Urban Forestry Master Plan

City of Chattanooga
2014

It is well that you should celebrate your Arbor Day thoughtfully, for within your lifetime the nation's need of trees will become serious. We of an older generation can get along with what we have, though with growing hardship; but in your full manhood and womanhood you will want what nature once so bountifully supplied and man so thoughtlessly destroyed; and because of that want you will reproach us, not for what we have used, but for what we have wasted.

~ Theodore Roosevelt, 1907 Arbor Day Message

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Introduction

The City of Chattanooga has made tremendous gains in the management of its tree and forest resources since the inception of the program in 1990. The City of Chattanooga has clearly demonstrated that it recognizes and values the benefits provided by urban vegetation. The staff has grown to eleven full-time positions including nine field positions and two management positions. There have been two previous management plans, both developed by the firm of ACRT in 1994 and again in 1999. Since 2001 the Urban Forestry Program has been housed in the Department of Public Works which has allowed for a much broader access to manpower and equipment useful in carrying out the unit's mission. The firm of ACRT estimated in 1993 that there are a minimum of 28,000 trees growing on City owned properties and rights-of-way in addition to significant numbers of privately owned trees that impact City streets. Since then there have been numerous Streetscapes projects that have added thousands of trees to the public realm. However the STRATUM analysis completed in 2008 and based on a sample inventory of street segments revealed that the number of trees on City rights-of-way is considerably higher and even exceeds the 200,000 tree level. And this estimate does not include trees in City parks and other city property.

All of the major goals in the previous plans are being met or have already been met. A few are on-going battles that will continue for many years. These goals include:

1. Maintaining adequate resources to address public safety and promptly meeting the public's request for service. The table below provides information on service requests.

Table 1. Service request analysis for ten years from February 6, 2003 through February 6, 2013.

Service Request Type	Total Count	Total Open	Total Closed	Set Duration for Completing (days)	Average Response Time for Completion (days)
Fallen Trees or Branches	6,157	1	6,156	5	4.33
General Tree Problems	482	0	481	90	18.73
Stump Grinding	6	0	6	180	12.27
Tree Pit Maintenance	6	0	6	270	17.19
Hazard Tree	204	2	202	14	14.13
Insect/Disease	7	0	7	180	8.45
Planting	6	0	6	365	9.57
Removal	1,883	2	1,881	240	21.43
Trimming	2,853	1	2,852	270	18.95

An analysis of all categories of service requests received through the Customer Service Request (CSR) system from its launch in 2003 to February 2013 indicated that service requests are handled in a very timely manner. During the course of this nearly ten year stretch the available resources increased from one in-house crew to two crews. And a third crew has been funded and is being hired in late 2013. Each crew consists of a crew leader, equipment operator, and a tree trimmer. The addition of the third crew will assure the prompt handling of both routine and emergency requests.

2. Budget and implement a policy of proactive tree maintenance.
The City is now able to provide routine pruning and maintenance on approximately 7,000 trees that are shown on the GIS system and located mainly in the "Expanded Central Business District." The addition of the second City crew which is led by an ISA Certified Arborist has allowed for the timely pruning and care for these trees. The pruning cycle for these trees varies according to age and species. Some of the young fast growing trees such as lacebark elm are pruned every year but some of the mature oaks are pruned every eight years. Trees outside the expanded central business district are pruned as time allows. A few are pruned as part of the street paving cycle. As money becomes available for re-paving, tree crews work in advance of milling and paving equipment to remove low hanging branches and deadwood and this serves the function of performing rotational pruning.

3. Adopt a protocol for storm recovery.
In September, 1999 ACRT drafted an Emergency Storm Response Manual. This plan was immediately implemented and then in 2005 it provided the foundation for writing an updated NIMS (National Incident Management System) plan detailing procedures for dealing with storm events and other emergencies for which the division of Citywide Services is responsible.

4. Integrate all aspects of the urban forest into a long-term vision for the community.
The following items were mentioned in the 1999 Urban Forestry Management Plan:

A. Interdepartmental Cooperation. The Urban Forestry section was cited as a model for communication and cooperation between departments. That same level of communication exists to this day and will continue well into the future.

B. Permitting. The position of Forestry Inspector was filled in January, 2000 and was transferred to the Land Development Office in 2005 and has been reclassified as a Landscape Architect. This individual performs plans review, administers the Landscape Ordinance, and checks for compliance with the Tree Ordinance. Both tree permits and timber removal permits are issued from the Land Development Office.

C. Planting. Recent increases in the planting budget have ensured that at least in the near term there will be a sufficient amount of new trees planted to replenish the urban tree canopy. Species diversity has been achieved by planting a large number of both native and non-native species and cultivars. The Take Root initiative was launched in 2008 and has resulted in the planting of over 1,500 trees, mostly in the Central Business District. There are over one hundred species and cultivars currently on the GIS inventory of trees. Planting standards have been incorporated into the City Engineers Auto CAD of City standards and are now mandated in all City planting projects. These standards are reviewed and revised every few years.

D. Public Outreach and Education. A step forward was made when the BMP Guide for Contractors and Builders was developed, printed, and distributed. A strong effort was made to reach out to homebuilders, engineers, and architects by making presentations to each group's local organization explaining the BMPs. The Citizen Forester educational initiative was launched in 2011 to provide training on basic tree care and to inform interested citizens on the value of the urban forest. The four hour course is taught on selected Saturdays in the fall of the year. Another outreach was made by sending flyers to all of the local schools offering assistance in education and special projects involving tree planting on their respective school campuses. Education is an ongoing process that will never be completed.

E. Invasive Exotic Vegetation. Our natural vegetation and their ability to regenerate and live in Their native areas is under assault. Invasive exotic vegetation in the form of kudzu, privet, English ivy, shrub honeysuckle and others are displacing native plants and ecosystems in everincreasing numbers. While both goats and chemical means of control have been successfully utilized in selected spots the problem of controlling invasive exotics is ongoing and quite serious and will require a massive effort to solve.

1 The Community Forest

The Community Forest can be thought of as "green infrastructure", just as roads and sewers comprise the City's "gray infrastructure". But trees are living entities and have some basic biological requirements for survival and growth. In an urban setting, trees should be actively managed and cared for to obtain the maximum amount of beauty, function, health, and value.

What is the Community Forest

Urban forests are a complex resource with multiple owners, a variety of landscapes and species, different forest types and ecosystems, and site specific management objectives. Chattanooga supports several forest systems within one urban boundary. Along the banks and lowlands which border the Tennessee River and its tributaries exists those species and understory trees that are water-loving. These include sycamore, river birch, cottonwood, willow, elm and others. There is also a dry ridge or upland system that is composed of pines, maples, hickory, oaks and others. These can be further classified as oak-hickory or oak-pine depending on the mix of species. Additionally there are many species of both ornamentals and invasive exotics which fight for dominance. Invasive species pose a serious threat to the long term health of the native forest. It is the estimate of the City Forester that most of the community forest can be found on private property. Some exists on National Park Service property but only one percent or less is owned by the City. The climatic zones in Chattanooga range from Zone 7 in the valleys to Zone 6 on the mountain tops.

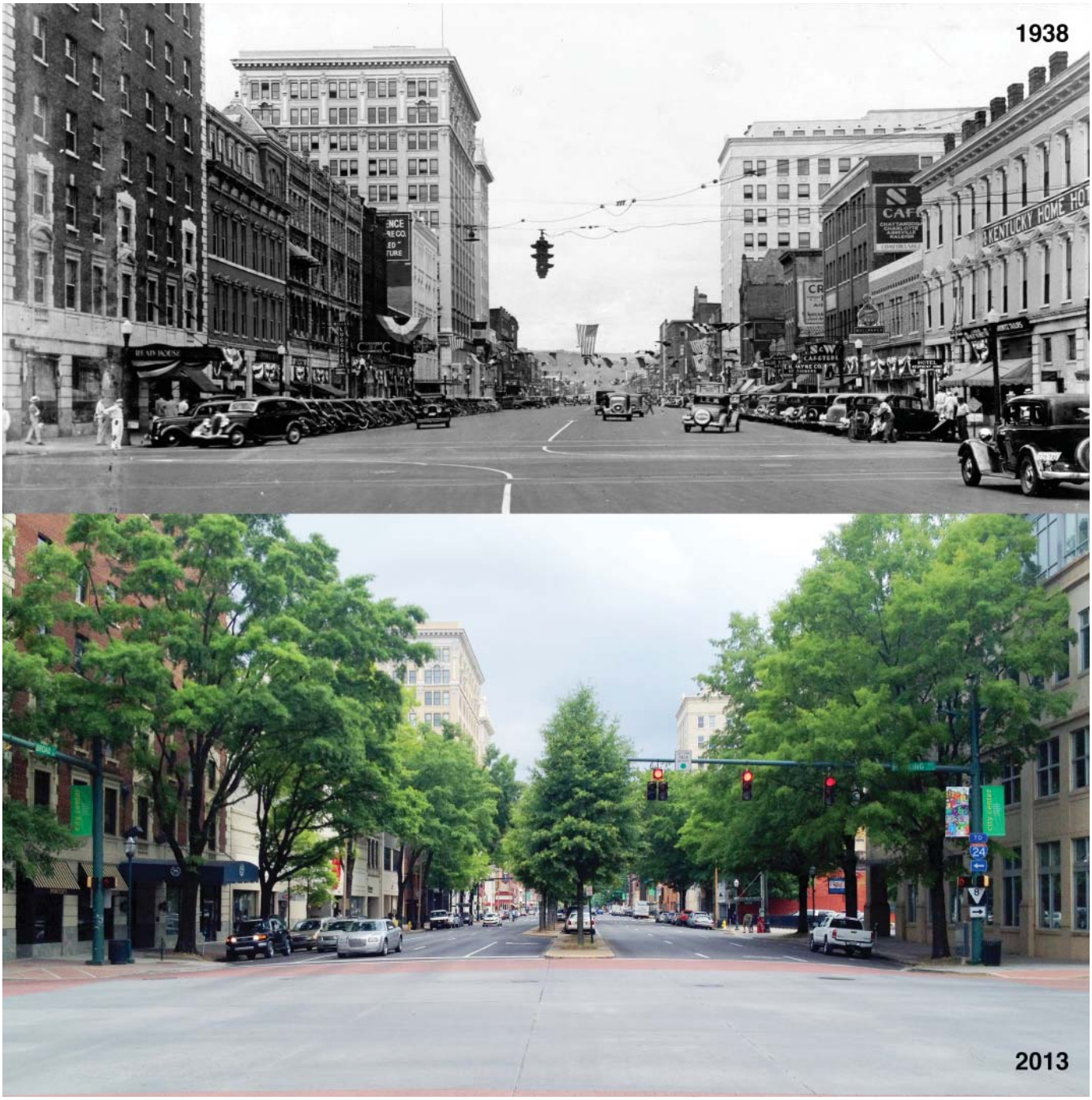
This plan addresses all the trees within the community but focuses particularly on the publicly owned trees for which the City bears responsibility. The community forest includes native, non-native, naturally grown, intentionally planted, ornamental, and invasive species. It is important to note that the multi-layered forest includes not only trees but also shrubs, vines, grasses, herbs, vertebrate and invertebrate animals, soils, and root micchorizae that all function together as a living system. The inventory data for this plan were derived from information that focused on the trees and tree canopies. However, the management strategies incorporated into this plan are intended to recognize that all components of the community forest contribute to the health of the environment.

History of the Community Forest

The Chattanooga area has been covered in forest for many eons. The Native Americans used the forest for food, shelter, transportation, medicine, heating and a variety of other purposes. The early European settlers learned from the Native Americans and used the forests for the same purposes. During the Civil War most of the mature trees in the Central Business District were removed by soldiers for fuel, shelter, and fortifications. Early photographs of Chattanooga after the war indicate that few, if any, trees remained in 1865. As various pockets of communities grew and expanded, residential development began to dominate the area and much of the forest land was converted to residential lots. Only a small percentage was dedicated to business and industrial development. Pockets of land and forest on Lookout Mountain and Missionary Ridge were incorporated into the Chickamauga Battlefield National Park and remain protected from development. It appears from the remaining mature willow oaks that a major tree planting effort was initiated in the early 1900's in the Central Business District. A few of those trees were alive and well as late as 2012. Other planting efforts were made in the 1960s to plant trees along Broad and Market Streets. Then in the mid 1980s a Community Development Block Grant was utilized to plant even more street trees along Market Street. In 1990 Chattanooga hired its first urban forester and the same year the City became a Tree City, USA community. Since then major Streetscapes projects have resulted in the planting of thousands of new trees of which the majority are located in the downtown area. Between 2000 and 2010 The Tennessee Urban Forestry Council designated six areas in Chattanooga as an arboretum. Detailed information about these facilities can be found in "Arboreta in Chattanooga". In December, 2003 City Council appointed The Tree Protection/Resource Management Committee to conduct a study regarding quality control for tree removal practices and development on sensitive sites and its impact on surrounding communities. As a result of this committee's work and recommendations the City Council in 2004 passed the Timber Removal Ordinance which regulates the removal of timber and subsequent reforestation operations on private property within the City of Chattanooga. The Take Root initiative was launched in 2008 with the purpose of increasing the tree canopy cover in the expanded Central Business District from an estimated 8% to the recommended cover of 15%. Over 1,500 trees have been planted under the Take Root banner and all indications are that the 15% goal will be reached as these newly planted trees reach maturity.

Scientific studies of the recent past years have determined that trees and forests provide a great variety of benefits and services which provides a firm economic return to the community. Healthy trees and forest cover provide a variety of ecological functions.

God has cared for these trees, saved them from drought, disease, avalanches, and a thousand tempests and floods. But he cannot save them from fools.
~John Muir



These two photos were both taken from the same location at the intersection of Broad Street and M.L. King Boulevard. They demostrate the extent of the transformation that has occurred during the 75 year time frame from 1938 to 2013.

Benefits of the Community Forest

The urban forest can be thought of as "green infrastructure", just as roads and sewers comprise the City's "gray infrastructure". But trees are living entities and have some basic biological requirements for survival and growth. In an urban setting, trees should be actively managed and cared for to obtain the maximum amount of beauty, function, health, and value.

Benefits are realized at different levels and scales. Some benefits are obtained from individual well-placed trees. Research has shown that some people in hospitals recover quicker when viewing trees and nature as opposed to similar patients without a comparable view. Some benefits impact the whole community. Forests intercept rainwater and hold back huge amounts from surging through the system and becoming flash floods. Forest stands enable rainwater to percolate into the ground and down into aquifers better than impervious surfaces. The following are a few of the services and benefits that trees and forests provide in our community:

Trees improve air quality by absorbing carbon dioxide during photosynthesis and producing oxygen as a byproduct. Trees also intercept and remove other pollutants and particulate matter from the air.

- A large healthy tree can produce enough oxygen each day for 18 people.
- An acre of trees can remove about 13 tons of dust and gases every year from the surrounding environment. (Tennessee Forestry Association, mid 1990s)
- A large tulip poplar on Staten Island in New York scrubs $34.33 worth of pollutants from the air every year and all trees in the area keep over $800,000 worth of pollution from New York lungs. (New York Times, 2003)

Trees and forests save energy by shading our homes and offices, streets, parking lots and other paved areas. Trees cool the air as their leaves transpire water.

- Trees can provide a 4% reduction in annual heating and cooling costs. (McPherson, 2002)
- The 200,000 leaves on a healthy 100 foot tall tree can take 11,000 gallons of water from the soil and breathe it into the air in a single season. (Head, 2001)

Trees and forests reduce stormwater runoff by intercepting rainfall and releasing it slowly. This reduces runoff and cuts peak flow rates that creates flooding and stresses stormwater systems.

- The leaves and branches of trees intercept 7 to 22% of precipita-

tion, hold it, and then release it slowly back into the atmosphere.

- One study has shown that for every tree, 2 cents in water control costs are saved for every gallon of water intercepted during a twelve-hour storm. In a medium-sized city this equates to a 17% reduction of 11.3 million gallons, and a savings of $226,000 (Head, 2001)
- In 1996, metro Chattanooga's tree cover was worth approximately $758 million in stormwater retention capacity. (American Forests, 1996)

Trees and forests improve water quality and reduce soil erosion and decrease the amount of sediment that enters creeks and the Tennessee River.

- The vegetation of forested streamsides helps disperse the energy of heavy rains so that soil particles are not carried into streams.
- Riparian forests remove, hold, or transforms nutrients from fertilizers, sediments, and other pollutants. Healthy root systems prevent soil compaction and retain valuable surface layers of organic soils.

Trees and forests provide habitat and wildlife food important to the survival of insects, amphibians, birds, mammals and other wildlife.

- Many species depend on the urban forest for food and shelter. Forested tracts and corridors provide shelter for deer, fox, squirrels, birds and other wildlife. Forested riparian corridors contribute to the health of aquatic ecosystems by providing shade to streams.
- Riparian or streamside forests help to moderate hot temperatures in the summer by reducing light levels providing much needed needed shade. These light levels affect the type and amount of algae in a stream and water temperature affects fish health. Animals in streams depend on litterfall, as the decay of woody debris releases food and nutrients into the aquatic system.

Trees and forests enhance the quality of life for our residents by creating environments that benefit peoples' health and functioning.

- Trees contribute to higher job satisfaction and lower absenteeism when employees can view trees or landscapes from the workplace. (Kaplan, 1993)
- Physical activity is linked to good health. Trees and forests create a natural setting for recreational activities such as walking, running, cycling, bird watching etc.
- Routine activity in parks with trees reduces Attention Deficit Hyperactivity Disorder (ADHD) symptoms in children. (Taylor, 2001)
- Views of nature from hospital windows also provide a measurable acceleration of the healing process following physical or emotional injuries. (Ulrich, 1991)

Trees and Forests enhance community economics by contributing to increased property values and enhancing commercial districts.

- Consumers shop more often and longer and are willing to pay 9-12% more in well landscaped business districts. (Wolf, 2005)
- Trees increase property values by adding to the visual appeal of property. One study found that each large tree in a front yard was associated with a 1% increase in sales price. Anderson and Cordell, 1988)
- Rental rates for landscaped commercial properties were 7% higher compared to properties with no plants. (Laverne, 2003)

Arboreta in Chattanooga

The Tennessee Urban Forestry Council in cooperation with the Tennessee Federation of Garden Clubs certifies arboreta throughout the state of Tennessee. In Tennessee an arboretum is defined as an area where there is a significant amount of woody vegetation in tree form that is cultivated for educational, scientific and/or aesthetic purposes. The size and location of an arboretum can vary from a small neighborhood school with 30 different species of labeled trees (Level 1) to a large research park with over 120 tree species labeled and staffed with full time employees and volunteers (Level 4). To be certified as an arboretum in Tennessee, strict standards must be met. All arboreta must be opened to the public, the trees must be properly labeled for educational purposes, and the trees must be properly maintained during the period of certification. There are currently six arboreta in Chattanooga:

Level 1.

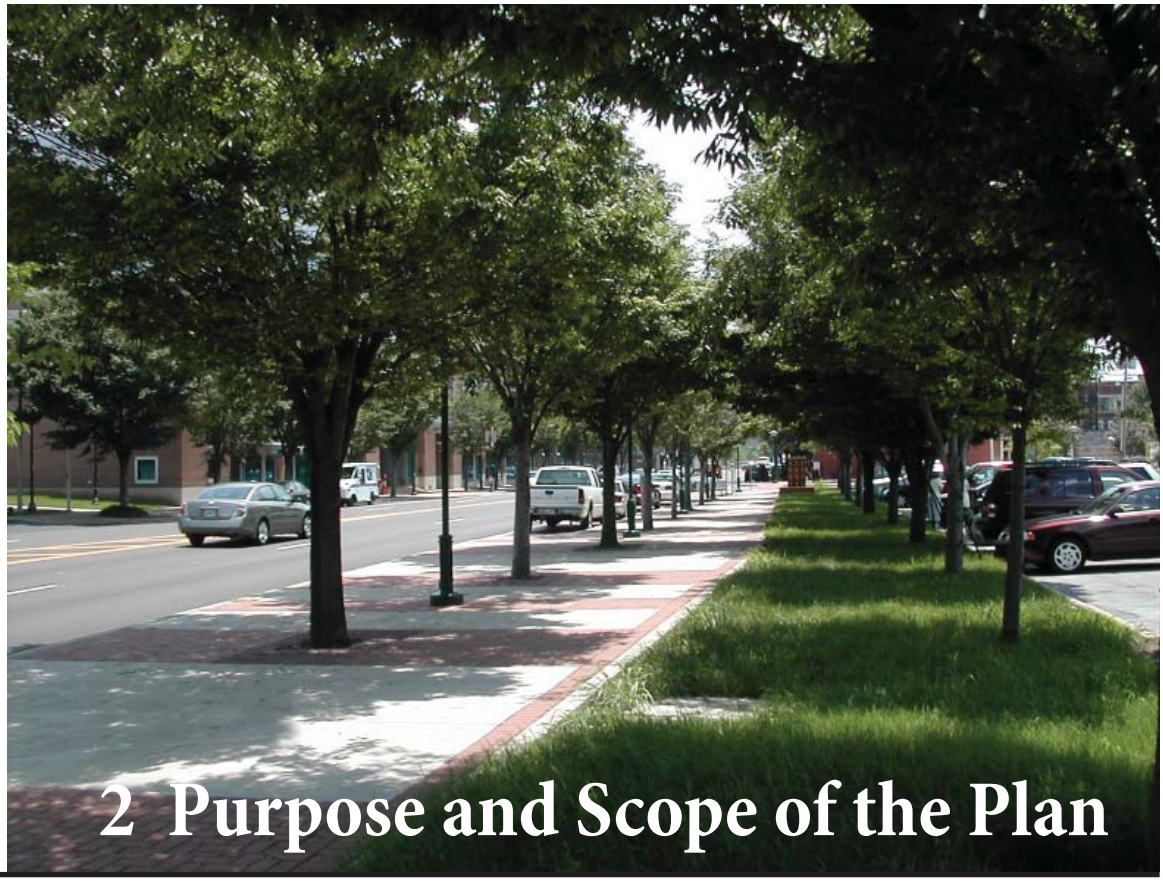
1. The Cherokee Trail located at the North Chickamauga Creek Greenway was given its designation in 2000. This arboretum includes a small wild area noted for its scenic, wildlife, and recreational values.
Certified in 2000.
2. The Bonny Oaks Arboretum is located off Adamson Circle and sits on acres and includes over 55 species of trees, shrubs, and groundcovers. Certified in 2000.
3. The Chattanooga Audubon Acres in East Brainerd on 130 Acres. This trail not only identifies trees by their common and Latin names but also with their Cherokee Indian names and uses. Certified in 2003.

Level 2.

1. Chattanooga State Technical College features an array of native and introduced species on its campus.
Certified in 2008.
2. The University of Tennessee at Chattanooga also features 60 native and introduced trees and shrubs on its 120 acre campus. Certified in 2010.

Level 4.

1. Reflection Riding Arboretum and Botanical Garden. Reflection Riding consists of 300 acres and a three-mile driving loop and a twelve-mile system of hiking trails. Hundreds of labels identify over one thousand species of trees, shrubs, wildflowers, and grasses in an area that has deep historical ties with the Cherokees and the American Civil War. Certified in 2002.



2 Purpose and Scope of the Plan

Chattanooga is blessed with a very diverse urban forest resource. The City Forester and staff can help to ensure a viable and functional resource at a reasonable cost for many years into the future. The foundation for this plan is based on recommendations from the Chattanooga Tree Advisory Commission, existing approved plans, and the input from a diverse group of stakeholders. The purpose of this plan is to encourage and facilitate appropriate management to sustain the health and to maintain the existing high percentage of urban tree canopy in Chattanooga. The plan vision is to increase the tree canopy where appropriate, improve tree health, and therefore increase the tree benefits for the residents in an equitable and sustainable manner.

The scope of this plan is limited to the development of actions that relate directly to trees on city owned property. This includes street trees, park trees, and trees on other public properties including fire stations, and back tax lots. It does not include trees on public school grounds, public housing units, Hamilton County property, or property owned by the State of Tennessee or the U.S. government.

3 Assessments

A. Administrative Needs

The Urban Forestry program in Chattanooga is a mature program with over twenty years of active professional management. During that time the program has evolved to meet the demands as changes have occurred within the administrative culture of city government. The unit has grown from a one-person outfit in 1990 with no budget, equipment or manpower to a well-staffed organization that is capable of meeting the daily needs as well as additional challenges brought on by storms and other emergencies. The new CSR/311 system developed in 2003 has time deadlines associated with each category of request. These time goals are met and usually exceeded for promptness. There is certainly a need to regularly monitor this system to ensure that this high performance standard for solving requests stays in place. Tighter internal controls now exist on grant administration and reporting and this also takes time to check for compliance. Other City of Chattanooga paperwork requirements for reports and personnel actions of many kinds can be time consuming. However, additional administrative needs at this time are minimal. The program is housed in the Department of Public Works and has access to administrative staff, computerized work order and GIS systems, and is governed by well-ordered personnel policies.

B. Public Awareness Needs

There is a huge need for informing the public on a various array of issues including proper tree selection, planting, and maintenance to include

watering, pruning, mulching, fertilization etc. Other important topics include how to hire an arborist, invasive plants, new insect invasions, and the dollar value of the ecosystems services which trees provide.

C. Tree Inventory and Analysis

One of the most critical pieces of information for any urban forest manager is an accurate inventory. This serves as the foundation for any management plan. Thanks to several studies completed in recent years we now have a good snapshot of the composition, canopy coverage, and dollar value of the ecosystems services which Chattanooga's trees provide for its citizens.

The STRATUM Analysis (2008)

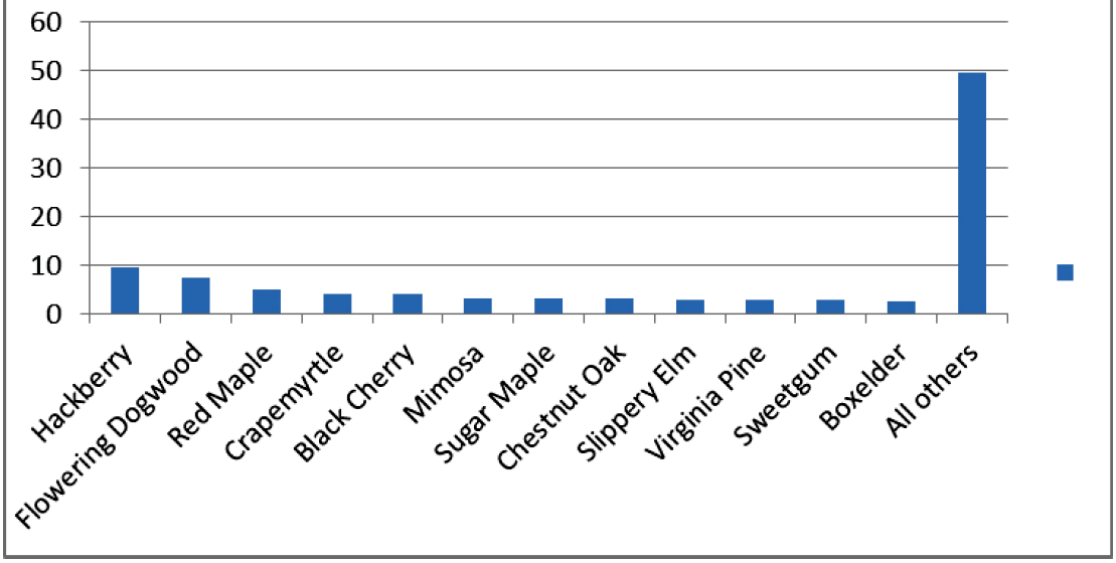
Based on a statistically significant sampling of Chattanooga's public streets, it is estimated there are over 204,000 street trees for which the City is responsible. Furthermore, the City actively manages 81.2% (165,984 trees) of the entire street tree population—which does not include 38,364 unmanaged trees within the rights-of-way, such as natural areas and privately planted trees. This assessment focused on those 165,984 city-managed street trees and includes information on the additional, unmanaged street trees when applicable. A structural analysis of the estimated population was conducted to reveal urban forest characteristics, such as species composition, age distribution, condition, canopy cover, and replacement value.

The following information characterizes Chattanooga's city-managed street tree resource:

There are over 102 distinct species growing along the streets of Chattanooga. Appendix A. provides detail on the species of street trees However the twelve most common street tree species and their percentage of the total population are:

1. Hackberry	Celtis spp.	10.8%
2. Flowering dogwood	Cornus florida	7.5
3. Red maple	Acer rubra	4.9
4. Crapemyrtle	Lagerstroemia indica	4.2
5. Black cherry	Prunus serotina	4.2
6. Mimosa	Albizia julibrissin	3.2
7. Sugar maple	Acer saccharum	3.0
8. Chestnut oak	Quercus prinus	3.0
9. Slippery elm	Ulmus rubra	2.8
10. Virginia pine	Pinus Virginia	2.8
11. Sweetgum	Liquidambar styraciflua	2.7
12. Boxelder	Acer negundo	2.6

Table. 1. The twelve most common street trees.



The 2008 STRATUM Analysis also produced the following metrics:

The age structure of Chattanooga's street trees approaches the ideal—with a large number of young trees. The City's street trees are distributed as 59% young trees (< 6 inches DBH), 20% established trees (6–12 inches DBH), 16% maturing trees (12–24 inches DBH), and 4% mature trees (>24 inches DBH). Consistent tree planting and continued proper plant health care is required to maintain the flow of benefits provided by the street tree resource.

The majority of Chattanooga's city-managed trees are in good condition (80.5%), with 17.4% classified as fair, 1.7% of its street tree resource in poor condition, and 0.4% are dead. The unmanaged street tree population is estimated with percentages of 73.2% good condition, 23.4% fair condition, 2.3% poor condition, and 1.1% dead. There is a need to maintain the entire existing street tree population to increase its useful lifespan and maintain a flow of benefits.

In Chattanooga, the estimated city-managed street tree canopy covers only 1,664 acres, or 1.9%, of the total land area of the City and 30.5% of the total street and sidewalk area (5,455 acres) within the City. The entire street tree population covers 2,071 acres, or 2.4%, of the total land area and 38.0% of the total street and sidewalk area.

To replace Chattanooga's estimated 165,984 city-managed street trees with trees of similar size, species, and condition would cost approximately $420.6 million (±$51.6 million). As for replacement value of the

entire population (204,348 street trees), that estimate is approximately $523.6 million (±$39.7 million).

Chattanooga's street trees provide cumulative annual benefits to the community. They help conserve and reduce energy use, reduce local carbon dioxide levels, improve air quality, mitigate stormwater runoff, and provide other benefits associated with aesthetics, property value increases, and quality of life. The City's street trees are providing the community these substantial benefits:

Chattanooga's city-managed street trees reduce electricity and natural gas use in the City from both shading and climate effects equal to 8,247 MWh and 314,882 therms, for a total retail savings valued at approximately $920,184 (±$112,961) and for an average of $5.54 per street tree. The combined population saves 10,273 MWh and 393,467 therms annually, valued at $1.1 million (±$87,036), with a citywide average of $5.54 per tree.

The city-managed street trees in Chattanooga reduce atmospheric CO2 by a net of 16,731 tons, valued at $250,962 (±$30,808) per year, for a net benefit per tree of $1.51. The entire street tree population reduces atmospheric CO2 by a net of 20,667 tons valued at $310,011 (±$213,515) for an average benefit of $1.52 per tree.

The net air quality improvement provided by the city-managed street tree population from the removal and avoidance of air pollutants is valued at $209,203 (±$25,682) per year, for an average net benefit per tree of $1.26. The combined population of street trees increases the net air quality benefit to $277,117 (±$21,020) with an average of $1.36 per tree.

Chattanooga's city-managed street trees intercept 235.5 million gallons of stormwater annually, for an average of 1,419 gallons per tree. The total value of this benefit to the City is $2.3 million (±$286,235) at an average value of $14.05 per tree. The entire street tree population intercepts 289.3 million gallons annually with an average of 1,415 gallons per tree, all valued at $2.7 million (±$217,256) for $14.02 per tree.

The estimated total annual benefit associated with property value increases, aesthetics, and other less tangible improvements is $3.1 million (±$381,882), for an average of $18.74 per city-managed tree. Considering the entire street tree population, the property value benefit increases to $3.9 million (±$294,278) and the value per tree becomes $18.99. See Appendix B. for more detail.

When the City's annual tree-related expenditures are considered ($560,155), the net annual benefit (benefits minus costs) of the city-managed street tree population to the City is $6.3 million (±$836,887), for an average net benefit of $37.73 per tree. Chattanooga receives

$12.18 in benefits for every $1 that is spent on its municipal forestry program. Additionally, if the entire street tree population is considered, that net annual benefit increases to $7.9 million (±$867,460), valued at $38.75 on average per tree. The benefit-cost ratio is $15.14 for every $1 spent.

The Urban Ecosystems Analysis (2010)

The conservation organization, American Forests, was asked to perform an ecosystems analysis of the entire land mass of the City of Chattanooga. This analysis was based on the assessment of "ecological structures" which is the unique combinations of land use and land cover patterns. Each combination performs ecological functions differently and is therefore assigned a different value. For example, a site with heavy tree canopy provides more stormwater reduction benefits than one with lighter tree canopy and more impervious surface area.

An analysis of high resolution 2008 NAIP (National Agricultural Imagery Program) found that overall the city has a robust tree canopy, higher than many U.S. cities American Forests has quantified east of the Mississippi River. However, there are areas such as the Central Business District (CBD) where canopy cover is less than recommended. The City is currently increasing canopy cover with additional plantings through its Take Root Program. Other findings include the following:

- As of 2008, Chattanooga's 51.4% tree canopy cover provided 421 million cubic feet of stormwater detention services valued at $1.26 billion, removed 4.5 million pounds of air pollution valued at $12.9 million, stored 2 million tons of carbon in trees' biomass, and sequestered 15,943 tons of carbon annually.
- When viewed by land use, the city's land use categories all have robust tree canopy percentages: Urban Residential is at 58.4 percent; Suburban Residential at 66.4 percent; Industrial at 42.7 percent; and Parks and Open Space at 72.3 percent. The exceptions are the most urbanized areas of the city – Commercial and Mixed Use is at 26.6 percent and the Central Business District is at 13.2 percent.

D. Challenges and Threats

The Chattanooga urban forest faces a multitude of threats and a few challenges. Like forests in rural and ex-urban settings, the urban forest is exposed to a broad array of human-caused natural challenges, most of which can be compounded by climate change. The proximity of the urban forest to relatively high numbers of people in an ever-expanding environment considerably increases the level and complexity of management challenges. The most significant of these include:

- Insects and diseases – Our forests are threatened by a number of insects and diseases, some are native and some are introduced from other continents. The Chestnut Blight and

Dutch Elm Disease have had a major impact on the composition of our forests that have eliminated some of the dominant tree species including American Elm and American Chestnut. Hemlock Wooly Adelgid has established a foothold in the higher elevations and is causing great harm. Inching ever closer are the Emerald Ash Borer and the Walnut Twig Beetle which brings the Thousand Canker Disease. And lurking just a bit further back are the gypsy moth and the Asian Long-horned Beetle. The Southern Pine Beetle, a native pest, is a cyclical problem that emerges every 10-20 years.

- Natural catastrophic events – The community forest can be greatly affected by natural catastrophic events such as ice storms, hurricanes, severe wind and tonadoes. The massive storms of 2011 which resulted in several FEMA level events and the loss of thousands of trees, human death, and property damage demonstrated the destructive forces that Chattanooga will encounter in the future.

- Invasive plants – Kudzu, English ivy, privet, mimosa, Ailanthus, wisteria, paulownia and shrub honeysuckle all thrive in our area. These plants and others have modified our forests and downgraded our native ecosystems by crowding out native plants. These cannot be overlooked if we are to retain our native ecosystems.

- Air pollution – Forest ecosystems can be substantially affected by air pollution, especially from deposition of ozone, nitrogen, sulfur, and hydrogen. Ozone has been documented to reduce tree growth, reduce resistance to bark beetle, and increase susceptibility to drought. Some pollutant particles can have a variety of effects on trees and heavy metals and other toxic particles that accumulate in the soil can cause damage and death in some species.

- Additional development/loss of tree canopy – Land clearing and development within the city can lead to a decrease in the overall forest canopy which could significantly affect plant and wildlife populations, forest biodiversity and health, and parcelization of forested areas where stands remain intact but have multiple landowners.

- Climate change – In the Chattanooga area this phenomenon is expected to bring warmer air temperatures, altered precipitation patterns, and more extreme temperature and precipitation events, all of which can cause changes in the urban forest. Climate change also has the potential to intensify all of the other threats described above. New design standards will need to be developed for tree pits to allow for an adequate soil volume for tree growth and development. This new

Emerald Ash Borer

standard will produce stronger and healthier trees which which will reduce the potential for blowovers as the intensity of storms is predicted to increase. Also a new palette of heat and drought tolerant species of varying mature sizes will need to be developed and refined regularly.

- Funding deficits – Operational budgets in the urban forestry operations have not kept pace with rising costs and this threatens to reduce the level of service and care which can be offered to protect and enhance the community forest.

The great French Marshall Lyautey once asked his gardener to plant a tree. The gardener objected that the tree was slow growing and would not reach maturity for 100 years. The Marshall replied, "In that case, there is no time to lose; plant it this afternoon!"
~ John F. Kennedy

4 Management Goals

1. **Operational Goals**
   A. Maintain a safe and healthy public tree resource.
   B. Achieve optimum stocking of street trees, and balance age distribution.
   C. Achieve optimum species diversity.

2. **Administrative Goals**
   A. Conduct efficient, cost-effective, and safe operations.
   B. Support a motivated well-trained staff.
   C. Keep and upgrade the Tree Ordinance.
   D. Provide support and technical assistance to other City departments.
   E. Provide support and assistance to the Chattanooga Tree Commission.

3. **Public Awareness Goals**
   A. Involve the public in tree planting events.
   B. Engage the public in proper tree care and tree health issues.
   C. Obtain and maintain special designations and recognitions.
   D. Inform local elected officials of the value of the urban forest.
   E. Recognize individuals and groups for outstanding works.

5 Detailed Management Tasks

Operational Goals

A. Maintain a safe and healthy public tree resource.

1. Tree Removals.
    a. The removal of hundreds of trees each year is a routine part of operations. Removals are assigned to a "super crew" composed of four or more workers. An additional but extremely useful piece of equipment for this purpose, a crane truck, is essential for the safe and efficient removal of trees. This is especially true for trees that are large or are growing in difficult to reach locations. The Office of Urban Forestry rents a crane truck on an hourly basis to assist with removals and other tasks. Even when the crane is not in use an hourly fee must be paid. Crane rental is expensive but the long term cost can be reduced by the outright purchase of a new crane.
    b. Responsibility: Department of Public Works
    c. Equipment: Purchase of a 18-20 ton capacity crane truck: $150,000.
    d. Evaluation Mechanisms: Public Works must make the budgetary commitment to continue to solve these removal problems in a safe and efficient manner. The capital budget will need to be increased to allow for the purchase of the crane truck. The set duration time allowed for removals is 240 days. However an analysis of City Works records from 2003 through 2013 indicated that the average response time was only 21 days. Therefore the evaluation mechanism will be the goal of not being slower than 21 days to solve removal requests.
2. Pruning for Safety.
    a. Although there are currently no backlogs for this class of work an average of about 300 requests for this service are received each year. These are high priority requests and should be resolved in a few days.
    b. Responsibility: Department of Public Works.
    c. Equipment: A new bucket truck with a working height of 75' is needed to replace the 1995 model bucket truck. Cost: $170,000.
    d. Evaluation mechanism: Public Works must take a proactive stance and budget for the replacement of the old 1995 bucket truck. The set duration time allowed within the City Works for completing tree trimming requests is 240 days.

An analysis of City Works records from 2003 through 2013 indicated that the average response time was approximately 19 days. Therefore the evaluation mechanism is to complete pruning requests within 19 days of the receipt of the request.

3. Stump Removals.
    a. Stumps are removed on a regular basis and although there are currently no backlogs. This is an important function that needs to continue at the current pace for completion.
    b. Responsibility: Department of Public Works
    c. Equipment: This function is outsourced to the private sector and will continue for the foreseeable future. The funding source for this activity is the contractual services line item in the operational budget. Cost: No increase in the operational budget is needed however this line item should not be reduced if the expectation for swift completion of this task is expected to continue.
    d. Evaluation mechanism: Stump grinding should occur within several months of the date the service is requested. The set duration for stump grinding is 180 days from the time of receipt of the request. Currently a list is kept by the Forestry Supervisor and then given to the contractor whenever there are eight to ten stumps to be ground. On rare occasion a complaint is received for slow service. If more complaints are received then the list will be given to the contractor on a monthly basis regardless of the volume of stumps on the list.
4. Citizen Service Request inspections and resolution.
    a. On-site inspections are made each day in all corners of the city to investigate and respond to 311 requests. This burden of this function has been carried out mainly by the Forestry Supervisor with assistance from others on staff. As seen in table one earlier in this plan the service requests are being solved in a timely manner but this standard of excellence will need to be sustained over the long run.
    b. Responsibility: Department of Public Works
    c. Equipment: New equipment will need to be purchased through both the R&R budget and through Fleet purchasing mechanisms and procedures. The larger pieces of equipment have been addressed earlier but chainsaws, pole saws and other small but necessary pieces of equipment costing less than $1,000 each will need to be acquired on an annual basis.
    d. Evaluation mechanism: The operating budget must also be maintained to ensure that this core mission continues to function at a high level. Each category of request has a set duration for resolution. An annual

review of the statistical report will for Urban Forestry will reveal if requests are solved within the allotted time. This operation will be successful if the average time for completing the each category does not increase showing that efficiency has slipped.

5. Routine pruning of young trees.
    a. The pruning of young trees is necessary to remove dead and dying branches, branches that interfere with pedestrian and vehicular traffic, and to set the trees' architecture. Although this is done routinely there have been some years, for example 2011, when the number and severity of the storms necessitated that full attention was aimed at clearing tree and vegetative debris from city streets. The proactive pruning operation is an extremely important function and should not be overlooked.
    b. Responsibility: Office of Urban Forestry
    c. Equipment: Small bucket truck, power pruner, hand tools. Cost: $500 per year for tools.
    d. Evaluation mechanism: There are approximately six to seven thousand trees of varying ages and species that were planted as part of some program or initiative. All of these need to receive proper pruning at routine intervals during their lives. A reasonable amount of trees to proactively prune each year is 1,500. Some of the mature trees will receive pruning on a frequency of every six to eight years while some of the young trees will need to be pruned every two years. The exact configuration of the proactive pruning cycle will need to be formulated by the City Forester and staff.
6. Water newly planted trees during times of drought.
    a. Given the likelihood that climate change will result in more extreme droughts it is imperative that all newly planted trees receive some measure of supplemental watering during the summer months. This has been achieved by attaching a 20-gallon Gator Bag to each newly planted tree. There are currently no funds budgeted for this purpose.
    b. Responsibility: Department of Public Works
    c. Equipment: The necessary equipment is in place but the Forestry Department will need to pick up this function or pay a contractor to provide supplemental watering. Cost: An extra $2,500 per year in the operating budget.
    d. Evaluation mechanism: Mortality rate of newly planted trees. The watering program will be considered successful if the mortality rate is less than two percent.

B. Achieve optimum stocking of street trees, and balance age distribution.

1. Achieve an optimum stocking of street trees.
    a. Every year it is necessary to replace trees that either die naturally, or have been knocked down or removed during the year. It is necessary to carry out an annual inspection of street trees to locate and map any sites without trees and to develop a planting list for the contract planter. Optimally trees are planted each year to ensure that every available site has a tree. Since the inception of the Take Root tree planting initiative all reasonably possible vacant tree pits in the expanded Central Business District have been located and planted. Therefore optimum stocking levels have been reached.
    b. Responsibility: City Forester
    c. Equipment: Paper, pencil, and a small pickup truck. Cost: Urban Forestry staff time. An annual budgetary commitment of $25,000 is needed for tree planting and replacement.
    d. Evaluation mechanism: The annual drive-by inspection will determine the stocking level. The average for annual replacements is approximately 150 trees and if that number remains constant then we are approaching full stocking.

2. Achieve a balanced age distribution of street trees.
    a. The large number of streetscapes projects in the past twenty years has greatly increased the population of street trees throughout Chattanooga with the majority of new plantings occurring in the downtown. The downside to this otherwise positive activity is the glut of mostly even-aged trees proceeding through their life cycle. And just like the current "baby boom" in the

human population with attendant strains on systems, this phenomenon could potentially cause a spike in pruning work, removals, and replacement plantings with corresponding fluctuations in labor requirements and budgetary needs. A full inventory of the street trees in the expanded Central Business District, and other selected area where street trees were intentionally planted, was completed in 2009. Since then there there have been almost several thousand new trees planted there. The inventory needs to be updated which will allow for an analysis of the street tree population. The City Forester will need to take a hard look at these numbers and decide what mix of species will be planted to achieve the optimum blend of species to achieve a balanced distribution of ages.

b. Responsibility: City Forester
c. Equipment: Desktop computer, pickup truck, office supplies and Urban Forestry staff time.
d. Evaluation mechanism: This is a difficult goal to measure because the of the different life cycles of each species. A planting scheme that will eliminate even-aged monocultures will need to be developed. However the evaluation mechanism will be the 10-20-30 rule as described below and determined in each inventory update.

C. Achieve optimum species diversity.

a. The palette should have a wide choice of trees that have an abundance of sizes, spring flowers, fall colors, shapes, and textures etc. In response to the anticipated changes as a result of climate change the trees should be drought tolerant and heat resistant. Trees considered to be both invasive and exotic should not be included on the palette. Only ornamental trees that do not have invasive characteristics as defined by the Tennessee Exotic Pest Plant Council will be selected. The palette should be reviewed and revised every three years. For maximum protection against the ravages of "new" pests or outbreaks of "old" pests the urban forest should contain:
   No more than 10% of any single tree species.
   No more than 20% of species in any tree genus.
   No more than 30% of species in any tree family.
b. Responsibility: City Forester with input from the Tree Commission.
c. Equipment: A personal computer with internet connections. Cost: Urban Forestry staff time.
d. Evaluation mechanism: An inventory of existing trees that is updated regularly will reveal if the 10-20-30 distribution of trees has been achieved.

Administrative Goals

A. Conduct efficient, cost-effective and safe operations.

1. This can be achieved by developing accurate job descriptions, hiring to fill needs, developing annual work plans, scheduling manpower for maximum efficiency, monitoring budget reports, and coordinating with other departments and agencies for their work needs.
2. Responsibility: City Forester
3. Equipment: Normal communication tools. Cost: Urban Forestry staff time.
4. Evaluation mechanism:
   Operational efficiency will be measured by historical averages not the set duration for each category of service request. They include the following:
   1. Fallen trees/branches 4 days
   2. General tree problems 19 days
   3. Tree hazards 14 days
   4. Tree removals 21 days
   5. Tree trimming 19 days

   Cost Effectiveness will be measured by the ability of the urban forestry operations to carry out all of its operational, administrative, and outreach functions within the allotted budget. A subcommittee of the Tree Commission will evaluate the performance for each year and assign a number from 1 to 100.
   The passing grade is 70.

   Safety will be measured by two categories:
   1. On the job accidents.
      Goal: No more than one (1) minor preventable vehicle accidents per year.
   2. On the job injuries.
      Goal: No (0) on the job injuries per year.

B. Support a motivated well-trained staff.

1. There are a number of webinars, seminars, and other opportunities both locally and on-line for learning new techniques and refreshing old memories. Forestry employees should be provided with 3-4 opportunities each year. In addition there should be 40-50 tailgate sessions offered each year on a variety of topics from safety to tree maintenance.

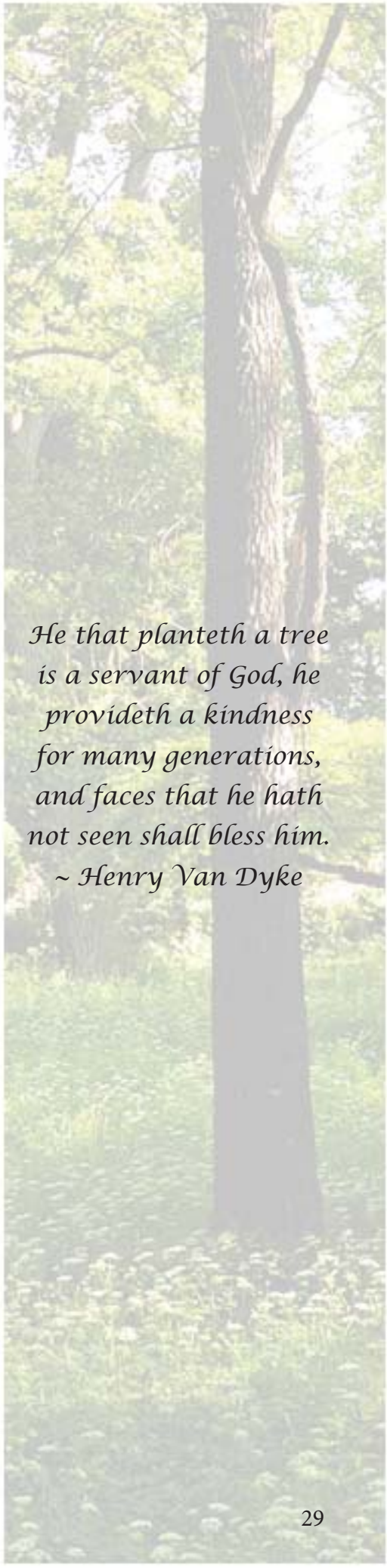
2. Responsibility: City Forestry leadership team.
3. Equipment: Projection equipment, time devoted to class room and seminar sessions. Cost: Approximately $100 per employee plus three to four work days committed to continuing education.
4. Evaluation mechanism:
    1. Number of employees to retain their ISA Certifica tion: All should be recertified.
    2. Employee performance reviews: All should have a minimum score of 3.0.
    3. Employee turnover in the Urban Forestry operations should not exceed one per year.

C. Keep and upgrade the Tree Ordinance

1. The tree ordinance was rewritten over the course of several years beginning in 2010 and culminating with the approval by City Council in the summer of 2012 of an updated Tree Ordinance. This was the first time in over twenty years that a major overhaul was performed. The Tree Ordinance needs to be reviewed every two to three years and upgraded in a timely fashion in order to keep up with changes in the program, administration, and new techniques.
2. Responsibility: The City Forester with advisory assistance from the Tree Commission.
3. Equipment: Desktop computer and appropriate word software. Cost: Urban Forestry staff time.
4. Evaluation mechanism: Review and upgrade by the City Forester and Tree Commission every three years.

D. Provide support and technical assistance to other City departments.

1. There are a number of City departments and agencies that need assistance with actual field work for planting or pruning or for technical assistance in the effective completion of their assigned functions. These include but are not limited to the Land Development Office, Department of Parks and Recreation, the Office of Sustainability, the Electric Power Board of Chattanooga, the Fire and Police Departments, the Moccasin Bend Treatment Plant, the Department of Neighborhood Services, the City Engineer, City Wide Services, and the Regional Planning Agency.
2. Responsibility: The Office of Urban Forestry.
3. Equipment: The usual office equipment. Cost: Urban Forestry staff time.
4. Evaluation mechanism: Proactively make an outreach each year to at least six organizations or agencies outside of the Department of Public Works.



He that planteth a tree is a servant of God, he provideth a kindness for many generations, and faces that he hath not seen shall bless him.
~ Henry Van Dyke

E. Provide support to the Tree Commission.

1. The Tree Commission was created by the original Tree Ordinance which was passed by the old City Commission in early 1990. Since then the Tree Commission has grown from five members to nine members. Most of these volunteers are take their charge seriously and are sincerely committed to serving to the best of their abilities. Their ideas reflect the mood and thoughts of the citizens of Chattanooga and their input has certainly advanced the cause of urban forestry within the city. As they consider new ideas and initiatives they deserve the most up-to-date information in both the technical and political realms.
2. Responsibility: The City Forester and professional staff.
3. Equipment: None. Cost: Urban Forestry staff time.
4. Evaluation mechanism: Tree Commission attitude and willingness to solve problems with current issues and tackle new projects.

Public Awareness Goals

A. Conduct efficient, cost-effective and safe operations.

1. This can be achieved by developing accurate job descriptions, hiring to fill needs, developing annual work plans, scheduling manpower for maximum efficiency, monitoring budget reports, and coordinating with other departments and agencies for their work needs.
2. Responsibility: City Forester
3. Equipment: Normal communication tools. Cost: Urban Forestry staff time.
4. Evaluation mechanism:
   Operational efficiency will be measured by historical averages not the set duration for each category of service request. They include the following:
   1. Fallen trees/branches 4 days
   2. General tree problems 19 days
   3. Tree hazards 14 days
   4. Tree removals 21 days
   5. Tree trimming 19 days

   Cost Effectiveness will be measured by the ability of the urban forestry operations to carry out all of its operational, administrative, and outreach functions within the allotted budget. A subcommittee of the Tree Commission will evaluate the performance for each year and assign a number from 1 to 100.
   The passing grade is 70.

B. Involve the public in tree planting events.

1. There are many people who enjoy planting a tree. Some want to provide shade, enhance the value of their property, or to memorialize a loved one. In any event tree planting provides instant gratification. As long as budgetary funds are available the Office of Urban Forestry should make an attempt to involve at least one group or neighborhood in a tree planting event each year. Such an activity helps to build a neighborhood as well as build support for the program.
2. Responsibility: City Forester with the help of the Tree Commission.
3. Resources: Trees from commercial nurseries. Cost: From $1,000 - $5,000 depending on the scope of the project. Also it will require a donation of time by Urban Forestry Staff to work on a weekend to guide the volunteers.

4. Evaluation mechanism:
    1. Hold at least one tree planting event per year during which the majority of the participants are from a neighborhood or a business.
    2. Pursue the idea of implementing a "Wedding Forest" as a complement to the Wedding Forest in our Sister City of Hamm, Germany.

C. Engage the public in proper tree care and tree health issues.

1. There seems to be a great lack of knowledge within the community regarding proper tree care. The practices of topping, volcano mulching, planting large growing trees under power lines and other poor practices can be found in all neighborhoods within the city. Also there are potentially catastrophic insect and disease threats which loom on Chattanooga's doorstep including Thousand Canker Disease, Emerald Ash Borer, and Gypsy Moth. Hemlock Wooly Adelgid is already here and has caused great harm. There is a strong need to provide education and information to the citizens regarding tree issues. The Citizen Forester program was launched in 2011 and has provided classes in the fall of the year to residents of the Chattanooga metropolitan area. This effort needs to be increased through websites, social media, special classes, media outreaches and other means to reach as many people as possible.
2. Responsibility: City Forester and the Chattanooga Tree Commission.
3. Cost: The out-of-pocket costs with this initiative are minimal but a significant amount of staff time will need to be dedicated to this effort.
4. Evaluation mechanism:
    1. Conduct a minimum of four Citizen Forester classes each year.
    2. Complete an Emerald Ash Borer management plan to include a section on public education of the problem.

D. Obtain and maintain special designations and recognitions.

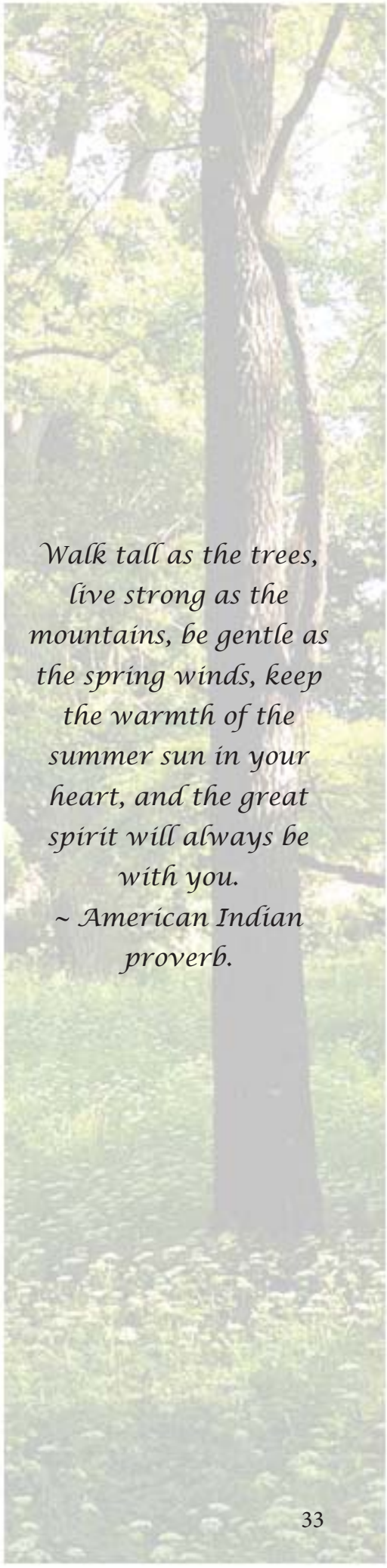
1. It was been a goal of the first Tree Commission to obtain and to maintain recognition as a Tree City community. This was accomplished in 1990 and it should be noted that Chattanooga was the first of the largest four cities in Tennessee to achieve this status. Since then the Chattanooga Tree Commission has been recognized as the Outstanding Tree Commission in the State (1996 and 2009). Chattanooga was also recognized for outstanding Arbor Day activities by the International Society of

Arboriculture in 2007. The Governor's Award for Environmental Excellence was awarded to Chattanooga (2009) for the creation of the Take Root program. And a number of Tree Commission members and staff have been recognized locally and state-wide for their contributions. One designation that has yet to be achieved is the accreditation of the Urban Forestry Department by the Society of Municipal Arborists (SMA). The SMA accreditation is the highest recognition for municipal and community forestry programs and is considered to be the gold standard.

2. Responsibility: The City Forester
3. Cost: Staff time to prepare the Tree City renewal documentation; staff time to prepare the SMA Accreditation application plus a $300 application fee.
4. Evaluation mechanism:
    1. The annual renewal of Tree City status.
    2. Achieving SMA accreditation for the Office of Urban Forestry.
    3. Listing Urban Forestry staff and Chattanooga Tree Commission awards winners on the Urban Forestry website.

E. Inform local elected officials of the value of the urban forest.

1. An Arbor Day celebration has been held each year since 1990. At each occasion the current Mayor and all city councilpersons are invited. Attendance results are mixed. Elected officials need to be made aware of the urban forestry program and the value that the trees provide to the community. Even though Arbor Day is a good event that can draw elected officials there are more than one way to engage them. Opportunities for interactions should include:
2. Responsibility: City Forester and the Tree Commission.
3. Cost: Staff time and a commitment from each Tree Commission member.
4. Evaluation mechanism:
    1. Providing an annual report to each member of the City Council providing them with facts, figures, and updates on the Urban Forestry program.
    2. Designating each Tree Commission member to represent one or more council districts and have them coordinate with their elected councilperson on a regular basis.
    3. Attendance by the Mayor and at least two members of City Council.



Walk tall as the trees, live strong as the mountains, be gentle as the spring winds, keep the warmth of the summer sun in your heart, and the great spirit will always be with you.
~ American Indian proverb.

F. Recognize individuals and groups for outstanding works.

1. There is a lot of good will and positive energy generated through a community based awards program. The Chattanooga Tree Commission held the first awards luncheon in 2005 to recognize those groups, businesses, and individuals who were leaders in using or caring for trees in an exemplary fashion. Awards winners are decided entirely by the Tree Commission and are honored to attend a special event to receive a plaque and be recognized. Each year's honorees are permanently listed on the Urban Forestry website.
2. Responsibility: Chattanooga Tree Commission with assistance from the City Forester.
3. Cost: $750-$1,000 per year.

The oaks and the pines, and their brethren of the wood, have seen so many suns rise and set, so many seasons come and go, and so many generations pass into silence, that we may well wonder what "the story of the trees" would be to us if they had tongues to tell it, or we ears fine enough to understand.
~Author Unknown, quoted in Quotations for Special Occasions by Maud van Buren, 1938

6 Action Items

	Short term Items for 2014-2015
Operations	Budget for new 75' bucket truck (170K) and crane truck (150K)
	Schedule for the annual pruning of at least 1,000 trees
	Execute a contract for the watering of newly planted trees each summer
	Complete the update of the GIS Inventory
	Evaluate stocking levels, species diversity, and age distribution of tree population
	Complete the Emerald Ash Borer Management Plan
Administration	Conduct employee performance appraisals
	Hold 26 tailgate safety sessions
	Conduct at least 10 Tree Commission meetings each year
Public Relations	Hold an annual Arbor Day celebration and invite elected officials
	Apply annually for recertification as a Tree City, USA community
	Produce and distribute an annual report
	Schedule a tree planting event with a neighborhood or a company
	Schedule Citizen Forester classes
	Make an outreach each year to at least six organizations or agencies outside of the Department of Public Works
	Hold an awards ceremony to recognize local heroes
	Obtain SMA accreditation for the Office of Urban Forestry
	Investigate the possibility for creating a Wedding Forest
	Medium term items for 2015-2018
Operations	Budget $18,000 for a new pick-up truck for the Forestry Technician
Administration	Review the current tree ordinance for necessary upgrades
	Review the current urban forestry master plan for necessary upgrades

Appendices

A. Listing of tree species on the rights-of-way.

City of Chattanooga

Complete Population of All Trees

2/24/2008

Species	DBH Class (in) 0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total	Standard Error
Broadleaf Deciduous Large (BDL)											
Hackberry	5,944	5,133	4,255	2,094	979	608	135	169	135	19,452	(±3,086)
Black cherry	2,229	2,735	2,296	743	473	68	0	0	0	8,544	(±1,597)
Sugar maple	2,364	1,182	1,283	709	338	68	101	0	0	6,045	(±2,333)
Chestnut oak	270	1,047	1,689	1,351	979	405	101	101	0	5,944	(±3,379)
Sweetgum	1,824	1,790	1,081	574	101	169	68	0	0	5,606	(±1,554)
Tree of heaven	2,432	1,689	878	135	0	0	0	0	0	5,133	(±1,705)
White oak	1,047	979	473	777	743	236	236	169	34	4,694	(±915)
Silver maple	203	540	743	979	979	338	169	68	68	4,086	(±970)
Winged elm	1,520	1,486	507	0	34	0	0	0	0	3,546	(±1,372)
Tulip tree	338	540	608	473	574	304	34	34	34	2,938	(±1,078)
Willow oak	473	473	507	304	439	135	169	68	270	2,837	(±721)
Mockernut hickory	642	777	878	270	101	101	34	0	0	2,803	(±1,009)
Water oak	608	439	371	574	68	101	68	0	68	2,296	(±663)
White ash	439	540	574	338	203	34	0	0	0	2,128	(±669)
Southern red oak	338	371	101	304	371	405	68	34	34	2,026	(±513)
Green ash	270	473	439	304	101	34	34	0	34	1,689	(±532)
Red mulberry	878	405	169	68	34	34	0	34	0	1,621	(±485)
Scarlet oak	135	135	169	371	304	236	101	101	0	1,553	(±391)
Sourwood	675	507	270	0	34	0	0	0	0	1,486	(±550)
Pin oak	236	304	135	304	203	101	34	34	34	1,385	(±524)
Honeylocust	811	135	338	0	0	0	0	0	0	1,283	(±782)
American sycamore	169	304	270	135	169	68	34	34	68	1,250	(±409)
Shagbark hickory	135	405	304	169	101	34	0	0	0	1,148	(±354)
Pignut hickory	338	236	236	101	203	0	0	0	0	1,114	(±327)
American elm	540	236	169	101	0	68	0	0	0	1,114	(±372)
Black oak	203	169	203	101	101	68	68	34	0	946	(±390)
Post oak	68	68	236	101	169	68	68	0	34	811	(±207)
Siberian elm	371	203	135	68	34	0	0	0	0	811	(±201)
Japanese zelkova	236	540	34	0	0	0	0	0	0	811	(±591)
Black walnut	169	135	304	68	34	34	0	0	0	743	(±173)
Shumard oak	34	0	101	68	135	34	34	0	0	405	(±247)
Northern red oak	68	34	135	34	101	0	0	0	0	371	(±164)
Pecan	0	34	135	68	68	0	34	0	0	338	(±102)
Cherrybark oak	34	34	135	34	101	0	0	0	0	338	(±122)
White poplar	0	0	68	34	68	34	34	0	0	236	(±98)
Hickory	169	34	0	34	0	0	0	0	0	236	(±98)
English oak	0	0	169	0	0	0	0	0	0	169	(±119)
American beech	34	34	0	34	34	0	0	0	0	135	(±105)
Bur oak	0	0	101	34	0	0	0	0	0	135	(±105)
Norway maple	0	34	0	0	34	0	0	0	0	68	(±47)
Bitternut hickory	0	0	0	34	0	0	0	0	0	34	(±33)
Cucumber tree	0	34	0	0	0	0	0	0	0	34	(±33)
Total	**26,240**	**24,214**	**20,499**	**11,887**	**8,409**	**3,782**	**1,621**	**878**	**811**	**98,341**	**(±15,439)**
Broadleaf Deciduous Medium (BDM)											
Red maple	2,161	2,803	2,972	1,216	540	203	135	34	0	10,064	(±4,136)
Slippery elm	3,310	1,216	675	338	135	68	0	0	34	5,775	(±1,437)
Boxelder	1,216	1,587	1,587	507	338	101	34	0	0	5,370	(±2,180)
Chinese elm	338	507	878	101	135	34	34	0	0	2,026	(±787)
Black tupelo	811	642	371	135	34	0	0	0	0	1,992	(±650)
Sassafras	743	979	203	0	0	0	0	0	0	1,925	(±803)
Ginkgo	405	675	203	0	0	0	0	0	0	1,283	(±714)

Complete Population of All Trees

2/24/2008

Species	DBH Class (in) 0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total	Standard Error
Mulberry	608	371	169	0	34	0	34	0	0	1,216	(±503)
Common persimmon	101	507	338	135	34	0	0	0	0	1,114	(±310)
Black locust	169	338	338	68	0	0	0	0	0	912	(±367)
Royal paulownia	34	101	405	169	0	0	0	0	0	709	(±427)
Chinese pistache	0	270	270	0	0	0	0	0	0	540	(±419)
Blackjack oak	34	101	68	169	101	34	0	0	0	507	(±148)
Magnolia	0	34	135	34	0	34	0	0	0	236	(±109)
Black willow	68	101	68	0	0	0	0	0	0	236	(±144)
River birch	0	203	0	34	0	0	0	0	0	236	(±144)
Overcup oak	34	0	169	0	0	0	0	0	0	203	(±199)
Osage orange	34	0	34	34	0	34	0	0	0	135	(±66)
Northern catalpa	34	0	0	34	0	34	0	0	0	101	(±57)
Black poplar	0	101	0	0	0	0	0	0	0	101	(±100)
Littleleaf linden	0	0	34	34	0	0	34	0	0	101	(±57)
Wisconsin weeping	0	0	0	0	34	34	0	0	0	68	(±66)
Yellowwood	0	34	0	0	0	0	0	0	0	34	(±33)
Chinkapin oak	0	0	34	0	0	0	0	0	0	34	(±33)
Willow	34	0	0	0	0	0	0	0	0	34	(±33)
Total	**10,131**	**10,570**	**8,949**	**3,006**	**1,385**	**574**	**270**	**34**	**34**	**34,953**	**(±7,130)**
Broadleaf Deciduous Small (BDS)											
Flowering dogwood	5,370	6,923	2,499	540	0	0	0	0	0	15,332	(±2,778)
Crapemyrtle	1,587	3,951	2,533	507	34	0	0	0	0	8,612	(±1,927)
Mimosa	3,276	2,600	608	68	0	0	0	0	0	6,552	(±1,578)
Callery pear	1,013	1,689	1,013	270	169	68	0	0	0	4,221	(±860)
Yoshino flowering cherry	1,689	1,790	304	34	0	0	0	0	0	3,816	(±2,457)
Eastern redbud	2,128	912	507	203	34	0	0	0	0	3,782	(±1,396)
Goldenrain tree	270	473	68	0	0	0	0	0	0	811	(±764)
Trident maple	675	34	0	0	0	0	0	0	0	709	(±665)
Apple	135	236	203	0	0	0	0	0	0	574	(±161)
Pear	0	169	304	34	0	0	0	0	0	507	(±466)
Japanese maple	135	236	101	0	0	0	0	0	0	473	(±137)
Plum	34	101	68	34	0	0	0	0	0	236	(±98)
Kwanzan cherry	0	101	101	0	0	0	0	0	0	203	(±93)
Peach	68	34	0	0	0	0	0	0	0	101	(±100)
Sumac	101	0	0	0	0	0	0	0	0	101	(±57)
Buckthorn	34	34	0	0	0	0	0	0	0	68	(±66)
Service berry	0	0	34	0	0	0	0	0	0	34	(±33)
Rose-of-sharon	34	0	0	0	0	0	0	0	0	34	(±33)
Chinese magnolia; Saucer	34	0	0	0	0	0	0	0	0	34	(±33)
Total	**16,582**	**19,283**	**8,341**	**1,689**	**236**	**68**	**0**	**0**	**0**	**46,199**	**(±5,411)**
Broadleaf Evergreen Large (BEL)											
Live oak	0	0	34	101	34	34	0	0	0	203	(±93)
Total	**0**	**0**	**34**	**101**	**34**	**34**	**0**	**0**	**0**	**203**	**(±93)**
Broadleaf Evergreen Medium (BEM)											
Southern magnolia	169	101	236	236	135	0	0	0	0	878	(±205)
Total	**169**	**101**	**236**	**236**	**135**	**0**	**0**	**0**	**0**	**878**	**(±205)**
Broadleaf Evergreen Small (BES)											
American holly	101	135	68	34	0	34	0	0	0	371	(±157)
Holly	34	101	101	34	0	0	0	0	0	270	(±114)
Carolina laurelcherry	0	203	68	0	0	0	0	0	0	270	(±235)
Privet	0	34	68	0	0	0	0	0	0	101	(±74)

City of Chattanooga

Complete Population of All Trees

2/24/2008

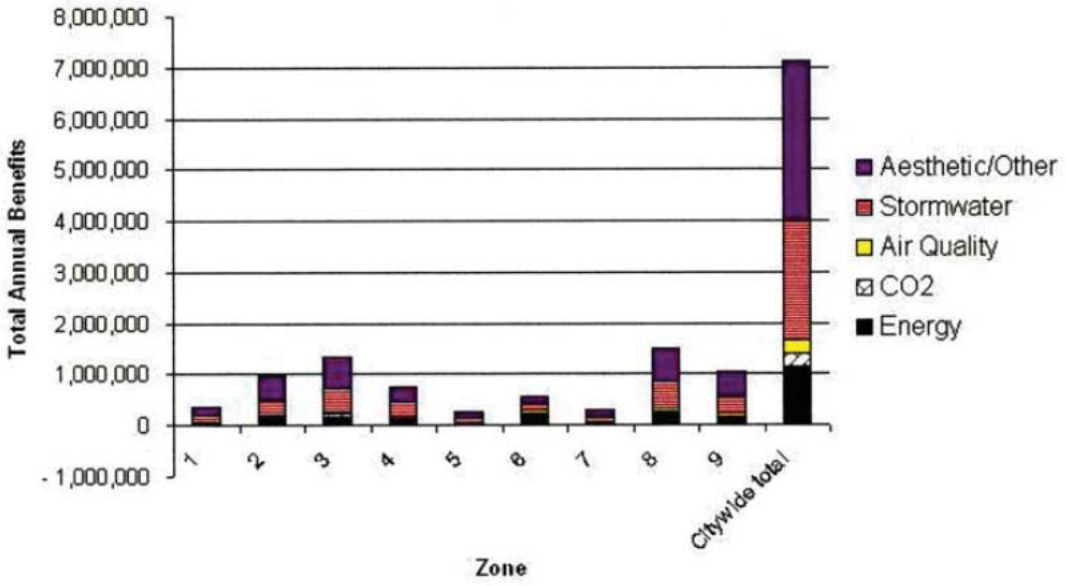
Species	DBH Class (in) 0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total	Standard Error
Total	**135**	**473**	**304**	**68**	**0**	**34**	**0**	**0**	**0**	**1,013**	**(±314)**
Conifer Evergreen Large (CEL)											
Eastern white pine	34	979	1,250	811	473	135	0	34	0	3,715	(±1,266)
Shortleaf pine	608	1,081	1,047	507	304	0	0	0	0	3,546	(±1,028)
Loblolly pine	946	608	777	473	405	101	0	0	0	3,310	(±997)
Leyland cypress	371	34	68	0	0	0	0	0	0	473	(±307)
Fir	0	0	34	0	0	0	0	0	0	34	(±33)
Deodar cedar	0	0	0	34	0	0	0	0	0	34	(±33)
Longleaf pine	0	34	0	0	0	0	0	0	0	34	(±33)
Total	**1,959**	**2,735**	**3,174**	**1,824**	**1,182**	**236**	**0**	**34**	**0**	**11,144**	**(±2,158)**
Conifer Evergreen Medium (CEM)											
Virginia pine	507	1,317	1,520	1,553	608	135	0	0	0	5,640	(±2,134)
Eastern red cedar	2,364	811	642	338	270	101	0	0	34	4,559	(±1,115)
Eastern hemlock	0	68	338	68	203	34	0	0	0	709	(±267)
Spruce	101	101	34	135	0	0	0	0	0	371	(±117)
Juniper	101	68	101	0	0	0	0	0	0	270	(±140)
Blue spruce	68	0	0	0	0	0	0	0	0	68	(±66)
Total	**3,141**	**2,364**	**2,634**	**2,094**	**1,081**	**270**	**0**	**0**	**34**	**11,617**	**(±2,530)**
Conifer Evergreen Small (CES)											
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
Palm Evergreen Large (PEL)											
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
Palm Evergreen Medium (PEM)											
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
Palm Evergreen Small (PES)											
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
Grand Total:	**58,356**	**59,741**	**44,172**	**20,904**	**12,461**	**4,998**	**1,891**	**946**	**878**	**204,348**	**(±15,500)**

B. Value of the ecosystems services which the street trees provide.

City of Chattanooga

Total Benefits of All Trees by Zone ($)

2/20/2008



Zone	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
1	48,172	13,448	9,938	117,764	165,824	355,146	(±145,018)	5.0
2	136,436	34,795	33,558	283,412	492,067	980,268	(±120,060)	13.8
3	183,796	49,239	41,418	456,954	607,393	1,338,801	(±213,632)	18.8
4	114,640	26,597	24,390	291,760	301,458	758,844	(±252,847)	10.7
5	38,342	10,645	-6,186	104,193	125,325	272,318	(±61,524)	3.8
6	221,598	11,968	61,988	127,082	132,150	554,786	(±95,723)	7.8
7	37,972	10,515	10,283	97,139	131,639	287,548	(±83,895)	4.0
8	220,186	55,770	66,088	497,710	673,357	1,513,110	(±256,953)	21.3
9	146,293	37,984	35,641	355,660	481,599	1,057,178	(±358,102)	14.9
Citywide total	1,147,434	250,962	277,117	2,331,675	3,110,812	7,117,999	(±539,920)	100.0

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