

Middle Cape Fear Local Watershed Plan

Executive Summary



North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program

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Introduction

Buck Engineering performed a technical assessment of three 14-digit hydrologic units (HUs) in the Middle Cape Fear River Basin as part of the development of a local watershed plan for the NC Ecosystem Enhancement Program (EEP) (Figure ES.1). Local watershed planning is a comprehensive effort initiated by the EEP to investigate all sources of pollution/degradation in a local watershed and recommend a comprehensive strategy for improving watershed functions. The EEP works to replace functional watershed losses through stream, buffer, and wetland improvement and protection projects.

Five technical memorandums were prepared during the technical assessment process (Figure ES.2). Technical Memorandum 1 summarized existing watershed and land use information collected within the study area. Technical Memorandum 2 provided detailed field data on specific stream reaches throughout the study area. Technical Memorandum 3 described the calibration of an empirical watershed model, the Soil and Water Assessment Tool (SWAT), which was used to assess general land use impacts to water quality in the study area and provide an estimate of baseline watershed conditions. Technical Memorandum 4 presented a functional status overview of the study area in terms of water quality, hydrology, and habitat, and suggested potential sources of observed degradation. Technical Memorandum 5 presented conclusions and recommendations for management actions based on work completed for the previous four memorandums and efforts to prioritize management opportunities.

Watershed Overview

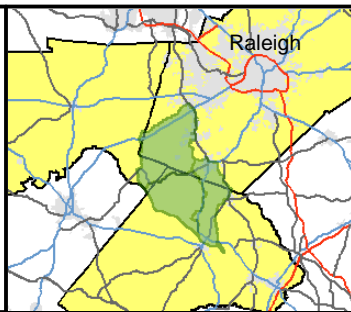
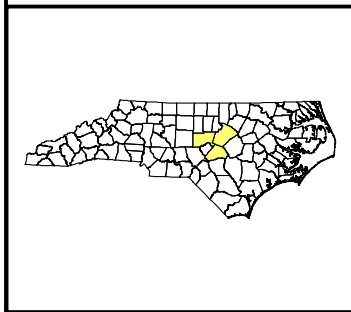
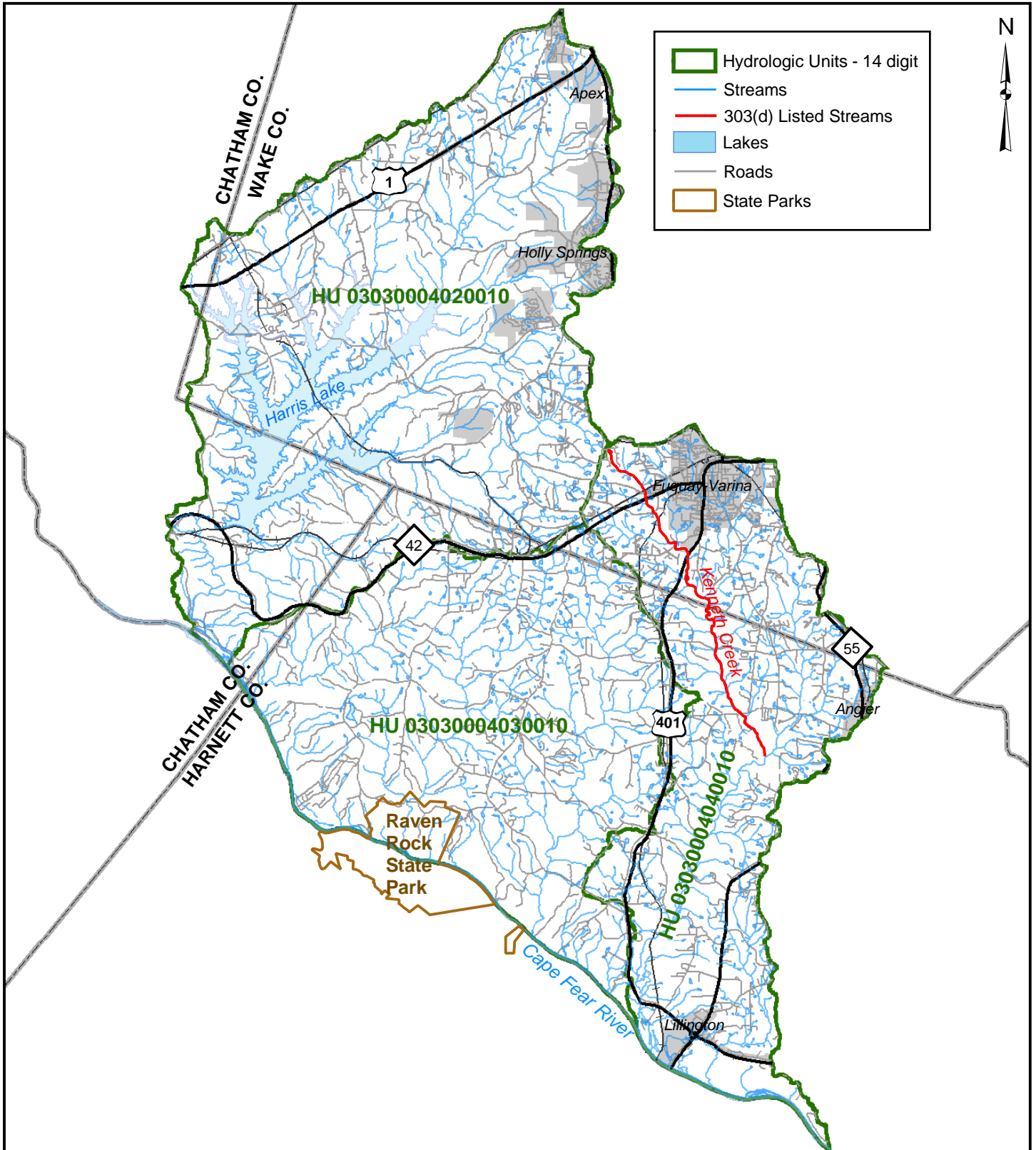
The study area encompasses three HUs that are parallel drainages to the Cape Fear River and are located within portions of Chatham, Wake, and Harnett Counties in the North Carolina Piedmont. The total land area is approximately 180 square miles. The HUs include parts of the towns of Apex, Holly Springs, and Fuquay-Varina and the portion of Raven Rock State Park north and east of the Cape Fear River. The individual HUs are described below.

HU 03030004020010 - Harris Lake & Tributaries

This HU is approximately 80 square miles in size, extending south from the Town of Apex to the Cape Fear River and east from the Chatham/Wake County line to the Town of Holly Springs. Both Apex and Holly Springs span the ridgeline that separates the Neuse and Cape Fear River basins. The watershed contains Harris Lake, an impoundment of Buckhorn Creek, which is used by Progress Energy's 900-megawatt Shearon Harris Nuclear Plant for cooling. The HU also contains six named tributaries to Harris Lake: White Oak Creek, Little White Oak Creek, Utley Creek, Cary Branch, Thomas Creek, and Tom Jack Creek.

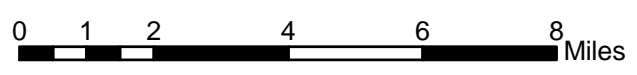
Progress Energy is a major landowner within the HU. The Shearon Harris Nuclear Power Plant is located on a 10,700-acre site near the town of New Hill. Progress Energy also owns land outside the power plant and has enrolled more than 13,000 acres within the HU into the North Carolina Wildlife Resources Commission's Game Lands Program.

Major point source dischargers in the HU are the Town of Holly Springs and Shearon Harris Nuclear Power Plant. There are two hazardous materials areas, the Harris plant and a Wake County (Feltonville) landfill near Apex. The landfill has a non-discharge permit for use of land application as waste disposal.



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Figure ES.1. Vicinity Map



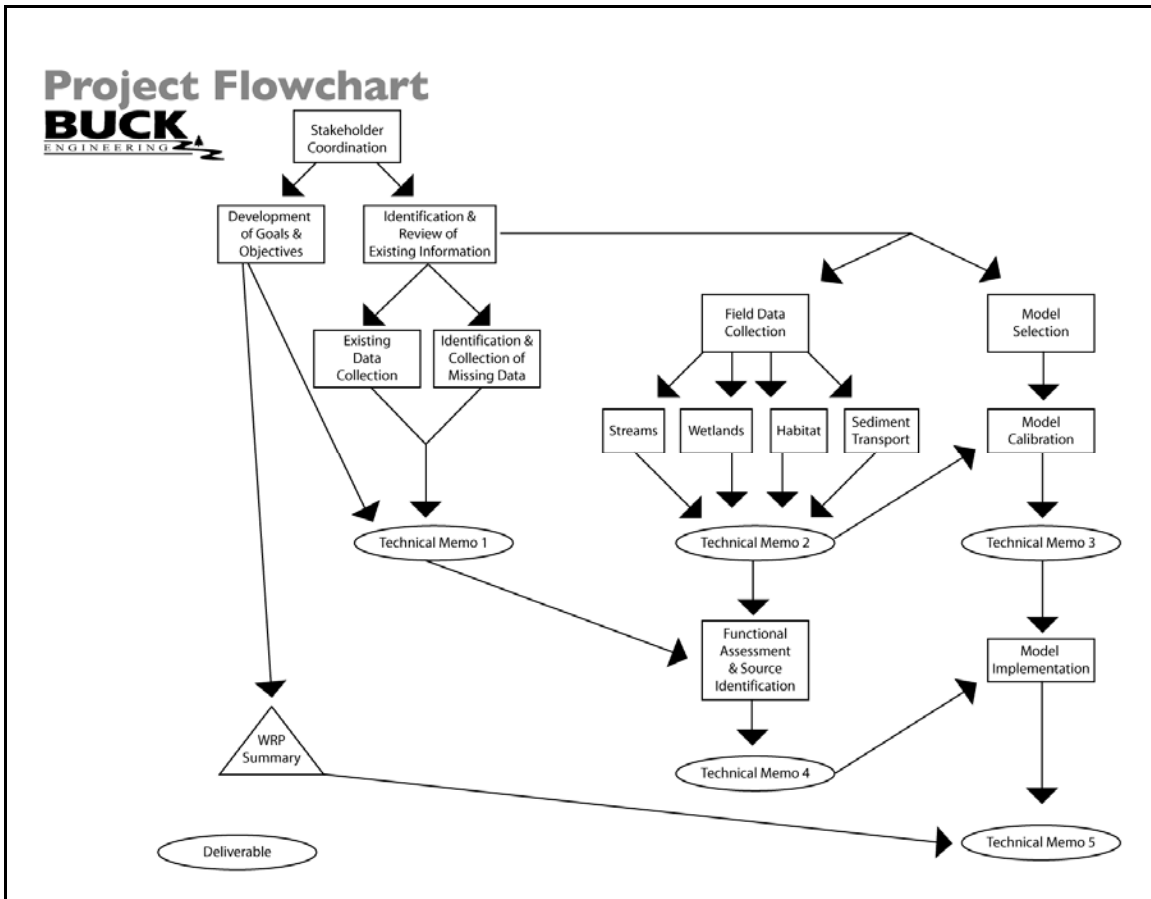


Figure ES.2 Local Watershed Plan Project Flow Chart

HU 03030004030010 - Parkers, Avents, & Hector Creeks

This HU is approximately 54 square miles in size, and is located almost entirely within Harnett County. Raven Rock State Park is located along the Cape Fear River on the southern boundary of the watershed. There are no municipalities within the HU. Most of the land area is part of the water supply watershed for the Town of Lillington, located farther downstream along the Cape Fear River.

The three mainstem streams in this HU, Parkers Creek, Avents Creek, and Hector Creek, all have High Quality Waters designations because of the “Excellent” water quality ratings they received from the NC Division of Water Quality (DWQ). There are no point source discharges or hazardous materials sites within the HU.

HU 03030004040010 - Kenneth & Neills Creeks

This HU is approximately 46 square miles in size, extending south from the Town of Fuquay-Varina to Lillington, and east from US 401 to the Town of Angier. It is the most urbanized of the three HUs in the study area. Kenneth Creek is a tributary to Neills Creek, which flows to the Cape Fear River near Lillington. A portion of Kenneth Creek was rated as impaired on North Carolina’s 2000 Clean Water Act Section 303(d) list due to a poor water quality rating.

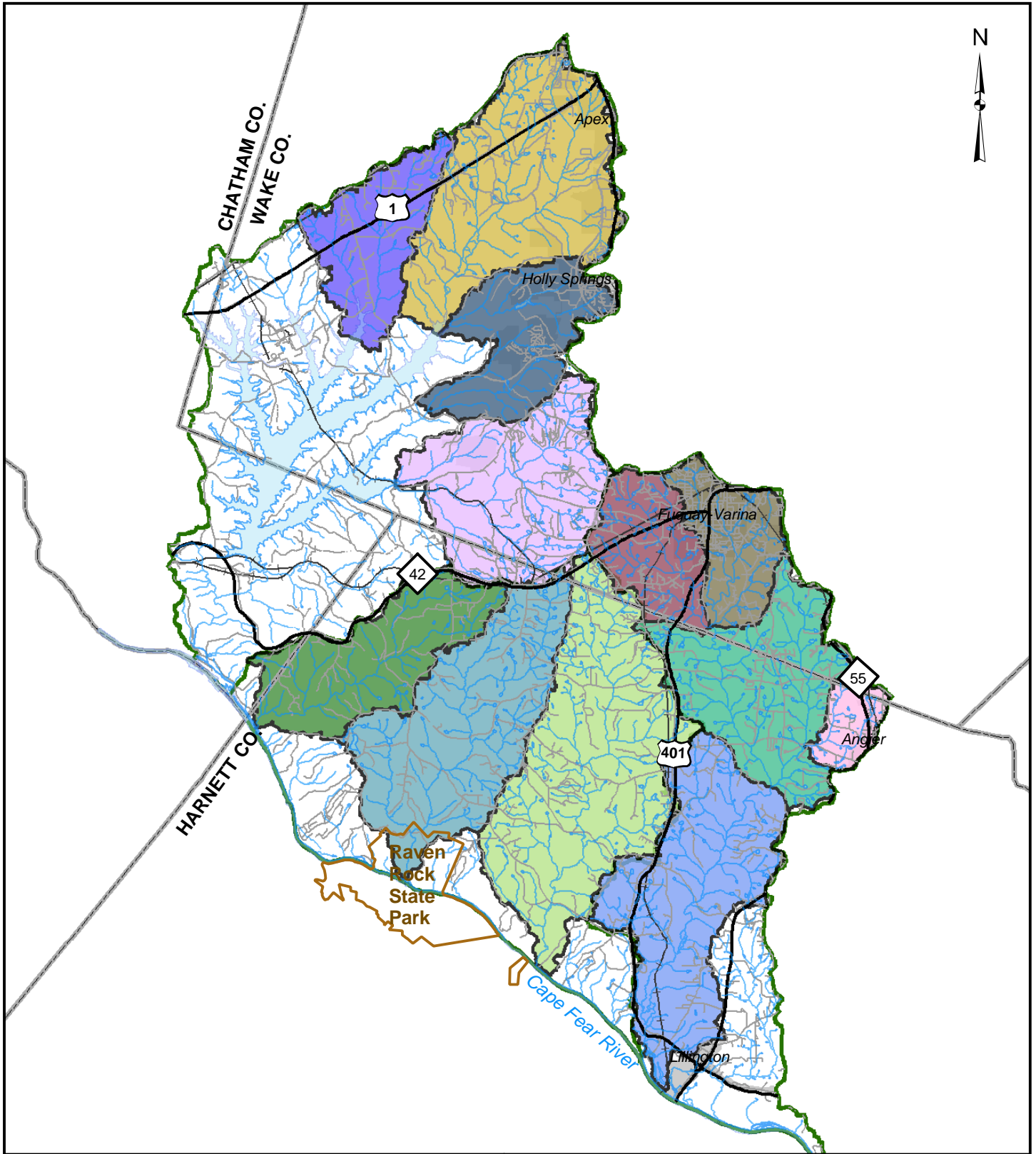
Watershed Functions

The study area was assessed in terms of three principal watershed functions: habitat, hydrology, and water quality.

- *Habitat* function includes both aquatic and terrestrial components. Functioning aquatic habitat provides a setting in which aquatic communities, such as fish and benthic invertebrates, can be both diverse and balanced. Good aquatic habitat in the study area has abundant and diverse microhabitat (sticks, leaf packs, logs, vegetated mats, and root masses), limited embeddedness (covering of channel by fine sediment), stable streambanks, and a variety of bottom substrate (sand, gravel, cobbles and boulders). For terrestrial habitat, a functioning system allows wildlife to move about more easily to find necessary resources (food, shelter, and community) and does not endanger or threaten native species. Properly functioning systems in the study area have minimally fragmented forest land cover that promotes wildlife travel and provides resources.
- *Hydrologic* function addresses whether streams effectively transport water and sediment. Good hydrologic function is most apparent in the stream channel, but extends to the riparian and upland areas, as well. A functioning stream channel has low bank height ratios (vertical stability), reasonably stable streambanks (lateral stability), higher base flows, and lower peak flows. Riparian zones in catchments that display good hydrologic function promote groundwater recharge and store stormwater discharge and deposited sediment. Upland areas have higher amounts of pervious cover that encourage infiltration, as opposed to rapid runoff to stormwater conveyance systems. Infiltration provides surface water storage and delivers water to the stream channel network slowly, if at all (due to uptake by vegetation, loss to deep groundwater, and soil field capacity).
- *Water quality* function is exemplified by contaminant levels that do not prevent a stream from attainment of its designated uses, such as biological integrity, recreation, or water supply. Practices that lead to good water quality are also considered part of a functioning system. For example, functioning riparian areas filter overland flow and are not circumvented by stormwater conveyance systems. Instream pollutant levels are a key indicator of water quality function; however, these quantities may be highly dynamic and difficult to characterize without extensive monitoring data over a full range of stream flows. Alternatives include benthic invertebrate or other biological monitoring that provide long term indicators of water quality. Sediment bioassays and chemistry also provide continuing data on evidence of water quality, as many toxic pollutants adhere to fine-grained, organic-rich sediment.

Subwatersheds and Functional Assessment Units

In order to develop more manageable units for analysis and management, the three study HUs were initially divided into 19 subwatersheds based on their drainage system, ranging in size from 3.6 to 16.5 square miles. Once initial data collection, field work, and model calibration were completed, these subwatersheds were further divided, and in some cases merged, into 12 functional assessment units (FAUs) with generally similar land use, landform, and riparian condition (Figure ES.3). The Parkers, Avents, and Hector Creek subwatersheds represent the largest FAUs. Initially, it was thought that it would be necessary to split the upper and lower portions of these subwatersheds into unique FAUs. However, land use in these subwatersheds is homogeneous and stream types are consistent in both the headwater and downstream sections.



- | | |
|-----------------------------|--------------------------------------|
| Buckhorn Creek | Hector Creek |
| Utley Crk/Cary Br/Norris Br | Upper Neills Creek - Urban |
| White Oak Creek | Kenneth Crk/Upper Neills Crk - Rural |
| Little White Oak Creek | Middle/Lower Neills Creek |
| Parkers Creek | Kenneth Creek - Suburban |
| Avents Creek | Kenneth Creek - Urban |


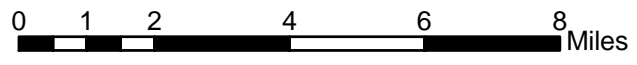

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Figure ES.3. Functional Assessment Units



The Harris Lake and Dry Creek subwatersheds, as well as small drainages flowing directly into the Cape Fear River, were excluded from the functional assessment process. Although nutrient management is a key concern for the management of Harris Lake, it was determined to be outside the relevant scope of issues important to the rest of the study area. Also, any sediment impacts within the drainage to the lake are contained within the lake. The Dry Creek sub-watershed and the small drainages directly to the Cape Fear River have no monitoring data available, which impedes model calibration. Due to the small size of their land areas compared to the other drainages, these areas also have a limited impact on the water quality of Cape Fear River. Therefore, it was determined that it would be more cost-effective to apply project resources to the other parts of the study area.

Methods

Existing Data Collection

Existing data collected within the study area include local government planning information, GIS data layers, North Carolina DWQ monitoring data, US Census data, and aerial photography. These data were supplemented with the development of an agricultural land use and practice data layer and a stormwater data layer for Holly Springs and Fuquay-Varina, both based on field visits to the study area. Additional visits were made to determine the types of feasible management opportunities (e.g., best management practices (BMPs), preservation, and stream restoration).

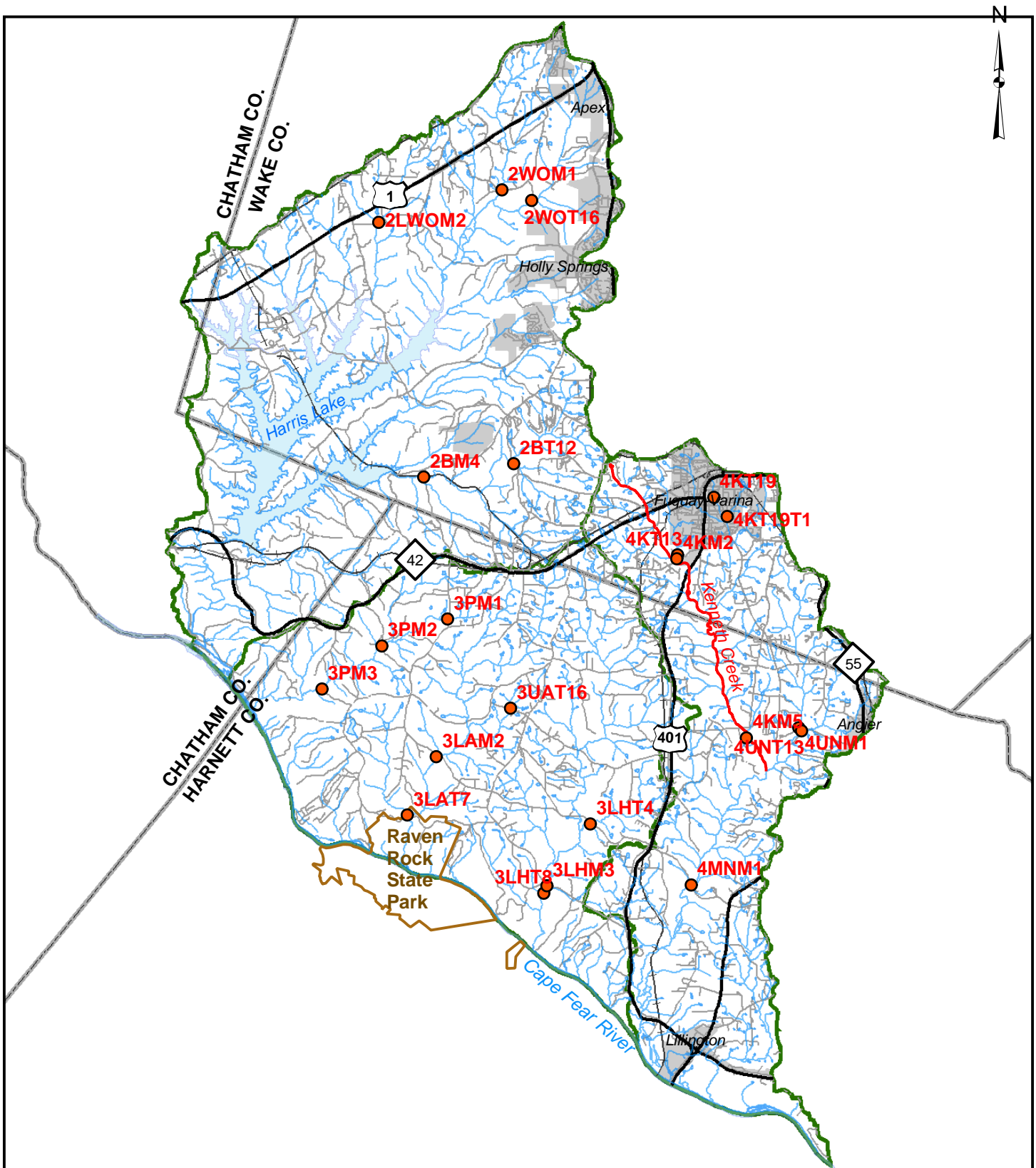
Field Data Collection

Environmental variables related to watershed function were sampled at 22 sites throughout the study area to produce quantitative measures of stream and buffer conditions. Tasks included watershed delineation, stream classification, longitudinal profile and cross-section surveys, bed sediment sampling, analysis of bank erosion, and evaluation of riparian vegetation. These study components were used to characterize the stability of each study stream, identify areas sensitive to disturbance, and document the baseline conditions of the stream channel.

Some parameters were collected at regular intervals throughout the watersheds while others were collected at representative study sites. The 22 study sites were chosen based on field reconnaissance at all road-crossings of streams throughout the HUs (Figure ES.4). Sites were chosen because of how well they represented typical conditions within the study area. Streams were not necessarily chosen because they were of high quality; rather, streams were chosen to represent actual conditions and allow for extrapolation to a larger area.

Modeling

Water quality modeling techniques were employed to produce sediment and nutrient loading estimates for the project watershed. The SWAT model incorporates geographic, environmental, and management data together with land use conditions to estimate sediment and nutrient loadings. The choice of SWAT was made after consideration of functional goals and provides an indication of progress towards achieving these goals.

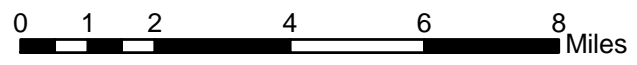


● Study Sites



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Figure ES.4. Study Sites



Modeling tasks included delineation of model catchments based on stream networks and groupings of uniform watershed characteristics, processing of meteorological data, definition of watershed hydrology, calibration of the model, and documentation of results. Once the SWAT model was calibrated, various land use and management scenarios were tested, including estimates of land development, implementation of BMPs, and adoption of stormwater and other land use regulations.

Functional Assessment

A “strength of evidence” approach was used to determine a rating for the watershed functions of habitat, hydrology, and water quality in each FAU. Levels of function are described as follows:

- Functioning - existing conditions indicate that function is achieved without immediate risk of alteration.
- Functioning at Risk - existing conditions indicate that function is minimally achieved, though immediate risk of alteration exists.
- Not Functioning - existing conditions indicate that function is not being achieved.

The assessment considered all lines of evidence developed during the course of the study using a process that incorporated existing scientific knowledge and best professional judgment in order to consider the strengths and limitations of each source of information. Lines of evidence (metrics) considered for the habitat function included land use, field assessment of habitat, invasive species abundance, habitat assessment performed during benthic surveys, and substrate analysis. For hydrologic function, headwater assessments, bank height ratios, percent impervious cover, and levels of existing or planned infrastructure were examined. The lines of evidence used to assess water quality function were bank erosion, SWAT modeling results, benthic monitoring data, and riparian area assessments.

Prioritization of Watershed Opportunities

Opportunities to protect or restore watershed functions were prioritized based on a number of factors, including the functional assessment status of the FAU where the opportunity is located, opportunity feasibility, and expected benefit. Priority matrices were used as the primary decision tool or framework. The priority matrices were developed by applying a priority classification (High, Medium, or Low) to combinations of opportunity types (preservation, stream restoration, agricultural BMPs, and stormwater BMPs) and functional status (functioning, functioning at risk, and not functioning) for each of the watershed functions (habitat, hydrology, and water quality). During development of the matrices, a high priority was placed on opportunities that would result in the greatest benefit per function level and a low priority on opportunities that would provide minimal benefit. The presence of high quality habitat, modeling results, and feasibility were used to break ties and adjust ratings, as necessary.

In addition to site-specific opportunities, low impact development design (LID) practices were also considered. LID incorporates a suite of development practices to conserve natural systems and reduce infrastructure footprints and costs. Goals may include preserving open space, minimizing land disturbance, protecting natural features, and implementing processes that provide “green” infrastructure. The SWAT model was used to estimate the impacts of moderate and aggressive LID practices within the study area and determine their likely effect on watershed functions.

Results

The study area lies within a rapidly growing region of the North Carolina Piedmont. While land use is still primarily forested, open space is rapidly being converted to residential and commercial uses. Growth is particularly significant in the headwaters of the three HUs. According to the US Census, the Towns of Fuquay-Varina, Apex, and Holly Springs have experienced population growth of 73%, 307%, and 912%, respectively, over the last decade. The surrounding counties have experienced similar growth with Wake County's population projected to increase by 500,000 people in the next 20 years. The local governments in the study area have all undertaken planning efforts to address these large increases in population.

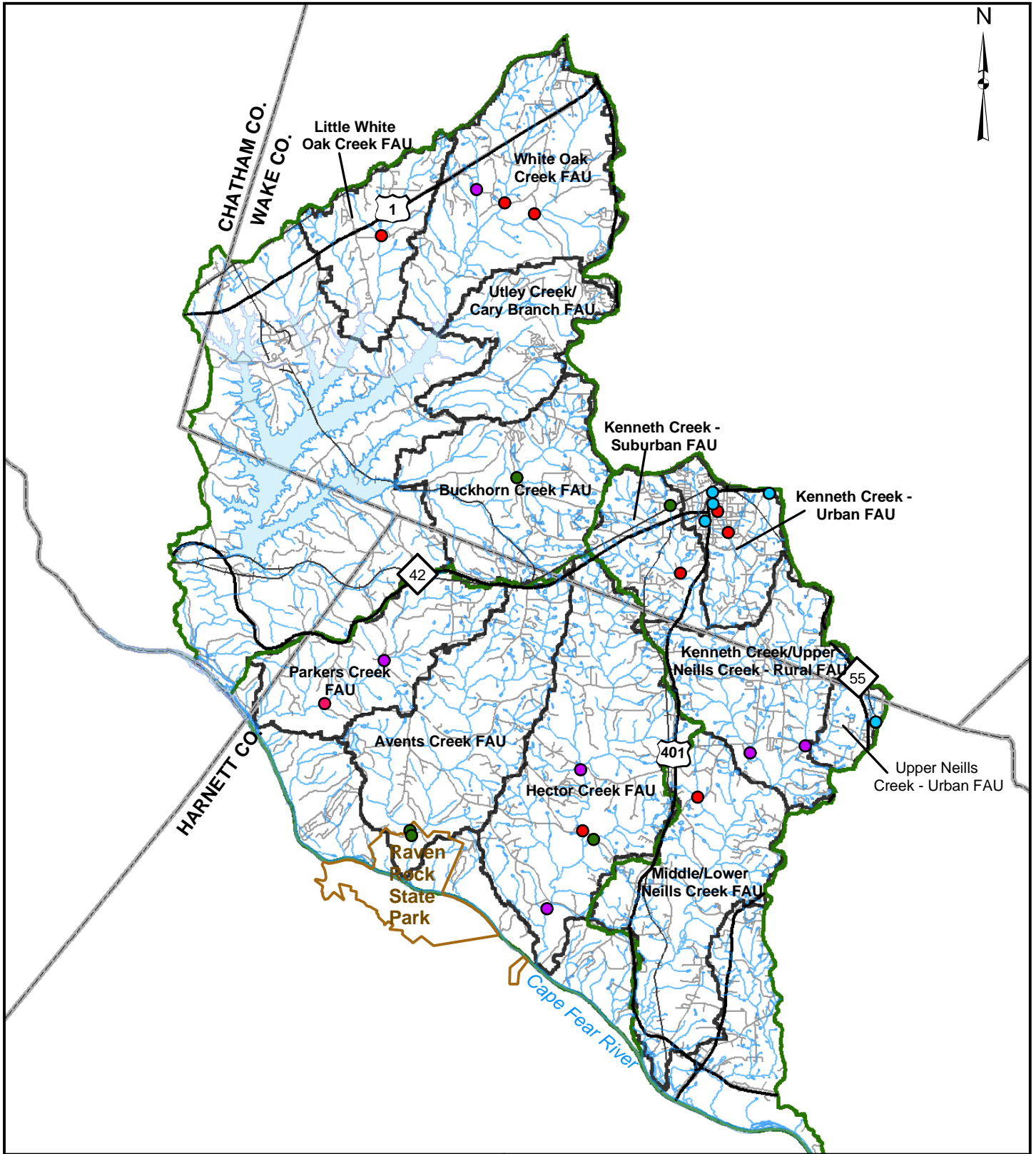
Field analysis determined that streams in the study area generally show signs of departure from stability. Many streams exhibit moderate incision and somewhat less sinuosity than reference streams. However, due in large part to well-vegetated riparian areas found in much of the watershed, stable channel dimensions are often maintained and the majority of surveyed cross sections are laterally stable at present.

Modeling results indicated that nutrient and sediment loadings vary greatly throughout the study area. Harris Lake has a strong water quality effect as it traps significant amounts of sediment and phosphorus. Agricultural activities and channel erosion from developed areas result in some catchments with very high sediment and nutrient sources. Transport and storage of sediments as they move through the steeper headwater creeks and onto the Cape Fear River floodplain play an important role in pollutant delivery. The location of streams is crucial in determining the importance of upstream pollutant sources.

In general, some of the more rural functional assessment units (notably, the Parkers, Avents, Hector, and Little White Oak Creek FAUs) exhibit very good riparian and upland habitat and hydrologic functions. On the other hand, the more urban Kenneth and Neills Creek FAUs exhibit the greatest signs of degradation, with a number of watershed functions at risk or not functioning.

Future development is predicted to have significant impacts on the study area. SWAT modeling forecasted that streams will become flashier, with higher peak flows and lower discharge during dry periods. An increase in sediment pollution is also predicted to coincide with future development. Only the relatively undisturbed portions of the study area and the presently built-out area around Kenneth Creek are unlikely to see major changes in water quality and habitat function. If development continues to follow its current trajectory, 65% of the study area will face new threats to functional qualities.

A number of opportunities to restore and protect watershed functions throughout the study area were identified, including preservation, stream restoration, agricultural BMPs, and stormwater BMPs (Figure ES.5). The highest ranked preservation and restoration opportunities are located in rural sections of the study area, while all the stormwater opportunities are located in urban sections of the study area. Prioritized project information sheets are included in Appendices 1 through 4 of Technical Memorandum 5.

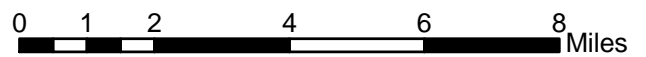


- Preservation Sites
- Restoration Sites
- Agricultural BMP Sites
- Stormwater BMP Sites



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Figure ES.5. Opportunity Sites



Conclusions

The water resources in the study area exhibit signs of stress with future development likely to cause additional impacts. Given the vulnerable condition of these natural resources, it is vital to expedite implementation of the recommended efforts. Many watershed functions are already degraded or threatened by current development, and future development is likely to continue at the same or, potentially, an accelerated pace. Failure to act will likely put watershed stakeholders in a reactive, rather than a proactive, position.

Many of the identified opportunities can be undertaken by the EEP, while others will need the involvement of local governments and other watershed stakeholders. The following action items are recommended:

- EEP should implement stream restoration projects, and possibly stormwater and agriculture BMPs that have been identified and evaluated in this plan.
- Local governments should undertake efforts to implement LID requirements to help prevent further degradation of watershed functions.
- In addition to adoption of LID practices, local governments should adopt stormwater ordinances to help mitigate the effects of development.
- Local governments should seek funding sources such as the Clean Water Management Trust Fund and the Division of Water Quality Nonpoint Source Program to implement additional efforts to protect and restore watershed functions.
- Local governments should decide how to allocate limited resources and choose which of the opportunities identified in this study to pursue.
- Implementation of these management actions should include monitoring before and afterwards to document successes.
- EEP, local governments, and the Triangle Land Conservancy should contact Progress Energy and other large landowners regarding preservation opportunities.

This Executive Summary and the five Technical Memorandums can be downloaded from the following web address: <http://www.nceep.net/>.