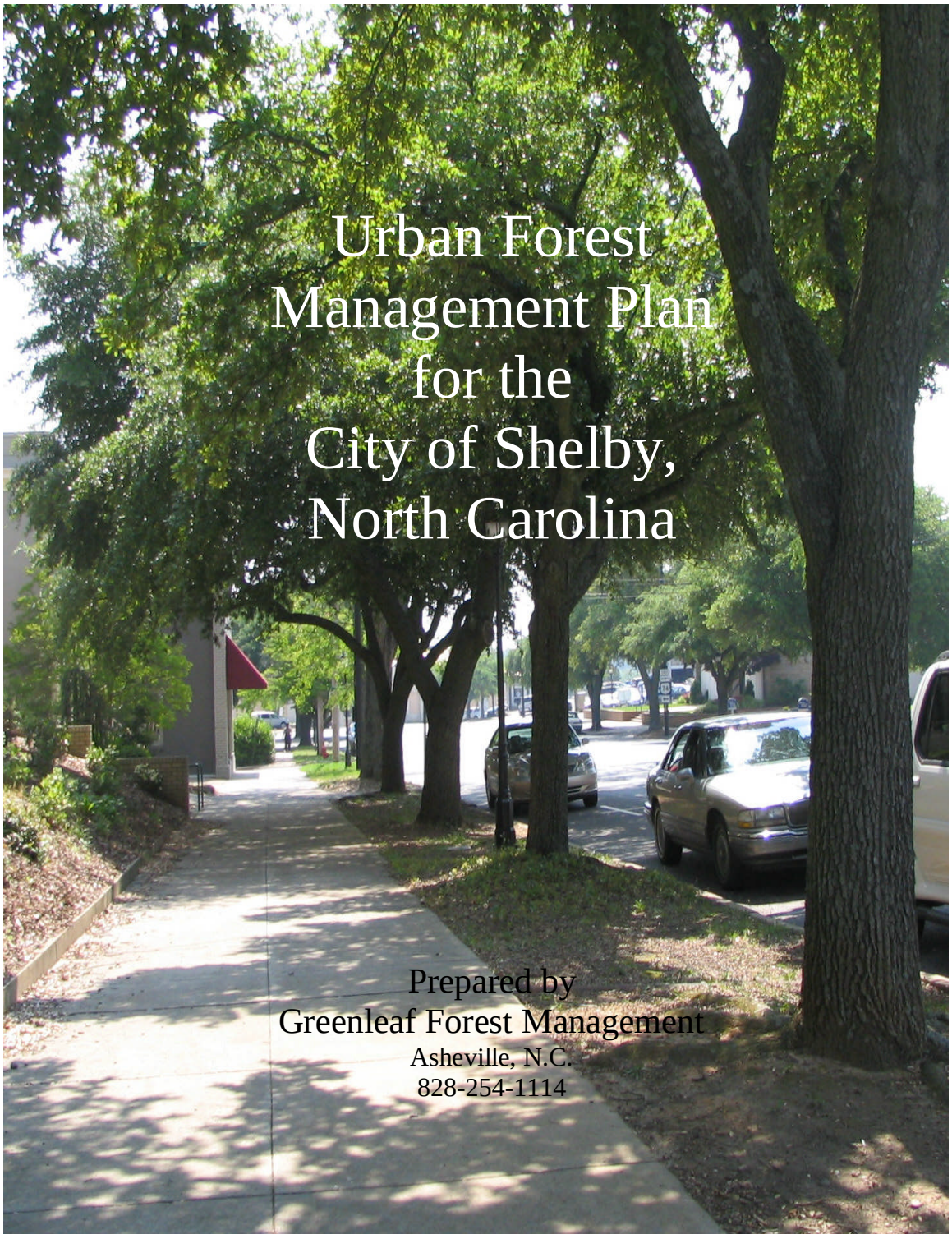

Urban Forest Management Plan for the City of Shelby, North Carolina

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EXECUTIVE SUMMARY

The City of Shelby contains almost 500 trees in the Center City area, a significant forest resource. The overall condition of this resource can be regarded as good. Some of our findings include the following:

- *Species mix* - The inventory indicates that tree numbers are heavily represented by primarily three species, elm, live oak and water oak. This is particularly true of the older and/or larger trees.
- *Tree health* - Overall average tree health is good although more than 10% of trees show some serious indications of decline. It is expected that the mortality rate for the subject trees is currently about 4-5%.
- *Factors effecting tree health* – The most prominent factor negatively effecting tree health is soil compaction. Approximately 50% of all tree-planting sites in the inventory area show negative effects from compaction.
- *Monetary Values of Subject Trees* – Average tree diameter and height are 17" and 31' respectively. The average value of an inventoried tree is $6,323.00. The estimated value of the City's urban forest resource in the study area is $3,066,655.00
- *Live oaks should be retained in the Uptown core* – The distinctive live oaks are closely associated with a shady, comfortable Uptown district. Because they are numerous, well-established, and now large enough to be less obstructive of store front views, we recommend the live oaks be retained, and any removed be replaced with another live oak.
- *Establishment of a tree maintenance program* - Because many of the trees are older, the City needs to set up a tree maintenance program to maintain the health of existing trees and begin the orderly replacement of unhealthy ones. This program will enhance the value of the existing tree resource, and reduce unpredictable, large expenditures for cleanup of unhealthy trees after storms and other weather events.
- *Funding options* – There are several options for funding tree work, including stricter enforcement of the Shelby Urban Forestry Ordinance, and increasing fines for violations of the Ordinance.

SHELBY URBAN FORESTRY MANAGEMENT PLAN

INTRODUCTION

Purpose - The purpose of this Plan is to provide the City of Shelby with a review of the existing city tree resource in the center city, and present a cost-effective framework of tree maintenance and replacement options to allow the City to maximize the benefits of its urban forest over the next 5-10 years.

Background - The City of Shelby has long recognized the important contribution of its urban forest to the attractiveness and livability of the town. In 1999, the City commissioned a study by Holmes and Associates to review tree practices. The City's Strategic Growth Plan, adopted in 2005, recommended preparation of a Street Tree Master Plan (including an inventory of street trees on city property and other significant trees), and creation of a management plan focusing on the maintenance and replacement of live oak trees located in the Uptown area. The City Center Master Plan, completed in 2007, stressed the need for trees, citing benefits of shade and the potential to link Uptown with local and regional greenways.

Study Area - This Plan focuses on the section of Shelby known as the "center city", an area of approximately 426 acres, encompassing much of the business district, and bordered roughly by the CSX Railroad on the north, US Highway 74 on the south, Dekalb Street on the east, and Morgan Street (including the Shelby Middle School) on the west (see Figure 1). It includes the historic Shelby Uptown district and the county courthouse square. The tree inventory for this plan is confined to trees on City owned property, so many trees (for example, many large elms and water oaks in the courthouse square) are excluded from this plan.

RESOURCE EVALUATION

Description of the City-owned urban forest resource - The Center City tree inventory conducted in the summer of 2008 indicates that the City-owned forest consists of 485 trees of 13 different species. The complete inventory is displayed in Appendix A. The number of trees in each species, along with average height and diameter is shown in Table 1. The average planting space was also tallied for each tree in see if there was any connection between the size of planting area and the vigor of the tree.

Figure 1: Shelby Urban Forestry Management Plan Study Area (green diamonds indicate trees in the City inventory)

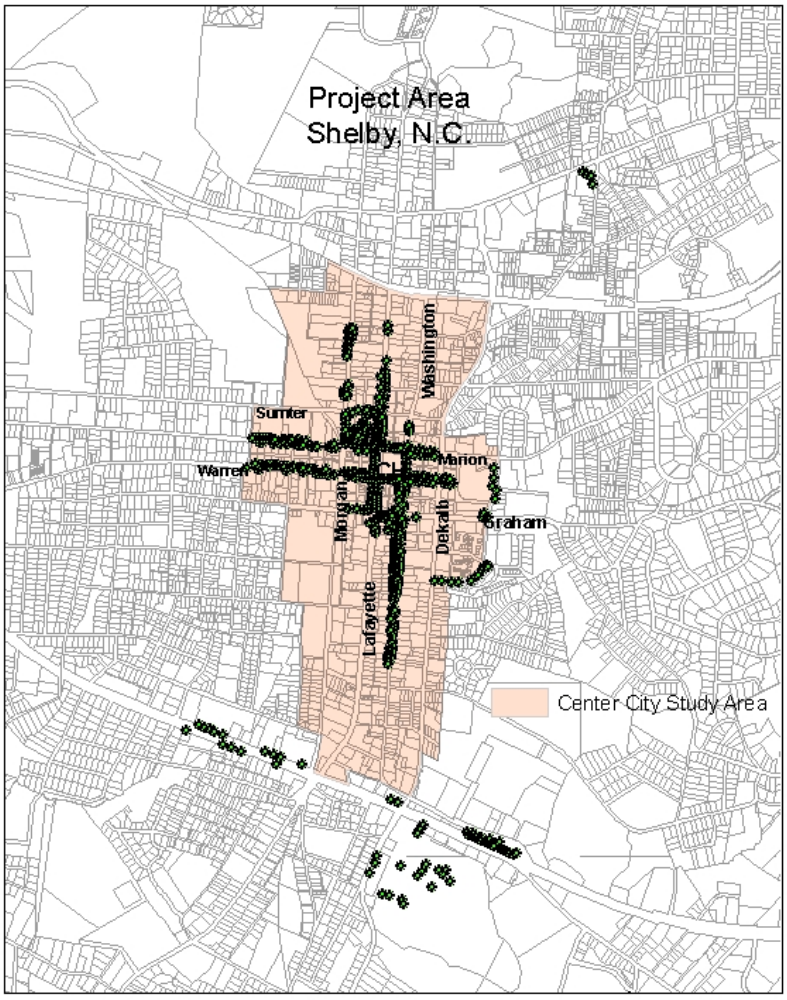


Table 1: Number of trees, average height, average diameter, and average planting space by species in the Shelby City Center Tree Inventory.

Species	No. Trees	Avg. Height (Feet)	Avg. Diameter (Inches)	Avg. Planting Space (Feet)
crepe myrtle	45	16	3	7
dogwood	45	19	10	8
Elm	42	40	17	11
Fir	1	35	24	8
ginkgo	3	13	4	9
holly	1	28	14	1
Japanese maple	2	14	7	7
Live oak	162	26	21	7
magnolia	3	20	9	9
maple	59	28	12	9
other oaks	119	49	22	7
pear	2	28	14	5
pecan	1	30	14	12
all trees	485	31	17	8

The most common species is live oak, representing one third of the total population, followed by other oak species (mostly water oak) at 25 percent. The other oak species are, on average, the tallest and largest diameter trees. These species, along with elms and maple, dominate the inventory both in size and quantity. The average tree diameter was 17 inches. Using stem diameter as a indicator of age, trees in the Study Area tend to be older and dominated by four species: live oaks, other oaks, maple, and elms. Sample borings in several trees indicate most trees fall into a 40-60 year old age class. This was confirmed by conversations with persons familiar with the tree planting history of the City Center.

Live Oaks - The live oaks are concentrated in a few blocks of the City Center (see Figure 2). Most were planted around 1970 as part of an effort to improve the business district. While not native to the area, many of the live oaks have developed the characteristic spreading evergreen canopy to provide shade, noise abatement, and a park-like feel to the streets. They come to define the City Center in the eyes of many people, and are featured in promotional brochures published by the Uptown Shelby Association. However, lower limbs have sometimes blocked business signage from street view and roots have cracked foundations and caused upheaval to sidewalks and street pavement. On the other hand, City workers report live oak branches have the ability to flex under great weight without breaking. This characteristic minimized branch breakage during the ice storm of 2002 when other species suffered severe limb breakage.

Figure 2: Locations of live oaks (in blue)

Our study indicated no greater tree health or maintenance problems associated with live oaks than with any other particular species. While it is true that a live oak planted in Shelby can be said to be out of its native range, that statement would be true of more than half the urban trees planted in the United States. While it is laudable to use as many native plants as possible it is not always practical to do so in an urban setting. Many times species that grow well in a rural setting at the edge of a city cannot survive in the windblown hardscape setting of that city. Therefore adaptability to a harsh environment has become as important as regionality when selecting a species. In regard to live oak

trees, the species has been successfully used as an urban tree both within and outside of its native region. In our opinion there are only two individual sites in Shelby (Lafayette & Graham, SW and Trade & Marion, NE) where we would recommend replacing the species with a smaller species.

Tree health - The overall health of the inventory is good. All trees were examined for three indicators of tree health: (1) dead top wood (DTW - see Figure 3), (2) injury to the bole or stem (cracks, cuts, scars,, etc. – see Figure 4), and (3) presence of a "v" notch in the main stem. Trees were rated "good" (3 points), "fair" (2 points) , or "poor" (1 point) based on criteria shown in Appendix B. These ratings are displayed in Table 2. Dead top wood is most commonly a problem in live oaks and elms that score below the overall average of 2.7 on a 3 point scale. Bole injuries occur slightly more in maples and elms. Presence of a "V" notch is most prevalent in crepe myrtle and dogwood, trees that are small in both height and diameter. Approximately 25% of trees had at least one health indicator rated as "Fair" and 10.3% had one or more indicators rated as "Poor". Only 5 trees, or about 1% showed a "Poor" rating in more than one indicator.

Figure 3 – Example of dead topwood.

Table 2: Relative health of trees by species for dead top wood, bole injury, and "V" notch on scale of 1 (poor) to 3 (good).

Species	No. Trees	Avg. rating DTW	Avg. rating Bole Injury	Avg. rating"V"	Avg. rating - all measures
crepe myrtle	45	2.8	3.0	2.5	2.8
dogwood	45	2.8	2.9	2.6	2.8
Elm	42	2.4	2.8	2.9	2.7
Fir	1	2.0	3.0	3.0	2.7
ginkgo	3	3.0	3.0	3.0	3.0
holly	1	3.0	3.0	3.0	3.0
Japanese maple	2	3.0	3.0	2.0	2.7
Live oak	162	2.7	2.9	2.9	2.8
magnolia	3	3.0	3.0	3.0	3.0
maple	59	2.8	2.7	2.9	2.8
other oaks	119	2.8	2.9	2.9	2.9
pear	2	3.0	2.5	3.0	2.8
Pecan	1	3.0	3.0	3.0	3.0
all trees	485	2.7	2.9	2.8	2.8

Probably the most telling fact is that 15.1% of trees showed a "Poor" rating in at least one indicator or a "Fair" rating in at least two indicators. The trees with "Poor" and "Fair" rating in multiple categories would receive higher scrutiny under an aggressive hazard tree maintenance program. One-third to one-half of such trees might be removed annually under such a program. This would mean removing and replanting a minimum of about 20 trees per year in the surveyed area. The actual number of trees, and the percentage that rated "Poor" for each of these three measures is shown in Table 3. It should be noted that the above health indicators do not differ greatly from what be found in the trees of a rural woodlot, where annual mortality commonly runs between 1-3%. However persistent targets, such as a pedestrian or a parked car, are not present in a woodlot. Therefore, in an urban setting it is more important to anticipate future mortality and remove the tree before damage can occur.

Figure 4 – Example of bole injury.

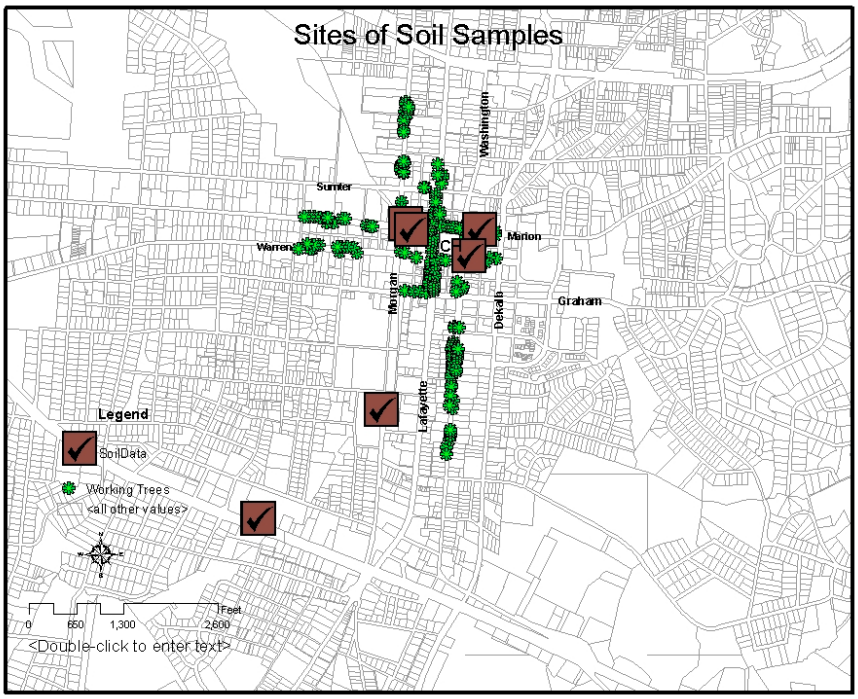
Factors Influencing Tree Health

Soils – A significant portion of a trees total mass is underground, 40% for some species. Therefore, what happens within the soil can have a pronounced effect on tree health. For a soil to support tree growth it must have an adequate nutrient level and must present sufficient aeration for water infiltration and the exchange of gases. To assess the condition of the soil in the City Center area soil samples and soil compaction readings were taken at various locations (Figure 5).

Table 3: Number and percentage of trees, by species. rated “Poor” for dead top wood, Bole injury or “V” notch.

Species	DTW - no. of trees rated Poor	Bole Injury - no. trees rated Poor	"V" - no. trees rated Poor	DTW - % of trees rated Poor	Bole Injury - % trees rated Poor	"V" - % trees rated Poor
crepe myrtle	1	0	0	2.2	0.0	0.0
Dogwood	1	1	8	2.2	2.2	17.8
Elm	3	2	0	7.1	4.8	0.0
Fir	0	0	0	0.0	0.0	0.0
Ginkgo	0	0	0	0.0	0.0	0.0
Holly	0	0	0	0.0	0.0	0.0
Japanese maple	0	0	1	0.0	0.0	50.0
live oak	8	5	4	4.9	3.1	2.5
Magnolia	0	0	0	0.0	0.0	0.0
Maple	3	6	2	5.1	10.2	3.4
other oaks	4	3	3	3.4	2.5	2.5
Pear	0	0	0	0.0	0.0	0.0
Pecan	0	0	0	0.0	0.0	0.0
all trees	20	17	18	4.1	3.5	3.7

Figure 5: Soil sample locations



Soil compaction readings were taken in tree lawns and tree pits throughout the City Center. Almost half of these readings indicated high rates of compaction (see Figure 6).

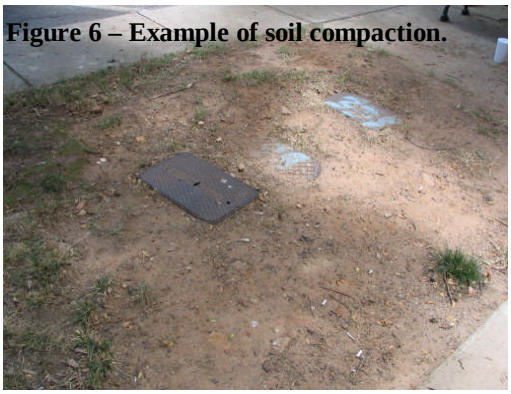


Figure 6 – Example of soil compaction.

Figure 7 – Geotex fabric in tree well.

There was a positive correlation between proximity to downtown and compaction. In other words, the further a site was from the center of Shelby (courthouse) the more likely that soil compaction was not a problem. This pattern is explained in part by the fact that older buildings near the courthouse are being renovated and heavy construction equipment is frequently driven onto sidewalk areas, compacting soil and increasing risk of damage to tree trunks and limbs. Some tree wells have a buried layer of Geotex fabric to inhibit growth of grass and weeds. Activities that compact the soil also expose this fabric that once uncovered, tends to tear and fray, creating an unsightly scene (Figure 7).

Soil samples were processed by the North Carolina Department of Agriculture laboratory (see lab results and soil profile photos in Appendix C). The results show an average pH balance very close to neutral. The nutrient deficits and corresponding need for the macronutrients, nitrogen, phosphorous and potassium are moderate. Generally speaking soil nutrient levels are adequate and are not limiting healthy tree growth.

Planting Space - There was no correlation found between planting space size and compaction. The high compaction found on many tree sites is contributing to the poor health of these trees. Some trees with large planting areas scored poorly, while trees in narrow parkways often appeared vigorous (Figure 8). As it happens most of the narrow spaces are found further from the city center. These spaces, though narrow, are generally in the form of tree lawns instead of tree wells and they typically exhibited little soil compaction. This provides more evidence that those trees in declining health are the result of activities surrounding the tree (mainly construction and parking) rather than any physical limitations of the planting spaces.

Figure 8: Examples of healthy trees growing in narrow planting spaces.

Monetary Values of Subject Trees

While urban trees are valued for their beauty and the ecosystem services they provide, placing a monetary value on these trees doesn't usually come to the forefront of the public's understanding. The trees in the city center area of Shelby typically have a high monetary value. If any one of the large trees had to be replaced with a tree of similar size and condition the cost would be quite expensive. The inventoried trees in Shelby have an average diameter of approximately 17 inches. The average height of these inventoried trees is about 31 feet. Using the Council of Tree and Landscape Appraiser's *Guide for Plant Appraisal* the resulting average value for a subject tree is $6,323.00. The total for all 485 inventoried trees in the Shelby downtown is $3,066,655.00.

Summary of Resource Evaluation Findings

- *Species* - The inventory indicates that tree numbers are heavily represented by primarily three species, elm, live oak and water oak. This is particularly true of the older and/or larger trees.
- *Tree health* - Overall average tree health is good although more than 10% of trees shown some serious indications of decline. It is expected that the mortality rate for the subject trees is currently about 4-5%.
- *Factors effecting tree health* – The most prominent factor negatively effecting tree health is soil compaction. Approximately 50% of all tree-planting sites in the inventory area show negative effects from compaction.
- *Monetary Values of Subject Trees* – Average tree diameter and height are 17" and 31' respectively. The average value of an inventoried tree is $6,323.00.

RECOMMENDATIONS

Tree Maintenance

Diversification of tree species and ages – Currently, three species (live oaks, other oaks, and maple) comprise 70 percent of the trees in the study area, and 73% of those 10 inches or more in diameter (Table 4). Most trees are 40-70 years old. An ongoing program of tree replacement will better distribute the age range.

Consideration should be given to replacing any tree that is removed with one of a different species suited to the site and having similar desirable characteristics. A list of suitable street trees is provided in Appendix D. An exception to this is live oak replacement in the City Center. In order to maintain the uniformity of the live "core", another live oak should replace any removed, unless special circumstances dictate otherwise. Isolated live oaks, or ones on the fringe of the "core" can be replaced with another species. In this way the urban forest can move towards greater age and species diversity. Selecting which trees to remove and replace can be accomplished through an ongoing program of tree maintenance.

Table 4: Tree species by diameter class

Species	0"-4.99"	5"-9.99"	10"-19.99"	20"+
crepe myrtle	39	6		
dogwood	5	25	14	1
Elm		6	23	13
Fir	1			
Ginkgo	3			
Holly			1	
Japanese maple		2		
Live oak		4	58	100
magnolia	2		1	
Maple	5	24	25	5
other oaks	3	7	57	52
Pear			2	
Pecan			1	
all trees	58	74	182	171

Prioritization - Tree maintenance for the City of Shelby will include several low impact practices such as mulching, fertilization, spraying and weeding, and some higher impact practices such as aeration, pruning, bracing, cabling and tree removal. In the past city staff has reacted to tree problems as they have happened. There were several noteworthy storms that brought trees down. These downed trees cut electrical service to some sites for several days. City staff spent many hours removing the obstructive material and cleaning up afterwards. Usually this involved many hours of overtime. Though not all

tree failure can be predicted it is recommended that the City of Shelby take a more proactive approach to tree care and thereby take action to reduce tree failure before it happens. Currently trees are only pruned or removed when failure occurs.

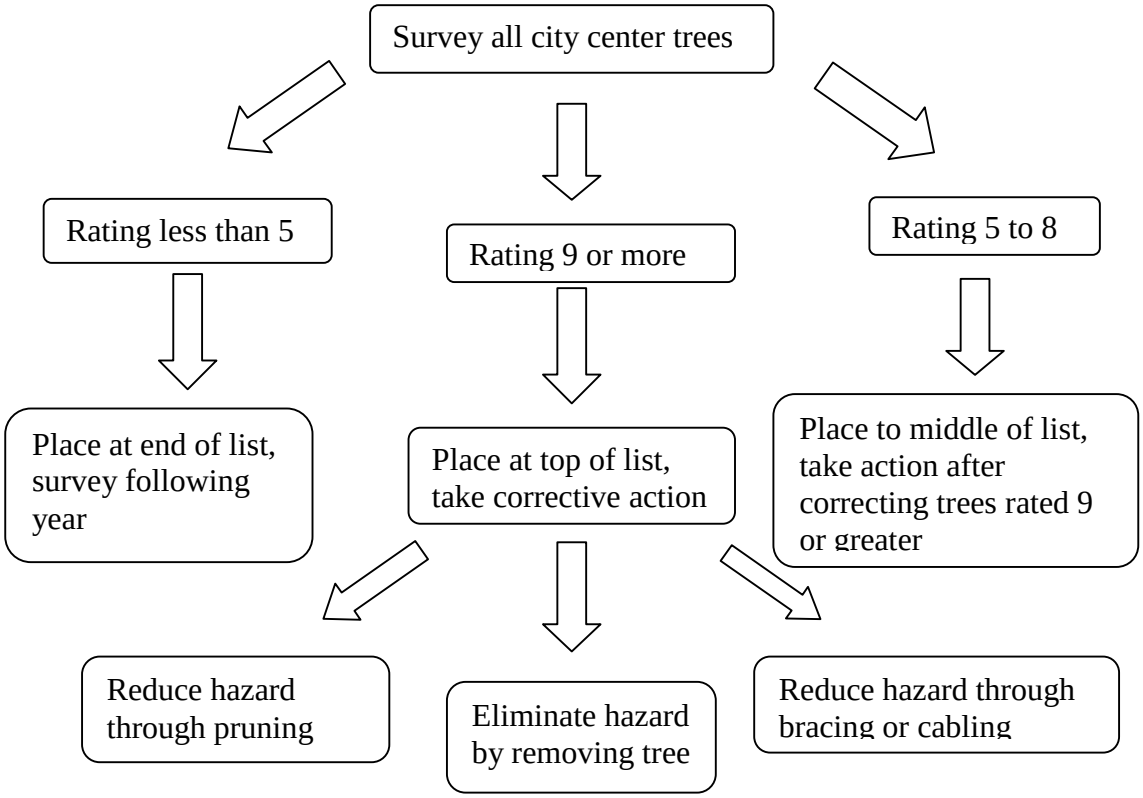
In order to anticipate tree failure, and to take action to prevent failure, each inventoried tree should be surveyed and rated as to its potential as a hazard tree (485 trees). After trees have been rated, they should be placed onto a work schedule in order of priority. Next city staff should begin treating trees weekly starting with those at the top of the list and moving down. If half of the inventoried trees are treated in any one year this would constitute treating 242 trees or 4 to 5 trees per week. In many cases this treatment might be aeration, pruning limbs, fertilizing, treating with insecticide or mulching the root area. In these cases the treatment will take less than a full day. In cases where bracing, cabling or tree removal is involved, the treatment will probably take one to 2 days. In the cases of tree removal, an additional day for replanting should be factored in.

Appendix E contains a tree maintenance schedule covering the period from 2009 to 2013, and listing the implementation times of a variety of practices meant to improve the health of trees in the Study Area.

The International Society of Arboriculture (ISA) has created a hazardous tree rating guide (*A Photographic Guide to the Evaluation of Hazard Trees In Urban Areas*). Factors such as health condition, structure and potential targets are taken into consideration when rating a tree. There is a 12 point rating system wherein a score of "0" denotes a tree with no hazard potential and a rating of "12" denotes a tree with an extreme hazard potential. It is recommended that after the survey is completed city staff take action on any tree with a rating of "5" through "12". These actions may include weekly monitoring, aeration, bracing, cabling or pruning. For trees with a rating of "9" or more the action to be taken moves up a degree. Simply monitoring a tree with a rating of "9"or greater is not sufficient. Actions to be taken can include pruning, cabling, bracing or removal. Once a tree reaches a rating of "9" remedial structural action that would negate the hazard must be taken. In many cases, trees with ratings of "9" or more will need to be removed. The flowchart on page 14 illustrates the steps to identify and treat hazardous trees.

Maintenance of Live Oaks – The City's live oaks require special consideration since they are closely identified with the image of the Uptown area. In particular, enhancement of their planting space by mulching and establishing barriers, and use of selective pruning will ensure a healthy population of live oaks.

Flowchart of Prescribed Tree Maintenance Actions
Using ISA Hazardous Trees Rating Guide



Mulching – The application of organic mulch to the surface area around a tree has been shown to have several health benefits to a tree. Mulch adds organic matter to the soil as it breaks down, retains moisture at the site, moderates soil surface temperatures, and reduces compaction. These benefits are generally realized whether the mulch is in the form of bark, pine straw, shredded fibers or, even in some cases, gravel. For the subject trees, it is probably most important to mulch those individuals located in the tree pits that were formally occupied by brick pavers. These pits are typically occupied by live oaks (Figure 9). In most cases, the pavers have been partially or wholly supplanted. In some cases citizens have placed mulch into the pits but in most cases the surface is a mixture of exposed soil, exposed

Figure 9 – Example of proper mulching.

geotex fabric and sporadic grass. General comments indicate that the public views these exposed pits as eyesores.

Figure 10 – Example of pavers and grass in tree wells.

Use of pavers in tree wells seems to be an unsatisfactory solution. The pavers are both expensive and difficult to maintain. They can shift to create an uneven surface, and unsightly weeds often grow up in the cracks (Figure 10). A two-part practice is recommended: (1) applying mulch to surface area of pits, and (2) erecting a low barrier between the mulched area and sidewalk or street. The purpose of erecting a barrier is two-fold. First, it will prevent the movement of mulch off of the intended site. Second, it will direct foot traffic away from the rooting zone thus reducing soil compaction. Currently the rooting zone around some trees is not well defined. These areas are used as sidewalks and occasionally support vehicle traffic. In some spots they serve as standing zones during special events. This is especially true of around the Courthouse Square. Compaction of these tree sites is typical during festivals, street concerts, parades and weekly farmer market days.

A variety of low barriers have been used at other sites to separate tree wells or tree lawns from streets and sidewalks. Low metal fences and railroad ties have commonly been used. In some cases, low walls of stone or brick have been employed. The primary function of the physical structure is to place a psychological barrier to walking or driving in the tree pit area. As such, whatever structure is chosen it should extend high enough above the ground (a minimum of 16”) to be obvious. It should also be wide enough or high enough as to not present a trip hazard. The construction of a low barrier combined with the application of mulch will greatly reduce soil compaction in tree pits.

Figure 11 – Example of tree well with barrier and ground cover.

Wherever the construction of a low barrier is impractical, the establishment of low vegetation in the rooting zone may be an acceptable alternative. Shrubs and ground cover growing in a tree well can sometimes be enough to discourage travel through the area (Figure 11). This is particularly true when the vegetation is prickly or rough. Such is the case when areas are planted to barberry, cotoneaster and holly. Other plants such as lilliturf, monkey grass and creeping juniper are capable of enduring a moderate amount of trampling and thereby provide a cushion to the soil underneath. Plants that could be planted in tree wells, tree lawns and utility strips have been included in the List of

Recommended Plants found in the Appendix D. In order to establish and maintain shrubs and ground cover around selected trees the soil will need to be ameliorated. The ground should be tilled and nutrients added. This will need to be accomplished with minimal disturbance to tree roots.

Pruning – Urban trees sometimes require pruning to remove deadwood or clear limbs from some obstruction such as overhead power lines (Figure 12). There are several different pruning methods specified in the ANSI A300 guidelines. Each method is specific to a particular situation. The arborist for the City of Shelby will primarily need to use three of these pruning methods. They are (1) cleaning, (2) raising, and (3) canopy reduction. Cleaning is used to remove dead, diseased and broken limbs. This pruning type should be applied to the vast majority of the live oaks in the municipal service area. Pruning to raise or raising is employed to selectively remove branches to provide vertical clearance. This method will apply to targeted trees for the purpose of providing more clearance underneath in situations where the growth of branches has blocked access or view. An example where raising might be a solution is when new growth along a street blocks the view of a traffic sign at the corner. The last method to be specified is that of canopy reduction. This type of pruning is used when to clear branches from building, utility lines or other structures. In the city center contract crews employed by the electrical service provider primarily conduct utility line clearance. In such cases it will be important for the city arborist to evaluate the pruning in order to affirm that such practices comply with the ANSI A300 standards (included with hardcopy report). In the city center a canopy reduction should not be conducted in conjunction with a raising. The combination of the two pruning methods at the same time would remove an excess of foliage, thereby endangering tree health. A step-by-step guideline of the ANSI A300 standards are depicted in the USDA publication *How to Prune Trees*, which is included in Appendix F.

Figure 12 – Example of live oak in need of pruning.

Maintenance Cost – The cost of maintaining the subject trees is primarily the cost of labor. There is currently a staff person employed by the city who is a certified arborist. Therefore no additional hiring or training is needed. This person spends about 50% of his time on tree-related tasks, and the other 50% on other duties. Creating a full-time position from this half-time position will increase cost to the city by about $25,000. Currently supplies such as gas and oil are being used in the tree program. These would be expected to increase only slightly. Increasing tree maintenance will increase the use of mulch, pesticide, fertilizer and perhaps growth regulators. Cost for these chemicals can be expected to be about $10.10 per subject tree or approximately $4,899 for the 485 trees. Cost including labor and supplies will be about $61.74 per tree or a total of $29,944 for the 485 subject trees. Given a value of $6,323.00 per tree this cost would represent a yearly outlay of less than 1% of the value of the resource. As indicated in the

Staff and Equipment section of the narrative, the labor cost may not be additional since the work is presently being done but only in reaction to tree failure events.

Staff and Equipment Needs - Currently the city crew that responds to tree problems only does so on an intermittent basis. One of the staff spends about half his time on tree related matters and the others help out as needed. No help may be needed for months at a time but then a great deal of help is needed in the aftermath of a storm. Reportedly the total hours spent by city crews in storm cleanup is greater than those required to staff a full time person dedicated to only tree related matters. It is recommended that a city arborist position be staffed full-time. This person should dedicate each day to tree related work. There is more than enough tree work in the city to keep one person occupied full-time and by effectively predicting tree failure before it happens total time spent on cleanup should be greatly reduced. By taking a proactive stance and treating trees prior to failure it is proposed that a significant portion of post storm cleanup time can be reduced. In this way the actual total staff time spent on tree work will not increase but will only be shifted from crisis response to a daily routine.

The City of Shelby already owns an adequate array of the equipment needed to maintain trees. This includes chainsaws, a bucket truck, a chipper and a stump grinder. The only additional piece of equipment that might be merited is an air spade to be used to aerate compacted soil. An air spade typically cost between $1,100-$1,800 depending on the model and accessories. Therefore an intensive tree care program will require little additional capitalization.

Funding Sources – Currently there is no budget for tree maintenance, although tree replacement is a line item in the utility department budget. As previously noted, personnel expense is the primary cost of a tree maintenance budget. The reality is that the majority of a tree maintenance program will need to be funded through the public works budget. Other sources will only pay a minority of the cost. Other sources of funding include grants, donations, fundraisers, in-kind services and penalties.

1. Grants for urban forestry can be acquired from both public agencies and private foundations. They are typically used to fund inventories, plans, tree ordinances, tree planting projects and special demonstration projects. They are not typically a source of maintenance funds.
2. Numerous communities have used donations and fundraisers to fund specific tree projects. These actions are usually carried out by a coordinating nonprofit organization. For the City of Shelby the Appearance Commission or Uptown Commission might be able to serve this function. It might collect and hold monies from its members and the general public for a specific use, such as placing low barriers and mulch on all live oaks between Lafayette and Washington.
3. In-kind services are a method of sometimes reducing maintenance cost. The general public, community groups or professional groups can provide in-kind services. These services are usually provided for a specific project, such as the Boy Scouts planting trees on a particular street or a garden club weeding and mulching tree pits at a particular site. There have been cases where professional arborist have committed to one day of service on a “pruning day” and done all the yearly

maintenance for a park or other public facility in that one day. As with monetary donations and fundraisers, the donation of in-kind services is best utilized when there is a coordinating nonprofit organization spearheading the project.

4. Penalties and permits can also be a source of funding for the tree maintenance program. During the collection of field data several incidents of tree damage were noted, including soil compaction in a tree pit adjacent to a construction site as shown in Figure 13. It is apparent that a significant amount of tree damage in the city center is related to construction (Figure 14).

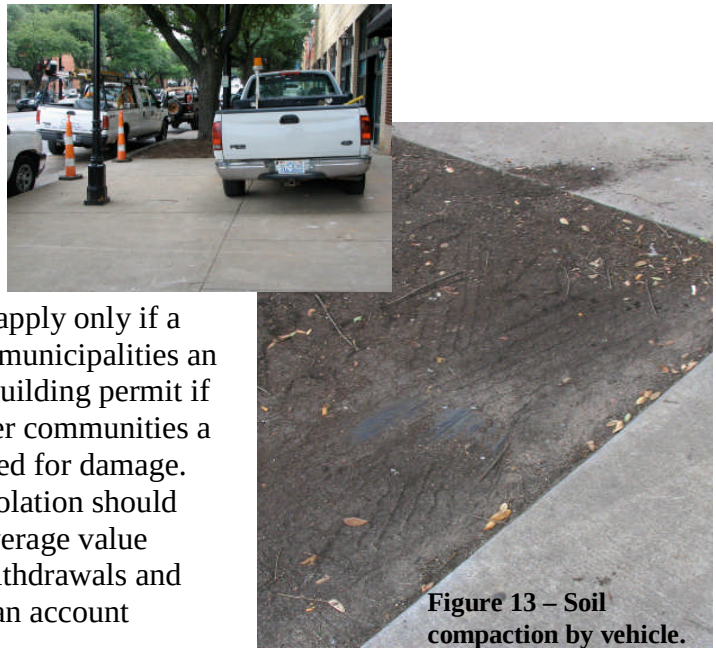


Figure 13 – Soil compaction by vehicle.

The Ordinance Regulating Urban Forestry Practices does encourage the maintenance of public trees during construction but does not require a payment in lieu of tree damage. Furthermore, fees for damage are excessively low and seem to apply only if a violation is intentional. In some municipalities an additional fee is charged onto a building permit if public trees are involved. In other communities a bond is held and monies subtracted for damage. Lastly, penalties charged for a violation should reflect the true value of a tree (average value $6,323.00). Permit fees, bond withdrawals and penalties can all be deposited to an account dedicated to tree maintenance.

Figure 14 – Example of construction damage.

Funding Recommendations – It is recommended that the City of Shelby seek an existing nonprofit 501-C3 organization or form such an organization whose primary purpose will be the promotion of trees within the city. The function of this organization will be to collect and hold donated monies, solicit in-kind donation and organize help from community groups. Countless such tree-oriented nonprofits throughout the country have organized within the past 50 years. Many of these organizations work to help their town become a Tree City USA. This program is sponsored by the Arbor Day Foundation, which may also be a source of information on how to form a tree-oriented organization.

Also, it is recommended that a more extensive penalty structure be established for violations of the Urban Forestry Practices ordinance. Under the current wording a first

violation would merit only a $50.00 fine. It is suggested that fines reflect the actual loss of value. Also, a specific fine structure for tree removal should be implemented. Fines could be based on tree size. For instance, the removal or mortally wounding of a tree with a diameter of 3 inches or less would generate a fine of $300. The same violation for a tree with a diameter of 3.5 to 8 inches would generate a fine of $1200, and so forth. Additionally, it is recommended that when public trees are involved at a city center construction site that the building permit includes a $50 nonrefundable tree maintenance fee. This is a simple acknowledgement that given the confined area at these sites it is highly probable that tree damage will occur. Also, a $500.00 - $5,000.00 (dependent on tree size) tree damage bond should be required. After construction is completed the city's arborist will inspect the trees and will withdrawal from the bond an amount equal to any damage that is above the $50 permit fee.

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Appendix A – Tree Inventory Data

The following table contains tree species, id number, height, circumference, and planting space data, along with values for the tree health indicators of dead top wood (DTW), bole injury and presence of a “V” notch. This information is extracted from the City of Shelby GIS project files containing tree inventory data collected in the summer and fall of 2008.

TREE_NUM	SPECIES	DTW	BOLE	"V"	HEIGHT	CIRC	PLANT_SPACE
141	CREPE MYRTLE	F	G	-	18	20	12
117	CREPE MYRTLE	G	G	-	18	13	12
143	CREPE MYRTLE	F	G	-	12	8	12
144	CREPE MYRTLE	F	G	-	12	8	12
145	CREPE MYRTLE	G	G	-	15	16	12
146	CREPE MYRTLE	F	G	-	20	12	12
319	CREPE MYRTLE	G	G	G	15	25	8
320	CREPE MYRTLE	G	G	G	15	14	8
75	CREPE MYRTLE	G	G	-	12	11	3
76	CREPE MYRTLE	G	G	-	12	9	3
77	CREPE MYRTLE	G	G	-	12	9	3
78	CREPE MYRTLE	G	G	-	12	11	3
86	CREPE MYRTLE	G	G	-	18	11	8
87	CREPE MYRTLE	G	G	-	18	15	8
88	CREPE MYRTLE	P	G	-	18	14	8
89	CREPE MYRTLE	F	G	-	18	15	8
90	CREPE MYRTLE	G	G	-	18	12	8
91	CREPE MYRTLE	G	G	-	18	12	8
92	CREPE MYRTLE	G	G	-	18	12	8
262	CREPE MYRTLE	G	G	-	15	6	12
263	CREPE MYRTLE	G	G	-	12	6	12
265	CREPE MYRTLE	G	G	-	8	6	8
266	CREPE MYRTLE	G	G	-	10	6	8
349	CREPE MYRTLE	G	G	G	10	8	5
353	CREPE MYRTLE	G	G	G	20	9	5
383	CREPE MYRTLE	G	G	G	15	2	5
384	CREPE MYRTLE	G	G	G	15	9	5
385	CREPE MYRTLE	G	G	G	15	8	5
386	CREPE MYRTLE	G	G	G	4	10	5
390	CREPE MYRTLE	G	G	G	30	10	5
391	CREPE MYRTLE	G	G	G	15	8	5
392	CREPE MYRTLE	G	G	G	20	7	5
393	CREPE MYRTLE	G	G	G	20	7	5
401	CREPE MYRTLE	G	G	G	25	9	5
402	CREPE MYRTLE	G	G	G	25	16	5
403	CREPE MYRTLE	G	G	G	25	12	5
404	CREPE MYRTLE	G	G	G	20	16	5
405	CREPE MYRTLE	G	G	G	20	12	5
406	CREPE MYRTLE	G	G	G	20	6	5
407	CREPE MYRTLE	G	G	G	20	8	5
409	CREPE MYRTLE	G	G	G	40	18	5
184	CREPE MYRTLE	G	G		10	6	12
183	CREPE MYRTLE	G	G		8	6	12
182	CREPE MYRTLE	G	G		10	6	12
374	CREPE MYRTLE	G	G	G	11	6	5
232	DOGWOOD	F	G	G	12	29	5
233	DOGWOOD	F	G	F	15	36	5
235	DOGWOOD	F	G	G	40	110	5
119	DOGWOOD	G	G	P	12	12	12
118	DOGWOOD	G	G	P	12	8	12
150	DOGWOOD	G	F	P	12	19	12

151	DOGWOOD	G	F	P	12	21	12
152	DOGWOOD	G	G	P	12	17	12
153	DOGWOOD	G	G	-	12	17	12
348	DOGWOOD	F	P	G	14	28	15
323	DOGWOOD	P	G	G	18	26	8
244	DOGWOOD	G	G	G	15	24	5
107	DOGWOOD	F	G	P	18	32	12
173	DOGWOOD	G	G	F	18	45	10
174	DOGWOOD	F	G	G	15	43	10
175	DOGWOOD	F	G	G	15	42	10
205	DOGWOOD	G	G	F	18	46	12
204	DOGWOOD	G	G	G	18	59	12
203	DOGWOOD	G	G	P	18	55	12
202	DOGWOOD	G	G	G	18	46	12
201	DOGWOOD	G	G	G	20	56	12
199	DOGWOOD	G	G	G	18	27	12
200	DOGWOOD	G	G	G	18	45	12
381	DOGWOOD	G	G	G	25	30	5
396	DOGWOOD	G	G	G	50	16	5
397	DOGWOOD	G	G	G	50	19	5
408	DOGWOOD	G	G	G	15	14	5
197	DOGWOOD	G	G	G	12	10	12
366	DOGWOOD	G	G	G	25	14	5
380	DOGWOOD	G	G	G	25	31	5
414	DOGWOOD	G	G	P	20	42	5
415	DOGWOOD	G	G	G	20	28	5
416	DOGWOOD	G	G	G	20	23	5
417	DOGWOOD	G	G	G	20	20	5
418	DOGWOOD	G	G	G	25	23	5
449	DOGWOOD	G	G	G	20	22	5
450	DOGWOOD	G	G	G	20	20	5
452	DOGWOOD	G	G	G	20	21	5
454	DOGWOOD	G	G	G	30	35	5
471	DOGWOOD	G	G	G	10	33	5
472	DOGWOOD	G	G	G	10	30	5
473	DOGWOOD	G	G	G	10	31	5
474	DOGWOOD	G	G	G	20	31	5
475	DOGWOOD	G	G	G	20	31	5
476	DOGWOOD	G	G	G	15	27	5
234	ELM	F	G	G	25	36	5
138	ELM	G	G	G	60	58	12
116	ELM	F	G	G	30	52	12
114	ELM	F	G	G	35	55	12
318	ELM	F	G	G	40	41	12
307	ELM	F	F	F	40	72	10
306	ELM	F	G	G	40	53	10
305	ELM	F	F	G	40	74	10
344	ELM	G	G	G	50	58	15
324	ELM	F	G	G	40	59	8
325	ELM	P	G	G	60	55	12
326	ELM	P	G	G	60	70	12
327	ELM	F	G	G	70	48	12
328	ELM	F	G	G	70	72	12
338	ELM	F	G	G	40	97	8

339	ELM	P	P	G	50	82	8
340	ELM	G	G	G	60	72	8
249	ELM	G	G	G	30	46	8
250	ELM	G	G	G	30	43	8
251	ELM	G	G	G	30	47	8
245	ELM	G	G	G	30	41	8
246	ELM	F	G	G	30	67	8
247	ELM	G	G	G	30	67	8
248	ELM	F	G	G	30	38	8
178	ELM	F	G	F	40	73	12
260	ELM	F	F	F	24	56	12
261	ELM	F	P	F	20	46	12
269	ELM	G	G	G	18	29	20
270	ELM	G	G	G	18	27	20
271	ELM	G	G	G	18	31	20
272	ELM	G	G	G	18	26	20
273	ELM	G	G	G	18	21	20
274	ELM	G	G	G	18	24	20
128	ELM	G	G	G	50	49	12
131	ELM	F	F	G	50	74	12
132	ELM	F	G	G	50	41	12
133	ELM	F	G	F	40	58	12
135	ELM	F	F	G	40	64	12
186	ELM	G	G	G	50	60	12
180	ELM	F	G	F	50	67	0
429	ELM	G	G	G	70	53	5
431	ELM	G	G	G	70	37	5
169	LIVE OAK	G	G	G	20	56	2
257	LIVE OAK	G	G	G	25	66	12
526	LIVE OAK	G	G	G	28	89	12
527	LIVE OAK	G	G	G	28	92	12
100	LIVE OAK	G	G	G	30	91	8
207	LIVE OAK	G	G	G	30	92	12
208	LIVE OAK	G	G	G	30	98	12
209	LIVE OAK	G	G	G	18	50	3
210	LIVE OAK	F	G	G	24	78	12
168	LIVE OAK	G	G	G	20	131	2
167	LIVE OAK	F	G	G	20	61	2
166	LIVE OAK	P	G	G	20	55	2
47	LIVE OAK	G	F	G	28	89	12
528	LIVE OAK	G	G	G	24	90	7
46	LIVE OAK	G	G	G	30	89	12
45	LIVE OAK	G	G	P	30	112	12
44	LIVE OAK	G	G	G	30	69	12
43	LIVE OAK	G	G	G	18	48	6
1	LIVE OAK	G	G	G	30	67	8
42	LIVE OAK	G	G	G	30	81	3
41	LIVE OAK	G	G	G	30	59	3
38	LIVE OAK	G	G	G	40	86	12
39	LIVE OAK	G	G	G	30	72	12
40	LIVE OAK	F	G	G	30	72	12
2	LIVE OAK	F	G	G	36	74	8
3	LIVE OAK	F	F	G	28	67	8
4	LIVE OAK	F	P	G	30	68	8

5	LIVE OAK	G	G	G	36	82	8
6	LIVE OAK	G	G	G	28	85	8
7	LIVE OAK	G	G	G	28	57	8
37	LIVE OAK	F	G	G	30	64	12
36	LIVE OAK	G	G	G	30	68	12
35	LIVE OAK	G	G	G	36	63	3
34	LIVE OAK	G	G	G	30	59	12
33	LIVE OAK	F	G	G	30	75	3
8	LIVE OAK	G	G	G	28	66	8
9	LIVE OAK	G	F	G	28	66	8
10	LIVE OAK	G	G	G	28	56	8
161	LIVE OAK	G	P	G	18	37	2
162	LIVE OAK	G	G	F	24	76	3
163	LIVE OAK	G	G	G	18	53	3
164	LIVE OAK	G	G	F	15	50	3
165	LIVE OAK	G	G	G	28	74	2
211	LIVE OAK	G	G	G	24	79	8
212	LIVE OAK	G	G	G	24	61	8
213	LIVE OAK	G	G	G	24	65	8
214	LIVE OAK	G	G	G	24	66	8
215	LIVE OAK	G	G	G	24	60	8
32	LIVE OAK	F	G	G	32	56	12
31	LIVE OAK	P	G	G	30	49	12
30	LIVE OAK	F	G	G	28	50	12
29	LIVE OAK	G	G	G	32	71	12
28	LIVE OAK	F	G	G	30	63	12
27	LIVE OAK	F	G	G	40	58	6
26	LIVE OAK	F	G	G	30	60	5
25	LIVE OAK	F	G	G	24	57	5
529	LIVE OAK	G	G	G	28	82	5
530	LIVE OAK	F	P	G	28	65	5
531	LIVE OAK	G	G	G	30	72	12
20	LIVE OAK	G	G	G	30	56	8
21	LIVE OAK	F	F	G	28	54	8
22	LIVE OAK	F	G	G	28	64	8
23	LIVE OAK	G	G	G	24	47	8
24	LIVE OAK	F	G	G	28	65	8
16	LIVE OAK	F	G	G	36	91	8
17	LIVE OAK	G	G	G	30	74	8
18	LIVE OAK	F	G	G	30	76	8
19	LIVE OAK	G	G	G	24	58	8
15	LIVE OAK	F	G	G	30	63	10
14	LIVE OAK	P	G	G	28	67	10
13	LIVE OAK	G	G	F	24	51	5
12	LIVE OAK	P	G	F	20	48	3
11	LIVE OAK	F	G	F	24	54	3
64	LIVE OAK	G	G	G	26	72	8
63	LIVE OAK	F	G	G	24	59	5
62	LIVE OAK	F	G	G	30	66	5
61	LIVE OAK	G	G	G	30	66	5
60	LIVE OAK	G	G	G	28	65	5
59	LIVE OAK	G	G	G	28	62	5
58	LIVE OAK	G	G	G	28	80	5
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158	LIVE OAK	G	G	G	26	73	5
157	LIVE OAK	G	G	G	24	57	2
156	LIVE OAK	G	G	F	24	79	5
155	LIVE OAK	P	G	G	20	46	2
154	LIVE OAK	P	G	G	22	49	2
532	LIVE OAK	G	G	G	24	80	5
533	LIVE OAK	G	G	G	24	85	5
534	LIVE OAK	G	G	G	24	89	5
284	LIVE OAK	G	G	G	20	90	3
285	LIVE OAK	G	G	G	20	87	3
286	LIVE OAK	G	G	G	20	59	3
535	LIVE OAK	G	G	G	24	85	0
536	LIVE OAK	G	G	G	24	82	5
537	LIVE OAK	G	G	G	28	90	5
470	LIVE OAK	G	G	G	30	75	5
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55	LIVE OAK	G	G	G	30	102	10
54	LIVE OAK	G	G	G	25	72	10
53	LIVE OAK	G	G	G	25	79	10
52	LIVE OAK	G	G	G	25	82	10
51	LIVE OAK	G	G	G	20	64	10
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49	LIVE OAK	G	G	G	25	90	10
48	LIVE OAK	G	G	G	20	62	10
224	LIVE OAK	G	G	G	18	35	5
223	LIVE OAK	G	G	G	20	62	5
222	LIVE OAK	F	F	G	18	60	5
221	LIVE OAK	F	G	G	15	45	5
227	LIVE OAK	G	G	G	20	61	3
226	LIVE OAK	G	G	G	20	53	3
225	LIVE OAK	F	G	G	20	67	3
228	LIVE OAK	G	G	G	25	79	5
229	LIVE OAK	G	G	G	25	101	5
236	LIVE OAK	G	G	G	26	68	5
237	LIVE OAK	G	G	G	28	71	5
238	LIVE OAK	G	G	G	20	53	5
239	LIVE OAK	G	G	G	20	61	5
230	LIVE OAK	G	G	G	15	34	5
231	LIVE OAK	F	G	P	7	28	5
216	LIVE OAK	G	G	G	25	75	5
217	LIVE OAK	G	G	G	25	64	5
218	LIVE OAK	F	G	G	25	81	5
219	LIVE OAK	G	G	G	20	94	5
220	LIVE OAK	G	G	G	18	65	5
310	LIVE OAK	G	G	G	18	23	10
309	LIVE OAK	G	G	G	18	22	10
308	LIVE OAK	G	G	G	18	19	10
212	LIVE OAK	G	G	P	24	51	5
241	LIVE OAK	G	G	F	24	65	5
240	LIVE OAK	G	G	P	24	46	5
243	LIVE OAK	G	G	G	24	61	5
525	LIVE OAK	G	G	G	24	74	8

253	LIVE OAK	G	G	G	24	60	8
254	LIVE OAK	G	G	G	24	65	8
70	LIVE OAK	G	G	G	24	55	8
69	LIVE OAK	-	-	-	26	81	5
68	LIVE OAK	F	-	-	26	75	5
67	LIVE OAK	F	-	-	26	64	5
66	LIVE OAK	P	G	G	26	65	5
65	LIVE OAK	F	G	G	26	65	8
101	LIVE OAK	G	G	G	28	82	5
102	LIVE OAK	F	P	G	28	65	5
103	LIVE OAK	G	G	G	30	72	10
104	LIVE OAK	G	F	G	30	72	10
82	LIVE OAK	G	G	G	24	63	5
84	LIVE OAK	F	G	G	24	63	5
85	LIVE OAK	F	G	G	24	60	5
83	LIVE OAK	G	G	G	24	78	5
93	LIVE OAK	G	F	G	26	70	8
94	LIVE OAK	F	G	G	24	46	8
96	LIVE OAK	F	G	G	20	37	8
97	LIVE OAK	P	G	G	20	49	8
99	LIVE OAK	F	G	G	24	62	8
105	LIVE OAK	F	G	G	30	76	8
106	LIVE OAK	G	G	G	35	76	8
539	LIVE OAK	G	G	G	26	90	8
258	LIVE OAK	G	G	F	24	53	12
283	LIVE OAK	G	G	G	18	35	5
482	LIVE OAK	G	G	G	30	75	5
137	MAPLE	G	G	G	7	24	12
136	MAPLE	G	G	G	7	5	12
115	MAPLE	G	G	G	18	23	12
108	MAPLE	F	G	G	18	20	12
109	MAPLE	G	G	G	20	24	12
110	MAPLE	G	G	G	20	28	12
111	MAPLE	G	G	G	20	26	12
113	MAPLE	G	G	G	20	25	12
317	MAPLE	G	G	G	32	33	12
316	MAPLE	G	G	G	36	37	12
315	MAPLE	G	G	G	36	37	12
314	MAPLE	G	G	G	32	33	12
313	MAPLE	G	G	G	30	27	12
312	MAPLE	G	G	G	40	47	12
311	MAPLE	F	G	G	40	54	12
345	MAPLE	G	G	G	40	59	15
255	MAPLE	G	G	G	24	36	8
256	MAPLE	F	G	F	24	36	8
73	MAPLE	G	G	G	30	56	5
72	MAPLE	G	G	F	26	40	8
74	MAPLE	P	F	G	20	31	5
71	MAPLE	F	G	G	24	35	8
79	MAPLE	G	P	G	20	33	5
80	MAPLE	G	P	G	22	60	5
81	MAPLE	G	P	G	30	81	5
95	MAPLE	F	P	G	20	24	8
98	MAPLE	F	G	G	24	34	8

296	MAPLE	G	G	G	24	15	8
297	MAPLE	G	G	G	20	19	8
298	MAPLE	G	G	G	24	19	8
299	MAPLE	G	G	G	24	24	8
300	MAPLE	G	G	G	24	18	8
301	MAPLE	G	G	G	28	17	8
302	MAPLE	G	G	G	28	18	8
303	MAPLE	G	G	F	28	21	8
304	MAPLE	G	G	G	24	19	8
170	MAPLE	P	P	G	25	24	8
171	MAPLE	P	P	G	25	27	8
172	MAPLE	G	F	G	25	16	8
259	MAPLE	G	F	G	20	28	12
277	MAPLE	G	G	G	30	67	2
279	MAPLE	G	G	G	25	45	5
281	MAPLE	G	G	G	30	60	12
282	MAPLE	G	G	G	30	57	12
191	MAPLE	G	G	G	40	53	12
190	MAPLE	G	G	G	40	71	12
189	MAPLE	G	G	P	18	14	12
188	MAPLE	G	G	G	18	11	3
451	MAPLE	G	G	G	40	22	5
453	MAPLE	G	G	G	40	27	5
458	MAPLE	G	G	G	70	70	5
459	MAPLE	G	G	G	50	36	5
460	MAPLE	G	G	G	20	131	5
461	MAPLE	G	G	G	20	10	5
462	MAPLE	G	G	G	40	36	5
478	MAPLE	G	G	G	40	43	5
479	MAPLE	G	G	P	40	61	5
480	MAPLE	G	G	G	50	49	5
541	MAPLE	G	G	G	24	58	8
463	OAK	G	G	G	30	57	5
464	OAK	G	G	G	30	57	5
465	OAK	G	G	G	30	68	5
466	OAK	G	G	G	40	55	5
467	OAK	G	G	G	30	58	5
468	OAK	G	G	G	20	40	5
469	OAK	G	G	G	20	57	5
140	OAK	G	G	P	50	35	12
139	OAK	G	G	G	60	150	12
127	OAK	G	G	G	30	29	12
126	OAK	P	F	F	40	77	12
125	OAK	G	G	G	30	29	12
124	OAK	F	G	G	40	46	12
123	OAK	F	G	G	30	36	12
122	OAK	G	G	G	28	23	12
121	OAK	F	G	G	40	108	12
120	OAK	G	G	G	50	122	12
142	OAK	F	F	F	40	9	12
147	OAK	F	G	F	40	105	12
148	OAK	P	G	F	40	122	12
149	OAK	F	G	F	50	112	12
347	OAK	G	G	G	50	118	15

346	OAK	F	G	G	50	161	15
343	OAK	G	G	G	20	103	15
321	OAK	G	G	G	50	84	8
322	OAK	G	G	G	50	111	8
329	OAK	G	G	F	40	105	12
330	OAK	P	G	G	40	73	12
331	OAK	G	G	G	50	88	12
332	OAK	G	G	G	50	97	12
333	OAK	G	G	G	40	42	12
334	OAK	F	G	G	60	141	8
335	OAK	G	F	G	60	125	8
336	OAK	F	G	G	60	77	8
337	OAK	G	G	F	70	186	8
176	OAK	G	G	P	40	83	12
177	OAK	G	G	G	40	108	12
179	OAK	G	G	F	40	75	12
198	OAK	G	P	G	40	106	12
264	OAK	G	G	G	24	34	10
350	OAK	G	G	G	65	74	5
351	OAK	G	G	G	60	56	5
352	OAK	G	G	G	50	48	5
387	OAK	G	G	G	50	56	5
388	OAK	G	G	G	40	48	5
389	OAK	G	G	G	50	55	5
394	OAK	G	G	G	70	120	5
395	OAK	G	G	G	70	24	5
398	OAK	G	G	G	50	77	5
399	OAK	G	G	G	50	51	5
400	OAK	G	G	G	50	57	5
410	OAK	P	P	G	20	48	4
411	OAK	G	G	G	70	72	5
412	OAK	G	G	G	60	53	5
129	OAK	G	G	G	35	42	12
130	OAK	G	G	G	30	28	12
134	OAK	G	G	G	40	32	12
196	OAK	G	G	G	40	84	12
195	OAK	G	G	G	40	84	12
194	OAK	G	G	G	35	44	12
193	OAK	G	G	G	35	53	12
192	OAK	G	G	G	35	48	12
185	OAK	F	G	G	60	124	12
181	OAK	F	G	G	50	110	12
355	OAK	G	G	G	45	44	5
357	OAK	G	G	G	50	84	5
358	OAK	G	G	G	50	81	5
359	OAK	G	G	G	50	79	5
360	OAK	G	G	G	50	78	5
361	OAK	G	G	G	50	62	5
362	OAK	G	G	G	50	60	5
363	OAK	G	G	G	40	30	5
364	OAK	G	G	G	60	60	5
365	OAK	G	P	P	60	142	5
367	OAK	G	G	G	70	92	5
368	OAK	G	G	G	70	102	5

369	OAK	G	G	G	70	133	5
370	OAK	G	G	G	70	72	5
371	OAK	G	G	G	70	64	5
372	OAK	G	G	G	70	116	5
373	OAK	G	G	G	50	77	5
375	OAK	G	G	G	50	59	5
376	OAK	G	G	G	70	87	5
377	OAK	G	G	G	50	70	5
378	OAK	G	G	G	50	69	5
379	OAK	G	G	G	50	45	5
413	OAK	G	G	G	50	48	5
419	OAK	G	G	G	15	6	5
420	OAK	G	G	G	50	62	5
421	OAK	G	G	G	70	76	5
423	OAK	G	G	G	18	9	5
424	OAK	G	G	G	70	60	5
425	OAK	G	G	G	70	53	5
426	OAK	G	G	G	50	38	5
427	OAK	G	G	G	70	53	5
540	OAK	G	G	G	60	100	5
428	OAK	G	G	G	70	54	5
430	OAK	G	G	G	70	37	5
432	OAK	G	G	G	70	47	5
433	OAK	G	G	G	70	36	5
434	OAK	G	G	G	70	38	5
435	OAK	G	G	G	70	41	5
436	OAK	G	G	G	50	33	5
437	OAK	G	G	G	50	42	5
438	OAK	G	G	G	50	45	5
439	OAK	G	G	G	50	48	5
440	OAK	G	G	G	50	46	5
441	OAK	G	G	G	50	48	5
442	OAK	G	G	G	50	45	5
443	OAK	G	G	G	50	42	5
444	OAK	G	G	G	70	53	5
445	OAK	G	G	G	30	33	5
446	OAK	G	G	G	50	46	5
447	OAK	G	G	G	50	41	5
448	OAK	G	G	G	25	22	5
455	OAK	G	G	G	60	49	5
456	OAK	G	G	G	70	54	5
457	OAK	G	G	G	70	78	5
481	OAK	G	G	G	40	69	5
354	PEAR	G	G	G	35	38	5
356	PEAR	G	F	G	40	48	5
187	PECAN ??	G	G	G	30	44	12
341	MAGNOLIA	G	G	G	10	12	8
342	MAGNOLIA	G	G	G	10	12	8
190	MAGNOLIA	G	G	G	40	58	12
280	FIR	F	G	G	35	75	8
267	GINGO	G	G	G	15	14	8
268	GINGO	G	G	G	15	18	8
275	GINGO	G	G	G	10	10	12
278	HOLLY	G	G	G	28	44	0

276	JAPANEESE MAPLE	G	G	P	12	20	10
382	JAPANEESE MAPLE	G	G	G	15	27	5

Appendix B – Tree Health Evaluation Guidelines

		Tree Health Indicator	
Rating	Topwood	Bole Injury	Structure/Notching
Good	Less than 10% dead topwood	No bole injury	No excessive branching or notches
Fair	10 – 40% dead topwood	1 -39% of circumference injured	Erratic, excessive branching present
Poor	Over 40% dead topwood	More than 40% of circumference injured; not necessarily contiguous	Presence of a large "V" branch of the main stem, especially if it has bark inclusion

Appendix C – Soil Sample Data and Pictorial Profiles

NCDA&CS Agronomic Division Phone: (919)733-2655 Web Site: www.ncagr.com/agronomi/ Report No: 02623

Soil Test Report

8/8/2008 SERVING N.C. RESIDENTS FOR OVER 60 YEARS

Grower: Wooten, Monty
26 Hampstead Rd
Asheville, NC 28804

Copies To:

Farm: Cleveland County

Agronomist Comments

B -- 4

Field Information		Applied Lime			Recommendations												
Sample No.	Last Crop	Mo	Yr	T/A	Crop or Year	Lime	N	P_2O_5	K_2O	Mg	S	Cu	Zn	B	Mn	See Note	
M+TNW	Marion + Trade				1st Crop: Tree, Shade	35M	(20 lbs 5-10-10 or EQUIV		PER 1000 SQ FT)		0			.0		4	
					2nd Crop:						0			.0			

Test Results																			
Soil Class	HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	Mn-I	Mn-AI(1)	Mn-AI(2)	Zn-I	Zn-AI	Cu-I	S-I	SS-I	NO_3-N	NH_4-N	Na
MIN	0.04	0.95	5.8	78.0	1.3	5.4	0	49	54.0	20.0	112			27	27	31	276				0.1

Field Information		Applied Lime			Recommendations												
Sample No.	Last Crop	Mo	Yr	T/A	Crop or Year	Lime	N	P_2O_5	K_2O	Mg	S	Cu	Zn	B	Mn	See Note	
WWNE1	Wash + Warren				1st Crop: Tree, Shade	0	(20 lbs 5-10-5 or EQUIV		PER 1000 SQ FT)		0			.0		4	
					2nd Crop:						0			.0			

Test Results																			
Soil Class	HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	Mn-I	Mn-AI(1)	Mn-AI(2)	Zn-I	Zn-AI	Cu-I	S-I	SS-I	NO_3-N	NH_4-N	Na
MIN	0.56	1.19	11.5	90.0	1.1	6.1	14	66	75.0	13.0	226			876	876	466	82				0.1

Field Information		Applied Lime			Recommendations												
Sample No.	Last Crop	Mo	Yr	T/A	Crop or Year	Lime	N	P_2O_5	K_2O	Mg	S	Cu	Zn	B	Mn	See Note	
M+MNW	Morgan + Hill				1st Crop: Tree, Shade	0	(20 lbs 5-10-10 or EQUIV		PER 1000 SQ FT)		0			.0		4	
					2nd Crop:						0			.0			

Test Results																			
Soil Class	HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	Mn-I	Mn-AI(1)	Mn-AI(2)	Zn-I	Zn-AI	Cu-I	S-I	SS-I	NO_3-N	NH_4-N	Na
MIN	0.13	1.09	9.6	99.0	0.1	7.0	0	22	79.0	18.0	96			309	309	108	92				0.1

Field Information		Applied Lime			Recommendations												
Sample No.	Last Crop	Mo	Yr	T/A	Crop or Year	Lime	N	P_2O_5	K_2O	Mg	S	Cu	Zn	B	Mn	See Note	
74SSW					1st Crop: Tree, Shade	0	(20 lbs 5-10-5 or EQUIV		PER 1000 SQ FT)		0			.0		4	
					2nd Crop:						0			.0			

Test Results																			
Soil Class	HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	Mn-I	Mn-AI(1)	Mn-AI(2)	Zn-I	Zn-AI	Cu-I	S-I	SS-I	NO_3-N	NH_4-N	Na
MIN	0.41	1.22	8.7	86.0	1.2	6.1	49	56	62.0	21.0	168			461	461	95	42				0.1

Field Information		Applied Lime			Recommendations												
Sample No.	Last Crop	Mo	Yr	T/A	Crop or Year	Lime	N	P_2O_5	K_2O	Mg	S	Cu	Zn	B	Mn	See Note	
M+LSW	Marion + Lab.				1st Crop: Tree, Shade	0	(20 lbs 5-10-10 or EQUIV		PER 1000 SQ FT)		0			.0		4	
					2nd Crop:						0			.0			

Test Results																			
Soil Class	HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	Mn-I	Mn-AI(1)	Mn-AI(2)	Zn-I	Zn-AI	Cu-I	S-I	SS-I	NO_3-N	NH_4-N	Na
MIN	0.09	1.21	15.9	100.0	0.0	7.9	0	40	90.0	9.0	129			67	67	91	93				0.1

Field Information		Applied Lime			Recommendations												
Sample No.	Last Crop	Mo	Yr	T/A	Crop or Year	Lime	N	P_2O_5	K_2O	Mg	S	Cu	Zn	B	Mn	See Note	
W+MNE	Wash + Marion				1st Crop: Tree, Shade	0	(20 lbs 5-10-5 or EQUIV		PER 1000 SQ FT)		0			.0		4	
					2nd Crop:						0			.0			

Test Results																			
Soil Class	HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	Mn-I	Mn-AI(1)	Mn-AI(2)	Zn-I	Zn-AI	Cu-I	S-I	SS-I	NO_3-N	NH_4-N	Na
MIN	0.13	1.16	30.9	100.0	0.0	7.9	0	55	94.0	5.0	98			32	32	137	241				0.1

PH Ave
6.7

Soil profile - Marion & Trade

Soil profile - Morgan & Mill

Soil profile - Highway 74

Soil profile - Marion & Lafayette

Soil Profile - Washington & Marion

Appendix D - Recommended List of Trees, Shrubs and Ground Cover To Be Used As Planting Material for the City of Shelby, North Carolina

Small Deciduous Tree - Approximate Size: 15' - 40'

Botanical Name Common Name	Native	Mature Height	Light Requirements
Acer Buergeranum Trident Maple	N	25-35'	sun
Acer ginnala Amur Maple	N	15-20'	sun or semi-shade
Acer leucoderme Chalk Maple	Y	30'	sun or semi-shade
Aesculus x carnea Red Horsechestnut	Y	30-40'	sun or semi-shade
Aesculus pavia Red Buckeye	Y	20'	sun or semi-shade
Amelanchier arborea Serviceberry, Sarvis	Y	15-25'	sun or semi-shade
Carpinus caroliniana American Hornbeam	Y	20-30'	sun or shade
Cercis canadensis Eastern Redbud	Y	20-30'	sun or semi-shade
Chionanthus virginicus White Fringetree	Y	15-20'	sun or semi-shade
Cornus alternifolia Pagoda Dogwood	Y	15-25'	sun or semi-shade

Cornus florida Flowering Dogwood	Y	20-30'	sun or semi-shade
Cornus kousa Kousa Dogwood	N	20-30'	sun or semi-shade
Crataegus phaenopurum Washington Hawthorn	Y	25-30'	sun
Franklinia alatamaha Franklin Tree	Y	15 -30'	sun
Hamamelis virginiana Witchhazel	Y	20-30'	sun or shade
Koelreuteria paniculata Goldenrain Tree	N	30-40'	sun
Magnolia soulangiana Saucer Magnolia	N	20-30'	sun
Magnolia virginiana Sweetbay Magnolia	Y	15-20'	sun or semi-shade
Malus floribunda Japanese Flowering Crabapple	N	15-25'	sun
Malus sp. Crabapple	N	15-25'	sun
Ostrya virginiana American Hophornbeam	Y	25-40'	sun or part shade
Oxydendrum arboreum Sourwood	Y	25-30'	sun or part shade
Parrotia persica Persian Parrotia	N	20-40'	sun

Prunus sargentii Sargent Cherry	N	20-30'	sun
Prunus subhirtella Higan Cherry	N	20-40'	sun
Virburnam prunifolium Blackhaw Virburnum	Y	15-20'	sun or shade
Large Deciduous Trees - Approximate Size: >40'			
Acer negundo Boxelder	Y	30-50'	sun
Acer rubrum Red Maple	Y	40-60'	sun or shade
Acer saccharum Sugar Maple	Y	50-70'	sun or semi-shade
Aesculus octandra Yellow Buckeye	Y	60-75'	sun
Betula nigra River Birch	Y	40-60'	semi-shade
Carpinus betulus European Hornbeam	N	40-60'	sun or semi-shade
Cercidiphyllum japonicum Katsuratree	N	40-60'	sun
Cladrastis lutea American Yellowwood	Y	30-50'	sun
Fagus grandifolia American Beech	Y	50-70'	sun or shade

Fagus sylvatica European Beech	N	50-60'	sun or shade
Fraxinus americana White Ash	Y	50-80'	sun
Fraxinus pennsylvanica Green Ash	Y	50-60'	sun
Ginkgo biloba Ginkgo, Maidenhair	N	50-80'	sun
Gleditsia triacanthos 'Inermis' Thornless Honeylocust	Y	30-70'	sun
Halesia carolina Carolina Silverbell	Y	30'-50'	sun orv shade
Larix decidua European Larch	N	70-75'	sun
Liquidambar styraciflua Sweetgum	Y	60-75'	sun or semi-shade
Liriodendron tuliperfera Tulip Poplar, Yellow Poplar	Y	70-90'	sun
Metasequoia glyptostroboides Dawn Redwood	Y	70-100'	sun
Magnolia acuminata Cucumber Magnolia	Y	70 - 90'	sun
Nyssa sylvatica Black Tupelo	Y	30-50'	sun or semi-shade

Platanus acerifolia London Planetree	N	70-100'	sun or semi-shade
Platanus occidentalis American Sycamore	Y	75-100'	sun or semi-shade
Prunus yedoensis Yoshino Cherry	N	40-50'	sun
Quercus alba White Oak	Y	50-80'	sun or semi-shade
Quercus bicolor Swamp White Oak	Y	50-60’	sun
Quercus coccinea Scarlet Oak	Y	70-75'	sun
Quercus imbricaria Shingle Oak	Y	60'	sun
Quercus lyrata Overcup Oak	Y	45'	sun
Quercus macrocarpa Bur Oak	Y	80'	sum
Quercus palustris Pin Oak	Y	60-70'	sun or semi-shade
Quercus phellos Willow Oak	Y	40-60'	sun
Quercus rubru Red Oak	Y	60-75'	sun or semi-shade
Salix babylonica Weeping Willow	N	30-50'	sun or semi-shade
Sophora japonica Japanese Pagoda Tree	N	50-70'	sun
Taxodium distichum Baldcypress	Y	50-70'	sun

Tilia americana Basswood, American Linden	Y	60-80'	sun
Tilia cordata Littleleaf Linden	N	60-70'	sun
Tilia tomentosa Silven Linden	N	50-70'	sun
Ulmus parvifolia Lacebark Elm	N	40-50'	sun or semi-shade
Zelkova serrata Japanese Zelkova	N	50-80'	sun or semi-shade
Evergreen Trees - Approximate Size: >15'			
Abies concolor White Fir	N	30-50'	sun
Cedrus atlantica Atlas Cedar	N	40-60'	sun
Cedrus deodara Deodar Cedar	N	40-70'	sun
Cedrus libani Cedar of Lebanon	N	40-60'	sun
Chamaecyparis pisifera Flasecypress	N	10-40'	sun
Cryptomeria japonica Japanese Cryptomeria	N	50-60'	sun or semi-shade
Cupressocyparis leylandii Leyland Cypress	N	60-70'	sun

Ilex opaca American Holly	Y	40-50'	sun or semi-shade
Ilex 'Nellie R. Stevens' Nellie Stevens Holly	N	15-25'	sun or semi-shade
Ilex attenuata 'Fosteri' Foster Holly	N	20-30'	sun or semi-shade
Juniperus scopulorum Rocky Mountain Juniper	N	30-40'	sun
Juniperus virginiana Eastern Redcedar	Y	40-50'	sun
Osmanthus americanus Devilwood	Y	15-20'	sun or semi-shade
Picea orientalis Oriental Spruce	N	50-60'	sun or semi-shade
Picea pungens Colorado Blue Spruce	N	30-60'	sun
Pinus bungeana Lacebark Pine	N	30-50'	sun
Pinus densiflora Japanese Red Pine	N	40-60'	sun
Pinus strobus White Pine	Y	50-80'	sun
Taxus baccata English Yew	N	30-60'	sun or shade
Thuja occidentalis American Arborvitae	Y	40-60'	sun

Thuja orientalis Oriental Arborvitae	N	15-25'	sun
Small Deciduous Shrubs - Approximate Size: 2' - 4'			
Callicarpa dichotema Purple Beautyberry	Y	3-4'	sun
Carytopteris cladonensis Blue-Mist Shrub	N	2-3'	sun
Deutzia gracilis Slender Deutzia	N	2-4'	sun
Fothergilla gardenii Dwarf Fothergilla	Y	2-3'	sun or semi-shade
Jasminum mudiflorum Winter Jasmine	N	2-4'	sun or shade
Spriaea bumalda Bumald Spirea	N	3-4'	sun
Spirea latifolia Meadowsweet	Y	4'	sun
Small Evergreen Shrubs & Groundcovers - Approximate Size: 1' - 4'			
Ajuga reptans Bugleflower	N	<1'	semi-shade

Buxus microphylla Little Leaf Boxwood	N	3-4'	sun
Cotoneaster apiculatus Cranberry Cotoneaster	N	2-3'	sun or semi-shade
Cotoneaster horizontalis Rockspray Contoneaster	N	2-3'	sun
Hypericum patulum St. John's Wort	N	3-4'	sun
Juniperus conferta Shore Juniper	N	1-2'	sun
Juniperus horizontalis Creeping Juniper	N	1-4'	sun
Juniperus *procumbens* Japanese Garden Juniper	N	1-2'	sun
Lavandula augustifolia English Lavender	N	2-3'	sun
Leucothoe fontanesiana Drooping Leucothoe, Doghobble	Y	3-4'	shade
Liriope muscarii Liliturf	N	1-2'	sun or shade
Pachysandra terminalis Pachysandra	N	1'	shade
Pinus mugo 'Compacta' Mugo Pine	N	3-4'	sun
Prunus laurocerasus, 'Otto Luyken' Otto Luyken Laurel	N	3-4'	sun or shade

Rhododendron obtusum Kurume Azalea	N	2-4'	semi-shade
Medium Deciduous Shrubs - Approximate Size: 4' - 6'			
Berberis mentorensis Mentor Barberry	N	5-7'	sun or semi-shade
Callicarpa americana American Beautyberry	Y	4-8'	sun or semi-shade
Hydrangea macrophylla Big Leaf Hydrangea	N	3-6'	sun or semi-shade
Itea virginica Virginia Sweetspire	Y	3-5'	sun or shade
Kerria Japonica Japanese Kerria	N	3-6'	sun or semi-shade
Rhododendron periclymenoides Pinxterbloom Azalea	Y	4-6'	semi-shade
Spireae thunbergii Thunberg Spirea	N	3-5'	sun
Vaccinium corymbosum Highbush blueberry	Y	6'	sun
Virburnam acerifolium Mapleleaf Virburnum	Y	4-6';	semi-shade or shade
Medium Evergreen Shrubs - Approximate Size: 4' - 6'			

Abelia grandiflora Glossy Abelia	N	4-6'	sun to semi-shade
Picea glauca 'Conica" Dwarf Alberta Spruce	N	5-6'	sun
Pieris floribunda Mountain Pieris	Y	4-6'	semi-shade or shade
Pieris japonica Japanese Andromeda	N	4-6'	semi-shade
Prunus laurocerasus 'Schipkaensis' Schipka Laurel	N	4-5'	sun or shade
Rhododendron carolinianum Carolina Rhododendron	Y	4-6'	sun or shade
Taxus media English-Japanese Yew	N	varies	sun or shade
Large Deciduous Shrubs Approximate Size: 6' - 15'			
Aesculus parviflora Bottlebrush Buckeye	Y	12'	sun to shade
Buddleia davidii Butterfly Bush	N	6-10'	sun
Calycanthus floridus Carolina Allspice, Sweetshrub	Y	6-10'	sun or shade

Chimonanthus Praecox Wintersweet	N	10-15'	sun or semi-shade
Clethra acuminata Cinnamon clethra	Y	12'	sun to shade
Clethra alnifolia Summersweet Clethra	Y	5-8'	sun or shade
Cornus sericea Redosier Dogwood	Y	7'	sun
Euonymus americanus Strawberry Bush	Y	7-8'	shade
Forsythia intermedia Forsythia	N	8-10'	sun
Fothergilla major Large Fothergilla	Y	6-10'	sun or semi-shade
Hydrangea arborescens Smooth Hydrangea	Y	8'	shade
Hydrangea quercifolia Oakleaf Hydrangea	Y	10'	sun or semi-shade
Ilex verticulata Winterberry Holly	Y	6-12'	sun or semi-shade
Lagerstroemia indica Crape Myrtle	N	15-25'	sun
Magnolia stellata Star Magnolia	N	15-20'	sun
Rhododendron arborescens Sweet azalea	Y	10'	shade
Rhodo. calendulaceum Flame Azalea	Y	4 - 8'	shade
Rhodo. cumberlandense Cumberland Azalea	Y	3 - 8'	shade

Rhodo. prunifolium Plumleaf Azalea	Y	8 - 10'	shade
Rhodo. vaseyi Pinkshell azalea	Y	5 - 8'	shade
Salix purpurea Purpleosier Willow	N	8-10'	sun
Spiraea prunifolia Bridalwreath Spirea	N	4-9'	sun or shade
Spiraea vanhoutei Vanhoutti Spirea	N	6-10'	sun or shade
Syringa vulgaris Lilac	N	8-15'	sun
Viburnum dentatum Arrowwood Virburnum	Y	6-8'	sun or semi-shade
Virburnum plicatum 'Tomentosum' Doublefile Viburnum	N	8-10'	sun or semi-shade
Virburnum burkwoodii Burkwood Virburnum	N	8-10'	sun or semi-shade
Viburnum nudum Smooth Winterod	Y	10'	sun or semi-shade
Large Evergreen Shrubs - Approximate Size: 6' - 15'			
Berberis julianae Wintergreen Barberry	N	6-8'	sun or semi-shade
Buxus sempervirens Common Boxwood	N	15-20'	sun or shade

Ilex crenata Japanese Holly	N	4-10'	sun
Ilex glabra Inkberry Holly	Y	6-8'	sun or semi-shade
Ilex meserveae Blue Holly	N	4-15'	sun
Juniperus chinensis Chinese Juniper	N	varies	sun
Kalmia latifolia Mountain Laurel	Y	6-8'	sun or shade
Rhododendron catawbiense Catawba Rhododendron	Y	6-10'	sun or shade
Thuja orientalis American Arborvitae	N	15-25'	sun
Virburnum rhytidophylum Leatherleaf Viburnum	N	10-15'	shade

Other Trees Recommended for Planting

Quercus acutissima Sawtooth oak	N	35’ – 45’	sun or semi-sun
Carya illinoensis Pecan	N	60’ – 70’	sun or semi-sun

Appendix E – Tree Maintenance Schedule

Year	Practice	Description
2009	Hazard rating	Survey all inventoried trees (488) and rate each tree according to hazard potential.
2009	Prune to clean	Remove all deadwood and broken branches from all live oak trees in the municipal service area.
2009	Hazard mitigation	Prune, brace or cable trees with a rating of “9” or more in order to reduce rating below “9”.
2009	Tree removal	Remove those trees in which hazard rating cannot be reduced below “9”, but with a maximum removal of no more than 25 trees per year.
2009	Tree replacement	Plant new trees in those places where trees were removed.
2010	Tree enhancement	Take corrective action (bracing, cabling, pruning) on trees with hazard ratings between “5”and “8”.
2010	Tree removal	Remove remaining trees with hazard rating greater than “9”, but with a maximum removal of no more than 25 trees per year.
2010	Tree replacement	Plant new trees in those places where trees were removed.
2011	Promote tree health	Aerate those sites in municipal service area where soil is compacted.
2011	Promote tree health	Apply fertilizer and mychorizae to selected trees in the municipal service area.
2011	Promote tree health	Construct low barriers on 40 selected sites in municipal service area and apply mulch.
2011	Tree removal	Remove remaining trees with hazard rating greater than “9”, but with a maximum removal of no more than 25 trees per year.
2011	Tree replacement	Plant new trees in those places where trees were removed.
2012	Promote tree health	Construct low barriers on 40 additional selected sites in municipal service area and apply mulch.
2012	Tree removal	Remove remaining trees with hazard rating greater than “9”, but with a maximum removal of no more than 25 trees per year.
2012	Tree replacement	Plant new trees in those places where trees were removed.
2013	Hazard rating	Survey subject trees again. Evaluate progress towards hazard reduction, species and age diversification, and an improvement in overall tree health.

Appendix F: How to Prune a Tree

NA-FR-01-95

USDA Forest Service

Northeastern Area State and Private Forestry

HOW to Prune Trees

Peter J. Bedker, Joseph G. O'Brien, and Manfred M. Mielke
Illustrations by Julie Martinez, Afton, MN

Introduction

The objective of pruning is to produce strong, healthy, attractive plants. By understanding how, when and why to prune, and by following a few simple principles, this objective can be achieved.

Why Prune

The main reasons for pruning ornamental and shade trees include safety, health, and aesthetics. In addition, pruning can be used to stimulate fruit production and increase the value of timber. Pruning for *safety* (Fig. 1A) involves removing branches that could fall and cause injury or property damage, trimming branches that interfere with lines of sight on streets or driveways, and removing branches that grow into utility lines. Safety pruning can be largely avoided by carefully choosing species that will not grow beyond the space available to them, and have strength and form characteristics that are suited to the site.

Pruning for *health* (Fig. 1B) involves removing diseased or insect-infested wood, thinning the crown to increase airflow and reduce some pest problems, and removing

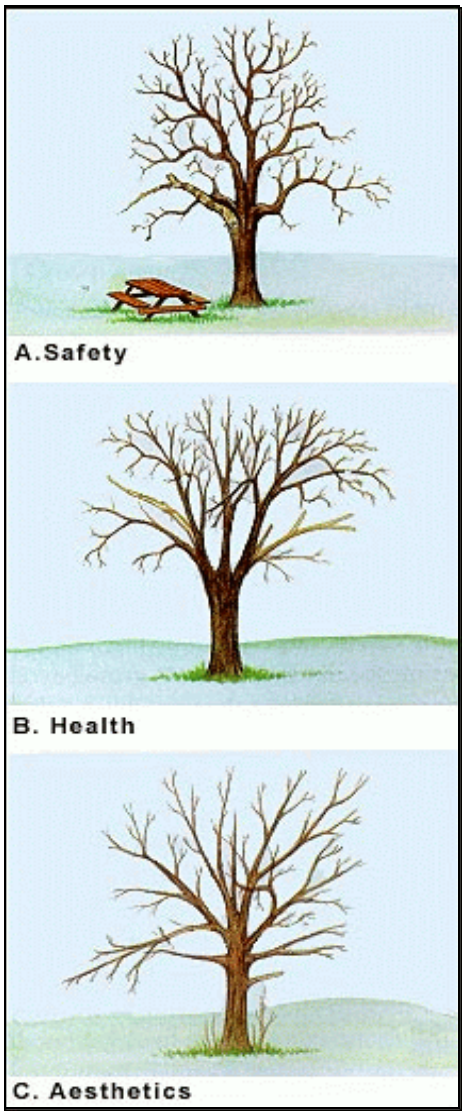


Figure 1. Reasons for pruning.

crossing and rubbing branches. Pruning can best be used to encourage trees to develop a strong structure and reduce the likelihood of damage during severe weather. Removing broken or damaged limbs encourage wound closure.

Pruning for *aesthetics* (Fig. 1C) involves enhancing the natural form and character of trees or stimulating flower production. Pruning for form can be especially important on open-grown trees that do very little self-pruning.

All woody plants shed branches in response to shading and competition. Branches that do not produce enough carbohydrates from photosynthesis to sustain themselves die and are eventually shed; the resulting wounds are sealed by **woundwood** (callus). Branches that are poorly attached may be broken off by wind and accumulation of snow and ice. Branches removed by such natural forces often result in large, ragged wounds that rarely seal. Pruning as a cultural practice can be used to supplement or replace these natural processes and increase the strength and longevity of plants.

Trees have many forms, but the most common types are pyramidal **(excurrent)** or spherical (**decurrent)**. Trees with pyramidal crowns, e.g., most conifers, have a strong central stem and lateral branches that are more or less horizontal and do not compete with the central stem for dominance. Trees with spherical crowns, e.g., most hardwoods, have many lateral branches that may compete for dominance.

To reduce the need for pruning it is best to consider a tree's natural form. It is very difficult to impose an unnatural form on a tree without a commitment to constant maintenance.

Pollarding and **topiary** are extreme examples of pruning to create a desired, unnatural effect. Pollarding is the practice of pruning trees annually to remove all new growth. The following year, a profusion of new branches is produced at the ends of the branches. Topiary involves pruning trees and shrubs into geometric or animal shapes. Both pollarding and topiary are specialized applications that involve pruning to change the natural form of trees. As topiary demonstrates, given enough care and attention plants can be pruned into nearly any form. Yet just as proper pruning can enhance the form or character of plants, improper pruning can destroy it.

Pruning Approaches

Producing strong structure should be the emphasis when pruning young trees. As trees mature, the aim of pruning will shift to maintaining tree structure, form, health and appearance.

Proper pruning cuts are made at a node, the point at which one branch or twig attaches to another. In the spring of the year growth begins at buds, and twigs grow until a new node is formed. The length of a branch between nodes is called an internode.

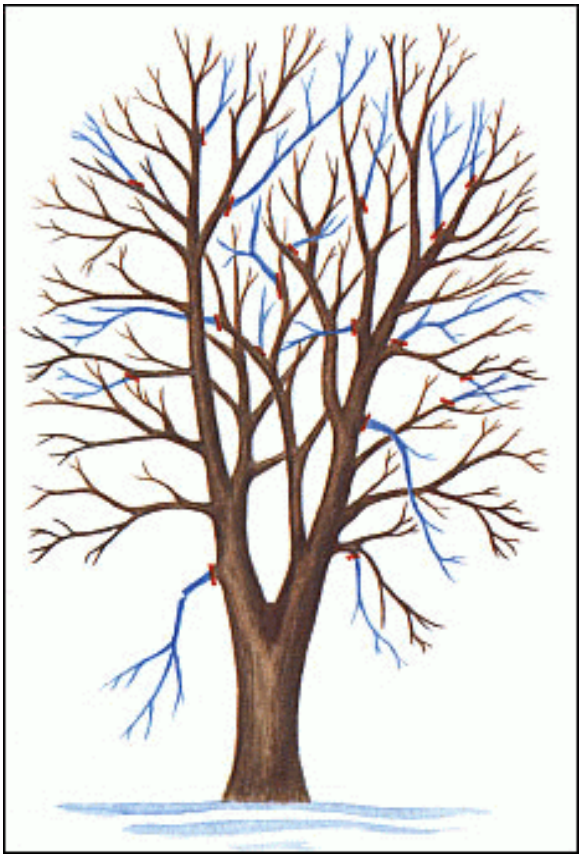


Figure 2. Crown thinning - branches to be removed are shaded in blue; pruning cuts should be made at the red lines. No more than one-fourth of the living branches should be removed at one time.

The most common types of pruning are:

1. *Crown Thinning* (Fig. 2)

Crown thinning, primarily for hardwoods, is the selective removal of branches to increase light penetration and air movement throughout the crown of a tree. The intent is to maintain or develop a tree's structure and form. To avoid unnecessary stress and prevent excessive production of epicormic sprouts, no more than one-quarter of the living crown should be removed at a time. If it is necessary to remove more, it should be done over successive years.

Figure 3. Types of branch unions.

Branches with strong U-shaped angles of attachment should be retained (Fig 3A). Branches with narrow, V-shaped angles of attachment often form **included bark** and should be removed (Fig. 3B). Included bark forms when two branches grow at sharply acute angles to one another, producing a wedge of inward-rolled bark between them. Included bark prevents strong attachment of branches, often causing a crack at the point below where the branches meet. Codominant stems that are approximately the same size and arise from the same position often form included bark. Removing some of the lateral branches from a codominant stem can reduce its growth enough to allow the other stem to become dominant.

Lateral branches should be no more than one-half to three-quarters of the diameter of the stem at the point of attachment. Avoid producing "lion's tails," tufts of branches and foliage at the ends of branches, caused by removing all inner lateral branches and foliage. Lion's tails can result in sunscalding, abundant **epicormic sprouts**, and weak branch structure and breakage. Branches that rub or cross

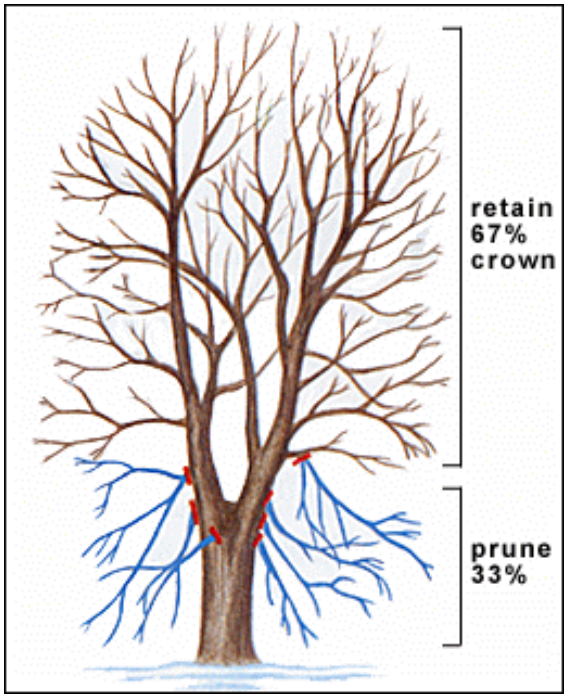


Figure 4. Crown raising - branches to be removed are shaded in blue; pruning cuts should be made where indicated with red lines. The ratio of live crown to total tree height should be at least two-thirds.

another branch should be removed.

Conifers that have branches in whorls and pyramidal crowns rarely need crown thinning except to restore a dominant leader. Occasionally, the leader of a tree may be damaged and multiple branches may become codominant. Select the strongest leader and remove competing branches to prevent the development of codominant stems.

2. *Crown Raising* (Fig. 4)

Crown raising is the practice of removing branches from the bottom of the crown of a tree to provide clearance for pedestrians, vehicles, buildings, lines of site, or to develop a clear stem for timber production. Also, removing lower branches on white pines can prevent blister rust. For street trees the minimum clearance is often specified by municipal ordinance. After pruning, the ratio of the living crown to total tree height should be at least two-thirds (e.g., a 12 m tree should have living branches on at least the upper 8 m).

On young trees "temporary" branches may be retained along the stem to encourage taper and protect trees from vandalism and sun scald. Less vigorous shoots should be selected as temporary branches and should be about 10 to 15 cm apart along the stem. They should be pruned annually to slow their growth and should be removed eventually.

3. *Crown Reduction* (Fig. 5)

Crown reduction pruning is most often used when a tree has grown too large for its permitted space. This method, sometimes called **drop crotch pruning**, is preferred to topping because it results in a more natural appearance, increases the time before pruning is needed again, and minimizes stress (see drop crotch cuts in the next section).

Crown reduction pruning, a method of last resort, often results in large pruning wounds to stems that may lead to decay. This method should never be used on a tree with a pyramidal growth form. A better long term solution is to remove the tree and replace it

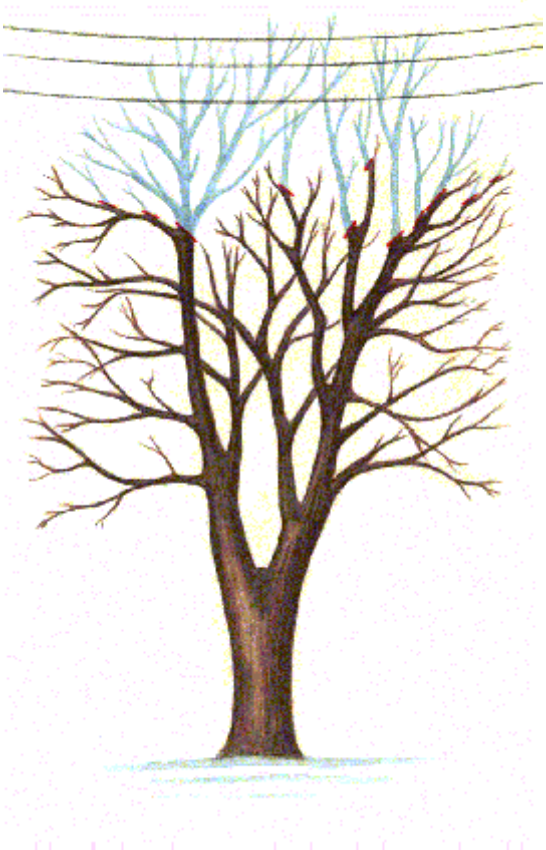


Figure 5. Crown reduction - branches to be removed are shaded in blue; pruning cuts should be made where indicated with red lines. To prevent branch dieback, cuts should be made at lateral branches that are at least one-third the diameter of the stem at their union.

with a tree that will not grow beyond the available space.

Pruning Cuts

Pruning cuts should be made so that only branch tissue is removed and stem tissue is not damaged. At the point where the branch attaches to the stem, branch and stem tissues remain separate, but are contiguous. If only branch tissues are cut when pruning, the stem tissues of the tree will probably not become decayed, and the wound will seal more effectively.

1. *Pruning living branches* (Fig. 6)

To find the proper place to cut a branch, look for the **branch collar** that grows from the stem tissue at the underside of the base of the branch (Fig. 6A). On the upper surface, there is usually a **branch bark ridge** that runs (more or less) parallel to the branch angle, along the stem of the tree. A proper pruning cut does not damage either the branch bark ridge or the branch collar.

A proper cut begins just outside the branch bark ridge and angles down away from the stem of the tree, avoiding injury to the branch collar (Fig. 6B). Make the cut as close as possible to the stem in the **branch axil**, but outside the branch bark ridge, so that stem tissue is not injured and the wound can seal in the shortest time possible. If the cut is too far from the stem, leaving a branch stub, the branch tissue usually dies and woundwood forms from the stem tissue. Wound closure is delayed because the woundwood must seal over the stub that was left.

The quality of pruning cuts can be evaluated by examining pruning wounds after one growing season. A concentric ring of woundwood will form from proper pruning cuts (Fig. 6B). **Flush cuts** made inside the branch bark ridge or branch collar, result in pronounced development of woundwood on the sides of the pruning wounds with very little woundwood forming on the top or bottom (Fig. 7D). As described above, stub cuts result in the death of the remaining branch and woundwood forms around the base from stem tissues.
When pruning small branches with hand pruners, make sure the tools are sharp enough

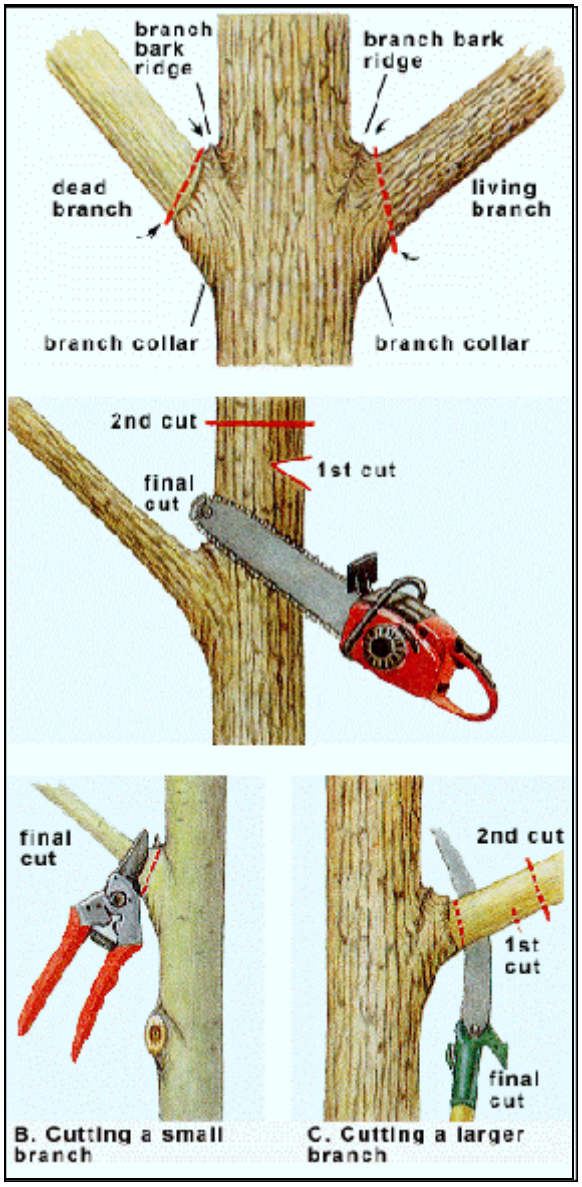


Figure 6. Pruning cuts

to cut the branches cleanly without tearing. Branches large enough to require saws should be supported with one hand while the cuts are made. If the branch is too large to support, make a three-step pruning cut to prevent bark ripping (Fig. 6C).

1. The first cut is a shallow notch made on the underside of the branch, outside the branch collar. This cut will prevent a falling branch from tearing the stem tissue as it pulls away from the tree.
2. The second cut should be outside the first cut, all the way through the branch, leaving a short stub.
3. The stub is then cut just outside the branch bark ridge/branch collar, completing the operation.

2. *Pruning dead branches* (Fig. 6)

Prune dead branches in much the same way as live branches. Making the correct cut is usually easy because the branch collar and the branch bark ridge, can be distinguished from the dead branch, because they continue to grow (Fig. 6A). Make the pruning cut just outside of the ring of woundwood tissue that has formed, being careful not to cause unnecessary injury (Fig. 6C). Large dead branches should be supported with one hand or cut with the three-step method, just as live branches. Cutting large living branches with the three step method is more critical because of the greater likelihood of bark ripping.

3. *Drop Crotch Cuts* (Fig. 6D)

A proper cut begins just above the branch bark ridge and extends through the stem parallel to the branch bark ridge. Usually, the stem being removed is too large to be supported with one hand, so the three cut method should be used.

1. With the first cut, make a notch on the side of the stem away from the branch to be retained, well above the branch crotch.

2. Begin the second cut inside the branch crotch, staying well above the branch bark ridge, and cut through the stem above the notch.
3. Cut the remaining stub just inside the branch bark ridge through the stem parallel to the branch bark ridge.

To prevent the abundant growth of epicormic sprouts on the stem below the cut, or dieback of the stem to a lower lateral branch, make the cut at a lateral branch that is at least one-third of the diameter of the stem at their union.

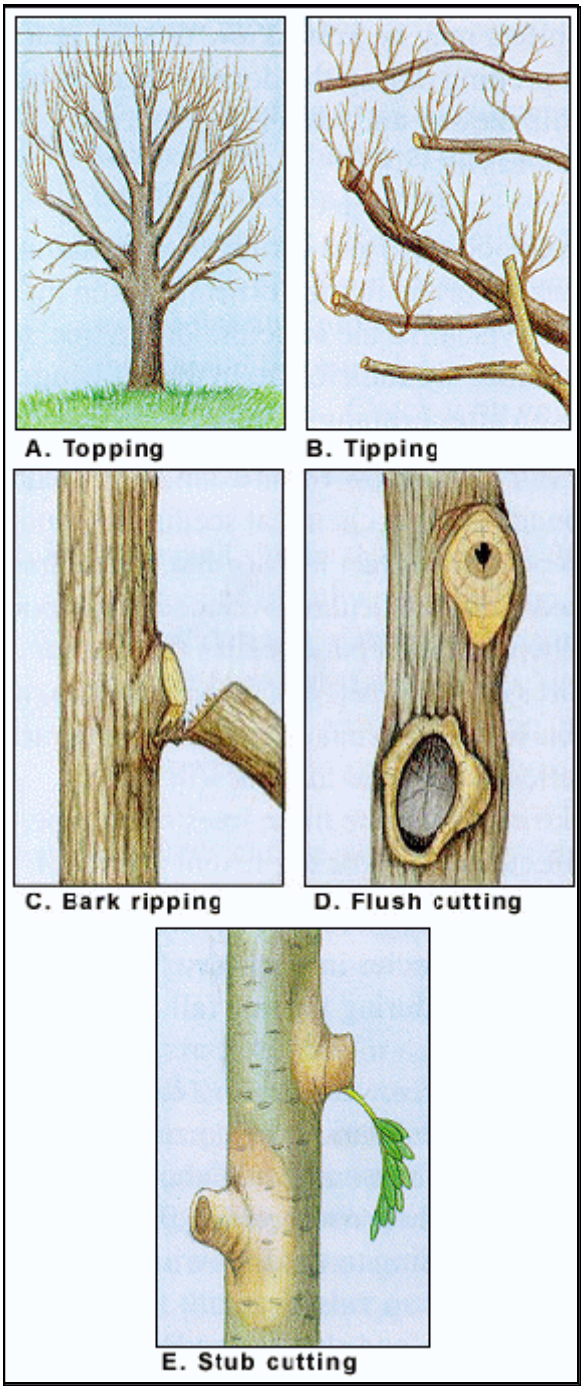
Pruning Practices That Harm Trees

Topping and **tipping** (Fig. 7A, 7B) are pruning practices that harm trees and should not be used. Crown reduction pruning is the preferred method to reduce the size or height of the crown of a tree, but is rarely needed and should be used infrequently.

Topping, the pruning of large upright branches between nodes, is sometimes done to reduce the height of a tree (Fig. 7A). Tipping is a practice of cutting lateral branches between nodes (Fig. 7B) to reduce crown width.

These practices invariably result in the development of epicormic sprouts**,** or in the death of the cut branch back to the next lateral branch below. These epicormic sprouts are weakly attached to the stem and eventually will be supported by a decaying branch.

Improper pruning cuts cause unnecessary injury and bark ripping (Fig. 7C). Flush cuts injure



stem tissues and can result in decay (Fig. 7D). **Stub cuts** delay wound closure and can provide entry to canker fungi that kill the cambium, delaying or preventing woundwood formation (Fig. 7E).

When to Prune

Conifers may be pruned any time of year, but pruning during the dormant season may minimize sap and resin flow from cut branches.

Hardwood trees and shrubs *without showy flowers*: prune in the dormant season to easily visualize the structure of the tree, to maximize wound closure in the growing season after pruning, to reduce the chance of transmitting disease, and to discourage excessive sap flow from wounds. Recent wounds and the chemical scents they emit can actually attract insects that spread tree disease. In particular, wounded elm wood is known to attract bark beetles that harbor spores of the Dutch elm disease fungus, and open wounds on oaks are known to attract beetles that spread the oak wilt fungus. Take care to prune these trees during the correct time of year to prevent spread of these fatal diseases. Contact your local tree disease specialist to find out when to prune these tree species in your area. Usually, the best time is during the late fall and winter.

Flowering trees and shrubs: these should also be pruned during the dormant season for the same reasons stated above; however, to preserve the current year's flower crop, prune according to the following schedule:

- Trees and shrubs that flower in early spring (redbud, dogwood, etc.) should be pruned immediately after flowering (flower buds arise the year before they flush, and will form on the new growth).
- Many flowering trees are susceptible to fireblight, a bacterial disease that can be spread by pruning. These trees, including many varieties of crabapple, hawthorn, pear, mountain ash, flowering quince and pyracantha, should be pruned during the dormant season. Check with your county extension agent or a horticulturist for additional information.
- Trees and shrubs that flower in the summer or fall always should be pruned during the dormant season (flower buds will form on new twigs during the next growing season, and the flowers will flush normally).

Dead branches: can be removed any time of the year.

Pruning Tools

Proper tools are essential for satisfactory pruning (Fig.6). The choice of which tool to use depends largely on the size of branches to be pruned and the amount of pruning to be done. If possible, test a tool before you buy it to ensure it suits your specific needs. As with most things, higher quality often equates to higher cost.

Generally speaking, the smaller a branch is when pruned, the sooner the wound created will seal. Hand pruners are used to prune small branches (under 2.5 cm diameter) and many different kinds are available. Hand pruners can be grouped into by-pass or anvil styles based on the blade configuration. Anvil style pruners have a straight blade that cuts the branch against a small anvil or block as the handles are squeezed. By-pass pruners use a curved cutting blade that slides past a broader lower blade, much like a scissors. To prevent unnecessary tearing or crushing of tissues, it is best to use a

by-pass style pruner. Left- or right-handed types can be purchased.

Slightly larger branches that cannot be cut with a hand pruner may be cut with small pruning saws (up to 10 cm) or lopping shears (up to 7 cm diameter) with larger cutting surfaces and greater leverage. Lopping shears are also available in by-pass and anvil styles.

For branches too large to be cut with a hand pruner or lopping shears, pruning saws must be used. Pruning saws differ greatly in handle styles, the length and shape of the blade, and the layout and type of teeth. Most have tempered metal blades that retain their sharpness for many pruning cuts. Unlike most other saws, pruning saws are often designed to cut on the "pull-stroke."

Chain saws are preferred when pruning branches larger than about 10 cm. Chainsaws should be used only by qualified individuals. To avoid the need to cut branches greater than 10 cm diameter, prune when branches are small.

Pole pruners must be used to cut branches beyond reach. Generally, pruning heads can cut branches up to 4.4 cm diameter and are available in the by-pass and anvil styles. Once again, the by-pass type is preferred. For cutting larger branches, saw blades can be fastened directly to the pruning head, or a separate saw head can be purchased. Because of the danger of electrocution, pole pruners should not be used near utility lines except by qualified utility line clearance personnel.

To ensure that satisfactory cuts are made and to reduce fatigue, keep your pruning tools sharp and in good working condition. Hand pruners, lopping shears, and pole pruners should be periodically sharpened with a sharpening stone. Replacement blades are available for many styles. Pruning saws should be professionally sharpened or periodically replaced. To reduce cost, many styles have replaceable blades.

Tools should be clean and sanitized as well as sharp. Although sanitizing tools may be inconvenient and seldom practiced, doing so may prevent the spread of disease from infected to healthy trees on contaminated tools. Tools become contaminated when they come into contact with fungi, bacteria, viruses and other microorganisms that cause disease in trees. Most pathogens need some way of entering the tree to cause disease, and fresh wounds are perfect places for infections to begin. Microorganisms on tool surfaces are easily introduced into susceptible trees when subsequent cuts are made. The need for sanitizing tools can be greatly reduced by pruning during the dormant season.

If sanitizing is necessary it should be practiced as follows: Before each branch is cut, sanitize pruning tools with either 70% denatured alcohol, or with liquid household bleach diluted 1 to 9 with water (1 part bleach, 9 parts water). Tools should be immersed in the solution, preferably for 1-2 minutes, and wood particles should be wiped from all cutting surfaces. Bleach is corrosive to metal surfaces, so tools should be thoroughly cleaned with soap and water after each use.

Treating wounds

Tree sap, gums, and resins are the natural means by which trees combat invasion by pathogens. Although unsightly, sap flow from pruning wounds is not generally harmful; however, excessive "bleeding" can weaken trees.

When oaks or elms are wounded during a critical time of year (usually spring for oaks, or throughout the growing season for elms) -- either from storms, other unforeseen mechanical wounds, or from necessary branch removals -- some type of wound dressing should be applied to the wound. Do this immediately after the wound is created. In most other instances, wound dressings are unnecessary, and may even be detrimental. Wound dressings will not stop decay or cure infectious diseases. They may actually interfere with the protective benefits of tree gums and resins, and prevent wound surfaces from closing as quickly as they might under natural conditions. The only benefit of wound dressings is to prevent introduction of pathogens in the specific cases of Dutch elm disease and oak wilt.

Pruning Guidelines

To encourage the development of a strong, healthy tree, consider the following guidelines when pruning.

General

- Prune first for safety, next for health, and finally for aesthetics.
- Never prune trees that are touching or near utility lines; instead consult your local utility company.
- Avoid pruning trees when you might increase susceptibility to important pests (e.g. in areas where oak wilt exists, avoid pruning oaks in the spring and early summer; prune trees susceptible to fireblight only during the dormant season).
- Use the following decision guide for size of branches to be removed: 1) under 5 cm diameter - go ahead, 2) between 5 and 10 cm diameter - think twice, and 3) greater than 10 cm diameter - have a good reason.

Crown Thinning

- Assess how a tree will be pruned from the top down.
- Favor branches with strong, U-shaped angles of attachment. Remove branches with weak, V-shaped angles of attachment and/or included bark.
- Ideally, lateral branches should be evenly spaced on the main stem of young trees.
- Remove any branches that rub or cross another branch.
- Make sure that lateral branches are no more than one-half to three-quarters of the diameter of the stem to discourage the development of co-dominant stems.

- Do not remove more than one-quarter of the living crown of a tree at one time. If it is necessary to remove more, do it over successive years.

Crown Raising

- Always maintain live branches on at least two-thirds of a tree's total height. Removing too many lower branches will hinder the development of a strong stem.
- Remove basal sprouts and vigorous epicormic sprouts.

Crown Reduction

- Use crown reduction pruning only when absolutely necessary. Make the pruning cut at a lateral branch that is at least one-third the diameter of the stem to be removed.
- If it is necessary to remove more than half of the foliage from a branch, remove the entire branch.

Glossary

Branch Axil: the angle formed where a branch joins another branch or stem of a woody plant.

Branch Bark Ridge: a ridge of bark that forms in a branch crotch and partially around the stem resulting from the growth of the stem and branch tissues against one another.

Branch Collar: a "shoulder" or bulge formed at the base of a branch by the annual production of overlapping layers of branch and stem tissues.

Crown Raising: a method of pruning to provide clearance for pedestrians, vehicles, buildings, lines of sight, and vistas by removing lower branches.

Crown Reduction Pruning: a method of pruning used to reduce the height of a tree. Branches are cut back to laterals that are at least one-third the diameter of the limb being removed.

Crown Thinning: a method of pruning to increase light penetration and air movement through the crown of a tree by selective removal of branches.

Callus: see woundwood.

Decurrent: a major tree form resulting from weak apical control. Trees with this form have several to many lateral branches that compete with the central stem for dominance resulting in a spherical or globose crown. Most hardwood trees have decurrent forms.

Epicormic Sprout: a shoot that arises from latent or adventitious buds; also know as water sprouts that occur for on stems and branches and suckers that are produced from the base of trees. In older wood, epicormic shoots often result from severe defoliation or radical pruning.

Excurrent: a major tree form resulting from strong apical control. Trees with this form have a strong central stem and pyramidal shape. Lateral branches rarely compete for dominance. Most conifers and a few hardwoods, such as sweetgum and tuliptree, have excurrent forms.

Flush Cuts: pruning cuts that originate inside the branch bark ridge or the branch collar, causing unnecessary injury to stem tissues.

Included Bark: bark enclosed between

branches with narrow angles of attachment, forming a wedge between the branches.

Pollarding: the annual removal of all of the previous year's growth, resulting in a flush of slender shoots and branches each spring.
Stub Cuts: pruning cuts made too far outside the branch bark ridge or branch collar, that leave branch tissue attached to the stem.

Tipping: a poor maintenance practice used to control the size of tree crowns; involves the cutting of branches at right angles leaving long stubs.

Topping: a poor maintenance practice often used to control the size of trees; involves the indiscriminate cutting of branches and stems at right angles leaving long stubs. Synonyms include rounding-over, heading-back, dehorning, capping and hat-racking. Topping is often improperly referred to as pollarding.

Topiary: the pruning and training of a plant into a desired geometric or animal shape.

Woundwood: lignified, differentiated tissues produced on woody plants as a response to wounding (also known as callus tissue).

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"How to Prune Trees" was written to help people properly prune the trees they care about. If you doubt your ability to safely prune large trees, please hire a professional arborist. Information in this publication can be used to interview and hire a competent arborist.