Eden Area
Watershed Assessment

cleanwater
MANAGEMENT TRUST FUND

December 2012

Piedmont Triad
Regional Council

Eden Area
Watershed Assessment

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INTRODUCTION

The Eden Area watershed focuses on the Dan and Smith Rivers of the Roanoke River Basin headwaters and covers approximately 225 square miles in central North Carolina and Virginia just east of the foothills of the Blue Ridge Mountains (Figures 2, 3 & 4). The landscape is hilly, but resides entirely within the Piedmont, and presents challenges found throughout the ecoregion due to its soils, history, and local weather. It includes all of the waters draining to the Smith River downstream of the City of Martinsville; to Matrimony Creek (Figure 1), a significant tributary to the Dan River; and to the Dan River between Stoneville and the exit of the river to Virginia in Caswell County, NC. It is bisected by the Virginia-North Carolina state boundary and a US EPA regional (Mid-Atlantic (Region 3) & Southeastern (Region 4)) boundary.

The Dan River has been listed as impaired for aquatic life due to high turbidity levels since 2002 and high fecal coliform bacteria levels since 2008 by the NC Division of Water Quality. Similarly, the Smith River has been listed as impaired for fecal coliform bacteria and biological habitat violating the action level for copper since 2008 by the NC DWQ, hindering its support of aquatic life (NC DWQ, 2012). The NC DWQ completed a Total Maximum Daily Load assessment (TMDL, aka "pollution diet") for turbidity on the entire Dan River in 2005, concluding that the dominant sources of sediment are rural erosion sites (NC DWQ, 2005).

The Virginia Division of Environmental Quality (VA DEQ) lists the Smith River and many of its tributaries within this watershed as violating their water quality standard for *E. coli*, a measurement of fecal material. It conducted a TMDL for *E. coli* in 2007, and determined that its sources of pollution were non-point sources, primarily from rural areas in Virginia and North Carolina, though stormwater runoff from Martinsville was also attributed as a source (VA Department of Conservation and Recreation [VA DCR] 2007; NC DWQ 2009). The VA DEQ and the Division of Conservation and Recreation (VA DCR) recently initiated implementation planning efforts to address the sources of pollution in Virginia (VA DCR 2012).

Figure 1: Turbidity in Matrimony Creek Tributary

According to the US EPA Ecoregion assessment "At Danville, the Dan River had an average turbidity of 1314 ppm between 1925 and 1930 (the period of earliest records), 268 ppm for 1930-1940, 134 ppm for 1940-1950, 129 ppm for 1950-1960, and

63ppm for 1960-1970. The NC water quality standard for turbidity is 50 nephelometric turbidity units (NTU). By 1974, filling of stream channels and valleys had stopped and the dissection and the removal of deposits to locations farther downstream had begun (Trimble, 1974; Woods et. al, 1999)." Danville is about 20 miles from Eden and just 2 miles downstream of the most downstream point of this watershed, and has an historical background of clear cutting and agriculture (and therefore a water quality history) that is similar to that found around Eden. It is also important to understand that although the turbidity levels have significantly been reduced in the Dan River, the River is still "impaired" for high levels of turbidity unhealthy for wildlife. The unstable flow levels from stormwater and dam discharge are contributing to the levels of turbidity in the waters.

The Dan River is the headwaters of the Roanoke River and is largely undeveloped. Historically, the Dan River Basin economy was largely based upon forestry and agriculture, with tobacco being the largest cash crop. Many of the farmers of the region were sharecroppers who were frequently indebted to large landowners for the use of the land for farming. Conditions were such that many of these farmers intensively developed their acreage for tobacco production, including clear cutting and the straightening or filling of streams, leaving just enough area for subsistence crop production. Often, this exploitation of land and soil resources was still not enough to relieve these farmers of their debt obligations, which was only enhanced by the industrialization of tobacco production and increased consumer demand (*personal communication with North Carolina and Virginia Soil & Water Conservation District staff*). Tobacco continues to be a major economic engine for Rockingham County (NC DA&CS, 2011).

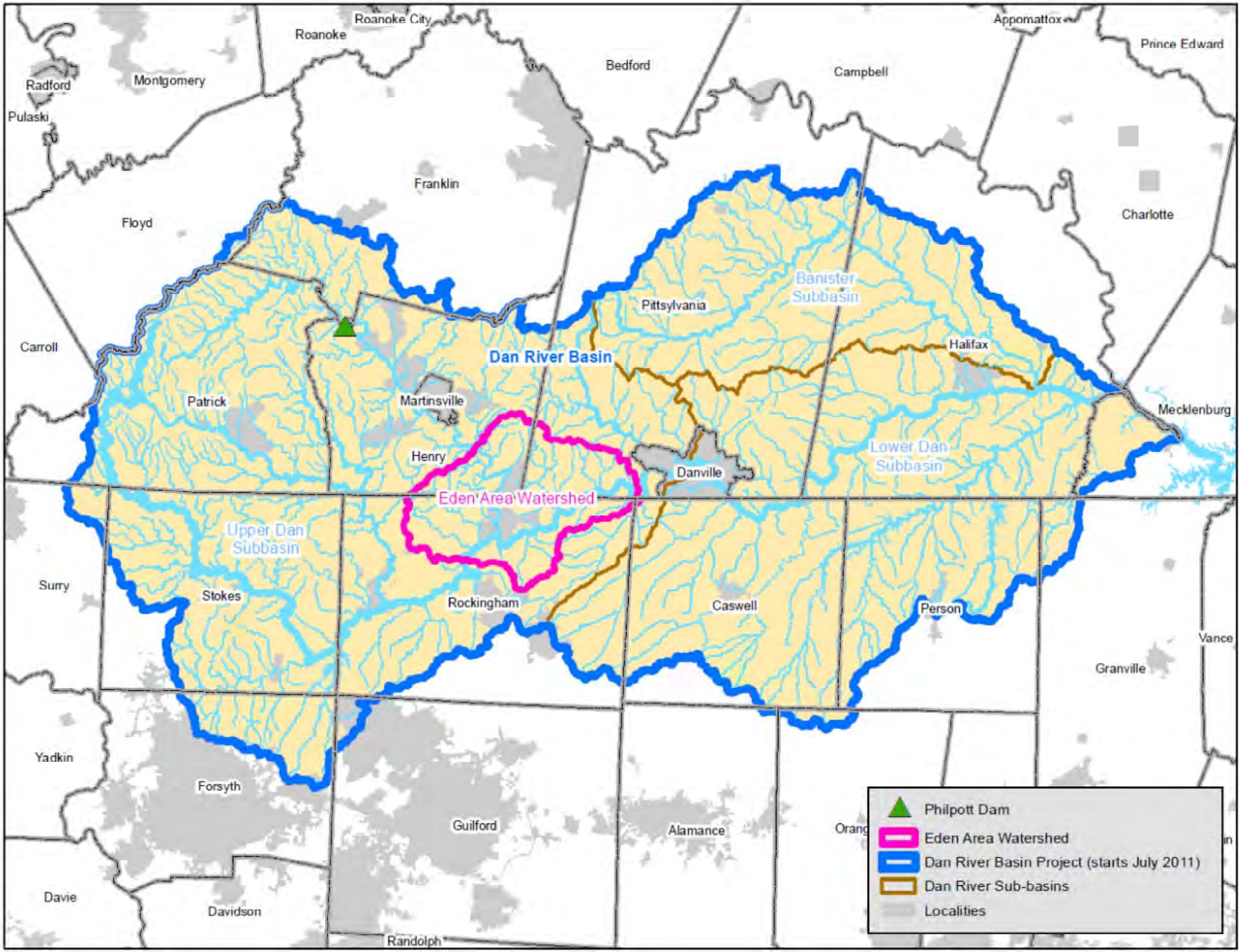

Figure 2: The Project Area in the Upper Dan River Subbasin

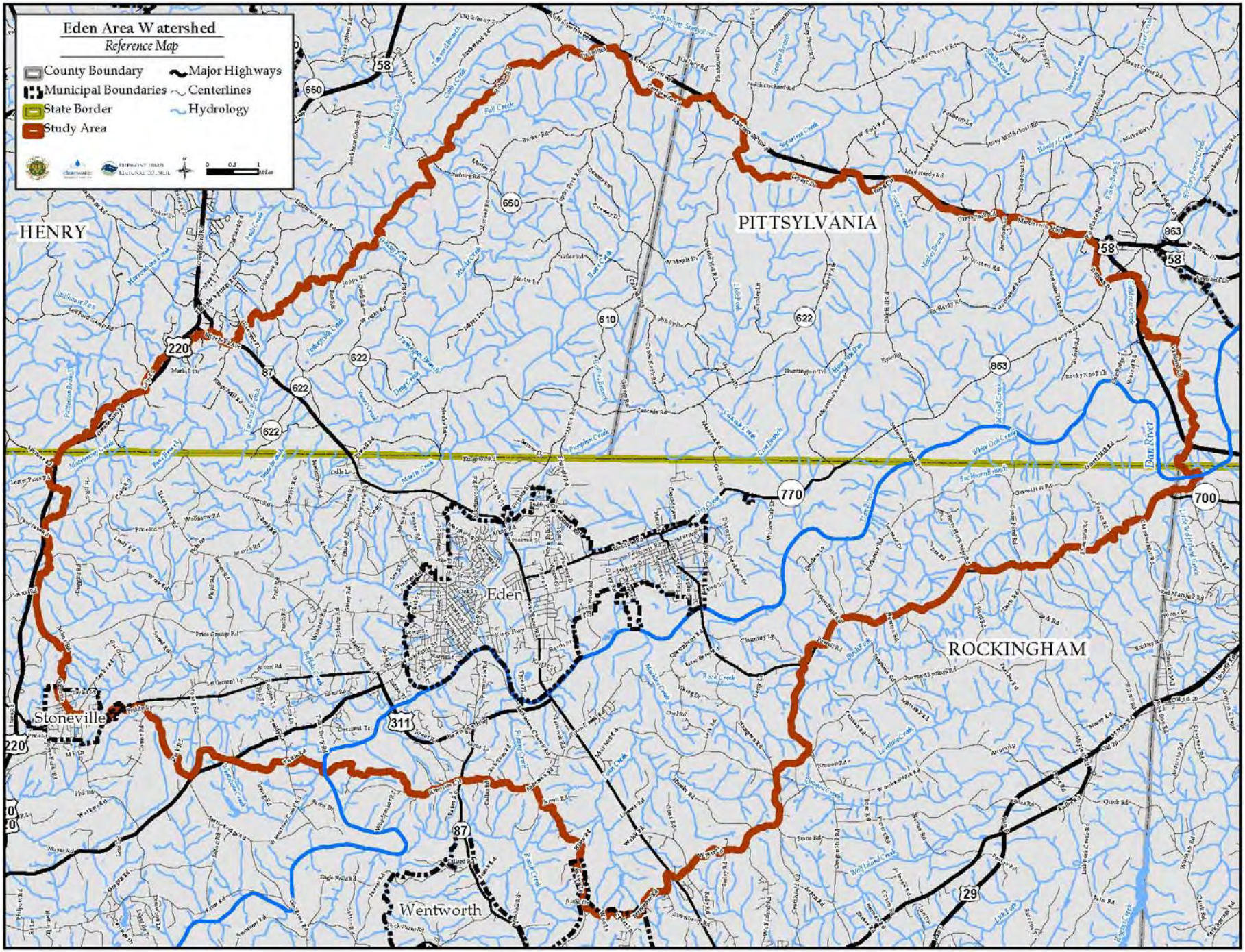

Figure 3: Eden Area Watershed

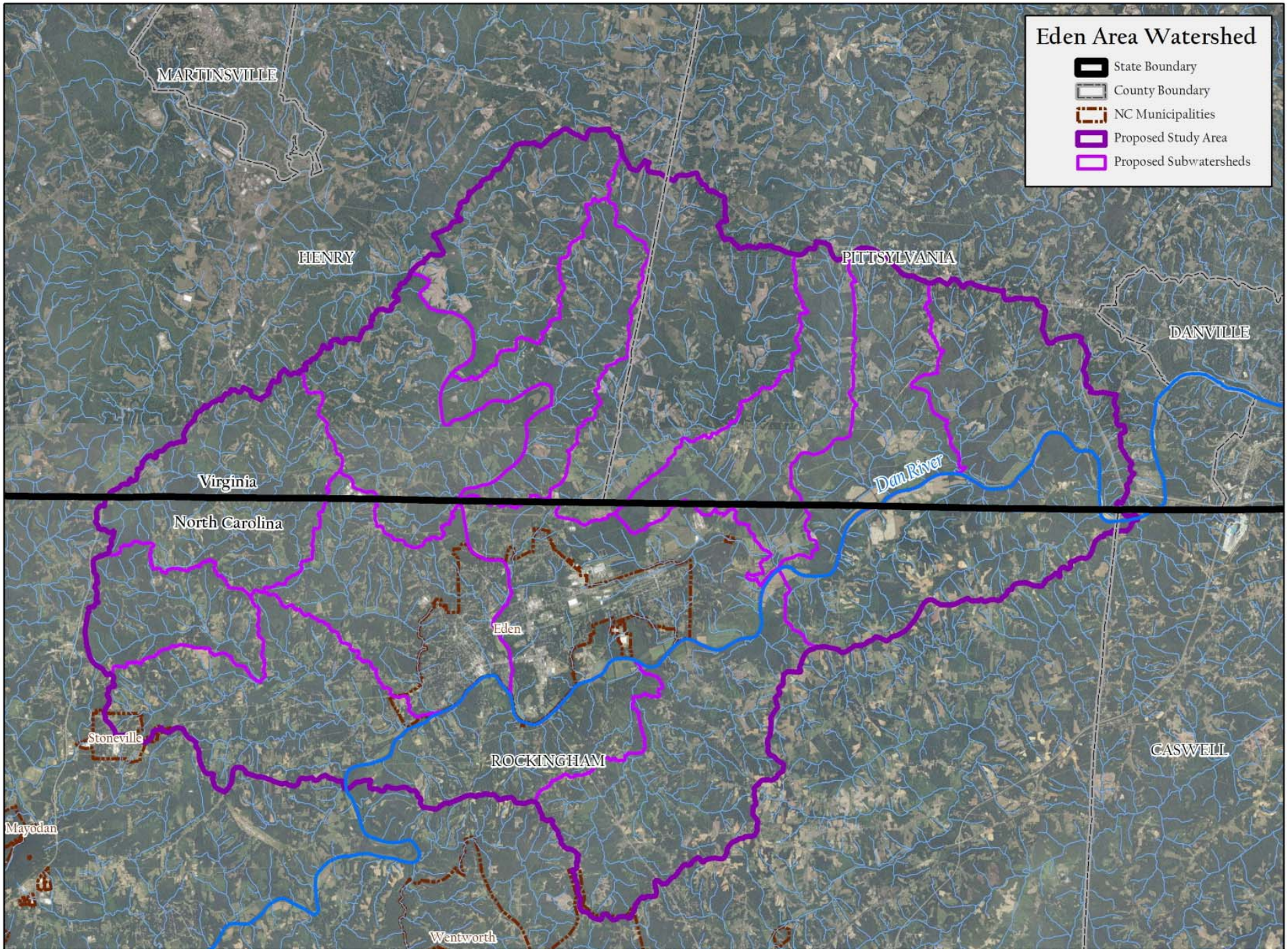

Figure 4: Eden Area Watershed Satellite Image

By the early 20th century, tobacco production began to wane due to the consolidation of small, privately owned farms and factories by companies such as R.J. Reynolds in Winston-Salem, NC. Workers also took advantage of jobs in textiles and manufacturing that were more profitable than farming. The furniture and textile industries took off with the increase in population and the establishment of Bassett Furniture Company in Bassett, VA, the American Furniture Company in Martinsville, VA, and Dan River Mills in Danville, VA. In North Carolina, industrial mills (Figure 5) sprang up in the towns and cities of Eden, Reidsville, and Roxboro (*personal correspondence with NC & VA S&WCDs*).

Figure 5: Spray Cotton Mill, Eden, NC

The City of Eden was technically founded in 1967, but that belies its much longer history as the Towns of Leaksville (est. 1796), Spray (est. 1813), and Draper (est. 1906). These economic sectors directly used the Dan River to transport goods to coastal communities and ports via bateaus and, later, steamboats. The value of this water for manufacturing and public health was recognized in 1906 with the establishment of the Spray Water Power and Land Company. The three adjacent towns consolidated their services and governments under the title of "Eden" in 1967, partly in an effort to minimize water and sewer maintenance costs. The City currently has a population of 15,557 people (City of Eden, 2007).

Beginning around the 1970's textile and manufacturing facilities throughout the basin started outsourcing jobs globally. This, along with the decreased demand for tobacco, sent the entire region into an economic slump that it has still not fully recovered from, with unemployment and poverty rates almost always above the state and federal averages (City of Eden, 2007; *personal correspondence*). Rockingham County is a NC Department of Commerce Tier 1 county, meaning that it is among the most economically-distressed in the state (NC DOC 2012).

Rockingham County is currently second in the state in burley tobacco production and fifteenth in the state in flue-cured tobacco production, emphasizing the region's legacy in its current economy. Total revenues, however, still place them in the bottom half of the state for county agricultural revenues (NCDA 2011). These legacies can also be seen in the land use within Eden, which has significant numbers of vacant homes and industrial sites, and a water and sewer infrastructure that once served three towns and had a capacity of 21 MGD, and is now

undersupported due to economic woes and a smaller population (Figures 7, 8 & 9; City of Eden 2007).

This watershed assessment analyzes watershed conditions and identifies sources contributing to impaired conditions which must be addressed if watershed functions are to improve. The *Eden Area Watershed Restoration Plan* will lay out detailed policy recommendations and a comprehensive project atlas and timeline for the most effective and efficient strategy to remediate watershed function and health.

Figure 6: US EPA Water Quality Scorecard

A watershed assessment attempts to characterize conditions in a watershed that may be significant factors in determining local water quality conditions. This includes assessments of current and past land use, local policies related to land use and development, water quality data, and field conditions recorded directly in the watershed. Local watershed planning principles established at the CWP and the US Environmental Protection Agency (US EPA) were used to address the sources of water quality issues of the Eden Area watershed (Figure 6). The Eden Area Watershed Assessment will focus on the conditions that are (some of) the sources of turbidity and fecal coliform bacteria impairments in the 13 miles of the Dan River and the fecal coliform bacteria and biological habitat impairments in the 5 miles of the Smith River in and around the City of Eden. The copper impairment in the Smith River will not be comprehensively addressed due to a lack of water quality data and questions about its relevance to present water quality conditions, but speculations on some of these higher levels will be made. This assessment will be accompanied by an Eden Area Watershed Restoration Plan that recommends policies and projects that can directly improve water quality conditions in this 110-square mile watershed. The *Restoration Plan* will be published in Summer 2013.

Restoration of the Eden Area watershed needs to be approached through both projects and policies. Projects address obvious impacts to current watershed health, such as eroding streambanks and agricultural best management practices (BMPs). Policy changes provide a more long-term strategy for sustainable watershed stewardship and public awareness necessary for a paradigm shift in land usage and development practices. In the Eden Area watershed, where a major insult to water quality appears to be a number of small, dispersed impacts, this is especially important. Projects can mitigate direct impacts, but to definitively address sources of sediment and fecal pollution, communities must foster behavioral changes

in their citizens through outreach and ordinances focusing on minimizing impacts upon streams through incentives and penalties.

The *Restoration Plan* will detail an implementation timeline for watershed stakeholders to draft and adopt policies, reach out to the public through diverse stewardship programs, and plan for restoration and conservation projects with both land use and financial tools. The Plan will not be static, but rather a living document that can be adaptively managed so that it is used for maximum cost-effectiveness and environmental benefit. The ultimate goal of the *Eden Area Watershed Restoration Plan* is to comprehensively address the sources of sediment and fecal coliform pollution that currently impair the aquatic life needs of the Dan and Smith Rivers, and be a useful tool in improving and then sustaining watershed conditions for both its ecological and human populations.

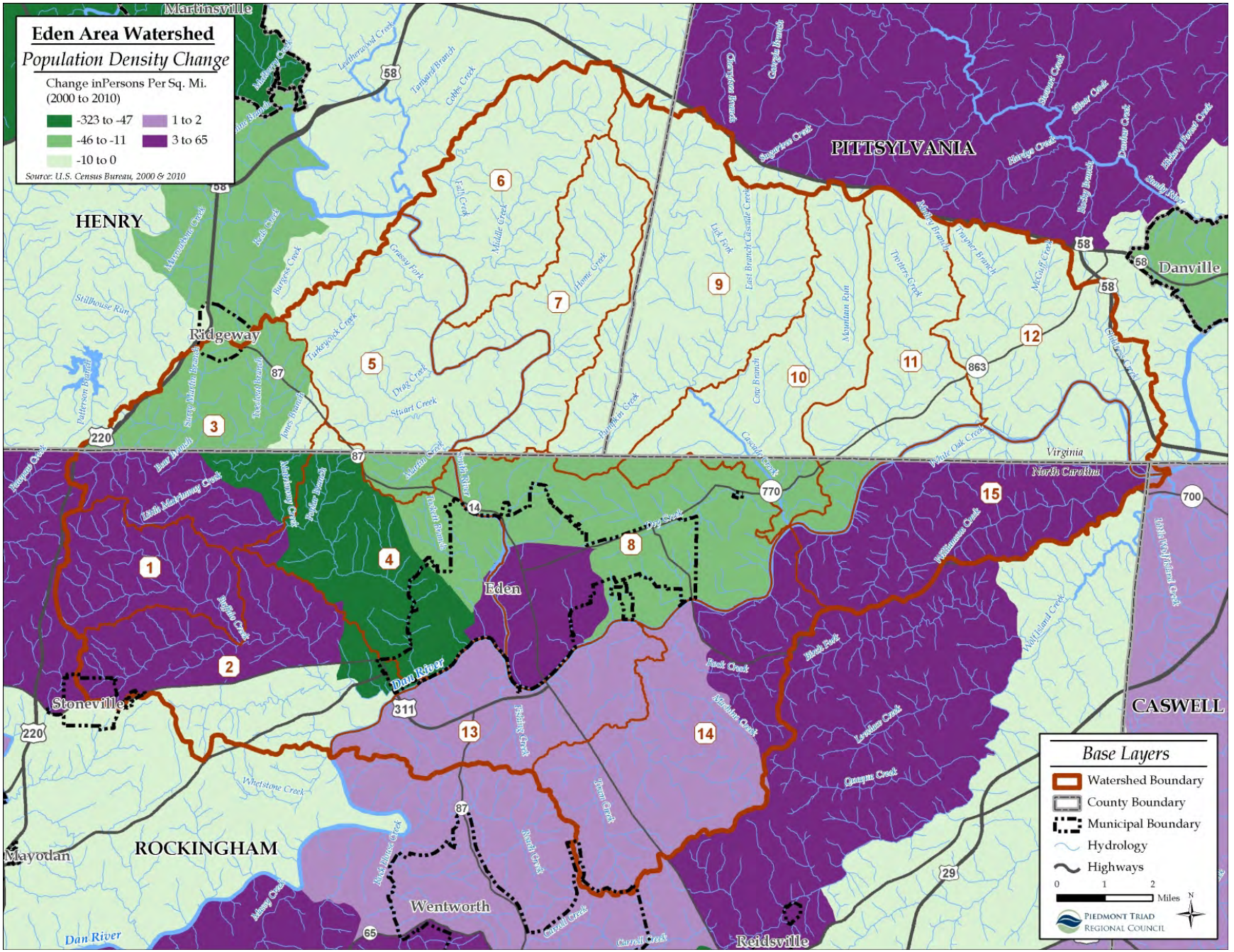

Figure 7: Population Density Change, 2000 – 2010

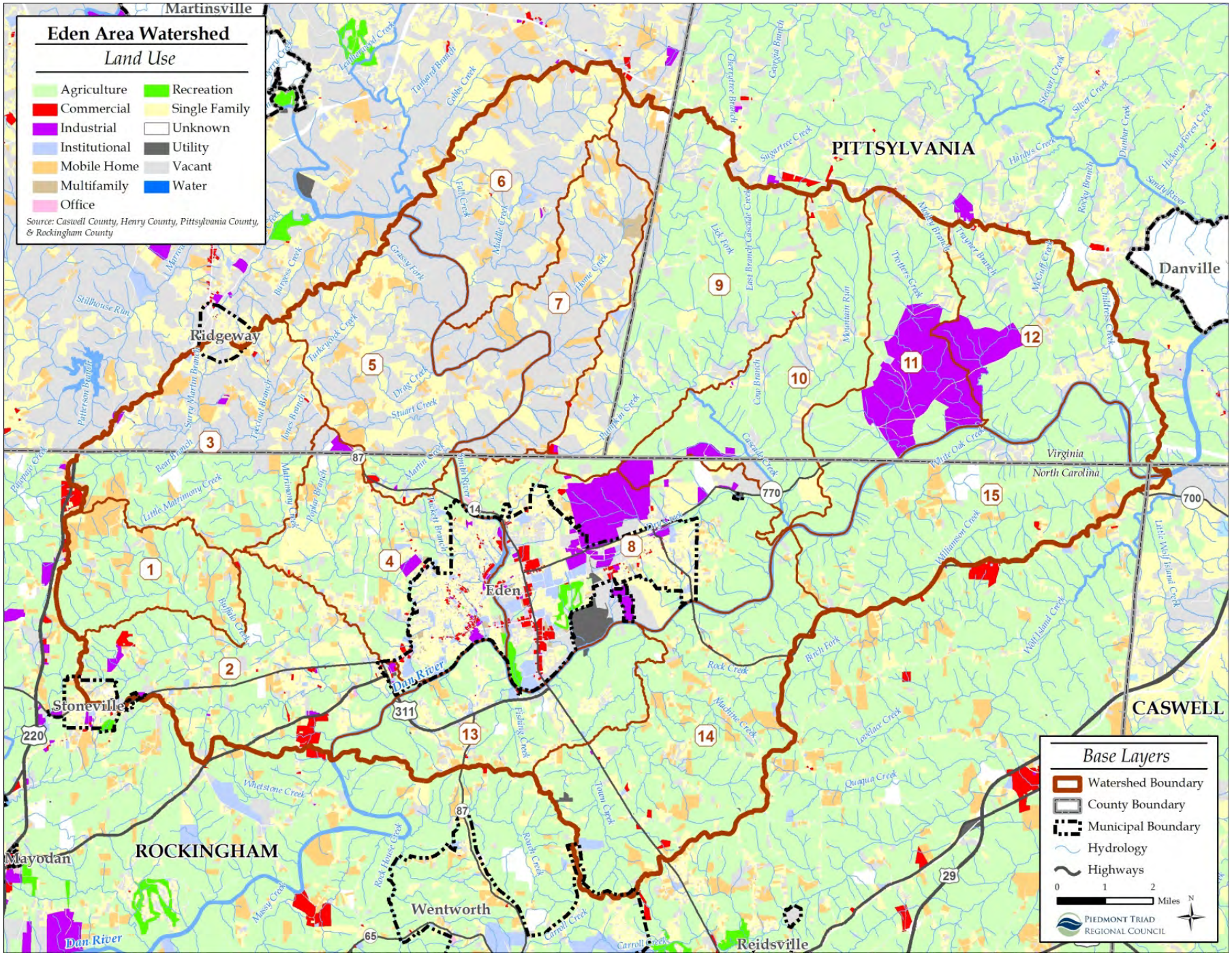

Figure 8: Eden Area Watershed Land Use

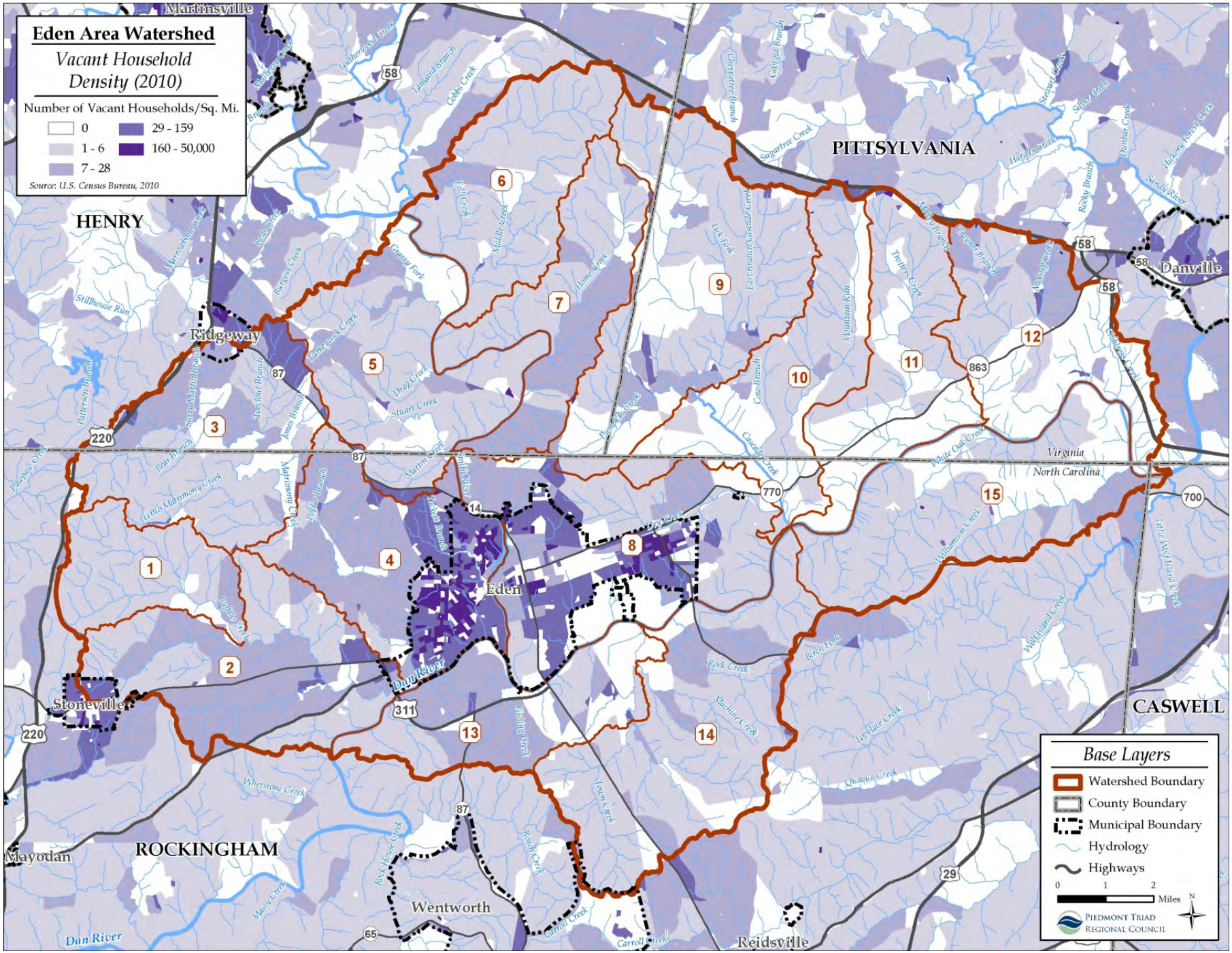

Figure 9: Eden Area Watershed Vacant Household Density

SECTION 1: STAKEHOLDER PROCESS

Table 1: Eden Area Watershed Stakeholder Committee

EDEN AREA WATERSHED STAKEHOLDERS COMMITTEE	
Dan River Basin Association Tiffany Haworth, Executive Director Jenny Edwards, Rockingham County Program Manager	**North Carolina Wildlife Resources Commission** Shari Bryant, Habitat Conservation Biologist Kacy Cook, Land Conservation Biologist
City of Eden Dena Reid, Water Plant Superintendent Terry Shelton, Director of Environmental Services Kelly Stultz, Director of Planning & Inspections Melinda Ward, Wastewater Superintendent	**Virginia Department of Conservation Resources** Chip Rice, Watershed Field Coordinator Eileen Rowan, Watershed Field Coordinator Heather Vereb, Watershed Field Coordinator
Henry County/Roanoke River Basin Association Michael Ward	**Rockingham County** Frankie Legeaux, Director of Planning Luke Carter, Interim Director of Planning
North Carolina Division of Water Quality Paul Clark, Environmental Program Consultant, Basinwide Unit	**Rockingham County Soil & Water Conservation District** Kevin Moore, District Conservationist
North Carolina Natural Heritage Program Judy Ratcliffe, Freshwater Ecologist	**Western Piedmont Planning District Commission** Aaron Burdick, Executive Director

WATERSHED STAKEHOLDER COMMITTEE

The Stakeholder Committee consists of members of the local community who will be immediately affected by Eden Area watershed restoration efforts. This Stakeholder Committee includes local landowners, members of environmental organizations, local government staff, and others who are interested in improving the quality of the community's environment, including parties from Virginia. Due to budgetary constraints, NC Department of Environment and Natural Resources (NC DENR), namely Division of Water Quality (DWQ), have been limited in their abilities to participate in meetings, but they have been as active as possible through e-mail and phone communication, selectively attending meetings that will have greater decision-making opportunities. Though not directly served by this state-funded planning effort, the VA Department of Conservation and Recreation (VA DCR) and the

Western Piedmont Planning District Commission (WPPDC) have participated in this process to the best of their abilities, representing the concerns and interests of the watershed stakeholders in VA, especially in regard to their ongoing *E.* coli TMDL on the Smith River and its tributaries. 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.

TECHNICAL SERVICES

PTRC received this NC Clean Water Management Trust Fund grant to assess the present water quality impacts and watershed restoration needs of the Dan and Smith Rivers on behalf of the City of Eden and Rockingham County. PTRC retains a Water Resources staff that is fully capable of water quality and watershed planning, as seen in multiple watershed planning efforts (www.ptrc.org/water; PTCOG, 2008; PTCOG 2009; PTRC 2011). It has won a National Association of Development Organizations Innovation Award in 2011 for its GIS-based watershed prioritization efforts at the basinwide scale. PTRC has a number of skills and resources that allow them to carry out these duties: watershed restoration planning through a combination of local experience and expertise from regional governments and other stakeholders, streambank field assessments, Geographic Information Systems (GIS) – based analysis, and a thorough analysis of the current protections and weaknesses within the jurisdictional rules and regulations of the governments presiding over the watershed. This watershed assessment uses these tools to identify current sources of watershed and water quality degradation that will be addressed in the *Restoration Plan*.

This technical role is in addition to the PTRC role in the Stakeholders Committee as facilitator and lead grantee in restoration planning efforts for the Eden Area watershed. PTRC presents its technical analysis and findings at regular Stakeholder Committee meetings for review and approval by all stakeholders. PTRC is not capable of comprehensively leading field work assessments of stream stability and ecological health and contracted with three private consultants for this work, with Stakeholder Committee approval. Please consult Appendix A for a detailed biography and list of qualifications of these individuals.

SECTION 2: WATERSHED CHARACTERIZATION

The Eden Area watershed is part of the Upper Dan River, the headwaters subbasin of the Roanoke River, which originates in the Appalachian foothills and discharges to the Albemarle Sound at Bertie and Martin Counties in North Carolina (Figure 2; (NC DWQ, 2012a). The Eden Area watershed occupies just over 225 square miles of the Upper Dan River Subbasin's easternmost extent, at the boundary between Rockingham and Caswell Counties. The Eden Area Watershed lies within five 12-digit Hydrologic Unit Code (HUC) watersheds delineated by the US Geologic Survey, including Matrimony Creek-Dan River, Trotters Creek-Dan River and Town Creek-Dan River in NC and Fall Creek-Smith River, and Cascade Creek in VA. Over 7% of the Dan River and its tributaries are impaired for human or ecological uses (NC DWQ, 2012a; VA Department of Environmental Quality [VA DEQ], 2012).

The Eden Area watershed is a diverse landscape due to both natural and artificial causes. Characterizing the watershed's natural attributes (i.e. geography, geology, floodplains and wetlands, ecological habitat, etc.) allows watershed stakeholders to understand the sources of current conditions in the watershed, and what steps can realistically and effectively be taken to remedy current water quality impairments. For example, the geology and soils of the Eden Area watershed make infiltration and storage of stormwater extremely challenging, so other remedies to mitigating stormwater runoff will likely have to be considered. The following text briefly describes the natural conditions that influence the area's hydrology and ecology. The "Review of Local Government Codes, Ordinances, Rules, and Programs" chapter will discuss how human decisions have impacted and continue to affect local water quality conditions.

GEOGRAPHY

The Eden Area watershed is a 225 square mile watershed centered on 14 miles of the Dan River and two of its significant tributaries (the Smith River and Matrimony Creek). The PTRC has delineated this watershed into 15 subwatersheds using the ArcHydro extension of ESRI's ArcGIS (Figure 10). The total amount of impervious cover in this watershed is <2%, effectively all within the city limits. 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 frequently are failing to support stream habitats; and >10% impervious coverage are incapable of providing sustainable habitats for aquatic and benthic habitat due to stormwater impacts (Schueler, 2000). Based on an impervious coverage of 2% the Eden Area watershed, the City should not be a significant obstacle to sustaining healthy waters throughout the watershed, though local impacts may be notable.

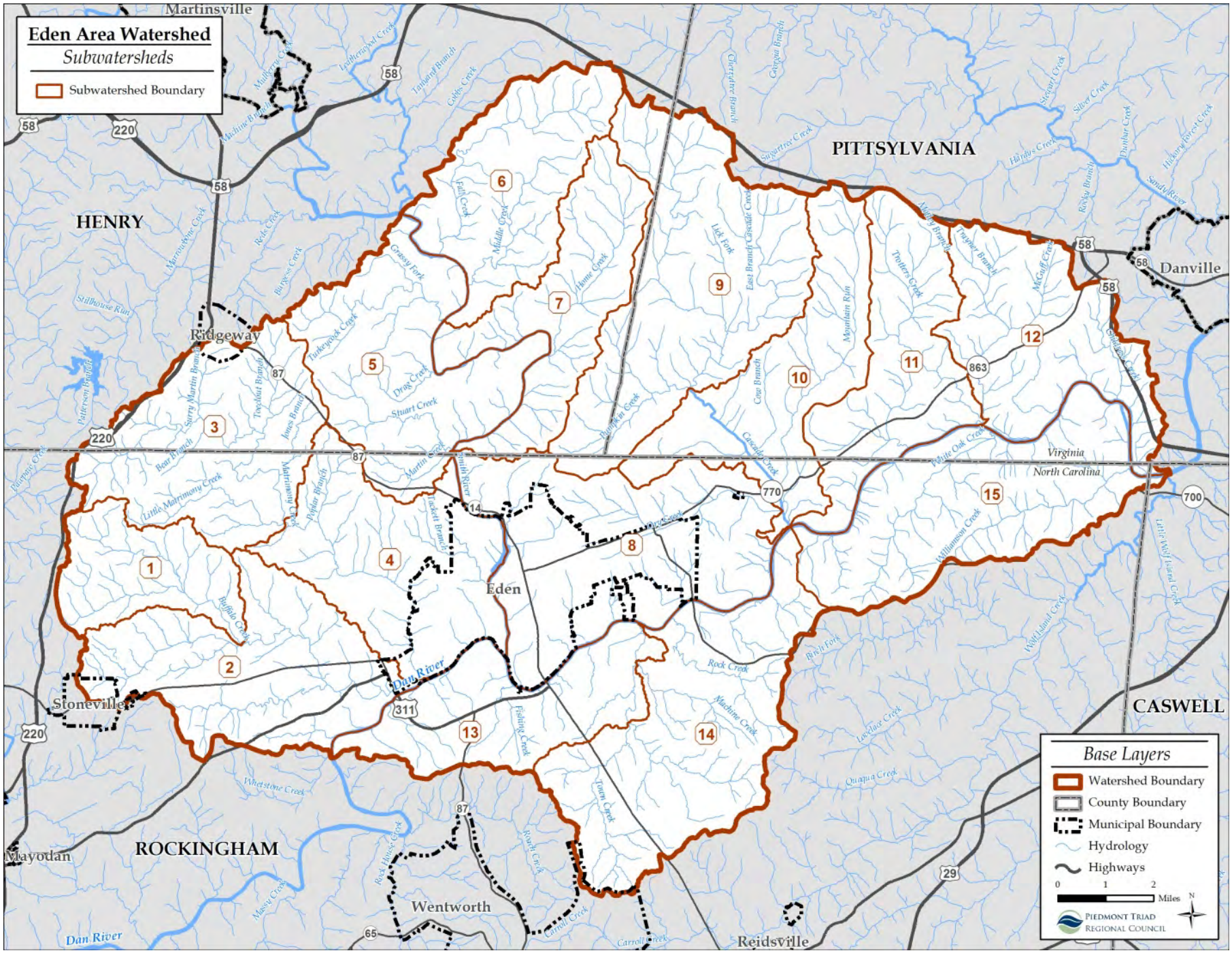

Figure 10: Eden Area Watershed Delineated Subwatersheds

GEOLOGY

The geology of the Eden Area watershed is highly diverse. The state boundary complicates the geology since it appears that the names of the geologic formations change with the state and date of publication of soil survey. For example, the geologic belt on the west side of the study area is known as the Inner Piedmont Belt in NC and as the Western Piedmont Belt in VA. While the US Geologic Service is national in scale, each state has their own geologic service that addresses geologic concerns within their respective states. In different states the funding and concerns may differ, thus producing unique products for each state.

The Piedmont of North Carolina and Virginia can be separated into sections with similar geologic histories. Those sections include geologic belts and the Triassic Basin (Figure 11). The Eden Area watershed lies within two geologic belts and the Triassic Basin. The Geological Survey (NCGS) describes geological belts; as: "areas with similar rock types and geologic history" (NCGS; Figure 11). The geologic region that runs through the middle of the study area known as the Triassic Basin was formed as faults along the edges of the belts moved and caused the Earth's crust to slowly fall below the surrounding geology thus forming a basin (Student, 2003). According to the Rockingham County Soil Survey (Staff, Soil Survey of Rockingham County, NC, 1992) the topography within the Triassic basin is usually 50-300 feet lower than the surrounding geology.

The Triassic Basin geology differs from the surrounding Milton and Piedmont Belts by being dominated by unmetamorphosed shales, sandstones, mudstones, siltstones, and conglomerates (Griffith et. al, 2012). The unmetamorphosed rocks are easier to erode encouraging stream valleys that cross the region to widen. The soils derived from this geology do not drain well, resulting in both unique ecology such as the Piedmont Upland Hardpan ecosystem, and stormwater management challenges.

The US Bureau of Land Management (BLM) highlights that the mudstones found in the Triassic basins are mined and processed to make brick, sewer pipe, structural tile and drain pipe (US Department of the Interior, Bureau of Land Management [BLM], 2008). The Triassic basin is also the rock formation in North Carolina that contains deposits of natural gas and is being studied for potential extraction of natural gas through the process of hydraulic fracturing or "fracking". The presence of the Triassic basin geology could therefore have important implications in the future of the economy and water resources of the Eden Area watershed.

The Belts to either side of the Triassic Basin include the Inner Piedmont and Western Piedmont to the West, the Milton Belt to the East (Figure 11). The NCGS describes the Inner Piedmont Belt as consisting of metamorphosed rocks including amphibolite and several types of gneiss and schist. The US Bureau of Land Management (BLM) describes the principle use of

rocks found in this belt is for crushed stone for road aggregate and building construction (BLM, 2008). The VA Department of Mines and Minerals describes the Western Piedmont belt as dating back to the Cambrian-Ordovician Era and containing intrusive igneous rocks including granite, gabbro, diorite and ultramafic rocks which date back to the late Proterozioic to Mississippian eras.

Both the NC and VA Geologic Services identify the region between the Carolina Slate Belt and the Triassic Basin as similar to the Carolina Slate Belt but with older and of a higher-grade rock (Pavlides, 1981). This region was identified as a unique geologic formation in the late 1990s (Hibbard, 2012)and thus any geologic references prior to that time call it either the Carolina Slate Belt in NC or the Central Virginia Volcanic-Plutonic Belt in VA. It is now simply referred to as the Milton Belt, and consists of metamorphosed rocks including several types of gneiss and schist and metavolcanic rock such as Felsic metavolcanic rock along with intrusive rocks. More detailed information on the rock species found within the geological sections can be found in Appendix B.

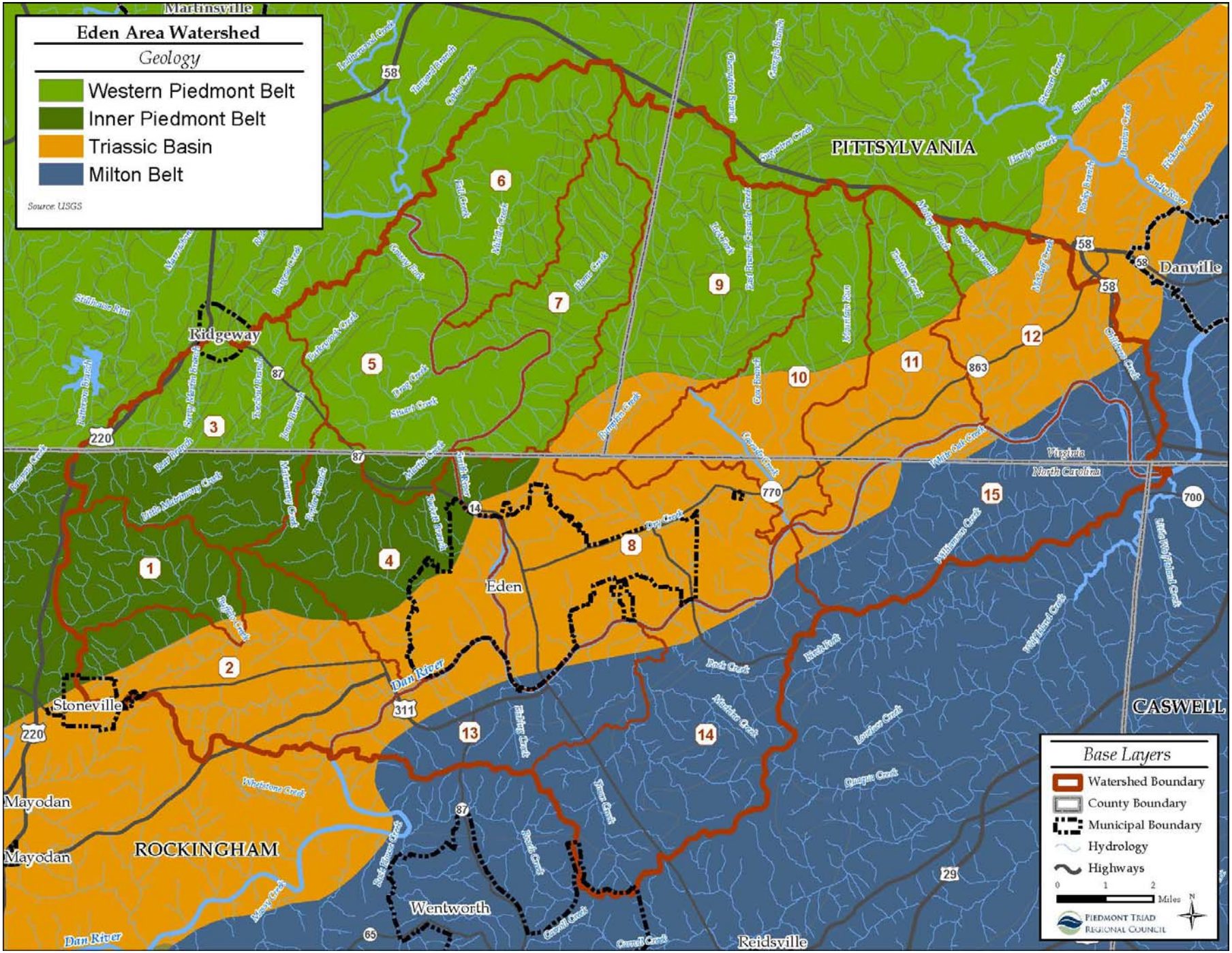

Figure 11: Eden Area Geology (in belts)

SOILS

The Eden Area watershed has no predominant soil type, but is a patchwork of 60 soil types derived from the Inner Piedmont, Western Piedmont, Triassic Basin and the Milton Belt geologies in North Carolina and Virginia (Figure 11). Soils formed from the poorly-draining sedimentary rock of the Triassic Basin overlap with the soils formed from the more porous but more erodible metamorphic rock of the Piedmont Plateau (including the Inner Piedmont, Western Piedmont and Milton Belts) creating a complex landscape. The soils derived from the Triassic Basin ecoregion tend to be high in clay with low permeability and moderate to high shrink-swell potential, such as the Clover or Mayodan soils group. Soils derived from the Triassic Basin include Ayersville (not hydric, slightly erodible), Leaksville (all hydric, moderately to highly erodible), Clover/Mayodan (not hydric, moderately erodible), Spray (not hydric, slightly erodible) and Stoneville (not hydric moderately erodible) (US Department of Agriculture [USDA], 2012). Due to weathering processes the soils derived from the Triassic Basin geology are often located on top of the ridges while the older, more erodible metamorphic derived soils exposed on the sides of the slopes. The alluvial soils along the Smith and Dan Rivers are thus formed from a weathered material from sedimentary, igneous and metamorphic rock from surrounding uplands. The soil composition of the watershed ensures that the receiving waters will be extremely prone to sediment pollution.

The predominant soil types comprise 65% of all soil in the Eden Area watershed: the Clifford group (27%), Clover group (13%), Poplar Forest (7%), Mayodan group (7%), the Cecil group (5%), and the Fairview-Poplar Forest complex (6%) (Figure 12). Of the dominant soil types, Clifford soils were found exclusively in Rockingham and Henry Counties, and the Mayodan soil group was found exclusively in Pittsylvania and Henry Counties (Figures 13-15). The remaining dominant soils were identified in only one of the three counties that have available soil survey data (USDA, 2012).

Prior to 2012, the Rockingham County Soil survey had the Cecil soil group covering approximately 17% and the Mayodan soil group covering 19% of the Eden Area watershed in Rockingham County. The soil survey for Rockingham County was updated in 2012 and the Cecil and Mayodan soil groups were replaced by alternate soils such as Clifford and Clover (Figure 15). In 2012 the Rockingham County Soil Survey began to include the Clover, the Clifford, and the Poplar Forest and Fairview-Poplar Forest Complex soils which were not included in the previous soil surveys. The Henry County Soil Survey is relatively recent and includes the Clifford Soil group along with the Ayersville soil group which are both found only in the Henry and Rockingham soil surveys (Figures 14 and 15).

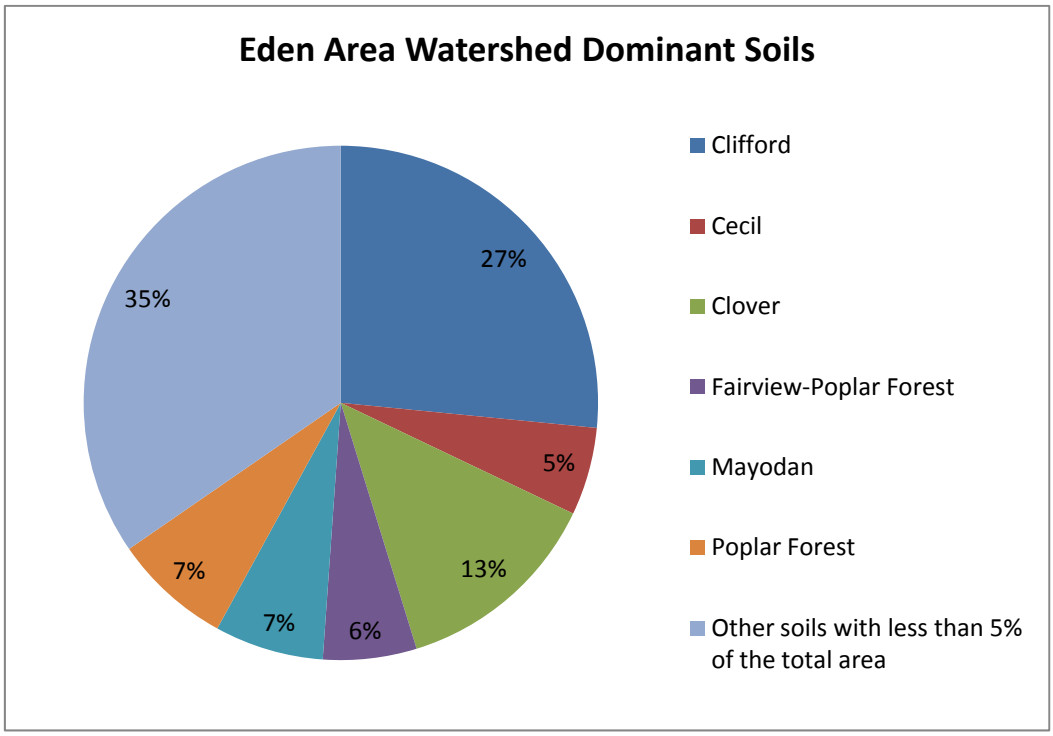

Figure 12: Eden Area Watershed Dominant Soils

Because the current soil survey removed the Cecil soil group from the soils found in Rockingham County the question is whether future soil surveys in Pittsylvania may also reclassify the Cecil soil group as different soil types. Although the soils located in Rockingham County did not change, the way that the soils were classified changed to address the mesic or thermic quality of the soils and the new classifications slightly altered the location and intensity of soil erodibility and how hydric the soils were (USDA, 2012). Again, discrepancies among the NCGS and VAGS staffs in their methodologies and conclusions have affected the consistency and usefulness of this data. This is most notable for the small part of the study area that falls in Caswell County which has no digital soils data.

Generally speaking, however, across the 225 square mile watershed, the soils have a low to moderate level of permeability and drain well, if very slowly. The predominant soils are all strongly acidic and may require lime application prior to cultivation. If done inappropriately, however, lime application can be a significant nutrient load in this watershed and river basin. Consultation with the Rockingham County Soil & Water Conservation District and/or the County's Cooperative Extension office is strongly recommended.

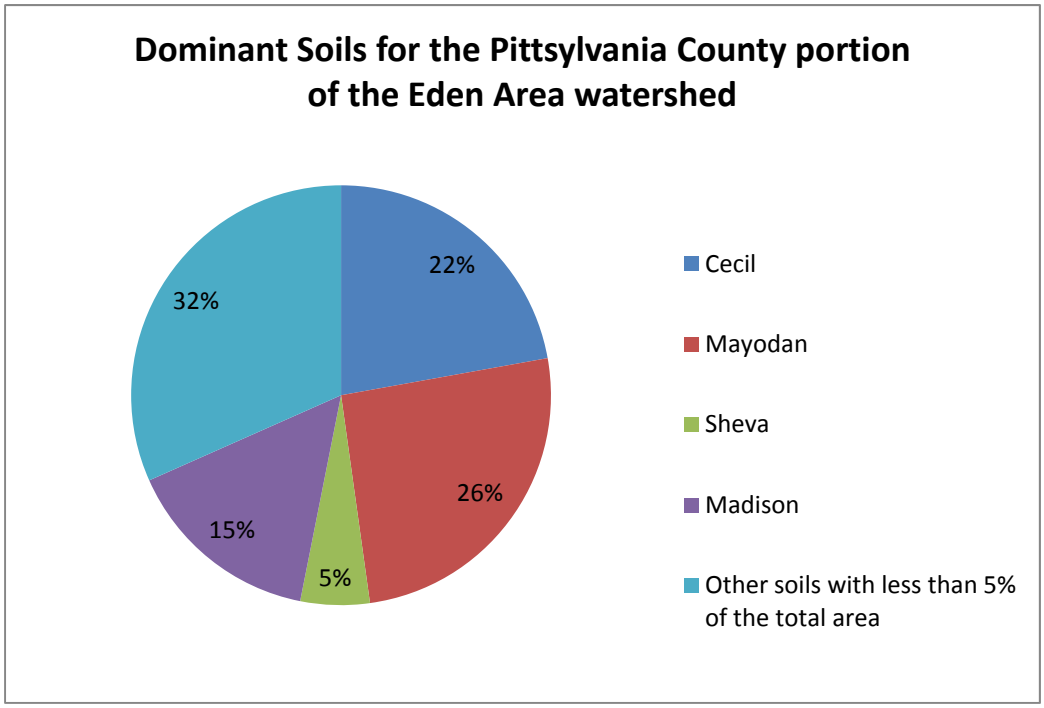

Figure 13: Dominant Soils in the Eden Area of Pittsylvania County VA

The greatest limitations for most of the soils are slope, shallow bedrock, potential for shrink-swell and the hazard of erosion, making infiltration and even soil amendment challenging. Many of these same challenges are seen in the Falls Lake watershed of the Upper Neuse River Subbasin in North Carolina, and the nutrient management strategy legislating their management provides guidance to all landowners and communities in this watershed and the entire Upper Dan River Subbasin on how to sustainably develop lands for optimal economic and ecological results.

The predominant soil types in this watershed have slight to moderate erodibility (Figure 16). The factors that affect the erodibility of a soil type include soil texture, organic matter content, structure and hydric properties. These erodibility factors can be estimated based on soil type and are represented by K factors which are broken into classes by soil scientists. Soils that are not prone to erosion have a K factor of 0.02 or 0.05. Slightly erodible soils have a K factor < 0.22 and account for approximately 128 square miles (57%) of the study area. Moderately erodible soils include those with a K factor between 0.23 and 0.40 and account for 90 square miles (40%) of the Eden Area watershed. With a K factor of 0.43 the Banister and Leaksville soil groups represent the only highly erodible soils of the Eden Area watershed and cover 4 square miles of Rockingham County which represents 1.5% of the watershed. The remaining 1.5% of the Eden Area watershed is comprised of pits of clay, urban land and water which all have unknown or zero erodibility.

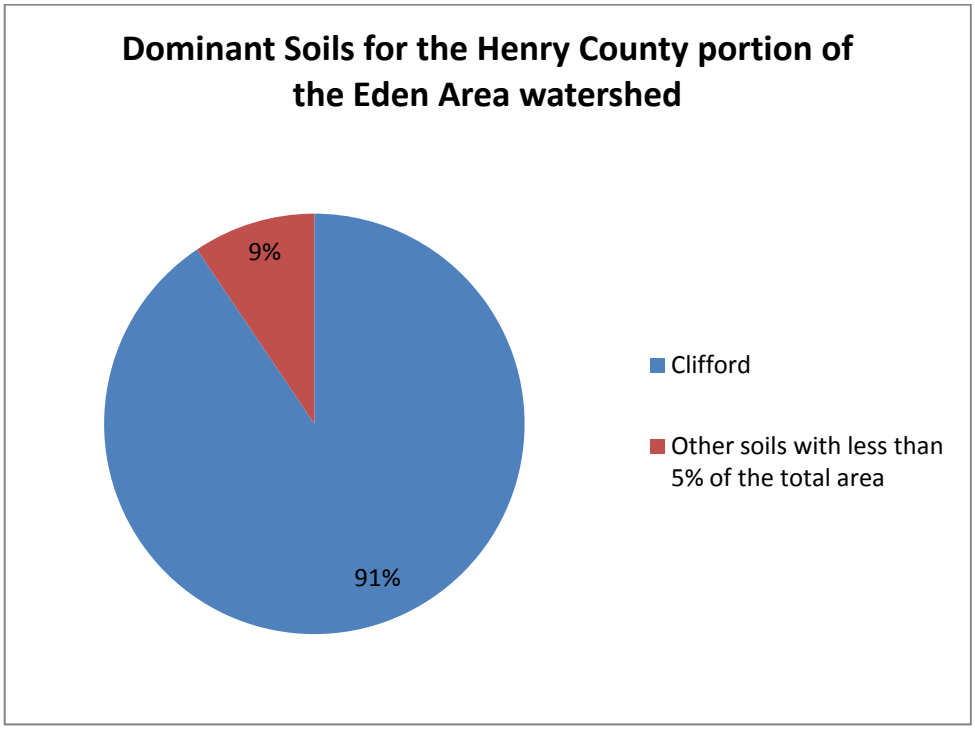

Figure 14: Henry County Soils

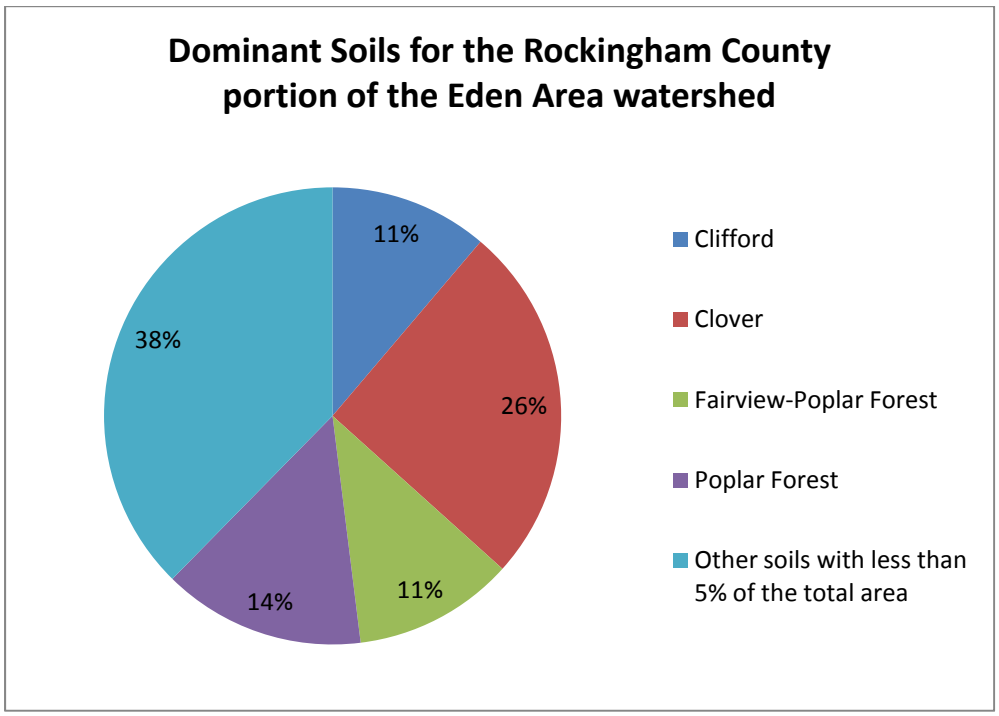

Figure 15: Rockingham County Soils

There are less than 2% all hydric soils (Leaksville silt loam, Hatboro (formerly included with the Wehadkee series) silt loam and Wehadkee silt Loam) in the center of this watershed and largely within the Draper section of Eden, surrounded by the "partially hydric" (Ayersville, Codorus, Colvard, Creedmoor, Dan River, Davie, Elsinboro, Halifax, Mayodan, and Stoneville) soil groups. They collectively comprise about 7% of the watershed's soils (Figure 17). While small in overall coverage, the hydric soils are very important for wetlands and the globally rare ecosystem Piedmont Headwater Stream Forest (Hardpan Type) identified while conducting field work.

Hydric soils are an indicator of saturated soils, and one of three attributes used to delineate and declare an area a wetland. The partially hydric soils in this watershed are noted almost exclusively along streams and rivers, indicating the importance of floodplain wetlands (Figure 17). This is supported by the number and quality of floodplain wetlands that were identified during the field work for this assessment. While the partially hydric soils are listed within the 100-year floodplain, the majority of the all hydric soils are located outside of the floodplain, but within the Triassic Basin, which highlights the significant impacts geology can have on the formation of hydric soils.

Pittsylvania County appears to lack the partially hydric soil formations found in adjacent Henry and Rockingham Counties. While Pittsylvania County has digital data for its soils that are in this analysis, there is no electronic Soil Survey for the County, and, thus determining why similar soils are categorized differently between the Counties is difficult to ascertain and indicates a need for a more regional or at least coordinated approach to soil surveying.

For a detailed profile of the soils in the Eden Area watershed, please consult with the NC Division of Soil & Water Conservation (NC DWSC)'s *Soil Survey of Rockingham County, NC*, or the US Department of Agricultural Natural Resource Conservation Service's Soil *Official Soil Series Description* for Rockingham County or the Soil Survey for Henry County (USDA, 2012) (Staff, Soil Survey of Henry County Virginia, 2010). Please see below for detailed descriptions of the dominant soil types in the watershed.

Clifford Soil Group (27% of the Eden Area watershed soils) is a fine sandy loam found on uplands and along intermittent drainage ways in the Piedmont of Virginia and North Carolina. This group is derived from weathered granite, gneiss and mica schist with a large percentage of sand sized particles. It drains well with low shrink-swell potential and erosion is a major hazard. This soil group was established in Henry County Virginia in 1996. This soil is often found in mixed hardwood and pine forests.

Clover Soil Group (13% of the Eden Area watershed) is a sandy loam found in the Piedmont basin. This group is derived from Triassic age materials. It drains well with moderate shrink-swell potential and no ponding or flooding frequency and low pH. The Clover soils were previously mapped as Mayodan soils. The April 1997 adjustment of the mesic/thermic line necessitated the establishment of a mesic counterpart. This soil is often cultivated and thus is typically found in agricultural fields.

Poplar Forest Soil Group (7% of the Eden Area watershed) consists of well drained, moderately permeable soils that formed in from felsic or intermediate, high-grade metamorphic or igneous rocks high in mica content. They are very deep soil beds to the bedrock and moderately deep soil beds to the saprolite. They are on gently sloping to steep uplands in the Piedmont. Slopes are mostly between 4 and 15 percent, but range from 2 to 60 percent. Near the type location, mean annual temperature is 57 degrees F., and mean annual precipitation is 43 inches. This series differs from the Clifford group by having a higher mica content in the soil. This series is proposed as a mesic equivalent to the Madison series mapped in thermic MLRA 136. The name comes from the summer house belonging to Thomas Jefferson in Bedford County VA which is the county where this soil series was proposed in 2008.

Mayodan Soil Group (7% of the Eden Area watershed) is a sandy clay loam found in uplands such as ridges, and on moderately steep hillsides around drainage ways. This group is derived from weathered Triassic sandstone, siltstone and conglomerate. It drains well, but does have moderate shrink-swell potential and is moderately erodible. It has low organic content, often only ~2% at the surface, which is prone to erosion.

Cecil Soil Group (5% of the Eden Area watershed) is a sandy clay 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 3 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, and is moderately erodible.

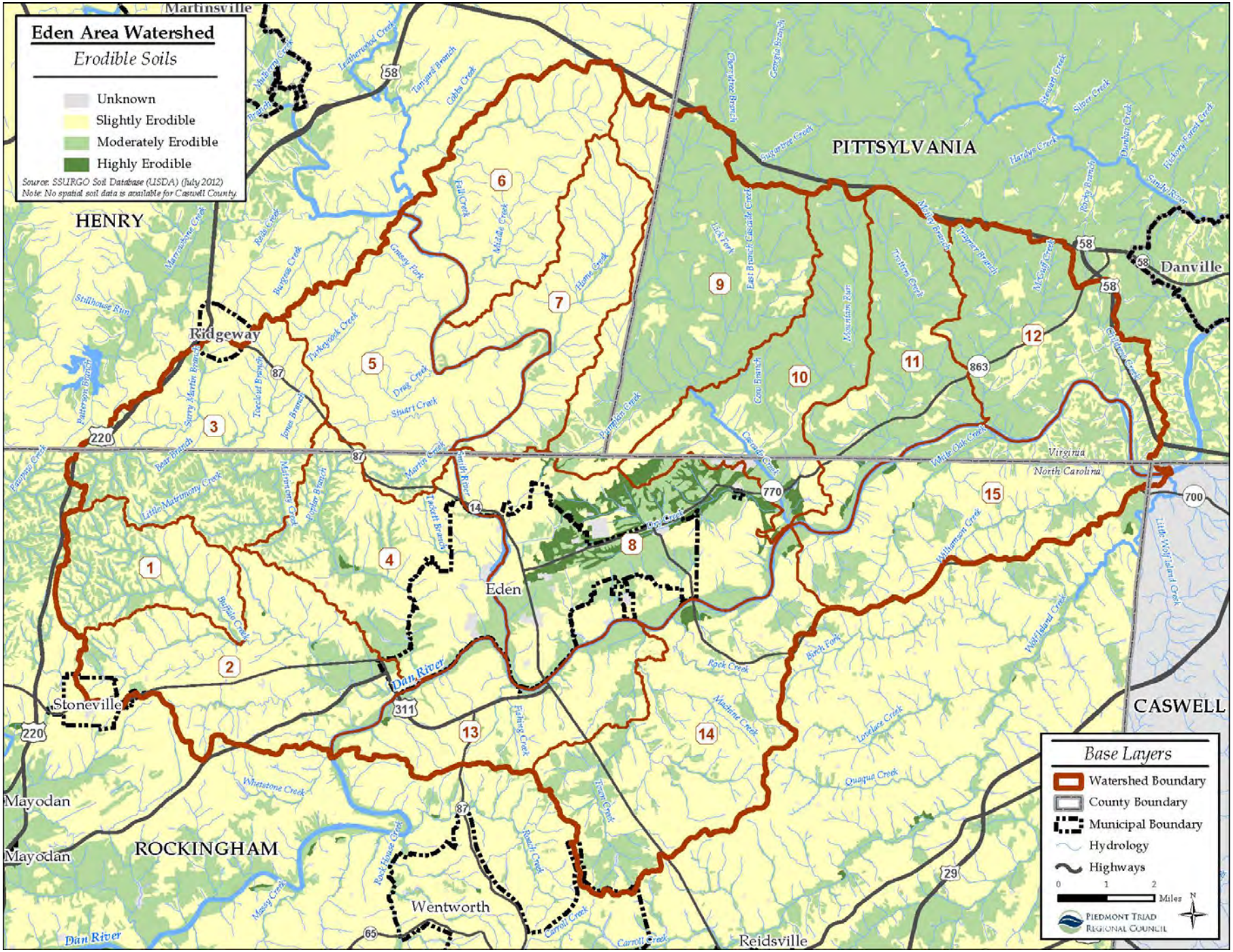

Figure 16: Erodible Soils

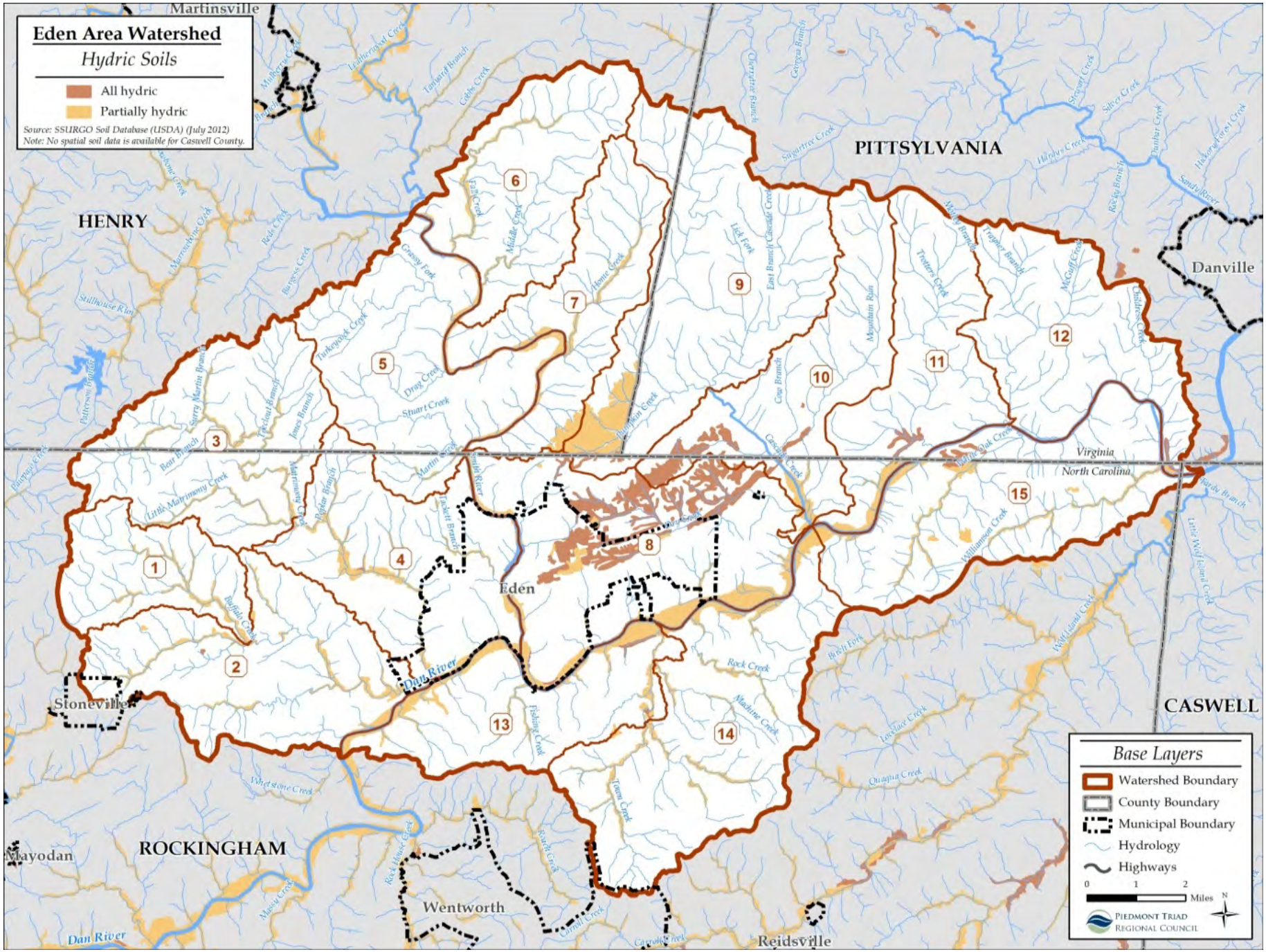

Figure 17: Hydric Soils

TOPOGRAPHY

The Eden Area Watershed falls 1,127 feet from the highest peak to the lowest reaches. The highest peaks are located in the Eden Area watershed are within the headwater subwatersheds 1, 3, 6, 7 and 9 many of which are along the small tributaries to the Dan River. The highest point is located in between Subwatershed 1 and Subwaterhsed 3 where the headwaters of Little Matrimony Creek, Matrimony Creek and Buffalo Creek originate (Figure 18).

The Center for Watershed Protection (CWP) considers slopes over 15% and cleared of vegetation to be a significant source of stormwater or agricultural runoff to catchment waters. 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. Approximately 28% of the Eden Area watershed has slopes >15%, which is equivalent to about 63 square miles of land with slopes that should not be developed. The steep slopes are predominantly found in Subwatersheds 1, 3, 5, 6, and 7 which coincides with the areas of greatest elevation change. Many of these steep slopes are along small tributaries to the Smith and Dan Rivers. Subwatershed 3 has the greatest mean slope with a value of 16% while Subwatersheds 1, 5, 6, and 7 all have a mean slope of approximately 15%. Therefore to reduce the erosion and subsequent sedimentation in these subwatersheds, best management practices for forestry, agriculture and development should be employed.

Subwatersheds 1 and 3 have a large portion of the steep slopes while subwatersheds 2, 4 and 8 have lesser amounts of steep slopes (Figure 20). The steep slopes seen in Subwatersheds 1 and 3 were in rural areas and often contributed to the erosion and channelization of the streams in those areas (Figure 19).

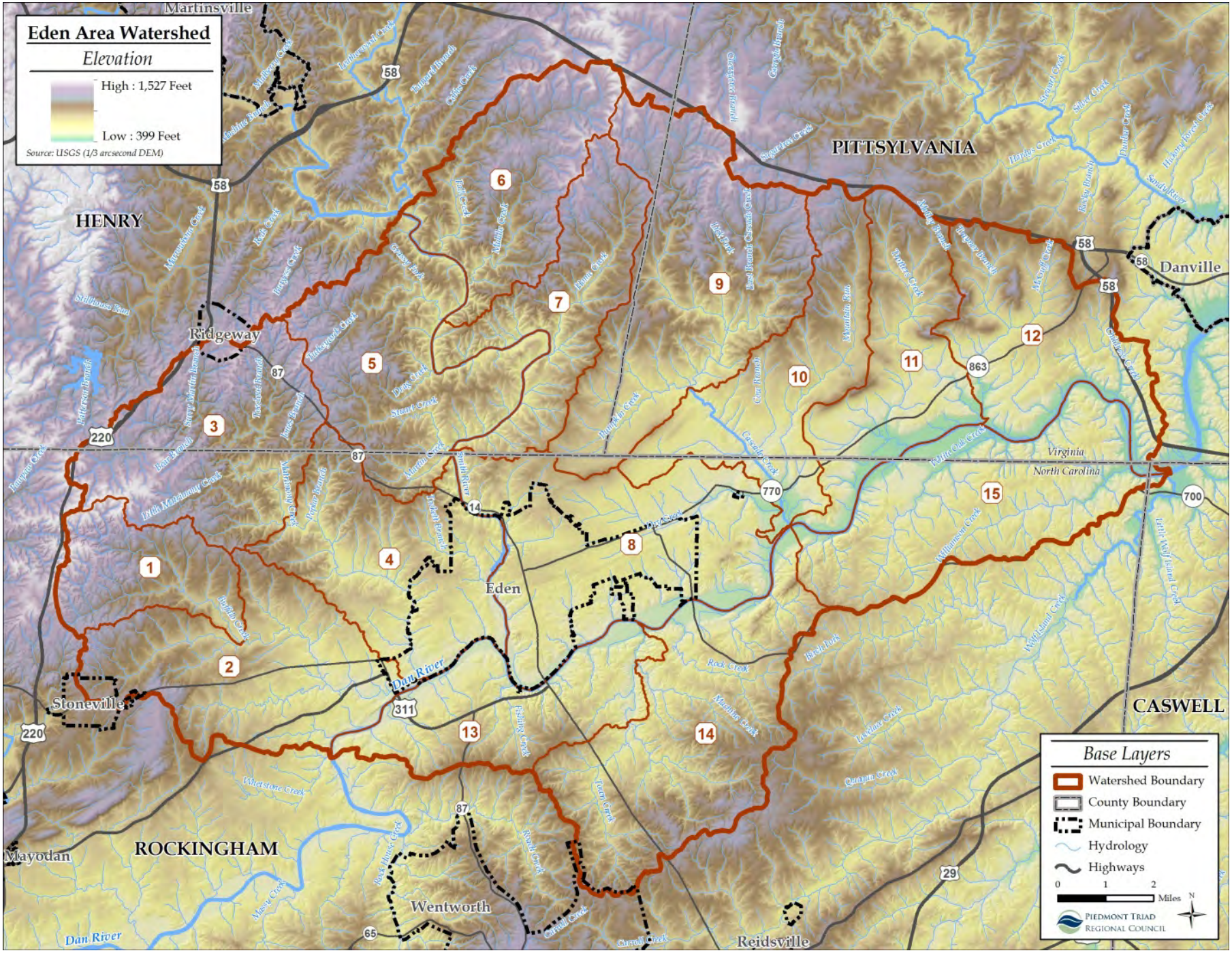

Figure 18: Elevation

Subwatersheds 2, 4 and 8 have lesser amounts of steep slopes but greater development pressures from the municipalities of Stoneville and Eden. A portion of Stoneville lies within subwatershed 2 while subwatersheds 4 and 8 contain the City of Eden and are the most urban subwatersheds in the study area.

Figure 19: Steep Slope in Subwatershed 1 Causing Erosion

The soils of subwatersheds 4 and 8 are formed from the Triassic Basin geology and are moderately to highly erodible (Figure 11; Figure 16). These subwatersheds also have the largest concentrations of impervious surfaces in the watershed, and already contribute more stormwater to the River than any of the other subwatersheds. Due to the limited presence of steep slopes within these urban subwatersheds future development should be focused in these areas, as long as the erosion of the erodible soils is limited through development practices that reduce the velocity and amount of stormwater (Figure 20).

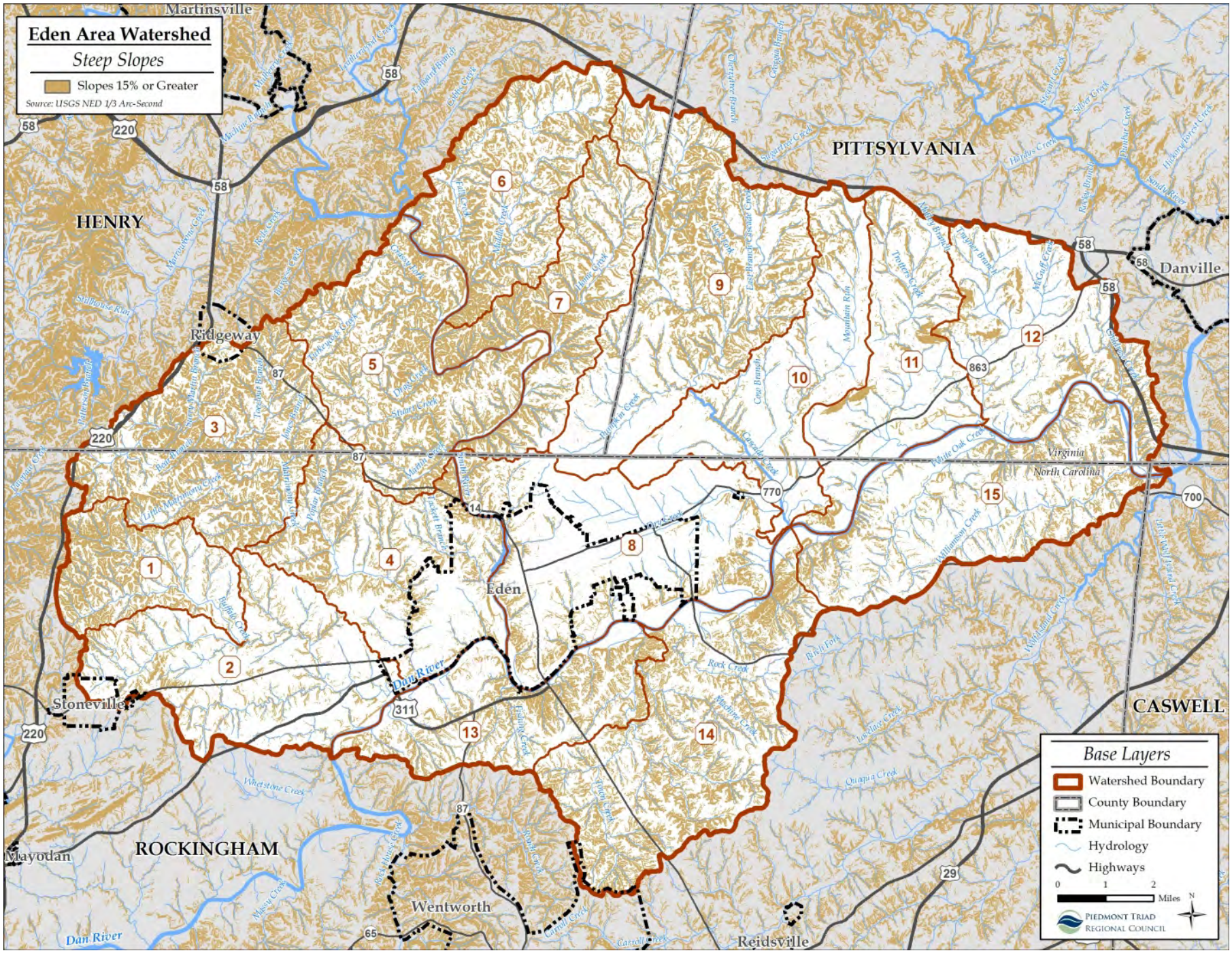

Figure 20: Steep Slopes

SURFACE HYDROLOGY

The Eden Area watershed is a 225 square miles area of the Upper Dan River Subbasin that features just under 50 miles of river length (Figure 21). To understand the Eden Area watershed hydrology it is important to understand how the upstream reaches of the Upper Dan River impact the conditions within the Eden Area. The first 11.6 miles of the Dan River itself are cold enough to support trout and are thus are classified as "trout waters" which have a turbidity standard (10 NTUs) that is significantly lower than the rest of the Upper Dan River Subbasin. Because the standard for turbidity is only 10 NTUs instead of 50 NTUs this segment is impaired for turbidity with the turbidity levels peaking in late spring and early summer, when rains are most common. The remaining 38.2 miles of the Dan River are not "trout waters" and are impaired for both turbidity and fecal coliform bacteria.

According to DWQ "The Upper Dan River Subbasin is the western most subbasin and runs along the North Carolina/Virginia state line. The subbasin contains two Impaired streams: five segments of the Dan River are Impaired for either fecal coliform bacteria, turbidity or both; and the Smith River is Impaired for biological integrity, fecal coliform bacteria and copper." (NC DWQ, 2012a). While local residents often refer to the Dan River as the "muddy Dan", the high turbidity levels negatively affect the water quality and need to be reduced to ensure the continued recreational, industrial and drinking water value of the Dan River.

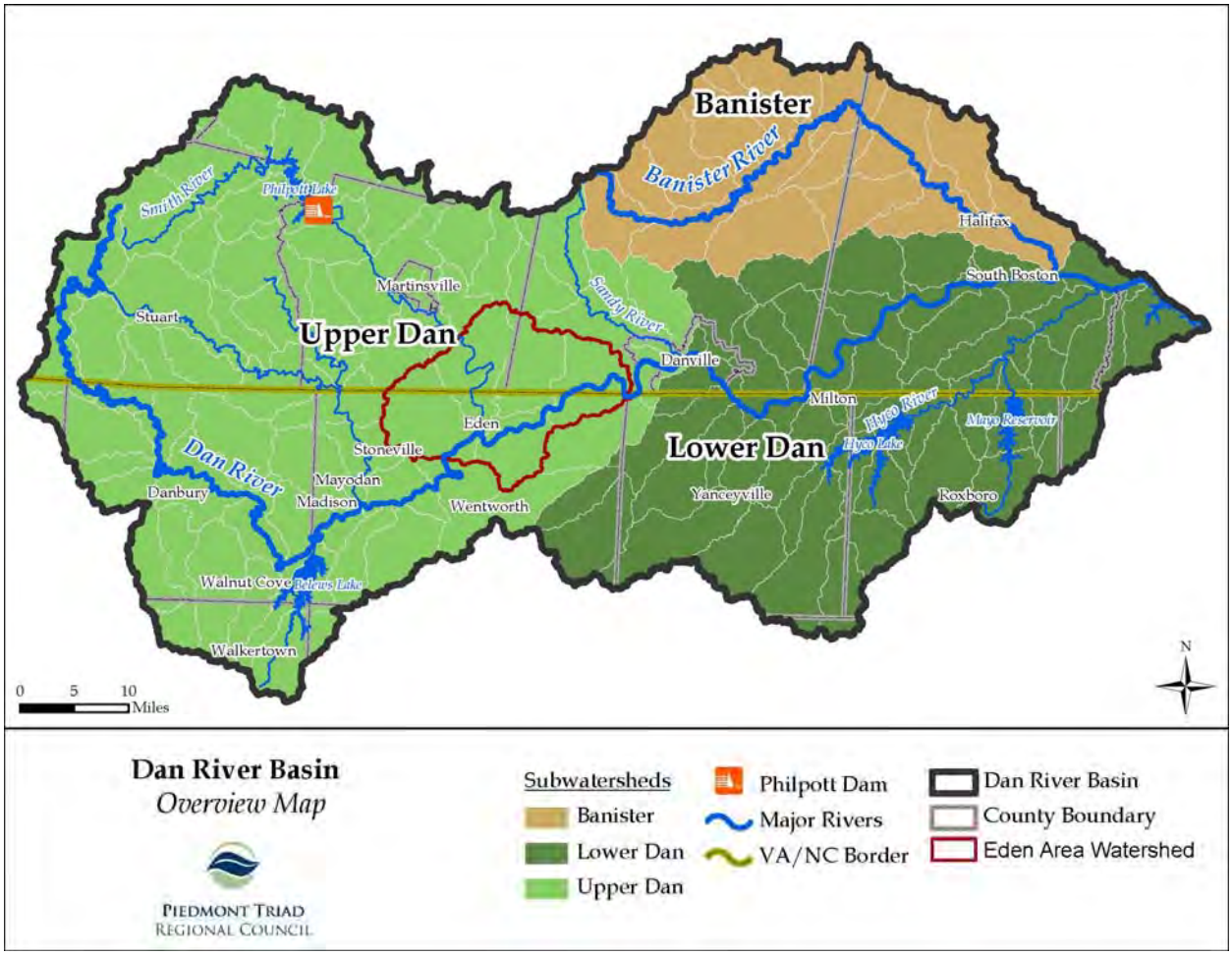

Figure 21: Dan River Basin

The Eden Area watershed tributaries can be grouped into three groups of stream orders. The first is the stream orders I – III that compose the many small headwater tributaries and streams that originate due to natural springs and stormwater runoff. Generally these small streams are completely shaded by surrounding trees and flow quickly into larger streams (Figure 22). These small order streams are abundant throughout the watershed due to steep topography and shallow bedrock. Many of these streams have dams near the headwaters that were and/or are currently used for agriculture.

Figure 22: Stream in order I-III (Subwatershed 1)

The second grouping of stream orders are IV – VI, which are mid-sized streams that have heavier water flow, but tend to be wider, allowing light to penetrate the water. Matrimony Creek, Buffalo Creek

Figure 23: Matrimony Creek (Subwatershed 4)

and Town Creek are examples of this level of stream order. Matrimony Creek begins in NC in Subwatershed 3, crosses into Virginia for three to four miles and then returns to North Carolina for approximately 11 miles before it drains into the Dan River near the Town of Eden (NC DWQ, 2012a). The majority of land use around Matrimony Creek is a mixture of agriculture, forestry and residential/urban around Eden (Figure 23). The confluence of Matrimony Creek and the Dan River is significantly eroded from the Dan River backing up into the creek during periods of high flow. The increased water volume from the Dan River scours the banks of Matrimony Creek as the water levels rise and recede during heavy rains.

Anything over a sixth order stream is considered a river, thus Dan River and the Smith River are the two examples of the VI-XII order streams in the Eden Area watershed. The Smith River begins in Virginia and passes through a mixed land use of agriculture, forest, residential and the urban areas of Martinsville, Virginia, and Eden, North Carolina (Figure 24). The Smith River flows through NC for approximately five miles before it drains into the Dan River.

The stream flow of the Smith River is monitored daily by the USGS, which measured an annual mean flow of 535 cubic feet per second (cfs) for 2011 with a peak flow of 5,510 cfs, and a low flow of 63 cfs. These USGS measurements are taken above the dam located on the Smith River in Eden but below the Philpott Dam in Virginia. The 2011 "water year" has a slightly lower annual mean when compared to the historical (1953-2011) mean of 641cfs (US Geological Survey [USGS], 2011). The peak flow for 2011 (5,510 cfs) is also significantly lower than the record peak flow of 24,800 cfs seen during hurricane Agnes on June 21, 1972. The 2011 peak flow of 5,510 cubic feet per second has the power to scour the riverbanks and increase the turbidity levels in the Smith River and receiving waters of the Dan River. Comparing the 2011 data with the historic levels shows the impacts that hurricanes can have on surface hydrology of the Dan and Smith Rivers. Hurricane Agnes hit June of 1972 and caused record floods on the Dan River at South Boston (Watson, 2005).

Figure 24: Smith River in Eden

The Philpott Dam is managed by the US Army Corps of Engineers (ACE) for power generation, with water levels managed for volume and flood control rather than ecological needs. This accounts for variable levels of water in the Smith River. The US ACE uses most of the water from the Smith River at Philpott Dam to generate electricity but during floods water is released over the spill way or through sluice gates near the bottom of the dam to prevent breaching of the dam and catastrophic flooding in Martinsville, VA. To ensure that the river meets the flow requirements deemed necessary for the ecological function, the US ACE also releases water through pipes in the spillway when the powerhouse is not in use. When the dam is releasing water from the sluice gates the flow of the water is fast and cold due to the water being released from the bottom of the lake. The tailwater (water below dam) community structure is impacted by the constant cold release temperature of the water and by the changes in the substrate composition that has led to a bedrock dominated substrate with little gravel sized particles (Orth, et al., 2004). Due to the preference trout have for cold water they are the dominant fish seen in the tailwater section with fish species richness increasing with increased distance from the dam (Orth, et al., 2004).

The Dan River Basin has a mild year-round climate with four seasonal changes. Average rainfall is approximately 45 inches annually (Southeast Regional Climate Center, 2012). 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" (NC State Climate, 2012). The weather in February and March 2012 when field studies were conducted were extraordinarily hot and dry, and not representative of historical averages (National Oceanic and Atmospheric Administration [NOAA], 2012).

Figure 25: Wetland (Subwatershed 4)

FLOODPLAINS AND WETLANDS

Wetlands are one of a hydroscape's most valuable assets. Providing natural flood control, pollutant filtration, and ecological habitat, the value of natural wetlands to a community cannot be overestimated. 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 wildlife that rely upon wetlands as habitat. The National Wetlands Inventory (NWI) for the Eden Area watershed includes freshwater ponds (over 285 in the NWI for VA alone), rivers, and wetlands. According to the National Wetlands Inventory 1.3% of the Eden Area watershed holds wetland classification (Figure 26).

As stated on the NWI website,

> "Today, NWI data are being updated by the Service at a rate of 1-2% per year with the help of outside partners. The program has averaged this slower rate since receiving a 50% budget cut in 1996 done in a response to the Administration's effort to reduce the federal deficit. This action severely reduced the funding available for mapping work (funding available for actual mapping declined from about $5M to $1.5M) and significantly compromised the NWI's ability to produce contemporary wetland data" (National Wetland Inventory [NWI] , 2012).

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 (i.e. lakes) better. Field data suggests that of the 626 wetlands identified by the NWI in the Eden Area watershed, a majority of those are farm ponds.

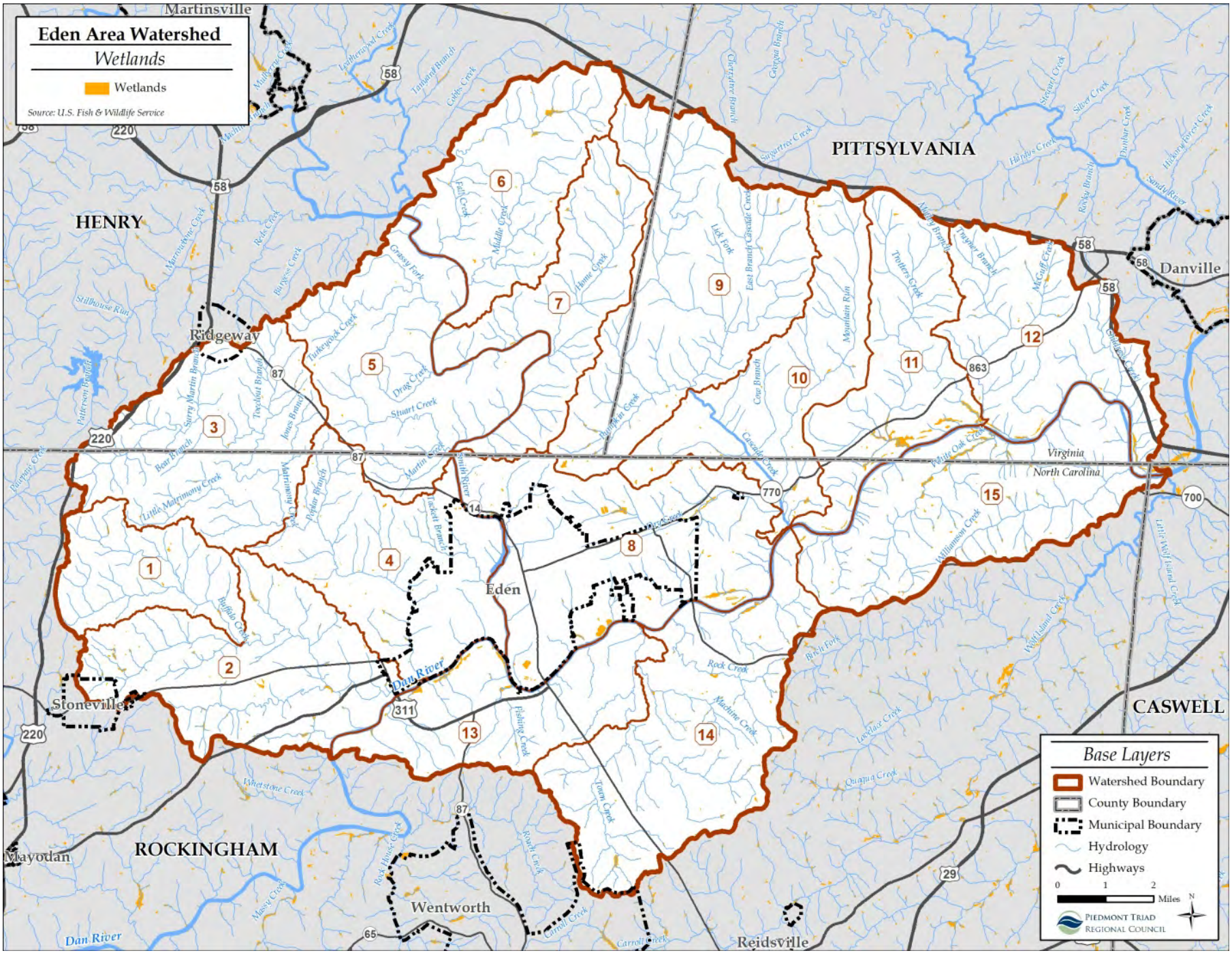

Figure 26: Wetlands

The scale (1:24K) that the NWI uses to identify wetlands is such that the smallest wetlands are often not mapped. The small wetland communities are seasonally flooded and are disconnected from streams and have a significant role in providing essential wildlife habitat, regulating floods, and encouraging groundwater recharge (Figure 25). Many of these small wetlands were identified by field staffs working in the watershed and evidence of the ecological importance was seen by the prevalence of salamander and frog egg masses found in the waters. Of these 27 wetlands found by field staff, only 4 appear in the NWI dataset, meaning only 4 would be subject to development review processes that protect wetlands. There is an obvious need to refine and improve the national dataset, but absent that, efforts should be made at the County level to update their wetlands inventory for watershed management and development permitting purposes. 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 the Dan River TMDL.

Floodplain data was obtained from the NC Floodplain Mapping Program and represents 100-year floodplains in the Eden Area watershed according to historic data (Figure 27). 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. Recent precipitation events show that this delineation is often an underestimate of flood potential, with waters cresting the 100-year floodplain more often than 100 years, and a much safer and more conservative development boundary is the 500-year floodplain. The Federal Emergency Management Administration (FEMA) restricts the flood insurance coverage permitted to those who build within this 100-year floodplain. According to the City of Eden's planning director the City regularly experiences flooding at levels that resulted in FEMA providing assistance to landowners, especially in the Matrimony Creek subwatershed. FEMA has a registered emergency documented for 1978 ((FEMA), 2013).

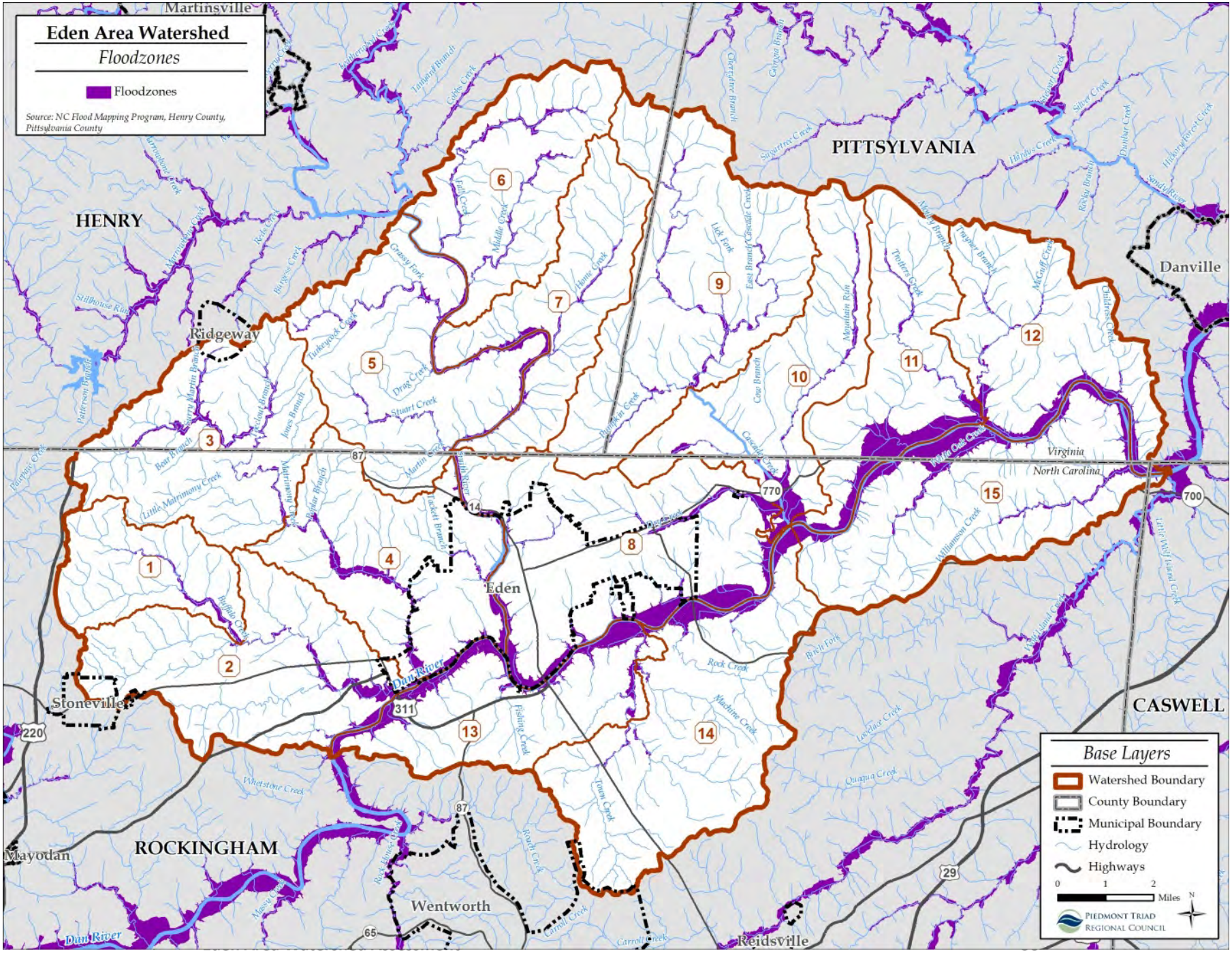

Figure 27: Floodzones

ECOLOGICAL HABITAT

The diversity of soil types, topography and hydrology has created a landscape around Eden, NC, that has a high number of unique and rare ecosystems. According to the NC Natural Heritage Program (NHP) there are 44 ecological element occurrences of special concern in the Eden Area watershed (Figure 32). These include terrestrial, aquatic species and natural communities such as the Roanoke Logperch (Figure 30), Virginia Blue Bells and Bear Slide Bluff natural community (Table 2). VA has 11 Natural Heritage element occurrences that cover over 1769 acres in Henry and Pittsylvania County. NC has 33 sites covering approximately 1,169 acres. Therefore there are a total of just over 2,938 acres of land in the Eden area watershed with significant value for 44 unique element occurrences that include plants, animals or natural communities.

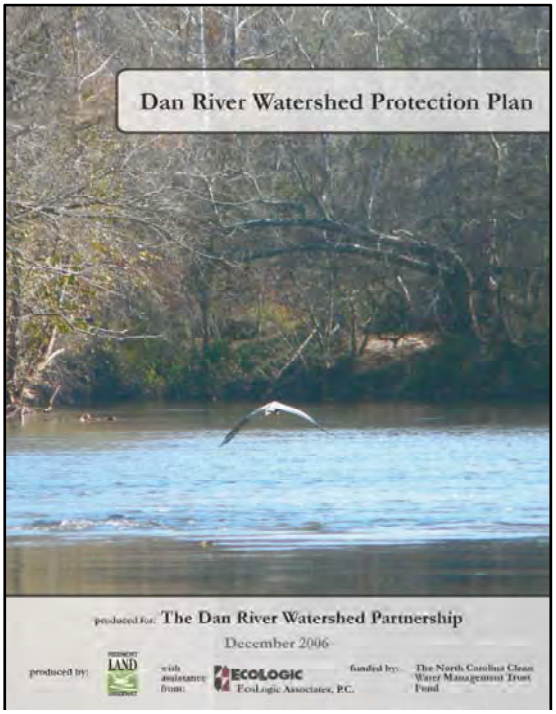

Figure 28: PLC Dan River Basin Watershed Protection Plan

The Piedmont Land Conservancy (PLC) authored the Dan River Watershed Protection Plan in 2006 to assist partners in planning for the protection and conservation of the natural resources along the Dan River in stokes, Rockingham and Caswell Counties (Piedmont Land Conservancy [PLC], 2006) (Figure 28). In that plan, PLC identifies High Priority parcels for conservation and restoration within a quarter-mile river corridor that, if protected, would significantly improve the natural resources along the Smith River and Dan River (Figure 29). These recommendations are based on PLC staff GIS and field analysis. PLC identified 28 high priority parcels along the Smith River, and 84 parcels along the Dan River within the Eden area watershed. Their high prioritization for conservation was because of their undisturbed forested buffers and their support of natural resources. Conserving these high priority parcels would protect the current communities and species of concern and have significant benefit for water quality protection.

Rockingham County's section of the Dan River is a unique NC-significant natural heritage aquatic habitat to one federally-endangered fish (the Roanoke Logperch), one state-endangered freshwater mussel (the Green Floater), and three fish species of concern (Roanoke Bass, the Roanoke Hog Sucker, and Riverweed Darter) (Table 2). Most of these species of concern are intolerant of or negatively affected by silted substrates and prefer

habitat with sandy to gravely stream bottoms (NatureServe, 2012). Remediation of the rivers to ecological function and supporting status may ensure the success of these species. Furthermore, it may create habitat for federal- and state-endangered species and increase the potential for restoration and de-listing from the endangered species list

Table 2: Species of Special Concern:

COMMON NAME	SPECIES NAME	COMMON TYPE	FEDERAL STATUS	STATE STATUS
Roanoke logperch	*Percina rex*	Fish	Endangered	Endangered
Green floater	*Lasmigona subviridis*	Mussel	Species of Concern	Endangered
Roanoke bass	*Ambloplites cavifrons*	Fish	Species of Concern	Significantly Rare
Bigeye jumprock	*Moxostoma ariommum*	Mussel	None	Threatened
Riverweed darter	*Etheostoma podostemone*	Fish	None	Special Concern
Roanoke hogsucker	*Hypentelium roanokense*	Fish	None	Significantly Rare
Quillback	*Carpoides cyprinus*	Plant	None	Significantly Rare

The terrestrial areas along the Dan River in Rockingham County are host to 11 significant Natural Heritage Areas. The state significant Natural Heritage Areas in the Eden Area watershed include the Fitzgerald Woodland, which is habitat to the Carolina Birdfoot-Trefoil, a US species of concern; the Smith River Bluffs and Slopes, where Cliff Stonecrop, a NC species of concern is found; Roundhouse Road and Leaksville Loam Forest where American barberry is found along with a basic oak-hickory forest and an upland swamp forest and the Rocky Branch and Widemouth Creek Conglomerate Exposures, where rare geology – including petrified wood – is found. The Smith River has a regionally significant Natural Heritage Area at Bear Slide Bluff which consists of a basic mesic forest adjacent to the river (PLC, 2006). For a more detailed description of the significant natural communities please see the Rockingham County Natural Heritage Inventory (Coomans & Bates, 1999).

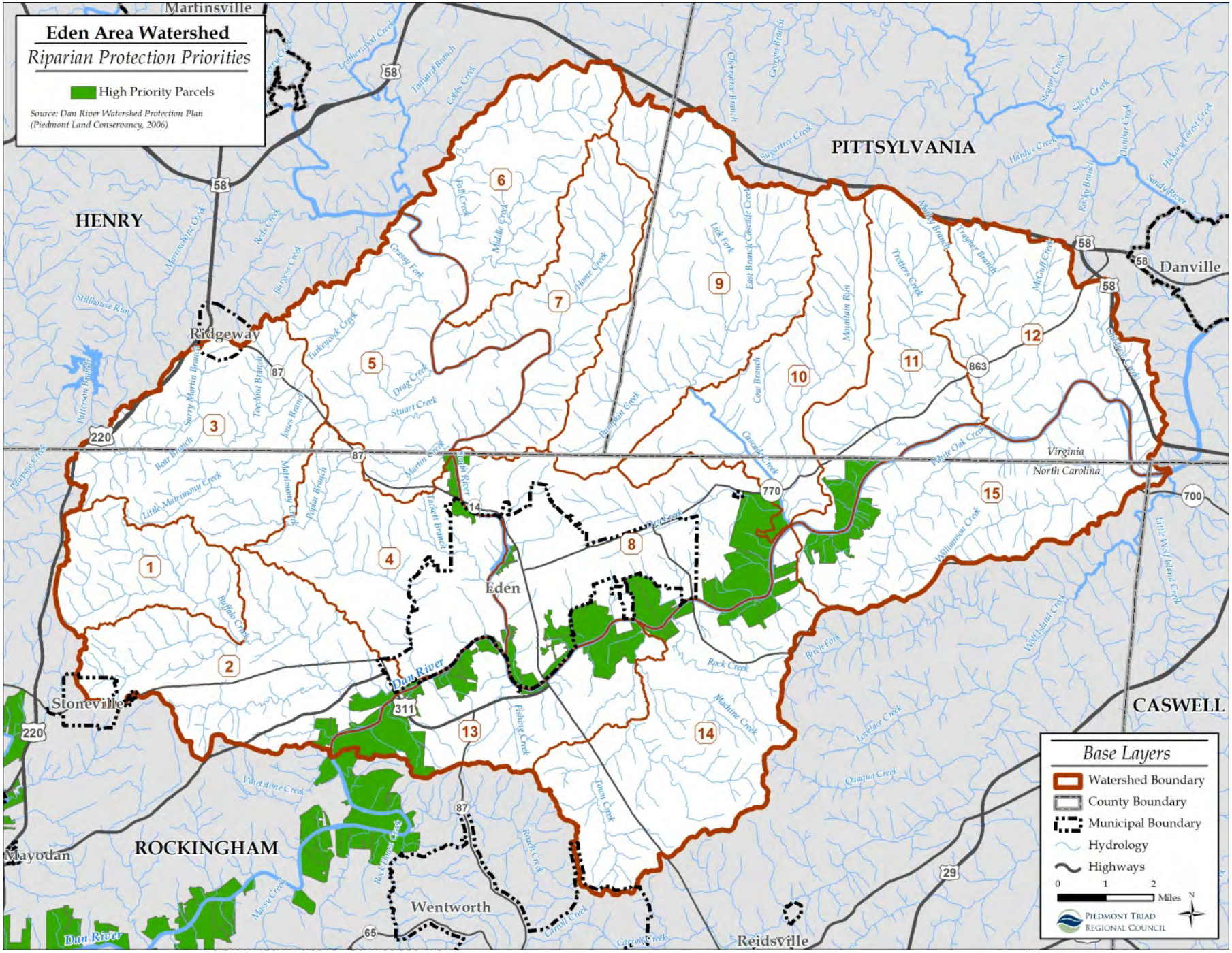

Figure 29: Riparian Protection Priorities Identified by PLC

The Eden Area watershed also hosts a Piedmont Hardpan Woodland and Forest, which is characterized by a unique mixture of upland species that have limited rooting ability due to the dense or shrink-swell clay which can stunt the growth of the species. Upland wetlands may also coexist due to the presence of standing water from the hardpan soils (Schafale, 2012). The occurrence of this "new" hardpan forest type as well as previously unidentified Virginia bluebell habitats by field teams in this watershed is evidence that the 1999 county inventory of Rockingham County may not have inventoried all of the unique areas of Rockingham County and may need to be updated with the new information that is being obtained.

Figure 30: Roanoke Logperch (Photo: US FWS)

Through GIS and field assessments the Eden area watershed was found to have several priority wildlife habitats that are identified in the NC Wildlife Action Plan (NC Wildlife Resource Commission [NC WRC], 2005). These include large parcels with contiguous forest habitats, small wetland communities (particularly upland depression swamps), floodplain forest, early successional habitat, rock outcrops and key aquatic habitats (NC WRC, 2005). Protecting these significant wildlife habitats would also improve water quality conditions. Forested communities along waters act as buffers to reduce pollutant loads and reduce the erosion of stream banks. These forested buffers that are contiguous with floodplain forests are especially important to protect when the surrounding topography includes steep slopes and the soils are highly erodible.

Figure 31: Virginia Bluebells (Photo: Joe Mickey)

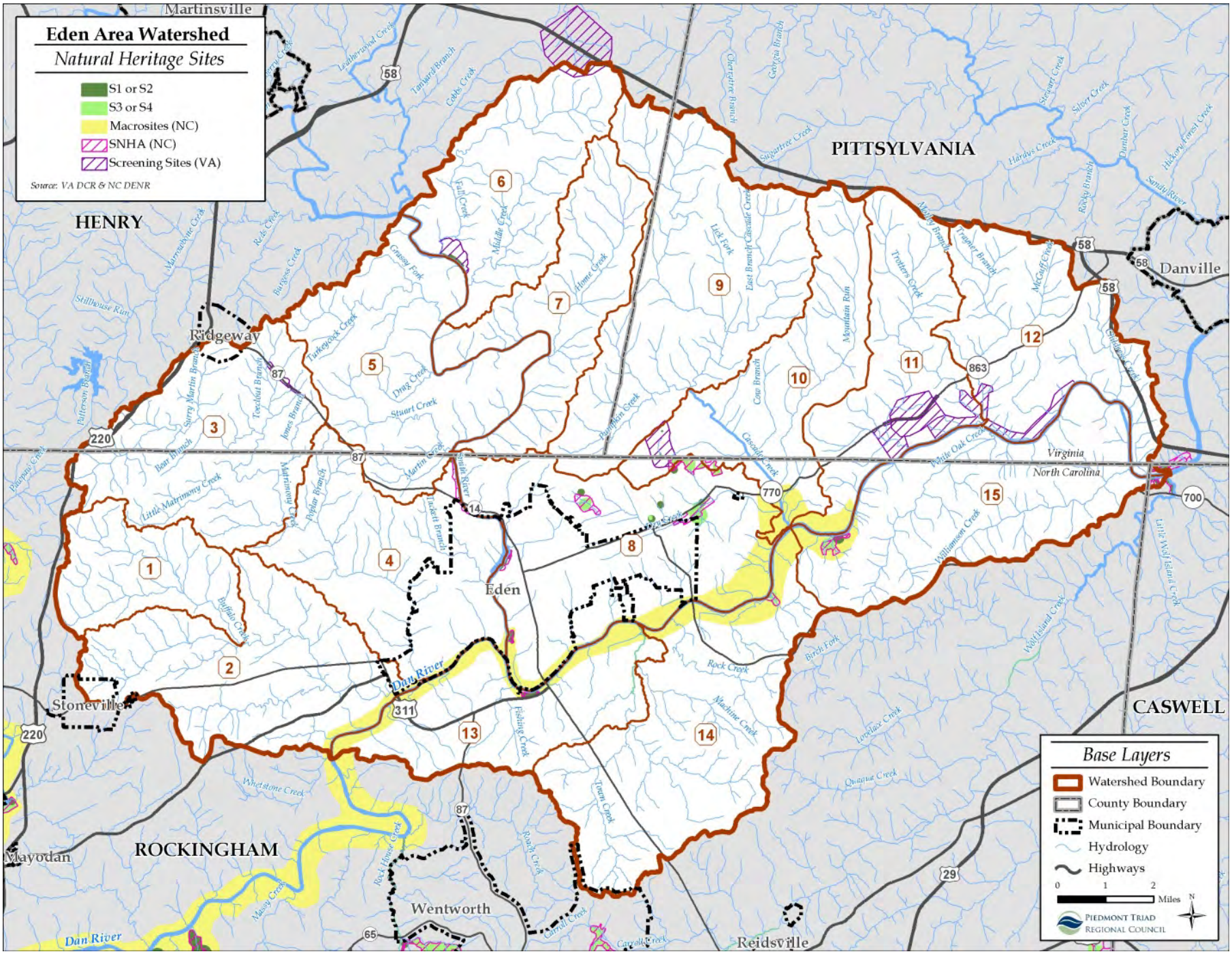

Figure 32: Natural Heritage Sites

WATERSHED DELINEATION

The GIS methodology used to delineate the Eden Area watershed relied on several steps first, the most accurate topography and stream data was obtained; then, a stream flow model was created; and, finally, stream catchments within the Eden Area watershed were delineated.

This watershed analysis was conducted using ESRI's ArcGIS 10.0 software, the Spatial Analyst extension, and the ArcHydro™ extension. The first step in delineating watersheds was obtaining the National Elevation Dataset (NED) 1/3 Arc Second rasters from the U.S. Geological Survey (USGS). The NED is a seamless raster elevation dataset for the United States. This raster product has a resolution of approximately 10 meters and a vertical accuracy of +/-7 meters. The "Mosaic" function in Spatial Analyst was used to combine the various 1/3 Arc Second rasters into a single "seamless" elevation raster for the Eden Area watershed.

Watershed delineation was further refined by using the ArcHydro™ application of the ArcGIS Spatial Analyst extension. ArcHydro was developed jointly by the Center for Research in Water Resources at the University of Texas at Austin headed by Dr. David Maidment, and ESRI. The watershed delineation methodology is described below, but more information on this tool can be found at the GIS Water Resources Consortium's web site (http://www.crwr.utexas.edu/).

The first step in the watershed delineation used the "Fill Sinks" tool to eliminate problems in the mosaicked elevation raster where water would be trapped in a cell surrounded by higher elevation cells. Then the "DEM Reconditioning" tool imposed linear stream features onto the elevation raster. The "Agree" methodology (Maidment, 2002) ensured that the stream data correctly corresponded with the elevation topography. The reconditioning step ensured that the next step, using the "Flow Direction" tool, was accurate. "Flow Direction" simply uses elevation data to estimate water flow over a landscape. It does not account for land coverage land use, or any impediments in the landscape not represented in the elevation raster. It does not address impervious surface effects upon surface hydrology other than their impacts on elevation, as of 2004. Nor does it incorporate curve numbers to model land cover and their relationship with surface water runoff. This flow direction data was then used in the "Flow Accumulation" tool, which computes the accumulated number of cells upstream for each raster cell. The flow accumulation grid was then input into the "Stream Definition" tool to create a stream grid, which was then input into the "Stream Segmentation" tool along with the flow direction data to create a grid of stream segments that have a unique identification. The flow direction data and the stream segmentation data were then input into the "Catchment Grid Delineation" tool to create a grid in which each cell has grid code indicating which catchment the cell belongs. This catchment grid was then input into the "Catchment

Polygon Processing" tool to create a polygon feature class of watershed catchments. This processing model created 59 catchments in the Eden Area watershed, which were then combined to create 15 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 (Figure 10).

SECTION 3: NC DIVISION OF WATER QUALITY (DWQ) SUMMARY OF EXISTING MONITORING DATA

The Dan River Basin is a rural watershed that has a corresponding history of agriculture, forestry, and recreation. It is known to many residents as the "Muddy Dan" due to its intensive land use, and, to many, has never been anything but a turbid and plentiful water resource (Trimble, 1974). By many reports, its forested landscape is the result of reforestation throughout the twentieth century when many rural residents moved to the Cities of Eden (formerly the mill towns Draper, Leaksville, and Spray) and Danville to be employed in the furniture, textile, and tobacco industries. Prior to this time, much of the Dan River was cleared of trees, supporting the intensive practices of the tobacco farms in the region, which were largely supported by share-cropping and slave labor that utilized every available piece of land – including floodplains – for cash crops or subsistence farming (Byrd, *et al.*, 2012).

With industrialization came urbanization, but the Dan River Basin was still a relatively sparsely-populated region of both NC and VA. The largest city was and is Danville, which had large tobacco warehouses and processing plants owned by R.J. Reynolds. Smaller cities included the North Carolina communities of Draper, Leaksville, Spray (the three of which now make up the City of Eden), Roxboro, and Yanceyville; and the Virginia communities of Halifax, Martinsville, and South Boston. These communities had different industrial economies, but all relied heavily upon and often heavily impacted their local water resources, especially the Dan and Smith Rivers. With economic globalization, many of the jobs and some of the people left these urban centers, and economic and population growth in the region continuing to stagnate (City of Eden 2007; Byrd, *et al.*, 2012). However, their legacies of these industries and their impervious surfaces remain upon regional waters.

The Dan River has been listed as impaired for aquatic life by the NC DWQ due to high turbidity levels since 2002 and fecal coliform bacteria since 2008. Similarly, the Smith River has been listed by the NC DWQ as impaired for high fecal coliform bacteria levels and failing biological habitat standards since 2008, and for violating the action level for copper since 2008 (NC DWQ 2012). The NC DWQ completed a Total Maximum Daily Load for turbidity on the entire Upper Dan River in 2007, concluding that the dominant sources of suspended solids are rural erosion sites. The turbidity TMDL stated that total suspended solids (TSS) levels from such rural sources need to be reduced by 59% to reach water quality conditions that will fully support aquatic life in the Dan River (NC DWQ 2007). These reductions need to be made in rural areas that do not fall under the regulatory authority of either the NC DWQ or the US EPA. Unlike Virginia, North Carolina does not require an implementation plan to comply with the TMDL. However, the NC Division of Soil and Water Conservation has received nearly $1 million in US EPA 319 funding over the last five years to address these rural sources of TSS with agricultural

BMPs throughout the Upper Dan River counties (Caswell, Forsyth, Guilford, Rockingham, Stokes, & Surry) in North Carolina, placing 37 agricultural BMPs on the ground (Byrd, *et al.*, 2012).

The VA DEQ has rated 81.5 miles of the Smith River and its tributaries impaired for supporting aquatic life due to high levels of *E. coli* bacteria, a metric that reflects the levels of fecal material in the water (VA DCR 2007). The NC DWQ uses a different metric (fecal coliform bacteria), and has a more stringent (though not necessarily more representative) water quality standard before it will declare a water body impaired for fecal material. Therefore, there are many fewer streams in North Carolina impaired for fecal coliform bacteria than those impaired for *E. coli* in Virginia.

E. coli impairments are present in 35 stream miles within and immediately upstream of the Eden Area watershed in Virginia. The VA DEQ issued a TMDL for *E. coli* in 2007, recognizing that the majority of fecal material draining to the river and its tributaries has rural sources, including wildlife that are more difficult to manage than human sources such as stormwater. There are no wasteload allocations to the one federally-regulated stormwater community (Danville) in the watershed – Danville is not a significant source of fecal coliform bacteria (VA DCR 2007). VA DEQ and VA DCR have recently initiated the implementation planning process for this TMDL, which is expected to be published in April 2013 (VA DCR, 2012). The NC DWQ followed up on this assessment in 2009 with a complimentary TMDL that determines waste load allocations for all potential sources of fecal coliform bacteria in North Carolina's share of the Dan River Basin (NC Division of Water Quality [NC DWQ], 2009). These ratings are not directly addressed in the VA TMDL implementation plan.

The NC DWQ assesses conditions for each of its seventeen river basins on a rotating basis. Historically, basinwide assessments have been published every five years for each of these basins, reflecting water quality trends, state and federal initiatives, and local actions and programs that are in response to these conditions. The NC DWQ Basinwide Planning Unit has endeavored to streamline these assessments in an effort to make them more accessible and useful to the public. The last *Roanoke River Basinwide Assessment* was published in 2012.

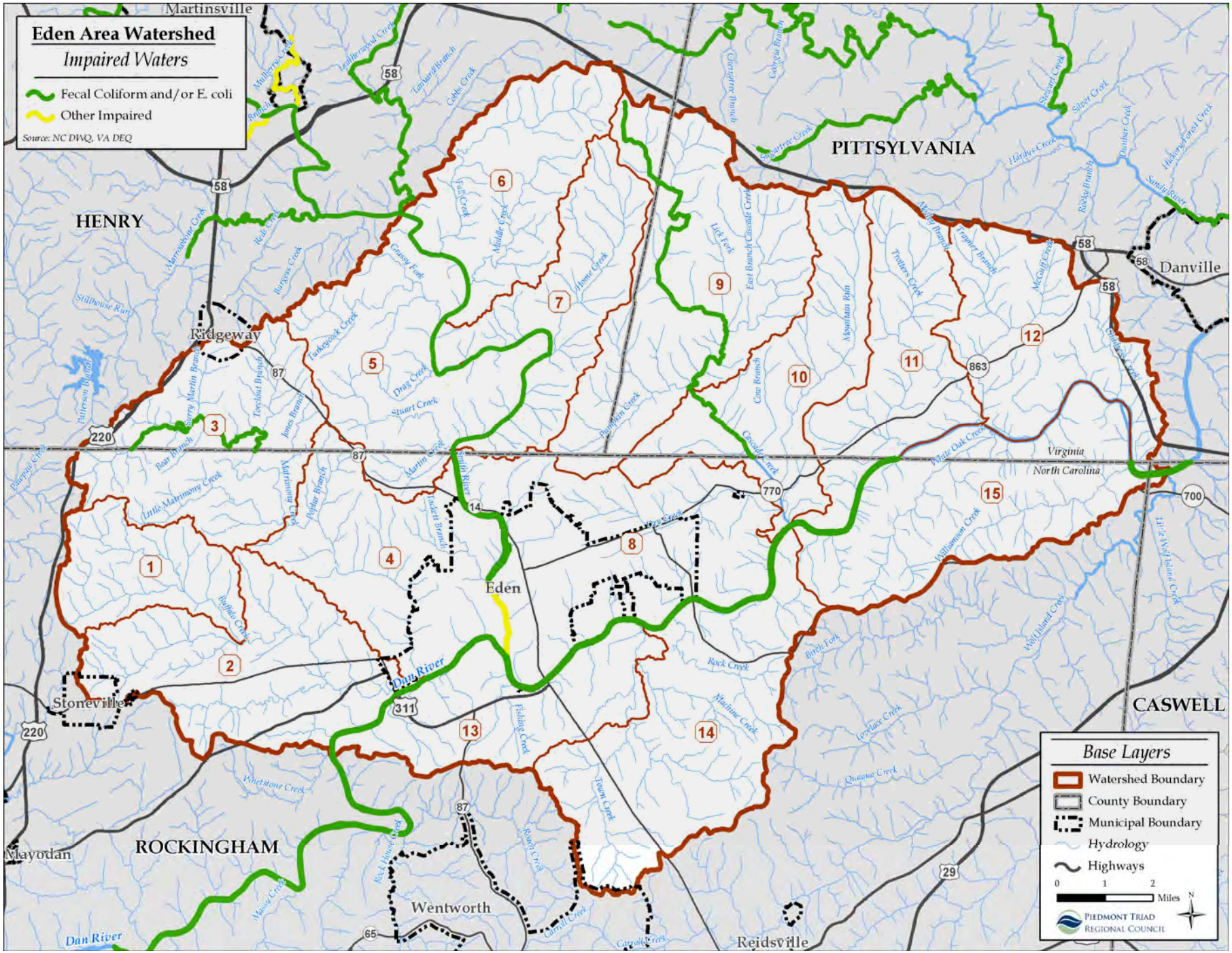

Figure 33: Eden Area Watershed Fecal Coliform Bacteria Impairments

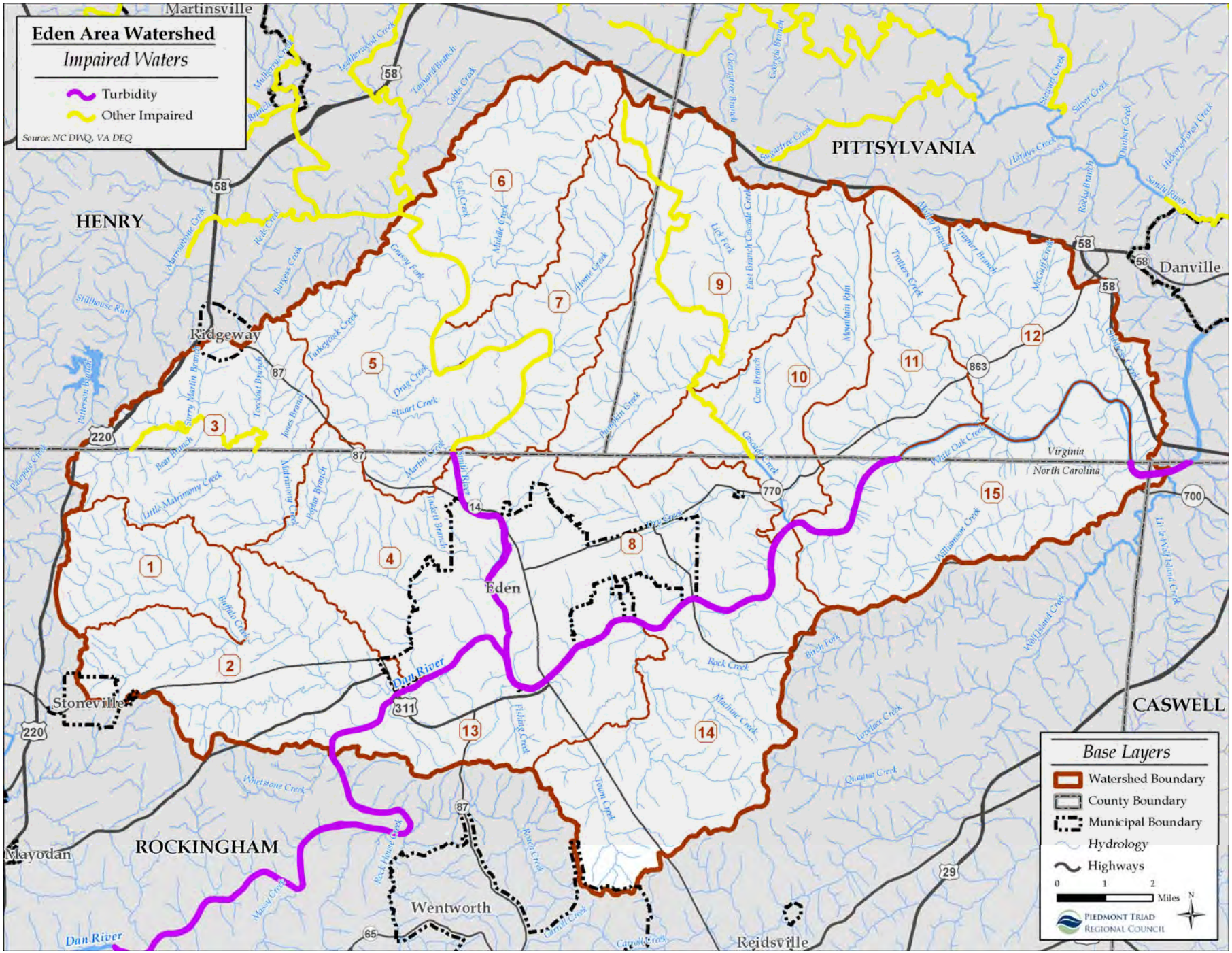

Figure 34: Eden Area Watershed Turbidity Impairments

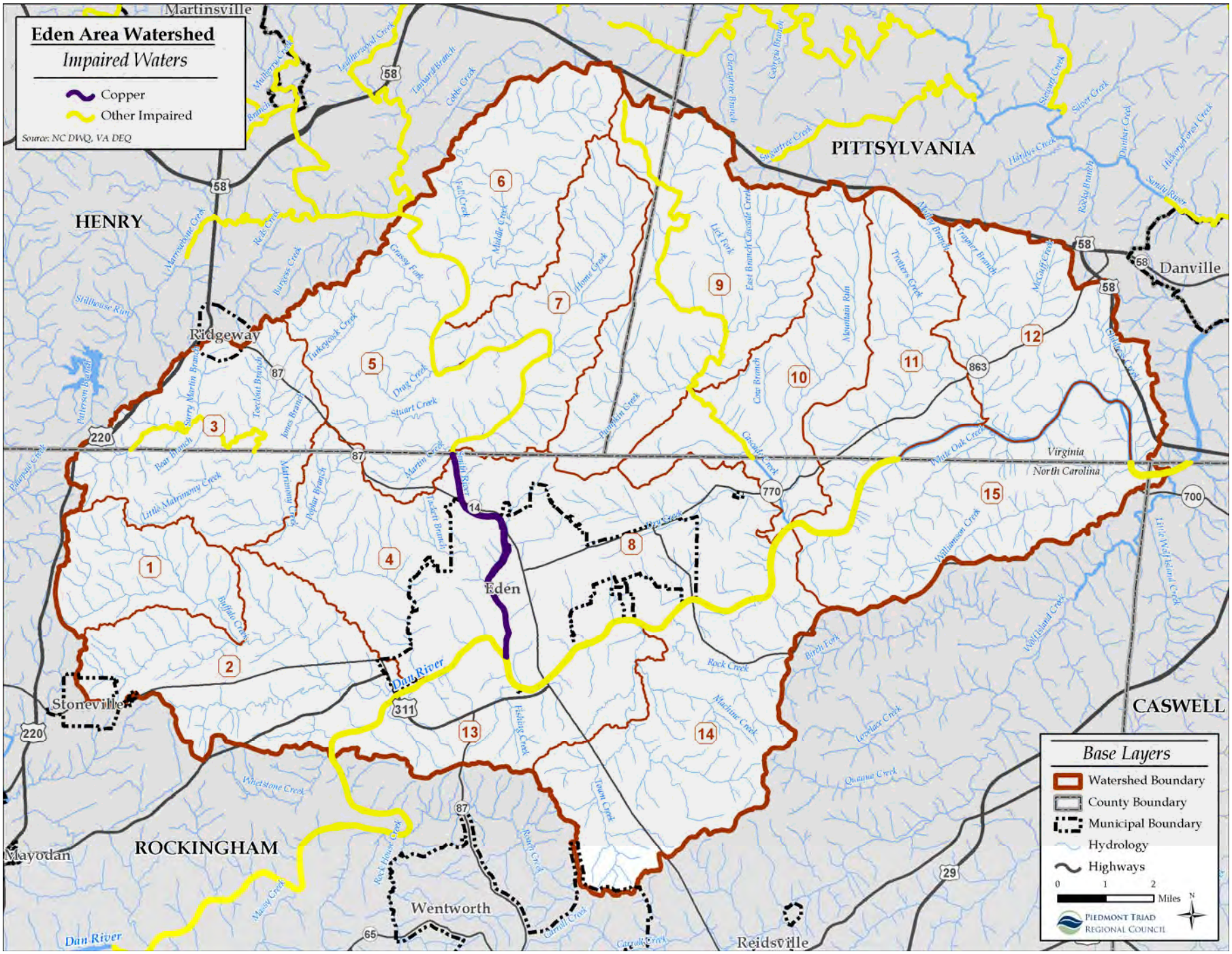

Figure 35: Eden Area Watershed Copper Impairments

The NC DWQ 2012 *Roanoke River Basinwide Assessment* summarized the TMDL's conclusions and recommendations for the Dan River Basin, identifying rural sources of stress as the main source of turbidity impairment, and both rural sources and failing wastewater infrastructures as the main sources of fecal coliform bacteria impairment. It states that "…*human land use practices may accelerate the process to unhealthy levels* [of TSS] *for aquatic life. Construction sites, mining operations, agricultural operations, logging operations and excessive stormwater flow off impervious surfaces are all potential sources* [of TSS]," later attributing sources to human land use and behaviors in both Virginia and North Carolina that cannot be regulated due to land use law and the regulatory restrictions of the US Clean Water Act (NC DWQ, 2012).

Copper is not addressed at all by either state, and is not addressed in this NC DWQ assessment, due to a lack of data resulting from a state moratorium on metals monitoring in state waters. The moratorium results from an ongoing discussion of how to account for naturally high levels of metals such as copper in regulations, especially the determination of natural background levels of metals versus human-caused metals pollution that requires a management strategy, such as contaminated groundwater from brownfields, brake dust from highways and state routes, and historic legacies of copper sulfate use to prevent algal growth (NC DWQ 2010). Without stronger guidance from the regulatory community, it is likely that the *Eden Area Watershed Restoration Plan* will make similar, inconclusive estimations of the sources of copper in the Smith River.

In North Carolina, the Smith River is impaired for aquatic life due to high levels of fecal coliform bacteria, turbidity, and copper (NC DWQ, 2013). However, only 5 miles of the Smith River lie in North Carolina before its confluence with the Dan River in Eden, NC. While the urbanized watershed of NC's Smith River are almost certainly adding to the pollutant loads of this river system , it is unlikely that the City is responsible for the entire pollutant load of this 49 square mile bi-state subwatershed. The VA DEQ rates the Smith River as impaired for aquatic life due to violations of its *E. coli* water quality standard and due to unhealthy benthic biological communities. The VA DEQ attributes the causes of these impairments to both rural and urban sources, including forestry practices, urban runoff, and damming of the river (VA DEQ, 2012).

The Dan River within the 225-square mile Eden Area watershed of study displays many of the traits described in Chapter 1 of the NC DWQ *Roanoke River Basin Assessment*: the turbidity problems are most intense and degrading in smaller headwaters streams, while fecal coliform bacteria levels appear to be consistently high throughout much of the watershed. These assessments must be considered in historical context, keeping in mind that the aquatic and benthic ecologies may have once been more diverse, sensitive, and significant, and that the

land use history of this region has been intense, creating sediment runoff to the level that the river was known as the "Muddy Dan" for most of the twentieth century.

According to the US EPA Ecoregion assessment "At Danville, the Dan River had an average turbidity of 1314 ppm between 1925 and 1930 (the period of earliest records), 268 ppm for 1930-1940, 134 ppm for 1940-1950, 129 ppm for 1950-1960, and 63ppm for 1960-1970. The NC water quality standard for turbidity is 50 nephelometric turbidity units (NTU). By 1974, filling of stream channels and valleys had stopped and the dissection and the removal of deposits to locations farther downstream had begun (Trimble, 1974)." Danville is about 20 miles from Eden and just 2 miles downstream of the most downstream point of this watershed, and has an historical background of clear cutting and agriculture (and therefore a water quality history) that is similar to that found around Eden. It is also important to understand that although the turbidity levels have significantly been reduced in the Dan River, the River is still "impaired" for high levels of turbidity unhealthy for wildlife. The unstable flow levels from stormwater and dam discharge are contributing to the levels of turbidity in the waters.

These bistate management and monitoring challenges are found throughout the Roanoke River Basin, and are an ongoing challenge for describing the sources of stress and pollution in this watershed, of which 110 square miles lie in NC and 115 square miles lie in VA. This challenge would be easier to address if there were more consistency between the states in monitoring, assessing, and reporting on water quality conditions. However, the states differ on how they measure fecal material (VA monitors *E. coli*; NC monitors fecal coliform bacteria) and turbidity (VA has no sediment standards).

BIOLOGICAL MONITORING

Biological conditions in the Smith and Dan Rivers are supportive of native ecological health and habitat. There are only one benthic macroinvertebrate and one fish community monitoring stations throughout the Eden Area watershed, but there are many throughout the larger Upper Dan River Subbasin. Many of the benthic macroinvertebrate monitoring stations are not yet rated due to monitoring just beginning recently. None of those that are assessed have less than a "Good" rating by the NC DWQ staff, with no declines in ecological community health. Similarly, the fish communities are all rated as ecologically-supportive, with three stations having "Good-Fair" ratings, and the other twelve stations better. 20% of these stations are declining in health, but all remain ecologically supportive (NC DWQ 2012). The data from the new water quality monitoring stations may show other conditions in the watershed, but available data show universal support of ecological communities. However, given the historically-elevated levels of sediment and fecal material in these waters, it could

be argued that the existing ecological communities are neither as sensitive nor as diverse as those that likely once resided throughout the Dan River Basin.

WATER CHEMISTRY MONITORING

Virginia has a much more robust ambient water quality monitoring program in the Roanoke River Basin than North Carolina (Figure 36). Virginia has more National Pollutant Discharge Elimination System (NPDES) wastewater permitees in the Dan River Basin than North Carolina, as well as one Phase II stormwater community (Danville) while North Carolina has none. In the 215-square mile Eden Area Watershed, VA DEQ has three water quality monitoring stations and the NC DWQ has two. The City of Eden has to monitor and report upstream and upstream of its wastewater treatment plant (WWTP) to satisfy its NPDES wastewater permit, and has shared its relevant water quality data for this project. To support this planning effort and better understand the urban contributions to water quality impairments, the City of Eden Department of Environmental Services has also monitored water quality conditions in the City at two locations on the Smith River: just downstream of the Spray Cotton Mill dam, and the other at the confluence with the Dan River.

The VA DEQ stations are located at the Smith River at Route 636 Bridge in a rural area of Henry County; the Smith River at the Morgan Ford Bridge; and the Dan River at the state border on Route 880. The NC DWQ stations are located in Rockingham County on the Smith River upstream of the Spray Cotton Mill dam and on the Dan River downstream of Eden at the state border (and downstream of the VA DEQ station). However, both states have other water quality monitoring data that provides some upstream and downstream context of water quality conditions throughout the Dan River Basin. The NC DWQ has established a headwaters monitoring station in Stokes County and another just upstream of this watershed near the Town of Wentworth, in Rockingham County. Immediately upstream of the Eden Area Watershed and downstream of the City of Martinsville, VA DEQ has established seven water quality monitoring stations that have data from the past fifteen years available that are integrated into this assessment to attempt to better describe upstream water quality conditions.

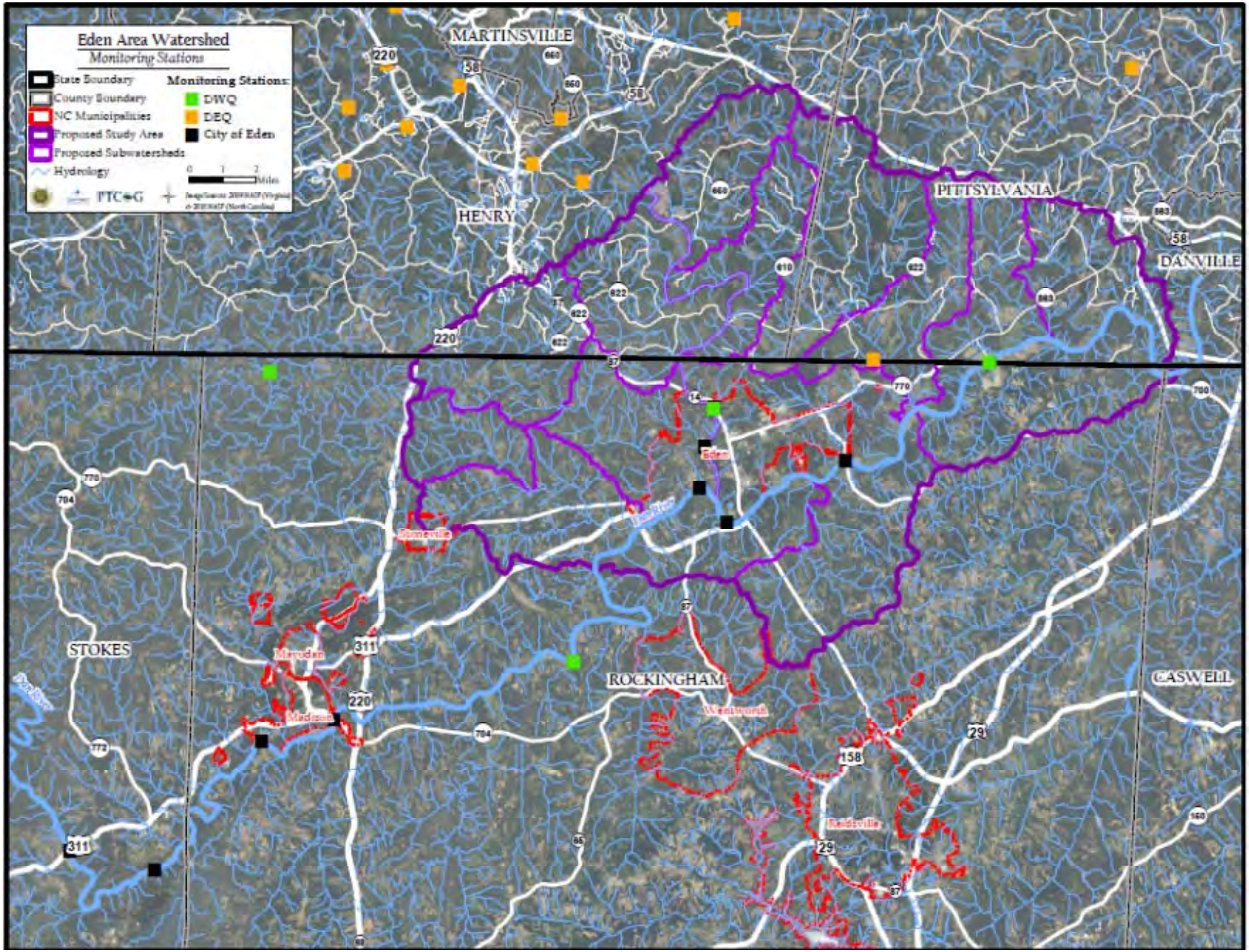

Figure 36: Eden Area Water Quality Monitoring Sites

NC DWQ was downloaded from the US EPA's STORET website, collecting all data available for the past fifteen years. There were difficulties with accessing comprehensive data for VA DEQ via STORET, but the DEQ staff provided it directly for this project. For the purposes of this study, data was collected by the City of Eden at four locations from January 2010 through April 2012, and relayed to the PTRC upon request. The City's laboratories and monitoring protocols are audited annually by the NC DWQ, so all data collection and analysis has been approved and can be assumed to have no quality control problems. The data from all sources was only available through December 2011, as all uploaded data requires a year of quality control analysis before it is permitted to be released to the public. The data is available from PTRC upon request.

WATER CHEMISTRY MONITORING SUMMARIES

Dissolved Oxygen & pH

The data from all three sources shows no outstanding water quality concerns with dissolved oxygen or pH levels in NC (Figures 37 & 38; NC DWQ, 2012).

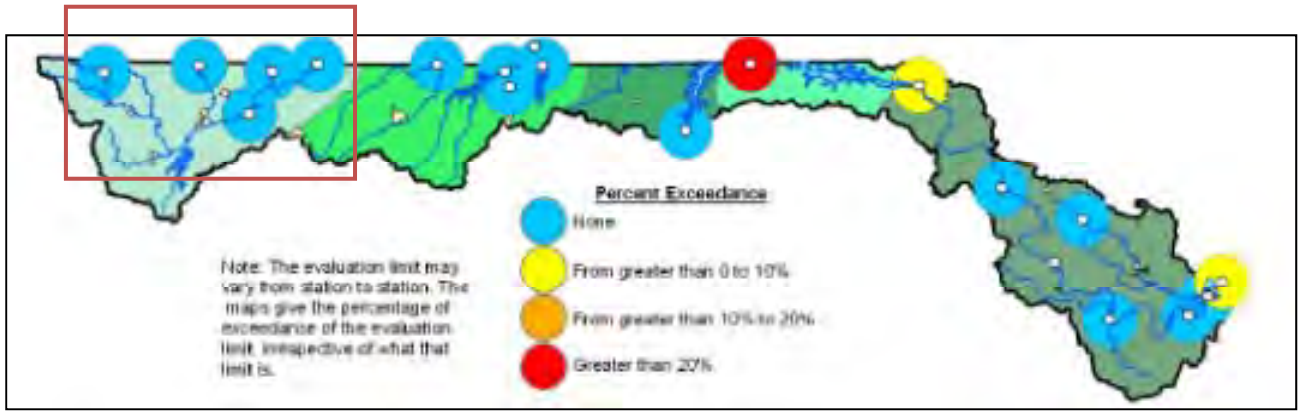

Figure 37: Dan River Basin Dissolved Oxygen Water Quality Data (in box) - from *Roanoke River Basinwide Assessment (2012)*

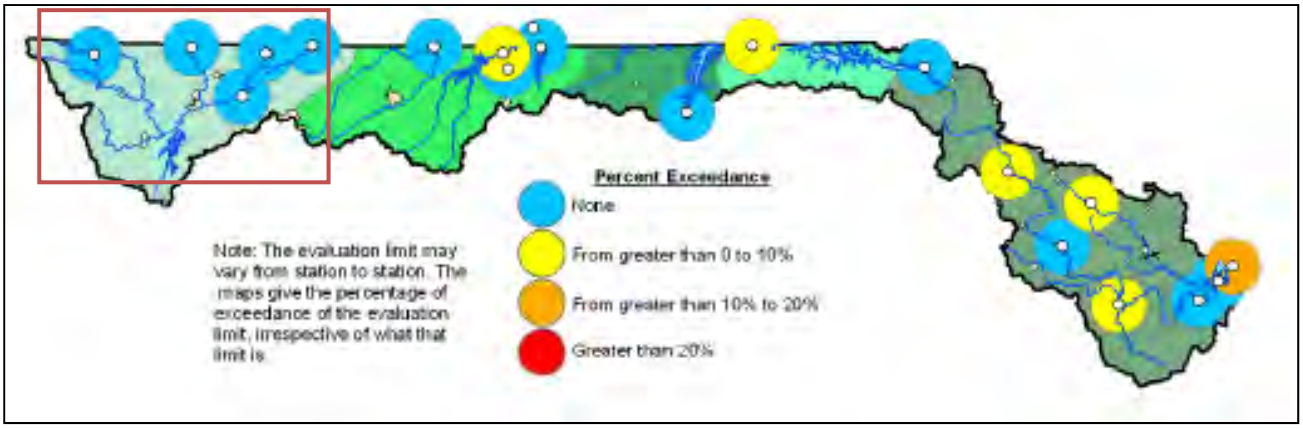

Figure 38: Dan River Basin pH Water Quality Data (in box) - from *Roanoke River Basinwide Assessment* (2012)

VA DEQ data shows low pH levels throughout the Smith and Dan Rivers in the early late 1990's and early 2000's. Unfortunately, more recent data is not available, nor is dissolved oxygen data, making impairment sources impossible to speculate. Furthermore, the relevance of these troubling trends in water chemistry to current conditions is unknown. The water quality data from NC DWQ shows none of these trends in recent history, indicating that this data may be obsolete. However, it merits further investigation.

Turbidity

As previously noted, the Upper Dan River – which includes all of this watershed – is impaired for aquatic life due to uniformly and persistently high levels of turbidity, though there are more frequent violations of the NC DWQ turbidity standard at the upstream monitoring station in Stokes County (Figure 39; NC DWQ, 2012).

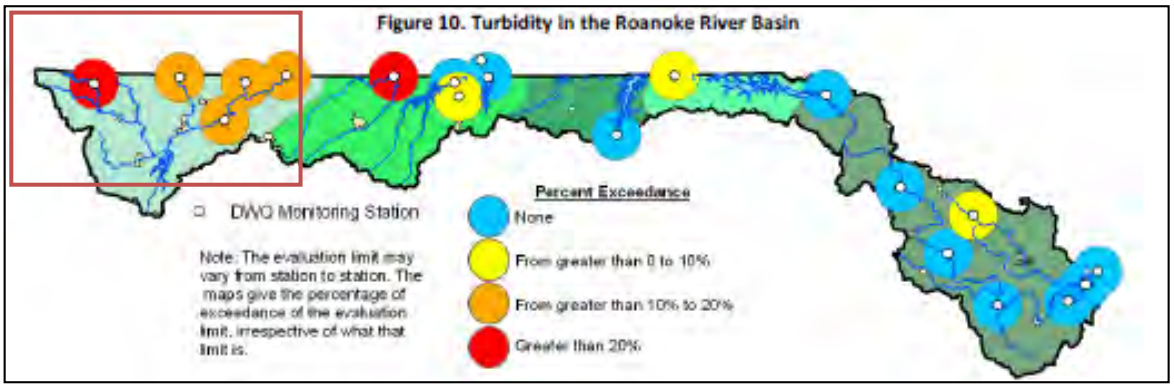

Figure 39: Dan River Basin Turbidity Water Quality Data (in box) - from *Roanoke River Basinwide Assessment* (2012)

The water quality data reviewed for this assessment (1995 – 2011) shows a different record, with only 3% of the data samples collected at this upstream monitoring station violating the turbidity water quality standard of 50 NTU. The downstream stations, in contrast, show a 16-year average of 15 – 20% of their measurements violating this standard. However, violations have become more common in Stokes County in the past ten years, the period the *Basinwide Assessment* reviewed.

The water quality records from the NC DWQ add more nuance to the turbidity issues upstream of the Eden Area Watershed. The NC DWQ maintains qualitative records of turbidity severity, rating them as "Extreme," "Serious," or "Moderate." 45% of the turbidity standard violations at these four water quality monitoring stations were recorded under conditions rated as worse than "Moderate" by NC DWQ staff (Figure 40).

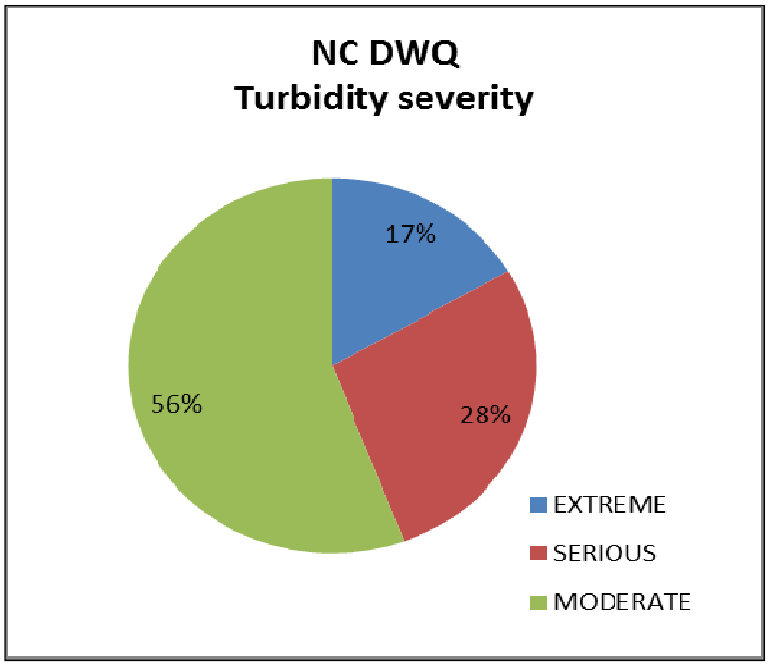

Figure 40: NC DWQ Turbidity Severity in the Upper Dan River Basin

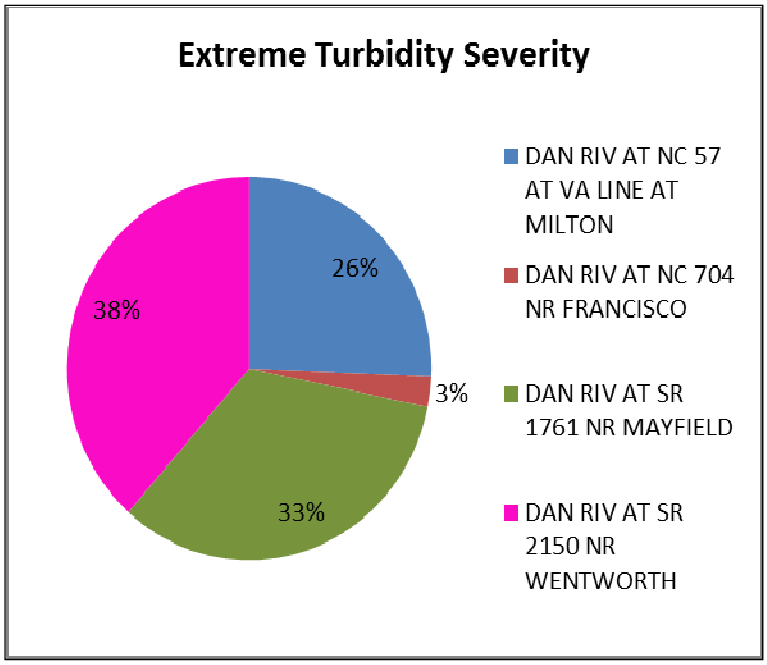

Figure 41: Extreme Turbidity Conditions in the Upper Dan River Basin, by Monitoring Station

Of the "Extreme" events, only 3% occurred at the Stokes County monitoring station, reflecting that its turbidity levels are both less intense and less common than downstream water quality conditions (Figure 41). This may be due to the greater levels of urban and suburban development in the Eden Area Watershed than at this upstream monitoring station, and need for greater stormwater measures among these communities and developments. There are few differences in local policies or programs between Rockingham and Stokes Counties that could explain the differences in water quality along the Dan River.

The sources of the sediment responsible for these turbidity violations appear to be common and consistent throughout the Eden Area watershed, and independent of upstream inputs, which are uncommon but intense. These conclusions are supported by TSS records at these same stations and coincident with the turbidity records, with TSS levels highest near the Town of Wentworth and the City of Eden, and often low upstream in the Dan River headwaters (Figure 42). It also supports a conclusion that sources of turbidity impairment are definitely present in both North Carolina and Virginia.

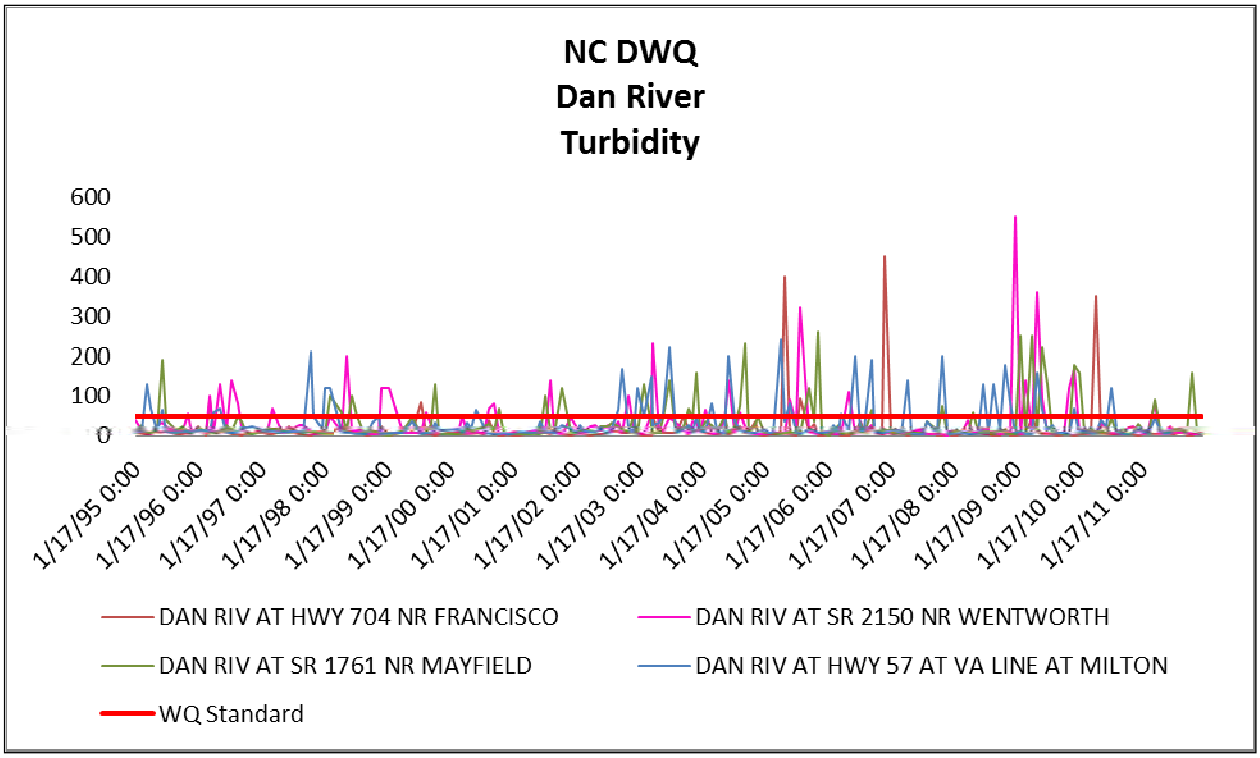

Figure 42: NC DWQ Turbidity Data for the Eden Area Watershed

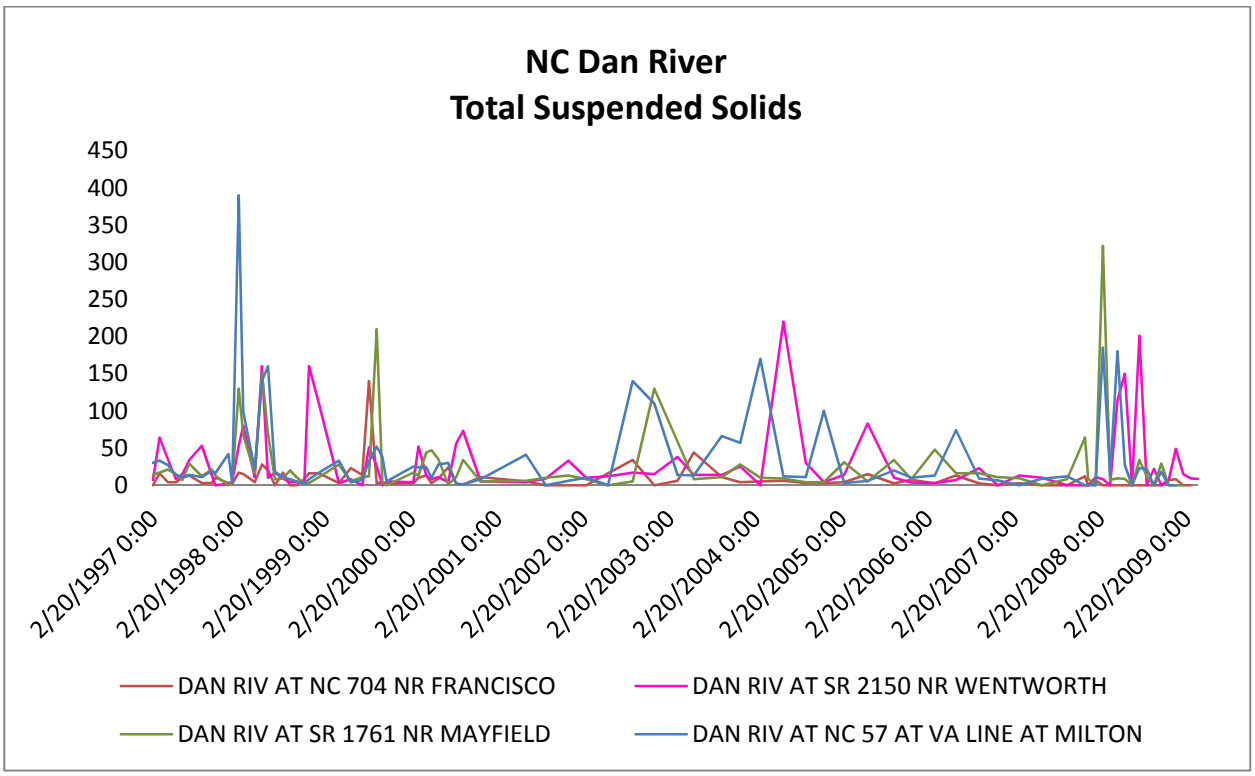

Figure 43: NC DWQ TSS Data for the Eden Area Watershed

The VA DEQ records for the Smith River and the City of Eden's one station on the Dan River show turbidity levels that do not indicate a water quality standards violation (Figure 44). However, these stations do show a consistent additive effect of sedimentation in both the Smith and Dan Rivers, as those with the most consistently-high levels of turbidity are those that are farthest downstream: the Dan River at the VA/NC border; the Smith River at the VA/NC border; and the monitoring station just upstream of Philpott Dam (used as a reference site). The Smith River and Dan River sediment levels do not appear to be correlated, suggesting different sources of pollution, perhaps due to different land use and/or policy environments. Without more recently-collected and reliable soils survey data, it is difficult to determine how significant the role of the natural environment is in determining sediment loading to these waters

These same trends (mostly good conditions, additive impacts) are seen in the City of Eden's water quality records for the Smith River (Figure 45). Again, the Smith River shows an additive effect, showing persistently and uniformly high turbidity levels among their water quality monitoring stations, reflecting the river's identity as the "Muddy Dan." This may be a product of the wide dispersal of these water quality monitoring stations, and suggests a need for more intensive ambient water quality monitoring and better data to be collected by the states that would pinpoint sites that are more persistent pollution sites.

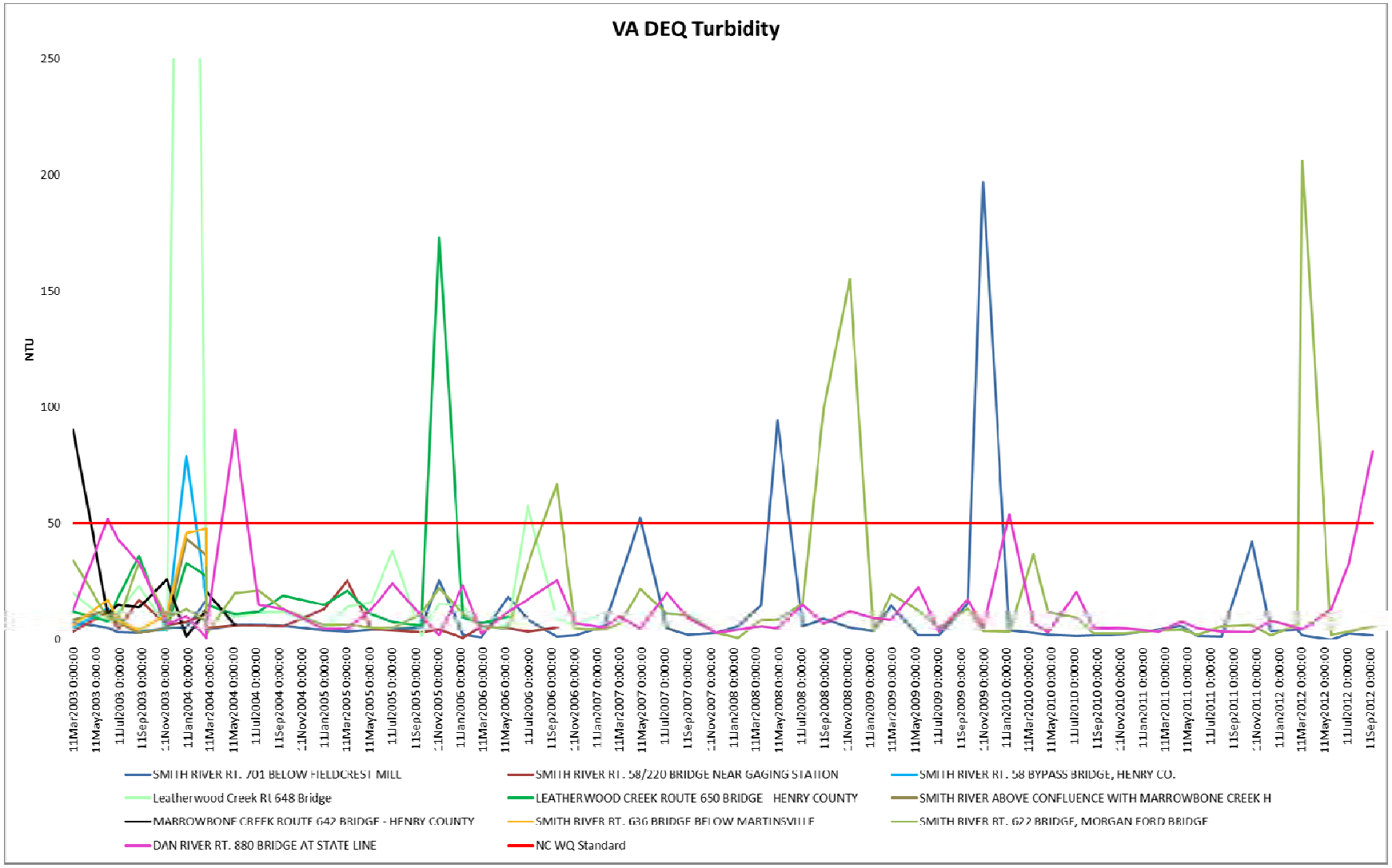

Figure 44: VA DEQ Turbidity for the Eden Area Watershed

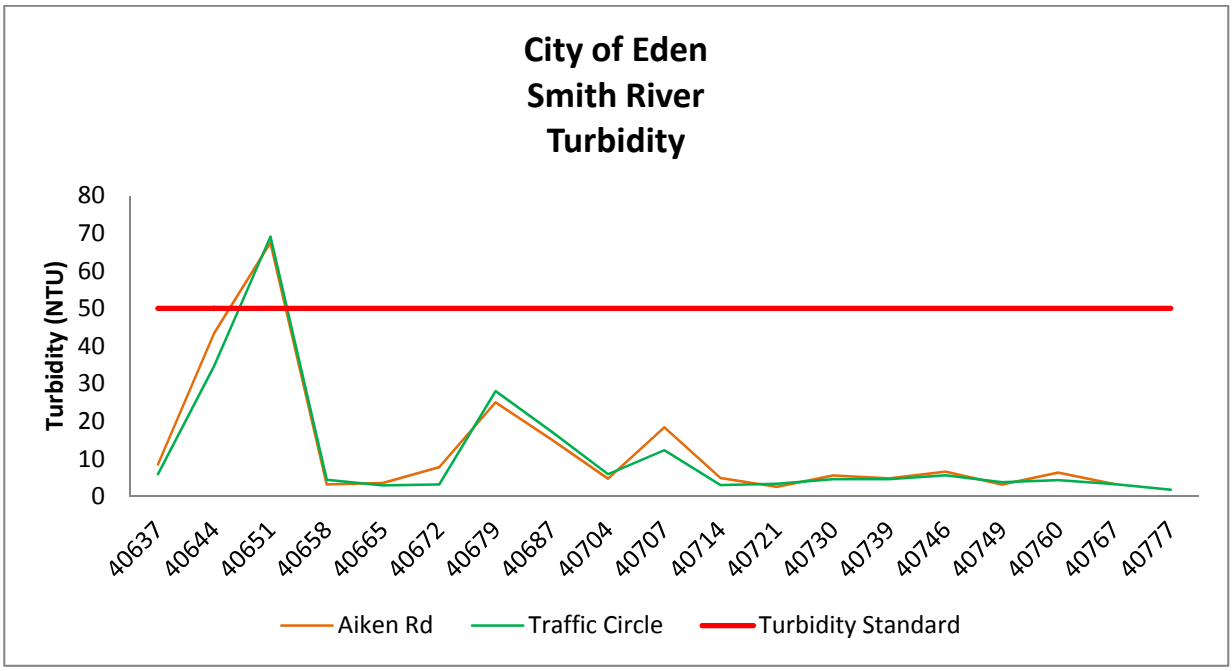

Figure 45: City of Eden Turbidity Data for the Eden Area Watershed

Fecal Material

Of the 715 VA DEQ fecal coliform records collected since 1995 and assessed for this study 27% of them are in excess of the aquatic life water quality standard used by the NC DWQ (200 coliform forming units (cfu)/100 mL). 22% of these NC DWQ samples from the last ten years violated this level (Figure 49).

These data show persistent and uniformly-high levels of fecal matter in the Virginia waters that drain to the Smith River. The monitoring sites upstream of the Philpott Dam, a rural tributary of the Smith River downstream of the Town of Martinsville, and the site on the Dan River downstream of the City of Eden have the highest and most consistent levels of fecal coliform bacteria, suggesting that rural sources of fecal material are actually being directly treated by the City's water treatment plant before being redistributed to the watershed as treated wastewater. However, all monitoring locations have high levels of bacteria suggesting widespread rural loadings of fecal matter to the watershed. All locations display consistent violations of the aquatic life water quality standards established by the VA DEQ (and those held by the NC DWQ) that remain unaddressed throughout the data record, with consistent peaks to 8,000 colony forming units (cfu)/100 mL, the limit of technology, prior to 2002 (Figure 47). These conclusions are further supposed by the VA DEQ *E. coli* data, which appear to violate the VA DEQ water quality standard of 235 MTEC MF/100 mL annually, often in the Fall, throughout the watershed. Much like the fecal coliform bacteria data, the violations are

less common since the early 2000's, but this may be due to less intensive monitoring (Figure 48).

The NC DWQ data shows similar fecal coliform bacteria problems to those in Virginia – uniformly and persistently high levels of fecal coliform bacteria regardless of rural or urban location; roughly 25% of all samples exceed the VA DEQ water quality standard (Figures 49).

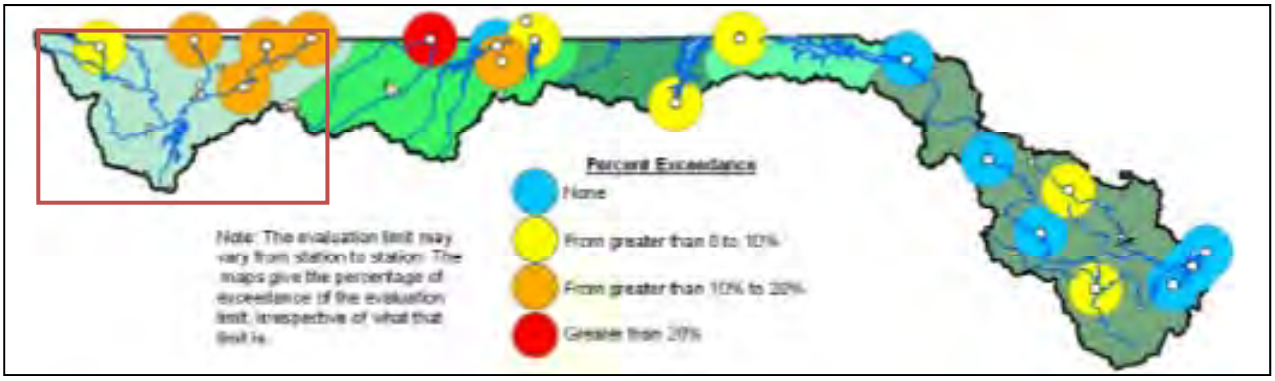

Figure 46: Dan River Basin Fecal Coliform Water Quality Data (in box) - from *Roanoke River Basinwide Assessment* (2012)

The samples taken downstream of the City of Eden violate this standard with less intensity, indicating a value in the municipal water and wastewater treatment facilities for downstream water quality conditions. The most intense records are seen in the rural headwaters monitoring station in Stokes County, but these are, similar to turbidity conditions, rare, and so appear to be less of a concern in the NC DWQ assessment. The rest of the Dan River Basin, including the Eden Area watershed, is subject to less intense but more regular violations of the fecal coliform bacteria water quality standard (Figures 49).

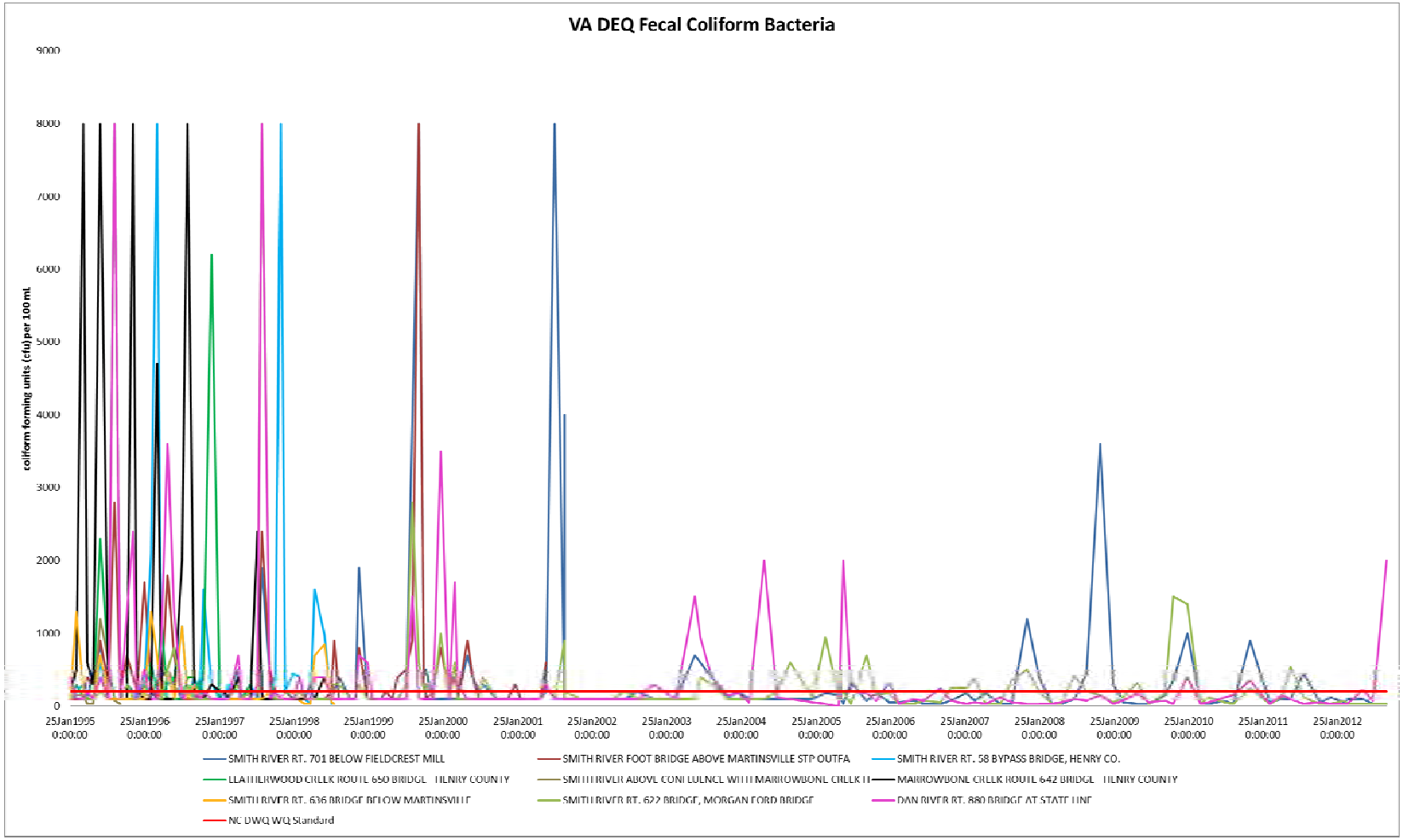

Figure 47: VA DEQ Fecal Coliform Bacteria Data for the Eden Area Watershed

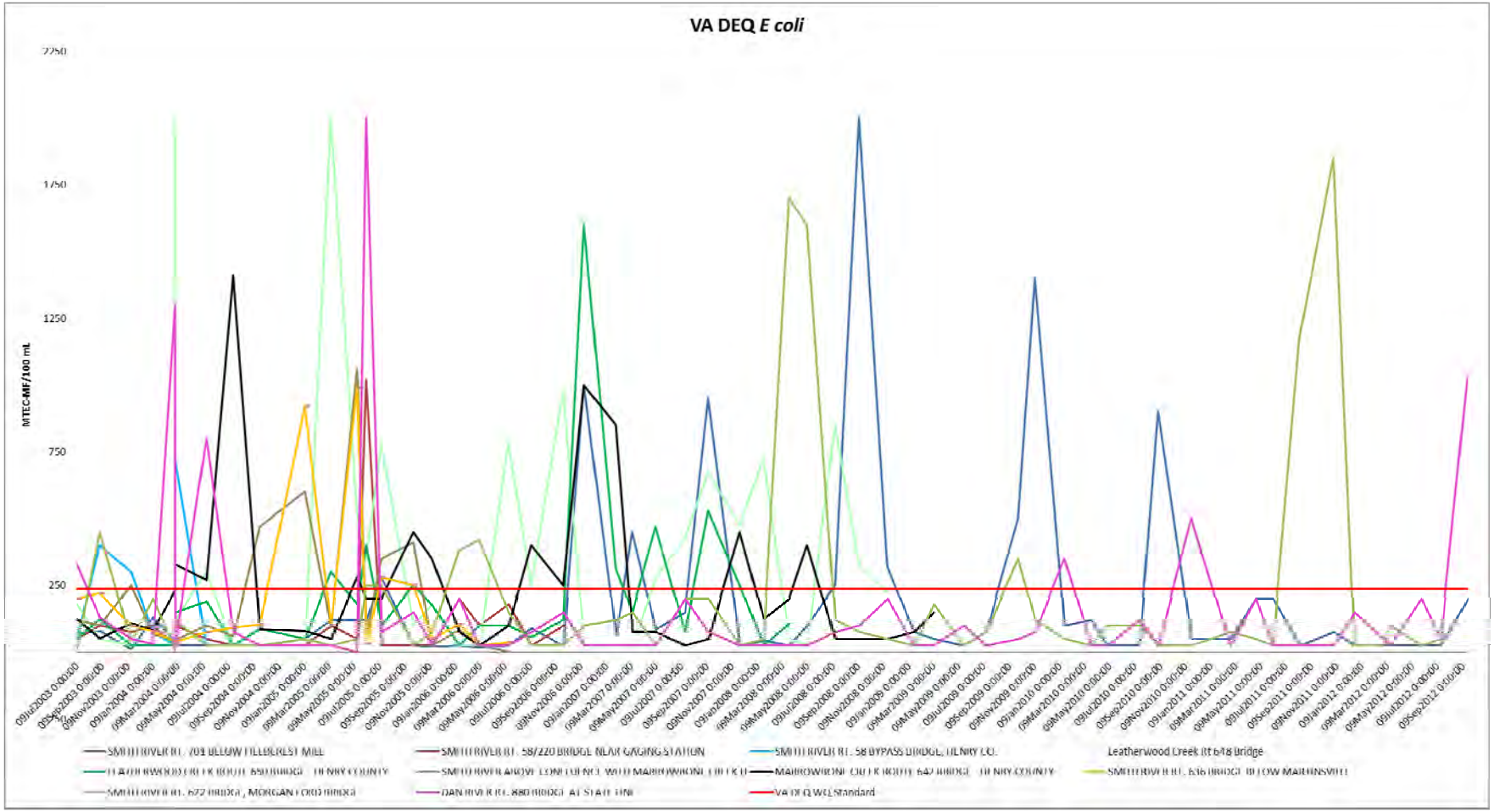

Figure 48: VA DEQ *E. coli* Data for the Eden Area Watershed

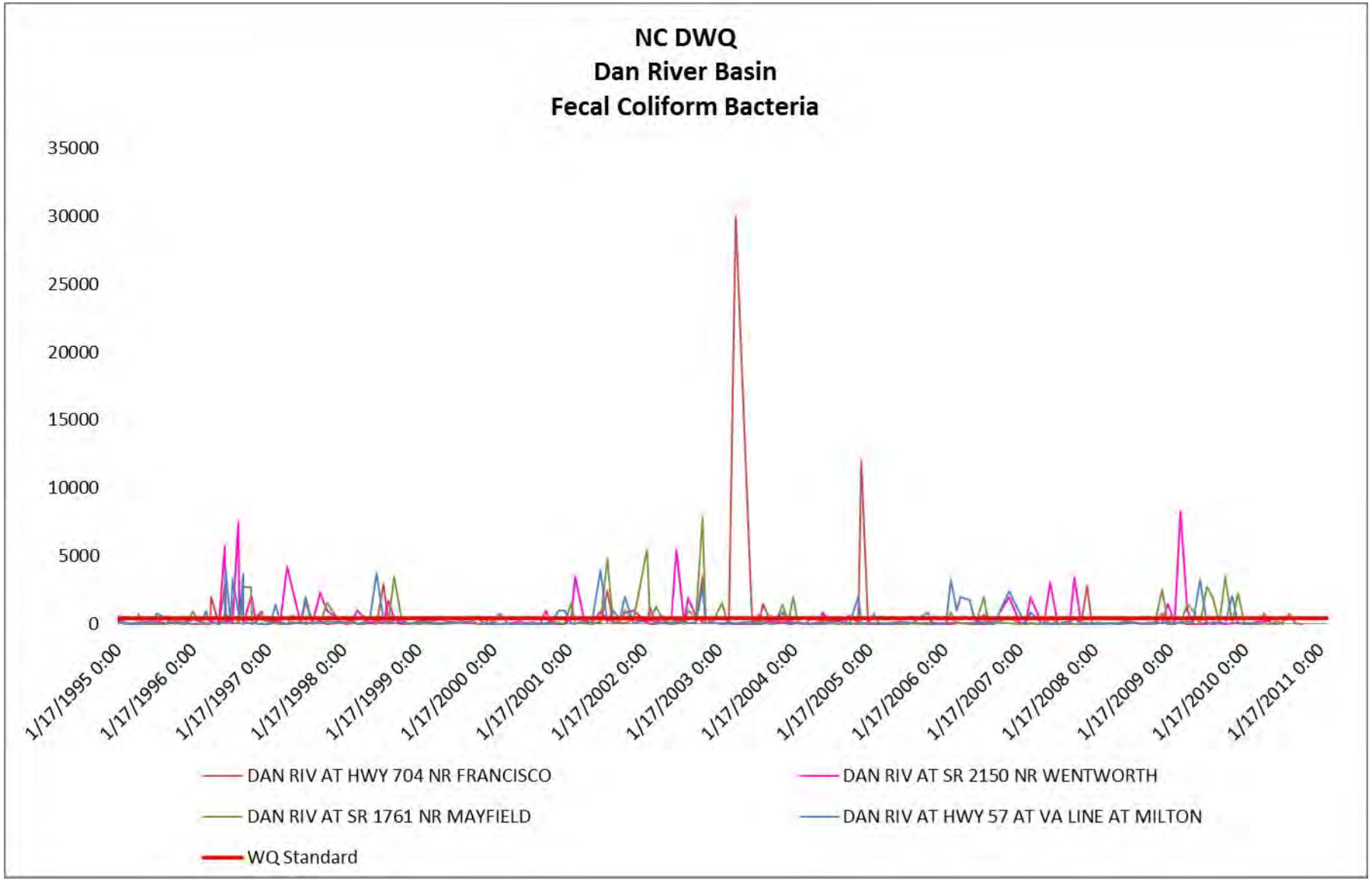

Figure 49: NC DWQ Fecal Coliform Bacteria Data for the Eden Area Watershed

Acute violations of the 235 cfu/100mL water quality standard have not led to an impairment rating of these waters by the NC DWQ due to the requirements that all fecal coliform bacteria impairments be declared only following a protocol that requires five samples within 30 days ("5-n-30"). While this approach is logical to suppress acute but rare incidents such as livestock access to waters from biasing data samples, it is taxing upon NC DWQ's resources (similar to the assessments of benthic and aquatic life conditions), which are already not well supported by the NC General Assembly, and has resulted in few comprehensive fecal coliform bacteria assessments throughout the state, including this river basin. A TMDL for fecal coliform bacteria has been authored to align with the VA DEQ *E. coli* TMDL for Dan River waters that are contiguous with those assessed here, but it is based upon waters that NC DWQ has still not declared impaired, a highly unusual situation (NC DWQ 2009). It is evident that there is a fecal coliform bacteria problem throughout the Eden Area watershed that remains unaddressed, and that it is persistent and common throughout the watershed, but that the City of Eden does not appear to have a significant impact upon fecal loadings to the Dan River beyond what is being loaded to their river from rural sources; the fecal sources in the Eden Area watershed are uniformly problematic.

Nutrients

The nutrient levels throughout the Eden Area Watershed are somewhat different from the fecal coliform bacteria levels found throughout the watershed, with approximately half of all data from both states reviewed violating proposed nutrient thresholds drafted by the NC DWQ. However, these records show that nutrient levels may be high throughout the watershed, with the headwaters monitoring location in Stokes County having the most persistently high total nitrogen records, and the rural site just downstream of Eden, NC, having the highest levels of total phosphorous, rather than the more uniform distribution of fecal materials seen in this watershed and immediately outside of it.

The highest levels of total nitrogen in Virginia appear to be downstream of the Town of Martinsville and directly draining to North Carolina (Figure 50). This suggests an additive impact from all sources, and a need to improve the wastewater facilities in Martinsville and/or non-point sources of nutrients that are collectively degrading water quality conditions. The Dan River also has high values of total nitrogen, but these records are lower than those in the Smith River. Much like the other water quality data for this watershed, this suggests more localized management strategies to address non-point sources of pollution rather than a concentrated program. North Carolina has also recorded persistent and separate levels of nitrogen throughout the Dan River. Interestingly, these levels are higher than those recorded in Virginia (Figure 51).

Total phosphorous records show better water quality conditions than those for nitrogen – especially since 2000 – though there are still consistent violations of threshold limits proposed by the NC DWQ (Figures 52 & 53). For some reason, the water quality records for total phosphorous are poorer than those for nitrogen, with only three monitoring stations recording data since 2000. This makes it challenging to identify any possible sources of pollution, though, again, the records from the Dan River and the Smith River display independence from each other. It is notable that the rural monitoring station upstream of Philpott Reservoir regularly displays high levels of both nitrogen and phosphorous, though not as high as those seen downstream in the Smith and Dan Rivers, suggesting background levels of natural and human non-point sources. The two monitoring sites upstream of the Eden Area Watershed in North Carolina appear to be those with the highest levels of total phosphorous, but they are also the only two with active NC DWQ monitoring, so this conclusion may be inaccurate. The historic data record, however, as well as data collected by the City of Eden, indicate that this conclusion is likely accurate.

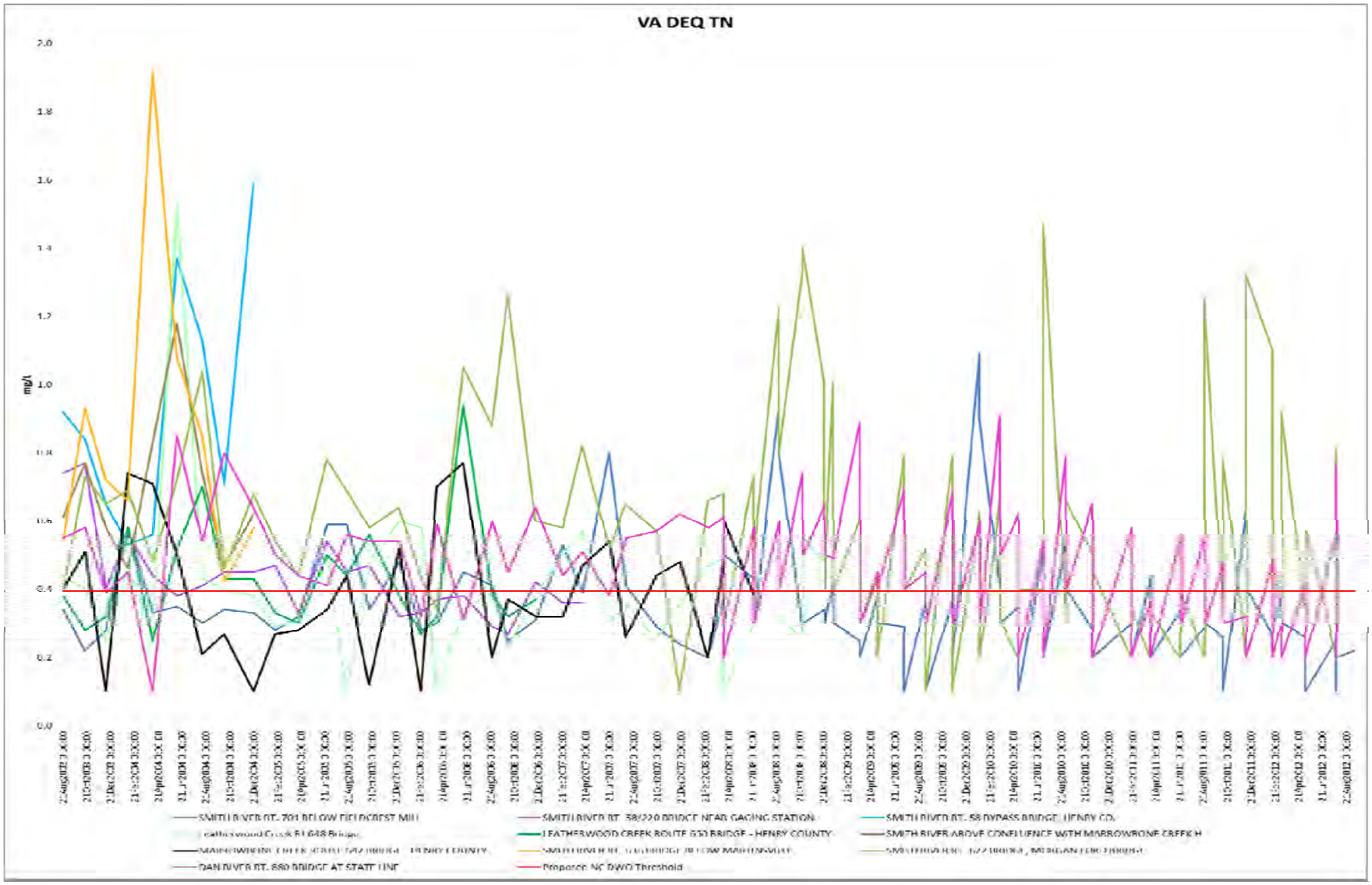

Figure 50: VA DEQ Total Nitrogen Data for the Eden Area Watershed

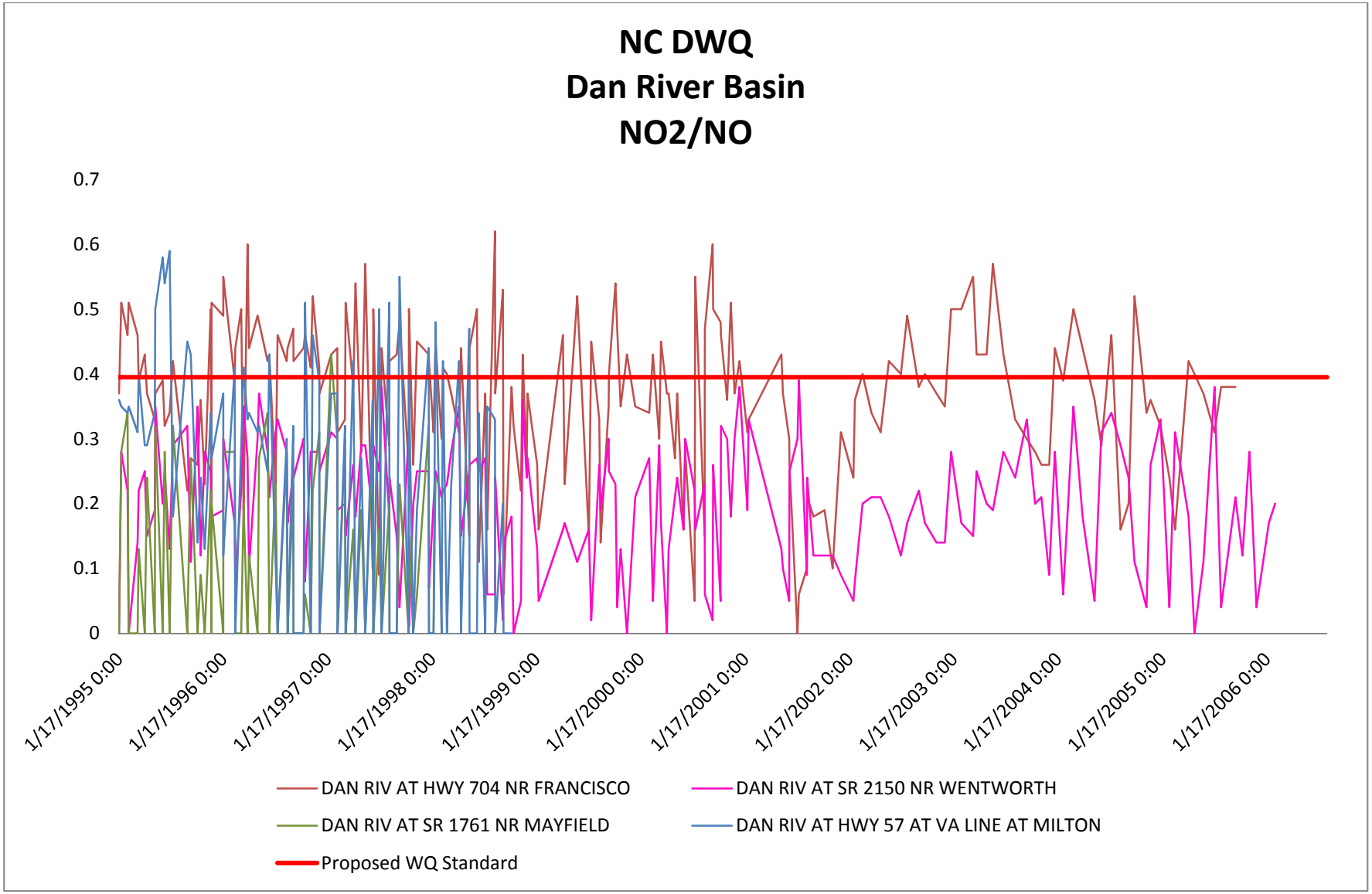

Figure 51: NC DWQ Total Nitrogen Data for the Eden Area Watershed

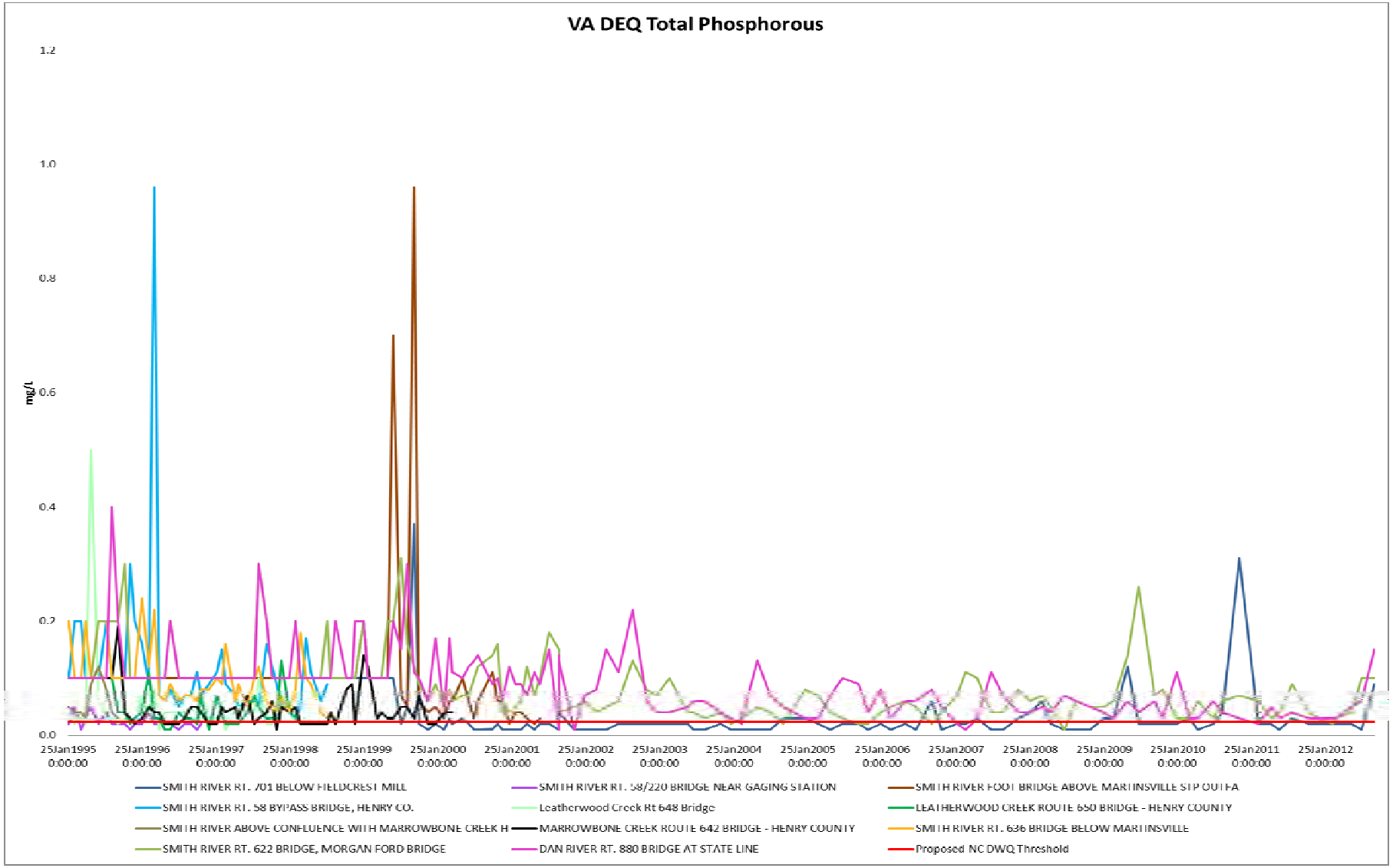

Figure 52: VA DEQ Total Phosphorous Data for the Eden Area Watershed

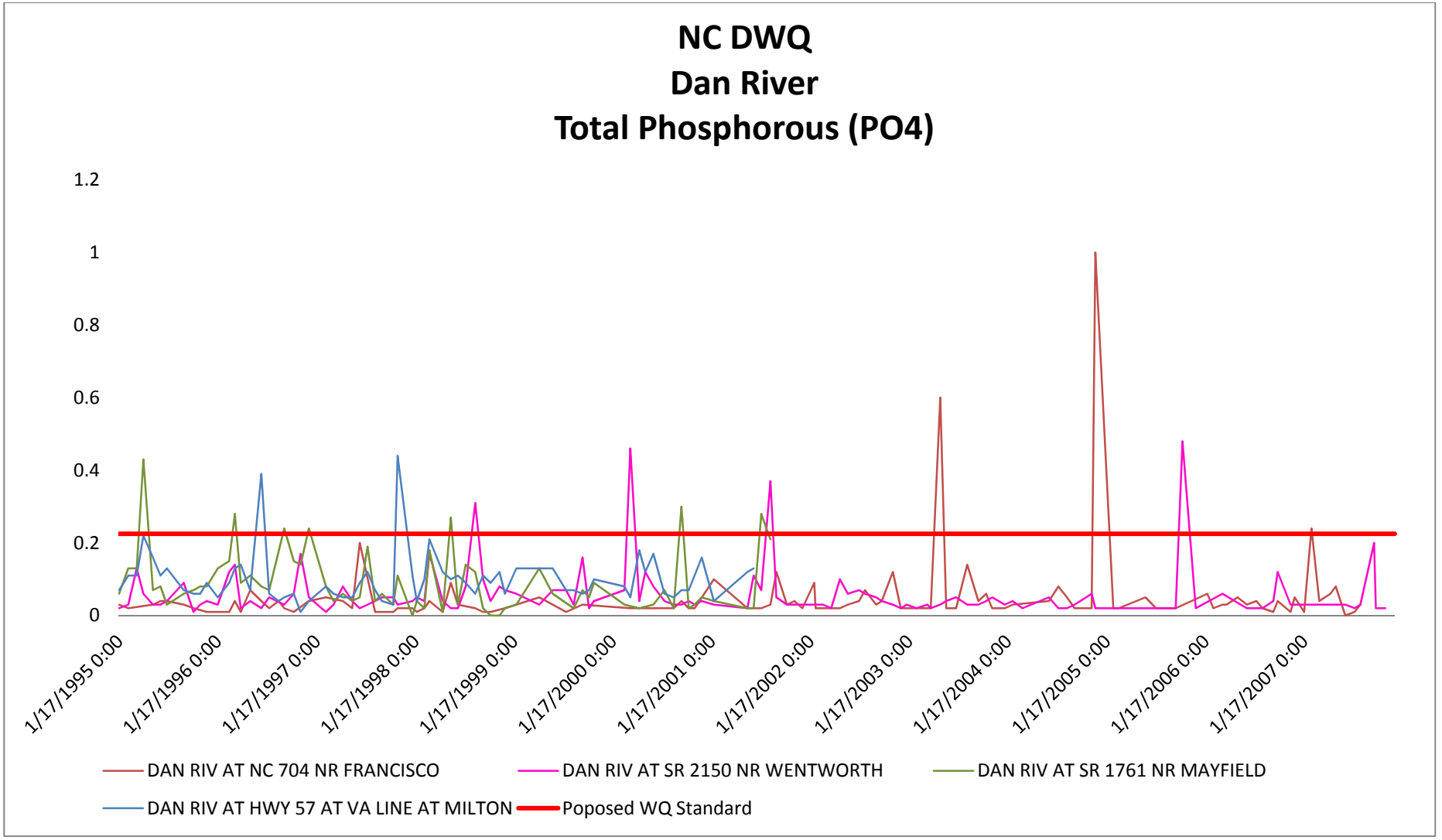

Figure 53: NC DWQ Total Phosphorous Data for the Eden Area Watershed

WATER QUALITY DATA SUMMARY

The Eden Area watershed does not have a single source of pollution that plagues it. As seen in the data contributed to this assessment by the City of Eden, NC DWQ, and VA DEQ, the sources of turbidity and fecal matter pollution are persistent and consistent throughout the 215-square mile watershed, suggesting natural, agricultural, residential, and urban sources of pollution. The largest receiving waters in the Dan and Smith Rivers have water quality records that were collected simultaneously and display a stark separation from each other, indicating unique non-point sources of pollution. The wastewater plants in the City of Eden and the Town of Martinsville seem to be filtering some of the fecal material in their operations, but not to the point where they significantly improve water quality conditions so they don't violate water quality standards for human and ecological health.

From the water quality record, the impacts of the City of Eden's failing wastewater infrastructure do not appear to be having significant detriment to either local or regional water quality conditions, with fecal material and nutrient levels downstream of the City nearly the same as those both in the Smith River and farther downstream in the Dan River. Compliance should actually make water quality conditions markedly better than much of the watershed and the Upper Dan River Subbasin, especially as the City does what it can to address elevated trihalomethane levels in the Dan River that violate US Safe Drinking Water Act standards. There do appear to be some additive impacts of nutrients, sediment, and fecal material in these waters, but with the reduction in already poorly-supported monitoring programs since the early 2000's, it is increasingly difficult to determine if these effects are real or due to local conditions.

Due to differences in data collection and analysis methodologies, as well as very different water quality standards for fecal material and sediment, it will be challenging for state parties in North Carolina and Virginia to address the non-point sources of pollution. While challenging without a consistent and uniform approach to water quality analysis, this may leave the responsibilities to local and regional stakeholders to identify and investigate non-point sources of pollution, and develop consistent programs across the state boundary to address them. Unfortunately, there is no big, bad polluter in this watershed – it appears that the waters are suffering from small contributions from everyone across 215 square miles.

SECTION 4: REVIEW OF LOCAL GOVERNMENT CODES, ORDINANCES, RULES, AND PROGRAMS

A network of local ordinances, rules and programs that determine how we use our lands and waters ultimately impact the function of a watershed and the quality of its waters. Watershed management policies can be found in watershed protection ordinances, development ordinances, growth strategies, and/or transportation plans. Ultimately, watersheds' fates are determined by the citizens living in them, and the land use and environmental decisions of those citizens' elected officials.

In North Carolina, the health of the Dan and Smith River watersheds is largely dependent on the policies of Rockingham County and the City of Eden. Virginia policies and the ordinances of Pittsylvania and Henry Counties, as well as the City of Martinsville also play a significant role in the health of these rivers. While the project recognizes the importance these codes, ordinances, rules and programs play, their analysis is beyond the scope of this project.

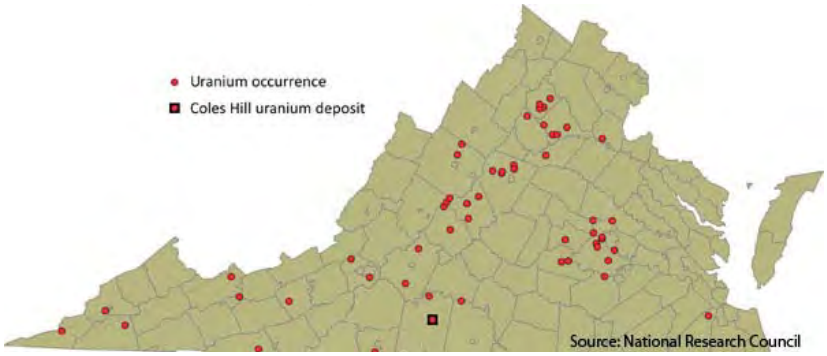

Figure 54: Uranium Occurrences in Virginia

It is important to note that Virginia is currently considering lifting a 30-year ban on uranium mining. The Cole Hills deposit in Pittsylvania County (Figure 52) is believed to contain the largest undeveloped uranium deposit in the United States (Hammack, 2012). If lifted, uranium mining has the potential to impact surface and ground water quality and quantity, particularly in the case of a natural disaster such as a hurricane (National Research Council [NRC], 2012).

In NC, Rockingham County uses a unified development ordinance to explicitly address and guide development. "A Land Use Plan for Managing Growth," (Rockingham County Planning Department et al., 2006) provides the County with a vision-driven, proactive guide for managing future physical growth and development, and the Rockingham County Comprehensive Transportation Plan guides current and future transportation needs. Additional information potentially impacting water quality can be found in the Rockingham County Hazardous Mitigation Plan. The City of Eden protects water resources through their zoning ordinance, the "City of Eden Land Development Plan," the "City of Eden Comprehensive Pedestrian Transportation Plan," the "City of Eden Comprehensive

Transportation Plan, the “Eden Greenway Master Plan,” and Eden’s “Comprehensive Water and Wastewater Master Plan.”

Using the Center for Watershed Protection’s (CWP’s) Code and Ordinance Worksheet (COW) to rate the watershed management of both jurisdictions, Rockingham County and Eden rated scores of 75 and 71, respectively. These scores indicate there are significant opportunities to improve development rules to better manage water resources in both jurisdictions. The COW worksheet is an in-depth review of the standards, ordinances, and codes that shape how development occurs. Institutional frameworks, regulatory structures and incentive programs are included (Center for Watershed Protection [CWP], 1998).

Using the EPA’s Water Quality Scorecard, the County scored 52.5 of a possible 238 points, while the City of Eden ranked considerably higher, scoring 118.5 of a possible 257. These scores reflect the proactive measures the City of Eden has taken to protect the Dan and Smith River and a need to adopt more stringent policies in the County to ensure protection for these waterbodies. The purpose of the scorecard is to address water quality protection across multiple scales (municipality, neighborhood, and site) and multiple departments and provide staff, stormwater managers, planners, and other stakeholders with a tool to better understand barriers and opportunities to implement a green infrastructure approach in their communities. Some of these aspects are intended to address concerns with combined stormwater and sewer systems that are, fortunately, not a concern in this watershed or much of NC. However, the Scorecard provides invaluable feedback and guidance for watershed stakeholders on how they can ensure sustainable watershed health and function while using these lands and waters for the resident communities (US Environmental Protection Agency [US EPA], 2009).

This section will review ordinances, codes, and programs that Rockingham County and Eden have that address watershed needs. It will highlight some significant strengths and failings that they both can address through ordinance amendments and/or revisions. Additional 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, and incentives for making extra efforts to improve local conditions. The policy recommendations included in the *Eden Area Watershed Restoration Plan* will more comprehensively cover some of these needs and outline a strategy involving programs, projects, policies, and partnerships that will ultimately create a healthier watershed.

WATERSHED PLANNING

Though not historically applied in such a way, regulatory measures (i.e. zoning and subdivision regulations) and planning techniques can be used to improve impaired watershed health and function, and craft a management strategy to ensure restored waters remain healthy. This can be done through policies, codes, and ordinances that address impervious cover, low impact development, and protect sensitive areas. Documents guiding community development vary in their detail and scope, and often utilize guidance rather than regulation. Neither Eden nor Rockingham County use a regulatory approach to environmental resource protections and growth management and, indeed, are frequently prevented from doing so by state legislation. Instead, they depend on the Eden and Rockingham County planning boards to make recommendations to City Council or County Commissioners on matters pertaining to land use and rezoning issues.

Figure 55: Smart Growth Planning Techniques Protect Natural Resources (Photo: US EPA)

While both communities state urban-centric development and open space preservation as goals, no requirements have been imposed, nor have steps been taken to make them more attractive to developers or investors through procedural or financial incentives. Consequently, despite environmental and economic conditions arguing for a different approach, neither of these jurisdictions will accomplish these ends with current ordinances and regulations. The Eden area watershed's growth needs to be low-impact in design to minimize water quality impacts and stabilize local soils while directing development to the vacant urban centers in and around Eden that are extremely capable of absorbing residential and business growth and is one of the least environmentally-sensitive areas of this watershed.

Table 3: Strategies to Improve Water Quality (from the Jordan Lake Nutrient Sourcebook)

WATERSHED PROTECTION	TECHNIQUE DESCRIPTION
NEW CONSTRUCTION	Local ordinances and codes that incorporate techniques into new construction sites to reduce their ecological footprint, minimize impervious cover, and/or manage stormwater flows with BMPs.
CONSTRUCTION INSPECTIONS AND ENFORCEMENT	Programs and policies that ensure sedimentation and erosion control best management practices are implemented.
BMP MAINTENANCE	Programs and policies designed to ensure structural BMPs are adequately treating stormwater runoff.
AGRICULTURAL BMPS	Programs and policies to ensure farmers implement and have funding to implement agricultural best management practices.
SEPTIC SYSTEM MAINTENANCE	Maintenance and operation programs designed to minimize septic tank malfunction.
LOW-IMPACT DEVELOPMENT (LID)	Programs and policies designed to simulate pre-development runoff volumes and water quality
FORESTRY GUIDELINES	Sustainable forestry practices minimizing sediment loading from timbering, roads, controlled burns, and other activities.
ILLICIT DISCHARGE DETECTION AND ELIMINATION (IDDE)	Programs and policies designed to identify and eliminate illegal discharges from flowing into a stormwater system including paints, greywater, grease, oil, etc.
RIPARIAN BUFFERS	The protection, restoration, or reforestation of stream, wetland, or lake buffers, and maintaining them perpetually.
WATER QUALITY MONITORING	Monitoring programs designed to identify problem areas, evaluate the effectiveness of best management practices and reporting compliance with water quality standards.
WATERSHED RESTORATION	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.
CONSERVATION EASEMENTS AND ACQUISITIONS	Programs or efforts to conserve undeveloped, ecologically-sensitive areas, and/or areas of historical, recreational, or cultural value.
OUTREACH, EDUCATION AND PUBLIC INVOLVEMENT	Programs designed to educate citizens and encourage behavioral changes through direct communication and mass media.

COMPREHENSIVE AND LAND DEVELOPMENT PLANNING

Rockingham County manages water resource protection through their Unified Development Ordinance (UDO) and addresses future growth in the *Rockingham County Land Use Plan.* The UDO contains seven elements, six of which impact water quality in the Dan and Smith Rivers: zoning, subdivisions, watershed protection, flood damage prevention, airport hazard, and voluntary farmland preservation (Rockingham County Planning Department et al., 2006). The seventh, the *Riparian Buffer Protection Ordinance for Lands Within the Jordan Watershed* applies only to the southern portion of the County located in the Haw River Basin, but is relevant to discussions in this watershed as a potential regulatory and policy precedent, and because it may lead to more development in the watershed study area.

The Land Use Plan was prepared for the Rockingham County Board of Commissioners in 2006 and identifies tools that should be used in managing growth for the next twenty years. The overall mission of this Plan is "to provide Rockingham County with a vision-driven, proactive guide for managing future physical growth and development over the next 20 years" (Rockingham County Planning Department et al., 2006). While the nature of the Plan is forward thinking, it clearly addresses the current differences between "facts" and "values." While the importance of protecting natural resources, particularly the river corridors, is clearly expressed, the regulatory structure to make this a reality is lacking. Current zoning regulations designate every acre of land as residential, commercial, or industrial. Though a "permitted-by-right" system is clearly more efficient, it has the unintended consequence of segregating residential and commercial uses and further contributing to urban sprawl. Despite a bounty of ecological and recreational resources, no lands in either the County or City are zoned as open space and/or conservation areas that limit development intensities in order to preserve natural resources for the public good.

The Plan examines existing regional conditions and while there appears to be little or no growth in the northern areas of the County (Figure 7), the southwestern quadrant of the county is growing considerably. This influx is due primarily to the proximity to the Greensboro/High Point area (Rockingham County Planning Department et al., 2006). However, the adoption of the Jordan Lake Rules in 2009 may have the unintended consequence of pushing development north, out of the Haw River watershed and into the Dan and Smith watersheds.

According to a recent study analyzing market trends, preferences and opportunities in the Piedmont Triad, Dr. Author Nelson estimates the population of jurisdictions in the Piedmont Triad Region of North Carolina will grow from about 1.6 million in 2010 to about 1.8 million in 2025, then to about 2.0 million in 2040. By 2040, the population demographic will change

considerably. Almost all growth will be in minority populations and/or among older adults. Demographic changes and the return to conventional mortgage underwriting will likely result in a greater demand for rental housing which is projected to account for two-thirds or more of the new housing demands while owner housing will drop to about 25% (Nelson, 2012).

In the Piedmont Triad, the housing demand will be strongest in the youngest and oldest groups – neither of which can afford, or desire large houses on single lots. In fact, there may already be enough sufficient housing built between 1990-2010 to accommodate households demanding peak space through 2040. There are many reasons home ownership is on the decline: rising energy costs, falling incomes, lagging employment, shifting wealth, tighter home finance, and demographic changes. These factors contribute toward a national shift in planning for new population growth (Nelson, 2012). Those moving to Rockingham County will look for community designs that support their needs, and reflect a trend towards "neo-traditional" or "new urbanism" design and away from low-density, single-family large lots that are heavily dependent on the automobile (Rockingham County Planning Department et al., 2006).

Table 4: Piedmont Triad Change in Households by Type, 2010-2025, and 2040

Household Type	House-holds 2010 (000s)	House-holds 2025 (000s)	Change in Households, 2010-2025 (000s)	Share of Change in Households, 2010-2025	House-holds 2040 (000s)	Change in Households, 2010-2040 (000s)	Share of Change in Households, 2010-2040
All HHs	658	742	84		797	139	
HHs with Children	191	198	7	8%	213	22	16%
HHs without Children	468	544	77	92%	585	117	84%
Single Person	185	227	42	51%	274	89	64%

Figures may not sum due to rounding.

Source: Figures for 2010 from Census; figures for 2025 and 2040 from Arthur C. Nelson based on population data from Woods & Poole Economics (2011)

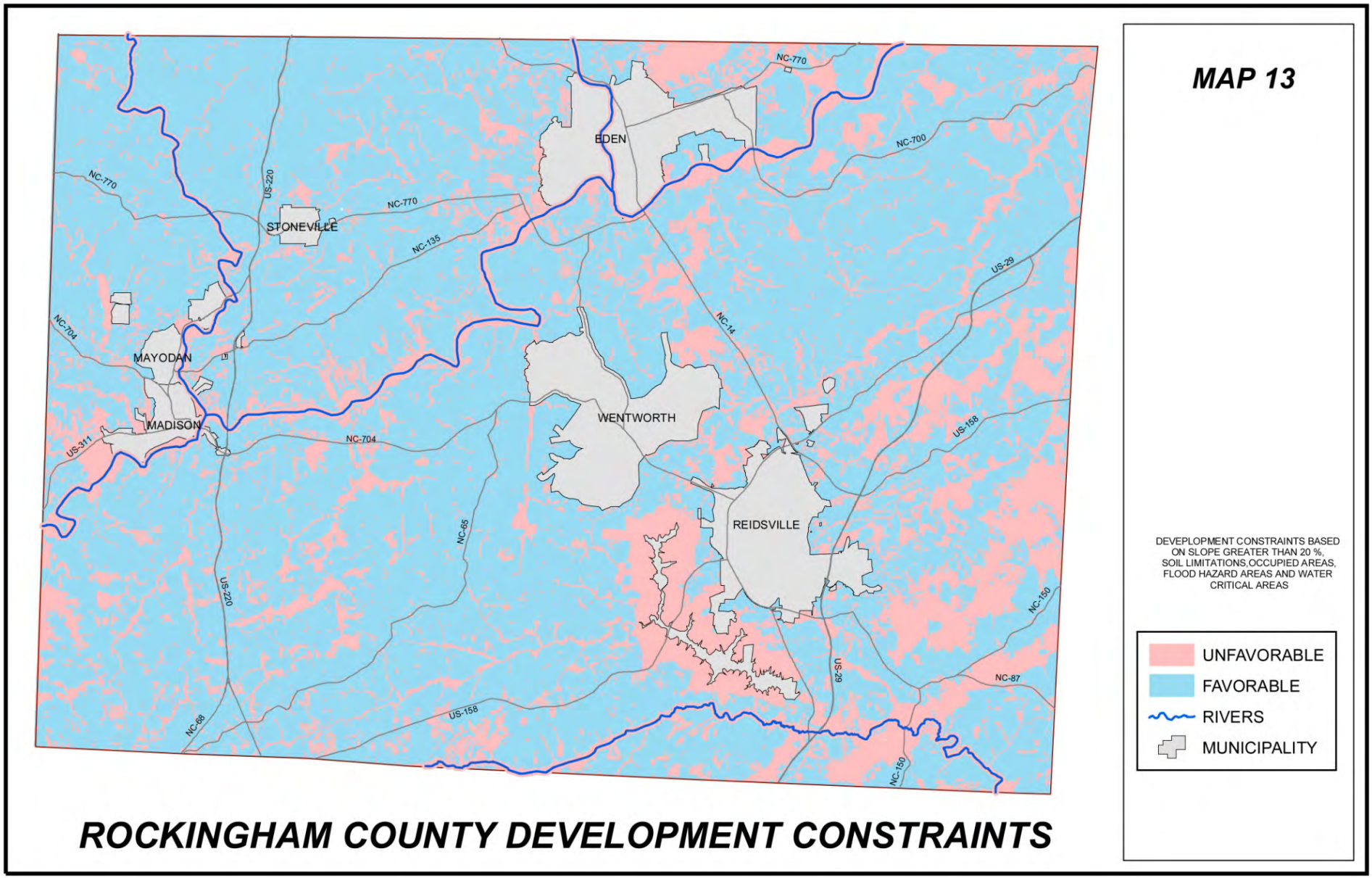

Figure 56: Rockingham County Development Constraints

The Rockingham County Land Use Plan identifies four key environmental growth factors – steep slopes, soil limitations, flood hazard areas, and watershed critical areas – that impose physical limitations or regulatory constraints to future land development. These factors vary in the level in which they impact both the environment and the potential for future growth. While some of these areas are protected through state and federal regulations, there are few local requirements to prevent developers from building on these sites, although usually with additional expense and design (Rockingham County Planning Department et al., 2006). Unfavorable areas total approximately 24% of the County jurisdiction and are recognized as less favorable to high intensity development (Figure 54). This will be further investigated in the final Restoration Plan.

The City of Eden manages water resource protection through their Zoning Ordinance and addresses future growth in the *City of Eden Land Development Plan.* The Zoning Ordinance protects water quality through zoning and subdivision ordinances, flood damage prevention, tree protection and stormwater management (City of Eden, 2007). While their policies recommend sustainable infrastructure, mandatory compliances is not yet required. However, the proactive nature of the City is evidenced in many City initiatives, including Eden's Greenway Master Plan.

The Eden Land Development Plan represents the City's first future land development planning process since 1977. The primary purpose of the plan is to provide guidance for making strategic decisions about future growth and development in the community. The Plan is intended to serve as a guide for property owners and developers who propose site improvements and the staff who review and comment on these proposals and the elected and appointed officials who consider these requests (City of Eden, 2007).

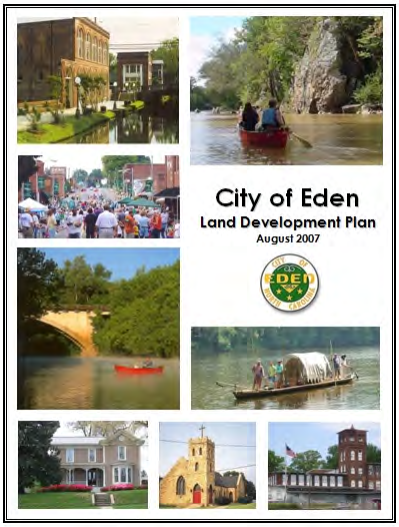

Figure 57: City of Eden Land Development Plan

The Plan is broken down into five sections including: "Community Overview", "Existing Conditions", "Community Values", "Land Use Recommendations", and "Implementation". The *Community Overview* deals with the planning area, historical context, the purpose of the plan and the planning process and methodology. *Existing Conditions* is broken down into demographics, an analysis of urban service growth factors including water systems, wastewater systems, transportation systems, parks and recreation and a summary of the *Greenway Master Plan*. This section also details an analysis of environmental factors including natural

and human environmental features, land development suitability, and existing land use and provides an overview of existing land development regulations. The *Community Values* were determined from a two-day Visioning Meeting which was ultimately used to "identify and clarify key issues, to develop and refine the Committee's mission, vision and goals, and guide other elements of the City's *Land Development Plan*" (City of Eden, 2007). The document provides land use recommendations which will be alluded to later in this section as well as implementation guidelines.

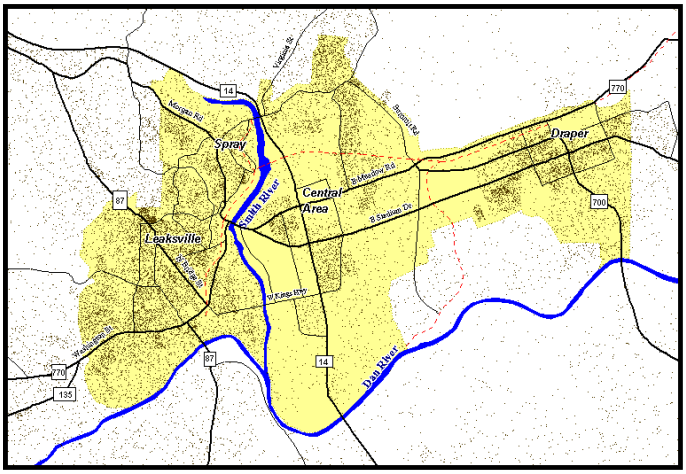

Figure 58: Population Density for Eden & Surrounding Area, 2000 (Source: 2000 Census)

According to state estimates, Eden has experienced population decreases in the past few decades. While population density is highest in Leaksville and Draper, these areas are not currently experiencing population growth. The central area of Eden is the fastest growing and provides some of the best opportunities for future "in-fill" development. While the demographic trends indicate a slow decline in population between 2000 and 2010, the aging baby-boomer population (ages 45-64) is on the rise. Ensuring proper housing and healthcare facilities to accommodate this age group needs to be taken into consideration. Particularly challenging to Eden is the median household income. At $27,411, Eden is roughly 30% lower than the state average (City of Eden, 2007). This is perhaps one of the most challenging aspects of incorporating green infrastructure into the community. The higher initial cost associated with green infrastructure can make it more challenging to ensure community members have access to affordable housing.

Zoning

The City of Eden and Rockingham County use two main tools to regulate land development: a zoning ordinance and subdivision regulations. The zoning ordinance is a legal and administrative tool to ensure land uses within the community are properly situated in relation to one another, and that adequate space is provided for each type of land development. It allows the control of development density so that property can be provided with adequate public services such as streets, schools, recreation, utilities, and fire and police protection. Zoning can also help to direct new growth into appropriate areas for cost-efficient development. Zoning protects existing property by requiring that new land development provide adequate light, air and privacy for persons already living and working within the

Figure 59: The Oaks Subdivision, Eden

community. Eden's zoning jurisdiction presently corresponds with the existing City limits and the extra-territorial jurisdiction (ETJ) outside of the City limits (City of Eden, 2007).

Conventional zoning ordinances were first established in the early 20th century to divide land into districts (or zones) for the purpose of separating uses. The rationale for this separation of uses was to protect public health and safety by providing minimum distances between noxious uses (e.g. polluting smokestacks, coal-burning factories, offensive odors of slaughter houses) and high-density residential areas. Over time, jurisdictions established specific zoning districts (residential, commercial, industrial, etc.) and a list of permitted uses within each district (City of Eden, 2007).

The basic authority to protect public health and safety has evolved from increasing the distance between polluting factories and houses, to dividing housing types by size and cost, and separating residential areas from daily shopping and services. As zoning categories became more exclusive, fewer provisions were made for walking and bicycling to "other use" districts and eventually the car became the only viable mechanism to cross zoning district boundaries regardless of the actual distance (City of Eden, 2007).

If a property is currently zoned for its intended use, then necessary permits are obtained through application and the payment of fees. If a land development proposal does not coincide with a parcel's current zoning designation, rezoning approval from the City Council or County Commissioners is required. This process may take several months, depending on the magnitude or complexity of a proposal, or the level of controversy generated by a proposed project. Zoning is the most commonly used legal device for implementing a community's land development plan. It plays a role in stabilizing and preserving property values through predictability of land use, but usually lacks specific design guidelines to ensure overall positive development. Eden currently has six areas zoned specifically for residential planned use developments (PUDs), which allow higher density housing in exchange for more open space and both allow and encourage this type of development, particularly in watershed overlay districts (Figure 57).

Subdivisions

Subdivision regulations are locally-adopted laws that govern the process of converting raw land into individual building sites. Regulation is accomplished through subdivision plat approval procedures, under which a land owner or developer is not permitted to make improvements or to divide and sell lots until a proposed subdivision plat has been approved. Approval is based on compliance of the proposal with development standards set forth in the subdivision regulations. Attempts to record an unapproved plat with the local registry of deeds, or to sell lots by reference to such a plat, are subject to various civil and criminal penalties (City of Eden, 2007).

The stated purposes of the City of Eden Subdivision Regulations are to:

- Coordinate proposed development with existing development and with officially adopted plans for the future development of the City;
- Insure the provision of adequate facilities for transportation, water, sewerage, and other public facilities to subdivisions;
- Insure proper legal description, documentation, and recording of subdivided land; and
- Create conditions essential to public health, safety, and general welfare (City of Eden, 2012b).

The stated purpose of Rockingham County's subdivision regulations are to "create conditions that substantially promote public health, safety and general welfare by providing for the orderly growth and development of Rockingham County" (Rockingham County, 2012).

Water Supply Watersheds

Almost half of the study area is classified as water supply watersheds. Water supply watershed classifications use density restrictions and wastewater discharge regulations to protect water quality. The lower the watershed number, the more highly land use is regulated within it. All of Subwatersheds 1 and 2, and parts of Subwatersheds 3, 4, 8, and 13 have a Class IV designation. These Class IV watersheds include: Little Matrimony Creek, Bear Creek, Poplar Creek, Matrimony Creek, Buffalo Creek, Whetstone Creek, Mill Branch, Martin Creek, Smith River, Dan River (West of Eden).

The remaining waters in the Eden Area watershed have a Class C designation. All water in North Carolina must meet standards for Class C waters and are protected for secondary recreation, fishing, wildlife, fish consumption, and aquatic life (NC DWQ, 2012). As the Smith River enters NC it is classified as WS-IV (water supply watershed) then downstream of the

confluence with Tackett Branch the Smith River becomes Class C which is its classification as it merges with the Dan River. Just prior to joining with the Smith River, the Dan River assumes the Class C rating and maintains it into Virginia.

The Class IV water supply watershed designations have significant impacts on growth and development, preventing sprawl and encouraging innovative LID and open space planning. This is primarily accomplished by limiting built-upon footprints of developments. All water supply watersheds in the study area are classified as WS-IV and are further broken down into critical and protected areas. The critical area is the 1/2 mile area around the water intake. The protected area is the rest of the watershed, or land area draining to the intake (NC DWQ, 2012). The Robert A. Harris Water Filtration Plant in subwatershed 8 has the capacity to produce 21 million gallons per day (MGD) of treated water, delivering drinking water to the City of Eden and Miller Brewing Company (City of Eden, 2012a).

WS-IV-CA - (Critical Area) Watershed District: Established to protect water quality in the Dan and Smith River watersheds, these regulations are applicable to all lands within the designated watershed area. Only new development activities that require an erosion/sedimentation control plan under State law or approved local program are required to meet the provisions of this ordinance when located in the WS-IV watershed. In order to address a moderate to high land use intensity pattern, single-family residential uses are allowed at a maximum of two (2) dwelling units per acre. All other residential and non-residential development shall be allowed twenty-four percent (24%) built upon area (NC DWQ, 2012).

The WS-IV-CA Watershed district is designated for two pie-shaped areas inside the Eden city limits. The pie-shaped wedge area north of Meadow Road on the Smith River. The other location is along the Dan River east and west of Hamilton Street. Please refer to Figure 59 for more detail.

WS-IV-PA - (Protected Area) Watershed District: Established to protect water quality in the Dan and Smith River watersheds, these regulations are applicable to all lands within the designated watershed area. Only new development activities that require an erosion/sedimentation control plan under State law or approved local program are required to meet the provisions of this ordinance when located in the WS-IV watershed. In order to address a moderate to high land use intensity pattern, single-family residential uses are allowed at a maximum of two (2) dwelling units per acre. All other residential and non-residential development shall be allowed twenty-four percent (24%) built upon area. A maximum of three (3) dwelling units per acre of thirty-six percent (36%) built-upon area is allowed for projects without a curb and gutter street system. A maximum of 10% of the

watershed area may be developed in residential or non-residential uses with a built-upon area of up to 70% on a project by project basis. Permission for such higher-intensity projects is granted by the City Council (NC DWQ, 2012).

The WS-IV Protected Area Watershed district encompasses a larger part of the planning area. This district is overlaid on top of the WS-IV-CA small pie-wedge shape, but extends further out. The WS-IV-PA district on the Smith River is roughly bound by Meadow Road (NC 700) to the east and by Victor Street, Morgan and Ridgeway to the west. The WS-IV-PA district on the Dan River is roughly bound by NC-87 and extends westward from this highway corridor. Please refer to Figure 59 for more detail.

Figure 60: PUDs Protect Water and Provide Open Space

Watershed Cluster Development:
Watershed District regulations also allow for minimum lots size requirements to be waived when single-family residential uses are clustered, as long as an equal number of lots are developed and the remainder of the site remains as open space in a vegetated or natural state. All other uses are restricted to a maximum of 24% built-upon area when public sewer is available. When land development exceeds the low-density option through approval of a cluster development, a minimum 100-foot buffer is required (NC DWQ, 2012).

Over 12% percent (28 square miles) of land in the study area is vacant or under-utilized, which provides opportunities for infill development and efficient use of existing transportation and sewer/water infrastructure. In addition, just over 44% percent (102 square miles) is categorized as agriculture with residential, vacant agricultural or forested uses. Therefore, there is an adequate amount of vacant or minimally used land within the watershed to accommodate future growth.

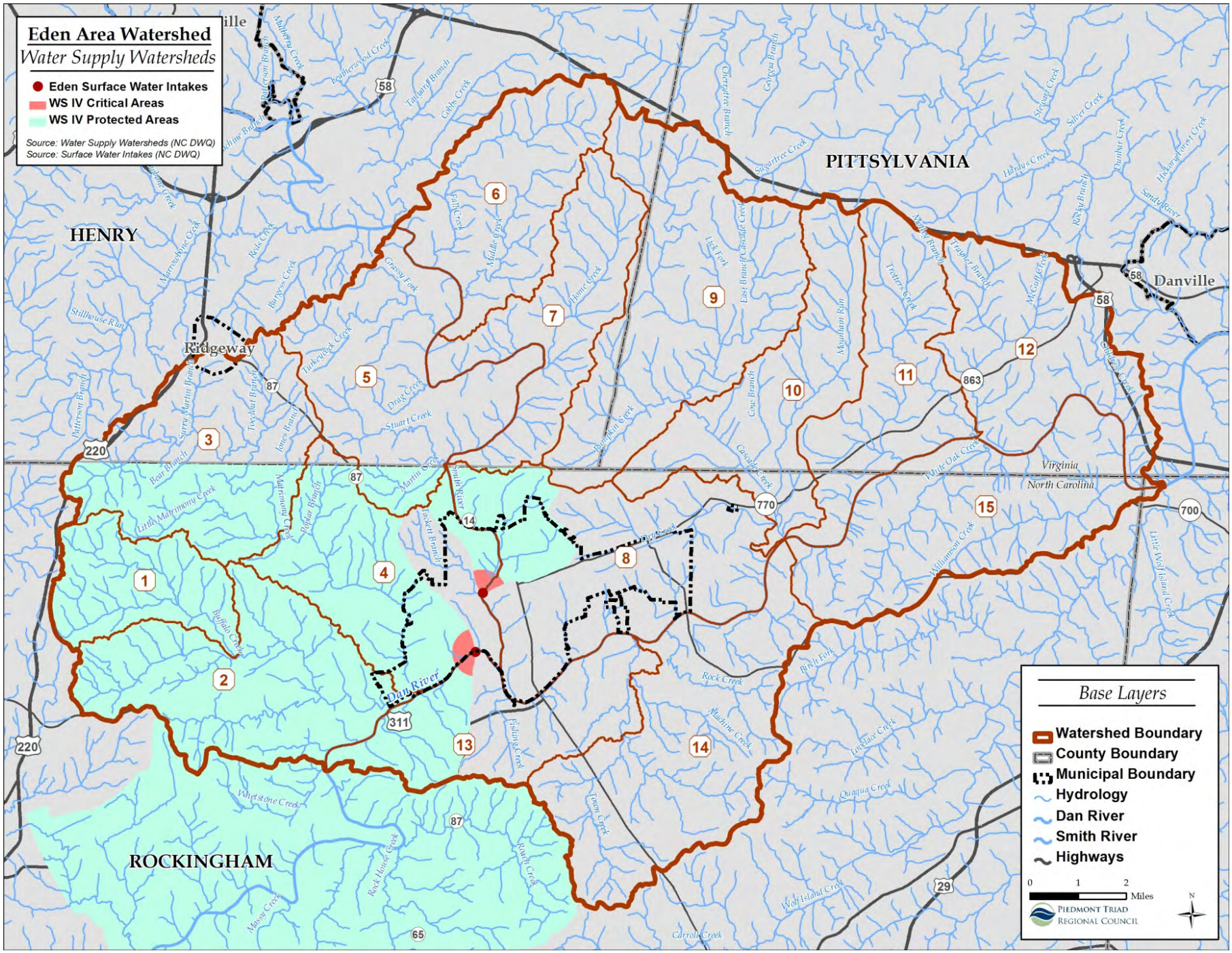

Figure 61: Water Supply Watersheds

DEVELOPMENT REQUIREMENTS

Site Design

Environmental Site Design (ESD), or Better Site Design (BSD), is an effort to mimic the natural flow of stormwater through a combined application of design principles replicating forested conditions and natural hydrology. These practices are considered at the earliest stages of design, implemented during construction and sustained in the future as a natural system. Each practice incrementally reduces the volume of stormwater on its way to the stream, ultimately reducing the amount of conventional stormwater infrastructure required. Practices include preserving natural areas, minimizing and disconnecting impervious cover, minimizing land disturbance, conservation (or cluster) design, using vegetated channels and areas to treat stormwater, and incorporating transit, shared parking, and bicycle facilities to allow lower parking ratios. The Center for Watershed Protection (CWP) is a national leader in protecting, restoring and enhancing our waters through creating practical solutions and partnerships. Their website provides various publications, training guides and other resources communities can utilize to ensure that "every community has clean water and healthy natural resources to sustain diverse life (CWP, 2012).

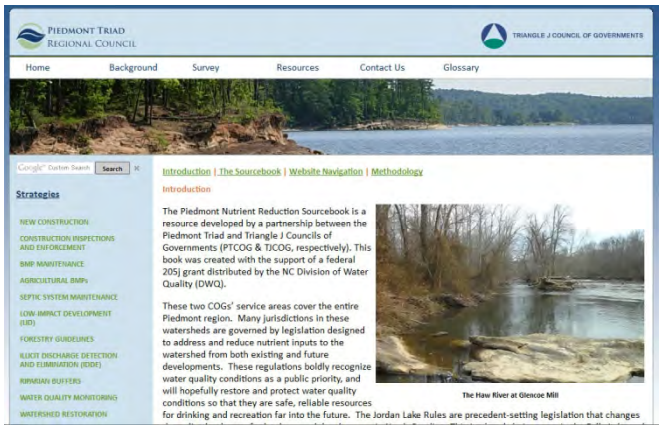

Figure 62: Piedmont Nutrient Sourcebook

The Piedmont Nutrient Reduction Sourcebook is a resource tool developed through partnership between the Piedmont Triad and Triangle J Councils of Governments to provide a set of strategies for reducing and managing nutrients to waters of the North Carolina Piedmont. The book outlines strategies in thirteen different categories including: New Construction, Construction Inspections and Enforcement, BMP Maintenance, Low-Impact Development, Forestry Guidelines, Illicit Discharge Detection and Elimination, Riparian Buffers, Water Quality Monitoring, Watershed Restoration, Conservation Easements and Acquisitions, and Outreach, Education and Public Participation. This resource is available both as a downloadable document and a website, www.piedmontnutrientsourcebook.org (Piedmont Triad Regional Council & Triangle J Council of Governments [PTRC & TJCOG], 2013).

Density Regulations

Both the City and County contain portions of water supply watersheds areas. Categorized as WS-IV critical and protected areas, these watersheds have additional density and buffer

requirements. The watershed overlay district regulations allow for minimum lots size requirements to be waived when single-family residential uses are clustered, as long as an equal number of lots are developed and the remainder of the site remains as open space in a vegetated or natural state. All other uses are restricted to a maximum of 24% built-upon area when public sewer is available. When land development exceeds the low-density option through approval of a cluster development, a minimum 100-foot buffer is required.

While Eden and the northern portion of Rockingham County are not regulated by the Jordan Lake Rules, the will be directly impacted by their implementation. The proximity of southern Rockingham County to the larger municipalities of the Triad (Greensboro, High Point & Winston-Salem) and a lower cost of living has led to more development than the northern portions of the County. However, the adoption of the Jordan Lake Rules in 2009 resulted in stricter development standards in the Haw River watershed. The challenges associated with the Rules have consequences for both new and existing development and will likely drive development out of the watershed and into the Dan and Smith watersheds. Without a regulatory framework to manage growth, the consequences could be severe for the watershed. While the density requirements are not significantly different than those found in the water supply watershed areas, the Rules do require a stormwater management program and additional controls on new and existing development, a mandatory buffer requirement, agricultural reductions and nutrient management as well as outreach, education and public participation (NC DWQ, 2009).

Parking Lot Regulations & Landscaping

Reducing the amount of impervious surface area and increasing the vegetative cover is one of the most effective ways to improve water quality (Figure 61). Neither Eden nor Rockingham County formally recognizes the advantages to reduced parking requirements for mixed use and transit-oriented developments, nor do they make any reductions through the provision of a minimum number of bicycle parking spaces. Both jurisdictions allow some flexibility in meeting parking space requirements by allowing the required parking spaces for any number of separate uses to be combined in one lot. Separate uses whose hours of operations differ significantly have some flexibility in the number of required parking areas. The City of Eden requires one shade tree or two ornamental trees for every twelve parking spaces in all new parking lots (City of Eden, 2012b).

Figure 63: Piedmont Parking Area with Permeable Pavement and Tree Coverage

The City of Eden regulates the protection, removal and long-term management of trees within the City and its extraterritorial jurisdiction. The City adopted the zoning ordinance in order to accomplish the following objectives:

- To preserve the natural beauty and resources of the City of Eden and its extraterritorial jurisdiction;
- To encourage the proper protection and maintenance of existing trees on all public and some private lands;
- To promote the economic health of the community by creating a more attractive environment for residents, tourists and business interests; and
- To protect private property owners' investments by allowing development of land and harvesting of timber, while preserving the value of surrounding properties and aesthetics of the community at large.

Activities requiring a permit include timbering one or more contiguous acres on public or private lands for timbering or development. The removal of trees in a watershed area must also comply with the Watershed Protection Ordinance, the landscaping requirements for parking lots in the Zoning Ordinance, and any public lands, right of way, or easements owned or maintained by the City of Eden or the State of North Carolina (City of Eden, 2012b). Eden has also been a Tree City USA® member for 18 years. The Tree City USA® program, sponsored by the Arbor Day Foundation in cooperation with the USDA Forest Service and the National Association of State Foresters, provides direction, technical assistance, public attention, and national recognition for urban and community forestry programs in thousands of towns and cities (Tree City USA, 2013).

The City also requires a buffer on any river, creek or stream, any public right of way or easement, or any adjoining developed property. A 30 foot timber buffer is required along all perennial waters (as defined in the Watershed Protection Ordinance), and along any portion of timbered area bordering a public park, greenway, trail, or utility easement owned or maintained by the City of Eden. Property that is cleared, but not developed requires two rows of six foot (minimum) evergreens along the length of the property along any adjoining property. Noncompliance is dealt with through stop work orders and development plans or building permits and final inspections all require compliance with the Tree Protection Ordinance. Violations of this ordinance are subject to fines (City of Eden, 2012b).

ENVIRONMENTAL CONSIDERATIONS

Soils

Soil limitations can also make potential land development more difficult or expensive. In the Piedmonts' Triassic basin, dominant soil limitations include hydric (wetland) conditions, rock content, or high shrink-swell potential due to high clay content and moisture fluctuations. Clay soils' higher susceptibility to erosion requires developers to be particularly vigilant and ensure sedimentation and erosion control measures are adequate. Clay soils are prone to shrink/swell impacts which can pose difficult problems for buildings. As soil water content increases, the soil swells. As water content decreases, the soil shrinks and the ground surface recedes and pulls away from the foundation. Soils can undergo as much as a 30% change in volume due to wetting and drying. Building on soils that tend to shrink and swell requires developers to build on concrete slabs or other surfaces that protect the structure from variable soils.

Developers may also face challenges with percolation of water through soils. "Perc" tests are performed before installing a septic system tank. These tests help determine how quickly organic material is absorbed into the surrounding soil. Soil must be capable of absorbing liquid at a reasonable rate or a building permit will not be issued. This would apply only to non-urban growth areas without access to Eden's public sewer services. Soil survey data indicates that large portions of the City's planning area outside of the sewer service area are rated as having slow percolation. In addition to poor percolating soils, the sedimentary rocks underlying most of the Triassic basin (siltstone, sandstone, mudstone, and conglomerate) are poor producers of groundwater, so water wells typically do not yield much water (North Carolina Geology, 2012). Thus, poor percolating soils and limited groundwater supply could be a significant consideration in potential growth areas if public sewer services are not available.

Because the mapping units for soils are only indicative of prevailing soil types in those areas, the actual distribution of hydric, rocky, or shrink-swell soils may differ somewhat from what is shown. Even where such conditions occur, there would likely be a way to undertake urban-type development, although with greater difficulty or expense.

The relationship between water quality and the soils found in the Triassic basin has the potential to endanger water for recreational uses, including swimming and fishing, and more significantly as a drinking water supply. While watershed classifications are currently considered adequate, future development may result in additional regulatory requirements. Working with jurisdictions in the Dan and Smith watersheds to ensure land is developed and

re-developed appropriately with minimal impact to water quality may help prevent a similar rule making process in Rockingham County.

Topographic Slope

Steep slope development poses unique health, safety, and environmental challenges. Rockingham County and Eden currently have no ordinances protecting hillsides and steep slopes from development. Erosion is most intense on steep slopes and along riverbanks where the energy of flowing water suspends and moves soil, requiring stronger erosion control measures. While land disturbance on steep slopes has many of the same problems as similar activity on relatively flat lands, steeper slopes exacerbate these problems.

Several local governments across North Carolina have adopted regulations related to steep slope development. While the level of regulations and guidelines are inconsistent, typical topics include:

- Amount of land disturbance and/or grading
- Amount of impervious surface allowed;
- Building height;
- Road width and slope
- Maximum cut and fill rations for lot and road development;
- Tree removal and replacement;
- Density

Most ordinances apply to properties on slopes between 15 -25%, using a formula that calculates average slope over the entire parcel. Regulations are applied based on average slope (Mountain Ridge and Steep Slope Protection Advisory Committee, 2008). While steep slope ordinances are more common in the mountains, the steep slopes present in the watershed area contribute significant levels of sediment and other pollutants to the waters and could benefit from such policies and ordinances.

Potential future land uses vary in their sensitivity to steep topographic conditions. Structures such as houses and small commercial and institutional buildings may have more topographic flexibility because their small footprints require less grading than large industrial buildings, shopping centers, and schools with their adjoining parking lots.

Another consideration is the land value of developable sites. For high-value sites such as those designated for industrial or commercial use, the costs of grading typically represent a smaller share of total development costs than on lower value sites. Thus, a developer proposing a project on a commercial site may view it as economically feasible even if steep topography calls for excessive grading. Steeply sloping topography is generally concentrated along multiple stream banks and tributaries. The Smith and Dan Rivers run through Eden, causing severe slopes within the city limits. Small tributaries to the Smith and Dan River cause a number of steep slopes between the old village centers of Leaksville, Spray and Draper. The contiguous steep slopes along the Dan and Smith Rivers and tributaries indicate intensive urban development is inappropriate close to the rivers, and that they be reserved for less intensive development and uses.

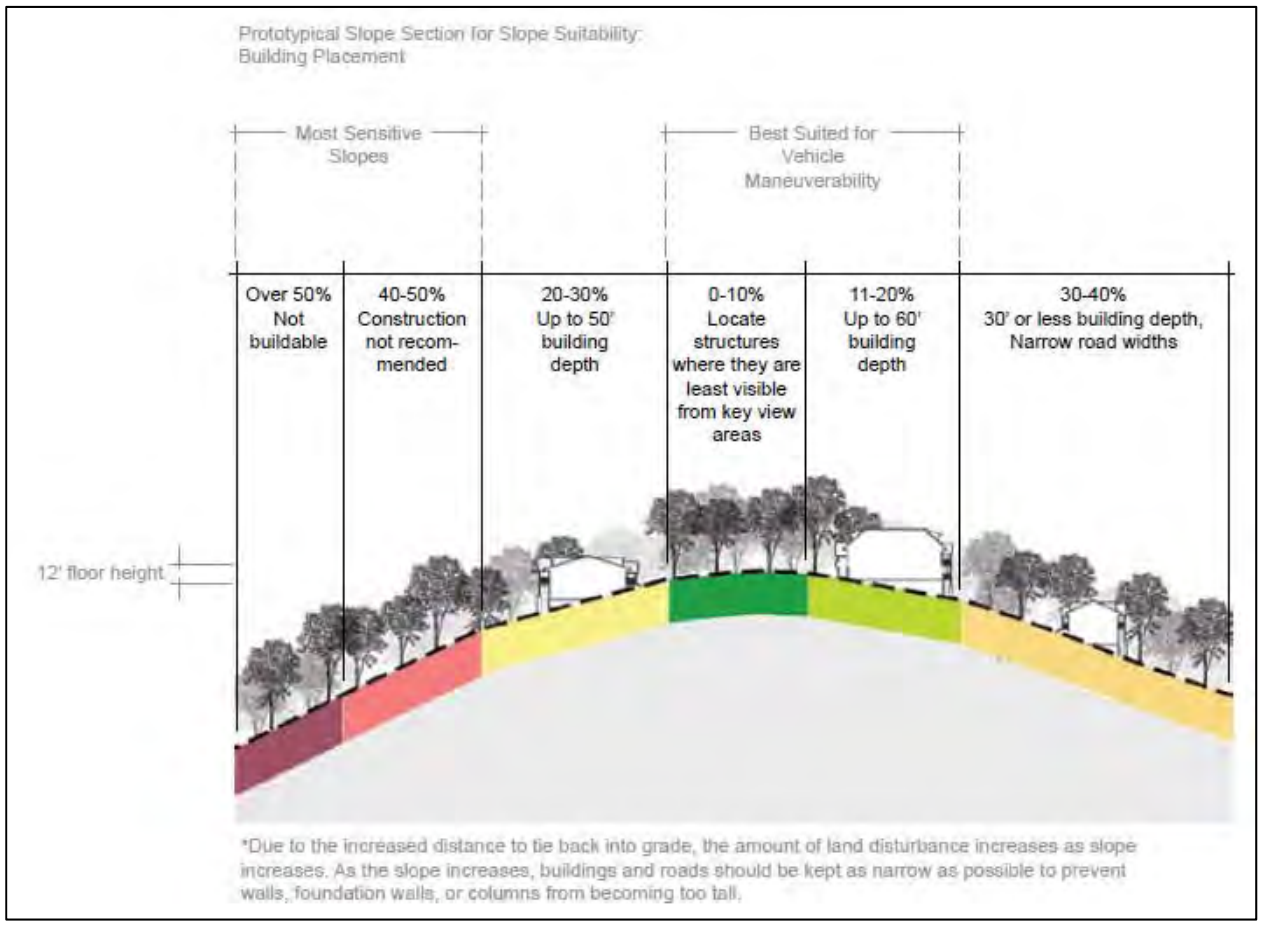

Figure 64: Slope Suitability (Source: Design Workshop, Inc.)

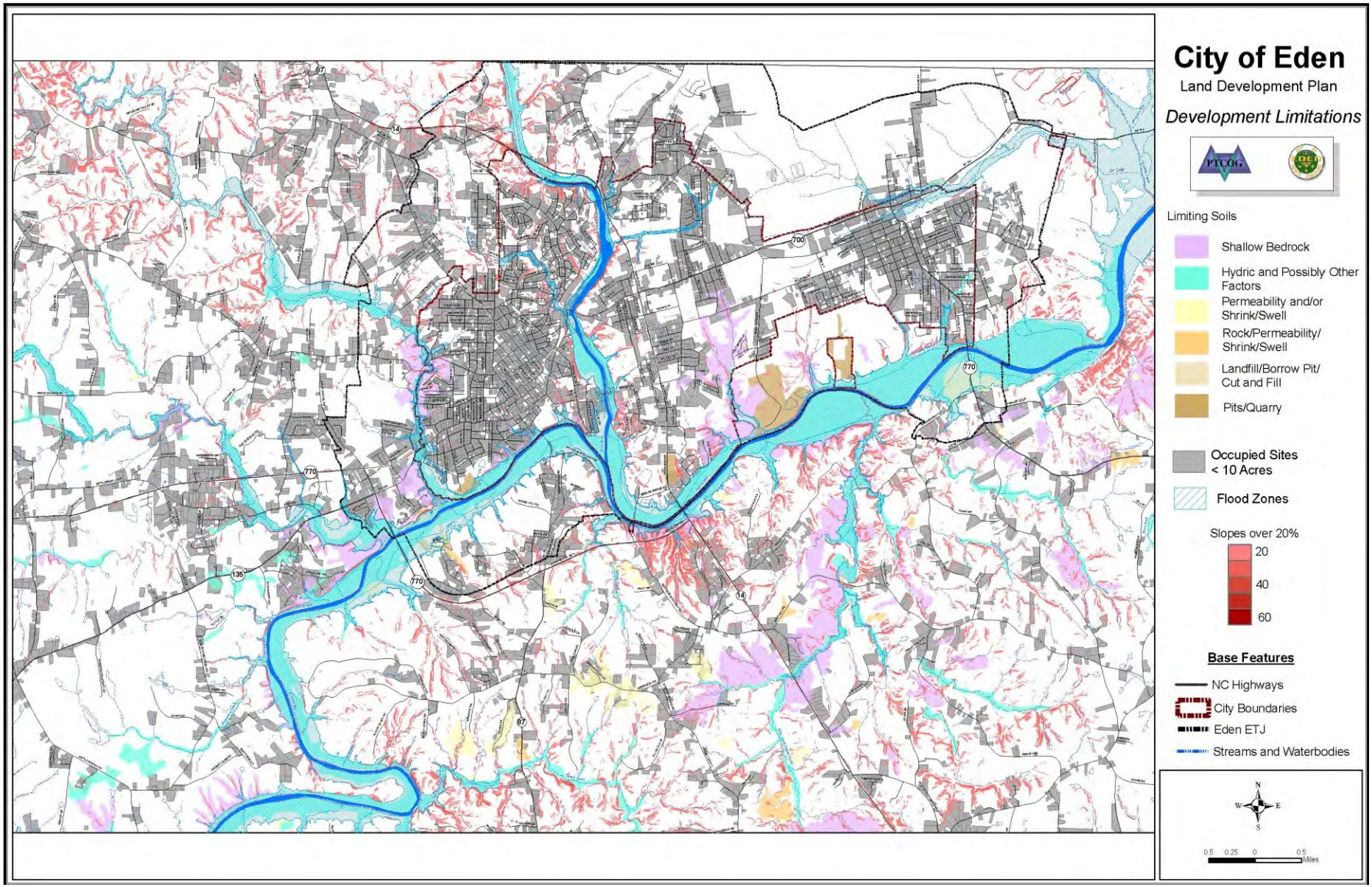

Figure 65: Eden Development Limitations

Floodplain Regulations

Eden and Rockingham County utilize a flood damage prevention ordinance to provide extra protection for public health, safety, and general welfare in flood prone areas beyond those provided through the underlying zoning. Both jurisdictions participate in the National Flood Insurance Program (NFIP) to promote sound development practices within areas vulnerable to potential 10, 50, 100, and 500-year flood events as administered by Rockingham County Emergency Management. A flood event refers to the probability that a flood will occur in any given period. Each of these events has a 10, 2, 1, and .02 percent chance of being equaled or exceeded during any year respectively. For example, the likelihood of a 10-year flood event occurring every year is 10%. This does not mean that every 10 years a flood of this magnitude will occur (Figure 66).

In all areas of special flood hazards (where base flood elevation data is provided) Eden's ordinance requires the lowest floor elevation of any new residential, commercial or industrial structure (or substantially improved existing structure) to be a minimum of one foot above the base flood elevation or freeboard (City of Eden, 2012b).

In areas where base flood elevation data is not available, the City requires: no encroachments, including fill, new construction, substantial improvements or new development is permitted within a distance of the stream bank equal to five (5) times the width of the stream at the top of bank or twenty (20) feet each side from the top of bank, whichever is greater, unless certification with supporting technical data by a registered professional engineer is provided demonstrating that such encroachments shall not result in any increase in flood levels during the occurrence of the base flood discharge (City of Eden, 2012b).

Any development that occurs within the floodplain must be designed to be flood-proofed and anchored, meeting rigorous structural strength. Structures need to be anchored and be in accordance with Article 5, Section B (2) of the flood damage prevention ordinance. Any permits issued in the floodplain require a zoning variance and certification of a qualified engineer for structural integrity.

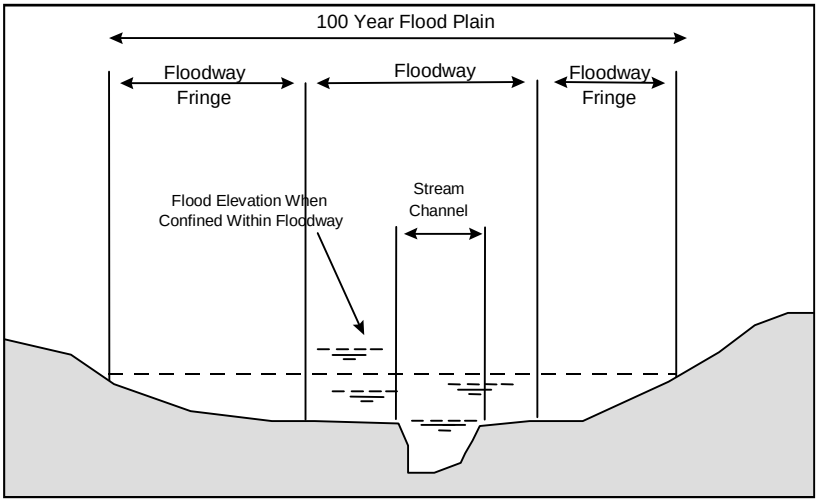

Figure 66: Floodplain Schematic

The Flood Damage Prevention in Rockingham County requires a Floodplain Development Permit for any development activities proposed within the flood prone areas. The lowest floor elevation of any new structure (or substantially improved existing structure) is required to be at least two feet above the highest adjacent grade. All encroachments to special flood hazard areas (including fill material or structures) must be located at least twenty feet away from the top of the bank, or five times the width of the stream at the top of the bank, whichever is greater (Rockingham County Planning Department et al., 2006)

Aquatic Buffers

Maintaining an undisturbed vegetated riparian zone can be one of the most effective ways of protecting water quality. Not only can buffers help trap, filter and process pollutants, they can also help reduce flooding, prevent erosion and provide essential wildlife habitat. A riparian buffer can also be one of the most cost-effective ways to improve water quality, as demonstrated by the NC Ecosystem Enhancement Program's exclusive use of riparian buffer restoration as the lowest cost method of nutrient offsets. Recognizing the value of riparian buffers to water quality, the DWQ implements Riparian Buffer Protection Rules in the Neuse River Basin, Tar-Pamlico River Basin, Catawba River Basin, Randleman Lake Watershed, Jordan Lake Watershed and Goose Creek Watershed. In addition to the State's riparian buffer rules, there are also many local buffer protection programs including those in the watershed study area (NC DENR, 2012a).

Both the Dan and Smith Rivers are listed as impaired for fecal coliform bacteria which impacts their suitability for recreational activities like swimming, wading and fishing. Fecal coliform is measured as an indicator of water contamination by human and animal waste. Contact with contaminated water may carry an increased risk of infection or disease. As the City of Eden and Rockingham County continue to promote the rivers for their recreational value, the need to improve water quality conditions is imperative. A strong buffer network will help bacteria safely absorb into the soil.

The Smith and the Dan are listed as impaired for turbidity and may not be able to support aquatic life which is essential for supporting a healthy ecosystem (NC DWQ, 2013). Turbidity may also impact the recreational value of the rivers by deterring recreational users from swimming, fishing or boating. A strong buffer network

Figure 67: Riparian Buffer (Photo: NRCS)

allows sediment to settle out and be deposited in the buffer, as well as stabilizing streambanks with resilient root networks. It is in the best interest to maintain buffer networks and repair channels which carry runoff directly in the waterbody, rendering the buffered area ineffective for reducing sediment, fecal coliform and other types of pollution.

Both Rockingham County and Eden mandate the use of riparian buffers. Rockingham County requires an undisturbed vegetated buffer of at least 100 feet around a water supply reservoir. A minimum fifty foot undisturbed vegetated buffer is required along all perennial waters. In Eden, a minimum 100 foot vegetated buffer is required for all new development that exceeds the low density option; otherwise, a minimum 30 foot vegetated buffer for development activities is required along all perennial waters. These requirements supercede all known federal and state regulations for riparian buffers in North Carolina. Property that is cleared but not developed requires two rows of six foot (minimum) evergreens along the length of the property along any adjoining property. Noncompliance is dealt with through stop work orders and development plans or building permits and final inspections all require compliance with the Tree Protection Ordinance. Violations of this ordinance are subject to fines. No new development is allowed in either jurisdiction's buffer except for water dependent and public projects including federal and state highways, public utilities and greenways and all activity should minimize built-upon surface area and maximize utilization of Best Management Practices (BMPs).

STORMWATER MANAGEMENT PRACTICES

The City of Eden requires a stormwater management plan for any development in which impervious surface cover will exceed 20,000 square feet. The plan details all pre-and post-development features or BMPs, topographic contours, rate of stormwater runoff from a ten-year storm, proposed drainage structures, infiltration areas, retention or detention ponds, and details and logical calculations and tables showing all design assumptions, methods of analysis, the pre- and post-development runoff qualities, capacities of proposed structures, slopes, sizes, identifying labels, and other information (City of Eden, 2012b).

Design Criteria

Unless the applicant has been approved to discharge stormwater runoff into an existing City stormwater facility, the stormwater management plan should be designed so that the post-development rate of stormwater runoff will not exceed the pre-development rate of stormwater runoff. The stormwater management plan may propose retention either on-site or off-site or by means of a combination of on-site and off-site. If any or all of the stormwater is proposed to be retained off-site, a recorded easement is required (City of Eden, 2012b).

Low Impact Development (LID)

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. Their central goal in regards to stormwater is to effectively reduce a site's impervious cover, and/or direct its runoff onto permeable surfaces (US EPA, 2013). There are no requirements for LID or sustainable development in the watershed outside of floodplain regulations. Rockingham County and Eden have some ordinances encouraging LID, but none that mandate open space or pervious surfaces in all developments.

LID techniques include regulations or ordinances that encourage or mandate land use practices such as cluster development, open space requirements, or pervious surface ordinances. Neither Eden nor Rockingham County require LID or include incentives to include LID or strive for LEED certification. NC requires that all publicly-funded or –owned buildings in the state achieve Leadership in Energy and Environmental Design (LEED) certification. LEED is a federal classification determined by the US Green Building Council (USGBC) that guides sustainability in building construction practices, and awards those sites that achieve their standards. The principles of LID are incorporated into all LEED-certified buildings, and, indeed, often take a larger scope of view to an entire site or landscape when considering construction and environmental impact.

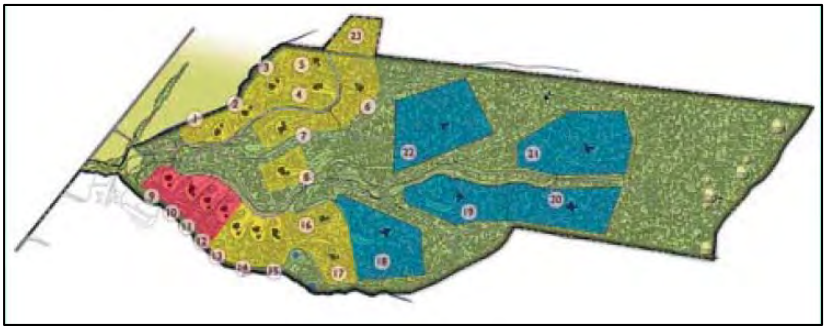

Figure 68: Conservation Subdivision (Source: Equinox Environmental)

Many LID principles regarding land use and intracommunity access are stymied by zoning designations and land use ordinances. Language in "Institutional/Office" or "Residential" 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 and less restricted community development concepts is absent in both the

City and the County. Similarly, zoning classifications are often restrictive to flexible developments that can encourage innovative designs and land uses. Allowances for rezoning that will promote watershed sustainability and health by appropriately mixing land use should be considered by both jurisdictions. Such an approach is new and very different for planners and planning boards, but such flexibility could ensure that LID can be economically attractive and environmentally sustainable.

Both Rockingham County and the City of Eden allow for these LID neighborhoods, and both allow 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. While both encourage Planned Unit Development (PUD) or cluster/conservation development, there are no incentives to use PUD. A conventional subdivision requires less time for review and approval without the restrictions of the PUD. Encouraging open space preservation, mixed-use development of residential and low-intensity commercial lots, and multi-storey buildings close to the urban core have the ability to provide the local public walkable access to necessities and improve residential quality of life.

Figure 69: Rain Garden Collects Roadway Runoff (Source: LID Center)

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. 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 demonstrates the long-term benefits far outweigh traditional building techniques. As Eden continues to grow into a city dependent on the cleanliness of the Dan and Smith Rivers, 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, particularly in those more sensitive water supply watersheds. The need for LID will be further explored in the *Eden Area Watershed Restoration Plan.*

Erosion and Sediment Control

Eden and Rockingham County use the NC Erosion & Sedimentation Control Design Manual when directing developers during new development or redevelopment that exceeds one acre. As they are not NPDES Phase II nor is the watershed in a regulated community, Rockingham County has no post-construction soil and erosion or stormwater control obligations. The City of Eden does have an ordinance requiring developers to develop a stormwater management plan for any development in which impervious surface cover will exceeding 20,000 square feet will address the pre-development rate of stormwater runoff.

Both Rockingham County and the City of Eden rely upon the NC DENR Winston-Salem Regional office to oversee and enforce their federal soil and erosion control requirements for new construction. 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 DWQ has a manual, last updated in 2007, that addresses all of these issues. It is frequently updated to reflect emerging research and technology in stormwater management. The DENR Division of Land Quality 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 Division of Energy, Mineral and Land Resources, 2013). 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.

The regulators at the Winston-Salem 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 DENR and local governments has created a legacy of poor permitting judgment, a poor enforcement record, and ever-degrading water quality.

Inspections, Maintenance, Funding Agreements & Responsible Parties

Because BMPs are managed as water quality treatment devices and not landscape features, inspection and maintenance is required annually, if not more frequently to perform as intended. BMPs require maintenance to ensure hydrologic and water quality function, landscape functions, and consideration of impacts on human health and safety. While specialized training is needed to perform inspection and maintenance activities, it also presents a business opportunity for inspection by licensed professionals such as engineers and landscape architects, and maintenance by landscape and other green industry professionals. As is standard practice, Eden requires the owner of each BMP or stormwater management facility to provide ongoing maintenance through a written inspection and maintenance agreement.

OPEN SPACE DESIGN & MANAGEMENT

Open space design is a method of planning residential development that conserves open space. The same number of homes as would be permissible in a conventionally-zoned development are allowed, but are designed to maximize open space. Both jurisdictions permit open space or cluster development designs in an effort to reduce impervious cover and preserve land, however Rockingham County does not require any additional review requirements while Eden requires Council approval upon recommendation from the Planning Board. Both jurisdictions consider open space or cluster design a by-right form of development and offer flexible site design for developers utilizing this option. The City of Eden has six special use districts zoned for residential planned use development (PUD-R). These districts allow for:

- Flexibility in design to take greatest advantage of natural land, water, trees and historical features.
- Accumulation of large areas of open space for recreation and preservation of natural amenities.
- Greater freedom for the developer to submit plans that embody a creative approach to land use and utilizing innovative techniques to enhance the aesthetic quality of the development.
- Efficient use of land which may result in smaller street and utility and maintenance costs.
- Simplification of the procedures for obtaining approval of proposed development through timely review of proposed land use, site plan, public needs and other relevant factors.

Land not shown as lots or reserved for residential development is considered commonly owned land for the use and benefit of residents of the PUD. Homeowners (through the homeowners association) are responsible for maintaining all commonly owned areas including stormwater BMPs (City of Eden, 2012b, p. 180). While both jurisdictions allow for this type of development, neither have regulatory structures requiring open space design and management. While there are no ordinances or incentives to encourage developers to use open space design, the City of Eden planning department makes every effort to lead the way by incorporating open space design into City planning efforts.

Agricultural Preservation

Rockingham County has a rich agricultural heritage. The County still has a few remnants left from the early days of large plantations but when the industrial revolution settled into America, mills were established on the rivers and became the dominant source of income. What were once large plots of land were broken into smaller parcels and tobacco became the main cash crop. Most folks who tended the crops also worked in the mills. Agriculture was more diversified until after World War II when dairies began to disappear. There were originally over 200 small dairies in the County, but as sanitization rules came into play, most dairies went out of business instead of making the investment to upgrade their facilities. From that time, up until recent times, many farms grew a tobacco crop of modest acreage. When the government stopped subsidizing tobacco, most of the small farms quit. There are now only a handful of farmers growing large crops (the aggregate crop is much smaller than in past years) (Moore, 2013).

Figure 70: Three North Carolina farmers on horse-drawn cart planting tobacco (Source: NC State University)

In addition to tobacco and dairies, beef cattle and timbering have played a role in the County's agricultural history. While there are still a handful of beef cattle, few farms consider it a real business. Timber resources have been poorly managed and today's forest is a result of many decades of loggers going in and taking only the very best trees. Landowner education has been challenging, particularly on forestry issues (Moore, 2013). However, the community remains embedded in their agricultural heritage and are strongly supported through the Rockingham County Soil and Water Conservation District, the Rockingham County Cooperative Extension, and other organizations.

In Rockingham County, farmland preservation overlay districts exist to promote agricultural land uses, protect prime soils, and prevent non-agricultural uses from negatively impacting agriculture as the primary land use. As development spreads beyond existing urban areas, it is not unusual to see "spots" of development scattered throughout a primarily agricultural area. As these developments grow, and as municipal services are extended to these areas, more discontinuity in land uses and urban sprawl often results. Farmland preservation districts help local communities insure that farming remains an integral feature of the rural landscape (Rockingham County Planning Department et al., 2006).

Farmland preservation can protect rural lands, particularly those near urban growth centers, high priority waters and other environmentally sensitive areas. Farmers have a vested interested in minimizing potential water and soil degradation as their operations depend on an adequate supply of clean water and as good soils. While farmland can also be a major source of pollution, if properly managed it can significantly improve water quality by minimizing the amount of impervious areas in a watershed. Integrating programs and policies supporting farmland preservation is integral to protecting water quality. Putting additional funds into managing farmlands should be considered as a cost-effect way to improve water quality.

Rockingham County established Voluntary Farmland Preservation Districts in 2004 to protect and preserve agricultural, silvicultural, horticultural, and livestock lands and activities. Farmland preservation overlay districts provide the farmers that enroll with several benefits, including the ability to defer utility assessments on new water and sewer lines. This district also enables farmers to request a public hearing whenever condemnation proceedings are initiated on their farmland and authorizes counties to inform all purchasers of real property that the property is within one aerial mile of an agricultural area and that certain agricultural activities, including but not limited to pesticide spraying, manure spreading, machinery, tractor, truck operations, livestock operations, sawing, and similar activities may take place in this area to help to reduce the number of nuisance suits from new neighbors (Rockingham County Planning Department et al., 2006).

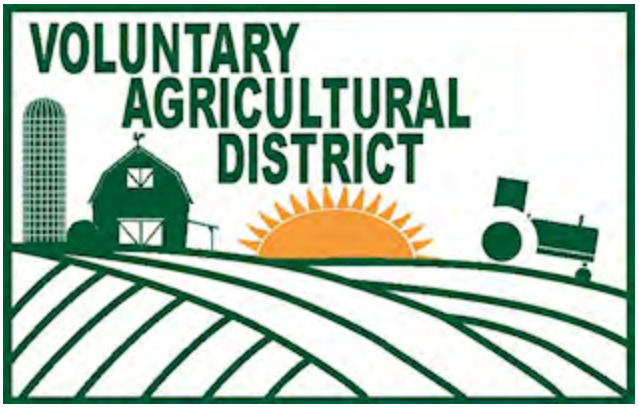

Figure 71: Voluntary Agricultural District Sign

These districts are strictly voluntary and depend on the landowner to apply and enroll to become a part of the farmland district. To execute a farmland preservation district, the landowner must certify that the land is a Qualifying Farmland and sign a conservation agreement to sustain,

encourage, and promote agriculture. This application process must be approved by the Rockingham County Agricultural Advisory Board. Yet, these voluntary districts do not completely protect farmland because the qualifying landowner has the right to revoke (i.e., non-binding) the conservation agreement by written notice to the Advisory Board (Rockingham County Soil and Water Conservation District [RC SWCD], 2013).

In the watershed, just over 44% of the land (102 square miles) is categorized as being used for agricultural and forestry purposes. The majority of this land exists outside of the city in its extra-territorial zoning jurisdiction (ETJ), or in Rockingham County. Within the watershed, there are only two farms registered as VADs.

Land Conservation Programs

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 as well as ecosystem services (i.e. stormwater filtration). There is little protected land within the watershed, and all of those lands that are primarily dedicated to public uses.

Voluntary Agricultural Districts: Landowners of two individual parcels are participating in the voluntary agriculture district (VAD) program, and thereby dedicated to its rural uses. VAD lands must be certified by the Rockingham 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, which often feature conservation practices. These dedicated parcels occupy less than one percent of the entire watershed. As Eden and the urbanized areas of Rockingham County grow, conserving open spaces and agricultural land is necessary to preserving the County's agrarian heritage and maintaining high quality waters (RC SWCD, 2013).

Figure 72: Mayo River State Park

Piedmont Land Conservancy (PLC): The Piedmont Land Conservancy works in the Piedmont Triad to permanently protect important lands to conserve the region's rivers and streams, natural and scenic areas, wildlife habitat and farmland. PLC goals include: acquiring and managing natural areas; protecting endangered or significant native specifics of flora and fauna and preserve areas with significant topographical features; maintaining the ecological integrity of the bioregion, including its air and water quality and biological diversity; fulfilling the human need for scenic land and open space to provide opportunities for learning from and enjoying the natural world; and, enhancing and buffering our communities (PLC, 2013b).

In 2006, PLC partnered with the Piedmont Triad Council of Governments, the Dan River Basin Association and the Rockingham County Soil and Water Conservation District to produce the Dan River Watershed Protection Plan. The Plan was funded by the North Carolina Clean Water Management Trust Fund (CWMTF) using GIS to synthesize information on topography, soils, human infrastructure, land cover and biological resources in the watershed in order to identify priority areas for land protection, stream restoration, and the implementation of Agricultural Best Management Practices" (PLC, 2006). Although not in the study area (Figure 70), PLC has protected 2,248 acres in the Dan River watershed in Stokes and Rockingham Counties (PLC, 2013).

North Carolina Natural Heritage Program (NHP): The Natural Heritage Program conducts inventories and consolidates information about hundreds of rare species and natural communities, ensuring the public is able to get the information that is needed to weigh the ecological significance of various sites and evaluate ecological impacts. This information helps project planners and landowners make land use decisions that have the most benefit for society and the economy while having minimal ecological impact. This information also helps facilitate the establishment of priorities for the protection of the State's most significant natural areas (NC Natural Heritage Program [NHP], 2013). In 1999, NHP produced the *Rockingham County Natural Heritage Inventory*. The report provides a representative survey of the county's natural heritage elements and provides a basis for planners and landowners to appropriately locate new development (Coomans & Bates, 1999).

Rockingham County Community Transportation Plan (CTP): The North Carolina Department of Transportation (NC DOT) also preserves and enhances natural and cultural resources through the transportation planning process. Through identifying environmental features including wetlands, water supply watershed areas and public water supply water sources, NHP inventories, priority conservation lands, and various other resources, NC DOT is able to better conserve and protect the natural heritage of the County (NC DOT, 2010)

POTENTIAL CONTAMINATE SOURCES

Sewer System Infrastructure

The Eden Wastewater Treatment Division manages a collection system consisting of 145+ miles of gravity and force main sewer pipelines. The pipelines are composed of a mixture of clay and ductile iron pipe, ranging in size from 2 to 36 inches. Age of the sewer pipelines range from new to more than 50 years old. Collection is accomplished by gravity from homes

and businesses until it is necessary to pump from low elevations in force main sewer lines that transport the sewage to the treatment plants. There are 20 pump stations in the collection system. These range in size from pumping a few thousand gallons per day to more than five million gallons a day (MGD). All of the city sewer drains, collects or is pumped to the Mebane Bridge Wastewater Treatment Plant (MBWWTP), which can treat 13.5 million gallons per day (City of Eden, 2012).

The *City of Eden Water and Wastewater Master Plan* was originally released in 2003 is the result of a two-year effort to provide a plan that maximizes current infrastructure and guides the expansion of the City's public utilities to meet the demand beyond the planning year 2020. The Wastewater Master Plan evaluated the City's collection system pump stations and treatment facilities based on age, material, and potential for inflow and infiltration problems associated with the different drainage basins and sub-basins in the City (City of Eden, 2007, p. 33).

Figure 73: Sewer Overflow in Eden

The City of Eden spent $13,399,000 on sewer needs between 2002 and 2011. According to their Capital Improvements Plan, they intend to spend an additional $32,249,700 in the next five years to address further outstanding water and sewer needs. To put things in contrast, the Eden's General Fund for all municipal operations in 2012 is $24,429,384, and its Water and Sewer Fund totals $10,806,155. Water and Sewer capital projects represent 44% of this budget. Its sewer fund alone represents 25% of all municipal expenditures. Yet, the Eden Comprehensive Water and Wastewater Master Plan identified $93,963,000 in pressing water sewer repair and enhancement needs. Not accounting for inflation, the City will have addressed 49% of all known needs in its infrastructure systems by 2017.

These investments are both a part of maintenance and operations by the Environmental Services Department, but also in response to a 2007 NC DENR Special Order of Consent (SOC) to address inflow and infiltration impacts causing sanitary sewer overflows (SSOs) at one of its older pump stations and a 2012 US EPA Administrative Order (AO) requiring the City to address the over 150 SSOs it experienced between 2006 and 2011, violating the clean water protections within its NPDES wastewater permit. The NC DENR was satisfied that the City had

complied with its needs, and terminated the SOC in 2009. The US EPA AO is still standing, and guides all sewer maintenance and improvement projects by the City. Among other requirements, the US EPA AO requires Eden to develop a System Evaluation and Rehabilitation Plan that features a Capacity Assessment Plan and Report and a Sewer System Evaluation Survey. The City has two years to comply with the AO.

Though some of these water, sewer, and stormwater projects have been supported by federal and state grants, much of the funding for these efforts have come from local taxpayers in the City of Eden. With only about a year left in the two-year compliance timeline for the US EPA AO, the City is going to need external sources of funding to reach its infrastructure improvement goals. Many of these investments were not made in the past, when the needs were apparent and the remedies would have been more affordable, but short-sighted decision-making has burdened the City and the larger public of the state and the nation with these financial obligations. In addition to serving immediate needs, augmented funding by external sources will allow support of improvements in water quality in other ways – namely stormwater management, landowner education, and stream bank stabilization.

The UNC Environmental Finance Center (UNC EFC) maintains an interactive dashboard designed to "assist utility managers and local officials analyze residential water and wastewater rates against multiple characteristics, including utility finances, system characteristics, customer base socioeconomic conditions, geography and history" (UNC Environmental Finance Center [UNC EFC], 2012). As of March 2012, the residential wastewater rate in Eden was $21.25 per 5,000 gallons and the business/commercial/industrial water rate was $5,140.32 per 1 million gallons. Both of these values are significantly below the state residential average of $36.40 and median of $33.50 and the business/commercial/industrial average of $5,751.47 and a median of $5,060 (UNC EFC, 2012). However, in both the residential and commercial sector, billing rates have increased exponentially since and are set for an additional increase in January 2013 (City of Eden, 2012).

The City of Eden currently has adequate sewage capacity for the foreseeable future; however, portions of the system require upgrading. As new land development occurs additional demand will be placed on both wastewater treatment plants. Therefore, it is recommended that the City identify potential future sewer service basins to help determine logical and cost-efficient ways to expand its sewer collection system over time and to coordinate the provision of sewer services with existing and future land development within each basin. The City may consider making strategic investments in new gravity sewer lines, to encourage land development in the most appropriate locations, and to reduce the need for costly pump stations and force mains, as new development occurs.

In addition, as the City acquires sewer easements for its future wastewater collection system expansions, it can simultaneously acquire rights for future greenway and recreational trail system development, providing safe and convenient pedestrian access among public uses, neighborhoods and businesses.

The County has minimal wastewater infrastructure but coordinated construction on the Wentworth sewer system that serves the County's Governmental Center, Rockingham Community College, and various institutional, commercial, and residential customers in the central Wentworth area. This system has recently been expanded east to serve the area along NC 65 and NC 87 between the Rockingham County High School and Sandy Cross Road. Wastewater collected by this system is pumped to the City of Eden for treatment and disposal. The County's Wentworth wastewater collection system has a maximum discharge capacity of 218,000 and is operating at an average daily flow of 61,500 gpd (Rockingham County Planning Department et al., 2006, p. 32).

Agriculture & Animal Feed Lots

There are regulations for runoff from animal feeding lots in Rockingham County. The County currently has no active permitted site for animal operations consisting of swine, cattle, poultry and horse farms that have Certified Animal Waste Management Plans (CAWMO) (NC Department of Environment and Natural Resources, 2012). County Poultry operations are exempt from regulatory oversight. In addition to following State O200 animal regulations with regards to animal feed lots and waste regulation; Commercial Feeder Operations require a 20 acre minimum lot size and must seek approval from the Rockingham County Health Department. 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 (RC SWCD, 2013).

Brownfields

In 2008, PTRC inventoried potential brownfields sites in the City. Brownfields are sites that have, or are perceived to have contamination and range in size from a single lot to multiacre postindustrial sites (Piedmont Triad Council of Governments [PTCOG], 2008). Though traditionally thought of as eyesores, brownfields have the potential to transform communities (American Planning Association [APA], 2013). Ten sites were identified as potential brownfield sites including a large lot on the banks of the Dan River (PTCOG, 2008).

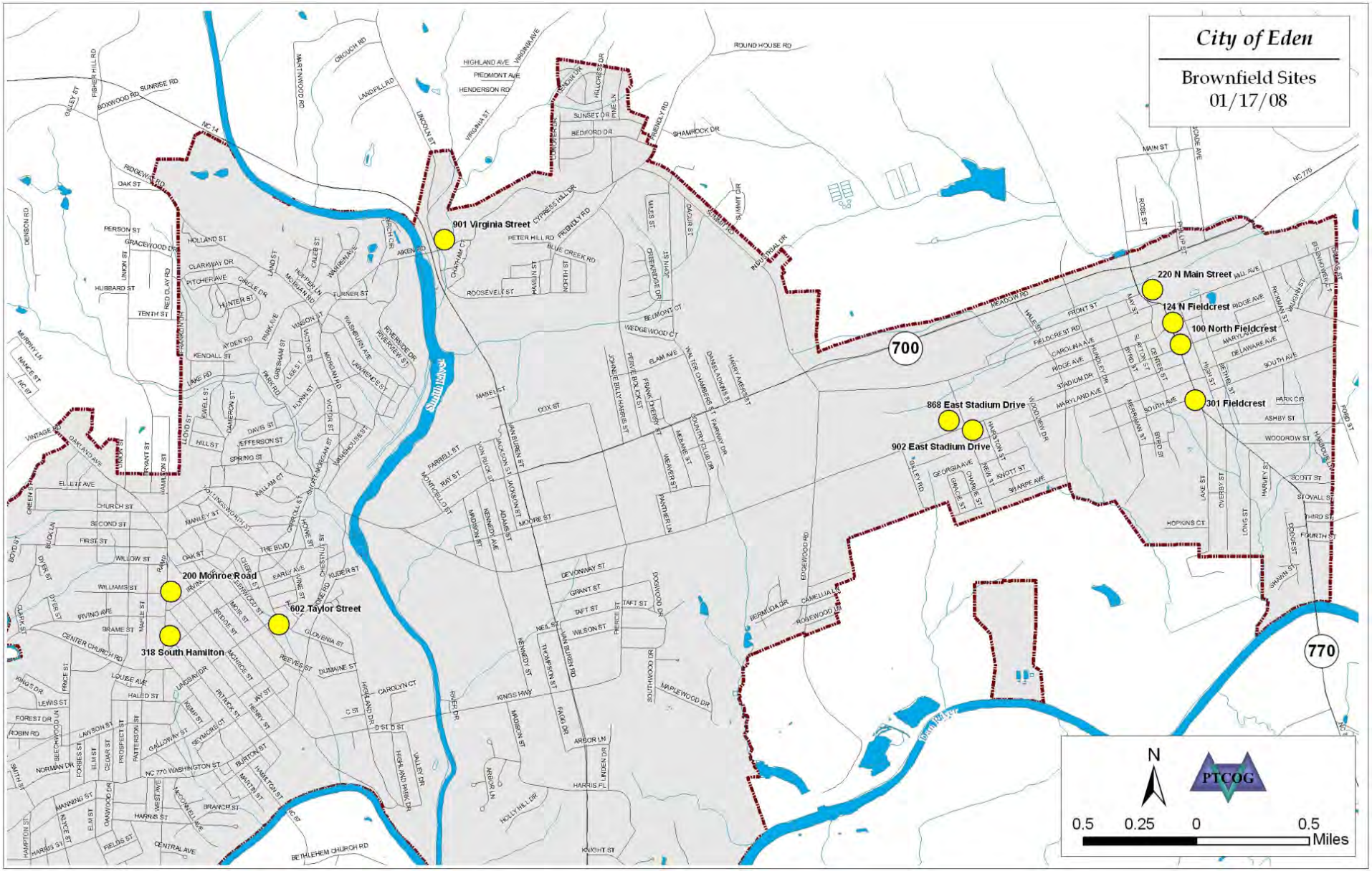

Figure 74: Eden Brownfield Sites

Hazardous Waste & Spill Response

The County zoning ordinance limits landfills and hazardous materials operations to specific districts and requires a special use permit to minimize negative impacts. The Rockingham County Inventory and Spill Containment Plan has been in effect since 1994 and identifies industries within watershed boundaries which use or manufacture chemicals that may pose a threat to the water supply. Volunteer fire departments are responsible for containing the spill until the site can be cleaned by a private contractor. The County also updated their *Hazardous Mitigation Plan* in 2010 which further addresses disaster response, hazardous materials spills, hazardous waste storage, and other emergency concerns for all county jurisdictions and citizens (Rockingham County, 2010).

TRANSPORTATION PLANNING

Highways, roads and related infrastructure such as parking lots compromise two-thirds of all paved surfaces in the U.S (American Rivers, 2013). Roads collect pollutants from tailpipe emissions, fluid leaks, and brake linings, and other pollutants which wash into rivers and streams during storms. Many brake pads contain heavy metals that wear away little by little. As the metal breaks down, small amounts of dust are released each time the brakes are applied. Brake pads may contain lead, zinc, and as much as 20 percent copper, which is toxic to aquatic life at the base of the food chain and may cause health problems (US EPA, 2013a). The Smith River is listed as impaired for copper on the North Carolina 303(d) making the need to address copper an immediate concern (NC DWQ, 2013).

Airborn pollutants from exhaust pipes can deposit back onto land and water, and can be an important contributor to declining water quality. Pollution deposited from the air can either be deposited directly into surface waters or be deposited onto land and carried by stormwater into nearby waterways. These pollutants can have negative health and environmental impacts including contaminating fish, causing harmful algal blooms, and may result in unsafe drinking water (US EPA, 2012).

An increase in impervious surface area also increases the possibility of flooding and sewer overflows. In addition to property damage, flooding can cause significant health hazards and result in significant costs for counties and municipalities. Encouraging alternative transportation and mitigating stormwater runoff are common methods to reducing stormwater pollution from roads and highways. There are a variety of resources available to minimize impacts from existing and future expansion of transportation networks. “Green Street” initiatives are becoming more common across the country. A Green Street is a sustainable stormwater practice that meets regulatory compliance and resource protection

goals by using natural systems such as sidewalk planters and street trees approach to manage stormwater, reduce flows, improve water quality and enhance watershed health.

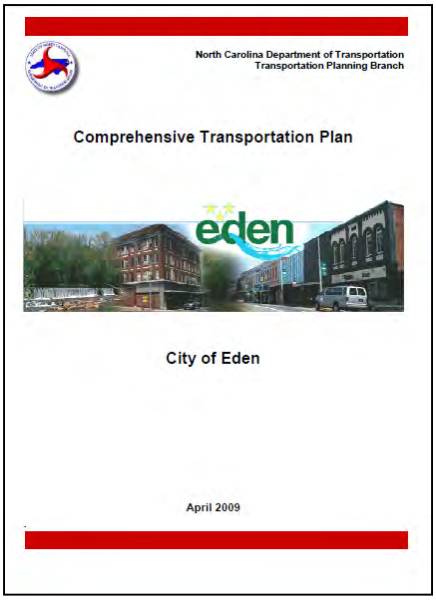

Figure 75: Eden Comprehensive Transportation Plan

The Eden Area watershed falls under the jurisdiction of the Piedmont Triad Rural Planning Organization (RPO), which "…provides long-range transportation planning services and related information to citizens in five rural counties," including Rockingham County. The RPO is housed at the PTRC. Eden and Rockingham County partnered with the RPO to produce comprehensive transportation plans (CTPs) in 2007 and 2010, respectively. CTPs are developed to serve as "an official guide to providing a well-coordinated, efficient, and economical transportation system for the future of the region" (NC DOT, 2010). Both CTPs recommend major upgrades and construction to meet current and future transportation needs. Eden's CTP recommends improvements to NC 14-87, NC 14-87 (Bypass), SR 2066 (W. Kings Highway), SR 3003 (W. Meadow Road), an extension of Harrington Highway, and the West Draper Spur, a new route constructed from NC 770 to the proposed Harrington Highway Eastern Extension. In the County, improvements in the watershed include US 220 and NC 14. If all new and expanded infrastructure identified in the CTPs were implemented, the watershed would accumulate an additional 41 acres of impervious surface. Two bridges, one on the Dan River and one on Matrimony Creek would negatively impact water quality as well.

The Environmental Impact Statement (EIS) for major projects identifies impacts to wetlands, wildlife, water quality, historic properties and public lands. Eden's CTP identifies wetlands, threatened and endangered species, historic sites, archaeological sites and educational facilities as factors considered in the development of the Comprehensive Transportation Plan. The Plan requires impacts to sites be avoided or minimized to the maximum extent practicable. Areas with threatened or endangered species may require a detailed field investigation prior to the construction of any highway project (NC Department of Transportation [NC DOT], 2009). Numerous environmental features were identified in Rockingham County which would require a more detailed environmental study prior to implementation (NC DOT, 2010). Both CTPs are significantly more detailed and take environmental factors into consideration more so than any other municipal or county planning documents.

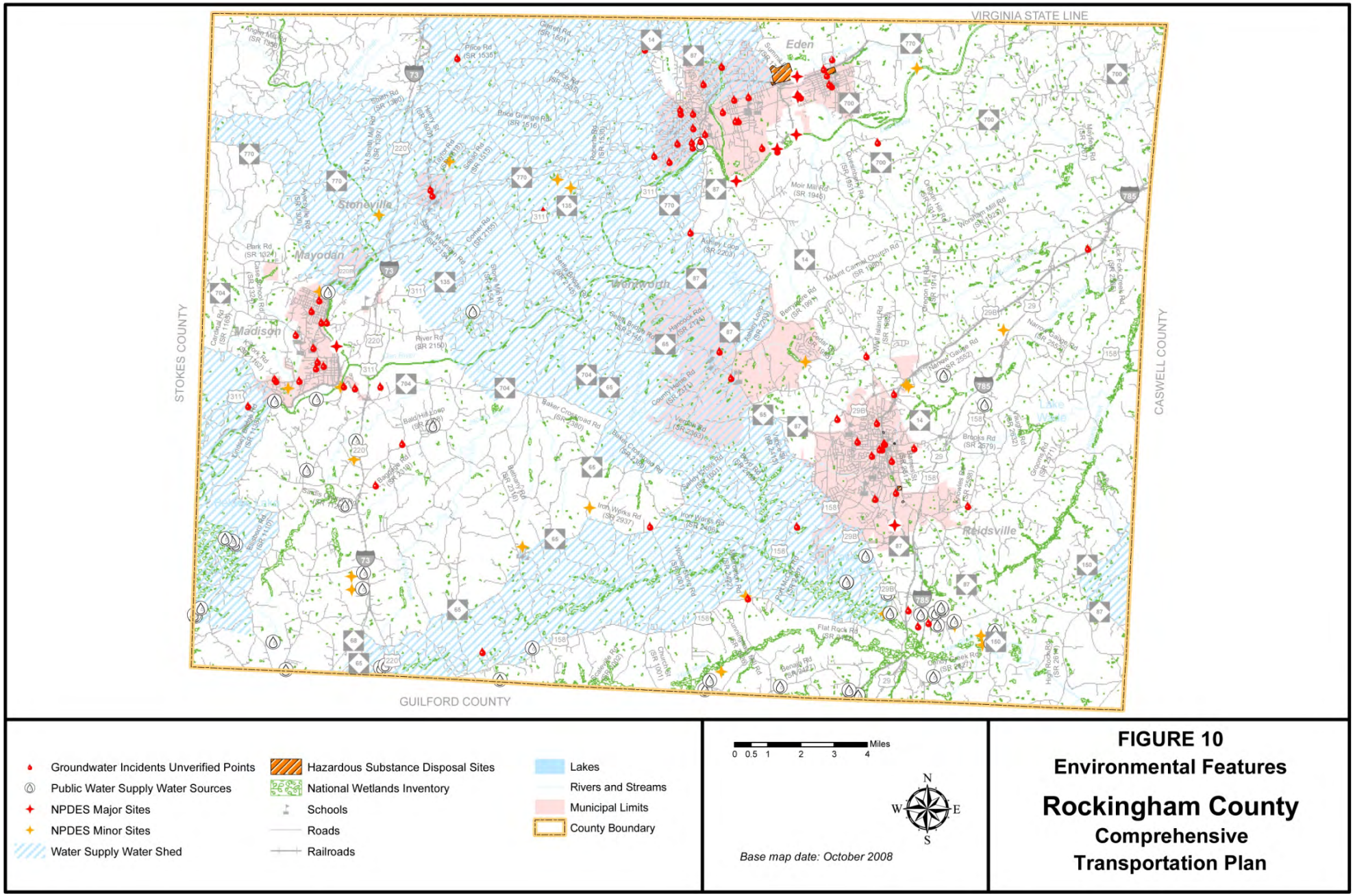

Figure 76: Rockingham County CTP Environmental Features

Public Transportation

Neither Eden nor Rockingham County currently has a fixed-route bus system nor are there any plans for a rail (NC DOT, 2009, p. 14) (NC DOT, 2010, pp. II-10). Likewise, there are no park and ride lots to take advantage of the regional transportation services, although several potential locations have been identified in the County. The area is not served by the Piedmont Authority for Regional Transportation (PART) or any other regional transportation system. Both CTPs recognize the important role bicycles and pedestrians play in the region and are working to improve mobility. Inventories of existing and planned bicycle and pedestrian facilities include "The Piedmont Triad RPO Regional Bicycle Study," the "Piedmont Triad RPO Sidewalk Inventory," and the "Eden Greenway Master Plan".

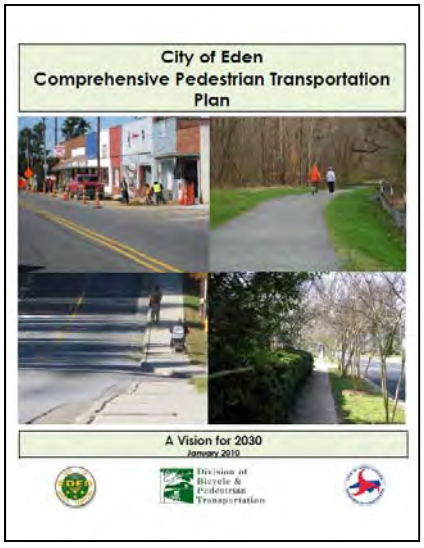

Figure 77: Eden Comprehensive Pedestrian Transportation Plan

Greenways

Greenways serve an important transportation need and can act as a unifying element to link neighborhoods, schools, parks and other land uses together. Greenways can be especially valuable because they are usually created as independent transportation elements that provide an alternative to the automobile and can help reduce traffic congestion and air pollution. When following streams, greenways provide environmental buffers, help reduce pollution caused by surface runoff, and often result in rapid reporting of leaks and illegal dumping to staff (WK Dickson, 2007). Although greenways can provide benefits, they may also impact aquatic and terrestrial wildlife habitat. Paved greenways can contribute to surface runoff, culverts for greenway crossings can impede aquatic life movement if not properly installed and/or maintained, construction of greenways immediately adjacent to streams can disrupt wildlife movements and fragment wildlife habitat (NC WRC, 2012). When designing greenways, transportation planners should make every effort to minimize these impacts.

Figure 78: Rockingham County Greenway

The physical and psychological health benefits of greenways and open space are also significant. A growing body of research indicates greenways and green spaces relieve anxiety and improve our ability to cope with

stress. In some instances nature has been shown to improve cognitive function and work performance as well as alleviate symptoms from conditions such as Attention Deficit Disorder. In addition, trails and open spaces provide safe places for kids to play outdoors which is a vital component in their development (Carolina Thread Trail, 2012).

In 2007, City of Eden released the "Eden Greenway Master Plan." The master plan includes maps and the overall vision of the many hours of collaboration between the City of Eden, its citizens, and WK Dickson. The goal of the Plan is to create a trail system that links the communities of Leaksville, Spray, and Draper, stimulating economic growth as well as conserving the City's natural resources. The completed greenway will provide recreational opportunities for residents as well as visitors, promote healthier lifestyles, improve the water quality of the rivers through preservation, education and awareness while protecting the environment for wildlife. The trails system will link districts, neighborhoods, and historical sites to the rivers and to one another and encourage the use of pedestrian and other non-motorized transportation creating a cleaner, healthier, and more livable city (WK Dickson, 2007).

The long range plan is to connect the future greenways of Eden to other greenways in Rockingham County as well as to other nearby greenways, parks, and trails including the Mayo River State Park and the Smith River Greenway in Virginia (WK Dickson, 2007). Construction of planned greenways has been challenging due to funding and land acquisition constraints. Eden continues to pursue greenway construction by integrating them into wastewater improvement projects. Not only is this a more cost effective approach, it eliminates the need to acquire easements which can be costly and time consuming. To date, only the Smith River Greenways in Eden has been constructed, however the City's dedication to establish a greenway system is demonstrated through the creation of the *Eden Greenway Master Plan*.

Rockingham County Pathways is a long range plan that strives to work with Rockingham County municipalities, citizens, business owners, and landowners to identify and prioritize opportunities to create recreational trails throughout the County. In addition to completing and adopting a plan, the project recommends to establish an

Figure 79: Rockingham County Pathways

implementation committee, a formal partnership between the County and its municipalities, apply for additional grant funding for implementation, draft trail easement dedication requirements for subdivisions in the County ordinance where proposed trails exist, hold events to support trail funding, complete an ATV trails master plan and execute a maintenance plan and agreement for existing, planned and future trails (Dan River Basin Association & Piedmont Triad Regional Council, 2012).

Transportation planning should aim to achieve Transit Oriented Development whereby land uses are mixed and encourage higher development density around public transportation hubs, providing needed ridership and minimizing urban sprawl, which is driven by road and sewer construction.

STEWARDSHIP

Stormwater SMART (Stormwater Management and Recovery of the Triad): Stormwater SMART is a stormwater outreach and education program primarily concentrating on the requirements of NPDES Phase II communities and communities subject to the Jordan Lake Rules. The southern portion of Rockingham County is in the Jordan Lake watershed and is required to provide an outreach and education program to meet regulatory requirements. Because the program covers the County in its entirety, citizens in the northern portions of the watershed receive outreach materials, programs and other services including representation at fairs and festivals, K-12 school programming and involvement with local civic and community groups.

Figure 80: Stormwater SMART Stream Monitoring

Dan River Basin Association (DRBA):
DRBA "preserves and promotes the natural and cultural resources of the Dan River Basin through stewardship, recreation and education" (Dan River Basin Association [DRBA], 2013). DRBA serves the Dan River in Virginia and North Carolina, offering a regional approach to stewardship, recreation, education and regional tourism. DRBA preserves the river corridor through working with municipalities and counties, state parks and trails associations, increasing public access to rivers, building constituency for the rivers and outdoor recreation through monthly outings, protecting water quality through monitoring, promoting regional nature and heritage tourism and bridging boundaries to create a bi-state community (DRBA, 2013).

Figure 81: DRBA Volunteers (Photo: DRBA)

Piedmont Land Conservancy (PLC): The PLC Stewardship program ensures lands protected through conservation easements are "cared for in a manner consistent with the site's ecological riches and the terms agreed to by all involved parties" (PLC, 2013a). Through the stewardship program, PLC ensures easement terms are upheld forever, landowner relationships are maintained and strengthened, acquired lands are placed with the most appropriate steward for the long-term benefit of the land and its ecological riches, serves as an example of high quality land stewardship that other landowners can follow, and adequate financial resources are available to carry out the Stewardship Program and legally defend easement terms (PLC, 2013a).

Rockingham County Soil and Water Conservation District (RC SWCD): The Rockingham County Soil and Water Conservation District conducts school programs to 4th and 6th grade students in Eden addressing watershed and the water cycle. Students also write essays and produce PowerPoints and design posters addressing water related topics (Overby, 2013). RC SWCD also participates in the area Envirothon, a student competition designed to help students learn about our natural resources (RC SWCD, 2013). In addition to their education efforts, Rockingham was one of three counties to receive funds from a 319 Grant for nonpoint sources received by the NC Division of Soil & Water Conservation. The three year grant allowed the Districts to cost share with landowners interested in implementing best management practices (BMPs) on agriculture land within the Dan River Watershed. Prior to the completion

of the 319 grant in March 2012, the NC Division of Soil & Water Conservation applied for and received a second cycle 319 Grant that will end on December 31, 2014 to continue the work started in the first cycle. Funding provided in the second cycle for the installation of BMPs included $238,000 to be divided between Stokes, Rockingham and Caswell counties (Stokes County Soil and Water Conservation District [SC SWCD], 2012).

Virginia Department of Conservation and Recreation (VA DCR): The Virginia Department of Environmental Quality (DEQ) developed bacteria Total Maximum Daily Load (TMDL) standards for the Dan River and its tributaries. To improve conditions in impaired streams, VA DCR is conducting intense public outreach with citizens and representatives from various state and federal agencies, counties and municipalities, nonprofit groups and the West Piedmont Planning District Commission (VA DCR, 2012). Development of the TMDL Implementation Plan (IP) in the Smith River watershed includes several layers of public involvement. Because no implementation plans had yet been developed in this area of the state, a kick-off meeting was held to introduce local stakeholders including governments and other organizations to the process of IP development. At the first public meeting, the contractor developing the IP presented similar, more specific information about the TMDL and the IP. Directly following the public meeting were the first sessions of the Agricultural and Residential/Urban Working Groups. In these meetings, DCR solicited input from stakeholders about issues in the watershed, local perceptions about bacterial water pollution and pollution prevention strategies, the technical and financial needs of implementing these strategies, as well as potential programs/organization in the watershed that may be able to assist with implementation. Next, local representatives were invited to a Government Working Group meeting to identify funding and technical resources available to assist with implementation in the watershed, evaluate the potential for collaborative water quality protection efforts, and consider regulatory controls that may compel actions to improve water quality. A second set of Agricultural and Residential/Urban Working Group meetings allowed working group members to review the numbers and costs of implementation measures proposed in the draft IP to ensure they seem reasonable and feasible. Finally, a Steering Committee composed of representatives from each of the Working Groups convened to review the minutes of each meeting and make recommendations on finalizing an IP that best suits the needs and represents the interests of local stakeholders while ensuring the water quality goals will be met. The document agreed upon in the Steering Committee meeting was presented at a final public meeting before being made available for a 30 day public comment period (Vereb, 2013).

SECTION 5: WATERSHED FIELD ASSESSMENTS

Fieldwork assessments can identify the most promising and effective restoration projects within a watershed, and preserve or enhance those sites that already benefit the watershed's ecological and human communities. GIS-based assessments are invaluable in characterizing watershed conditions, and it is fast becoming the preferred interface with water quality data. However, direct evaluations of field conditions are necessary to "ground truth" the computer-based conclusions, and can lead to relationships with watershed residents that can directly and immediately improve water quality. Furthermore, direct field analyses are the only ways in which to evaluate watersheds for illicit discharges, (most) illegal dumps, residential riparian buffer needs, and the potential for lands to be protected as preserved habitats or passive recreational features.

Table 5: Eden Area Watershed Priority Subwatersheds

SUBWATERSHED NAME	ASSIGNED SUBWATERSHED #
BUFFALO CREEK	1
LITTLE MATRIMONY CREEK	3
MATRIMONY CREEK/SPRAY	4
DRAPER	8
DAN RIVER DOWNSTREAM OF EDEN	15

Based on the initial computer-based watershed characterization conducted by PTRC, the Eden Area watershed stakeholders concentrated limited resources and staff time to conduct rapid streambank assessments of five of the fifteen delineated subwatersheds: 1, 3, 4, 8, & 15 (Figure 82; Table 5). Selection of these priority subwatersheds was based upon stakeholder priorities, as well as identification of likeliest sources of impairment through GIS analysis. While such assessments would benefit watershed restoration efforts and water quality conditions in the Eden Area watershed, they were not eligible for this work, and no entities in Virginia were prepared and/or funded to concurrently conduct rapid stream assessments. As such, five of the eleven subwatershed found partly or entirely within North Carolina were assessed by three field teams staffed by the PTRC and contracted consultants.

The public and stakeholders' concerns for the watershed are flooding, especially in the Matrimony Creek subwatershed, and unknown rural sources of sediment. Given the uniform nature of these concerns, and the stakeholder interests in improving rural and urban watershed conditions, it was determined that resources were needed to survey both urban and rural conditions. Consequently, all of the City of Eden is represented in this assessment in subwatersheds 4 & 8; conditions downstream of the City were assessed in subwatershed 15; Matrimony Creek and its headwaters were directly assessed in subwatersheds 3 & 4; and rural watershed conditions were provided a reference example in subwatershed 1.

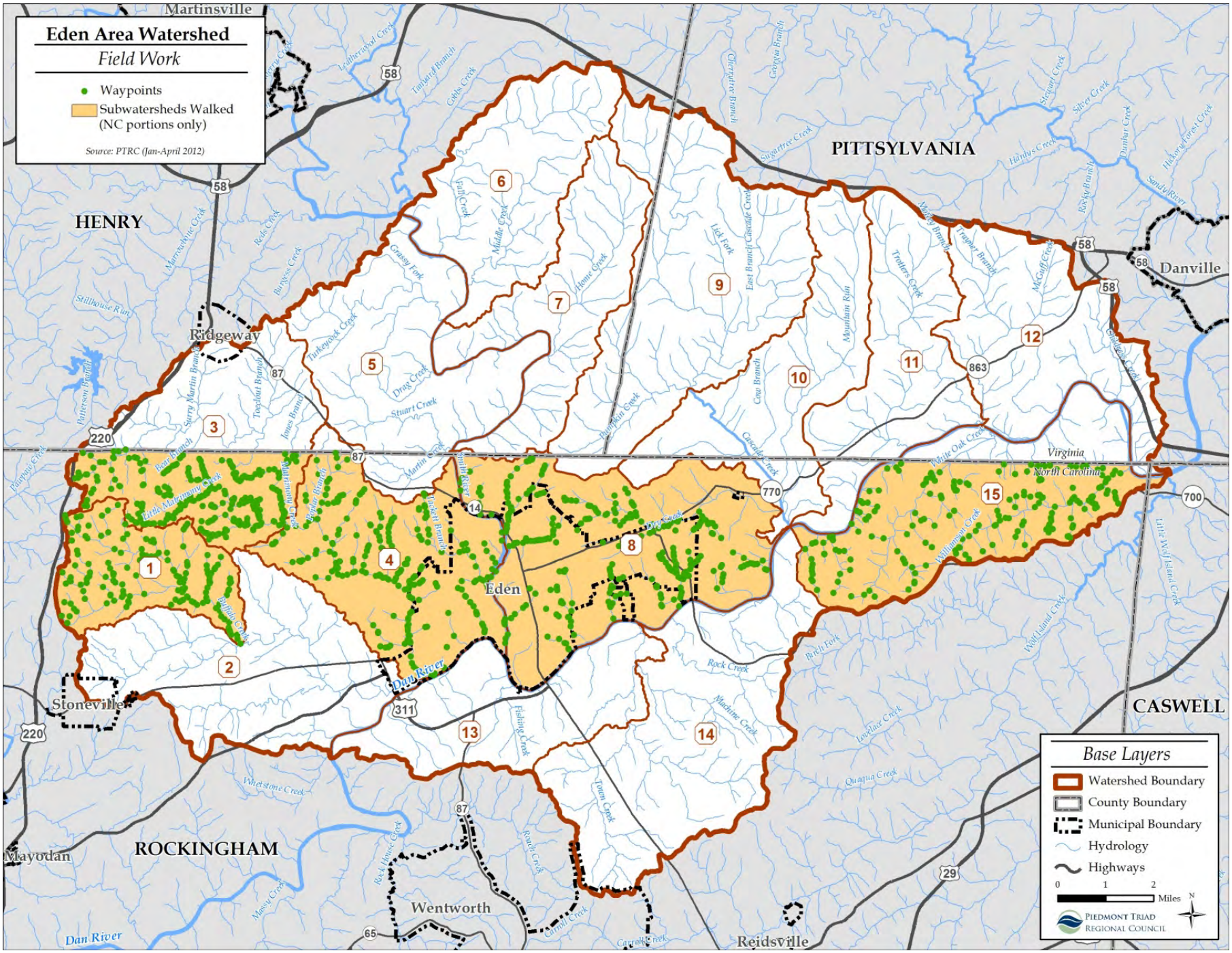

Figure 82: Eden Area Watershed Priority Subwatersheds and Recorded Improvement Sites

RESULTS

Rapid Stream Assessments

The Eden Area watershed streams and rivers were directly analyzed using fieldwork guided by local knowledge of impaired areas, DWQ monitoring sites, and relevance to flooding concerns. Data collection was overseen by Cy Stober, PTRC Water Resources Manager, to ensure it was done consistently by the field teams: at each impact, a GPS point was taken, at least one digital photograph was taken, and a brief description of the impact and the apparent water quality was noted on a spreadsheet, which had twenty-one categories to which an impact could be ascribed (Appendix C). PTRC Water Resources and Planning staff provided support for the field work in the Eden Area watershed.

These evaluations were loosely based upon the NC State University (NCSU) Water Quality Group's *Stream Restoration Evaluation Assessment Form* (NCSU, 2006). Adapting the methodology of this document to ensure efficiency and rapid progress in data collection, the consultants and the PTRC used a combination of basic spreadsheets records, photographs, and Global Positioning System (GPS) units to identify potential sites for restoration or conservation efforts.

In an attempt to determine the sites of greatest ecological benefit and/or restorative need, this project's field work was led by a staff of three private ecological consultants: Ms. Moni Bates, Mr. Joe Mickey, and Mr. Dick Everhart (see Appendix A for consultant credentials and experience). Expert field consultants are necessary when assessing the resident watershed conditions for rare, threatened, or endangered ecosystems. The NC Natural Heritage Program offers stakeholders guidance in this regard, but the Rockingham County assessment was done in 1999 and may not reflect current land use and environmental conditions.

Fieldwork was initiated the week of February 6, 2012, and lasted through April 2, 2012. The winter of 2012 was highly unusual, being much hotter and drier than the historic averages for these months (Table 6). Only one illicit discharge from a septic tank was observed, which would be remarkable in any watershed, and seems unlikely with almost the whole rural population on septic systems in this watershed.

Table 6: 2012 and Historic Temperatures for February & March in Rockingham County (Weather Underground, 2012)

	TEMPERATURE (°C)	PRECIPITATION (INCHES)
FEBRUARY, 2012	44	0.94
FEBRUARY, HISTORIC AVERAGE	41	3.52
MARCH, 2012	58	2.77
MARCH, HISTORIC AVERAGE	49	4.31

Many of these discharges are the product of rain events that were seldom seen over the eight weeks of field assessments. Similarly, the impacts of flooding to the watershed may have been underserved by field assessments, as they were not observed during this dry period. Identification of persistent sediment loading sites were also probably underrepresented due to a lack of rain events that would aggravate erosion. Lastly, it is likely that assessments of livestock access to streams were underserved due to most of them being penned up for the winter. That is an accepted consequence of conducting winter field work and understood by watershed stakeholders.

Three teams of two were assigned subwatersheds for detailed study, and they were expected to walk every stream mile within those subwatersheds that was obtained from the National Hydrologic Dataset (NHD) and represented in maps. Among the three field teams, approximately 69 square miles of subwatersheds and 300 linear stream miles were directly assessed over eight weeks, using CWP and NC State University stream assessment protocols as guidelines for data recording (including written descriptions, photographs, and notation of significantly poor or excellent sites)

Watershed assessment data were collected in an Excel database and incorporated into a GIS Geodatabase, and are available in both formats upon request. In summary, the Eden Area watershed rapid stream assessments offered 2,091 individual opportunities identified at 1,172 sites to improve watershed function and health (Table 7). Most of these opportunities had multiple advantages if addressed (i.e. wetland restoration + buffer enhancement + stormwater improvement), which actually created more restoration opportunities than sites noted on maps (Figure 82).

As expected from feedback and concerns stated by the Stakeholders Committee and public as well as the water quality records, the opportunities were evenly distributed throughout the watershed, with rural non-point source controls needed as well as improved urban stormwater and wastewater management. The majority of these needs were for stream enhancement, landowner education, and “other,” a catchall category that allowed field teams to recommend a more tailored approach for that particular concern.

Many impacts were evenly distributed throughout the watershed, though there are notable exceptions. Subwatershed 4 has most of the negative impacts and subwatersheds 8 and 15 host many of the ecological conservation and wetlands currently benefitting watershed function and health. All of the sanitary sewer needs were found within the City of Eden while almost no logging impacts were found in or near the City – they were almost all identified in subwatershed 3. Subwatershed 15 has the majority of pond work concerns, with 40 of the 71

Table 7: Eden Area Watershed Field Assessment Findings

Priority Site	Buffer Enhancement	Buffer Restoration	Logging Impacts	Cattle Exclusion	Invasive Plants	Landowner Education	ATV	LogJam	Pond Work	StrEnhancement	SW Pipe	StrRestoration	Sanitary Sewer Maintenance	SW Retrofit	Trash Dump	Wetland Enhancement	Wetland Preservation	WetRestoration	Ecological Conservation	Other
1	5	15	18	7	16	8	49	13	7	6	36	0	11	0	0	10	0	0	2	9	59
3	45	78	19	29	55	46	57	26	33	10	51	12	22	0	1	5	2	2	0	9	25
4	51	69	7	3	15	31	73	16	12	8	44	14	6	27	8	29	1	2	3	12	61
8	22	88	5	7	15	39	42	31	33	7	45	35	3	22	20	22	4	1	3	17	43
15	20	14	1	7	6	3	43	9	14	40	42	3	3	0	0	8	3	2	3	14	60
	143	**264**	**50**	**53**	**107**	**128**	**264**	**95**	**99**	**71**	**218**	**65**	**45**	**49**	**29**	**74**	**10**	**7**	**11**	**61**	**248**

noted (some of these concerns were lumped in with “Other”). Subwatersheds 3 and 4 were also notable in having the majority of priority sites (96 of 143) noted by the field teams.

Twenty-one BMP categories were used to characterize current watershed conditions, and they are reflected below (some of the categories have been collated for simplification):

- 314 instances of riparian buffer enhancement or restoration
- 264 needs for landowner education
- 263 sites where the streambank requires structural enhancement and/or comprehensive restoration
- 128 observations of invasive plant take overs
- 107 needs to exclude livestock from streams
- 99 log jams that significantly disrupt stream structure and flow
- 95 instances of ATVs impacting stream conditions
- 94 stormwater systems that need improvements and/or replacement
- 74 trash dumps that need to be cleaned up
- 71 ponds that have concerns, including compromised dam structures
- 68 sites of high ecological value
- 53 instances of logging impacts to waters
- 49 failures in sanitary sewer infrastructure failures that are discharging fecal material
- 21 opportunities to enhance or restore wetlands and improve universal watershed hydrology
- 20 observations of leaking sewer systems

Despite the large number of proposed projects, watershed conditions were regularly acknowledged to be better than feared by field teams, with some even stating that many areas in subwatersheds 3 and 15 could be used for NC Piedmont ecological and stream reference sites by state and federal entities. In reviewing the data with the consultants, their chief concerns lay with the failing sewer infrastructure within the City of Eden, poor

agricultural and forestry management in the rural subwatersheds, and the aging and potential failing of farm ponds throughout the Eden Area watershed.

Looking at the data, it is evident that more outreach and watershed stewardship is needed throughout the watershed. The collective impacts of urban and rural sources of fecal material and sediment are degrading water quality and habitat conditions in the Dan and Smith Rivers. Many of the data collected by the field teams shows a widespread disconnection between the population and their watershed, especially on how their behaviors impact water quality. This disconnection includes a lack of awareness of the assets that the watershed communities possess that could support economic development within the watershed. If the landowner education needs were addressed in conjunction with the trash dump, ATV and livestock exclusion, logging impacts, and buffer needs, often coincident sites, 45% of all watershed concerns would be addressed and significant benefits would be gained in reducing turbidity concerns in both rivers. These are all very direct, simple measures that rely upon changes in land use behavior that can be easily altered with little to no cost to those within the watershed. In the case of cattle exclusion and logging impacts, there are existing cost-share programs to incentivize this good behavior.

The City of Eden is doing what it can to address its priority concern, failing infrastructure, investing $13 million in the past ten years to repair and enhance its system, and preparing to spend $33 million over the next five years to further improve their infrastructure system and end sewer loadings to the Dan and Smith Rivers (*personal communication with City staff*). The Rockingham County Soil & Water Conservation District is participating in a basinwide agricultural BMP implementation program that has used nearly $1 million in US EPA 319 funds to invest in 37 BMPs to directly serve the basinwide needs with fecal coliform bacteria and sediment. These BMPs have primarily been in the form of livestock exclusion (Byrd, *et al.*, 2012*)*. These efforts will be incorporated into the *Restoration Plan* and complimented by other recommended projects.

Based upon history and existing land use trends, it seems safe to assume that many of these same concerns persist in Virginia and are stressing water quality conditions throughout the watershed there as well. The ongoing fecal coliform bacteria TMDL and implementation planning process in Virginia should clarify whether or not this assumption is valid. What such programs in both states do not address are the many smaller behaviors that affect fecal loadings (i.e. pet waste pickups) and sediment loading (i.e. buffer maintenance) that must be met through more robust resident engagement and eventual stewardship and/or confrontation with known bad players. Programs to address agricultural BMPs, forestry practice guidelines, and trash/litter disposal will all be simple, cost-effective approaches to improving water quality in the Dan and Smith Rivers.

It is evident that the impacts in the Eden Area watershed are 1) local, and 2) universal, if land use dependent. Similar impacts are found throughout most of this watershed and are causing universal watershed degradation, and must be addressed through widespread programs and funding, not targeted to one particular area of the watershed or sector of the community. The sediment and fecal coliform bacteria are not accumulating with the streams and rivers, which is why healthy ecological communities were found by NC DWQ and the project field teams throughout this watershed, especially on its tributaries. This may be due to the rivers' volumes growing with distance or it may be to the non-distributive qualities of fecal material and sediment: they are heavy and do not stay in suspension over a long distance. Poor logging practices, rampant ATV use, stormwater, and a lack of riparian buffers are all having ramifications at larger scales than the local catchment and allowing flood events to threaten human health and safety in eastern Eden (Spray and Leaksville). Furthermore, the old farm ponds identified by the field teams and prioritized by the consultants are a potential pollutant sources that could be highly destructive water quality conditions if left unaddressed.

Specific projects that redress the water quality problems identified through field work will be the focus of the *Eden Area Watershed Restoration Plan*. This *Plan* will couple these project recommendations with policy recommendations in an effort to most effectively and efficiently improve local water quality conditions, as well as those of the entire Upper Dan River Subbasin, whenever possible. The *Restoration Plan* will feature an Implementation Timeline and a Project Atlas that will highlight proposed projects, and estimate their local reduction potential and costs so that they are immediately useful for watershed stakeholders.

SECTION 6: WATERSHED SUMMARY

The Eden Area watershed holds great potential for the City of Eden and Rockingham County, and is currently recovering from over a century of intensive agricultural and industrial impacts. Given this history, the watershed is in remarkably good condition, with terrestrial and aquatic conditions that are supportive for ecological and human health needs and recreation interests. However, despite millions of dollars being invested by stakeholders to address these issues, the Dan and Smith River remain impaired due to high levels of fecal material and sediment. The sources of these pollutants appear to be diverse and uniformly distributed through North Carolina and Virginia, and will require long-term programmatic and policy solutions (which will require public and political support) in addition to projects that address immediate needs.

The Eden Area watershed holds great value for all stakeholders residing within it. For the resident ecology, this watershed is the home to one federally-endangered species, many rare species, and their habitats. These natural resources must be prioritized for protection, as they are the holders of the Dan and Smith Rivers' natural and historical legacies. The diversity of species demands a diversity of strategies to address the pollutants in the Dan and Smith Rivers. Some are highly sensitive to high sediment levels (i.e. the green floater), and others are more sensitive to high fecal coliform bacteria levels (i.e. Roanoke log perch). The Dan River Basin Association and the Piedmont Land Conservancy have made many planning efforts in these regards, but, as seen in the obsolete soils survey data and the globally-rare habitats discovered by this project's field work, there is still much to do.

Many of the watershed's sensitive ecological settings are also excellent potential recreational resources that the City of Eden, Rockingham County, the Dan River Basin Association, and other partners, who are doing as much as they can to protect and restore these assets with limited resources and support. The NC Mountains-to-Sea Trail; the Rockingham County Trails program, and the Eden's own greenway and pedestrian programs offer many planned opportunities for recreation. There are opportunities to capitalize upon these assets through a focus on the Dan River as a potential blueway and protection of the significant historical and ecological assets in the area. Similar plans and efforts in Virginia could be collaborative, and result in more regional recreational resources that could be promoted a shared bi-state feature. The potential within this watershed could draw many to this area, and provide visitors as well as local residents with hiking, hunting, paddling, and other recreational opportunities. However, such features will require investments by local stakeholders in new programs and policies and by state and federal stakeholders in direct support that has, thus far, been absent. Support has been focused in both Virginia and North Carolina on more high profile water resources issues in denser population centers. Without support, it will be

extremely difficult to sustain improvements in local water quality conditions and watershed functionality.

Lastly, the Dan River Subbasin is wealthy with water, which served its historical successes as an agricultural and textile producer. Unfortunately, impacts from economic globalization and the failures by past political bodies to ensure the long-term stability of infrastructure has led to conditions in which the City of Eden and Rockingham County have outstanding programmatic needs – especially infrastructure – but no funding to address them. However, the City of Eden has an underutilized water and wastewater infrastructure that could support a much larger economy and community. Currently, this infrastructure ensures that the City's largest employer MillerCoors has enough clean water to make beer. The City also has an abundance of industrial, commercial, and residential spaces that are coincident with some of the less environmentally-sensitive areas of the Eden Area Watershed. Redevelopment of the City will serve their economic needs while also minimizing increases in impervious cover. Reuse and revitalization of the urban core(s) in Eden is a sustainable and healthy growth strategy for the local economy as well as the local ecology, and a pathway to a successful future.

The *Eden Area Watershed Restoration Plan* will provide watershed stakeholders with a manual on which projects, programs, and policies may provide this watershed with the greatest water quality benefits. It will determine a timeline that can most quickly and directly address the widespread inputs of sediment and fecal material to the Dan and Smith Rivers, impairing their support for ecological and human communities. Fundamental to this *Plan* will be the utilization of existing resources that have been developed by the City of Eden, Rockingham County, the DRBA, the PLC, and the states of NC and VA, as well as federal partners. Notable efforts include the use of US EPA 319 water quality funds to address agricultural impacts to the Dan River, the City of Eden's investments in its wastewater infrastructure, and the DRBA's involvement with the Model Forestry Planning Program. The *Plan* will also respect the goals of all stakeholders, ensuring that recreation, economic redevelopment, ecological protections, and regional approaches to these challenges with basinwide partners from both states are prioritized and considered in all parts of the *Plan* so that they may be addressed with shared solutions that can benefits all as part of any implementation efforts.

For centuries, the Dan River Basin and the Eden Area watershed have been home to natural and human communities that rely upon its waters for their sustenance and sustainability. The Dan River and its tributaries will be critical to these communities' future survival and the economic revitalization of the area. There is an abundance of water in this watershed and the larger river basin, but it will take small efforts by all who live and work here to address these

challenges with a multitude of solutions that ensure that this abundant resource is clean and healthy for today's and future generations.

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APPENDIX A: STAFF PROFILES

RAMONA (MONI) C. BATES
8023 Witty Road Summerfield, NC 27358
336-643-3344

EXPERIENCE QUALIFICATION SUMMARY:

- Conduct status surveys for federal and state listed plant species; design, implement, and analyze rare plant monitoring; conduct botanical inventory surveys; prioritize sites and write grants for land acquisition to protect listed plant species; participate and provide leadership in conservation site planning on a statewide basis; and conduct restoration and management activities on protected preserves.
- Conduct Phase One Environmental Site Assessments/Botanical Surveys for the conservation community and wetland delineation for environmental firms.

EDUCATION:

- M.S. in Botany - University of North Carolina at Greensboro (1996)
- M.A.T. in Science Education - University of North Carolina at Chapel Hill (1982)
- B.S. in Biology - Iowa State University (1978)

BOTANICAL EXPERIENCE:

- **Phase One Environmental Site Assessments/Botanical Surveys**
  Provide a unique service to the conservation community for meeting their needs for baseline documentation on land transactions.
- **2005 – present North Carolina Zoological Park - botanist**
  Conduct natural heritage site surveys, habitat management, and write management plans.
- **1997 - 2005 North Carolina Plant Conservation Program - botanist**
  Conduct field research, status surveys, design and implement monitoring protocols, conduct habitat management, and coordinate site planning
- **Contract Project - North Carolina Natural Heritage Program**
  Guilford County Natural Heritage Inventory
  Rockingham County Natural Heritage Inventory
  Randolph County Natural Heritage Inventory
  Montgomery County Natural Heritage Inventory
  Wrote a manual for conducting county natural heritage inventories
- **Contract Project - U.S. Forest Service**
  Botanical surveys for the Uwharrie National Forest
  Helianthus schweinitzii survey for the Sumter National Forest
- **Contract Project - U.S. Army**
  Pyxidanthera brevifolia reproductive biology research
- **Contract Project - The Nature Conservancy**
  Lobelia boykinii reproductive biology research

SUMMARY OF HELIANTHUS SCHWEINITZII PROJECTS:

- Located new *Helianthus schweinitzii* occurrences during botanical surveys for county natural heritage inventories and the Uwharrie National Forest
- Conducted a *Helianthus schweinitzii* survey for the Sumter National Forest
- Prioritized *Helianthus schweinitzii* occurrences for site protection efforts
- Procured funding to acquire a high priority *Helianthus schweinitzii* sites
- Conduct monitoring and analyze data for *Helianthus schweinitzii*
- Build partnerships among state and federal agencies, private landowners, and private organizations to restore Piedmont Prairie habitat for *Helianthus schweinitzii*
- Build partnerships to protect and restore Piedmont Prairie communities

Joe Mickey, Jr. Fisheries Biologist, retired. Mr. Mickey received his Bachelor of Science in Biology from Gardner-Webb College. Before retirement, Mr. Mickey was employed for over 34 years with the NC Wildlife Resources Commission. Mr. Mickey's areas of expertise include environmental permitting, fisheries surveys and research, fisheries and habitat restoration projects, conservation easement development, and design, construction and monitoring of stream restoration projects. Mr. Mickey has completed all four levels of training in River Restoration and Natural Channel Design from Wildland Hydrology of Fort Collins, CO. Mr. Mickey has authored, co-authored or edited numerous fisheries management publications.

Mr. Mickey is a founding board member of the Yadkin River Trail Association, the Foothills Nature Science Society and the Surry County Natural Resources Committee. He also serves on the board of the Mitchell River Coalition and is a member of the Piedmont Land Conservancy and National Committee for the New River.

Honors:

1988 - Governor's Award as Soil Conservationist of the Year - presented by the NC & National Wildlife Federation - for efforts to protect trout waters from off-site sedimentation to trout waters from golf course construction.

1992 - Trout Unlimited Silver Trout Award - for efforts to protect and enhance trout habitat in northwestern NC.

1994 - American Fisheries Society, Southern Division, First Place Best Paper Award as co-author for paper entitled *First Year Assessment of Delayed Harvest Trout Regulations.*

1995 - Water Quality Professional Achievement Award - from the NC Chapter of the Soil & Water Conservation Society - for efforts to restore riparian zones along trout streams to improve water quality and aquatic habitats.

2000 - Certificate of Appreciation from the U.S. Army Corps of Engineers (ACE), Wilmington District for "dedicated efforts and professionalism in coordinating Agency review of ACE permits within the trout water counties of Western NC".

<u>Natural Stream Design Training</u>

Rivers and Operational Hydrology (Leopold)	1990
Applied Fluvial Geomorphology (Rosgen Level I)	1991
River Morphology Applications (Rosgen Level II)	1998
River Assessment and Monitoring (Rosgen Level III)	1998
Natural Stream Design (Rosgen Level IV)	1999
RIVERMorph Stream Restoration Software	2003

<u>Miscellaneous</u>

Sedimentation and Erosion Control Workshops	1994, 1996
Soils Bioengineering Workshop	1995
Introduction to Riparian Restoration	1995
Innovative Stream Repair	1995, 1997
Stream Reference Reach Workshop	1996
Riparian Management Workshop	1997

Erosion & Sediment Control for Stream Restoration Designers and Installers 2005
Stream Restoration Construction Training (NCSU/EEP) 2006

Restoration Experience - Projects Completed (Priority I, II an Enhancement Projects while with NCWRC):

Laurel Fork, Alleghany Co. (State of NC)	1500 ft	1992[1]
Little Glade Creek, Alleghany Co. (NC 319 funds)	2640 ft	1994[1]
Meadow Fork Creek Site 1, Alleghany Co. (DOT)	300 ft	1994[1]
North Fork New River, Ashe Co.	2000 ft	1994[1]
Meadow Fork Creek Site 2, Alleghany Co.	2090 ft	2000[1]
Laxon Creek, Watauga Co. (DOT)	1200 ft	1999[1]
Carp Site – UT Laxon Creek, Watauga Co.	538 ft	2000[2]
Racey Site – Laxon Creek, Watauga Co.	1150 ft	2000[2]
Bare Site – UT Peak Creek, Ashe Co.	2150 ft	2001[2]
Wild Site – Obids Creek, Ashe Co.	1805 ft	2002[2]
Miller Site – Meat Camp Creek, Watauga Co.	652 ft	2002[2]
Lemmond Site – UT Goose Creek – Union Co.	253 ft	2004[3]
Little Site – UT Goose Creek – Union Co.	109 ft	2004[3]
Haigler/McConaughey Site – UT Goose Creek, Union	1060 ft	2004[3]
Coppolla et al Site – UT Goose Creek, Union Co.	123 ft	2004[3]
Greene Site – Goose Creek, Mecklenburg Co.	783 ft	2005[4]
National Park Service/Blue Ridge Parkway (Meadow Fork – 701 ft, Peak Cr. & unnamed tributary – 668 ft, Little Glade Cr. – 863 ft, Ashe and Alleghany counties)	2232 ft	2005[5]
Ecosystem Enhancement Program repair project (Brush Cr – 400 ft. Little Pine Cr – 983 ft, Alleghany Co.)	1383 ft	2006[6]

Projects completed as a private consultant

Alamance Co. stream assessments for Piedmont Triad Council of Governments (PTCOG) through Ecologic Consulting. Several miles of streams surveyed.	unknown	2007[7]
Mathis Site – Priority I restoration (design & construction unnamed tributary to Brier Cr., Wilkes Co.), and 2008 monitoring done quarterly for NC Div. of Water Quality (DWQ).	300 ft	2007[7]
Big Horse Creek – bank stabilization - design & construction for National Committee for the New River (NCNR), Ashe Co.	1250 ft	2007[7]
Elk Shoals – S. Fork New River – design & construction for NCNR, Ashe Co.	400 ft	2007[7]
Wall site – S. Fork New River construction for NCNR	300 ft	2007[7]
Deerwood Estates – bank repairs (Piney Creek, Alleghany Co) for US Army Corps of Engineers and DWQ	675 ft	2008[7]
Davidson Co. stream assessments for PTCOG Surveyed several miles of streams.	unknown	2008[7]
South Fork New River – Boone Greenway Project, scoping plan for NCNR. (Watauga Co.)	4000 ft	2008[7]
Johnson Site – unnamed tributaries to Fisher River, monitoring reports for landowner and NCDWQ (Surry Co.)	300 ft	2008[7]
Eason site – unnamed tributary to Little Phoenix Cr. – design and construction for NCNR, Ashe Co.	300 ft	2008[7]
Oliver-State Park tract – S. Fork New River, Ashe Co. for NCNR – project design	1385 ft	2008[7]
Langer site – unnamed tributary to S. Fork New River – project	300 ft	2008[7]

design for NCNR		
Rea site – S. Fork New River – supervise construction for NCNR, Ashe Co.	100 ft	2008[7]

[1]Miscellaneous projects (State of NC court system, NC DWQ 319 funds, DOT local projects, USFWS grant) New River Watershed = 9730 ft
[2]US 421 DOT/WRC Memorandum of Agreement – New R. Watershed = 6396 ft
[3]Clean Water Management Trust Fund Projects – Yadkin R. Watershed = 1545 ft
[4]I-485 DOT/WRC Memorandum of Agreement – Yadkin R. Watershed = 783 ft
[5]National Park Service/Blue Ridge Parkway – New River Watershed = 2232 ft
[6]Ecosystem Enhancement Program – New River Watershed = 1383 ft
[7]Projects done as private consultant = 9310 ft
Total = 31,379 ft

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J. Richard Everhart

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Profile

Natural resource conservationist with 37 years of experience working with local, state and federal government, nonprofits and the private sector to protect and improve North Carolina's natural resources.

Skills

- Survey, data collection, map reading.
- Experience with biological, chemical and physical monitoring of streams.
- Work quickly and meet deadlines under pressure.
- Enjoy problem solving in a work environment.
- Experienced with a variety of federal and state environmental programs.
- Strong team builder.
- Solid judgment, reliable, versatile and accurate.
- Skilled at leading projects.

Professional Experience

1976 – 2011 Natural Resource Conservation with Soil and Water Conservation Districts and the Natural Resources Conservation Service

- Recent work: Established South Fork Environmental, LLC to work with nonprofits, government agencies and a variety of firms to carry out conservation projects with a focus on stream and riparian restoration and protection.
- 1979-2010 – Led the conservation program in Stanly, Surry and Yadkin Counties as District Conservationist with the USDA Natural Resources Conservation Service.
    - Conservation: Conservation planning and implementation on a complex mix of private and public lands. Focused on work with the agricultural community to collect resource data and develop options to address resource needs and public concerns relating to livestock operations, soil erosion and soil quality, water quality and quantity and game and nongame wildlife issues. Helped to develop and carry out a number of watershed assessment projects in the Mitchell River watershed.
    - Adaptability: As District Conservationist worked with constantly changing array of state and federal cost share, grant funded and regulatory programs and partners.

- Promoter: As a Conservationist I marketed conservation and conservation programs through newsletters, newspaper articles, television and radio appearances, talks to local groups and large conventions and in one on one meeting with individual landowners.
- Coaching: Supervised and trained a number of student conservationist and new employees with NRCS who came with a variety of backgrounds and educational levels and have gone on to full time careers in conservation.
- Community leadership: Served and serving on a variety of resource related boards and committees including Pilot Mountain Park Advisory Committee, NC Natural Heritage Board and the Surry County Natural Resources Committee. Worked with local citizens to establish the Mitchell River Coalition which has protected thousands of acres and restored miles of river in the Mitchell River watershed.
- Education: Assisted with watershed assessment and stream restoration training throughout the southeast for students from across the US. Helped to develop a manual for restoring and managing small wetlands which is used by NRCS. Developed a variety of educational tools for use with landowners including a series of Stream Notes funded by the US Fish and Wildlife Service.
- Planner: Conservation planner on tens of thousands of acres of agricultural lands. These plans resulted in millions of dollars of conservation practices installed and thousands of acres benefiting from best management practices.
- Manager: Managed a multicounty program that relied on county, state and federal funds to operate. Supervised local and federal employees along with a number of volunteers. Responsible for millions of dollars in state, federal and grant contracts that provided the resources to carry out the conservation programs in Surry and Yadkin counties.

Pre-1979:

- Soil Conservationist with NRCS in Iredell and Stanly Counties in NC where job focused on conservation planning and implementation on private agricultural lands.
- District Technician with the Iredell Soil and Water Conservation District providing support to NRCS with their conservation program in Iredell County.

Education: BS in Biology with a focus on ecology from Hobart College, graduate level soils course from UNC Charlotte. Numerous courses provided by USDA in personnel management, natural resource planning and conservation. Series of courses in stream restoration from NC State University, Rutgers and Wildland Hydrology.

Awards: 2009 North Carolina Land Trusts Local Government Partner of the Year, 2009 NC Chapter Soil and Water Conservation Society Professional Achievement Water Quality, 2009 Pilot View RC&D Environmental Award, 2003 NC Wildlife Federation Water Conservationist of the Year, 1995 NC Wildlife Federation Land Conservationist of the Year.

Joe Mickey, Jr. Fisheries Biologist, retired. Mr. Mickey received his Bachelor of Science in Biology from Gardner-Webb College. Before retirement, Mr. Mickey was employed for over 34 years with the NC Wildlife Resources Commission. Mr. Mickey's areas of expertise include environmental permitting, fisheries surveys and research, fisheries and habitat restoration projects, conservation easement development, and design, construction and monitoring of stream restoration projects. Mr. Mickey has completed all four levels of training in River Restoration and Natural Channel Design from Wildland Hydrology of Fort Collins, CO. Mr. Mickey has authored, co-authored or edited numerous fisheries management publications.

Mr. Mickey is a founding board member of the Yadkin River Trail Association, the Foothills Nature Science Society and the Surry County Natural Resources Committee. He also serves on the board of the Mitchell River Coalition and is a member of the Piedmont Land Conservancy and National Committee for the New River.

Honors:

1988 - Governor's Award as Soil Conservationist of the Year - presented by the NC & National Wildlife Federation - for efforts to protect trout waters from off-site sedimentation to trout waters from golf course construction.

1992 - Trout Unlimited Silver Trout Award - for efforts to protect and enhance trout habitat in northwestern NC.

1994 - American Fisheries Society, Southern Division, First Place Best Paper Award as co-author for paper entitled *First Year Assessment of Delayed Harvest Trout Regulations.*

1995 - Water Quality Professional Achievement Award - from the NC Chapter of the Soil & Water Conservation Society - for efforts to restore riparian zones along trout streams to improve water quality and aquatic habitats.

2000 - Certificate of Appreciation from the U.S. Army Corps of Engineers (ACE), Wilmington District for "dedicated efforts and professionalism in coordinating Agency review of ACE permits within the trout water counties of Western NC".

<u>Natural Stream Design Training</u>

Rivers and Operational Hydrology (Leopold)	1990
Applied Fluvial Geomorphology (Rosgen Level I)	1991
River Morphology Applications (Rosgen Level II)	1998
River Assessment and Monitoring (Rosgen Level III)	1998
Natural Stream Design (Rosgen Level IV)	1999
RIVERMorph Stream Restoration Software	2003

<u>Miscellaneous</u>

Sedimentation and Erosion Control Workshops	1994, 1996
Soils Bioengineering Workshop	1995
Introduction to Riparian Restoration	1995
Innovative Stream Repair	1995, 1997
Stream Reference Reach Workshop	1996
Riparian Management Workshop	1997
Erosion & Sediment Control for Stream Restoration	

Designers and Installers	2005
Stream Restoration Construction Training (NCSU/EEP)	2006

Restoration Experience - Projects Completed (Priority I, II an Enhancement Projects while with NCWRC):

Laurel Fork, Alleghany Co. (State of NC)	1500 ft	1992[1]
Little Glade Creek, Alleghany Co. (NC 319 funds)	2640 ft	1994[1]
Meadow Fork Creek Site 1, Alleghany Co. (DOT)	300 ft	1994[1]
North Fork New River, Ashe Co.	2000 ft	1994[1]
Meadow Fork Creek Site 2, Alleghany Co.	2090 ft	2000[1]
Laxon Creek, Watauga Co. (DOT)	1200 ft	1999[1]
Carp Site – UT Laxon Creek, Watauga Co.	538 ft	2000[2]
Racey Site – Laxon Creek, Watauga Co.	1150 ft	2000[2]
Bare Site – UT Peak Creek, Ashe Co.	2150 ft	2001[2]
Wild Site – Obids Creek, Ashe Co.	1805 ft	2002[2]
Miller Site – Meat Camp Creek, Watauga Co.	652 ft	2002[2]
Lemmond Site – UT Goose Creek – Union Co.	253 ft	2004[3]
Little Site – UT Goose Creek – Union Co.	109 ft	2004[3]
Haigler/McConaughey Site – UT Goose Creek, Union	1060 ft	2004[3]
Coppolla et al Site – UT Goose Creek, Union Co.	123 ft	2004[3]
Greene Site – Goose Creek, Mecklenburg Co.	783 ft	2005[4]
National Park Service/Blue Ridge Parkway (Meadow Fork – 701 ft, Peak Cr. & unnamed tributary – 668 ft, Little Glade Cr. – 863 ft, Ashe and Alleghany counties)	2232 ft	2005[5]
Ecosystem Enhancement Program repair project (Brush Cr – 400 ft. Little Pine Cr – 983 ft, Alleghany Co.)	1383 ft	2006[6]

Projects completed as a private consultant

Alamance Co. stream assessments for Piedmont Triad Council of Governments (PTCOG) through Ecologic Consulting. Several miles of streams surveyed.	unknown	2007[7]
Mathis Site – Priority I restoration (design & construction unnamed tributary to Brier Cr., Wilkes Co.), and 2008 monitoring done quarterly for NC Div. of Water Quality (DWQ).	300 ft	2007[7]
Big Horse Creek – bank stabilization - design & construction for National Committee for the New River (NCNR), Ashe Co.	1250 ft	2007[7]
Elk Shoals – S. Fork New River – design & construction for NCNR, Ashe Co.	400 ft	2007[7]
Wall site – S. Fork New River construction for NCNR	300 ft	2007[7]
Deerwood Estates – bank repairs (Piney Creek, Alleghany Co) for US Army Corps of Engineers and DWQ	675 ft	2008[7]
Davidson Co. stream assessments for PTCOG Surveyed several miles of streams.	unknown	2008[7]
South Fork New River – Boone Greenway Project, scoping plan for NCNR. (Watauga Co.)	4000 ft	2008[7]
Johnson Site – unnamed tributaries to Fisher River, monitoring reports for landowner and NCDWQ (Surry Co.)	300 ft	2008[7]
Eason site – unnamed tributary to Little Phoenix Cr. – design and construction for NCNR, Ashe Co.	300 ft	2008[7]
Oliver-State Park tract – S. Fork New River, Ashe Co. for NCNR – project design	1385 ft	2008[7]
Langer site – unnamed tributary to S. Fork New River – project design for NCNR	300 ft	2008[7]

Rea site – S. Fork New River – supervise construction for NCNR, Ashe Co.	100 ft	2008[7]

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APPENDIX B: GEOLOGY

The geology in the Eden area watershed consists of sedimentary rock including conglomerate, mudstone and sandstone: Metamorphic rock including biotite gneiss and other metasedimentary rock, felsic gneiss, granitic gneiss and mica schist: and setamorphosed granitic rock and mylonite (Figure 81). Stuart Creek gneiss dominates part of the study area in Henry County with smaller traces of amphibolite, ultramafic rock and others make up the rest of the geology underlying the watershed. 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);

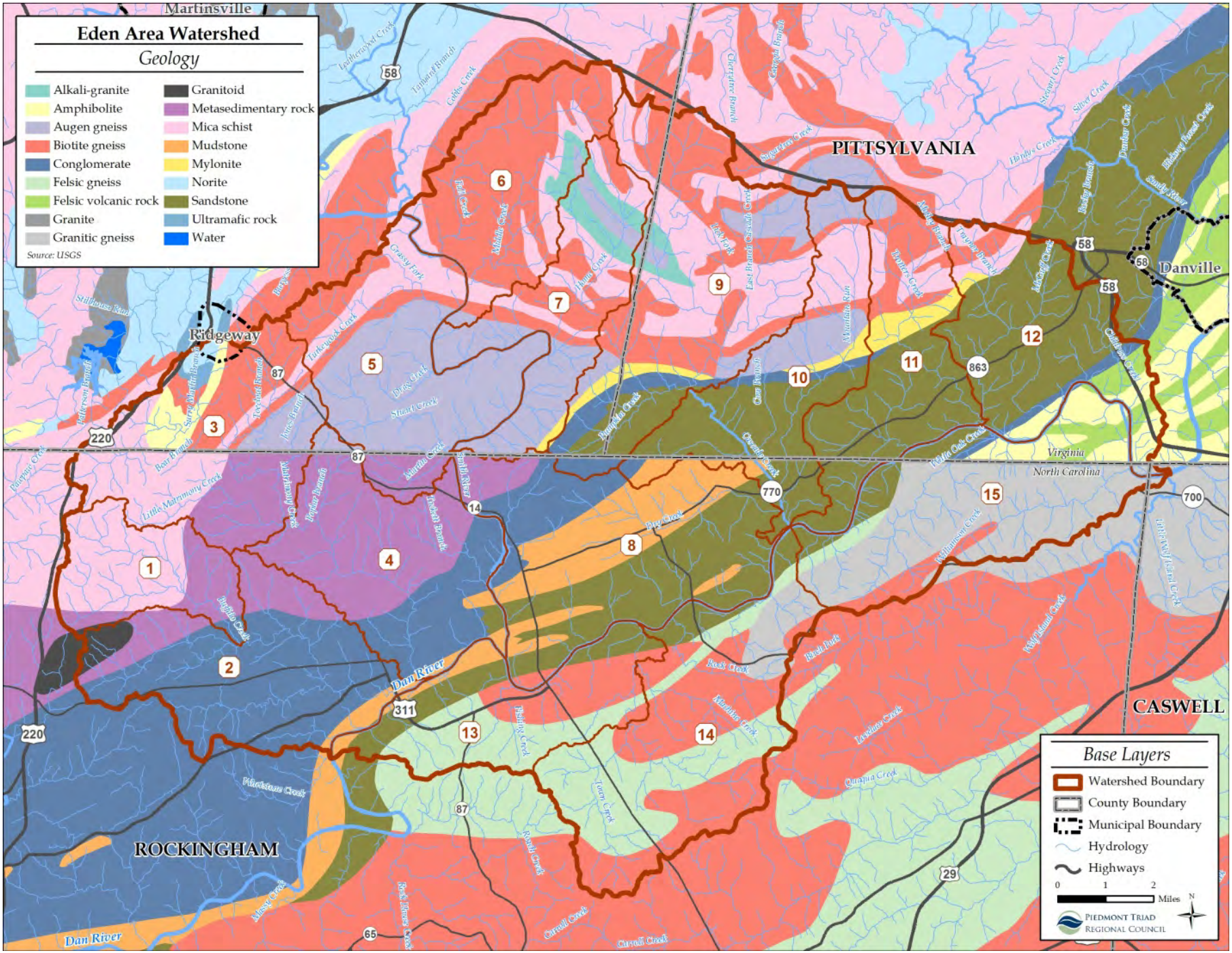

Figure 83: Eden Area Watershed Geology

Alkali-granite or Alaskite – Dates from the Proterozoic Era. Described as white to light-gray, medium to coarse-grained leucocratic muscovite granite and granite gneiss with potassium feldspar (perthite or microcline) + plagioclase + quartz + muscovite +/- biotite +/- epidote +/- kyanite +/- garnet. Geophysical signature: negative or flat magnetic signature; positive radiometric signature.

Amphibolite – Dates from the Cambrian/Late Proterozoic Era. Found in the Virginia side of the watershed. Amphibolite consists of metamorphosed mafic extrusive and intrusive rock; includes hornblende gneiss, thin layers of mica schist, calc-silicate rock, and, rarely, marble. Also includes small masses of metadiorite and metagabbro. Amphibolite is the secondary rock in the Alligator back formation found in Henry County VA.

Augen gneiss – Dates from the Proterozoic Era. Gneissic rock containing augen (large lenticular mineral grains or mineral aggregates having the shape of an eye in cross section). Found in the Virginia side of the Watershed. The USGS describes it as Light-gray to black and white, massive to irregularly-layered augen and flaser gneiss with anastamosing layers of mylonitic biotite schist, hornblende schist and foliated leucogranite. Augen gneiss is composed of microcline, plagioclase, and perthite porphyroclasts up to 4 cm across in a matrix of plagioclase, quartz, and biotite, with accessory titanite, epidote, hornblende, and opaque minerals. It is the primary rock in the Stuart Creek Gneiss formation which dominates the southeastern part of Henry County VA within the study area.

Biotite gneiss- Dates from the Cambrian/Late Proterozoic Eras and describes by the USGS as a granitic gneiss in which the dominant mafic mineral is biotite. Biotite Gneiss and Schist - inequigranular, locally abundant potassic feldspar and garnet; interlayered and gradational with calc-silicate rock, sillimanite-mica schist, mica schist, and amphibolite. Contains small masses of granitic rock. Found in Both NC and VA sides of the watershed and covers up to 47% of Rockingham County.

Conglomerate – Dates from the Triassic Era; A coarse-grained clastic sedimentary rock, composed of rounded to subangular fragments larger than 2 mm in diameter typically containing fine-grained particles in the interstices, and commonly cemented by calcium carbonate, iron oxide, silica, or hardened clay. Conglomerate is located on the North Carolina and Virginia sides of the Eden Area Watershed. Conglomerate is the primary rock in the Stoneville Formation which consists of conglomerate, sandstone, and mudstone, in lenticular and laterally-gradational bedding and forms part of the Dan River Group where it combines with Mudstone and Sandstone.

Felsic gneiss - Dates from the Cambrian/Late Proterozoic Eras; A gneissic rock dominated by light-colored minerals, commonly quartz and feldspar. Found in Rockingham County near the southeastern part of the Eden Area Watershed.

Felsic volcanic rock - Dates from the Proterozoic Z Era; A light-colored, fine-grained or aphanitic extrusive or hypabyssal rock, with or without phenocrysts and composed chiefly of quartz and feldspar. Found in Virginia as part of the Milton Belt.

Granite Rock - Dates from the Cambrian/Late Proterozoic Eras.

Granitic gneiss- Dates from the Silurian Era *(429 my)*; A gneissic rock with a general granitoid composition Found in Rockingham County as *Shelton Granite Gneiss, a poorly foliated; lineated granitic to quartz monzonitic gneiss.*

Granitoid - Datse from the Late Proterozoic Era (680-710 my); Metamorphosed Granitic Rock massive to foliated, locally mylonitic. Covers 0.3 % of the surface of Rockingham County and is found primarily in subwatershed 2 on the western side of the study area.

Metasedimentary rock – Dates from the Cambrian/Late Proterozoic Eras; A sedimentary rock that shows evidence of having been subjected to metamorphism. Found in Rockingham County as Metagraywacke and Muscovite-Biotite Schist consisting of *metagraywacke (biotite gneiss) interlayered and gradational with muscovite-biotite schist; minor marble and granitic rock.*

Mica schist – Dates from the Cambrian/Late Proterozoic Eras; a schist whose essential constituents are mica and quartz, and whose schistosity is mainly due to the parallel arrangement of mica flakes. Mica Schist is the primary rock found in the *Alligator Back Formation which covers parts of Henry and Pittsylvania Counties*. This category may also used for biotite schist.

Mudstone – Dates from the Triassic Era; a general term that includes claystone, siltstone, shale, and argillite, and that should be used only when the amounts of clay-sized and silt-sized particles are not known or specified, or cannot be precisely identified. Part of the Triassic basin and the primary rock in the Cow Branch Formation, which consists of mudstone with minor sandstone, gray, laterally-continuous bedding. Intertongues with Stoneville and Pine Hall formations.

Mylonite – Dates potentially from Proterozoic through the Paleozoic Eras; A compact, chert-like rock without cleavage, but with a streaky or banded structure, produced by the extreme granulation and shearing of rocks that have been pulverized and rolled during overthrusting or intense dynamic metamorphism. Most mapped belts of mylonite represent fault zones with multiple movement histories. Many Piedmont mylonite zones contain dextral-transpressional

kinematic indicators that formed during Late Paleozoic collision al tectonics (Bobyarchick and Glover, 1979; Gates and others, 1986).

Norite – Dates from the Cambrian Era; A plutonic rock satisfying the definition of gabbro. Norite is the primary rock in the Rich Acres Formation found on the western edge of the Virginia section of the watershed. The Rich Acres Formation consists of dikes, sills, and irregularly-shaped plutons of dark-greenish-gray, medium-grained, locally porphryitic, biotite-hornblende gabbro rocks.

Sandstone - Dates from the Triassic Era; A medium-grained clastic sedimentary rock composed of abundant sand-sized fragments, which may have a finer-grained matrix (silt or clay), and which is more or less indurated by a cementing material. Sandstone forms part of the Triassic basin and the primary rock in the Rockingham County *Pine Hall Formation which consists of sandstone, mudstone, and conglomerate with a yellowish orange to brown coloration.*

Ultramafic Rocks – Dates from the Proterozoic Z-Cambrian Eras; Grayish-green to light-gray talc chlorite-actinolite or talc-tremolite schist. Found in Virginia on the Northwestern edge of the Eden Area Watershed.