



Urban Forest Management Plan

2013 ~ WAKE FOREST, NC



Urban Forest Management Plan

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Accepted in 2013



TOWN of
WAKE FOREST



“No town can fail of beauty, though its walks were gutters and its houses hovels, if venerable trees make magnificent colonnades along its streets.”

~ HENRY WARD BEECHER



Executive Summary

BACKGROUND: Wake Forest is recognized for its continuing commitment to maintaining an attractive and productive urban forest. The town currently is responsible for 14,700 street trees, 630 acres of forests, and more than 1,100 maintained trees in parks and town property. There are approximately 5,400 sites where additional trees may be planted in the future. Currently, the town's street trees provide annual benefits valued at approximately \$389,000 and have an estimated replacement value of \$16.9 million.

VISION: "Wake Forest's Urban Forestry Program develops and maintains the health, beauty, and value of the town's urban forest as a key feature that draws residents, businesses, visitors, and recognition to our community."

GOALS: The following goals are recommended to achieve this vision:

- maintain a town-wide canopy cover of at least 40%,
- maintain at least 90% of public trees in "good" condition (defined as 75%-100% of perfect condition)
- maintain living trees in at least 95% of available public planting spaces
- ensure that no species, genus, or family of trees comprise more than 10%/20%/30%, respectively, of the town's street tree population

RECOMMENDED ACTIONS, FY2013-2014: Current staff and funding levels are inadequate to provide the recommended level of service in maintaining the town's tree resources. These maintenance demands are increasing as a result of both continued development within the town, and the increasing size of the individual trees that comprise the urban forest. To meet the goals and vision outlined above, we recommend that the town:

- Hire, train, and equip 2 Arborist Technicians to plant, maintain, and remove trees. If all currently needed street tree maintenance activities were performed by staff, the town would save approximately 39% to 66% versus contractors. The difference in total costs over the next 5 years is estimated at between \$498,000 to \$859,000, depending on staff salaries.
- Hire and train 2 seasonal interns to complete the street tree inventory. It is estimated that this will save about \$100,000 compared to the quote given by the town's previous tree maintenance contractor. A complete inventory will reduce the town's liability for deaths or injuries caused by hazardous trees and allow for efficient maintenance of this resource.
- Continue to contract out work for hazardous tree removal, large tree pruning, and insect and disease treatment until the necessary skills and equipment can be developed to perform this work in-house.
- Continue to provide adequate funding levels for tree maintenance, planting, and education programs, maintenance, planting, and education programs.
- Update the Official Planting List using knowledge gained from the 2012 inventory.



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Introduction & Background



Purposes of this Plan

“Without a management plan, the governments and individuals responsible for taking care of an urban forest will not be effective in meeting the true needs of the trees and the community. A management plan establishes a clear set of priorities and objectives related to the goal of maintaining a productive and beneficial community forest.”

~ AMERICAN PUBLIC WORKS ASSOCIATION, 2007C.

This document is intended:

- To identify the town’s goals and priorities for managing its trees and forests
- To describe the current status of the town’s urban forest resources and its management program
- To document the methods, resources, and personnel that will be used to achieve these goals over the next five years

Statutory Requirements

The Town’s Ordinance Sec. 34-74 requires the Urban Forestry Board “To study, investigate, counsel, develop and/or update annually, and administer a written plan for the care, preservation, pruning, planting, replanting, removal or disposition of trees, shrubs and other planting materials in parks, street and utility rights of way and easements and any other public areas. This plan shall constitute the official town urban forestry plan.” This document is intended to fulfill this obligation by the Urban Forestry Board.

Visions and Policies from the 2009 Community Plan

“Support for street trees in Wake Forest is very strong. Area residents at town meetings held for the community plan offered a firm consensus in support of tree planting and preservation. Comments received at the first town meeting, for example, included ‘strong tree preservation ordinance’ and ‘replant trees’. Another citizen simply said ‘Keep Wake Forest green.’ Regardless of the exact words chosen, there is little doubt that residents want Wake Forest to be a beautiful community and street trees are one of the most effective, least costly ways to do that.”

~ WAKE FOREST COMMUNITY PLAN, 2009



Overarching street trees provide shade along neighborhood sidewalks.

In 2009, an 11-member steering committee appointed by the Town Board created a Community Plan, containing vision statements and policies to guide staff decisions and proposed changes in town facilities and services.

The Wake Forest Community Plan contains a number of visions involving the town's trees. Together, they paint a picture of a town in which quality of life benefits greatly from trees in parks, along greenways and streets, and in town-owned open space.

Vision 1: Small Town Character, Attractive Appearance

"...Streets in Wake Forest exude a welcoming, small town charm; overarching street trees, lush landscaping, understated signage, and wide, shaded sidewalks combine to create a truly inviting community character... Greenery is everywhere. Small parks and natural areas are within walking distance of most parts of town. Office and retail parking lots, once viewed as "seas of asphalt", are now tree-shaded and landscaped."

Vision 7: Open Space and Environmental Quality

"In managing its growth, Wake Forest has worked to preserve open space and minimize adverse impacts to the region's air and water quality... Streams and drain-age ways passing through Wake Forest receive less storm water runoff and pollution due, in part, to policies on dedicated open space, tree preservation, landscaped parking areas, compact two and three story buildings, and vegetated buffer strips along streams and roadsides."

Vision 8. Expanded Park and Recreation System

"As the community has grown, Wake Forest has steadily added to its system of parks and open space...An extensive system of greenway trails, primarily adjoining area streams, is enjoyed by hikers, bicyclists, and others. These greenways also serve as natural corridors for the movement of wildlife in Wake Forest."

Vision 11. Affordable Housing and Quality Neighborhoods

"Wake Forest is known for safe, secure, quiet neighborhoods in every part of the community, with well-tended yards and gardens, and small parks close at hand."

Policy ST-1: The town should prepare and maintain an official STREET TREE PLANTING MASTER PLAN to address: 1) the retrofitting of existing streets, where appropriate, 2) the planting of future streets and 3) the maintenance and replacement of dead, diseased or disfigured trees.

Policy ST-2: So as to create a unity of design and effect, CONSISTENT STREET TREE SPECIES should occur along predetermined sections of streets.

Policy ST-3: To prevent future decimation of tree cover over entire areas of the community by disease (e.g. Dutch Elm disease), NO SINGLE TREE SPECIES should comprise more than 10 to 15% of the total street tree population of the town. Further, trees in a neighborhood area should vary from street to street.

Policy ST-4: REGULARLY SPACED STREET TREES should be planted in central medians, frontage street medians, plaza strips and, where necessary, in dedicated easements on private property.

Policy CC-5: Large trees, ponds, creeks, or other natural features of the landscape should be saved when locating new streets, buildings, parking lots, etc.

Policy HSE-6: VEGETATED RIPARIAN BUFFERS (natural or planted) shall be required along all creeks, rivers, lakes and other water bodies in Wake Forest.

Policy HSE-12: A combination of incentives and disincentives may be employed to protect EXISTING TREES and/or require the replacement of trees removed for development.

Overall Urban Forestry Program Vision

To summarize these statements, the following vision is offered:

“Wake Forest’s Urban Forestry Program develops and maintains the health, beauty, and value of the town’s urban forest as a key feature that draws residents, businesses, visitors, and recognition to our community.”

Program Goals

To achieve this vision, the following goals are recommended:

- maintain a town-wide canopy coverage of at least 40%
- maintain at least 90% of public trees in “good” condition (defined as 75%-100% of perfect condition)
- maintain living trees in at least 95% of available public planting spaces
- ensure that no species, genus, or family of trees comprise more than 10%/20%/30%, respectively, of the town’s street tree population

A Brief History of Wake Forest's Trees

In the early 1700s, botanist and explorer John Lawson passed through the piedmont of North Carolina, including the Falls of the Neuse River, and described a landscape far different from today's:

"However, we all got safe to the North-Shore, which is but poor, white, sandy Land, and bears no Timber, but small shrubby Oaks. We went about 10 Miles, and sat down at the Falls of a large Creek. ... I take this to be the Falls of Neus-Creek. ... We lay here all Night. ... The next Morning we set out early. ... We went, this day, above 30 Miles, over a very level country, and most Pine Land."

-JOHN LAWSON, 1709

Because pine trees cannot grow in the shade of their ancestors, it is likely that the pine forests around this area were dependent on grazing herbivores and frequent fires that prevented hardwood forests from developing. These two disturbing forces also would have reduced the underbrush enough to allow the explorers to cover 30 miles per day.



The area around Wake Forest once contained a mix of pine forests and prairies grazed by bison and elk, as documented by explorer John Lawson in 1709.

Over the next century, trees had become a defining feature of this area, and by 1820, this area was known as "Wake Forest Township". In the late 1800s, trees were planted along town streets. Historical maps show trees in the campus that is now the Southeastern Baptist Theological Seminary, and some of these trees still survive.

The 1909 Sanborn fire insurance maps show two large lumber planing mills on between South White Street and the railroad, indicating the economic importance of local timber harvesting.

Aerial photos from 1938 reveal Wake Forest as a town surrounded by farms and forests, with shade trees planted in yards and along Main Street.

The Wake Forest Tree Board was established in 1978. That same year, the first recorded street tree inventory was conducted. Wake Forest was one of the first communities in North Carolina to be named a "Tree City USA" in 1979. In

1990, the Tree Board commissioned an Urban Forestry Report, and this information was used to amend the town's zoning ordinance.

During the 1990s, multiple grants helped to fund tree planting and educational projects throughout town. During the 2000s, Wake Forest grew rapidly, and many developments were created that incorporated street trees. In 2004, another street tree inventory was conducted by Davey Resource Group. In 2010, Wake Forest was named North Carolina's Tree City USA of the year. The town also received the prestigious Sterling Award for 10 years of continuous program growth. To date, only eight other municipalities in North Carolina share this distinction.

Growth of Wake Forest's Street Tree Population

Previous tree inventories performed by Davey Resource Group in 2004 and by the NC Division of Forest Resources in 1978 and 1990 show slow, steady growth in the number of street trees. Between 2004 and 2012, many new developments were added to the town, and both population and the number of street trees increased dramatically (Figure 1).

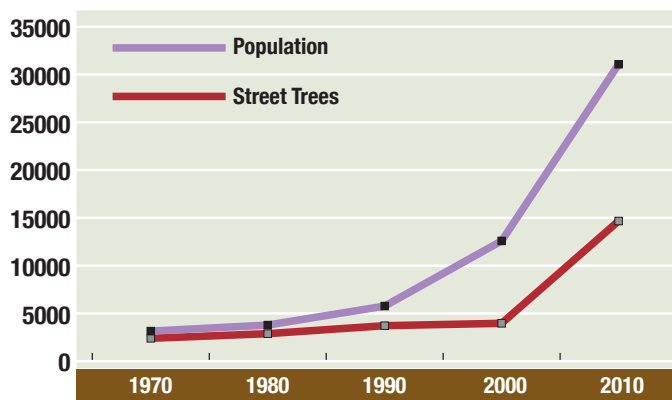


FIGURE 1: Population of residents and street trees by decade, 1970 to Present



Wake Forest has been a Tree City since 1979, received the Tree City USA Sterling Award in 2002, and was named North Carolina's Tree City USA of the Year in 2010.



Urban Forest Resources and Recommendations

Wake Forest's Tree Resources: Tree Canopy, Forests and Public Trees

TREE CANOPY COVERAGE

Tree canopy coverage is a measure of the portion of the town that is shaded by trees. Digital aerial photos taken during the 2010 growing season and iTree Canopy software were used to estimate townwide canopy cover at 44% ± 3% (Figure 2).

American Forests' General Tree Canopy Goals

American Forests, a national not-for-profit conservation organization, has developed tree canopy goals for various areas in the United States, with the following recommended generally for cities east of the Mississippi:

- 40% tree canopy overall
- 50% tree canopy in suburban residential areas
- 25% tree canopy in urban residential areas
- 15% tree canopy in central business districts

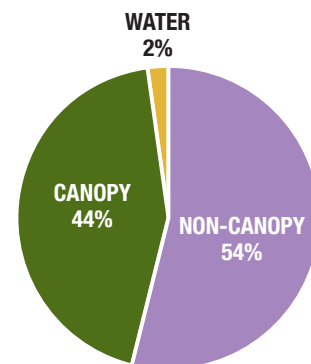


FIGURE 2: Approximately 44% of Wake Forest was shaded by trees in 2010

TABLE 1: Urban Tree Canopy in North Carolina Municipalities

CITY	TREE CANOPY COVERAGE	TREE CITY USA?	POPULATION (2011)	CANOPY GOAL
Hickory	32% (2009)	Yes	39,965	40%
Selma	34%	No	6,209	-
Smithfield	43%	No	11,194	-
Wake Forest	44% (2010)	Yes	31,073	40% (proposed)
Clayton	52%	Yes	16,472	-
Charlotte	49% (2008)	Yes	751,087	50% BY 2050

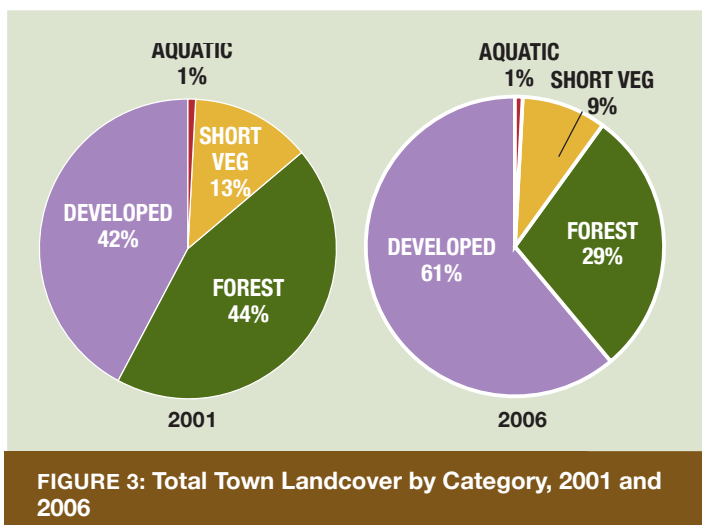


FIGURE 3: Total Town Landcover by Category, 2001 and 2006

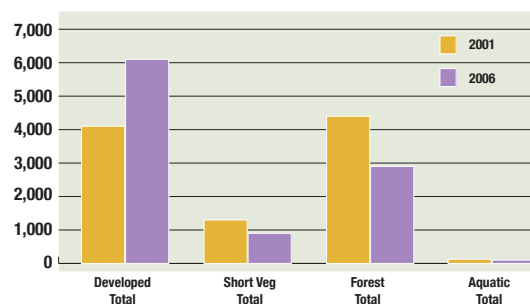
While the town exceeded this goal in 2010, continued development is likely to result in falling below this threshold. Significant investments in tree preservation, planting, and protecting forested open space from future development are needed to keep Wake Forest from falling behind other North Carolina municipalities (Table 1).

Using diameter estimates and US Forest Service canopy models, the town's street trees are estimated to provide 3 million square feet of canopy, or about 70 acres. This is a relatively tiny percentage of overall canopy cover, but represents an important type of canopy that shades heavily used areas of pavement, sidewalks, and buildings.

Overall Town Landcover

Free landcover data provided by the MRLC, a consortium of Federal agencies, shows a decrease in forest and an increase in developed land between 2001 and 2006 (Figures 3 & 4). Data from 2011 is expected to be available in December 2013. In 2001, the area within the current corporate limits was predominantly covered by forest, and there was 1 acre of forest for every acre of developed land. By 2006, developed land was predominant, with 2 acres of development for every acre of

FIGURE 4: Landcover in Acres, 2001-2006, for Areas Within the 2012 Town Limits



RECOMMENDATION:

Set a goal of at least 40% canopy coverage overall. Identify areas of below-average coverage, and encourage measures to preserve and expand tree canopy coverage. Continue to purchase and preserve forested open space to offset canopy loss due to new development.

forest. During this 5-year period, more than 1/3 of the forest (2.3 square miles) was removed, and more than 3 square miles of developed areas were created. Almost half of the forest removed was evergreen, likely from pine plantations or old fields.

Landcover on Town Property

For property currently owned by the town, forest was the dominant landcover in both 2001 and 2006 (Figure 5). About 6% of forested land (37 acres) was converted to developed property. Using digital aerial photos taken in 2010, it is estimated that the town currently owns approximately 630 acres of forested land (0.98 square miles). Upland deciduous forests are the most common type of forest on town property (Figure 6).

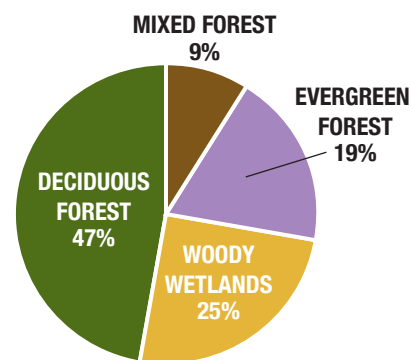
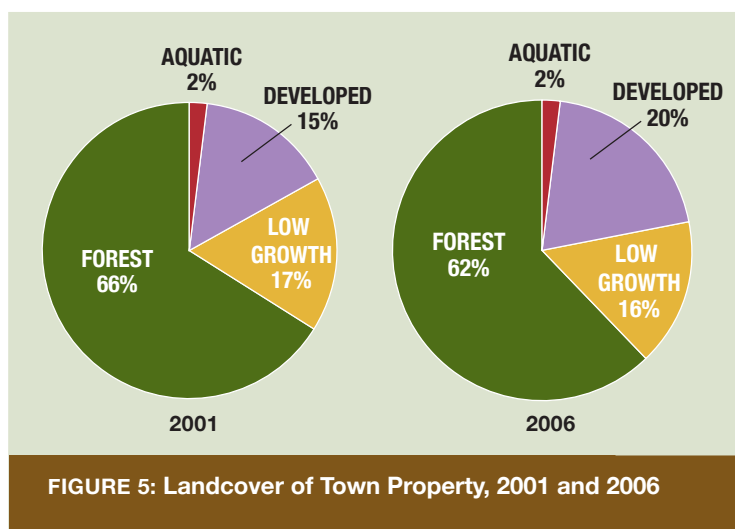
TOWN FORESTS

Currently, there is no written plan for the management of the town's significant holdings of forested land. However, the following general issues have been identified:

- Overly thick stands of loblolly pines need to be thinned to reduce the threat of wildfires, pests, and disease.
- Invasive exotic plant species such as kudzu, Chinese privet, Japanese stiltgrass, Callery pear, and Chinaberry have infested town property and should be controlled.

RECOMMENDATION:

Create management plans for all town forests, describing these resources and detailing how they are to be managed. Create a wildfire risk management plan.



- Species composition and regeneration within town forests may be affected by high populations of white-tailed deer.

Therefore, it is recommended that a forest management plan be developed to describe and manage each stand of forest on town property. This will reveal opportunities to make these forests safer, healthier, more productive, and possibly economically productive through carefully planned thinning or harvesting operations.

See Appendix on page 53 for maps of forested land in Wake Forest.

TREES ON PUBLIC GROUNDS

Using aerial photos, it is estimated that there are more than 1,100 maintained trees in town parks and cemeteries, and around public facilities (Table 2). The pecan grove at Joyner Park, historic trees of the Wake Forest Cemetery, and shade trees in town parks represent some of the most highly visible and appreciated trees in town, and should be maintained at a level equal to or exceeding the town's street trees.

In addition to these maintained trees, there are thousands of trees along trails and greenways in the town's park system, which periodically require inspection and pruning to ensure that the trails are safe and clear for pedestrians and bicyclists.

TABLE 2: Estimated Number of Maintained Trees on Town Property

TOWN PROPERTY	MAINTAINED TREES
E. Carroll Joyner Park	300
Wake Forest Cemetery	250
Town Hall and Miller Park	150
Flaherty Park	150
Heritage High Park	100
Smith Creek Soccer Center	75
Plummer Park	50
Holding Park	25
Public Works Facility	20
Ailey Young Park	20
Tyler Run Park	20
Taylor Street Park	15
TOTAL	1,175

RECOMMENDATION:

Conduct a tree inventory for all maintained trees on Town property, and inspect all trees along trails and greenways periodically. Create a plan to respond to trees damaged by storms, which may fall across streets or greenways.

Condition and Maintenance Needs

STREET TREE POPULATION

The Town of Wake Forest is currently responsible for maintaining approximately 14,700 trees along the public right-of-way (ROW) (Table 4). The town now contains a street tree population that rivals municipalities that are known nationally for their trees, such as Burlington, Vermont (6,987) and Charleston, South Carolina (15,244). The total number of street trees has grown rapidly from the 2004 tree inventory, likely due to the large number of trees planted in new neighborhoods.

Most of these trees are along streets maintained by the town, while some are found on streets maintained by the NC Department of Transportation (NCDOT), with Main Street (Route 1A) being the most visibly forested. Most of the trees in the right of way are of a size and species appropriate for town maintenance, but a small percentage of the trees were small-growing ornamentals, which would not qualify for town maintenance.

Planting Site Types

Most trees are planted behind the sidewalk, which is ideal for root growth (Figure 7). A large number are also planted in the space between the sidewalk and the street, known as a “treelawn”, “verge”, or “devil strip”. In most cases, this space is 6 feet wide, which is adequate for many species, though 8 feet or wider is better for tree health. Relatively few trees are planted in tree pits, sidewalk cutouts, or in street medians.

Stumps, Dead Trees, and Vacant Planting Sites

There are approximately 200 stumps from recently removed trees, 100 standing dead trees, and more than 5,000 locations where additional trees could be planted (Figure 8). More than 70% of spaces that could support street trees currently contain a living tree. This “stocking level” is fairly good, but indicates that there is a significant opportunity to plant additional trees. Standing dead trees and stumps are unattractive and potentially hazardous, and should be removed.

FIGURE 7:
Location of Current Street Trees

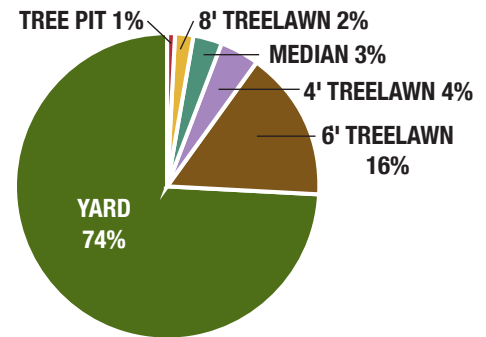
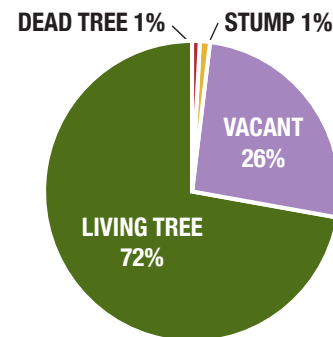


FIGURE 8:
Current Use of Potential Planting Spaces for Street Trees



RECOMMENDATION:

Identify and remove standing dead trees and stumps as soon as possible, and plant additional trees as resources allow.

TABLE 3: Current Estimated Street Tree Population

All ranges represent 80% confidence intervals (rounded to 3 significant figures)

	WAKE FOREST TOWN ROADS	NCDOT STATE ROADS	TOTAL
Publicly Maintained Trees	14,200 (±2,370)	474 (±202)	14,700
Privately Maintained Trees in ROW	318 (±111)	95 (±25)	413
Stumps	175 (±65)	24 (±20)	199
Dead Trees	48 (±33)	71 (±39)	119
Potential Planting Spaces	5,190 (±830)	213 (±95)	5,400
Total Planting Spaces	19,900 (±2,530)	876 (±218)	20,800

Species

The 10/20/30 Rule

Each tree's strengths, weaknesses, needs, and benefits are determined largely by its species. In order to reduce the threat and spread of devastating pests and diseases, such as those that decimated the American elm and the American chestnut, it is important to plant a variety of different species. It is generally recommended that no more than 10% of a town's street trees be of the same species, no more than 20% of the same genus, and no more than 30% of the same family. Following this 10/20/30 rule will help to ensure that pests and diseases are isolated and controllable, and have little impact on the total value of the urban forest.

According to the 10/20/30 rule, Wake Forest has too many oaks, red and Freeman maples, and crapemyrtles (Table 4). Recommendations for alternatives to commonly planted species are provided in Table 5.

Oaks

In Wake Forest, one in four street trees is a member of the red oak group. This group contains the very popular willow oak, as well as Shumard, Nutall, pin, water, northern red, southern red, black, and other oaks. The white oak group, which includes the white, post, chestnut, and other oaks,



Oaks in the red oak group have lobed, pointed leaves originating on alternating sides of the stem.



A Freeman maple, a cross between a red and silver maple, with outstanding fall color.

is also represented. The large-growing, acorn-bearing oaks provide the majority of the value and benefits of the town's street tree population. However, they are increasingly vulnerable to existing threats, such as root rot fungi, and potential future threats, such as oak wilt, sudden oak death, and gypsy moths.

Maples

Red maples are native trees, commonly found in lowlying areas and wetlands. Freeman maples are hybrid cross between red maple and silver maple. Both species are prized for their fall color and rapid growth rate. However, they are vulnerable to gloomy scale, and perform poorly compared to other species. Their thin bark, relatively weak wood, and low tolerance for decay can create a number of maintenance problems and lower their overall quality and lifespan.

Crapemyrtles

Crapemyrtles are extremely popular small trees that originate in East Asia. They are known for their summertime flowers and attractive bark, suffer from few health problems, and tolerate dry, compacted soils. However, they provide fewer benefits than larger trees and represent only one of many available small tree species.

TABLE 4: Most Common Street Tree Species

SPECIES	PERCENTAGE
Red Oak group <i>(multiple species)</i>	25%
Crapemyrtle	15%
Red and Freeman Maples	10%
Cherry group <i>(multiple species)</i>	5%
Sycamore/Planetree	5%
Lacebark Elm	4%
Leyland Cypress	3%
Holly group <i>(multiple species)</i>	3%
Chinese Pistache	2%
Juniper species	2%
American Elm	2%
Arborvitae group <i>(multiple species)</i>	2%
Eastern Redbud	2%
Loblolly Pine	2%
Zelkova	2%
Other	16%



A young crapemyrtle in full bloom

Leyland Cypress

Leyland cypresses are a popular evergreen tree, as they grow quickly and provide a good hedge or screen. Leyland cypresses are intolerant of overly wet or dry conditions more than other evergreens, and can contract fatal fungus and other disease issues. Because they are commonly planted in groups or rows, disease can spread rapidly. These problems can be reduced by creating hedges of multiple alternating species, and by planting other evergreens for screening.

TABLE 5: Recommended Alternatives to Commonly Planted Street Trees

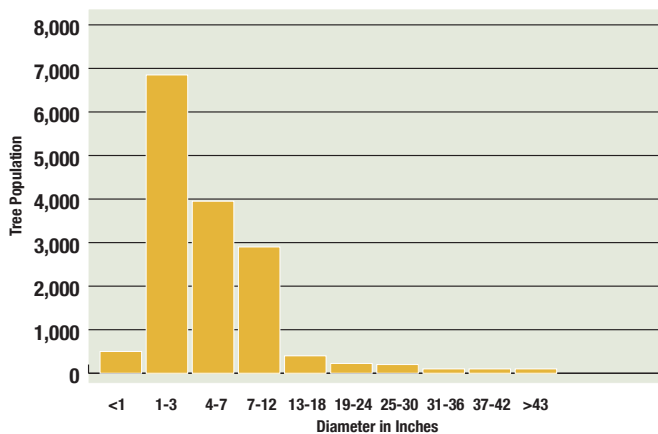
TREE TYPE	PLANT FEWER:	PLANT MORE:
Large growing deciduous	oaks, red or Freeman maple	river birch, tulip poplar, fruitless sweetgum, katsura tree, hackberry, hornbeam, black gum, and ginkgo
Evergreen	Leyland cypress	cryptomeria and arborvitae
Small ornamental	crapemyrtle	goldenrain tree, smoketree, fringetree, witchhazel, magnolia, waxmyrtle, and chaste tree

Type and Size Class

In this climate region, large-growing deciduous trees provide more total value and a better benefit-cost ratio than smaller-growing trees or conifers (USFS, 2006). About 40% of the town’s street trees are in the largest size category. There are some locations where large trees cannot be planted due to lack of root space, overhead power lines, or nearby buildings.

Half of Wake Forest’s street trees are less than 4 inches in diameter (Figure 9). Some of these are small-growing trees, while others are larger growing trees that have been planted in recent years. Few trees were observed in the larger diameter classes; these largest trees provide the most value to the town, but many have not received the care they require. Following neglect or injury, it is not uncommon for a large growing tree to be removed as a potential hazard.

FIGURE 9: Trees by Diameter Class



RECOMMENDATION:
 Adopt the 10/20/30 rule to protect and improve the town’s street tree population. Discourage or disallow the planting of trees that are too commonly planted.

RECOMMENDATION:

Focus efforts to identify, protect, and maintain large-diameter trees, which are relatively rare, but have tremendous value. Ensure that the large number of young trees are receiving necessary care to correct problems when they can be addressed quickly and inexpensively.

An ideal size distribution would contain more large-diameter trees and fewer young trees. The large percentage of young trees also represents a maintenance challenge, as problems with health or structure are best addressed when a tree is young.

TREE HEALTH CONDITION

During the 2012 inventory, the health and structure of each living tree were assessed, and the tree given one of four condition ratings; “good”, “fair”, “poor”, or “very poor” (Figure 10). Most of the town’s street trees are in “good” condition, meaning that they have no health or structural problems that would reduce their value to less than 75% of a tree in perfect condition. They may have some minor issues with their foliage, stems, or roots, but are structurally sound. With neglect, however, these trees can degenerate into “fair” or “poor” health in a matter of years.

Approximately 20% of the street trees are in “fair” condition, meaning their health or structural integrity is between 50% and 75% of a tree in perfect condition. With effort, these trees could become “good” trees, but without effort, they are likely to decline into “poor” condition.

8% of trees are in “poor” or “very poor” condition, indicating major health or structural problems that can lead to death or structural failure. Trees in these conditions are likely to require removal in the near future, and recovery is only possible with sustained effort.

It should be pointed out that the large number of “good” trees likely reflects the recent planting of these trees, and does not mean that the trees do not require immediate attention. The majority of trees observed in this inventory showed signs of significant issues that require correction, such as buried root collars, structural pruning needs, stakes, pests, or disease. Trees can have significant energy reserves that are depleted by stress, and decline rapidly once these reserves are exhausted. Without attention, many of the town’s street trees will decline in health.

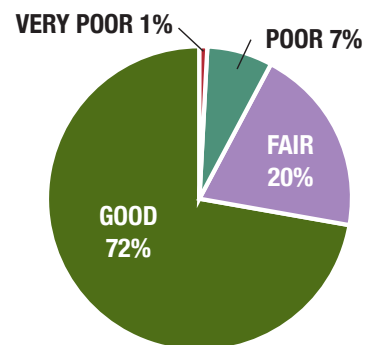
RECOMMENDATION:

Identify species that are performing poorly, and remove them from the official planting list. Avoid planting large numbers of trees that do not have a proven record of success, and expand the use of uncommon species that perform well.

Tree Condition by Species

Tree condition varies significantly between species, indicating species that should probably be avoided (Table 6). Less than half of red and Freeman maples are in good condition. Ornamental cherries are affected by a variety of defoliators and diseases.

FIGURE 10:
Overall Condition of Wake Forest’s Street Trees



Eastern redbuds have a short lifespan, and have more trees in fair condition than good, and the highest percentage of very poor. Zelkovas are reported susceptible to Dutch elm disease and bacterial canker. Many trees were observed in very poor condition; if one tree contracts Dutch elm disease, then it could be spread to nearby trees. Because this disease can also be spread by pruning equipment, it is important to have all pruning done by qualified staff.

TABLE 6: Lowest Performing Street Tree Species

SPECIES	% IN "GOOD" CONDITION	TREES INVENTORIED
Eastern redbud	27%	15
Japanese zelkova	40%	15
Red and Freeman maple	43%	95
Ornamental cherry (multiple species)	61%	49

Value and Benefits of Street Trees

Replacement Value

Wake Forest's street trees have a financial value that can be calculated using industry accepted formulas, applied using the peer-reviewed iTREE Streets program. These values are commonly used in legal cases, insurance claims, and in estimating the damage caused by storms and other disasters. The value of a tree is dependent on its species, condition, location, and size. These values may range from a few hundred dollars for a young tree to tens of thousands for a large, healthy tree of a desirable species (Figure 15). Because value is directly related to size, young trees can gain hundreds or thousands of dollars worth of value within years. To maximize the value of the town's street trees, it is important to provide care for trees of all sizes.

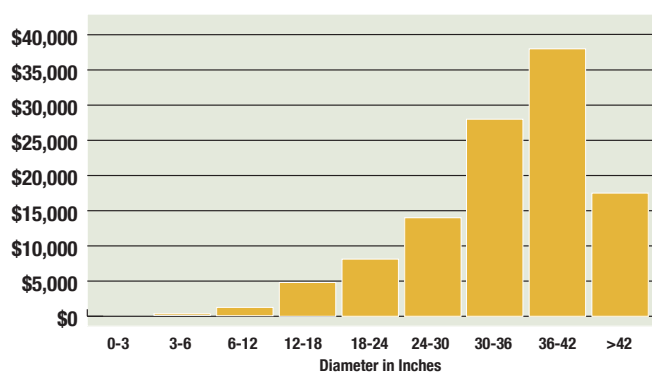


The current replacement value of the street tree population is approximately \$16.9 million.

Replacement Value by Species

More than a quarter of the value of the town's street trees is in red oaks, with most of that value concentrated in willow oaks (Table 7). Other species, including white oaks, loblolly pines, and the combination of red and Freeman maples, are each estimated to have a replacement value of more than \$1 million. These values indicate the potential loss due to pests and disease, and underscore the need to plant a wider range of species.

FIGURE 11: Average Tree Replacement Value by Diameter



The total annual benefits of Wake Forest's street trees are estimated at \$389,000.

Annual Benefits

Living trees provide services which can also be assigned a financial value, using the peer-reviewed iTree software suite. These services include increased property values, energy conservation, air quality improvement, stormwater retention, and carbon dioxide reduction.

The total annual benefits of Wake Forest's street trees are estimated at \$389,000 each year (Figure 12). Property values and aesthetic benefits represent more than half of these benefits, followed by stormwater retention and energy conservation. If the large numbers of small trees currently growing are maintained properly, these benefits are likely to increase dramatically.

Maintenance Needs

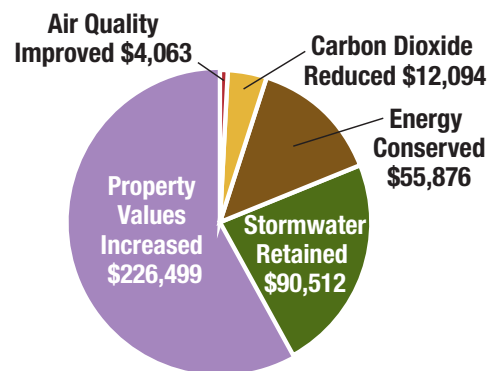
Pruning

- 98% of trees need at least one type of pruning
- 75% need structural pruning
- 35% need crown raising
- 18% need to have dead branches removed (cleaning)
- 11% have codominant stems or weakly attached branches
- 1% need side pruning
- 1% need reducing
- 1% need priority pruning
- 1% have large dead limbs
- 0.2% need thinning

TABLE 7: Total Street Tree Replacement Value by Species

SPECIES	REPLACEMENT VALUE
Red oak group (Willow oak)	\$4,200,000 (\$2,380,000)
White oak	\$1,880,000
Red and Freeman Maple	\$1,640,000
Loblolly pine	\$1,560,000
Sycamore/Planetree	\$798,000
Cherry group	\$768,000
Crapemyrtle	\$726,000
Lacebark elm	\$584,000
Pines (other than loblolly)	\$359,000
Southern sugar maple	\$357,000
Other	\$4,030,000
Total	\$16,900,000

FIGURE 12: Estimated Financial Value of Annual Benefits of Street Trees



Pruning is the predominant need for most town street trees. Young trees need to have future structural problems “nipped in the bud,” while older trees have dead or decaying limbs that could pose a threat to people or property.



Street trees are pruned to maintain the health of the tree and to protect people and property from decaying limbs.

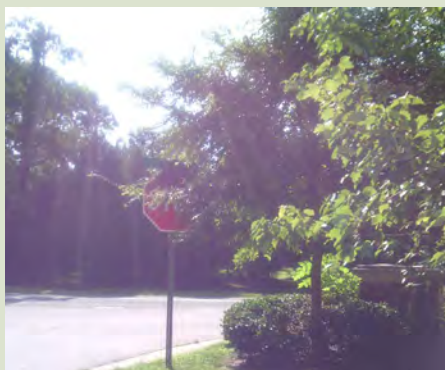
RECOMMENDATION:

Provide necessary maintenance to allow this resource to grow in value and provide increased dividends to residents and business owners.

RECOMMENDATION:

Increase the frequency of pruning cycles to correct and prevent problems that can become more difficult or impossible to address in the future.

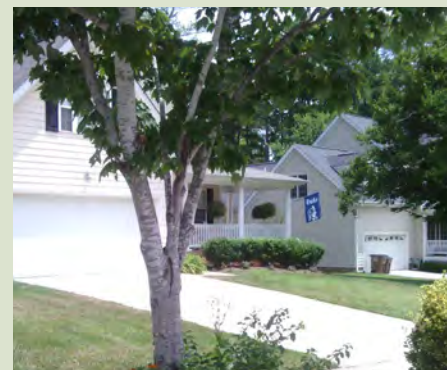
Pruning for Health



A tree in need of a crown raise.



Codominant stems; frequent structural pruning can prevent these weak joints, which can split like wishbones in a storm.



A tree with poor structure, with multiple limbs originating at the same point, and no dominant stem.

Root Health

- 58% need root collars excavated
- 18% need mulch added
- 12% have surface roots
- 4% have girdling roots
- 2% of trees have created sidewalk conflicts

More than half of all street trees have more than 3 inches of soil and mulch piled on the root system. This can cause roots to girdle the stem, cutting off circulation to the canopy. It also creates an environment that encourages termites and fungus that can eventually kill the tree. Other issues include lack of mulch on newly planted trees and surface roots, indicating very poor, compacted soil conditions.



An extreme example of excessive mulching, which creates perfect conditions for fungus and termites to attack the lower stem.



This cherry tree has roots that girdle the stem, and can cut off circulation and eventually kill the tree.

RECOMMENDATION:

Excavate buried root collars and provide public education to prevent easily preventable tree death from excessive mulch and soil.

Pruning for Health



A tree with a low fork. This limb will need to be subordinated and removed to preserve the strength and long term health of the tree.



These two branches are poorly attached, and one should be removed during periodic structural pruning.

Scale

- 7% of all street trees are affected by scale

Scales are small insects that suck the sap out of trees, reducing the tree's resources. Freeman and red maples are affected by gloomy scale, which was observed in more than 80% of Freeman and 35% of red ma-

ples. Additionally, a different type of scale (lecanium) was observed in willow oaks in Heritage and it is known to occur in Olde Mill Stream as well. Given the large amount of value in maples and willow oaks, the impacts of scale could be severe if untreated.

RECOMMENDATION:

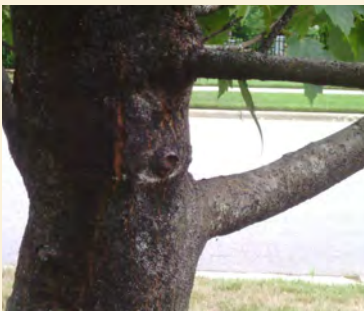
Reduce planting of willow oaks and maples immediately and attempt to control these pests with insecticides. This can only be done at certain times of the year when the scale's lifecycle allows.

Defoliators

- 14% are affected by defoliating insects

Ornamental cherries were heavily attacked by leaf eating insects, which is common for members of the rose family. American elms also show signs of insect damage. Some red oaks were entirely defoliated by orange striped oakworm. However, these can be treated easily, and even full defoliation should not kill the tree unless repeated annually.

Common Pests and Diseases



Gloomy scale on a red maple. These armored insects reduce the tree's energy, making it more vulnerable to environmental conditions, pests, and diseases.



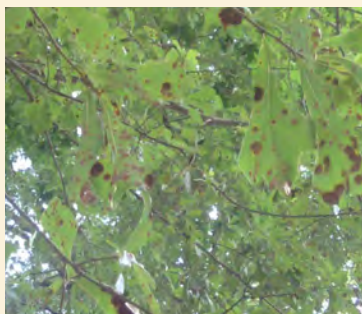
Severe defoliation by orange striped oakworm



Cristulariella leaf spots on a sycamore leaf



Minor defoliation on an ornamental cherry tree



Leaf spots on water oak, a member of the red oak group

RECOMMENDATION:

Inspect oaks for oakworm outbreaks, particularly where the trees were defoliated in previous years, and treat as necessary. Monitor American elms, and provide routine maintenance as needed.

RECOMMENDATION:

Inspect elms and zelkovas for signs of Dutch elm disease, and monitor trees for signs of new diseases. Create a plan to prevent, identify, and respond to large-scale outbreaks of pests or diseases.

Disease

- 25% have a level of disease that affects aesthetics

Bacteria, viruses, and fungi can affect a tree's leaves or trunk. Generally, these microbes had limited impact on overall tree health, and were mainly aesthetic concerns for certain deciduous trees. Dutch elm disease, sudden oak death, and other diseases can have more severe consequences, and actions should be taken to limit the possible impact of these threats.

tain deciduous trees. Dutch elm disease, sudden oak death, and other diseases can have more severe consequences, and actions should be taken to limit the possible impact of these threats.

Trunk Health

- 16% have wounds; 4% need to have these wounds traced to speed healing
- 8% have internal decay
- 3% have stakes or supports that need removal
- 2% are leaning
- 2% have cavities
- 2% have termites
- 1% have borers

RECOMMENDATION:

Remove stakes and supports within 1 year of planting for all trees, and trace wounds as needed. These actions require very little staff time, but can have lasting impacts on tree health.

The health of observed trunks was generally good; however, there are a number of trees that have uneven wounds that will not heal quickly, or stakes and supports that can constrict circulation. These issues can kill a tree if unchecked, but are easy to address if caught early.

Other

- 5% have foliage discoloration
- 4% need to be removed and replaced
- 3% require additional inspection

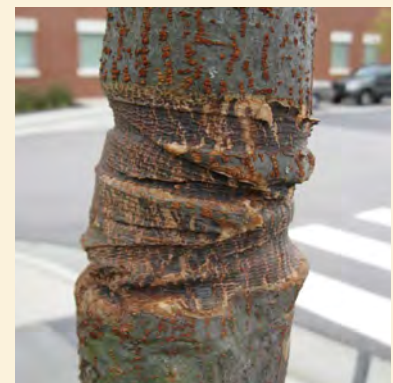
Some trees showed foliage discoloration, which may result from drought stress, lack of nutrients, disease, or other factors. Others need to be removed entirely due to their health or structural problems, or have follow-up inspections to identify and assess issues in further detail.

Trunk Health

Young maple tree with trunk wounds that should be traced with a sharp knife to speed healing and reduce decay



Borer hole in a Shumard oak



Supporting guide lines, if left on too long, can severely injure and kill young trees.

Work Management Plan, Staffing and Budget



Street Tree Management Priorities

In order to minimize the hazards and costs and maximize the long term value of the town's urban forest, the following management activities are recommended, in order of descending priority:

1. Inventory all trees, inspect potential hazard trees, and maintain inventory by inspecting 1/5 of the town's trees annually. This will ensure the safety of people and property and ensure that accurate information is used to guide management decisions.
2. Remove any hazard trees, and correct any dangerous structural issues such as dead limbs and weak forks to ensure public safety.
3. Maintain large trees, particularly in heavily used parks and town property, as these are the town's most valuable trees, and also those most likely to become hazardous if not maintained.
4. Maintain young trees to prevent problems that may become public safety concerns in the future, or which could lead to the decline or death of the tree in the future.
5.
 - a. Remove stakes and ties that are no longer needed.
 - b. Prune for structure and clearance.
 - c. Excavate root collars and correct girdling roots.
 - d. Provide mulch and water to ensure survival and increase growth rate.
6. Maintain pests and diseases at an acceptable level using an integrated pest management (IPM) approach.
7. Replace trees that have been recently removed.
8. Plant additional trees in available spaces using inexpensive stock and volunteers where possible.

Current Estimated Street Tree Maintenance Workload

Staff costs could not be estimated for the following tasks using currently available information:

- Hazardous tree removal: (Number of trees unknown due to sampling methods, but likely to exceed 25 trees) \$10,000 per year (A conservative estimate based on FY 2011/2012 tree removals)
- Pest and disease control: 730 trees per year at \$21,900 per year (Estimated using 2009 contract with Bartlett Tree Experts; data on equivalent staff time unavailable)

TABLE 8: Estimated Total Workload and Total Costs of Performing Work with Contractors Versus Additional Staff

ACTIVITY	CURRENT ESTIMATED WORKLOAD	TOTAL ESTIMATED COSTS FOR CONTRACTORS	TOTAL ESTIMATED HOURS FOR STAFF	ESTIMATED COSTS OF STAFF (\$18-\$33 PER HOUR)	CONTRACTOR COSTS MINUS STAFF COSTS
Large Tree Pruning	3,486 trees	\$318,656 (Estimated using 2009 contract with Bartlett Tree Experts)	6,945 hours (Estimated using per-tree pruning data provided in APWA 2007b)	\$125,010 to \$229,185	\$89,471 to \$193,646
Inventory and Inspection	15,000 trees	\$117,000 (Based on quote from Bartlett Tree Experts, 2012)	1,000 hours (estimated based on work experience with tree inventories)	\$15,000 to \$33,000	\$84,000 to \$99,000
Small Tree Pruning	10,863 trees	\$282,834 (Estimated using 2009 contract with Bartlett Tree Experts)	7,280 hours (Estimated using per-tree pruning data provided in APWA 2007b)	\$131,040 to \$240,240	\$42,594 to \$151,794
Root Collar Excavation	8,277 trees	\$372,335 (Estimated using 2009 contract with Bartlett Tree Experts)	6,375 hours (Estimated from demonstration at 2012 NCUFC conference)	\$114,750 to \$210,375	\$161,960 to \$257,585
Mulching	2,700 trees	\$45,051 (Estimated using 2004 Tree Inventory Management Plan by Davey Resource Group)	675 hours (Estimated at 4 trees per hour + cost of mulch)	\$12,150 to \$22,275	\$22,776 to \$32,901
Nonhazardous Tree Removal	545 trees	\$71,087 (Estimated using 2004 Tree Inventory Management Plan by Davey Resource Group)	525 hours (estimated based on removals performed in 2011 and 2012)	\$9,450 to \$17,325	\$53,762 to \$61,637
Tree Planting	860 trees, stumps, and obvious vacancies currently in need of replanting	\$86,000 + costs of trees (estimated from 2011 tree planting contract)	1,290 hours + costs of trees (estimated at 1.5 hours per tree for transport and planting)	\$23,220 to \$42,570	\$43,430 to \$62,780
Total	41,731 trees	\$1,293,000	24,090 hours	\$434,000 to \$795,000	\$498,000 to \$859,000

Addressing the Current Street Tree Workload: The Levels of Service Concept

The effectiveness of an urban forestry program is dependent on the resources available for each maintenance task. When fewer resources are available, the program must operate at a lower level of service often becoming reactionary and focusing on emergencies and major problems as they arise. While maintenance costs may be less, the health and quality of the forest is lower, and the work that is performed is less efficient. As service levels increase, more frequent preventative work is possible, and the safety, health, aesthetics and benefits of the urban forest increase, often allowing the municipality to achieve both higher total benefits and receive more value per maintenance dollar.

Description of Service Levels

- **SERVICE LEVEL 1** represents a minimum responsible level of service. Below this level, community safety is threatened by falling trees and limbs. At this level of service, large trees are periodically inspected and pruned, and dangerous trees or limbs are removed. Residents and volunteers are responsible for planting and maintaining trees. Wake Forest's previously expressed goals for the urban forest cannot be met at this level of service, and it would be difficult to maintain Tree City USA status.
- **SERVICE LEVEL 2** represents a program that provides a degree of preventative maintenance and planting. The town actively plants and maintains trees in the right of way, and problems with trees are eventually addressed. Without the assistance of residents and volunteers, trees cannot be replaced as quickly as they are removed. Currently, most aspects of Wake Forest's Urban Forestry Program fall within this level of service.
- **SERVICE LEVEL 3** represents a typical mature urban forestry program that is both financially efficient and arboriculturally effective. A focus on preventative maintenance ensures that most problems are addressed at an early stage, decreasing mortality and unplanned work requests. More trees are planted than are removed, and the value of the resource steadily increases over time. This overall level of service is the recommended goal for the program by 2017.
- **SERVICE LEVEL 4** represents an advanced urban forestry program that provides the highest reasonable level of service for a given street tree population. While the total costs of level 4 are the highest, the benefits are also the highest, and the benefit to cost ratio is better than in other levels. This level of service is usually only seen in areas in which landscaping is of very high importance. Over the next 5 years, only a few program components are recommended for this level of service.
- **BEYOND SERVICE LEVEL 4**, the increased costs of maintenance are unlikely to result in significant improvements in the quality of the urban forest.

TABLE 9: Levels of Service for Annual Street Tree Maintenance, Removal, and Planting

	LEVEL OF SERVICE 1	BUDGET IMPACT / STAFF TIME	LEVEL OF SERVICE 2	BUDGET IMPACT / STAFF TIME	LEVEL OF SERVICE 3	BUDGET IMPACT / STAFF TIME	LEVEL OF SERVICE 4	BUDGET IMPACT / STAFF TIME
Hazardous Tree Removal	Highest priority removals only	\$5,000 (estimate)	All high priority removals and some medium priority removals	\$7,500 (estimate)	All high and medium priority removals as needed	\$10,000 (estimate)	Proactive mature tree care (lightning protection, cabling, etc.)	\$10,000+
Large Tree Pruning	Prune one-tenth of large trees	\$31,900 or 695 hrs	Prune one-eighth of large trees	\$39,800 or 868 hrs	Prune one-fifth of large trees	\$63,700 or 1,389 hrs	Prune one-third of large trees	\$106,000 or 2,315 hrs
Inventory & Inspection	Inventory one-fifteenth of trees	\$7,800 or 70 hours	Inventory one-fifth of trees	\$23,400 or 200 hours	Inventory one-third of trees	\$39,000 or 330 hours	Inventory all trees	\$117,000 or 1,000 hours
Small Tree Pruning	No young tree pruning	\$0	Prune one-fifth of small trees	\$56,600 or 1,460 hrs	Prune one-third of small trees	\$94,300 or 2,430 hrs	Prune one-half of small trees	\$141,000 or 3,640 hrs
Root Collar Excavation	Root problems are not corrected	\$0	Correct one-tenth of current root problems	\$37,200 or 638 hours	Correct one-fifth of current root problems	\$74,500 or 1,280 hours	Correct one-third of current root problems	\$124,000 or 2,130 hrs
Mulching	No mulching	\$0	Mulch one-tenth of unmulched trees	\$4,510 or 68 hours	Mulch one-fifth of unmulched trees	\$9,010 or 135 hours	Mulch one-third of unmulched trees	\$15,000 or 225 hours
Pest and Disease Control	No pest/ disease treatment	\$0	Treat up to 1% of all trees	\$4,500	Treat up to 2.5% of all trees	\$11,000	Treat up to 5% of all trees	\$21,900
Nonhazardous Tree Removal	No tree removal	\$0	Perform one-fifth of necessary removals	\$14,200 or 105 hours	Perform one-third of necessary removals	\$23,700 or 175 hours	Perform all necessary removals	\$71,087 or 525 hours
Planting	No tree planting	\$0	Plant trees only upon resident request	\$22,500 or 150 hours + up to \$7,500 for trees	Plant enough trees to maintain current tree population	\$115,500 or 770 hours + up to \$38,500 for trees	Plant enough trees to grow tree population by 5%	\$208,500 or 1,390 hours + up to \$69,500 for trees

Tables based on Davis, 2002; APWA 2007a

TABLE 10: Proposed Levels of Service, 2012-2017

	LEVEL OF SERVICE 2012-2013	RECOMMENDED LEVEL OF SERVICE 2013-2014	RECOMMENDED LEVEL OF SERVICE 2014-2015	RECOMMENDED LEVEL OF SERVICE 2015-2016	RECOMMENDED LEVEL OF SERVICE 2016-2017
Hazardous Tree Removal	L3: All high and medium priority removals	L3: All high and medium priority removals	L3: All high and medium priority removals	L3: All high and medium priority removals	L3: All high and medium priority removals
Large Tree Pruning	L1: Prune one-tenth of large trees	L2: Prune one-eighth of large trees	L3: Prune one-fifth of large trees	L3: Prune one-fifth of large trees	L3: Prune one-fifth of large trees
Inventory and Inspection	L1: Inventory one-fifteenth of trees	L4: Inventory all trees	L2: Inventory one-fifth of trees	L2: Inventory one-fifth of trees	L2: Inventory one-fifth of trees
Small Tree Pruning	L2: Prune one-fifth of small trees	L2: Prune one-fifth of small trees	L3: Prune one-third of small trees	L3: Prune one-third of small trees	L3: Prune one-third of small trees
Root Collar Excavation	L1: No root collar excavation	L4: Correct one-third of current root problems	L4: Correct one-third of current root problems	L4: Correct one-third of current root problems	Root Collar excavation expected to be complete. Continued public education and tree inventories to reduce future need.
Mulching	L1: No mulching	L2: Mulch one-tenth of unmulched trees	L2: Mulch one-tenth of unmulched trees	L2: Mulch one-tenth of unmulched trees	L2: Mulch one-tenth of unmulched trees
Pest and Disease Control	L2: Treat up to 1% of all trees	L2: Treat up to 1% of all trees	L3: Treat up to 2.5% of all trees	L3: Treat up to 2.5% of all trees	L3: Treat up to 2.5% of all trees
Nonhazardous Tree Removal	L2: Perform one-fifth of necessary removals	L2: Perform one-fifth of necessary removals	L2: Perform one-fifth of necessary removals	L2: Perform one-fifth of necessary removals	L2: Perform one-fifth of necessary removals
Planting	L2: Plant up to 150 trees per year.	L2: Plant up to 150 trees per year.	L3: Replace removals, and achieve > 90% full stocking in 10 years (770 trees/year)	L3: Replace removals, and achieve > 90% full stocking in 10 years (770 trees/year)	L4: Replace removals, and achieve > 90% full stocking in 5 years (1,390 trees / yr)

Proposed Levels of Service for Street Trees, 2013-2017

Current staffing and funding levels are sufficient for service levels 1 and 2 for most maintenance activities. It is recommended that the program be grown to service level 3 by 2017 (Table 10). This would entail the following actions:

- Complete a full tree inventory in 2013-2014, followed by inventory and inspection of one-fifth of publicly maintained trees each year
- Increase mature tree pruning frequency to prune each tree every 5 years
- Initiate a root collar excavation program to correct easily preventable and potentially fatal root problems within 3 years
- Increase small tree pruning frequency to prune each tree every 3 years
- Increase treatment of harmful pests and diseases to 370 trees per year
- Accelerate tree planting to replace the hundreds of trees that have been removed and begin to fill the thousands of available planting sites

Estimated Costs for Street Tree Work to be Performed by Contractors and Staff

Currently, almost all planting, maintenance, and removal work is performed by private contractors. Town staff perform limited maintenance and removal work when contracting would be too slow or inefficient to perform the required work. However, the current workload is large enough to support a crew of town staff that would be responsible for planting, maintaining, and removing trees on town property.

The costs of private contractors and the hours of town staff time were estimated for each service level by comparing data from the 2012 tree inventory with information provided in the 2004 Tree Inventory Report by Davey Resource Group, the American Public Works Association, and the town's most recent maintenance contract. It is recommended that the town continue to contract some tasks, particularly those that require expensive equipment, extensive experience, or bear very high levels of risk. However, for many routine tasks, the town would save hundreds of thousands of dollars by hiring staff. Neighboring municipalities, including Raleigh and Durham, rely on full-time municipal employees to perform urban forestry maintenance work.

Calculated Costs of Staff

Annual salary data were located for 4 full-time permanent tree maintenance positions. One was advertized recently by the City of Raleigh, another by Wake Forest's Electric Department, and two additional positions were generally described by the American Public Works Association. The total costs of all employee benefits were added to the salary ranges and divided by estimated working hours to determine the total hourly cost to the town (Table 8).

Summer interns often perform tree inventory services for between \$11 and \$15 per hour without benefits, depending on experience. Given the state of the economy and Wake Forest's

TABLE 11: Advantages of Contractors and Staff

CONTRACTORS	STAFF
<ul style="list-style-type: none"> • Provide and maintain own equipment • May have advanced training and experience • No long-term commitment • Self-insured • Handle their own human resources issues • Work is paid for only if performed correctly 	<ul style="list-style-type: none"> • Less expensive on a per-hour or per-job basis • Available to respond immediately to work requests, storms, and emergencies • More flexible in work assignments • Can be held accountable individually for work performed, even months or years later • Necessary skills and experience can be selected for during hiring process, and additional skills and training can be developed as needed • Develop increasing knowledge of local streets and trees, and build relationships with other staff, volunteers, and residents • Can be called upon to lead volunteers, further increasing program effectiveness • Less administrative time spent on contracts and financial management

location near schools with excellent programs in forestry and horticulture, it should not be difficult to find candidates that have the necessary skills to perform this work effectively. These interns could also assist with tree planting and maintenance activities if needed.

Street Tree Maintenance Services Recommended to be Performed by Town Staff by 2017

TREE INVENTORY: (\$38-\$117/hour if contracted, \$11-\$15/hour with summer interns)

Potential savings of staff versus contractors: 61%-91%

The tree inventory is a critical tool in guiding the Urban Forestry Program. For the data collected in the 2012 Tree Inventory, Bartlett Tree Experts quoted a cost of \$7.80 per tree. Davey Resource Group recently charged Raleigh \$2.50 per tree. The town's Urban Forester was able to achieve a data collection rate of 15 trees per hour. Assuming a similar data collection rate for a qualified contractor, this means an average cost of \$38 to \$117 per hour.

Required equipment: One data collector with ArcPad per intern.

PLANTING: (\$50-\$100/hour if contracted, \$18-\$33/hour with staff)

Potential savings of staff versus contractors: 34%-82%

Hundreds of street trees require replacement annually, and there are thousands of locations where additional street trees can be planted. To replace 14 trees in the fall of 2011, the winning contractor charged the town \$100 per tree in addition to the estimated wholesale cost of the tree. Similar work would take a staff member or volunteer approximately 1-2 hours per tree, depending on the size of the tree and the number of total trees being planted at one time.

Where larger trees are required for special projects, heavy equipment and skills may be needed, and it is recommended that this work be contracted out in those cases. To reduce the cost and equipment needed for tree planting, it is recommended that 1.5" to 2" caliper trees be planted. These trees can be purchased from local wholesale nurseries and/or grown in the volunteer tree nursery.

Required equipment: Vehicle, shovels, auger or power tools for larger diameter trees



Balled and burlapped trees ready for planting by town staff and volunteers, spring 2012

TABLE 12: Urban Forestry Position Summaries

	Tree Trimmer / Arborist Technician	Tree Crew Leader	Tree Trimmer	Tree Trimming Tech II	Urban Forester
Source	APWA 2007b	APWA 2007b	City of Raleigh, 2012	Wake Forest Electric Department, 2012	APWA 2007b, Wake Forest 2011
Total Cost to Town, Including Benefits	\$17.64-\$24.93 per hour	\$20.53-\$29.33 per hour	\$20.78-\$30.23 per hour	\$24.49-\$32.23 per hour	\$27.19-\$41.65 per hour
Annual Salary	\$23,500 – \$36,100	\$28,500 – \$43,700	\$28,930 - \$45,255	\$37,066-\$48,721	\$40,000 – \$65,000
Summary	Drives and operates bucket truck, chipper; Performs pruning and removal work; Helps set up safe work zones; Maintains equipment; Completes reports, paperwork; Communicates with supervisors.	Coordinates daily work activities of the crew; Ensures work is carried out safely, efficiently; Applies various safety standards, organizational policies, and applicable laws; Completes paperwork; Communicates with higher levels of management; Performs public relations with the general public.	Uses climbing techniques, aerial lift truck, knuckleboom loader, stump grinder and other hand operated tools to perform tree removal and pruning, stump removal and other related duties. Participates in tree planting events with volunteers and other staff; Responds to afterhours tree emergencies on a rotation.	Work near energized conductors/high voltage lines and operate specialized, heavy forestry/ arboricultural vehicles and equipment working from an aerial lift and/ or climbing trees and skillfully using power hand tools to perform multiple tree pruning, removal, planting and maintenance functions.	Plans, develops, implements, and manages the town's urban forestry program. Responsible for program finances, contractors, staff, volunteers, equipment, work planning, and relations with public and other organizations. Provides technical expertise as needed.

A compressed air tool loosens soil quickly without harming the tree, and allows workers to correct problems with roots that may strangle and kill the tree if left uncorrected.



ROOT COLLAR EXCAVATION: (\$58-\$100/hour if contracted, \$18-\$33/hour with staff)

Potential savings of staff versus contractors: 43%-82%

This process involves using either hand tools or a compressed air tool to remove excess soil and mulch from a tree's roots, and then correcting any revealed root problems. It requires a modest investment of equipment and some skill, and can be done at any time of year. This procedure can save a tree's life, preventing needless removal and replacement expenses. In 2008, Wake Forest's contractor was paid \$100 per man-hour to perform this work.

Required equipment: Vehicle, shovels, brushes, saws, and chisels; air compressor, pneumatic excavation tool, and protective equipment recommended for increased efficiency.

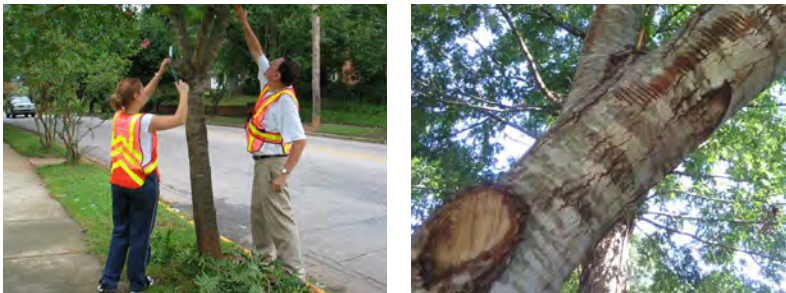
YOUNG TREE PRUNING: (\$39-\$78/hour if contracted, \$18-\$33/hour with staff)

Potential savings of staff versus contractors: 15%-76%

Careful pruning of young trees is critical in determining whether they grow to be tall, strong, and healthy. A few cuts made at the right time can save a tree from future death or disfigurement. Because most of the work is in carefully looking at the tree, it can take almost as much time for a staff member to inspect the work that a contractor has done as it does to do the work.



Pruning is of critical importance in developing a strong, healthy trees. If not performed frequently, well-meaning but untrained residents can cause lasting damage while attempting to prune street trees. Note marks (below right) where the chainsaw grazed the limb, and the ragged wound that is not healing properly.



The tools needed to do this work are inexpensive, the urban forester is qualified to train and review staff work. This would also provide staff with the skills needed to ensure clearance of sidewalks, roads, lights, and signs, which are common resident concerns throughout the year. In 2008, Wake Forest paid its contractor \$78 per man-hour to perform this work, but rates may vary depending on tree size.

Required equipment: Vehicle, bypass pruners, loppers, pole pruner

MULCHING: (\$85/hour if contracted, \$18-\$33/hour with staff)

Potential savings of staff versus contractors: 61%-79%

Mulch prevents damage as the result of lawnmowers and soil compaction, and encourages young tree growth by reducing competition with grass and weeds.

Required equipment: Vehicle, hand tools, mulch (unprocessed wood chips available through Environmental Services)

Street Tree Services Recommended for Contract Through 2017

PEST AND DISEASE CONTROL: (Cost and time dependent on species, size, and manner of treatment)

Each pest and disease must be treated differently, often requiring special chemicals, procedures, and equipment. This work can also vary greatly depending on environmental conditions and time of the year, so it makes sense to leave this work to qualified contractors with the required experience, materials, and tools.

Required equipment: Vehicle with spray rig, pesticides, protective equipment

Services that may be Performed by Either Staff or Contractors

NONHAZARDOUS TREE REMOVAL: (\$130/hour if contracted, \$18-\$33/hour with staff)

Potential savings of staff versus contractors: 74%-86%

Most of the trees that require removal are small enough that they can be cut at ground level. Depending on the size of the tree, this can still be dangerous work.

Required equipment: Vehicle, chainsaw, protective gear; chipper, trailer, stump grinder, or other equipment may also be needed.

LARGE TREE PRUNING: (\$80/hour if contracted, \$18-\$33/hour with staff, \$37 per hour for bucket truck)

Potential savings of staff versus contractors: 13% to 31%

HAZARDOUS TREE REMOVAL: (Cost and time dependent on tree size, location, and other circumstances)

Large tree pruning and removal is among the most important tasks for the urban forestry program, as people can be killed or injured by dead trees and limbs. Due to the size of large trees, this can be dangerous work, and becomes even more dangerous when trees are near buildings, cars, and driveways. If the town is willing to accept these risks, the program would need a bucket truck and at least one staff arborist with necessary skills and experience working aloft. These resources would allow the program to respond immediately to hazardous trees and damage from severe storms.

Large tree pruning and removal require highly trained staff and either specialized climbing equipment or a bucket truck. Capital and maintenance expenses for a 40' bucket truck are estimated at



Qualified staff and equipment, such as this bucket truck and chipper, are needed for large tree removal.

\$36.75 per hour (FEMA, 2010). The town's contractor quoted \$80 per man hour to prune a very large tree in early 2012. We recommend contracting this work for the immediate future, and consider expanding the urban forestry program to perform this work in two years.

Required equipment: Bucket truck and/or climbing gear, chainsaws, rigging equipment; chipper, trucks, and/or trailers to remove materials

Additional Street Tree Responsibilities:

The following activities will also be performed by the Urban Forestry Program, but the amount, timing, and cost of work cannot be estimated in advance:

- Provide assistance and advice to residents upon request
- Inspect trees for pine beetles and other severe pests upon request
- Assist with storm response and cleanup
- Correct conflicts between trees and sidewalks, streets, or other infrastructure.
- Inspect trees planted by developers to ensure appropriate species, location, condition, and methods used

Currently, all of these responsibilities fall on the Urban Forester, but they could be performed by other urban forestry program staff, depending on their training and availability.

Additional Urban Forestry Program Responsibilities

So far, this chapter has focused entirely on the upkeep, removal, and planting of street trees. However, the Urban Forestry Program currently also has responsibility for maintaining trees in parks, facilities, greenways, delivering educational programs and providing support for other town departments. As these resources have not yet been inventoried, and these additional responsibilities are often temporary in nature, it is more difficult to plan and calculate the costs of this work. However, we believe that this work is important, and that the costs of having internal staff perform these functions will likely be less expensive than relying on private contractors.

Within the next 5 years, it is recommended that the urban forestry program perform the following actions.

Town Forests

- Assess the composition of each stand within forests on town property, documenting the species composition, average diameter and height of dominant trees, and other special considerations



A turkey takes flight in a town-owned forest near Heritage High School.

- Identify stands that should be thinned to reduce the risk of wildfires, pests, and disease
- Develop management plans detailing each stand's purpose, condition, and actions recommended to improve the stand for its intended use (aesthetics, wildlife, timber production, recreation, or other uses).

Town Parks, Facilities, and Wake Forest Cemetery

- Inventory all individually-maintained trees in town parks, facilities, and Wake Forest Cemetery
- Maintain the historic Wake Forest Cemetery and the pecan grove at Joyner Park for visitor safety and tree health
- Identify and measure potential historic or landmark trees in town property, and submit them for recognition
- Work with other town staff to plan and implement landscaping projects
- Assist with environmental education opportunities within town parks and greenways

Greenways and Trails

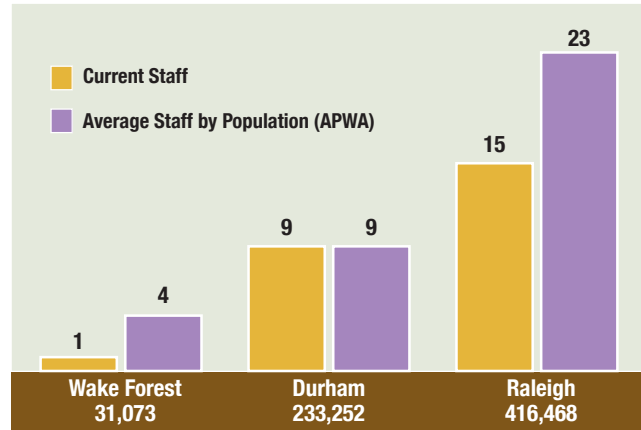
- Inspect all trees along greenways and trails for potential hazards, and remove those that are immediate threats
- Work with the Greenways Advisory Board to develop a plan for planting and maintaining trees along each greenway and at entrances
- Clear low-hanging branches and vines
- Locate, mark, and remove logs and trees from future trails, taking care to avoid damage to trees and other sensitive resources

Urban Forestry Program Staff and Volunteers

According to a 1994 report of municipalities across the United States, a town with Wake Forest's population (25,000 to 49,999) has an average of 4 full-time employees in its urban forestry program (APWA 2007b; ISA/USFS 1994). In the Research Triangle, both Raleigh and Durham have well-developed urban forestry programs. Both cities have crews of trained staff to perform tree maintenance work. Durham's program has the average number of full-time staff as documented in the 1994 report, while Raleigh has 8 fewer staff than the average municipality of its size (Figure 44; City of Raleigh, 2012; City of Durham, 2012). Raleigh recently advertized 2 new staff positions, and benefits greatly by its partnership with Trees Across Raleigh, a volunteer organization founded in 1996. According to its website, Trees Across Raleigh has "planted over 8,000 trees with over 4,000 volunteers on nearly 50 projects with a total value of over \$1,000,000 in both trees and volunteer labor for the City of Raleigh." Other local municipalities do not have designated urban forestry divisions, but delegate some or all of these responsibilities to staff in the Planning, Public Works, and/or Parks and Recreation departments.

Currently, the Urban Forestry Division contains one employee, the Urban Forester. The Urban Forester is responsible for all of the town's street trees, forests, and trees in the parks and greenways. As described previously, the amount of work needed to maintain the town's trees far exceeds what is possible by one person, so the town relies on contractors to perform this work. The Urban Forester is also responsible for a wide range of other tasks, including coordinating with other organizations and departments, responding to questions and concerns from the public, delivering educational programs, providing technical support to other departments, managing finances and grants, planning new planting projects, and providing general support to the Parks and Recreation Department.

FIGURE 13: Urban Forestry Program Employees in the Research Triangle Area



Hiring additional staff is expected to save hundreds of thousands of dollars versus contractors (Table 7), and would greatly increase the speed and efficiency of tree maintenance by avoiding the procurement process. Unlike contractors, staff can also supervise teams of volunteers,

TABLE 13: Impact of Crew Size on Performance

CREW SIZE	IMPACT OF CREW SIZE ON PERFORMANCE
1	Cannot safely engage in dangerous work, such as using power tools. Inefficient for moving materials or performing street work. Quality of work directly dependent on character of individual worker.
2	Crew can engage in more dangerous tasks, such as using chainsaws and wood chippers. Crew can perform work on both sides of the street at once, increasing efficiency. Second crew member adds accountability for performing work and increases team safety.
3	Allows one crew member to perform customer service responsibilities, perform less dangerous work in another location if needed, or field a two-man crew if one member is sick, on vacation, or in training. This allows for increased potential for crew member specializations, such as root collar excavation, aerial work, stump grinding, or promotion to supervisory responsibilities.
4	Crew can fit comfortably in a single vehicle, and also be split into two teams of 2. If a second vehicle is available, this allows great flexibility in managing both planned and emergency work activities.

TABLE 14: Proposed Hiring Timeline for Additional Staff

2012	2013	2014	2015	2016	2017
1 Urban Forester					
	2 Arborist Technicians		4 Arborist Technicians, at least 1 with climbing and/or bucket truck experience, preferably 2 or more		
	2 Seasonal Interns for tree inventory	Seasonal interns as needed to assist staff			
	Contractors for large tree pruning and removal, insect and disease treatment		Contractors for insect and disease treatment		
	Volunteers for tree nursery, planting projects, and other events				

allowing even more work to be done for the same cost. With additional staff, the Urban Forester could focus on high-value activities such as inspecting hazard trees, training volunteers and staff, designing landscapes, coordinating with developers, and securing grants. Therefore, it is recommended that two additional Urban Forestry Program staff be hired as soon as possible.

FY 2013-2014

- Hire 2 summer interns to complete the tree inventory.
- Hire 2 Arborist Technicians to plant and maintain trees.
- Continue contracting for large tree pruning and removal, insect and disease treatment.

FY 2014-2015

- Hire seasonal interns as needed to assist with data collection, planting, and maintenance.

FY 2015-2016

- Hire 2 Arborist Technicians, at least one with aerial experience, to keep up with increasing demand and perform large tree pruning and removal.
- Hire seasonal interns as needed to assist with data collection, planting, and maintenance.
- Continue contracting for insect and disease treatment.

Crew Size and Responsibilities

A crew of 2 full-time staff can perform tasks that cannot safely be performed by 1, but do not impact the program's budget or impose as many logistical difficulties as a staff of 3 or more (Table 13). In their first year, these additional Arborist Technicians would have the following responsibilities:

- Complete orientation and training
- Prune one-fifth of young trees
- Excavate and correct one-third of root problems (if pneumatic equipment available)
- Perform one-fifth of nonhazardous tree removals
- Plant 150 trees at resident request
- Inspect all greenways and trails and remove branches or unsound trees that may threaten the path
- Assist with storm response and cleanup
- Lead volunteer groups
- Perform other duties as assigned
- Other responsibilities as assigned

TABLE 15: Seasonal Workload Breakdown

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pruning										Pruning	
		Planting							Planting		
				Inventory							
				Watering							
Removal											
Root Collar Excavation											
Mulching											

Volunteers

Currently, the Urban Forestry Program relies on volunteers periodically for planting projects and for assistance with events such as Arbor Day. The value of volunteer assistance in 2012 is estimated at \$15,366. While volunteers cannot be asked to assist with dangerous or skilled tasks such as tree removal or pruning, they can provide valuable assistance on a wide range of projects. Volunteers require supervision by town staff, and additional staff could multiply their efforts by engaging volunteers where possible. It is recommended that the Urban Forestry Program continue to work with volunteers wherever feasible.

Wake Forest Tree Stewards

The purpose of the Tree Stewards program is to train a group of volunteers who can assist with urban forestry programs throughout Wake Forest. The first class of 25 Tree Stewards is planned for late spring 2013, and is supported



In 2012, adult volunteers gave 280 hours of service as part of Wake Forest's urban forestry program, and youth gave 457 hours. According to the Arbor Day Foundation, the value of this volunteer service is more than \$15,000.

through a grant from the North Carolina Division of Forest Resources. These volunteers will engage residents in the urban forestry program, and allow limited staff and financial resources to focus on more difficult or dangerous tasks. Municipalities throughout the region have developed successful programs using this same model, including Charlottesville, Front Royal, Richmond, and Roanoke, Virginia; Atlanta and Marietta, Georgia; Clarksville, Tennessee; and Washington, D.C.

Volunteers will receive training through a series of classes focused on topics including tree identification, maintenance, planting, and hazard assessment. Each Tree Steward will then receive a certificate and be asked to provide at least 4 hours of volunteer service. Tree Stewards can assist by planting seedlings and saplings, performing simple preventative maintenance such as stake removal and mulch correction, providing information to their friends and neighbors at public events, and inspecting public trees in their neighborhoods.

Vehicles, Tools and Equipment

Wake Forest currently owns and maintains much of the equipment that would occasionally be needed for staff to plant, maintain, or remove trees. It is recommended that the Urban Forestry Program coordinate with other departments to borrow this equipment or exchange services for intermittent tasks that require currently available vehicles, equipment, or tools. For tasks of a recurring nature or where such exchanges are not possible, it is recommended that additional equipment be purchased.



An electronic data collector allows staff to locate and assess the condition of trees. One Juno 3b allowed for the collection of all data used to prepare this document.

CURRENTLY AVAILABLE TOWN VEHICLES AND CAPITAL

Urban Forestry

- Pickup truck: For transporting staff, tools, trees, and materials; could pull trailers as well

Parks Maintenance

- Dump truck and trailer: For transporting trees and other materials

Electric Department

- 60' bucket truck with chip dump: Allows reaching the tops of the larger trees, transporting chips from tree removal or pruning operations. Requires CDL and expertise to use.
- Wood chipper: For removing wood waste from tree removal projects

- Stump grinder: Removes stumps to allow new trees to be planted
- Track hoe: For moving logs, felling trees, and digging large holes or trenches quickly

CURRENTLY AVAILABLE TOOLS AND SUPPLIES

Urban Forestry Program

The urban forestry program has hand tools, polesaws, Gator bags, diagnostic tools, and other supplies and equipment needed to perform tree inspections and maintenance. Additional tools and supplies would be needed for additional full time staff, but would be relatively inexpensive.

Greenways Advisory Board (GAB)

The GAB has shovels, rakes, and other hand tools for maintaining trails, which could also be used for volunteer tree planting projects.

CAPITAL TO PURCHASE BY 2017

- 40' bucket truck: Because most trees are relatively small, the Urban Forestry Program does not need the largest size truck. A truck with a smaller reach is far less expensive, is easier to maneuver, does not require a CDL, is easier to maintain and repair, and runs on unleaded fuel.



Currently, most street and park trees could be pruned or removed using a pickup truck with a 40' bucket. (Versalift East)

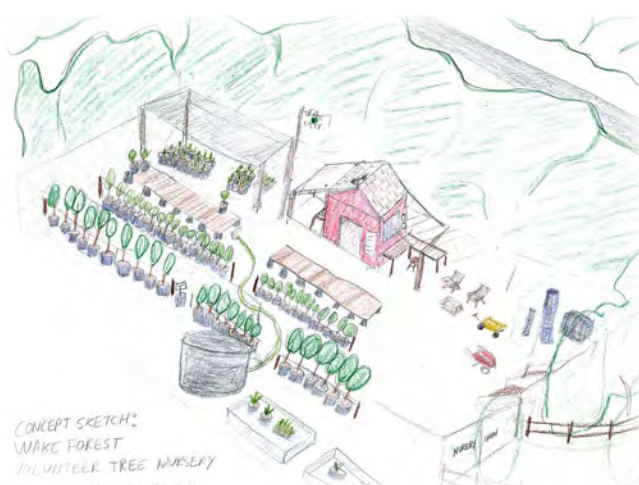
TOOLS AND EQUIPMENT RECOMMENDED FOR PURCHASE BY 2017

- Trailer mounted air compressor: \$8,000+, depending on size
- Air Spade kit and hand tools for root collar excavation: \$2,000
- Additional data collector for 2013 tree inventory, including software and accessories: \$1,600
- Chainsaws, protective equipment, and accessories for tree removal, storm response, greenways maintenance, and large tree pruning: \$450 per new employee
- Pruning saws, loppers, and polesaws for small tree pruning and removal: \$450 per new employee

FACILITIES

Town staff and volunteers are currently working to create a Volunteer Tree Nursery behind the maintenance facility at Joyner Park (pictured at right). This nursery will provide inexpensive trees for planting, volunteering opportunities for residents, and storage space for tools and materials. The 1,680 gallon cistern used to water the nursery trees could also be used to fill watering trailers during tree planting.

Concept sketch of Volunteer Tree Nursery, currently under construction



Young trees at the City of Raleigh's tree nursery



The Parks and Recreation Department and Facilities Department are planning to expand the maintenance facility in upcoming years to provide space for additional vehicles and Facilities Department staff. When this expansion is designed, we recommend that space be provided for Urban Forestry Program vehicles, trailers, and staff.

Urban Forestry Program Budget

TABLE 16: Urban Forestry Program Budget, 2007-present

	2007	2008	2009	2010	2011	2012	2013
Landscape Services (5463)	\$140,000	\$135,000	\$140,000	\$140,000	\$125,369	\$80,000	\$110,000
Urban Forestry Projects (5490)	\$55,000	\$95,000	\$75,000	\$85,665	\$25,833	\$8,500	\$25,000
Administration	\$10,855	\$15,035	\$11,020	-	-	-	-
Salary & Benefits	\$65,690	\$37,500	\$37,500	\$37,500	\$60,000	\$60,000	\$61,714
Total	\$271,545	\$282,535	\$263,520	\$263,165	\$211,202	\$148,500	\$195,047
Population	24,970	26,634	27,217	28,539	30,329	31,073	31,073
Urban forestry expenses per capita	\$10.87	\$10.61	\$9.68	\$9.22	\$6.96	\$4.78	\$6.27

FIGURE 14:
Urban Forestry Program Budget, 2007-present

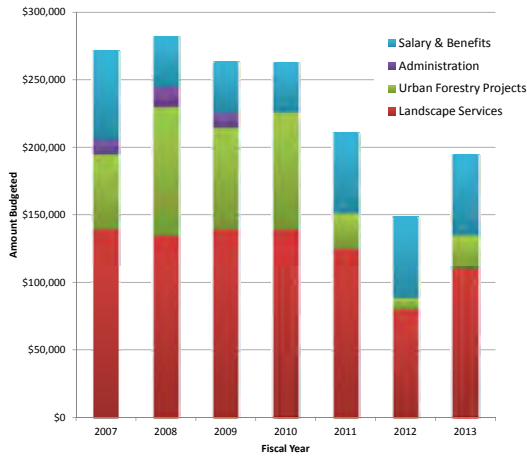


FIGURE 15:
Change in Wake Forest Population and Urban Forestry Program Budget, 2007-present

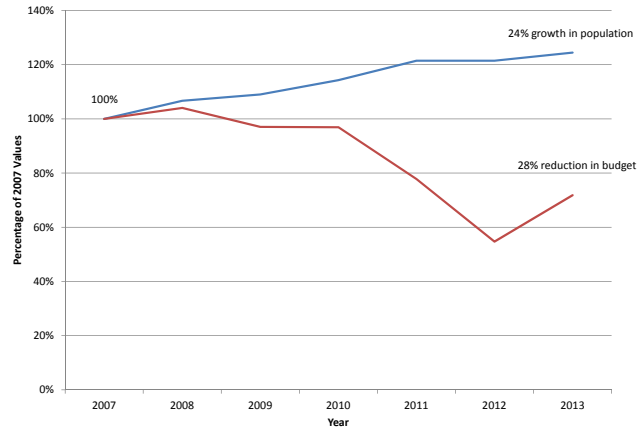


FIGURE 16:
Per-Capita Urban Forestry Program Budget, FY 2007-2013

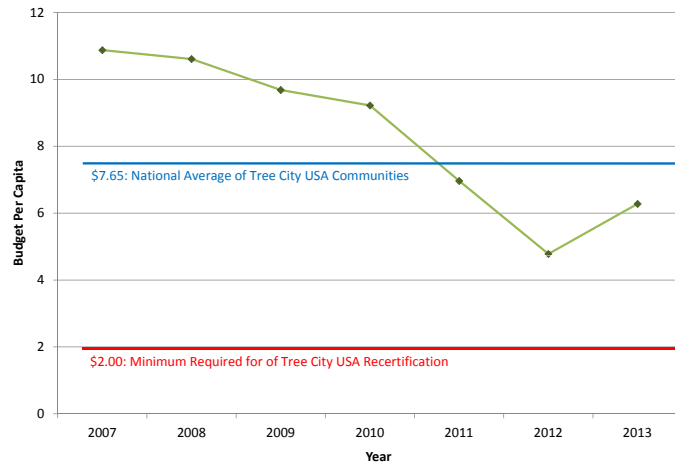


TABLE 17: Proposed Urban Forestry Program Budget for FY 2013-2014

	2012-2013	2013-2014
Landscape Services	\$110,000	\$54,300 (Mainly hazardous tree removal, mature tree pruning, and disease treatment)
Urban Forestry Projects	*\$25,000	\$15,000
Salary and benefits	\$61,714	\$165,714 (1 Urban Forester and 2 Arborist Technicians, assuming full pay rate on all technicians)
Temporary staff	\$0	\$15,000 (tree inventory)
Training and travel	\$2,500	\$3,100
Uniforms	\$100	\$400
Capital Improvement	\$25,000 (truck)	\$0
TOTAL	\$224,314	\$238,514

* Town is receiving grants to defray these expenses

Urban Forestry Program Budget, 2007-Present

Available budget records and Tree City USA renewal applications were reviewed to determine the amount that was budgeted for urban forestry program expenses (Table 16). These expenses include Landscape Services (contracted tree planting, maintenance, and removal), Urban Forestry Projects (Arbor Day, public education, volunteer tree planting projects, tools, supplies, equipment, training, memberships, and other expenses), Urban Forestry Administration (contracted management, 2007-2009), and employee salaries and benefits. Per-capita funding for the urban forestry program has decreased by 47% over the last 6 years. Funding per tree could not be calculated, but likely decreased significantly during this period. Additionally, most of the trees increased in size, and therefore maintenance costs.

Comparison to Other Municipalities' Budgets

PER CAPITA

In order to qualify as a Tree City USA, Wake Forest needs to spend a minimum of \$2.00 per capita on its urban forestry program. Towns with a population the size of Wake Forest spend an average of \$8.73 per capita (APWA 2007a). The program's funding level was above this rate between 2007 and 2010. If Wake Forest (population 31,073) were to return to this level of funding, the annual budget would be \$271,267.

FIGURE 17: Annual per Tree Spending of Wake Forest and Other Municipalities (City of Burlington 2003, CUFR 2005, CUFR 2006)

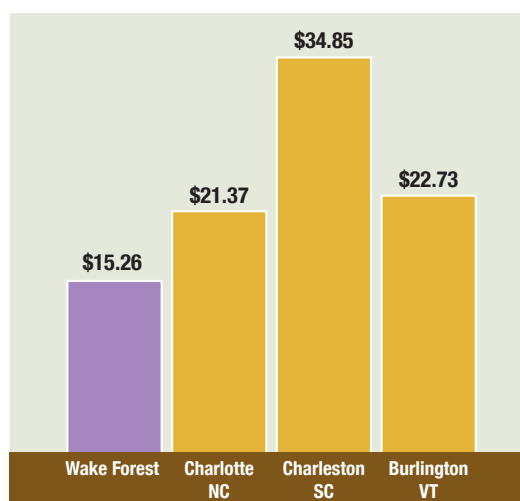


TABLE 18: Estimated Costs and Benefits of Wake Forest's Street Trees Over 40 Years (from USFS 2006).

	# OF TREES	ANNUAL COSTS	ANNUAL NET BENEFITS	AVERAGE ANNUAL BENEFITS	NET BENEFITS OVER 40 YEARS	BENEFIT/COST RATIO
Small Trees	4,740	\$113,774	\$85,331	\$170,661	\$1,327,366	1.50
Medium Trees	2,750	\$65,929	\$96,146	\$145,593	\$2,637,151	2.21
Conifers	1,510	\$37,674	\$66,306	\$90,417	\$1,687,777	2.40
Large Trees	5,680	\$153,426	\$522,784	\$636,432	\$17,956,485	4.15
TOTAL	14,700	\$370,802	\$770,566	\$1,043,103	\$23,608,779	2.81

PER TREE

Cities such as Charlotte, Charleston, and Burlington spend between \$20 and \$35 per tree (Figure 17). If Wake Forest were to spend a comparable amount on maintaining the current population of 14,700 street trees, this would mean a budget of between \$314,000 and \$512,000 annually. However, it is likely that Charlotte and Charleston have tree populations that are more mature than Wake Forest's, and therefore require more maintenance each year. Current per-tree data is not available for Raleigh, Durham, or other local municipalities, but

may become available when their tree inventories are completed.

The Town should continue to search for and apply for grants, collect donations from community organizations and individuals, and locate alternate sources of program funding.

Proposed 2013-2014 Budget

While current economic conditions require careful prioritization of how town funds will be spent, it is important to recognize that the growing number and size of trees, expanding

greenway system, and increasing demand for parks and open space will require the town to provide additional resources or see a decline in services. In any year in which the urban forestry program's budget is decreased, the town also becomes ineligible for the Tree City USA Growth Award.

The proposed program budget for FY 2014 represents a slight increase (7%) over the current budget, but will allow for a greater level of service, due to the increased cost-effectiveness of new program staff versus contractors. Over the next 5 years, we recommend additional increases in the total program budget, either through staff or contractors, in order to meet growing demands.

Grants, Donations, and Fines

The urban forestry program has received numerous grants from the state for planting projects, and more recently, to construct and outfit a volunteer tree nursery and to begin a volunteer training program. Additional staff would allow the urban forester to continue to apply for these programs. Local organizations and individuals have made one-time and recurring donations to the program as well, particularly in support of Arbor Day and tree planting projects in the spring. Additionally, partnerships with other organizations, in-kind and financial support. In 2012, one fine was issued to a resident who destroyed trees on town property, and these funds also support the urban forestry program.

Cost/Benefit Ratio:

The US Forest Service has published estimates for the average annual benefits and costs of four types of trees over a 40 year period. Using these estimates and the 2012 street tree inventory data, it is estimated that the town can expect to pay an average of approximately \$370,000 to maintain its street trees (Table 16). The benefits of these trees, including increased property values and improved air and water quality, are estimated at more than \$1 million annually. Large deciduous trees and conifers have the best benefit to cost ratio, while small trees have the lowest. Overall, for every dollar invested in street trees, the town can expect to receive \$2.80 in services. If maintained properly, these trees will provide \$23 million in benefits above and beyond their maintenance costs.

Summary and Recommendations



CANOPY COVERAGE	
Canopy Coverage, 2010	44%
Recommended minimum canopy goal	40%
STREET TREES	
Current street trees	14,700
Available planting spaces	5,400
Total replacement value of street trees	\$16,900,000
Current annual benefits of street trees	\$389,000
Projected average annual benefits over 40 years (USFS)	\$1,040,000
Predominant species	Red oaks, crapemyrtle, red and Freeman maple
Percentage of trees in "good" condition	72%
Recommended goal for species in "good" condition	90%
Predominant maintenance needs	Structural pruning, root collar excavation
STREET TREE VALUES, COSTS, AND BENEFITS	
Average street tree replacement value	\$1,150
Average annual benefits per tree	\$26.46
Per tree annual spending	\$15.26
Benefit/cost ratio for street trees	1.7 : 1
FORESTS	
Percentage of forest cover in town limits	29%
Acres of forest owned by town (2010)	630
Estimated number of maintained trees in parks, cemeteries, and facilities	1,100
STAFFING AND BUDGET	
Current FTE	1
Current program funding	\$224,314
Value of volunteer service, 2012	\$15,366

Recommendations

General Recommendations:

- Increase maintenance service levels for both mature and young trees in order to meet program goals
- Increase pruning frequency
- Remove stakes and lines from trees within 1 year of planting
- Continue to seek support for urban forestry projects through grants, private donations, and volunteer assistance

FY 2013-2014

- Hire 2 additional full-time Arborist Technicians, and purchase necessary tools, uniforms and equipment
- Hire 2 seasonal interns to collect data for the tree inventory during the summer, and purchase an additional data collection unit
- Assess and correct or remove any hazardous trees identified during the inventory
- Review tree inventory and landcover data and adjust recommendations as needed
- Update official tree species list to avoid red oaks, red and Freeman maples, and other species that are overplanted and/or performing poorly
- Inspect all trees along trails and greenways

FY 2014-2018

- Hire 2 additional Arborist Technicians, at least one with experience in aerial tree work, and consider purchasing a 40' bucket truck
- Prepare the master planting plan for street trees specified in the 2009 Community Plan. Develop additional urban forestry plans, including and plans for storm damage response, pest and disease prevention and response, management of town-owned forests, wood reuse and disposal, environmental education, and wildfire prevention and response
- Review the town's tree ordinances and revise as needed
- Initiate the Trees for Tomorrow Program (Appendix A)
- Correct all buried root collars within 3 years
- Review canopy coverage and determine if 40% goal is being met
- Update tree inventory as work is performed
- Implement a work management system

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Appendix A: Trees for Tomorrow Program

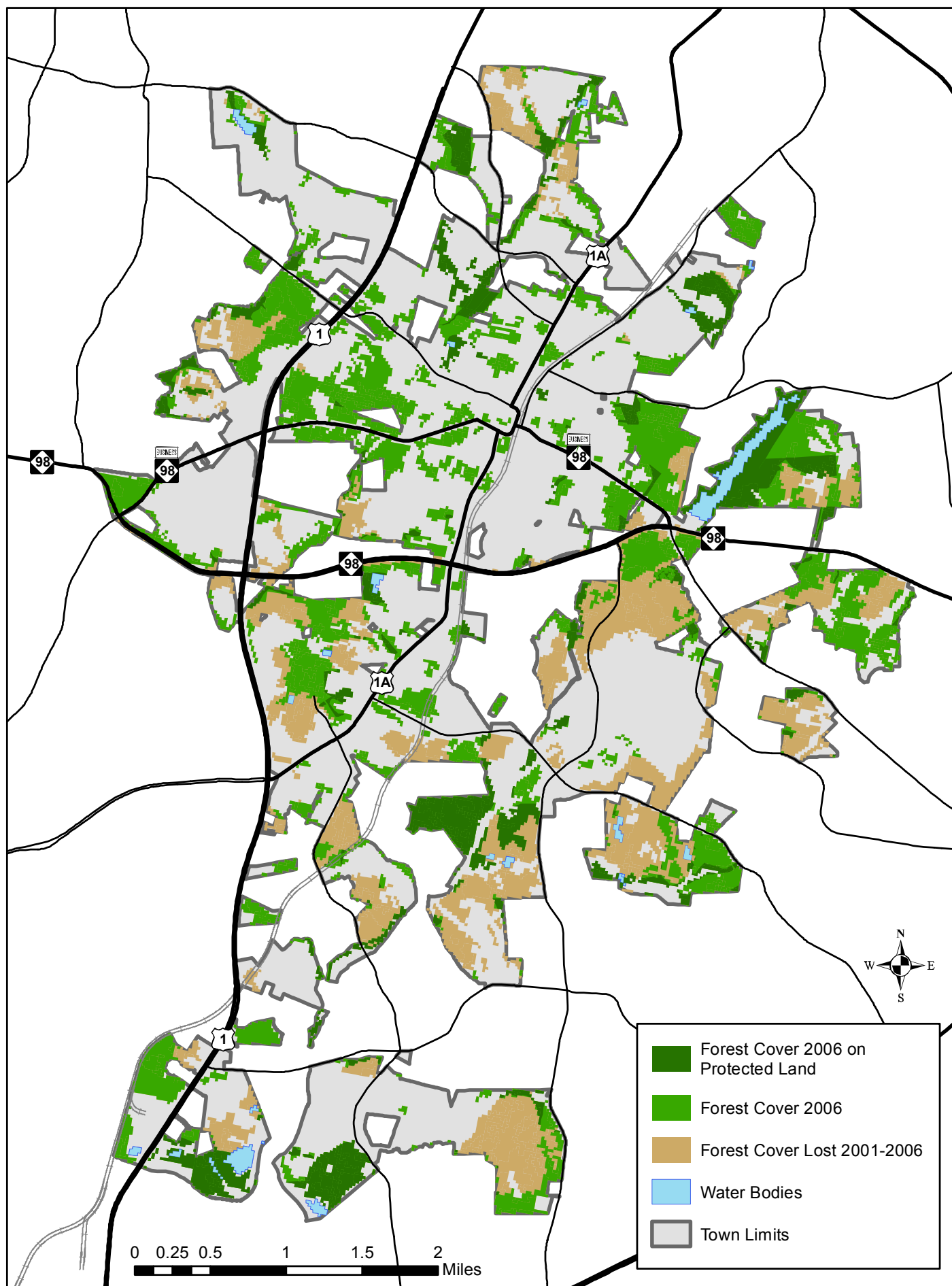
The goal of the Wake Forest Trees for Tomorrow (TFT) program is rejuvenate, enhance and sustain the town's tree canopy by partnering with community members to plant and care for trees.

There may be significant financial and logistical hurdles to planting additional trees throughout the Town of Wake Forest if we continue to contract out tree work. Based on current funding levels, it is estimated that it would take \$1.1 million to perform the pruning and root collar excavation that is needed to maintain the current street trees. There is also a 10 year backlog of tree maintenance work to be done, not including the trees that are going to be planted with new developments. It is also estimated that there are more than 5,000 locations where additional street trees can be planted, and an immediate need for more than 500 trees needed to replace dead or unhealthy trees or stumps; including more than 50 trees need to be replaced this fall.

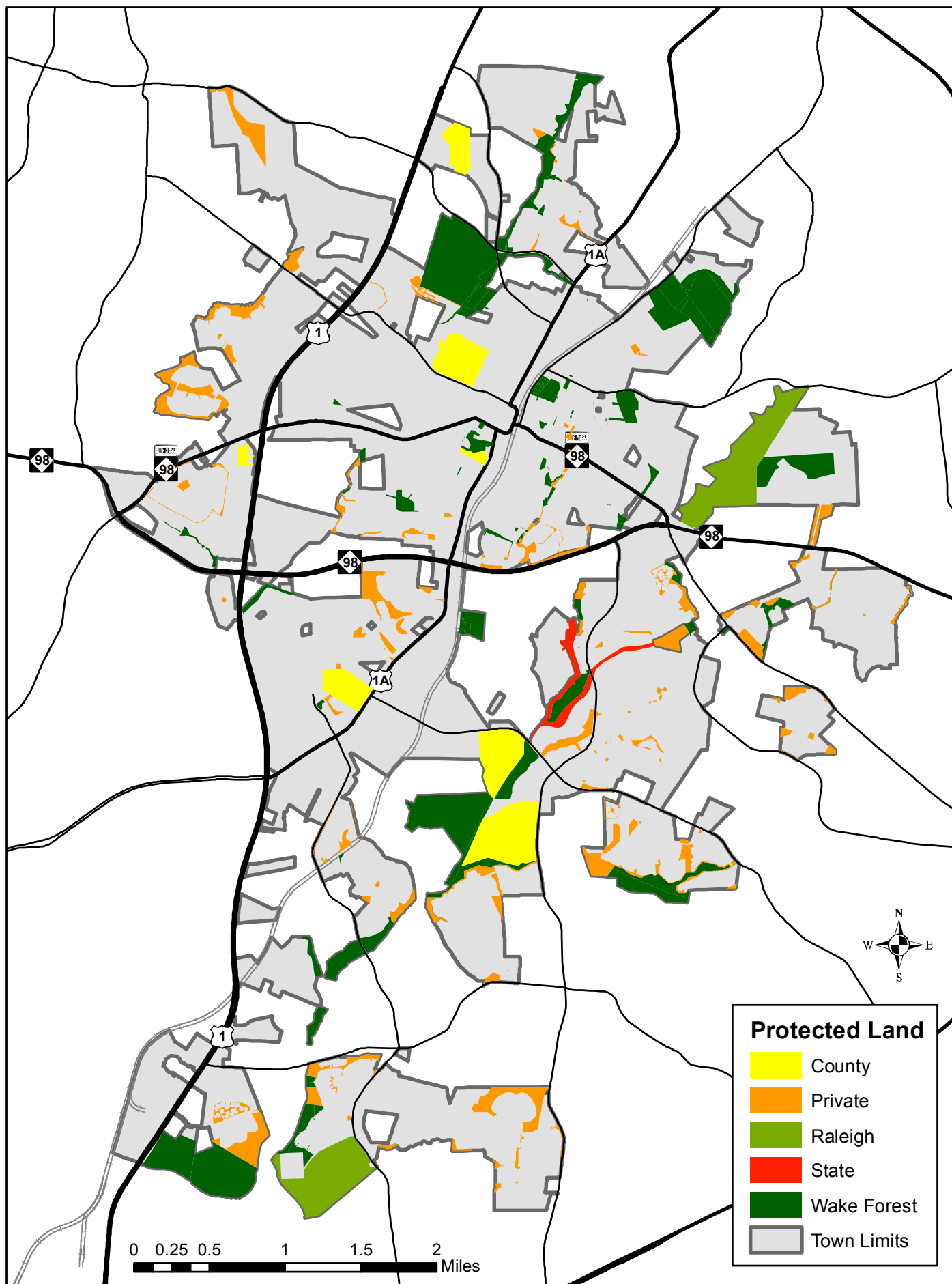
The Wake Forest Trees for Tomorrow program is a way to alleviate some of this cost by adopting a model that partner's with the town's citizens and businesses to plant trees. The TFT partnership can take the form of an individual request of up to three trees, or a TFT request to participate in a community project by either providing financial support or trees. The tree(s) supplied through the TFT program can be either "street trees" or "private property" trees. The town is also in the process of establishing a tree nursery in E. Carroll Joyner Park that may be able to provide a low-cost tree stock for this endeavor. The trees will be free, but citizens will be required to plant and care for the trees.

Education is a big part of the TFT program. In fact the nursery program will provide educational programs beginning in the spring of 2013 that will provide the manpower needed to plant and maintain the nursery trees. The Urban Forestry Board section of the town's website, in addition to housing access to the application, will provide access to planting and tree care information. It will also ask applicants to take a "Volunteer Tree Caretaking Pledge," creating an additional level of commitment and buy-in from the community towards enhancing the urban tree canopy of Wake Forest.

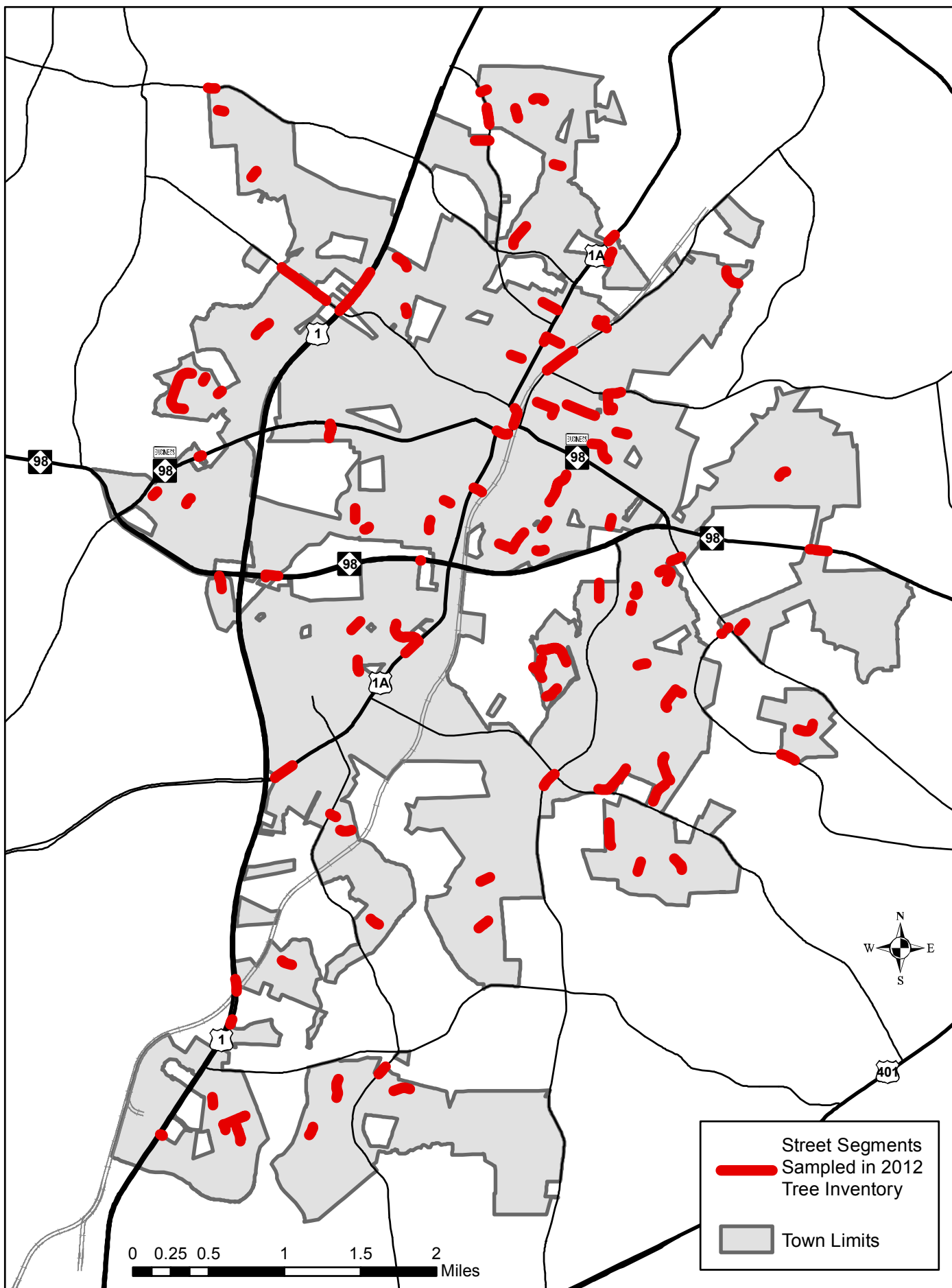
In order to qualify to receive assistance through this program Wake Forest residents would fill out an application, which will ask for specific information including: is the request for trees or financial assistance, when and where the tree(s) will be planted, the species of tree(s) to be planted, and who will plant and care for the tree(s), etc. Only Wake Forest residents would be eligible for this program and all tree plantings must be located within the Town of Wake Forest. The Urban Forestry Board reviews and accepts or rejects all applications. The board will consider tree species, planting season, location along with other factors when making their decisions. All decisions made by the UFB would be final. Rejected applications may be re-submitted for future approval with appropriate changes. Approved applications will be forwarded to the town for implementation. Town staff and/or UFB members will visit the property and evaluate existing site constraints, such as overhead power lines, underground utilities, and soil types, among others. Street trees must be planted within or adjacent to the town right of way. If the town's participation in a project is requested, a project description must accompany the application, along with a description of care that the trees will receive.



Ownership of Protected Lands, 2012



Street Segments Sampled, 2012 Tree Inventory



Appendix C

Changes in Wake Forest Landcover, 2001-2006

LANDCOVER TYPE	2001 COVERAGE (Acres)	2006 COVERAGE (Acres)	DIFFERENCE (Acres)	PERCENT DIFFERENCE	CHANGE PER YEAR (Acres)
Developed, Low Intensity	1,235.6	1,945.3	709.7	57.4%	141.9
Developed, Open Space	2,430.8	3,123.1	692.3	28.5%	138.5
Developed, Medium Intensity	348.3	593.1	244.9	70.3%	49.0
Barren Land	73.6	138.6	66.3	91.7%	13.3
Developed, High Intensity	72.3	138.6	66.3	91.7%	13.3
DEVELOPED, TOTAL	4,160.6	6,114.7	1,954.2	47.0%	390.8
Scrub/Shrub	112.8	82.1	-30.7	-27.2%	-6.1
Cultivated Crops	69.2	9.8	-59.4	-85.9%	-11.9
Pasture/Hay	641.8	485.0	-156.8	-24.4%	-31.4
Grassland/ Herbaceous	488.4	312.0	-176.4	-36.1%	-35.3
SHORT VEGETATION, TOTAL	1,312.1	888.9	-423.2	-32.3%	-84.6
Woody Wetlands	262.2	218.8	-43.4	-16.5%	-8.7
Mixed Forest	431.7	282.4	-149.2	-34.6%	-29.8
Deciduous Forest	1,993.5	1,418.7	-574.9	-28.8%	-115.0
Evergreen Forest	1,770.3	1,015.7	-754.6	-42.6%	-150.9
FOREST, TOTAL	4,457.7	2,935.6	-1,522.1	-34.1%	-304.4
Emergent Herbaceous Wetland	2.2	1.1	-1.1	-50.0%	-0.2
Open Water	104.1	96.3	-7.8	-7.5%	-1.6
WATER AND WETLANDS, TOTAL	106.3	97.4	-8.9	-8.4%	-1.8