

**LANDSCAPE TREE INVENTORY AND MANAGEMENT PLAN FOR THE  
UNITED COMPANY CORPORATE CAMPUS, BRISTOL, VIRGINIA**

by

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## ABSTRACT

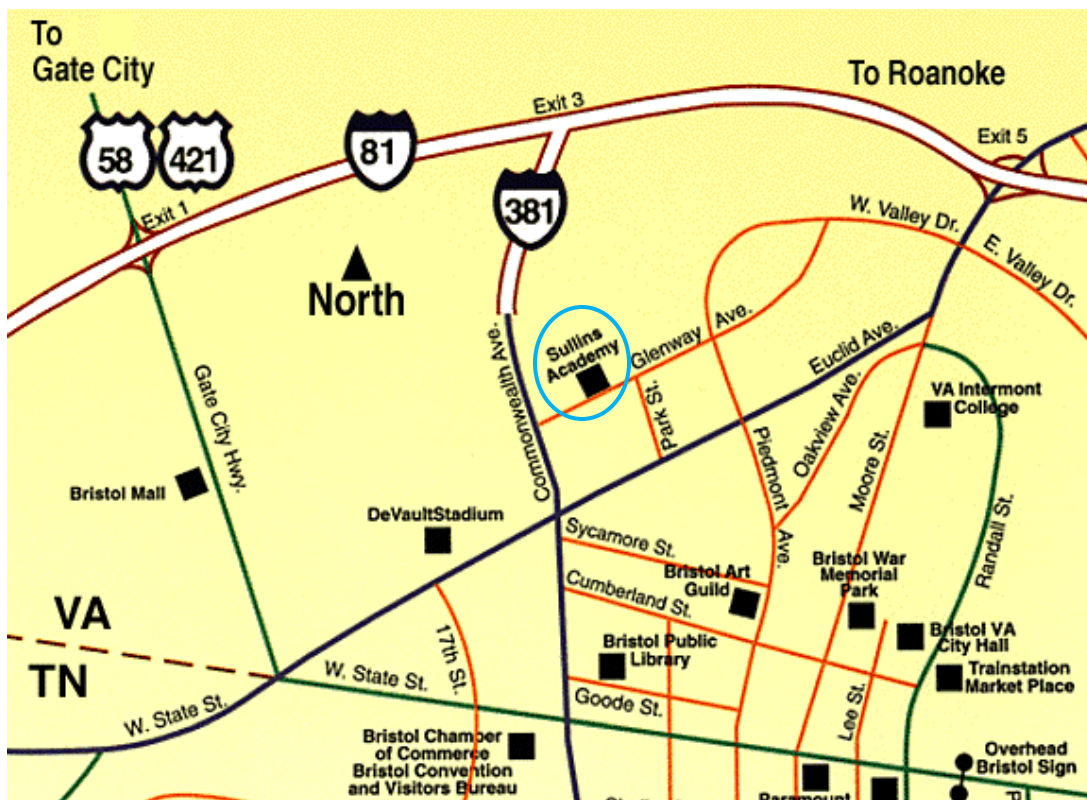
The United Company's corporate headquarters resides on 65 acres in a residential area just east of downtown Bristol, Virginia. The main office complex on the south side of campus is accented by a mixed landscape of trees, shrubs, and lawns. In 2008, foresters with Virginia Cooperative Extension and Virginia Tech were contracted to develop a landscape tree management plan for the corporate campus. A complete tree inventory was conducted in summer 2008 to assess campus tree composition and maintenance needs. The inventory provided the basis for developing the management plan, which describes the priorities, goals, and objectives that should guide landscape tree management on the United Company corporate campus over the next decade and beyond. The inventory enumerated 630 landscape trees consisting of 67 different species. Flowering dogwood, yellow-poplar, and eastern white pine were the three most abundant species, each accounting for about 15% of the total population. The campus landscape is dominated by mature and geriatric trees. Despite the "graying" of the tree population, it is in fair to good condition overall. Structural defects that may threaten tree stability were commonly observed in the inventoried trees. Fortunately, most of these defects were mild to moderate and do not pose a significant threat to the landscape. However, critical defects were observed in several trees and should be attended to immediately. An assortment of disorders that may threaten tree health were also observed in campus trees. Prevalent disorders included trunk wounds, soil compaction, buried root collars, and inadequate mulching. These disorders can threaten tree health and should be addressed through a systematic tree maintenance program. In this paper, general recommendations for tree planting, maintenance, and removal are provided based on the primary goal of attaining a safe, attractive, and sustainable campus forest. In addition, specific management recommendations are provided for 11 critical-priority

trees, 8 notable trees, and 3 prevalent species groups. Finally, an appendix has been assembled at the end of this report to provide definitions on common tree care terms and guidance on common tree care practices.

## INTRODUCTION

### CAMPUS HISTORY

In October 1976, the United Company acquired the properties and assets of Sullins College in Bristol, Virginia. United's corporate offices have been headquartered there since September 1978 (Fig. 1). Sullins College was founded by the Methodist Episcopal Church in 1870, serving first as a grammar and high school for girls and later as a women's junior college.



**Figure 1:** The United Company corporate campus is located in Bristol, VA on the grounds of the former Sullins Academy, which is denoted at the center of the map.

The original college building located in downtown Bristol, Virginia burned in December 1915, and the Methodist Church declined to rebuild the institution.

In 1917, William E. Martin, past president of Sullins College, reestablished the college at its present day location on property donated by the city of Bristol. The college continued to

operate under the control of the Martin family until the 1960s, when it was transferred to an independent board of trustees. Sullins College was beset with declining enrollment during the early 1970s, and in July 1976, it was announced that Sullins College would close. Later that year, the United Company acquired the property.

### **PRESENT-DAY CAMPUS**

The United Company corporate campus resides on 65 acres in a residential area just east of downtown Bristol, Virginia. The campus includes five major office buildings and three additional buildings and structures. The main office complex on the south side of campus is accented by a mixed landscape of trees, shrubs, and lawns. There are numerous landscape trees located within the lawns, adjacent to the buildings, and in the woodland perimeter. A significant portion of the north campus is pasture. The northern and western perimeter of campus has been naturalized with mixed hardwoods over the last 30 years. On the south side of Glenwood Avenue, the United Company also owns a residence with several large landscape trees and numerous ornamental shrubs.

### **CAMPUS TREE MANAGEMENT**

The United Company corporate campus is populated by an assortment of landscape trees that is a mixture of naturally occurring and planted specimens. These trees are an important asset to the campus. They add aesthetic character, cast shade, prevent soil erosion, protect water quality, and provide wildlife habitat. Limited preventive maintenance has been performed on the campus trees through the years, and there are no clear long-term objectives for managing the resource. Thus, the health, structural integrity, and appearance of many of these trees may be at risk. Poor condition trees are unsightly, hazardous, short-lived, and costly to repair.

Programmed maintenance of landscape trees promotes their health, safety, and appearance in a cost-effective manner. A comprehensive management plan provides guidance for executing programmed maintenance, describing management priorities, goals, and tasks that are necessary to provide a sustainable, high-quality urban forest.

## **SCOPE AND PURPOSE OF THE MANAGEMENT PLAN**

The scope of this management plan is the naturally occurring and planted landscape trees residing in improved areas around the main office complex, around campus residences, and along the woodland perimeter adjacent to these buildings. The purpose of this management plan is to describe the priorities, goals, and objectives that should guide landscape tree management on the United Company corporate campus over the next decade and beyond. It is not practical to describe the management needs of every campus tree in this document. Instead, the focus of this document is on describing the overall status of the campus tree population, providing general management recommendations for the tree population, and providing specific recommendations for select trees. The intended use of this document is to aid United Company staff in prioritizing and executing tree care practices and/or contracting such practices with a commercial arborist. A glossary of the arboricultural terms used in this document is provided in Appendix A. A list of useful tree management websites is provided in Appendix B.

The specific objectives of this landscape tree consultation project were:

1. Perform an inventory of campus landscape trees to assess their location, abundance, composition, and condition
2. Establish management goals for the campus trees

3. Identify tree planting, maintenance, and removal needs based on inventory results and management goals
4. Prescribe prioritized management tasks to address tree planting, maintenance, and removal needs

### **TREE INVENTORY & ASSESSMENT METHODS**

In August 2008, a complete inventory was conducted of naturally occurring and planted landscape trees residing in improved areas around the main office complex, around campus residences, and along the woodland perimeter adjacent to these buildings on the United Company corporate campus. The inventory was performed by an urban forestry student from Virginia Tech under the supervision of Bill Worrell. Two types of landscape trees were included in the inventory and assessment:

1. *Trees residing within maintained lawn areas* – any woody plant greater than 8 ft tall or possessing a single stem within 1 ft of ground line
2. *Trees residing within the woodland perimeter* – any tree greater than 8 in trunk diameter at breast height (DBH; 4.5 ft above ground line) that was within 40 ft of a campus building, street, sidewalk, or other improvement

Inventory data were collected in the field using a handheld computer running ArcPad 7 (ESRI Inc., Redlands, CA) field mapping software with a customized data collection form. A digital photograph was taken of each tree and its location was digitized onto a georeferenced map of the campus. Tree height was visually estimated and trunk DBH was measured with a



logger's tape. Eleven tree attributes were assessed for each tree to describe its identity, size, condition, and management needs. Each tree was assigned a management priority from low to critical depending on its perceived value, severity of its defects/disorders, and potential consequences of foregoing its maintenance. Up to three maintenance tasks were prescribed for each tree. A complete list of tree attributes assessed in this inventory, along with their definitions and value ranges, is provided in Appendix C. The entire inventory dataset is available in the Excel spreadsheet that accompanies this report.

Upon completion of the field inventory, data were checked for errors and omissions and then entered into a geographic information system (GIS) for use in analysis, mapping, and management planning. An overview map of the campus trees, created using the GIS, is provided in Appendix D.

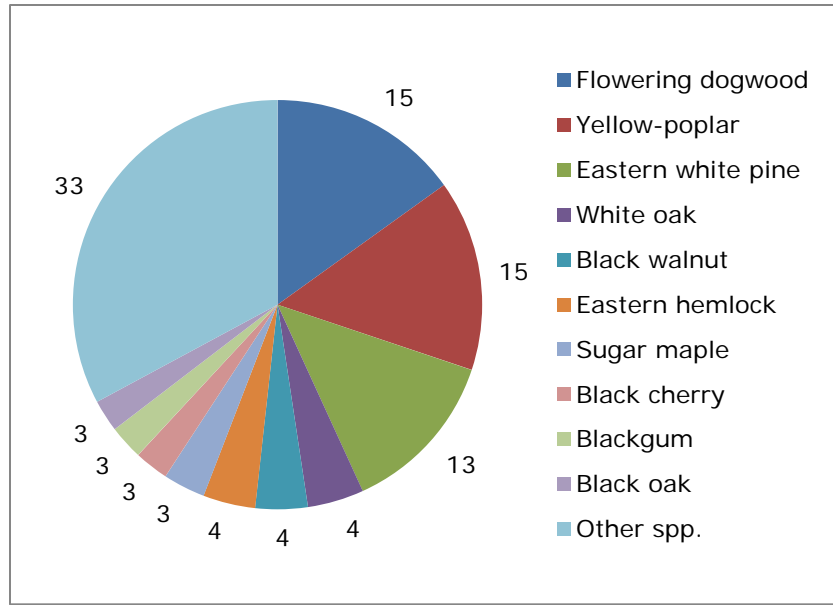
## **TREE INVENTORY & ASSESSMENT FINDINGS**

### **TREE POPULATION DESCRIPTION**

The inventory enumerated 630 trees consisting of 67 different species on the United Company campus. Flowering dogwood, yellow-poplar, and eastern white pine account for 43% of the total tree population alone (Fig. 2). Rounding out the top ten most common species includes white oak, black walnut, Eastern hemlock, sugar maple, black cherry, blackgum, and black oak.

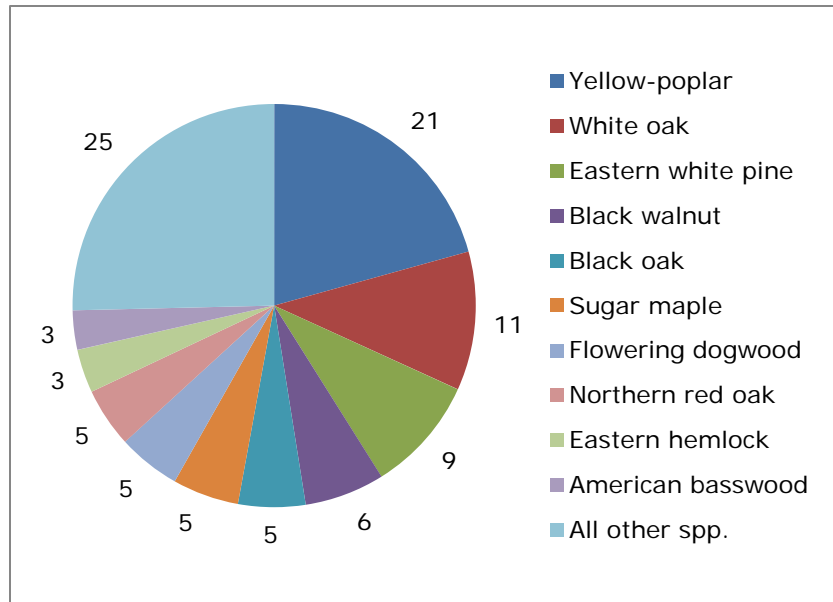
In terms of landscape tree canopy cover, yellow-poplar is the most dominant species on campus, accounting for 21% of the canopy, followed by white oak (11%), and eastern white pine (9%) (Fig. 3). Most of the inventoried white pines are located in a single, dense stand north of

the main office building; thus, they are not as conspicuous on campus as the data indicate. Although flowering dogwood is one of the most abundant trees on campus, these small-stature trees only account for 5% of the landscape tree canopy cover.



**Figure 2:** Tree species relative abundance on the United Company campus (percent of total tree population).

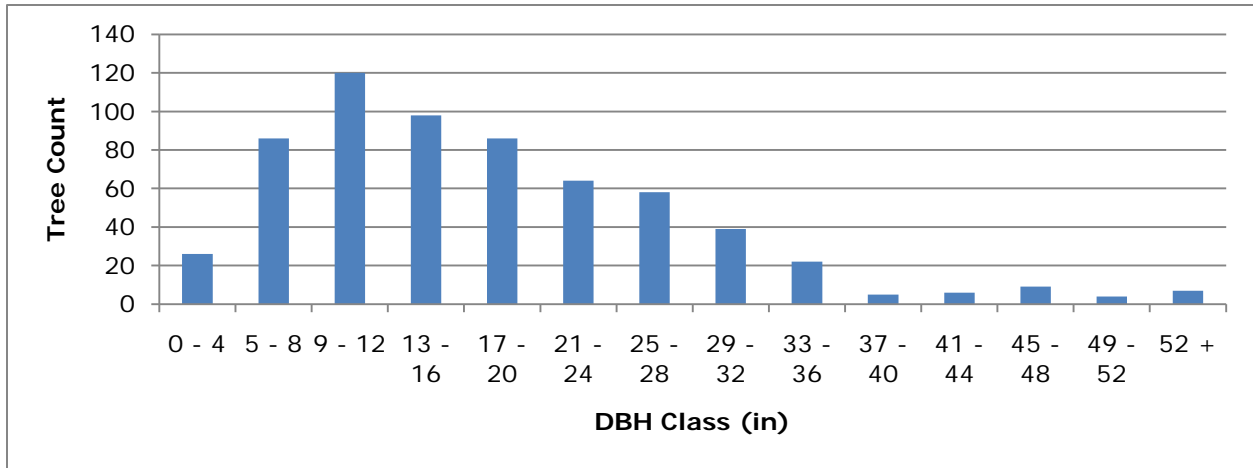
Trunk DBH of inventoried trees ranged between 1 and 56 inches (Fig. 4). About half of the landscape trees on campus are  $\leq 16$  in trunk DBH. Most of the small trees on campus are flowering dogwood whereas



**Figure 3:** Tree species dominance on the United Company campus (percent of total tree canopy cover).

most of the large trees are yellow-poplar, white oak, and eastern white pine. There are three white oaks measuring over 50 in trunk DBH on campus.

Although 70% of the campus trees are mature or geriatric (Fig. 5), the tree population is in fair to good condition overall (defined in Appendix C). Not surprisingly, tree condition shows



**Figure 4:** Trunk DBH distribution of landscape trees on the United Company campus.

evidence of decline in the older age classes; the majority of mature trees are in fair condition while most of the geriatric trees are in poor condition. Most of the 15 dead inventoried trees that were hazardous were removed during fall 2008; however, several high priority dead trees remain standing.

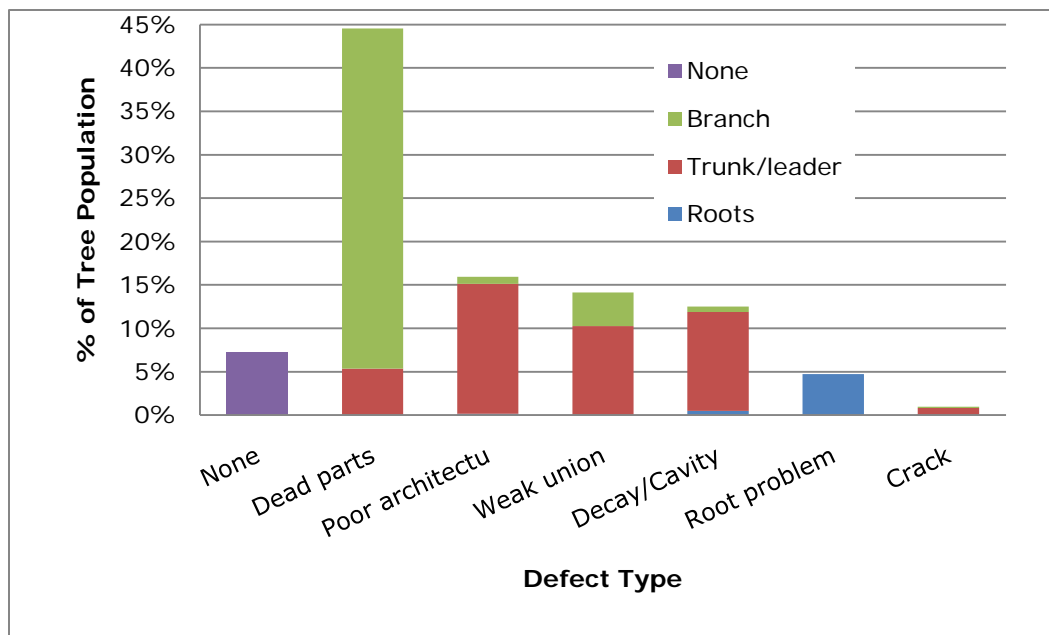
### **TREE DEFECTS, DISORDERS, AND MANAGEMENT NEEDS**

Structural defects were reported in 93% of the inventoried trees (Fig. 6). The most commonly observed defects were dead branches and poor architecture of the trunk/leader. Fortunately, most of these defects were mild to moderate. However, there were 16 critical priority and 154 high priority trees possessing defects (Fig. 7). Among critical priority trees, decayed trunk/leader and dead branches were the most common defects. Among high priority trees, dead branches and leaders with weak unions were the most common defects. These trees demand immediate management attention for tree health and personal safety considerations. Specific recommendations for critical priority trees are provided in the Management Recommendations section of this report.



**Figure 5:** Condition of campus trees by age class (overall campus tree condition is shown in inset).

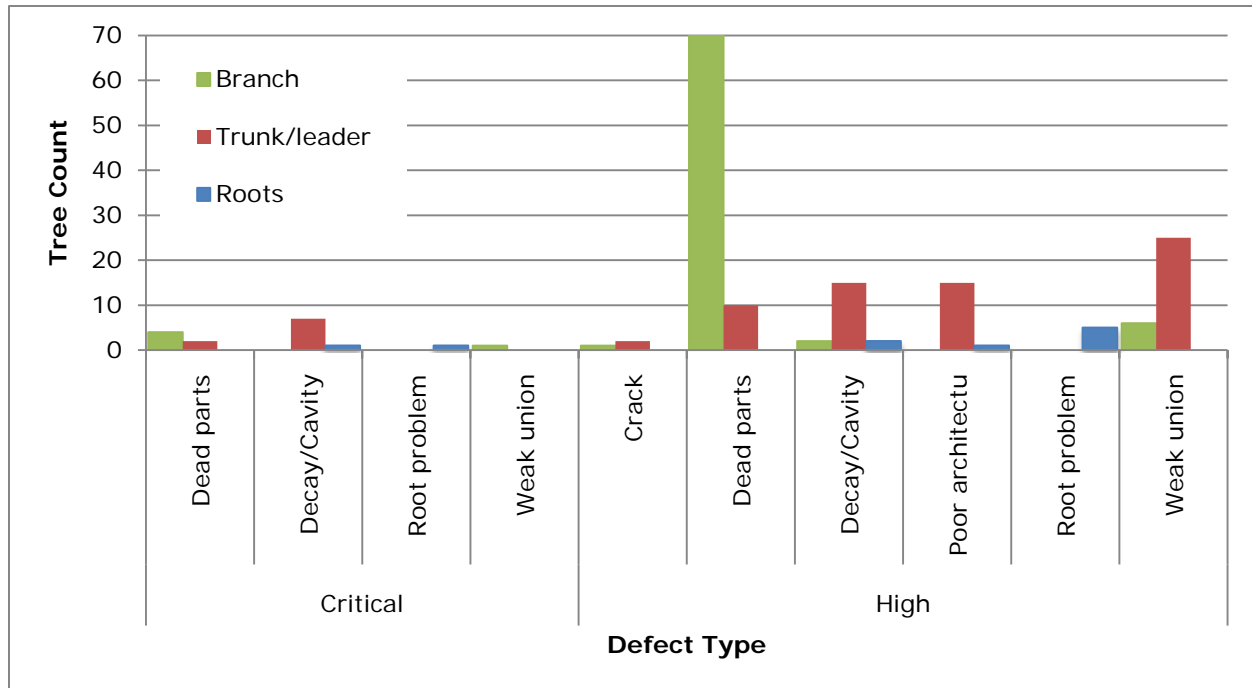
Disorders were observed in 78% of the inventoried trees (Figure 8). The most common priority-one disorder found in campus trees was wounding, which was observed in 32% of the trees.



**Figure 6:** Distribution of structural defects by tree part in the United Company campus tree population.

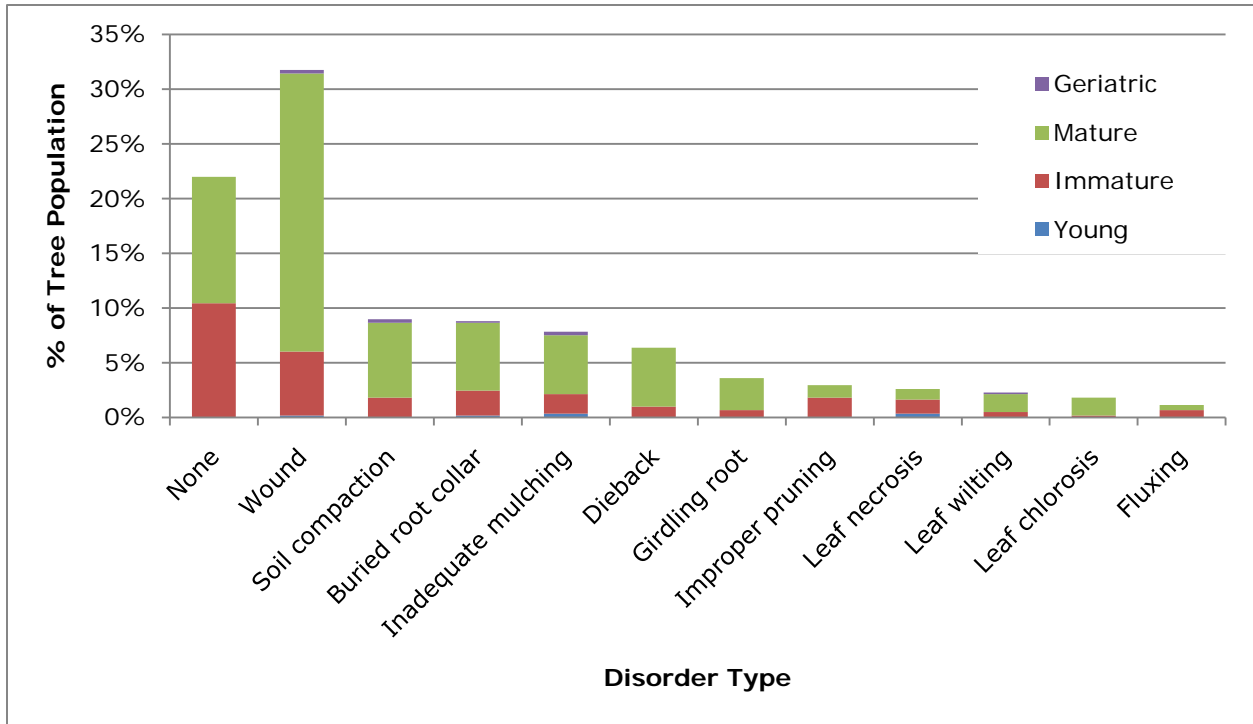
Wounds are most commonly caused by vehicles and landscape equipment, but may also be caused by pests, weather, neighboring trees, and improper pruning. Other common priority-one

disorders were soil compaction, buried root collar, and inadequate mulching. Mature trees most frequently had priority-one disorders, which was not surprising given their abundance in the overall tree population.

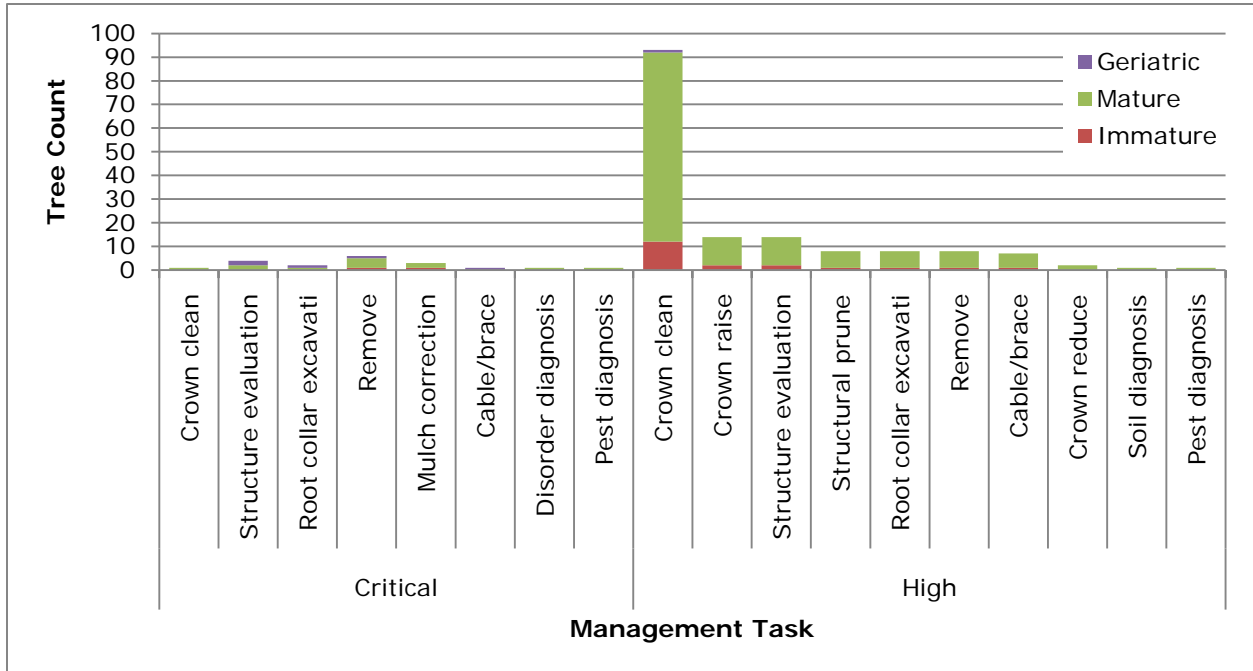


**Figure 7:** Distribution of structural defects by tree part among critical and high priority trees on the United Company campus.

Management tasks were prescribed for 19 critical priority trees and 156 high priority trees on the campus (Fig. 9). The majority of these trees were in the mature age class. Six critical priority and eight high priority tree removals were prescribed, most of which were addressed in fall 2008. Other tasks prescribed for critical priority trees were structure evaluation (for hazard assessment) and root collar excavation. Among high priority trees, the majority of prescribed tasks entailed some form of pruning, most frequently of which was crown cleaning. Structure evaluation was also recommended for 14 high priority trees. Management of the 19 critical priority trees is addressed in the Specific Recommendations section of this report. In that section, the 19 trees are subdivided into critical trees (11) and notable trees (8).



**Figure 8:** Tree disorder distribution by age class in the United Company campus tree population.



**Figure 9:** Management tasks by age class prescribed for critical and high priority landscape trees on the United Company campus.

## MANAGEMENT RECOMMENDATIONS

### GENERAL RECOMMENDATIONS

#### *Tree Planting*

##### Summary

The majority of the landscape trees on the United Company corporate campus are mature, large-stature trees. These trees are majestic and provide tremendous aesthetic and environmental value for the campus urban forest. However, inadequate stocking of young and immature trees threatens the forest's long-term sustainability. There are inadequate numbers of trees in the younger age classes to replace the aging veterans when they eventually succumb to old age. Now is the time to begin strategically planting new trees around campus to ensure that the tree population remains stable and that eventual removal of old trees minimally impacts the landscape's appearance and value. To conserve the urban forest, it is recommended that at least ten trees be planted annually in maintained campus landscapes over the next decade.

Tree species diversity is a key consideration for future planting efforts. At present, yellow-poplar dominates the overstory (particularly on the east end of campus), and flowering dogwood is very common in the understory. While both of these species are desirable, well-adapted natives, their high abundance poses a risk to the campus urban forest. Should a pest or disorder affect either of these species, the cost of mitigation and the impacts on forest appearance could be significant. As such, planting efforts in the near future should not include either of these species. Instead, alternative native species that are adaptable to the local environment should be selected for planting. Large-stature trees that are suitable alternatives to yellow-poplar include American beech, blackgum, sugar maple, hackberry, hickories, and oaks. Small-stature

trees that are suitable alternatives to flowering dogwood include redbud, serviceberry, witch hazel, fringe tree, and silverbell. It is imperative that both large-stature and small-stature species be planted in stages so that the existing multiple layers of tree canopy on the campus are sustained.

Given the current composition of the campus urban forest, it is recommended that future plantings incorporate species native to the region. Introduced species are not inherently bad (assuming they are not invasive). In fact, they can be instrumental in achieving landscape goals when site conditions preclude the use of native species. However, introduced species would not complement the mostly native tree population that currently exists on campus and should only be used where a suitable native species is not available.

To ensure that newly planted trees thrive, cause minimal conflicts with campus operations, and complement the existing assemblage of species, it is important to properly match species with planting site. Consideration should be given to the light, soil, and water requirements of new trees as well as their eventual crown size. Once suitable species are selected, it is important to obtain high-quality trees from a nursery or landscape contractor. Many disorders that develop in landscape trees over time are attributable to nursery stock issues. Key considerations are the branch architecture of the young tree and the quality of its root system. The website resources in Appendix B provide more insight on the topics of site evaluation, species selection, and nursery stock quality.

Finally, it is important to follow proper tree planting procedures. Improper planting techniques, such as failing to remove root ball packaging materials and planting the tree too deeply, can cause many long-term issues for tree health and stability. Inadequate care after



planting is also a common issue. Proper mulching and irrigation are critical to successful tree establishment. Guidelines for proper tree planting are provided in Appendix E.

#### Planting Focus Area #1

This planting area is located at the intersections of Piedmont Avenue and Glenway Avenue (Appendix D). This area is dominated by mature yellow-poplars and flowering dogwoods. Several of these trees are showing early symptoms of decline. Therefore, replacement trees should be strategically planted within the grove to eventually replace these aging trees as they are removed.

#### Planting Focus Area #2

This planting area is located on the lawn south of the old library building. A couple of trees have been removed recently in this vicinity and it is further recommended that nearby Norway maples be removed. In this space, it would be appropriate to plant a large maturing tree such as a northern red oak to match the immature specimen that resides on the opposite side of the lawn.

#### Planting Focus Area #3

This planting area is located on the main lawn in front of the museum building. There are two poor condition catalpa located in this area that will eventually require removal, leaving a large void in the lawn. As such, it is recommended that 1 to 3 large-maturing trees be planted here to eventually replace the catalpas.

#### Planting Focus Area #4

This planting area is located in the large lawn east of the museum building. Although it

might be desirable to retain this open space for aesthetic reasons, there is ample room to add 2 to 4 large maturing trees that could eventually shade the museum building and accentuate its architecture.

#### Planting Focus Area #5

This planting area is located north of the main campus drive on the west side of the museum building. Planting several large maturing trees on this slope could eventually reduce lawn mowing and shade the adjacent roadway. Drought tolerant species would be required to tolerate dry soil on the steep slope.

#### ***Tree Maintenance***

##### Pruning

Pruning is the most commonly prescribed maintenance task for high-priority trees on the United Company corporate campus. Pruning is recommended to reduce tree hazards, promote tree health, enhance tree appearance, and mitigate tree conflicts with site use. Crown cleaning – selective pruning to remove dead, dying, diseased, and broken branches – is a routine procedure for keeping mature trees healthy, safe, and attractive. In most cases, this is the only routine pruning task that is required for mature trees. In fact, live branch pruning on mature trees should be kept to a minimum to avoid unnecessary wounding and stress. It is recommended that crown cleaning be performed as prescribed, focusing first on the critical and notable trees on campus and then addressing lower priority trees as time and money allows.

Structural pruning – selective pruning to improve tree and branch architecture – is recommended for several high-value, immature trees on campus. Structural pruning strives to prevent defects such as co-dominant leaders and included bark from developing in trees as they

mature. When these defects occur in mature trees, it can be impractical and costly to repair them and can threaten tree health and public safety. Recommended structural pruning on high-value trees should be undertaken immediately because the opportunity for correcting defects in immature trees is often brief.

Individuals tasked with pruning campus trees should be knowledgeable of pruning methods and practices. In particular, arborists contracted to prune campus trees should abide by ANSI A300 standards for tree pruning. It is imperative to use proper branch removal cuts when pruning trees in order to reduce the risk of pest infestation and facilitate wound closure (see Appendix F for guidance on pruning). Some trees on campus showed signs of topping – an inappropriate technique for reducing branch length or tree size. Topping increases the incidence of decay in pruned branches and instigates development of prolific sprouts, which deform the tree and pose hazards when attached to decaying stems (French and Appleton, 2009; Kirwan and Kane, 2009). Campus trees should never be topped in the future. Another important consideration in future tree pruning is to ensure that excessive amounts of live branches are not removed during a pruning session – particularly on mature trees. When branches and foliage are removed, the tree’s food-producing capacity is reduced. If too much of the crown is removed, the tree can starve or become susceptible to secondary pests. Standard practices dictate that not more than 25% of branches bearing foliage should be removed within an annual growing season.

## Vegetation Management

English ivy and other types of vines were observed growing on some campus trees. Vines should not be allowed to grow prolifically on landscape trees because they can compete with the tree for water and nutrients and can obscure structural defects from detection. If the tree trunk and main branches are covered with vines, then it becomes very difficult to inspect the tree for defects such as cracks and decay, which can predispose the tree to failure. In some instances, vines climbing on trees can add aesthetic character to the landscape. In such cases, it is recommended that the vines be pruned periodically to prevent excessive growth.

Mowing and grass trimming should be performed carefully around landscape trees. Wounds from mowing equipment were frequently observed on lower trunks and surface roots of campus trees. Wounds predispose trees to decay and pest infestation. Individuals tasked with mowing around landscape trees should be advised to avoid injuring them. Mulching the critical root zone of injury-prone trees to keep mowers and string trimmers away from tree trunks and surface roots is another approach to minimizing wounding. In outlying areas of campus, it may be practical to forego mowing and raking and instead allow leaves and litter to accumulate to suppress weedy vegetation and minimize soil erosion. Occasional spot spraying with herbicide and/or trimming with a weed whacker can be performed to eliminate any undesirable vegetation that encroaches into these areas.

## Soil Management

Many landscape trees on campus are growing in undesirable soil conditions. Soil compaction and competition with turf grass are pervasive. The single best measure to improve soil conditions is to apply mulch to the critical root zone of each tree. Mulch helps improve

water infiltration and soil moisture conservation, which helps trees in times of drought.

Mulching also helps alleviate soil compaction and supplies organic matter and nutrients to the soil. An added benefit of eliminating turf with mulch is that mowing expenses can be reduced.

Although mulching is an important tree care practice, improper mulching techniques can contribute to a host of tree problems, including girdling roots, root decay, and pest infestation (Appleton and Kauffman, 2009). Installation of landscape fabric or plastic under mulch is not advised because these materials can disrupt water and nutrient transport, girdle trunks, and provide habitat for voles, which often chew on the trunks of young trees. Heaping mulch upon the base of the tree – known as the root collar – may also predispose the tree to girdling roots and pests (Appleton and Kauffman, 2009). A 3”–5” layer of organic material (shredded bark or wood chips) spread across the root zone and kept away from the root collar is advisable for most of the high-value campus trees. In some circumstances, it may be practical to incorporate several closely placed trees into a single mulch bed. A schematic of improper versus proper tree mulching is provided in Appendix G.

It is necessary to protect trees and soil from damage during facility repair, construction, and maintenance. To prevent soil compaction and root injury, heavy vehicles should not be driven across the root zones of landscape trees. Excavation near trees should be performed cautiously to prevent trunk/branch injury and avoid unnecessary root cutting. A certified arborist should always be consulted before commencing construction activities that may impact high-value campus trees.

Fill soil should never be placed over tree roots because this can lead to root death from suffocation, which can kill trees outright or predispose them to failure from root decay (Wells et

al., 2006; Smiley, 1999). Numerous trees on campus have had their root collars buried with fill soil during past construction projects. Root collar excavation has been recommended for several of these trees due to concerns about fill soil effects on tree health or stability. Root collar excavation should be performed by a qualified arborist, and the exposed trunk and structural roots should be evaluated for decay or other defects. For some trees, it is advisable to perform root collar excavation in conjunction with a soil decompaction treatment. A recommended arboricultural practice is to use an air excavation tool to extract fill soil from around the root collar and loosen compacted soil within the critical root zone. Consult with a certified arborist to learn more about suitable techniques for root collar excavation and soil decompaction.

Soil testing and prescription fertilization is recommended for several high-value campus trees. The types and amounts of fertilizers applied to trees should be based upon a soil test that determines pH and nutrient content. Subsurface injection is the preferred method for fertilizer application because it minimizes fertilizer runoff and places it below the roots of turf grass, which competes for the nutrients. High rates of nitrogen application are discouraged because doing so can predispose trees to infestation by certain pests.

### ***Tree Removal***

Landscape trees often need to be removed in order to fulfill management objectives. Common reasons for tree removal include defective structure, declining health, poor appearance, obstructed site use, and adverse effects on neighboring vegetation. Defective trees are the highest priority for removal due to the threat they pose to people and structures. Several high-priority tree removals have been noted in subsequent sections of this report as well as in the inventory database. A few secondary priority tree removals have also been recommended. For

example, it is advised that all Norway maples be removed from the property. It is a non-native, invasive species that prolifically spreads seedlings into the neighboring woodland. In addition, this species does not complement the landscape composition, which is dominated by species native to the region. Another priority is removal of low-value trees that compete with high-value trees.

In performing tree removals, it is necessary to employ a qualified contractor. Unskilled contractors often cause unnecessary harm to neighboring trees and vegetation when removing trees in precarious locations. Contractors should be expected to use suitable aerial rigging techniques to safely remove trees and prevent collateral damage.

## **SPECIFIC RECOMMENDATIONS**

### ***Critical Trees***

Trees in the following list were classified as critical management priority during the field inventory due to the size and location of the trees and the severity of the defects that they possess. Management recommendations for these trees range from structure evaluation to removal. These trees demand immediate attention to address the issues noted.

#### **Blackgum (ID# 47)**

This 12 in DBH, immature tree is located at the lower parking lot entrance from Wellmore Drive and is in poor condition. It has a dead central leader and should be removed; however, the dead part could be pruned out (a topping cut would occur) to save part of the tree for a few more years. This tree is along Wellmore drive but since it is only a private street with low traffic the risk is low.

Callery pear (ID# 87)

This 22 in DBH, mature tree is located in a courtyard east of the Suite Four building and is in poor condition. This tree shows evidence of past leader failure, branch failures, and it contains many weak branch attachments which makes it at risk of failure and potentially damaging the plaza near the building or the campus street. The first recommendation is tree removal because of the poor placement of the tree and the fact that it is a low value species. The second recommendation would be to install a cable and brace to reduce the risk of leader failure and to minimize the hazard and risk associated with failure. The tree would likely need four or more brace rods and at least one cable installation.

Blackgum (ID# 89)

This 32 in DBH, mature tree is located in the lawn east of the Museum Building and is in poor condition. It has a cavity from ground level to the height of two feet. The size of this cavity is 25% of the tree circumference and stress cracks are visible above the cavity. The main leader contains a cavity 30 feet above ground. Recommend a climbing inspection by a certified arborist to complete a structure evaluation of this tree. A root collar excavation should also be performed. The tree should be managed based on the results of the climbing tree inspection.

Yellow-poplar (ID# 132)

This 51 in DBH, geriatric tree is located near the west campus entrance from Glenway Drive and is in poor condition. The tree has a cavity from ground level to seven feet in height and is 10% of the circumference of the tree trunk. The tree has had a large leader failure 50 feet in height. Recommend crown restoration to remove the broken leader and broken branch. A climbing inspection should be conducted by a certified arborist to complete a structure



evaluation of this tree. Recommendation for management based upon results of the arborist inspection.

Elm spp. (ID# 175)

This 36 in DBH, mature tree is located near the United Central Accounting Building and parking lot and is in poor condition. Its canopy is very thin and has recently had a branch failure. Given the advanced state of decline and the potential hazard that dead branches may pose to buildings and vehicles, removal of this tree is recommended. However, an alternative recommendation for this tree would be to conduct a crown cleaning and sever the ivy from the tree.

Yellow-poplar (ID# 221)

This 41 in DBH, mature tree is located in a lawn area south of Wellmore Drive and is in poor condition. The trunk contains a cavity from ground level to 4 feet above ground that is less than 10% of the total circumference. The main central leader is broken off at 50 feet in height and continuous internal decay and rot is suspected from the top to the bottom of this tree. This tree should be removed, but it is in a low target area.

Sugar maple (ID# 274)

This 35 in DBH, geriatric tree is located next to the President's House south of Glenway Avenue. This tree is 75% dead and should be immediately removed due to the high traffic location and the extremely high risk of tree failure.

Yellow-poplar (ID# 293)

This 48 in DBH, geriatric tree is located immediately northeast of the Old Library

Building and is in poor condition. Signs of potentially serious defects were observed in this tree from the ground. To fully evaluate the defects and assess the risk that they pose, a climbing inspection should be performed by a certified arborist. The tree should then be managed based on recommendations from the structural evaluation.

Yellow-poplar (ID# 294)

This 32 in DBH, mature tree is located immediately northeast of the Old Library Building and is in poor condition. Signs of potentially serious defects were observed in this tree from the ground. To fully evaluate the defects and assess the risk that they pose, a climbing inspection should be performed by a certified arborist. The tree should then be managed based on recommendations from the structural evaluation.

Black locust (ID# 446)

This 15 in DBH, mature tree is located in the north lawn adjacent to the Bachelor Pad and is in poor condition. Removal is recommended because the main leader is dead, contains dead branches, and poses a hazard to its surroundings.

Black oak (ID# 559)

This 28 in DBH, mature tree is located in the wooded area that borders Glenway Drive on the west end of the campus and is in poor condition. The north leader of this tree is declining with dieback in the branches. The south leader leans toward Glenway Drive and has a weak attachment at ground level. The preferred management recommendation is to remove the tree. Alternatively, the tree could be cleaned to remove dead branches from the north leader, reduced to remove branch weight from the south leader, and cabled to reduce the risk of leader failure. However, this might not be a cost-effective option given the tree's minor value to the landscape

and the uncertainty of its long-term health.

### *Notable Trees*

Trees in the following list were identified as high-value (notable) trees based on their age, size, placement, beauty, or contribution to the landscape. Following potentially hazardous trees, notable trees are the highest priority for management on the campus. Because most of these trees are of advanced age, they are very sensitive to disturbance and environmental stress. Thus, it is important to take preventive measures to sustain their health, vitality, and integrity. Chief among these are preventing injury and maintaining soil quality.

#### Yellow-poplar (ID# 58)

This 42 in DBH, mature tree is located on the south lawn next to the Main Office entrance on the east end of Glenway Avenue and is in good condition. This magnificent tree is very valuable due to its stature and placement in the landscape and should be managed to maintain its health. Mulch the critical root zone of the tree and correct any nutrient deficiencies based on a soil test. In addition, a lighting protection system should be installed to reduce the risk of lightning injury (Smiley et al., 2002).

#### Northern red oak (ID# 77)

This 12 in DBH, immature tree is located on the lawn near the southwest corner of the old library building and is in good condition. This is a high-quality tree and will make a significant contribution to the landscape for decades to come. However, it was planted close to the neighboring black walnut (ID# 78) and their crowns are beginning to conflict with one another, which could deter the oak's development. Given that the walnut is nearing the end of its useful lifespan, it is recommended to reduce the crown of the black walnut to mitigate the crown

conflict and promote development of the oak.

#### White oak (ID# 83)

This 56 in DBH, geriatric tree is located between the Old Library and Suite Four buildings and is in fair condition. This is one of the largest trees on campus and it has a critical priority management need. Recommendations for maintaining this high-value tree include mulching the tree to maintain soil moisture, which will also protect the roots and tree trunk from damage caused by mowers and trimmers. Inspect and upgrade the existing lightning protection system to reduce the risk of lightning injury. A root collar inspection is recommended due to a large fungal conk being found on the base of the tree, which could indicate root or trunk decay. Manage the tree based upon the results of the root collar excavation.

#### Eastern hemlocks (ID# 105 & 108)

These ~28 in DBH, geriatric trees are located on the front lawn overlooking Glenway Avenue and the President's House. They are in a prominent location and are among the largest hemlocks on campus. There are signs of past hemlock woolly adelgid(HWA) infestation, which can kill hemlocks if left unmanaged. The trees should be periodically inspected and treated for this pest. The chemical control methods for HWA are dormant oil, imidacloprid, and thiamethoxam which should be applied by a trained professional according to the chemical label (Pest Management Guide, 2010). The best chemical control method is imidacloprid, which is a systemic that is taken up by the tree and provides protection for a longer period of time (Pest Management Guide, 2010). Soil management tasks for these trees should include soil decompaction, fertilization based on soil tests, and mulching of the critical root zone to improve soil moisture. In addition, a defective pine (ID # 107) near these trees is at risk of failing and

potentially injuring these trees. It should be removed to prevent injuring the hemlocks.

Black walnut (ID# 120)

This 39 in DBH, mature tree is located on the front lawn at the southeast corner of the Museum building and is in fair condition. This tree is important because of its large size and location in the landscape. A large mulch ring is recommended to nourish the soil and protect the tree from mowers. Correct any nutrient deficiencies based on a soil test. A root collar excavation is recommended to remove fill soil and examine the root collar for decay, which could increase the risk of tree failure. The location and size of this tree puts it at risk of lightning strike; therefore, a lightning protection system should be installed in the tree.

Yellow-poplar (ID# 144)

This 53 in DBH, geriatric tree is located on the front lawn at the southwest corner of the Museum building and is in fair condition. This tree has a critical management need. Inspect and upgrade the existing lightning protection system to reduce the risk of lightning injury. In addition, install a support cable on the northeast leader that originates at 12 feet above ground line to reduce the risk of leader failure. This will help support the tree and reduce the risk of failure at this main leader. Crown cleaning is also recommended to remove dead branches for this tree to maintain its health.

White oak (ID# 182)

This 47 in DBH, mature tree is located in the garden on the north side of the Museum building and is in good condition. No pruning or mulching are needed for this tree. Inspect and upgrade the existing lightning protection system to reduce the risk of lightning injury and correct any nutrient deficiencies based on a soil test. Because of the tree's confined root system,

supplemental irrigation is recommended in periods of prolonged drought.

### ***Prevalent Trees***

Trees in the following list are discussed here because they account for a significant proportion of the tree population and are therefore conspicuous in the landscape. Due to their abundance, a pest or disorder that specifically impacts these trees could impose substantial mitigation costs or – if decimated – could negatively impact landscape quality.

#### Yellow-poplar

Yellow poplar is the most abundant large stature tree found on the United Company corporate campus. Many of these trees are very large and are located in prominent places in the landscape. These are very high quality trees and because of their abundance and size draw attention of visitors. A key consideration in managing this species is protecting it from injuries that might predispose it to wood decay, which is a common problem for the species. Landscaping and industrial equipment must be used cautiously around the specimens to prevent injury. Storm damage to the trees should be repaired immediately using proper pruning techniques to prevent decay spread. Finally, the species is sensitive to drought; therefore, trees should be mulched where practical to conserve soil moisture.

#### Flowering dogwood

Flowering dogwood is the most abundant small stature tree found on campus. This small tree is an important part of the urban forest and it brings beautiful spring flowers and nice fall color in the lower level of the forest. Most of the flowering dogwoods are mature to geriatric, which makes them susceptible to dogwood borer – an insect pest. A key to maintaining these trees is protecting them from wounding, which creates infestation points in the tree. One way to

protect the tree is by mulching the critical root zone, which also prevents moisture stress – a predisposing factor for the pest. Another important step is to make proper pruning cuts. Periodically crown cleaning the trees is recommended to remove dead branches that attracts and harbors the dogwood borer. Flowering dogwood is also susceptible to several fungal foliar diseases. Fungicide application may be warranted to protect highly valuable trees that are at risk of infection. Pruning dead branches from the trees and cleaning up litter keeps the growing environment sanitary and reduces disease pressure. Correcting soil nutrient deficiencies can also help boost the trees' immune system.

### Eastern hemlock

Numerous large, mature hemlocks are located on the campus and are very valuable native evergreens in the landscape. These trees are threatened by hemlock woolly adelgid (HWA), an exotic invasive insect pest. HWA feeds on the needles of hemlocks, causing defoliation and dieback over a period of years. Left unchecked, HWA infestation causes the tree to decline and eventually die. Additional disorders or environmental conditions can add more stress to the tree, hastening its demise. In order to preserve the hemlocks, they need to be periodically inspected for HWA by a qualified arborist and treated based on findings of the inspection. Because managing HWA can be quite expensive, it might be appropriate to cull low-value hemlocks and replace them with a suitable species. High-value hemlocks could then be placed on an inspection and treatment program to protect them from HWA. In addition to pesticide applications, cultural practices can help reduce environmental stress and keep the hemlocks healthy. For example, proper mulching around the critical root zone of each tree can help reduce drought stress, which is exacerbated by HWA infestation.

## Literature Cited

Appleton, B. and K. Kauffman. 2009. Selection and Use of Mulches and Landscape Fabrics. Virginia Cooperative Extension Publication 430-019.

<http://pubs.ext.vt.edu/430/430-019/430-019.pdf>

French, S. C. and B. L. Appleton. 2009. A Guide to Successful Pruning Stop Topping Trees. Virginia Cooperative Extension Publication 430-458.

<http://pubs.ext.vt.edu/430/430-458/430-458.pdf>

Kirwan, J. and B. Kane. 2009. Urban Forestry Issues. Virginia Cooperative Extension Publication 420-180. <http://pubs.ext.vt.edu/420/420-180/420-180.pdf>

Pest Management Guide: Horticultural and Forest Crops, 2010. Virginia Cooperative Extension Publication 456-017. <http://pubs.ext.vt.edu/456/456-017/456-017.html>. (Accessed April 27, 2010)

Smiley, E. T., A.W. Graham, Jr., and S. Cullen. 2002. Best Management Practices, Lightning Protection Systems. International Society of Arboriculture. Champaign IL.

Smiley, E.T.. 1999. Root Collar Disorders Technical Report. Bartlett Tree Research Laboratories. Charlotte, NC. [http://ncatree.com/articles\\_information/root\\_collar\\_disorders.pdf](http://ncatree.com/articles_information/root_collar_disorders.pdf)

Wells, C., K. Townsend, J. Caldwell, D. Ham, E. T. Smiley, and M. Sherwood. 2006. Effects of Planting Depth on Landscape Tree Survival and Girdling Root Formation. *Arboriculture & Urban Forestry* 32(6):305-311.



## APPENDICES

### APPENDIX A: GLOSSARY OF ARBORICULTURE TERMS

Definitions of the following terms were excerpted from the International Society of Arboriculture's Glossary of Arboricultural Terms, which can be accessed online at <http://www.isa-arbor.com/Dictionary>.

**Bracing** – installation of metal rods through portions of a tree for supplemental support.

**Cabling** – installation of steel or synthetic cable in a tree to provide supplemental support to weak branches or crotches.

**Cavity** – open or closed hollow within a tree stem, usually associated with decay.

**Chlorosis** – whitish or yellowish leaf discoloration caused by lack of chlorophyll.

**Codominant leaders** – forked branches nearly the same size in diameter, arising from a common junction and lacking a normal branch union.

**Critical root zone** – area of soil around a tree where the majority of the roots are located and that provide stability as well as uptake of water and minerals. Minimally defined as ½ foot radius per inch of trunk diameter.

**Crown cleaning** – in pruning, the selective removal of dead, dying, diseased, and broken branches from the tree crown.

**Crown raising** – in pruning, the selective removal of lower limbs from a tree crown to provide clearance.

**Crown reduction** – method of reducing the height and/or spread of a tree crown by making appropriate pruning cuts.

**Crown restoration** – method of restoring the natural growth habit of a tree that has been topped or damaged in any other way.

**Crown thinning** – in pruning, the selective removal of live branches to reduce crown density.

**Decay** – (1) (noun) an area of wood that is undergoing decomposition. (2) (verb) decomposition of organic tissues by fungi or bacteria.

**Decline** – gradually diminishing health or condition of a tree.

**Defect** – any naturally occurring or secondary conditions such as cavities, poor branch attachments, cracks, or decayed wood in the trunk, crown, or roots of a tree that may contribute to structural failure.

**Dieback** – condition in which the branches in the tree crown die from the tips toward the center of the crown.

**Girdling root** – root that encircles all or part of the trunk of a tree or other roots and constricts the vascular tissue and inhibits secondary growth and the movement of water and photosynthates.

**Hazard** – in tree management, a tree or tree part that is likely to fail and cause damage or injury, and the likelihood exceeds an acceptable level of risk.

**Root collar** – flared area at the tree trunk base where the roots and trunk come together.

**Root collar excavation** – process of removing soil to expose and assess the root collar of a tree.

**Soil compaction** – compression of the soil, often as a result of vehicle or heavy-equipment traffic, that breaks down soil aggregates and reduces soil volume and total pore space.

**Structural pruning** – selective pruning to improve tree and branch architecture.

**Topping** – inappropriate pruning technique to reduce tree size. Cutting back a tree to a predetermined crown limit, often at internodes.

## **APPENDIX B: USEFUL TREE CARE WEBSITES**

Virginia Tech Urban Forestry Gateway

<http://www.cnr.vt.edu/urbanforestry>

Virginia Cooperative Extension

<http://ext.vt.edu>

Mid-Atlantic Chapter of International Society of Arboriculture

<http://www.mac-isa.org>

Tree care information from the International Society of Arboriculture

<http://www.treesaregood.com>

Forestry factsheets from VA Cooperative Extension

<http://pubs.ext.vt.edu/category/forestry.html>

Tree and shrub care factsheets from VA Cooperative Extension

<http://pubs.ext.vt.edu/category/trees-shrubs-groundcovers.html>

Hemlock Woolly Adelgid Factsheet

<http://njaes.rutgers.edu/pubs/download-free.asp?strPubID=FS751>

Searchable database for local Certified Arborists

<http://www.goodtreecare.com/search/index.cfm>

## APPENDIX C: TREE INVENTORY ATTRIBUTES

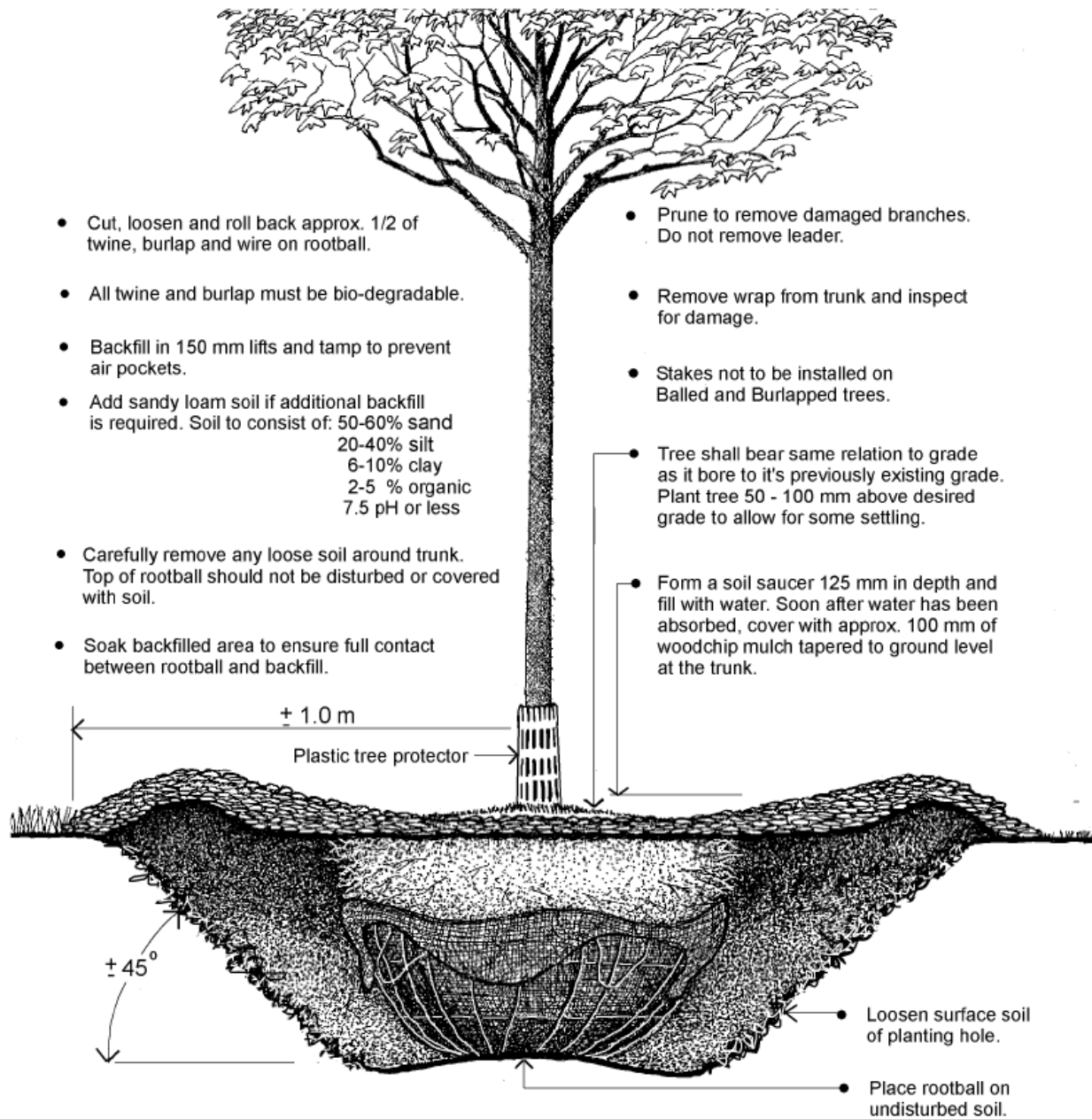
ATTRIBUTES	VALUES	DEFINITIONS
<b>Species</b>	common name	Select common name from pick list
<b>Trunk Diameter</b>	1" increment	For trees with single trunk, measure at breast height. For trees with branches or multiple leaders at breast height, measure the smallest common diameter between breast height and ground line.
<b>Crown Radius</b>	1' increment	Measure typical crown radius from trunk to edge of crown.
<b>Height Class</b>	1' increment	Manually enter value
<b>Height Class</b>	Visually estimate the height of the tree	
	< 10'	
	10'-20'	
	20'-40'	
	40'-60'	
	> 60'	
<b>Age Class</b>	Young	Recently planted tree (<3 years) that is not established
	Immature	An established tree that has not yet matured
	Mature	Approaching typical size/age for the species in an urban environment
	Geriatric	Achieved typical size/age for the species in an urban environment and now senescing
<b>Condition</b>		A qualitative measure of tree health and structural integrity
	Good	No apparent problems
	Fair	Minor problems
	Poor	Major problems
	Dead	No signs of life
<b>Defect Type</b>		Up to three prioritized defects could be enumerated
	None	
	Root problem	cracked, decayed, severed, missing roots; confined root system; buried root collar; girdling root
	Decay/Cavity	wood that is decomposing or decomposed; indicators-conks, fluxing, bulging
	Crack	fissure in bark that exposes sapwood
	Poor architecture	lean; horizontal crown asymmetry; low live crown ratio; poor stem taper; topped
	Weak union	epicormic branches; included bark
	Dead parts	loose, peeling bark; no buds/leaves; broken/lodged branches
<b>Defect Location</b>		Up to three prioritized defects could be enumerated
	None	
	Roots	
	Trunk/leader	
	Branch	
<b>Disorder Type</b>		Up to three prioritized disorders could be enumerated
	None	
	Soil compaction	compression of the soil, often as a result of vehicle or heavy-equipment traffic
	Girdling root	root that incircles all or part of the trunk of a tree or other roots and constricts the vascular tissue
	Buried root collar	soil or mulch covering the flared area at the tree trunk base where the roots and trunk join
	Excessive mulching	
	Inadequate mulching	
	Wound	
	Dieback	condition in which the branches in the tree crown die from the tips toward the center of the crown
	Fluxing	seeping of sap or other fluid from the bark surface
	Leaf wilting	drooping of leaves due to insufficient water content
	Leaf chlorosis	whitish or yellowish leaf discoloration caused by lack of chlorophyll
	Leaf necrosis	localized death of leaf tissue
	Improper pruning	
<b>Management Task</b>		Up to three prioritized tasks could be enumerated
	None	
	Structure evaluation	Tree structure requires further evaluation to assess failure risk
	Disorder diagnosis	Suspected disorder requires diagnosis and treatment
	Pest diagnosis	Suspected pest requires diagnosis and treatment
	Soil diagnosis	Suspected soil nutrient deficiency requires diagnosis and treatment
	Root collar excavation	Remove fill soil covering root collar
	Girdling root removal	Remove girdling root
	Stake removal	Remove straps, stakes, guys, etc.
	Mulch	Apply/add mulch
	Mulch correction	Remove excessive mulch to expose root collar and attain appropriate depth
	Irrigation	Irrigation needed to alleviate drought stress from weather, topography, or soil quality
	Cable/brace	A support system is recommended to reduce risk of branch/leader failure
	Structural prune	Selective pruning to improve branch architecture primarily on young- and medium-aged trees
	Crown clean	Selective pruning to remove dead, diseased, and/or broken branches
	Crown thin	Selective pruning to reduce density of live branches
	Crown raise	Selective pruning to provide vertical clearance
	Crown reduce	Selective pruning to decrease height and/or spread
<b>Management Priority</b>		Denote the relative priority for managing the tree
	Critical	Management tasks require immediate attention
	High	Management tasks require attention
	Moderate	Management tasks are discretionary
	Low	No management tasks are required at this time

**APPENDIX D: OVERVIEW MAP OF CAMPUS TREES**



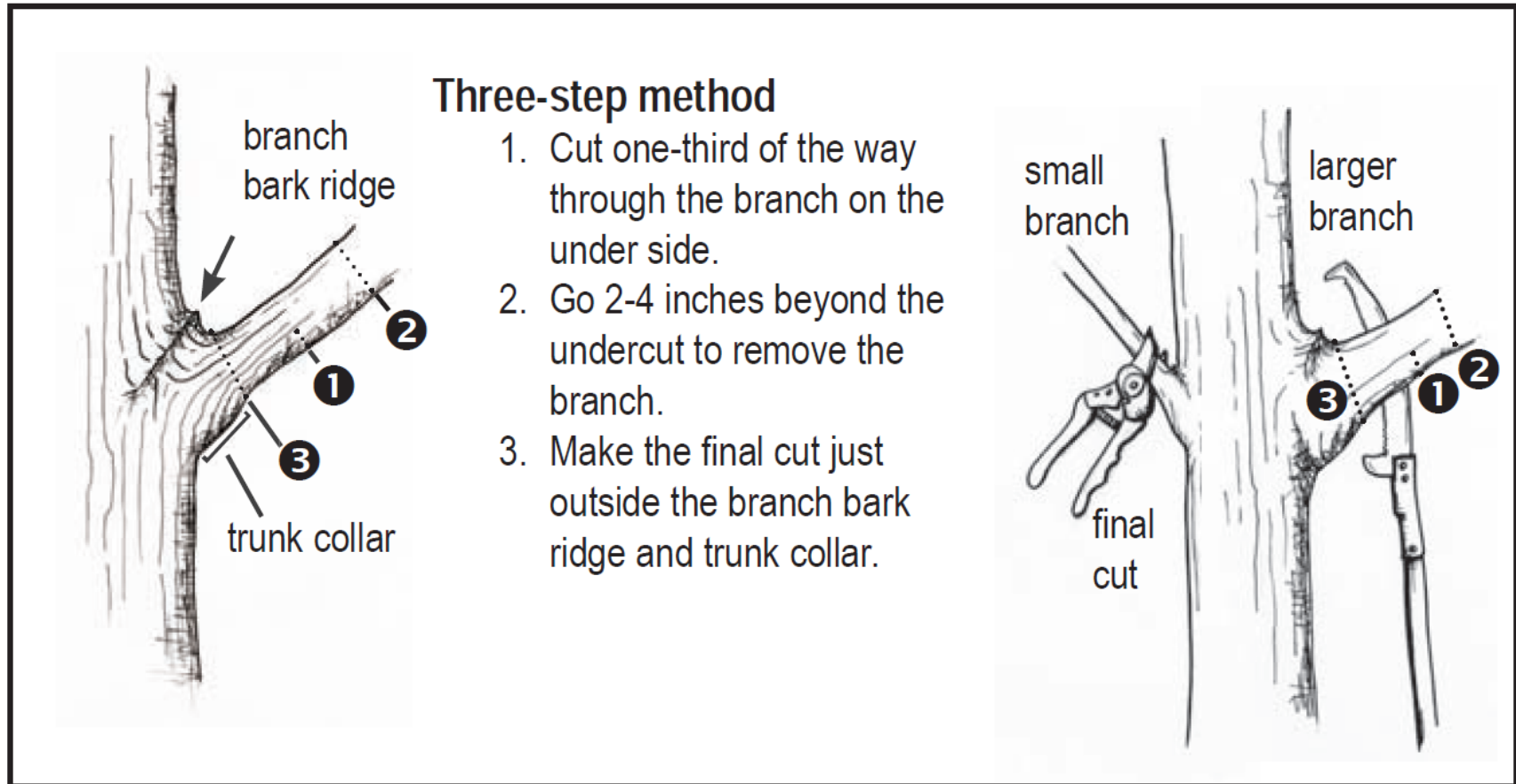
- 1. Museum
- 2. United Central accounting building
- 3. Bachelor pad
- 4. Maintenance shop
- 5. Suite #4
- Lower parking lot
- 6. Library
- 7. Main office building
- 8. Lower parking lot
- 9. President's house

## APPENDIX E: PROCEDURE FOR LANDSCAPE TREE PLANTING



Source: <http://www.toronto.ca/trees/pdfs/DetailPD101bbinturf.pdf>

**APPENDIX F: PROCEDURE FOR BRANCH PRUNING CUT**



Source: [http://na.fs.fed.us/pubs/uf/tom/090202\\_tom\\_hr.pdf](http://na.fs.fed.us/pubs/uf/tom/090202_tom_hr.pdf)

**APPENDIX G: PROCEDURE FOR MULCH APPLICATION**



**"Mulch volcanoes" cause many problems for trees.**



**Mulch wide—not deep.**

**Source:** <http://www.cityoffrederick.com/cms/files/parks-division/mulching.htm>