section 4: Current Land Use

Watershed Population

According to the 2000 US Census data, the Swearing Creek watershed population was estimated to be 23,811 people. The 2010 US Census data estimated it to be 24,512, an increase of 685 people or 1%. The increase is attributable to the growth in the suburban around Lexington, especially of US-52 and -64. Much of the decrease is in Lexington, where the highest household vacancy rates and population decreases are also seen. These areas of the watershed have some of the highest altitudes, steepest slopes, and highest densities of wetlands, making them more sensitive – and possibly hydrologically-valuable – than other parts of the watershed. The City of Lexington also has plenty of infrastructure to accommodate growth and use the area of the watershed that is already developed (US Census Bureau, 2006).

Watershed Land Use

Land use data for the Swearing Creek watershed were compiled by gathering tax parcel, zoning, and land use GIS layers directly from Davidson County's Planning Department (see Figure 31). This dataset was compiled to help characterize how parcels in the watersheds are being used. In later planning phases, this data will aid in estimating the impacts of current land use and potential growth upon water quality.

Swearing Creek is largely (71%) rural, with the City of Lexington occupying 18 square miles of its total 49 square mile area. This urban area is entirely upon the creek's eastern bank, which will be strategically significant in implementing the *Restoration Plan*. Land use in the Swearing Creek watershed is overwhelmingly residential (29%), agricultural (26%), or vacant (24%). There are concentrations of industrial and commercial properties along the interstate highways and within the city, especially in the southern areas of Lexington. The zoning data shows that the fate of some of these suburban areas is as industrial parks, which could have profound impacts on commercial and residential growth in the area, all of which could impact local and downstream waters.

There is a significant area (2 square miles) of land dedicated to mobile home use throughout the watershed. Unlike in the Lower Abbotts Creek watershed, mobile homes are a common residence for folks living throughout the unincorporated areas of the watershed, not just the seasonal residences of vacationers visiting High Rock Lake. All mobile home parks rely upon large septic systems to hold the communal sewage of all residents. Any parks that are over twenty years old likely need to replace their tanks and/or pipes. Mobile homes used by seasonal residents are said to be having a significant impact upon water quality due to straight-piping gray water into High Rock Lake and failing septic systems discharging raw sewage to the lake. The NC DEQ's Department of Environmental Health's regional staff are responsible for inspecting all septic systems and ensuring they are not failing.

At this time, it is not possible to predict future development in the Swearing Creek watershed, though 2010 US Census data, NC Department of Transportation data, and population growth estimates from the American Communities Survey allow for speculation. There are two Transportation Improvement Projects (TIPs) in this watershed (see Figure 32). One will enhance US-64, including the bridge that crosses Swearing Creek. The other project will create a bypass around the City of Lexington that will likely have incidental impacts upon the watershed but nothing as direct as the larger bridge over the creek.

The community of Welcome currently occupies only a couple of acres in Subwatershed 1. Should it grow as a Triad economic and/or residential center, this could be a significant watershed management concern. It is already a site of disproportionate commercial development, and may be a node of residential growth.

The City of Lexington is dedicating resources to an Uptown Lexington urban revitalization and reinvestment program, and investing monies and staff in implementing Brownfields redevelopment at abandoned furniture factories within the City. As seen in Section 5, municipal ordinances support these aims, and support conclusions that further development in the Lower Abbotts Creek watershed should not exceed current city limits in the near-future. However, no Davidson County ordinances discourage low density growth patterns, or even mention the issue explicitly.

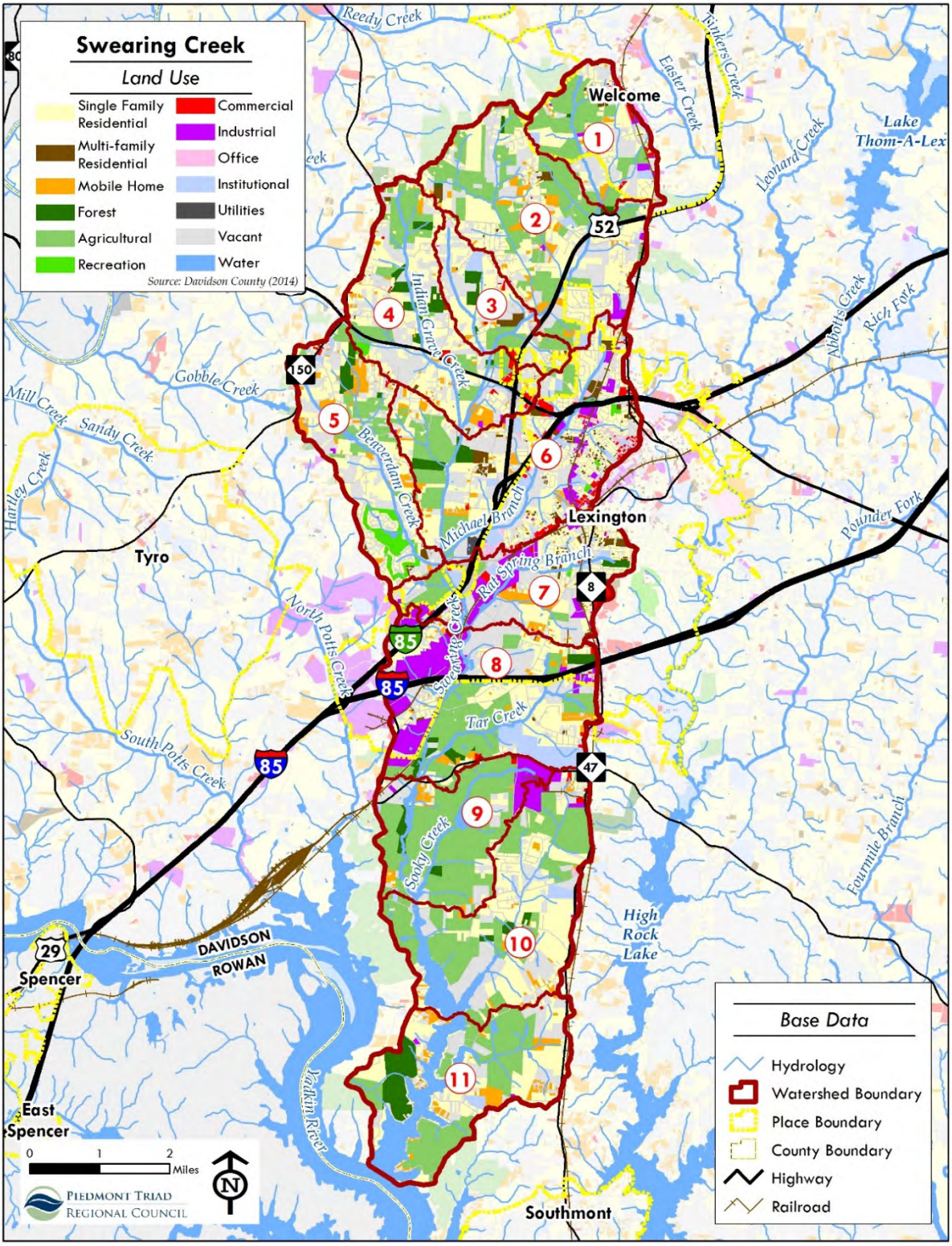


Figure 31: Swearing Creek Watershed Land Use Map

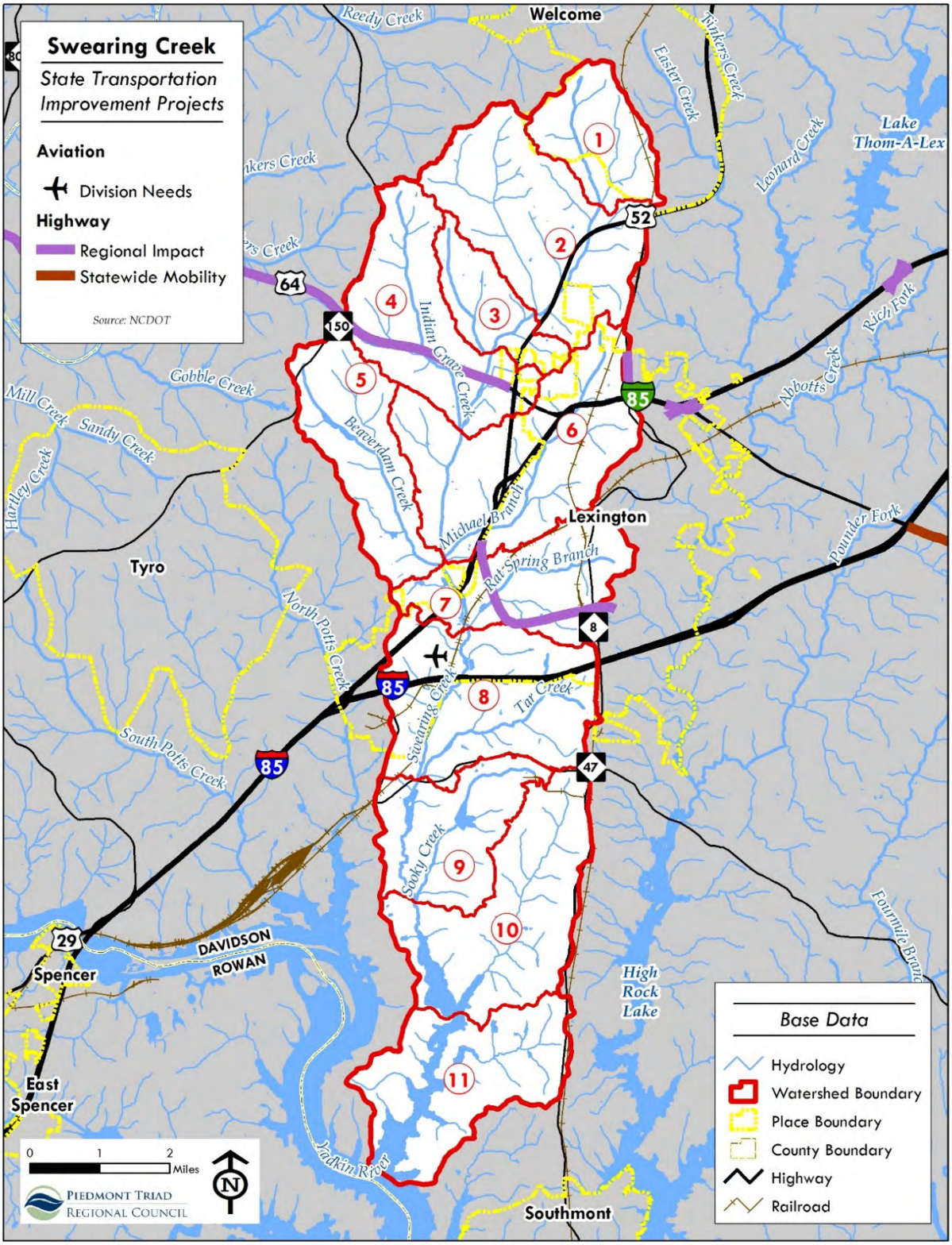


Figure 32: Swearing Creek Watershed NCDOT TIPs Map

Section 5: Review of Local Government Codes, Ordinances, Rules, and Programs

A network of local ordinances, rules, and programs determine how we develop, protect, and use our lands. These same local laws ultimately impact the function of a watershed and the quality of its waters. Swearing Creek watershed health and function is determined by the policies of Davidson County and the City of Lexington. Using the Center for Watershed Protection's (CWP's) Codes and Ordinance Worksheet (COW) to rate the watershed management of both jurisdictions, Davidson County and Lexington rated scores of 51 and 76, respectively. These scores reflect that Lexington has taken concrete steps to protect its waters from development impacts, but that Davidson County has not.

The COW scores were adjusted to reflect their inapplicability within the State of North Carolina's legal framework (and therefore inactionable by local governments) and/or inappropriate for a smaller municipality in a rural setting. The following items were deemed irrelevant for the scores of either the City of Lexington or Davidson County for either or both of these reasons:

- Pervious material being used for spillover areas
    - It was deemed to be a likely contributing factor of erosion and encourage individuals to change oil and wash cars on porous surfaces
- NC law prohibits sidewalks narrower than five feet
- "Alternate pedestrian networks" are fine for walking and connectivity but are counterproductive for general sustainability purposes and do not acknowledge the needs of those with physical handicaps to access natural areas
- Discharging of untreated stormwater to a wetland can be an effective use of ecosystem services and should not be uniformly punished.

The use of the COW also identified several areas where either jurisdiction could gain some additional points through small actions. These include:

- Permitting permeable materials to be used for residential driveways;
- Incentivizing or requiring developers and business to reserve parking for compact cars and/or bicycles;
- Adjusting parking ratio requirements for businesses near mass transit nodes;
- Drafting a model shared parking agreement for use by property and business owners;
- Reducing right of way minimum widths from fifty feet; and
- Further integrate NC Complete Streets standards into ordinances and plans.

Lexington has taken substantial strides in recent years to invest in protecting and restoring environmental features within its city limits. Most of the city's protective policies and ordinances are correlated to other municipal goals such as infill development, economic development, and community safety. This level of strategic integration is very hopeful, but it would be well-served by a roundtable strategy to target some easily-attained water quality protections that also serve many of the city's other interests. The timing of such an effort is ideal, as the city has been identified as a USEPA's National Pollutant Discharge Elimination System (NPDES) stormwater program, requiring them to abide by the six minimum measures of the program: good housekeeping, illicit discharge detection and elimination (IDDE), construction stormwater management, post-construction stormwater management, community education, and public involvement. Compliance with this program can be done directly and simply, or communities can use more comprehensive approaches to

stormwater management that yield many other benefits for the community. Lexington may choose to roll out its stormwater program with this comprehensive strategy.

Davidson County generally does not prioritize water quality protection as a regulatory priority, but does identify it as a high priority for its recreational and agricultural needs, especially related to protecting the use(s) of High Rock Lake. However, without political leadership to protect these resources with regulations, these valuable assets could degrade due to actions by those uninterested and/or unable to take advantage of the multiple incentives available to protect local waters. Unfortunately, these actions are both out of the control of Lexington, even though their consequences are fundamental to the quality of life for municipal residents.

This section will review ordinances, codes, and programs that Davidson County and Lexington have that address watershed needs. It will highlight some ways to improve watershed conditions through ordinance amendments and/or revisions. Work on codes and ordinances is needed to better protect the watershed and ensure that water quality is being accounted for in community growth. Citizen stewardship, enforceable penalties, and incentives for those making extra efforts to improve local conditions all need to be explored by these jurisdictions to improve watershed conditions. The policy recommendations included in the *Swearing Creek Watershed Restoration Plan* will more comprehensively cover some these needs and outline a strategy involving programs, projects, policies, and partnerships to create a healthier watershed.

Watershed Planning

Though not historically applied in such a way, zoning and subdivision regulations, as well as other local ordinances and codes, can be used to improve impaired watershed health and function. This can be done with language that addresses impervious cover, open space, and protect sensitive areas. Davidson County does not use a regulatory approach to environmental resource protections and sprawl management. Instead they use negotiations in the Technical Review Committee (TRC) to serve these purposes. While this permits flexibility in the permitting and design process, it also de-prioritizes water quality protection in the development process, which has consequences for construction and community planning.

The City of Lexington clearly articulates water quality protections in its *Land Development Plan*, but largely uses a spectrum of incentives to encourage more non-traditional practices that protect water quality and watershed functions, all of which can be discussed through the TRC process. This is especially true in Lexington in regard to infill development, which cannot be required in the State of North Carolina, but is specifically identified as a municipal priority in the city's LDP. This approach was strongly recommended in the *Lower Abbotts Creek Watershed Restoration Plan*, as it is cost-effective for the city to use its existing infrastructure to serve residential and economic growth while also not burdening the watershed with sprawling development. Indeed, redevelopment of many of Lexington's commercial and industrial properties offer a wide variety of opportunities to affordably retrofit sites with stormwater practices that offset the impacts of runoff and pollution that have plagued both Abbotts and Swearing Creeks in this highly impervious area. However, all of these efforts will be for naught if Davidson County does not complement them with their own incentives or ordinances that direct growth toward existing jobs centers, protecting the watershed and farmland from development and the transformative changes it can bring to the countryside.

Comprehensive and Land Development Planning

The Davidson County Planning Department has a *Land Development Plan* (LDP), adopted in 2002, updated in 2009, and current to 2020. The County collaborated with PTRC to develop its Unified Development Ordinance in 2010 to address growth and development up to 2025.

The LDP currently in use by the County examines the social, environmental, and economic growths of the County, and with ordinances dedicated to "Water and Sewer Services," "Industrial Development," "Commercial and Office Development, "Housing and Neighborhood Development, "Agricultural and Rural Area Preservation," "Parks, Recreation and Open Space," "Water Quality," "Air Quality," and "Planning Coordination." The County also examined its qualitative features (i.e. slope, population growth trends, 100-year floodplain, large transportation arteries, green space, etc.), and created different values for future growth based upon these analyses (Davidson County, 2009).

The County is committed to improving water quality conditions within its boundaries, particularly in waters listed as impaired by the NC DWR and US EPA (Davidson County, 2009). Davidson County limits development within the 100-year floodplain to low-impact or non-intensive recreational uses. This is a rare example of explicit regulation of land use within the County, as most other water-related ordinances within the LDP only recommend actions and policies for the County. This may be due to explicit citizen feedback featured in the Plan update that was conducted – water quality issues were a top five priority in the workshops and surveys conducted by the county and PTRC. Davidson County has a Water Quality ordinance, in which it recommends maintaining predevelopment watershed conditions, preserving natural features, the development of a comprehensive drainage and flood management plan, and reducing stormwater impacts, including soil and erosion. However, outside of the water supply watersheds, it generally has little enforcement strength in its language.

Watershed Protection	Technique Description
Watershed Planning	The application of regulatory measures and/or planning techniques that are designed to protect sensitive areas, restrict development to practices that minimize impacts upon the watershed and its catchment waters, and maintain or limit future impervious cover.
Land Conservation	Programs or efforts to conserve undeveloped, ecologically-sensitive areas, and/or areas of historical, recreational, or cultural value.
Aquatic Buffers	The protection, restoration, or reforestation of stream, wetland, or lake buffers, and maintaining them perpetually.
Better Site Design	Local ordinances and codes that incorporate techniques into new and redevelopment sites to reduce their ecological footprint, minimize impervious cover, and/or manage stormwater flows with BMPs.
Erosion and Sediment Control	The use of erosion control, sediment control, and dewatering practices at all new development and redevelopment sites.
Stormwater Management	The incorporation of structural practices into communities to help attenuate the impacts of stormwater runoff on catchment waters. These are especially important in regards to new development.
Non-Stormwater Discharges and Stewardship	Locating, quantifying, and controlling non-stormwater pollutant sources in the watershed. Operation and maintenance practices that prevent or reduce pollutants entering the municipal or natural drainage system (e.g. illicit discharge monitoring, sand-type wastewater filters). Education or outreach programs fostering a behavior that reduces pollution over a range of uses and activities.

Almost all of the language found within the Davidson County LDP is supportive and suggestive (i.e. ***Policy 14.2:*** *Development that preserves the natural features of the site…. should be encouraged*"). Strengthening the language within these measures both gives the County the mandate it needs to support the community values and growth that are their priorities, and will provide tangible incentives and penalties for those persons wishing to develop in Davidson County. In accordance with these changes, more detailed ordinances with explicit instructions on land use and its impacts on all natural resources and communities of the County are needed. The County will also need language, programs, and staff to enforce these new ordinances, a politically-challenging task.

The Davidson County LDP addresses a number of watershed management needs as vague concepts, barring the explicit restrictions on density and stream buffers detailed in the water supply watershed protection ordinance, which is not applicable to the Swearing Creek watershed. Environmental stewardship is mentioned repeatedly; and mixed-use and in-fill developments are encouraged to minimize sprawl development throughout the watershed. The County pays special interest to the redevelopment of "traditional" neighborhoods and "greenspace" development, which optimize planning to protect natural resources (i.e. streams) and open spaces for ecological, recreational, and public health purposes. This is extremely similar to language that the City of Lexington uses in their land use ordinances to encourage future residential developments to better protect water quality.

The City of Lexington utilizes a Land Use Plan (LUP) and a Land Use Ordinance (LUO) to manage development and growth within the City, as dictated by the Land Use Goals and Policies detailed in the LUP. There are multiple instances throughout the Ordinance that explicitly addresses the City's interest in redevelopment the urban blight throughout Lexington. This interest is clearly articulated through incentives that are identified repeatedly in the ordinance, and for each type of development. Lexington has enrolled in the US EPA Brownfields program, and has completed a Phase II site assessment at a one-million square foot former furniture factory owned by Lexington Home Brands, which is beginning to be redeveloped.

In its Land Use Plan, the City has been broken down into five different geographic planning districts that each has a designated suite of land use recommendations and development missions appropriate to their current land use, existent vacant structures, transportation access, and environment. The Plan uses zones to guide development within the Central Planning Area, the North-East Planning District, the South-East Planning District, and the South-West Planning District. These areas are those essentially east of the railroad tracks, which bisect the City along the ridgeline that separates the Lower Abbotts and Swearing Creek watersheds. These districts have been recommended for urban redevelopment, focusing on Urban Infill, Primary Growth, and Secondary Growth (mainly in the South-East and South-West Planning Districts). The development recommended for these zones are "Traditional Neighborhood Development," and "Neighborhood Center" and "Village Center Districts," with Conservation Corridors promoted to connect various development nodes spread out in the greater Lexington area (PTCOG 2004).

The LUO applies to all development within the city, and dictates the parameters within which it can occur. Only one ordinance is explicitly protective to the environment, and that is the Stream Protection Overlay District, which, similar to Davidson County, limits floodplain development to low-impact residential and recreational uses. The Resource Preservation and Community Appearance goal detailed in the LUP is not explicit in regard to environmental protection. Nearly all policies outlined within this goal are protective of the environment as a secondary goal, with the primary goals being urban and economic revitalization and recreational development. While these policies are laudatory, the lack of stewardship policies in a community so reliant upon a regional water resource (High Rock Lake) is concerning and does not serve its future economic and environmental prosperity. Only two policies are directed at environmental protection: 3.2, which speaks to the need for water quality restoration in Abbotts and Swearing Creeks; and 3.3, which states that it "…*will preserve, protect, and restore the natural resources of our community (e.g. rivers & streams, wetlands, woodlands, wildlife habitats) for the benefit & enjoyment of all* [emphasis in original]" (City of Lexington 2010).

The City mandates open space of all of its new development, requiring any site with at least ten dwelling units to set aside 15% of the site's area for open space. 10% of this area then must be dedicated to the public good, and can be used for parks, greenways, or other recreation purposes. There is no language

addressing open space or building requirements in the redevelopment of current sites (City of Lexington 2010).

Transportation Planning

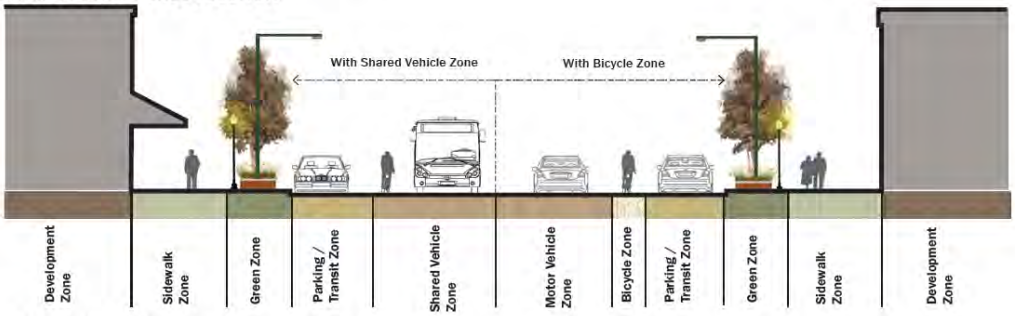
The Swearing Creek watershed falls under the jurisdiction of the High Point and Winston-Salem Metropolitan Planning Organizations (MPOs), which provide citizens of the greater High Point area with the "*tool for guiding transportation decisions…* [to] *support the efficient movement of people and goods, while considering economic, social, and environmental goals and constraints…*" (HPMPO 2008). Lexington has been determined to be directly affected by the transportation decisions of both Winston-Salem and High Point, as evidenced by the commuting patterns in Davidson County and Lexington. However, the High Point MPO more directly integrates Lexington's transportation needs and long range plans into its efforts.

Most of the environmental concerns addressed by the MPOs are focused air quality impacts and environmental justice concerns. To this end, the MPOs' detail bicycle and pedestrian projects that encourage the public to utilize these non-automotive modes of transportation. There is also a concerted effort to collaborate with the Piedmont Area Regional Transit (PART) on its expansion of bus services that will create a route to connect Lexington to the rest of the Piedmont Triad region, especially for commuting purposes.

Both MPOs identify Capital Improvement Projects (CIPs) that will enhance the economic development, alternative transportation options, and quality of life conditions for residents in all of the communities served by them. US-52 and -64 are recommended for expansion within the NC DOT Transportation Improvement Program. Even with new stormwater BMPs to offset the impervious cover impacts of these projects, there may be greater stormwater stresses upon water quality in the Swearing Creek watershed with these road expansions due to affiliated developments. This is particularly true immediately downstream of Lake Thom-A-Lex.

URBAN/SUBURBAN MAIN STREET

ILLUSTRATIVE STREET CROSS-SECTION



STREET COMPONENT DIMENSIONAL GUIDELINES

	Sidewalk Zone *(feet)*	Green Zone *(feet)*	Parking /Transit Zone *(feet)*	Motor Vehicle / Shared Vehicle Zone *(lane width- feet)*	Bicycle Zone *(feet)*
Central Business District	10' - 12' 12' - 20' in high volume pedestrian areas	6' - 8'	8' - 10'	10' - 13' (see note 4)	6' lanes (see note 4)
Urban Center / Suburban Center	8' - 12' 12' - 20' in high volume pedestrian areas	6' - 8'	8' - 10'	10' - 13' (see note 4)	6' lanes (see note 4)
Suburban Corridor / Urban Residential / Suburban Residential	8' - 10' 12' - 20' in high volume pedestrian areas	6' - 8'	8' - 10'	10' - 13' (see note 4)	6' lanes (see note 4)

NOTES

1. Sidewalk zone should typically extend to the front of buildings. Sidewalks are the most important element on a main street, because pedestrians are the priority. Therefore, the sidewalk width should typically be at least 10', unobstructed.
2. Green zone may include hardscaping, landscaping, street trees, lighting, and related pedestrian/bicycle/transit amenities. Hardscaping (with street trees in appropriately-designed planters) is typical for access to on-street parking and transit.
3. Parking is expected on main streets. Parking zone dimension may vary depending upon type of parking provided. Angle parking is allowed, preferably reverse angle parking. Angle parking will require a wider dimension than shown.
4. Shared lanes are the preferred treatment, due to the low speeds. In this case, travel lanes should be 13' to allow for maneuvering and opening car doors. Shared lane markings can be used on streets < 35 mph. If bicycle lane is provided, it should be 6' wide, and motor vehicle lane should be narrowed to 10'.

North Carolina Complete Streets Planning and Design Guidelines 71 Chapter 4

Neither the city nor the county have yet adopted the NC Complete Streets planning design guidelines for use within their communities. These guidelines are intended to safely accommodate interdependent, multi-modal transportation for all users. It provides explicit guidance offers a diversity of road and community types so that cars, buses, bicycles, and pedestrians can all have access to their entire community and safely get from a to b within it. Many of the Complete Streets elements incorporate green infrastructure and stormwater management and can also be used to protect and improve local water quality conditions.

Zoning

The Swearing Creek watershed is not in a water supply watershed, which is generally the most protective set of zoning regulations in either Davidson County or the City of Lexington for water quality. Swearing Creek otherwise has limited environmental protections, especially in Davidson County. The City of Lexington's zoning ordinance is more protective, though many of these protections in the zones are more focused on optimizing available space in the city rather than protecting environmental assets. The primary exception to this statement are the universal requirements in Lexington to buffer all streams with a fifty-foot vegetated area and to set aside at least 10% of all new developments for open space that is accessible to the public.

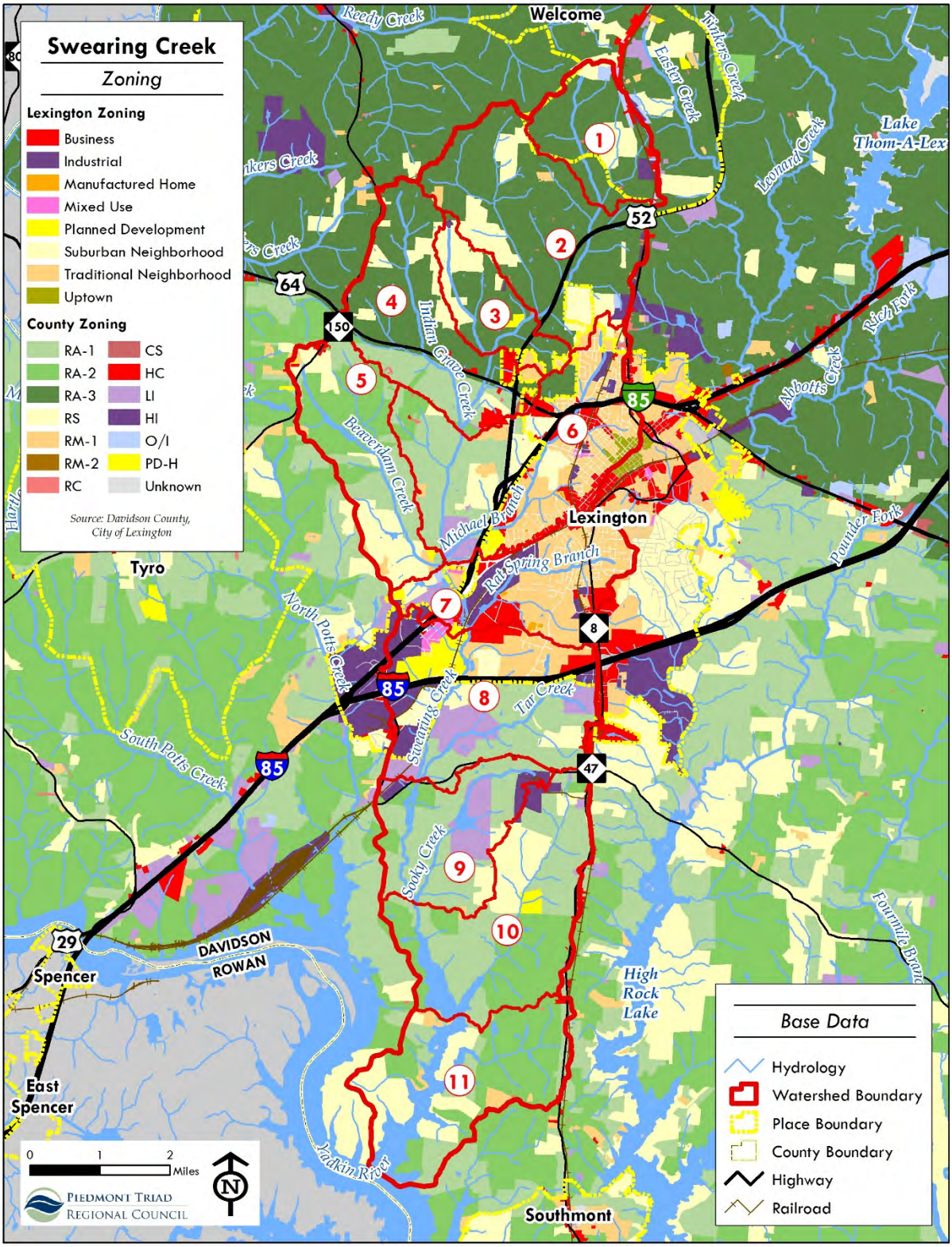


Figure 33: Swearing Creek Watershed Zoning Map

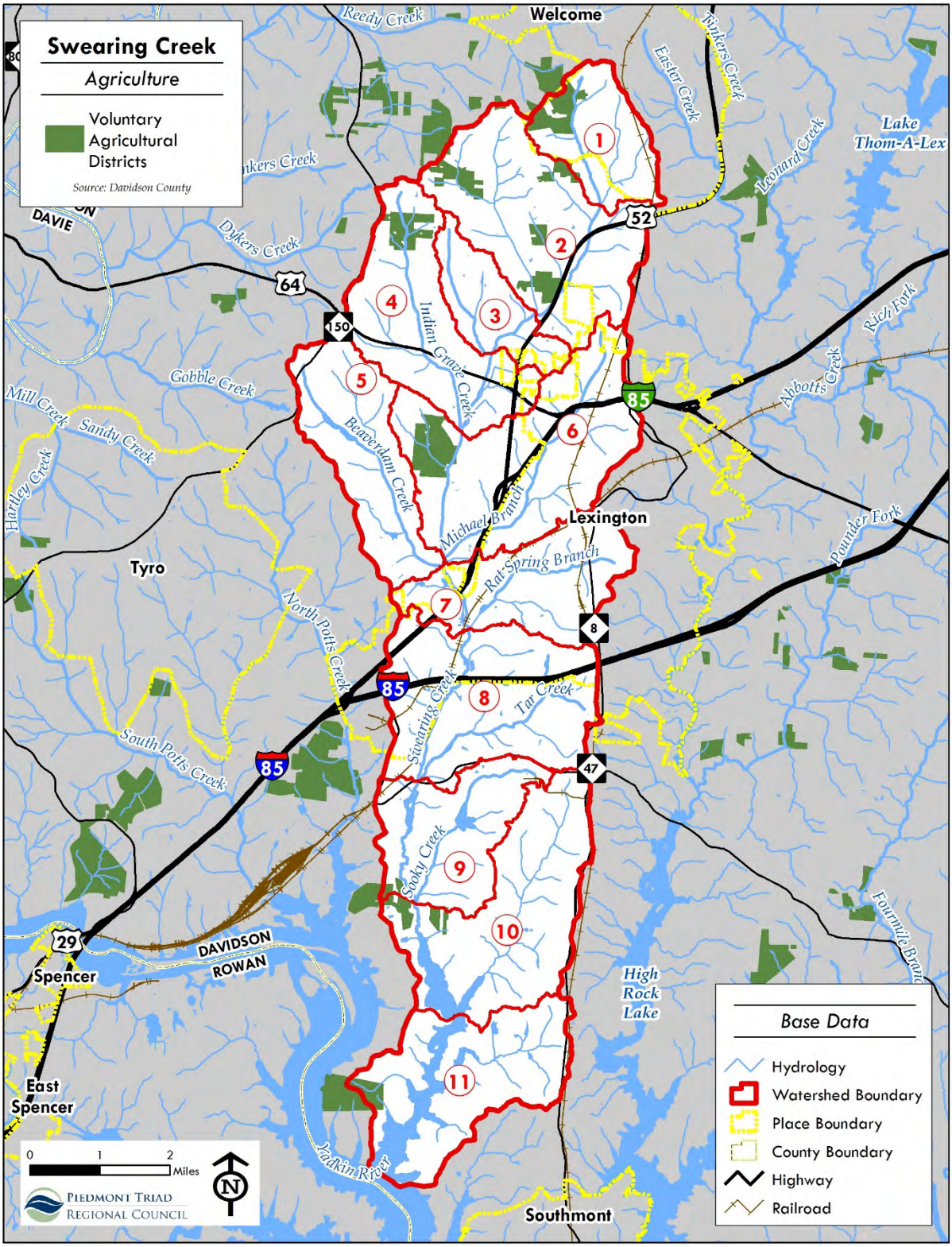


Figure 34: Swearing Creek Watershed VAD Map

The land use zoning and ordinances within the watershed support the infill aspirations mentioned in the Lexington LUP and LUO. Uptown Lexington is a mixture of commercial, high density residential, and institutional parcels, but many commercial and industrial properties are now vacant. Light and heavy industrial parcels and heavy commercial areas are focused in the City and the main transit thoroughfares. Commercial growth in the watershed is focused on the three main transit arteries that transect Lexington (I-85, I-85 BUS, & US-64). There are scattered commercial zones throughout the rural areas of the watershed in expected ways (i.e. crossroads, near High Rock Lake). Residential growth has occurred just north of Lexington's City limits (Subwatershed 6 & 7), and to its southwest in the Swearing Creek watershed. Perhaps most importantly, though, is the large areas of suburban and traditional residential zones, which encourage both mixed-use development as well as denser and more innovative approaches to community development than that seen in single-family residential subdivision developments. Such flexibility and multiple incentives explicitly detailed in the LUO will strongly serve the City's economic and redevelopment aspirations.

Zoning in the watershed's rural areas is almost entirely classified for large area, low-density residential use. There are no ordinances limiting subdivision or altering use through application in either Davidson County or Lexington (PTCOG 2004). Given these conditions, the unregulated sprawl of decentralized residences and businesses relying on uninspected septic tanks for their waste disposal is a likely and unfortunate future without better land use regulations and enforcement capacity. Such developments contribute to suburban sprawl, as planners realize the environmental and public costs of rural residents who must rely upon urban services (e.g. ambulance, fire, etc.). Though access to open, rural spaces is a stated value of many Lexington residents, there are limited programs in the City and County to protect those lands. Parallel scenarios throughout the State and Nation's recent history have shown that the political and economic costs of rectifying these water quality issues greatly outweigh proactively addressing them with ordinance updates and staff enforcement.

Land Conservation

Conservation of undeveloped, ecologically sensitive areas or areas of historical or cultural value in a watershed is a strategy that can both protect water quality and benefit resident communities through recreational and aesthetic values as well as ecosystem services (i.e. stormwater filtration). There is little protected land within the Swearing Creek watershed, and all of those lands that are present are either dedicated to public use as municipal parks and golf courses. Municipal parks are fantastic investments that also yield multiple economic and public health benefits, but they are generally sites of compacted soils and intensive use. In the Swearing Creek watershed, none of these parks are in particularly valuable areas for watershed and water quality protection, although their presence is more helpful than their absence. Golf courses can be huge benefits to a watershed and the two in this watershed are in strategic locations that could be very valuable to water quality protection in this watershed. However, if not managed properly, golf courses can also be intense sources of pollution due to the over application of fertilizers and pesticides while not maintaining vegetated buffers along streams on the course. It will be crucial to work with the course managers to discuss these concerns and acknowledge their role as watershed stewards to the larger watershed population.

Landowners of 11 individual parcels are participating in the voluntary agriculture district (VAD) program, and thereby dedicated to rural uses. VAD lands must be certified by the Davidson County Tax Department in order to receive a property tax deferment or credit, and are inspected regularly to ensure that they are meeting VAD requirements. These dedicated parcels occupy a small area of the entire watershed area. As the urban centers within Davidson County grow in population, conserving open spaces and agricultural land will help preserve the County's agrarian heritage and maintain high quality waters. Davidson County's status

as one of the fastest-growing counties in the Upper Yadkin River Basin only emphasizes the need to protect these lands.

The PTRC's Green Infrastructure Network offers guidance for further investment in conservation and open space protection in the Swearing Creek watershed. The darker green areas are those that have been determined to have the highest potential or real value for all environmental assets (including agriculture) in the watershed. It is intended for use by all local governments as well as relevant non-profit groups like the LandTrust for Central North Carolina or the Davidson County Tourism and Recreation Investment Partnership (DCTRIP).

The NC Wildlife Resources Commission (WRC) has also developed a Green Growth Toolbox, which is a comprehensive set of resources that provides communities with tools to identify their natural assets and develop protections for them. The toolbox includes a technical assistance tool, a handbook on developing ordinances for protecting the environment, a GIS dataset and a website developed by the NC WRC to assist communities in growing in ways that conserve the most valuable natural resources including streams and habitat. These resources, as well as additional information, can be found at http://www.ncwildlife.org/Conserving/Programs/Green-Growth-Toolbox.

Floodplain Regulations

The Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP) delineates the 100-year floodplains nationwide in an effort to discourage development in these environmentally-sensitive and hazardous areas (see Figure 18). Davidson County and Lexington discourage, but do not prohibit, construction within the 100-year floodplain. Construction within this zone is limited to "low intensity" uses, namely recreation and agriculture (Davidson County, 2009). Lexington also requires a Greenway Overlay District for these areas, ensuring their potential use as a non-automotive transit corridor (City of Lexington 2010). As determined in the Rich Fork Creek watershed planning process, writing greenway overlay districts into all public easements and public right of ways will ease both floodplain management and preservation needs.

Agricultural Preservation

Davidson County has an ordinance entitled "Agricultural and Rural Area Preservation" designed to "discourage any negative impacts that conversion from farming to development may bring." It states that the County actively prefers agriculture and "very low-density" residential land use and supports preserving its legacy of family farms as opposed to urban sprawl. It also requires all residential development that abuts agricultural parcels to set aside vegetated buffers between the two land uses. The size of the buffer is not stated, nor is it stated if the Davidson County Planning department can use their discretion in determining this buffer. Perhaps most importantly, Davidson County explicitly ties agricultural preservation to its "open space system," but this relationship is extended necessarily to watershed protections (Davidson County, 2009).

The Davidson County Tax Department has a tax-deferment program for lands that obligate themselves to use conservation practices in their farming, forestry, or conservation operations. North Carolina recently reduced its requirements for tax deferment so that only 20 acres must be committed to conservation practices in order to have tax obligations reduced. VADs are also used in the County, with 11 in the Swearing Creek watershed. These properties are an effective incentive that preserves Davidson County's agrarian heritage in this fast-growing County.

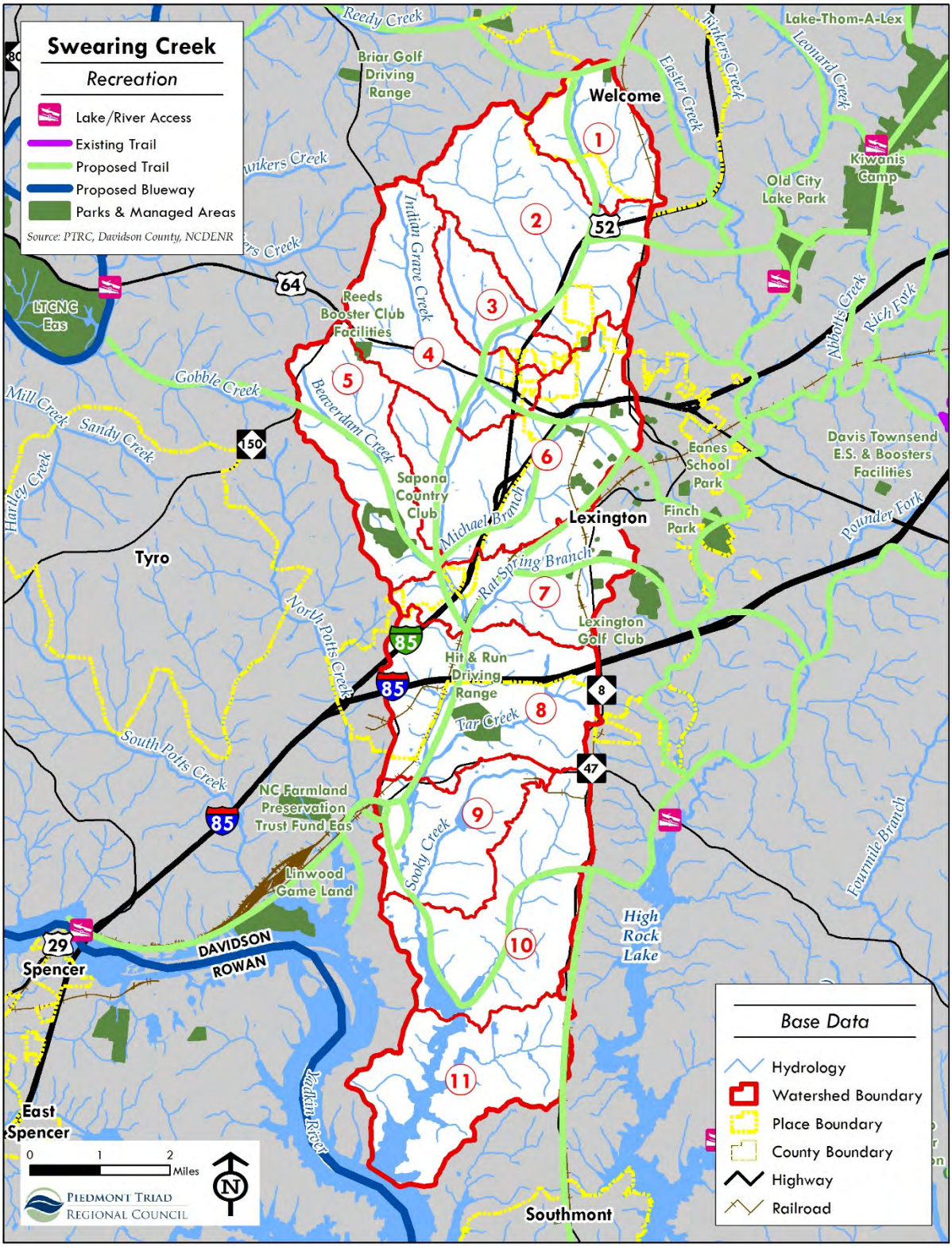


Figure 35: Swearing Creek Recreation Infrastructure Map

Outside of the Land Use Goal of "Resource Preservation," and its policies 3.3 ("…[to] *preserve, protect, and restore the natural resources of our community… for the benefit & enjoyment of all,*") and 3.4, which names "family farms" as a "cultural and historic resource," Lexington does not discuss farming in its plans and ordinances. This approach limits the city's abilities to partner with the county's farmers and residents to build relationships focusing on local concerns, including food and the environment. In other communities, rural-urban partnerships have made significant differences in how environmental and economic planning is done, and served all of those involved well by identifying common concerns and priorities that can then be the focus of common campaigns and investments of limited resources. The city's ordinance in support of intergovernmental cooperation makes agricultural preservation such a topic, but one that will need more dedicated attention and discussion in the future.

Steep Slopes and Wetlands Preservation

The City of Lexington prohibits development from disturbing any soils on slopes >10% (City of Lexington 2010). Many of these slopes in the Swearing Creek watershed have already been developed or are within the creek's floodplain, and are, therefore, relatively unaffected by the ordinances. Davidson County has no steep slopes protections, leaving these environmentally-sensitive areas vulnerable to disturbance. Fortunately most of these steep slopes are not in the same locations as the erodible soils, which reduces the vulnerability of this watershed to sensitive areas, unlike natural conditions in the adjacent Abbotts Creek watershed.

Neither of the jurisdictions have ordinances protecting wetlands, though Lexington does acknowledge that hydric soils should be avoided for optimal cost:benefit returns (City of Lexington 2010). Currently, the soil survey data from the US Geological Survey does not identify any hydric soils in this watershed, although 155 wetlands covering 439 acres are documented in this watershed (see Figure 17). This clearly documents the needs for local soil surveys, as wetlands must have hydric soils.

Federal 404 permits are required to be filed with the US Army Corps of Engineers for any and all wetlands disturbances or takings, and federal 401 water quality certificates must be filed with NC DWR prior to any disturbances to wetlands or the riparian buffer zone. Reference to these requirements in local ordinances will enhance the compliance success with these federal regulations (NC DENR 2011).

Aquatic Buffers

This subsection describes the protection, restoration, creation, or reforestation of stream, wetland or lake buffers within the Swearing Creek watershed.

Figure 36: Ideal Riparian Buffer Conditions

Davidson County encourages open space and buffer preservation, but does not mandate these features for new or enhanced development. No riparian buffers are required in Davidson County, though development within them is limited to "Low Impact" and "Recreational" (Davidson County, 2009). The Davidson County TRIP identifies floodplains as potential sites of low-impact recreational development, such as greenways. Davidson County has a *Tourism Development Master Plan* to achieve this goal and its potential economic stimulation, and a

greenway connector with the City of Lexington and High Rock Lake is seen as a potential ecotourism investment (PTCOG, 2005).

The City of Lexington has mandatory 50-foot buffers for all watercourses, and a 25-foot buffer for all impoundments. This is a strict regulation, only permitting development "…limited to flood control, stream bank stabilization, water dependent structures and other projects such as road crossings and greenways where no practical alternative exists." The public use variances have detailed construction requirements that will limit impervious surface within the buffer zone and minimize stormwater flows to the receiving stream. This development requires complete stormwater attenuation through the use of BMPs (City of Lexington, 2010).

Figure 37: Degraded Riparian Buffer Conditions

Lexington also discourages – but still permits – development within the 100-year floodplain if it is outside the buffer zone. The City's development ordinances also encourage riparian buffer protection by allowing developers the option to include the buffer region in their minimum open space requirements. Its LUP encourages the implementation of greenway connectors on municipal rights-of-way for sewer lines through a Greenway Overlay District. The regulations for greenway construction explicitly protect the streams and streambank through a 20-foot vegetated buffer zone along the greenway trail, which must be constructed from 2-inch high asphalt on a trail no more than 10 feet wide (City of Lexington 2010).

Better Site Design

Local ordinances and codes can promote building and design techniques for new and redeveloped sites that can minimize a project's environmental footprint. This general approach to sustainable site design and construction is termed Low Impact Development (LID). LID is an approach to site development in which minimal disturbances are placed upon the surrounding environment by constructing structures using sustainable practices, such as using recycled building materials, solar-oriented structures, water recycling, or natural landscaping. The central goal in regards to stormwater is to effectively reduce a site's impervious cover, and/or direct its runoff onto permeable surfaces. This is both highly challenging and important in the relatively impermeable soils of the NC Piedmont. For more details on LID, please consult the LID Handbook, available for free from NC State University's Cooperative Extension program (Perrin et al., 2009). There are no requirements for LID or sustainable development in Swearing Creek watershed outside of floodplain regulations. Davidson County and Lexington have some ordinances encouraging LID, but none that mandate open space or pervious surfaces in all developments.

Low Impact Development (LID) Techniques

Figure 38: Rain Garden in Kinston, NC

LID techniques include regulations or ordinances that encourage or mandate land use practices such as cluster development, open space requirements, pervious surface set asides or stormwater BMPs. In the Swearing Creek watershed, unless a site is publicly-funded, there are no requirements, and minimal incentives, to include LID. Developers often balk at deviating from their typical approaches to development, and argue that LID is more expensive. While this is true when regarding the short-term construction costs, the reality is that these approaches to residential development are increasingly in greater demand, and there is a greater willingness to pay for LID assets from the consumer community. LID techniques also prevent environmental degradation, minimizing future restoration or public safety work. Given that developers nearly always pass all construction costs on to the eventual property owners, this well-documented demand for LID approaches from homebuyers and the young professional classes, and the regulatory requirements that Davidson County and Lexington must anticipate with regard to High Rock Lake, the argument against LID holds little merit, truth, or foresight. Encouraging these development techniques is a first step, primarily through incentives for developers and entrepreneurs, but LID requirements should be made in the near-future. The need for LID will be explored at great length in the *Swearing Creek Watershed Restoration Plan*.

Both Davidson County and the City of Lexington allow for LID neighborhoods, and Lexington allows the innovative uses of open space on their cluster developments. However, neither requires LID techniques for new construction, or for redevelopment of currently constructed sites. Lexington encourages "Traditional Neighborhood Planning Districts," which requires open space preservation, mixed-use development of residential and low-intensity commercial lots, and multi-story buildings close to the urban core and "Neighborhood/Village Centers," all of which are designed to provide encourage safe pedestrian access to necessities and thereby improve residential quality of life (Davidson County 2009; City of Lexington 2010).

These development approaches are ideal for Lexington's abandoned residential and commercial areas, and especially its Brownfields sites. The one million square foot Lexington Home Brands site has been assessed using the Brownfields' Phase I and II programs, and is ready to be redeveloped. It has been conceived as a mixed use commercial and residential center, featuring public spaces for entertainment and recreation.

Many LID principles regarding land use are stymied by zoning designations and land use ordinances. Language in the "Institutional/Office" or "Residential" zones is, by default, exclusionary to other innovative ways in which to mix and create more efficient uses of individual parcels. Creative land development can be fostered through the Technical Review Committee (TRC) process, and reportedly is, but the language needed to stimulate more innovative community development concepts is absent in the County. The City has many clear incentives to encourage mixed use development and promoting residential and business growth in its urban core. However, Lexington has not yet revisited its zoning ordinance to codify these regulations, which could streamline the applications of such innovative approaches.

While both the City and the County have Greenway Overlay Districts that can coincide with public utility easements and riparian buffers, this overlay is an additional piece of legislation that must be considered separately by developers. Incorporating greenway use into public utility easements and riparian zones will permit the expansion of bicycle and walking paths throughout the watershed and give watershed residents alternate transit options in Davidson County and Lexington. Similar language is needed for streetscape developments to encourage bikeway creation on – especially – Lexington's streets, and to encourage continuous sidewalk access to all interest points in the City and throughout all its neighborhoods.

Parking Lot Regulations & Landscaping

The City of Lexington requires all parking lots to have tree cover and be offset by vegetative zones. These plantings are required for aesthetic purposes, and no explicit environmental needs such as stormwater or heat island attenuation are made, although these services will be provided if the plantings are made thoughtfully. However, modification of these parking requirements that explicitly utilize vegetated zones for environmental purposes could yield great benefit through small changes in design practices. There are no developer incentives to expand parking vertically or compactly. Bicycle parking structures are also not required by either jurisdiction, although Lexington does encourage them.

Open Space Design & Management

Davidson County addresses open space needs in its "Parks, Recreation and Open Space" ordinance, though open space planning is repeatedly referenced in the residential development, agricultural, and watershed conservation ordinances. The objectives of open space planning for the County are: "natural area conservation, visual enhancement, promotion of cultural and historic preservation, watershed and flood prone area protection." The County also clearly states that it "should" protect wildlife areas and greenways and hiking trails, but provides no regulatory language that would ensure this outcome. The Davidson County TRIP also recognizes green infrastructure and investment in open space as retaining the agricultural heritage of the County, something desirable for potential tourists visiting the area (Davidson County, 2009; PTCOG, 2005).

Open space is featured prominently throughout both the *Lexington Land Use Plan* and the LUO, and is required for all residential developments of >10 units. 15% of the gross area of the development must be dedicated as open space, and 10% of this area must be centrally located and be "improved open space," meaning that it serves a public service beyond natural area. This open space can include the mandatory riparian buffers along perennial and intermittent streams. This open space must be maintained by a local entity (preferably the Homeowners Association), and must abide by regulations regarding structural placement, proximity to development, obstruction height, and landscaping (City of Lexington 2010).

Figure 7-5. LID scenario with higher density and increased units depicted in Union County, North Carolina

Figure 39: Figure taken from Low Impact Development: A Guidebook for North Carolina, NCSU, 2009.

Erosion and Sediment Control

Sediment and erosion control practices at all new development and redevelopment sites are of high importance to water quality in the Swearing Creek watershed. Sediment is the top water quality pollutant in the United States, and soil and erosion control practices are an effective method to reduce this pollution from waters. High Rock Lake is impaired for turbidity and will require more effective soil and erosion controls within its watershed and all tributaries. The state has a fairly rigorous erosion and sediment control program, with an extensive field manual for design and implementation of controls and measures (NC SCC, et al., 2009).

Lexington and Davidson County use the NC Erosion & Sedimentation Control Design Manual when directing developers during new development or redevelopment that exceeds 1 acre. As they are not yet NPDES Phase II communities, they have no post-construction soil and erosion or stormwater control obligations.

Both Davidson County and the City of Lexington rely upon the NC DEQ Winston-Salem Regional office to oversee and enforce their federal soil and erosion control requirements for new construction. The regulators at the Winston-Salem office generally only inspect stormwater controls on newly-constructed sites. While they do respond to public complaints or concerns, they simply do not have the staff capacity to regularly inspect sites for post-construction stormwater controls, nor are they federally-obligated to do so. This partnership between DEQ and local governments has created a legacy of poor enforcement and, consequently, degrading water quality.

Developers must create a comprehensive soil erosion and sedimentation control system, minimizing their land grading, disturbance to the riparian buffer, efficacy of stormwater control BMPs, and fill material. NC DEQ has a manual, last updated in 2009, that addresses all of these issues (NC SCC et al., 2009). The DEQ Division of Energy, Mineral, and Land Resources (DEMLR) updates the field manual and employs inspectors to enforce rules and regulations based upon the North Carolina Sedimentation Pollution Control Act passed in 1973 and amended in 1989 (NC SCC, et al., 2009). In addition to specifications and installation instructions on different erosion and sediment control practices, the Design Manual discusses the following:

- sedimentation control law;
- principles of erosion and sediment control;
- vegetation that can be used for erosion control;
- how to develop an approved erosion and sedimentation control plan; and
- inspection checklist for site evaluation and how to remedy and report deficiencies.

Stormwater Management Practices

Stormwater is identified as the primary source of impairment by the NC DEQ in its rating for Swearing Creek. Non-point source water pollution is also the dominant concern in watershed management nationwide. Stormwater runoff impacts from existing and new development is having a significantly degradative impact upon the water quality of Swearing Creek. Originating at multiple sites dispersed over dozens of square miles, comprehensive strategies that use regulations and policies to address the issues – as opposed to projects – are needed to remedy these problems.

Stormwater is surface runoff from urbanized areas with high levels of impervious cover. These paved surfaces prevent soils from absorbing water, which instead flows over the ground carrying nutrients, metals, pesticides, and organic pollutants in its runoff. These flows can cause flash flooding and erode stream banks and stream beds. Though there is a need to manage the stormwater flowing from the impervious surfaces that currently exist (and that have played a role in degrading watershed conditions to the impaired level

that they are now at), one of the best stormwater management practices is to ensure that future developments will invest in measures that will prevent this degradation from continuing.

The USEPA's NPDES program has two tiers of stormwater permitting called Phase I and Phase II. Phase I applies for cities of 100,000 people and their greater metropolitan areas. Phase II applies to cities of 20,000 people and their ETJs. The City of Lexington was notified in 2015 that it will have five years to prepare to be a Phase II stormwater community. However, the city already has most of the regulations and programs in place for this new status. NPDES permittees must comply with six minimum measures: public involvement, community education, good housekeeping, illicit discharge detection and elimination (IDDE), on-site construction controls, and post-construction site controls. Lexington has all of the pieces in place to fulfill these requirements, and simply needs to adopt ordinances that identify the need for stormwater controls for construction and post-construction sites, as well as for IDDE. Many of these issues are generally addressed with soil and erosion control; explicitly identifying and requiring stormwater management in ordinances will strengthen water quality protections and incentivize the city and developers to use innovative LID practices on sites that will also feed local economic development interested.

Figure 40: Alamance High School Bioretention Cell - Graham, NC

Davidson County manages its stormwater impacts through grass swales and open space preservation, allowing municipalities to place more stringent requirements upon their systems than the County does (Davidson County, 2009). All stormwater BMPs along the watershed's transit thoroughfares are constructed and maintained by the NC DOT.

Inspections, Maintenance, Funding Agreements & Responsible Parties

All inspections, maintenance, and enforcement of stormwater practices for both Davidson County and Lexington are executed by the NC DEQ Winston-Salem Regional office. There is no inspections or maintenance schedule to ensure BMP performance, and the office only responds to public complaints regarding site conditions. They simply do not have the staff capacity to regularly inspect sites for post-construction stormwater controls, nor are they federally-obligated to do so.

Non-Stormwater Discharges & Stewardship

This subsection describes programs for locating, quantifying, and controlling non-stormwater pollutant sources (i.e. illicit discharges) in the watershed. The operation and maintenance practices that prevent or reduce pollutants entering the municipal or natural drainage system (e.g. illicit discharges, sand-type wastewater filters) are covered.

Sewer System Infrastructure

The City of Lexington uses one centralized wastewater treatment plant (WWTP) for all residents within its limits and extraterritorial jurisdiction. It is located on Abbotts Creek just upstream of the Abbotts Creek Arm of High Rock Lake. It has a permit to discharge 6.5 million gallons per day (MGD), but its average daily discharge is 3 MGD. The City conducts regular water quality monitoring upstream and downstream of its WWTP under its discharge permit from the NC DWR, using both in-house laboratory staff and the YPDRBA monitoring data, collected and analyzed by EnvironmentOne, Inc.

Currently, the infrastructure serves the city east of Swearing Creek, where the flatter topography and less erodible soils provide a better environment for development. There are plans to expand these pipes across the Creek to prevent non-point sources of fecal and nutrient inputs for poorly-maintained residential septic tanks, but these investments have not yet been made. The plans are to connect two schools within the Swearing Creek watershed that are under a Special Order of Consent (SOC) with NC DWR to improve their onsite wastewater systems, as they are currently failing. Following this investment, the City intends to enhance the water and wastewater systems on its west side.

Figure 41: Illicit Discharge to Abbotts Creek

Davidson County is largely disconnected from any centralized wastewater system in the Swearing Creek watershed. Most residential and commercial properties are served by on-site septic systems. The County has no staff to inspect these systems, and all complaints regarding nuisances and failure are forwarded to the NC DEQ Winston-Salem Regional office's Division of Environmental Health. This situation is representative of all the non-urban areas of the watershed, about 71% of its total area. This is of particular concern for recreational housing along High Rock Lake, where anecdotal information indicates that septic failure and illicit discharges of gray water and sewage are a significant source of nutrient inputs to the watershed and High Rock Lake.

Agriculture & Animal Feed Lots

There are regulations for runoff from animal feeding lots in Davidson County. Davidson County presumably follows the State O200 animal regulations with regards to animal feed lots and waste regulation; no current ordinance addressing this concern is written. Poultry operations are exempt from regulatory oversight. There is one poultry farm in the watershed, but the stakeholders and water quality data indicate that it is not a significant source of agricultural pollution (Personal correspondence with Davidson County Soil & Water Conservation District). The County utilizes the North Carolina Agriculture Cost Share Program and the USDA EQIP program to preserve natural resources, and employs many of the agricultural BMPs commonly associated with these programs (i.e. cattle exclusion fencing). Participation in any benefits program requires a site specific conservation plan to preserve land and water quality.

Hazardous Waste & Spill Response

Davidson County has an ordinance that prohibits the disposal of regional hazardous waste within its boundaries. This ordinance also prohibits the disposal of regional waste within the County (Davidson County, 2009). This ordinance is complimented by the *Davidson County Hazard Mitigation Plan*, which specifically addresses disaster response, hazardous materials spills, hazardous waste storage, and other emergency concerns for all county jurisdictions and citizens, which was revised in 2009.

Section 6: Watershed Summary

Swearing Creek's is facing many of the same issues it has faced historically for sustainability and stability of its watershed: the growth of jobs and homes in Lexington could grow outward from the city limits, consuming farmland and paving over parts of the watershed. Based upon this characterization of historic and current conditions, these impacts from suburban sprawl are likely the primary cause of water quality impairment in Swearing Creek. Without greater controls on protecting water quality conditions (e.g. stream buffers) or development impacts (e.g. mandatory stormwater mitigation), the creek could be further imperiled by development in Lexington. The watershed assessment will verify that these practices will remedy this initial diagnosis of water quality impairment for biological life in Swearing Creek, and the restoration plan will recommend local policies and practices that can address these sources of impairment.

However, this initial characterization of Swearing Creek's watershed stability and function are very hopeful, for both ecological and societal reasons. Ecologically, the watershed is largely undeveloped, with its most sensitives areas used for farmland or open space. There are opportunities to better protect these areas and bolster the planned Piedmont Together Green Infrastructure Network and DC TRIP plans for High Rock Lake and its tributaries, but most land cover in the watershed is low-impact. The watershed is also seeing brighter days for growth in Lexington, which will be focused on redevelopment and infilling its urban core rather than sprawling into suburban and rural areas. Already the Uptown Lexington district is seeing growth and residential growth in the city is slowly recovering from the Great Recession. While the development of industrial parks immediately outside Lexington's city limits is concerning for their potential impacts upon local watershed conditions, the recent advent of incentives for denser, more focused growth by Lexington gives hope that the community will grow without negatively affecting the environment.

The watershed assessment and restoration will further diagnose and prescribe remedies for the sources of stress that currently impair conditions in Swearing Creek. This characterization shows that the current state of the watershed is almost entirely informed by its past and natural conditions. Future watershed efforts will build upon these findings to recommend practices that respect the heritage of both the City of Lexington and Davidson County, while providing guidance for a healthier and more prosperous future for the watershed and residents.

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