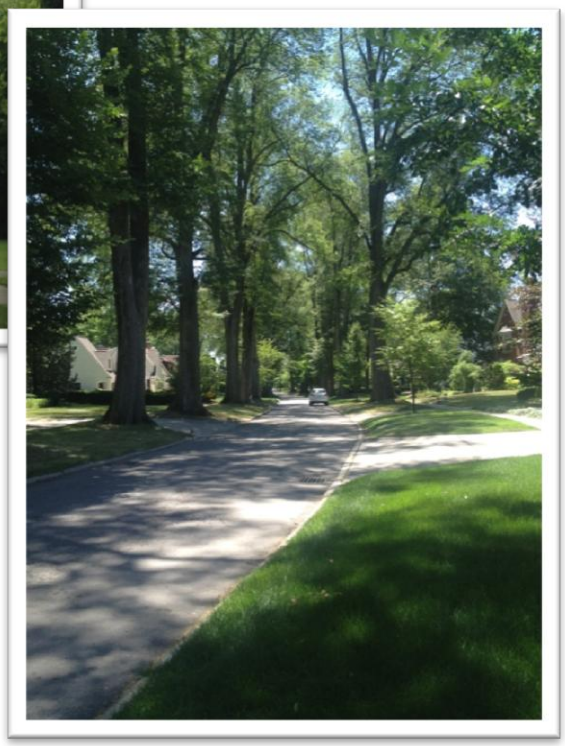
Public Tree Management Plan

Birmingham, Michigan

August 2012



DAVEY RESOURCE GROUP

A Division of The Davey Tree Expert Company

Public Tree Management Plan

Birmingham, Michigan

August 2012

Prepared for:

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Acknowledgments

Birmingham's vision to promote and preserve the urban forest and improve the management of public trees was the fundamental inspiration for this project. These efforts will ensure canopy continuity, which will reduce stormwater runoff, improve air quality, promote public health, and enhance the aesthetic value of this resource.

Birmingham is thankful for the grant funding they received from the Michigan Department of Natural Resources in cooperation with the U.S. Department of Agriculture Forest Service through its Urban and Community Forestry Program, the goal of which is to preserve, protect, expand, and improve Michigan's urban and community forestry resources.

Notice of Disclaimer

Inventory data provided by Davey Resource Group, a Division of The Davey Tree Expert Company (Davey), are based on visual recording at the time of inspection. Visual records do not include individual testing or analysis and do not include aerial or subterranean inspection. Davey is not responsible for discovery or identification of hidden or otherwise non-observable hazards. Records may not remain accurate after inspection due to variable deterioration of inventoried material. Davey provides no warranty with respect to the fitness of the community forest for any use or purpose whatsoever. Clients may choose to accept or disregard Davey's recommendations, or to seek additional advice. Important: know and understand that visual inspection is confined to the designated subject tree(s), and that the inspections for this project are performed in the interest of facts of the tree(s) without prejudice to or for any other service or any interested party.

Table of Contents

Acknowledgments i
Executive Summary iv
State of the Existing Street Trees iv
Tree Maintenance and Planting Needs iv
Urban Forest Program Needs v
Introduction 1
Approach to Tree Management 1
Section 1: Benefits of the Urban Forest 3
Economic 3
Environmental 3
Social 4
Section 2: Tree Inventory Analysis 5
Tree Inventory Data Collection Methods 5
Project Area 6
Assessment of Tree Inventory Data 6
Species Diversity 7
Section 3: Street ROW Tree Management Program 17
How Risk Was Assessed During the Inventory 17
Priority and Proactive Maintenance 18
Proactive Maintenance 24
Inspections 26
Tree Planting 27
Tips for Planting Trees 29
Newly Planted and Young Tree Maintenance 30
Community Outreach 30
Inventory and Plan Updates 31
Maintenance Schedule 32
Section 4: Golf Course Tree Management Program 34
Priority Tree Removal 34
Priority Pruning 35
Proactive Maintenance 37
Maintenance Schedule 38
Conclusions 40
References 41
Glossary 43

Figures

1. Number of sites collected during the inventory 5
2. Ten most abundant species of ROW trees identified during the inventory 7
3. Diameter size class distribution of ROW trees compared to the ideal distribution 9
4. Condition ratings of ROW trees during the inventory 10
5. Condition ratings of ROW trees by relative age during the inventory 10
6. Relationship between average tree condition class and number of years since last pruning (adapted from Miller and Sylvester, 1981) 19
7. ROW trees recommended for removal, by diameter size class and risk rating 21
8. ROW trees recommended for pruning, by diameter size class and risk rating 23
9. ROW trees recommended for the RP Cycle by diameter size 25
10. Planting sites identified by mature tree size 26

Tables

1. Tree-Related Conflicts Recorded During the Inventory. 12
2. Observations Recorded During the ROW Tree Inventory. 14
3. Golf Course Trees Recommended for Removal, by Diameter Size Class and Risk Rating 35
4. Golf Course Trees Recommended for Pruning, by Diameter Size Class and Risk Rating 36

Appendices

A. Tree Location Methods
B. Species Diversity (Golf Courses and Street Trees)
C. Suggested Street Tree Species
D. Pests and Diseases
E. Davey Planting Guidelines
F. Mulch Installation and Renovation
G. Projected Work Plan and Estimated Costs: Seven-Year Management Plan for Street ROW Trees
H. Projected Work Plan and Estimated Costs: Five-Year Management Plan for Golf Course Trees

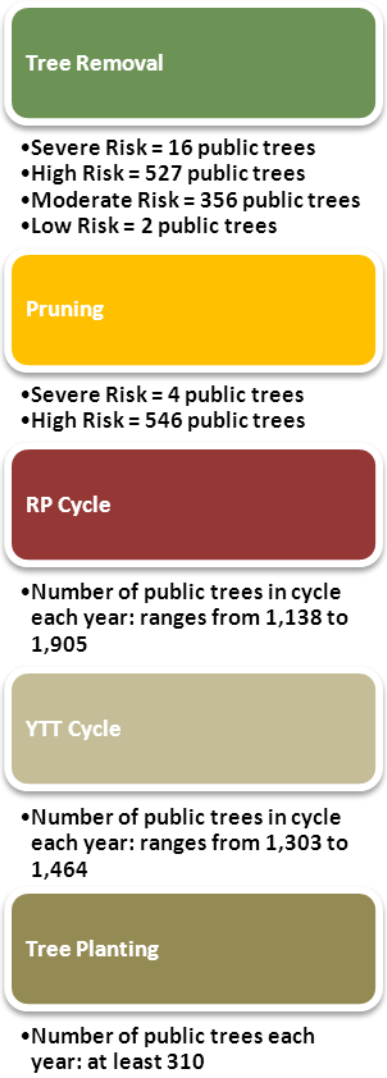
Executive Summary

This Plan was developed for the City of Birmingham, Michigan by Davey Resource Group, a Division of The Davey Tree Expert Company (Davey), with a focus on addressing short- and long-term maintenance needs and tree planting initiatives. Davey completed a tree inventory to gain an understanding of the needs of the existing urban forest and to project budgets for tree care and planting. To develop this Public Tree Management Plan, analysis of inventory data was utilized, along with information about the City's existing program and vision for the urban forest.

State of the Existing Street Trees

The tree inventory included the trees, stumps, and planting sites along public street rights-of-way (ROWs) and the trees in two golf courses that are city owned and operated, Lincoln Hills Golf Course and Springdale Golf Course. A total of 16,012 sites were recorded during the inventory: 14,480 trees, 679 vacant planting sites, and 19 stumps along the street ROW and 827 trees and 7 stumps in the two golf courses. Analysis of the inventory data found:

- The approximate value of Birmingham's public tree asset is $21,817,630.
- The overall condition of the inventoried trees was rated to be Fair to Good.
- Two species, thornless honeylocust (*Gleditsia triacanthos inermis*) and Norway maple (*Acer platanoides*), made up such a large percentage of the street ROW population (19% and 18%, respectively) that the urban forest is at risk of severe loss due to existing and potential pest and disease threats.
- Throughout the City, maple (*Acer*) was found to be overabundant: 48% of the street ROW trees and 18% of inventoried golf course trees. Its dominance of this genera creates a concern for the biodiversity of the tree population.
- Overall, the diameter size class distribution of the ROW trees trended towards the ideal, with a greater number of young trees (0–8 inches in diameter at breast height [DBH]) than established, maturing, or mature trees (9–17 inches DBH, 18–24 inches DBH, and >24 inches DBH, respectively).



Tree Maintenance and Planting Needs

Trees provide many environmental and economic benefits that justify spending the time and money for planting and maintenance. The maintenance needs most recommended for the public trees during the inventory were pruning (90%), removal (6%), and planting (4%). Reducing tree-related risk should be prioritized so that the trees with the highest risk are addressed first. Hazardous trees should be removed or pruned immediately to promote public safety: the inventory noted several Severe- and High-Risk trees (1% and 7% of public trees assessed, respectively). Moderate- and Low-Risk trees should be addressed after all elevated risk tree maintenance has been completed.

Birmingham's urban forest will benefit greatly from the continuation of a seven-year routine pruning cycle (RP Cycle) and a three-year young tree training cycle (YTT Cycle). Proactive pruning cycles improve the overall health of the tree population, eventually reducing program costs. In most cases, pruning cycles will correct defects in trees before they worsen, which will avoid costly problems. Based on inventory data, approximately 1,500 trees should be pruned during the RP Cycle each year and at least 1,400 young or newly planted trees should be structurally pruned each year during the YTT Cycle.

Planting trees is necessary to maintain canopy cover and to replace trees that have been removed or lost to natural mortality (expected to be 1–3% per year) or other threats (for example, construction, invasive pests, or impacts from events such as storms, wind, ice, snow, flooding, and drought). Davey recommends that the City should continue its planting program, to plant 310 trees per year. If budgets allow and follow-up maintenance is feasible, the number of trees to be planted should be increased to exceed what is recommended in this Plan to better prepare for impending threats.

Photograph 1. The city of Birmingham recognizes that its urban forest is a vital resource to the overall public health and economic growth of the city. Continued action is required to promote and sustain a healthy urban forest.

Birmingham's tree planting should focus on increasing species diversity, creating canopy in areas that promote economic growth such as business districts, and filling in gaps in existing canopy. The current planting and diversity plan used by the City implements these ideals to improve the urban forest. Increasing public education on species diversity and land conservation will help to extend tree planting efforts.

Urban Forest Program Needs

Funding will be needed for the City to continue its tree management program that will provide short- and long-term public benefit, to ensure that priority maintenance is performed expediently, and to establish proactive maintenance cycles. The estimated total cost for the first year of the seven-year program to maintain the public trees is $643,980; this total will decrease by Year Seven to approximately $247,925. High-priority removal and pruning is costly; most of this work is scheduled during the first year of the program, which is why the budget is higher for that year. After this priority work has been completed, the forestry program will mostly involve proactive work, which is generally less costly, so budgets for later years are projected to be lower. It is important to note that the projected costs are estimates and may not be exact.

Continued support of proactive management of trees through funding will over the long term reduce municipal tree care management costs and possibly the costs to build, manage, and support some city infrastructure.

Birmingham has several opportunities to improve its urban forest. The City's commitment and investment in its urban forest will help preserve the character of Birmingham, promote public safety, improve program efficiency, and increase the economic and environmental benefits the community receives from its trees.

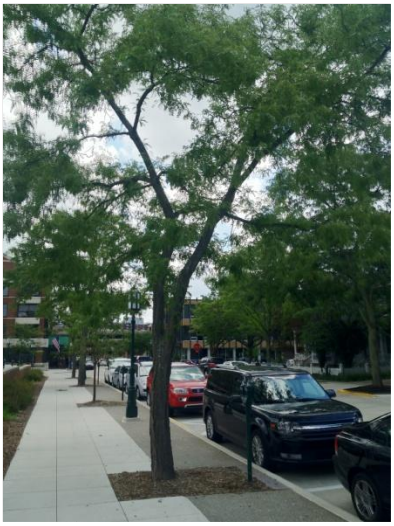
Introduction

The City of Birmingham is home to more than 20,000 full-time residents who enjoy the beauty and benefits of their urban forest. The City's urban forestry program manages trees on public property: along the street rights-of-way (ROW), in parks, and in public spaces. The City currently manages the public trees in the ROW with a seven-year pruning cycle, which promotes public safety and improves the aesthetic value of this resource.

Funding for Birmingham's urban forestry program comes from a combination of sources dedicated to maintaining the urban forest. Birmingham's established tree ordinance, planting plan, diversity plan, and annual Arbor Day celebrations show the City's commitment to supporting a healthy urban forest for its citizens.

Approach to Tree Management

The best approach to managing an urban forest is to develop an organized, proactive program that includes tools (such as a tree inventory) to set goals and measure progress. This tool can be utilized to establish tree care priorities, to generate strategic planting plans, to draft cost-effective budgets based on projected needs, and to ultimately reduce to a minimum the need for costly, reactive solutions to crises or urgent hazards.



Photograph 2. Trees such as this honeylocust in downtown Birmingham bring both an aesthetic beauty and an increase in economic benefits. These trees not only reduce run-off from rain water, but will also reduce energy costs by providing shade and breaking up the concrete landscape.

In 2012, Birmingham received a grant from the Michigan Department of Natural Resources and worked with Davey Resource Group, a Division of The Davey Tree Expert Company (Davey), to inventory trees and develop a plan for the management of those trees. This Plan considers the general condition, diversity, and distribution of the inventoried trees and ultimately provides a prioritized system for the management of street ROW and golf course trees. The following tasks were completed:

- Inventory of trees, stumps, and vacant planting sites within street ROWs.
- Inventory of trees in two golf courses that are city owned and operated, Lincoln Hills Golf Course and Springdale Golf Course.
- Analysis of tree inventory data.
- Development of this Plan that prioritizes the recommended maintenance of the inventoried tree population.

This Plan is divided into four sections:

- *Section 1 (Benefits of the Urban Forest)* presents information about the economic, environmental, and social benefits that trees provide to communities.
- *Section 2 (Tree Inventory Analysis)* summarizes the Public tree inventory data and presents trends, results, and observations.
- *Section 3 (Street ROW Tree Management Program)* utilizes inventory data to develop a prioritized system and projected budget for the implementation of the recommended tree maintenance over a seven-year period for the public street ROW trees.
- *Section 4 (Golf Course Tree Management Program)* utilizes inventory data to develop a prioritized system and projected budget for the implementation of the recommended tree maintenance over a five-year period for public golf course trees.

Section 1: Benefits of the Urban Forest

There is a growing understanding and validation of the importance of trees to a community. Scientists and researchers have studied the effects of trees on human behavior, traffic patterns, crime rates, air quality, stormwater runoff, and property values. Trees are demonstrably beneficial and positively affect human and public health. The benefits trees provide are commonly divided into three categories—economic, environmental, and social.

Photograph 3. Tree-lined streets not only add to the beauty of Birmingham, they provide economic, environmental, and social benefits including temperature moderation and cooling, reduction of air pollutants, energy conservation, and overall increases in property values.

Economic

Consumers are willing to pay more to park and shop in landscaped business districts. On average, consumers will pay about 11% more for goods in landscaped areas, with this figure being as high as 50% for convenience goods (Wolf, 1998(a); Wolf, 1999; and Wolf, 2003). Consumers also feel that the quality of the products is better in business districts having trees over those that were considered barren (Wolf, 1998(a)). Additionally, the quality of landscaping along the routes leading to the business district had a positive influence on consumers' perceptions of the area (Wolf, 2000).

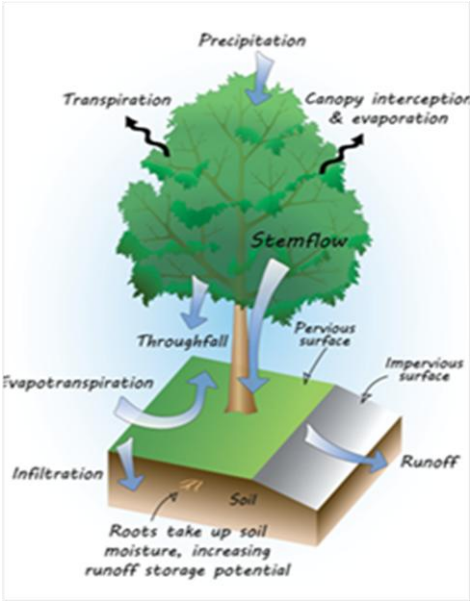
Several studies in the United States analyzed the effect of tree cover on the price of residential home sales, finding that values of properties in tree-lined areas may be 3% to 7% higher when trees are in the yard, 5% to 20% when the property is next to natural open space, and 9% when adjacent to street trees. Commercial property rental rates were 7% greater when trees were present on the property (Wolf, 2009).

Environmental

Trees improve air quality. During photosynthesis, trees remove carbon dioxide (CO_2) from the atmosphere to form carbohydrates that are used in plant structure/function and return oxygen (O_2) back to the atmosphere as a byproduct. Trees, therefore, act as a carbon (C) sink. Urban forests cleanse the air by intercepting and slowing particulate materials and by absorbing pollutant gases on their leaf surfaces. Pollutants partially controlled by trees include nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), CO_2, ozone (O_3), and small particulates less than 10 microns in size (PM_{10}). Coder (1996) found that trees could reduce street level air pollution by up to 60%. Lovasi (2008) suggested that children who live on tree-lined streets have lower rates of asthma.

Trees reduce energy usage by lowering local air temperatures when they transpire water and shade surfaces. Urban trees shade buildings in the summer and block wind in the winter. The net cooling effect of a healthy tree is equivalent to 10 room-sized air conditioners operating 20 hours a day (North Carolina State University, 2012). Trees placed properly around buildings as windbreaks can save up to 25% on winter heating costs (Heisler, 1986).

Planting trees in strategic areas can augment the function of existing stormwater infrastructure, increasing its capacity, delaying onsets of peak flows, and improving water quality. Because trees act as mini-reservoirs, planting trees can reduce the long-term costs incurred by the City to manage runoff. Leafy tree canopies catch precipitation before it reaches the ground, allowing some water to gently drip and the rest to evaporate. This lessens the initial impact of storms and reduces runoff and erosion. For every 5% of tree cover added to a community, stormwater runoff is reduced by approximately 2% (Coder, 1996). Research by the U.S. Department of Agriculture (USDA) Forest Service indicates that 100 mature tree crowns intercept about 100,000 gallons of rainfall per year, reducing runoff and providing cleaner water (USDA Forest Service, 2003(a)). A typical urban forest of 10,000 trees will retain approximately 10 million gallons of rainwater per year (USDA Forest Service, 2003(b)).



Trees reduce stormwater runoff by capturing and storing rainfall in their canopy and releasing water into the atmosphere.

- *Tree roots and leaf litter create soil conditions that promote the infiltration of rainwater into the soil.*
- *Trees help slow down and temporarily store runoff and reduce pollutants by taking up nutrients and other pollutants from soils and water through their roots.*
- *Trees transform pollutants into less harmful substances.*

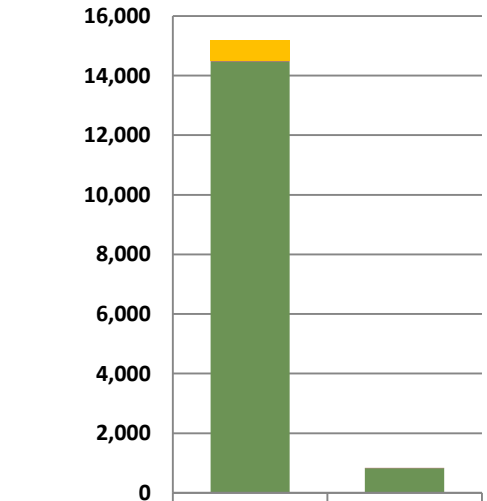
Social

In addition to increasing property values, research has shown that trees can lead to reduced crime rates, decreased amounts of human stress, and shorter lengths of hospital stays. Kuo and Sullivan (2001(a)) studied apartment buildings in Chicago and found that buildings with high levels of greenery had 52% fewer crimes than those without any trees, and buildings with medium amounts of greenery had 42% fewer crimes.

Tree-lined streets are safer; traffic speeds and the amount of stress drivers feel are reduced, which likely reduces “road rage” (Wolf, 1998(b); Kuo and Sullivan, 2001(b)). Ulrich (1984, 1986) found that hospital patients who were recovering from surgery and had a view of a grove of trees through their windows required fewer pain relievers, experienced fewer complications, and left the hospital sooner than similar patients who had a view of a brick wall.

Section 2: Tree Inventory Analysis

In July and August 2012, Davey arborists certified through the International Society of Arboriculture (ISA) assessed and inventoried the trees, stumps, and vacant planting sites along the street ROW and the trees in two golf courses that are city owned and operated, Lincoln Hills Golf Course and Springdale Golf Course. A total of 16,012 sites were recorded during the inventory: 14,480 trees, 679 vacant planting sites, and 19 stumps along the street ROW and 827 trees and 7 stumps in the two golf courses (Figure 1).



	ROW Sites	Park Sites
Planting Sites	679	0
Stumps	19	7
Trees	14,480	827

Figure 1. Number of sites collected during the inventory

Tree Inventory Data Collection Methods

Tree inventory data were collected using a system developed by Davey that utilizes a customized ArcPad program loaded onto pen-based field computers equipped with geographic information system (GIS) and global positioning system (GPS) receivers. The knowledge and professional judgment of Davey's arborists ensure the high quality of inventory data. Data fields are defined in the glossary, and the site location method is provided in Appendix A. At each site, the following data fields were collected:

- aboveground utilities
- blockside
- clearance requirements
- condition
- further inspection
- growing space type
- hardscape damage
- location
- location rating
- maintenance needs*
- mapping coordinate
- notes
- observations
- plant tree
- risk assessment
- space size
- species
- stems
- tree size**

* Based on American National Standards Institute (ANSI) A300 Standards (2011).

** Measured in inches at diameter at breast height, at 4.5 feet above ground (DBH).

Primary and secondary maintenance are based on American National Standards Institute (ANSI) A300 Standards (2011). Risk assessment and risk rating are based on the USDA Forest Service Community Tree Risk Rating System.

The data collected were provided in ESRI® shapefile and Microsoft Excel™ spreadsheet and Access™ database formats on a CD-ROM accompanying this Plan.

Project Area

The City selected the project area for the tree inventory: seven zones that comprise 88 linear miles of public street ROWs and two golf courses that are city owned and operated (Lincoln Hills Golf Course and Springdale Golf Course).

Assessment of Tree Inventory Data

Photographs 4 and 5. Davey's ISA Certified Arborists inventoried trees along the street ROW and in two city golf courses to collect data to assess the state of the urban forest.

Data analysis and professional judgment are used to make generalizations about the state of the inventoried tree population. Recognizing trends in the data can help guide short- and long-term management planning. In this Plan, the following characteristics of the inventoried tree population were assessed:

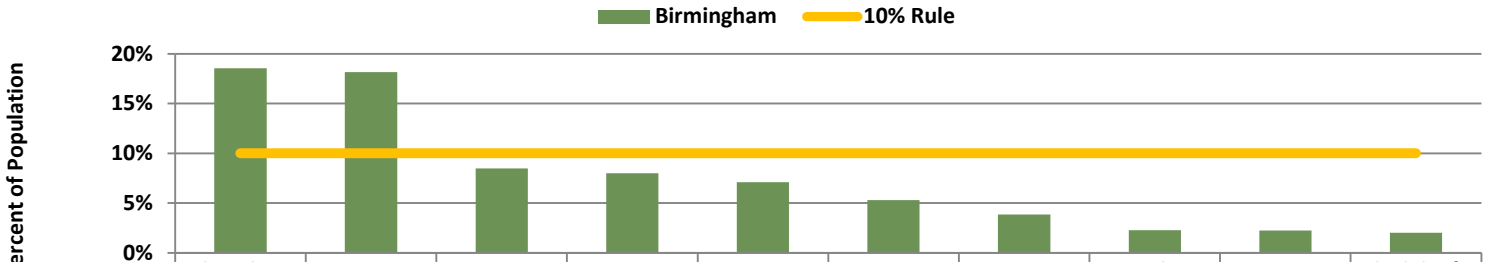
- Species diversity is the variety and abundance of trees in a specific population. It affects the population's ability to sustain threats from invasive pests and diseases. It also impacts maintenance needs and costs, planting goals, and canopy continuity.
- Diameter size class distribution, the proportion of trees by diameter size class in a specific population, can be used to estimate the relative age of the population. It affects the environmental and economic benefits provided as well as maintenance needs and costs, planting goals, and canopy continuity.
- The general health of a tree population indicates how well trees are performing given their site-specific conditions. General health affects both short- and long-term maintenance needs and costs as well as canopy continuity.

Analysis of inventory data provides insight into past maintenance practices and growing conditions that may affect future management decisions; other findings are presented for these purposes.

Species Diversity

Species diversity is an important consideration that affects maintenance costs, tree planting goals, canopy continuity, and the forestry program's ability to respond to threats from invasive pests or diseases. Low species diversity (large number of trees of the same species) can lead to severe losses in the event of species-specific epidemics (for example, Dutch elm disease). Program costs would likely increase significantly if such an event occurred when the affected species dominated the population.

The composition of a thriving tree population should adhere to the 10-20-30 Rule for diversity: no more than 10% of the urban forest should be of the same species, no more than 20% should be of the same genera, and no more than 30% should be of the same family (Ohio Department of Natural Resources Urban Forestry Program, 2012).



	thornless honeylocust	Norway maple	sugar maple	silver maple	Freeman maple	callery pear	red maple	London planetree	hybrid elm	littleleaf linden
Birmingham	19%	18%	8%	8%	7%	5%	4%	2%	2%	2%
10% Rule	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%

Figure 2. Ten most abundant species of ROW trees identified during the inventory

Findings

Analysis of Birmingham's street ROW tree inventory data indicated that the population had relatively good diversity, with 57 genera and 114 species represented; however, data analysis revealed some concerns for species diversity.

Figure 2 compares the percentages of the most common species identified during the street ROW inventory to the 10% Rule. Honeylocust and Norway maple far exceed the recommended 10% maximum for a single species in a population, comprising 19% and 18% of the inventoried street ROW tree population, respectively. Sugar maple (*Acer saccharum*), silver maple (*Acer saccharinum*), and Freeman maple (*Acer x freemanii*) approach the 10% limit. Appendix B provides listings of the tree species found along Birmingham's street ROW and in the two inventoried golf courses.

Discussion/Recommendations

The large numbers of honeylocust and maple species are the result of Birmingham's management response to replace the trees lost to Dutch elm disease. The dominance of honeylocust and maple species is a concern for species diversity. Maple species are hosts for Asian longhorned beetle (ALB); considering the large numbers identified during the inventory, the City should limit the planting of maple species to minimize the potential for severe loss in the event that ALB reaches Birmingham.

The City already has a planting plan to increase the diversity of its urban forest and to include an array of both small-statured and large-statured tree species. Appendix C provides an expanded list of recommended tree species for planting.

Diameter Size Class Distribution

The distribution of size classes can be used to estimate the relative age of a tree population. Analyzing the diameter size class distribution within a managed population also provides insight into the maturity of the population as well as maintenance practices and needs.

The inventoried trees were categorized into diameter size classes: young trees (0–8 inches DBH), established trees (9–17 inches DBH), maturing trees (18–24 inches DBH), and mature trees (>24 inches DBH). These categories were chosen so that the population could be analyzed following Richards (1983). Richards proposed an ideal diameter size class distribution for street trees based on observations of well-adapted trees in Syracuse, New York. Richards' ideal distribution suggests that the largest fraction of trees (approximately 40% of the population) should be young (<8 inches DBH), with a smaller fraction (approximately 10%) in the large-diameter size class (>24 inches). A tree population with a trend like the ideal will have an abundance of newly planted and young trees. Established, maturing, and mature trees will be present but in lower numbers.

The presence of all sizes and, thus, ages of trees in a population is important because it ensures continual canopy, maximizes the environmental benefits provided by trees, and spreads out maintenance costs. Newly planted trees are especially important to the livelihood of tree population. They are the future of the urban forest. They fill in gaps in existing canopy that may have been caused by past storm events and new development, or the lack of a formal tree planting program. New tree plantings are also the successors of the existing mature tree canopy.

Findings

Figure 3 illustrates the diameter size class distribution of Birmingham's street ROW trees identified during the inventory. This distribution trends toward the ideal; however, young trees (<8 inches DBH) are under the ideal by approximately 5% while larger diameter size classes are over the ideal by 2% to 4%.

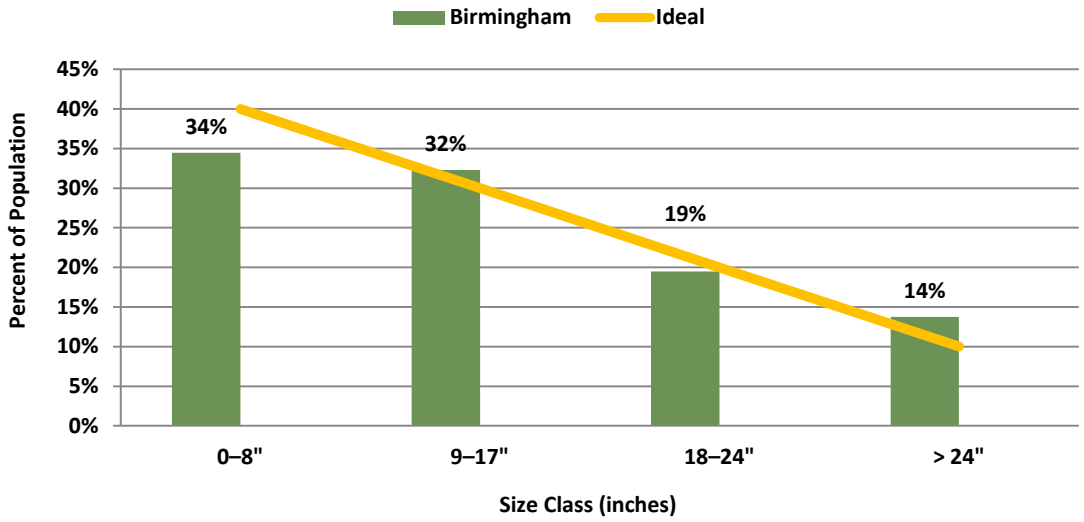


Figure 3. Diameter size class distribution of ROW trees compared to the ideal distribution

Discussion/Recommendations

Birmingham has too few younger trees, so the distribution is skewed. To correct this distribution, Davey recommends that Birmingham continue to support a strong planting and maintenance program to ensure that young, healthy trees are in place to fill in gaps in tree canopy and provide for gradual succession of older trees. The City must promote tree preservation and proactive tree care to ensure mature trees survive as long as possible. Tree planting and tree care will allow the distribution to normalize over time.

Planting trees is necessary to increase canopy cover and to replace trees lost to natural mortality (expected to be 1% per year) and other threats (for example, invasive pests or impacts from events such as storms, wind, ice, snow, flooding, and drought). Planning for the replacement of existing trees and finding the best places to create new canopy is critical.

Photograph 6. Continued planting of young trees such as this ginkgo (Ginkgo biloba) will ensure a continued healthy growth of the urban forest.

General Health

Davey assessed the condition of individual trees based on methods defined by ISA. Several factors were considered for each tree, including root characteristics; branch structure; trunk, canopy, and foliage condition; and the presence of pests. The condition of each inventoried tree was rated Very Good, Good, Fair, Poor, Critical, or Dead.

In this Plan, the general health of the inventoried tree population was characterized by the most prevalent condition assigned during the inventory. Additionally, comparing the condition of the inventoried tree population with generalized tree age can provide some insight into the stability of the population. In this Plan, relative age was based on DBH: young (0–8 inches DBH), established (9–17 inches DBH), maturing (18–24 inches DBH), and mature (>24 inches DBH).

It is important to understand that relative age is an estimation or generalization used for management purposes. Since tree species have different lifespans and mature at different diameters, heights, and crown spreads, actual tree age cannot be determined from diameter size class alone. However, general classifications of size, such as small, medium, and large or young, established, maturing or mature, can be used to describe the general characteristics and make management inferences.

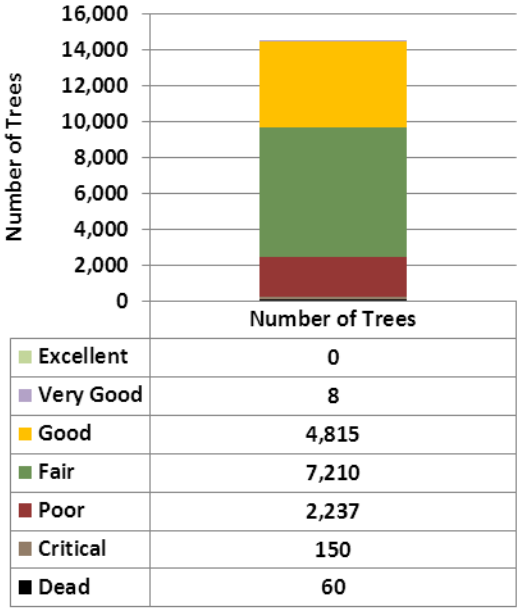


Figure 4. Condition ratings of ROW trees during the inventory

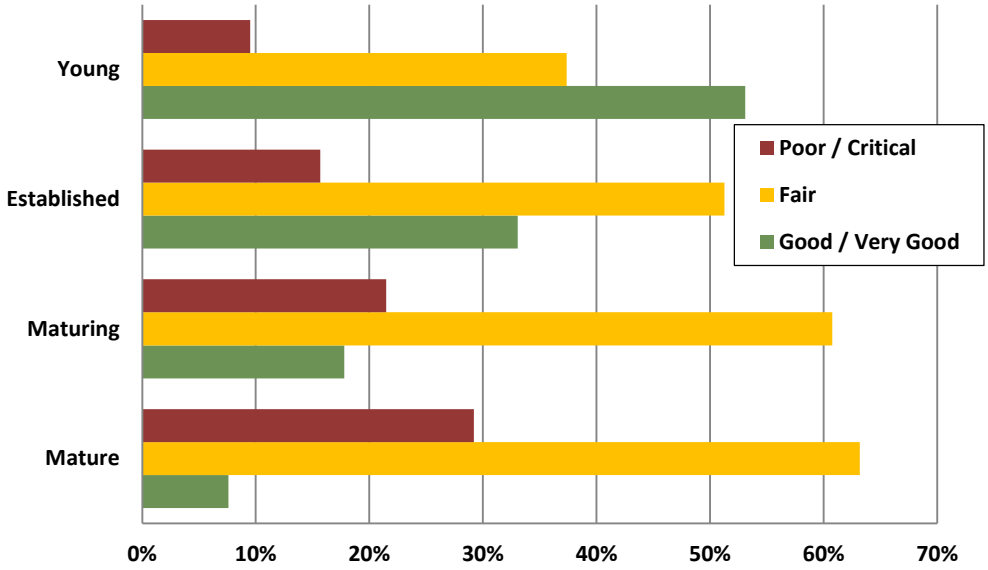


Figure 5. Condition ratings of ROW trees by relative age during the inventory

Findings

Most of the inventoried trees were recorded to be in Fair or Good condition (50% and 33%, respectively). Based on inventory data, the general health of the overall street ROW tree population was rated to be Fair. Figure 5 illustrates that most established, maturing, and mature trees were rated to be in Fair condition, and most the young trees were rated to be in Good/Very Good condition.

Discussion/Recommendations

Even though the condition of Birmingham's inventoried ROW tree population is typical, the conditions found lent some insight into maintenance practices:

- The condition ratings of the inventoried ROW trees were typical of trees growing in an urban setting. However, the City regularly improves the condition of their street trees by removing dead or decaying branches during the established proactive pruning cycles.
- Dead trees and trees in Critical condition should be removed because of their failed health; they most likely will not recover even if care is increased.
- Younger trees rated in Fair or Poor condition may benefit from improvements in structure that in time may improve their health. Pruning practices should follow current professional standards—the ANSI A300 Standards.
- Poor condition ratings given to mature trees were generally due to visible signs of decline and stress, including decay, dead limbs, sparse branching, or poor structure. These trees will require corrective pruning, regular inspections, and possible intensive plant health care to improve their health.
- Related to the long-term general health of the urban forest is the need for proper tree care practices. Birmingham's forestry program includes many long-term and proactive practices to manage its urban forest; as a result, most of the street ROW tree population is in Fair and Good condition (50% and 33%, respectively).
- A model population would have young and established trees in Good and Very Good condition and maturing and mature trees in Fair condition; Birmingham's street tree population will be closer to ideal when the overall mature tree health improves.

Infrastructure Conflicts

In an urban setting, space is limited both above and below ground. Trees in this environment may conflict with infrastructure such as buildings, sidewalks, and utility wires and pipes, which in turn may affect people or their vehicles. Existing or possible conflicts between trees and infrastructure (above and below ground) were recorded during the inventory:

- *Clearance Requirements*—The inventory recorded trees that cause physical difficulties for vehicles, pedestrians, or buildings, and trees that block the visibility of traffic signs or signals, streetlights, or other safety devices. This information should be used to schedule pruning activities.
- *Overhead Utilities*—The presence of overhead utility lines above a tree or vacant planting site were noted; it is important to consider these data when planning pruning activities and selecting tree species for planting.
- *Hardscape Damage*—Sometimes trees adversely impact hardscape, which may adversely impact trees. The inventory recorded damage related to trees causing curbs, sidewalks, and other hardscape features to lift; these data should be used to understand future growing requirements related to species needs.

Photograph 7. This silver maple along the ROW is recorded to have overhead utilities as an infrastructure conflict. The pruning that needs to be performed on these large trees can often over-stress them and cause them to be in Poor condition.

Findings

There were 3,532 (24.4%) ROW trees recorded with some type of infrastructure conflict; most were related to overhead utilities (13.9%), which was noted when a tree's canopy interfered directly with overhead utilities or when a tree was located below overhead utilities. During the inventory, 783 trees (5.4%) were noted for clearance conflicts, and 738 trees (5.1%) were noted for hardscape damage.

Table 1. Tree-Related Conflicts Recorded During the Inventory

Tree and Infrastructure Conflict	Number of Trees	Percent of Population
Pedestrian Clearance	531	3.7%
Vehicle Clearance	190	1.3%
Light Clearance	26	0.2%
Sign/Signal Clearance	20	0.1%
Building Clearance	16	0.1%
Overhead Utilities	2,011	13.9%
Hardscape Damage	738	5.1%

Discussion/Recommendations

Tree canopy should not interfere with vehicular and pedestrian traffic; rest on buildings; or block signs, signals, or lights. Pruning to avoid clearance issues and raise tree crowns should be completed in accordance with ANSI A300 Standards. Clearance distance guidelines are: 14 feet over streets; 8 feet over sidewalks; and 5 feet from buildings, signs, signals, or lights.

Planting only small-growing trees within 20 feet of overhead utilities, medium-size trees within 20 to 40 feet, and large-growing trees outside 40 feet will help lessen future conflicts, improve future tree conditions, and lessen costs of maintaining trees under overhead utility lines.

When planting around hardscape, it is important to give the tree enough growing room above ground. Davey recommends the following guidelines for planting trees among hardscape features: give small-growing trees 4 feet and large-growing trees 5 feet or more between hardscape features. In most cases, this will allow for the spread of a tree's trunk taper, root collar, and immediate larger diameter structural roots.

Growing Space Conditions

Information about the type and size of the growing space was recorded. Growing space size was recorded as minimum width of the growing space for root development:

- *Island*—surrounded by pavement or hardscape (for example, parking lot divider or cul-de-sac).
- *Median*—located between opposing lanes of traffic.
- *Natural Area*—large areas providing habitat for wildlife and plant succession.
- *Open/Restricted*—open sites with restricted growing space on two or three sides.
- *Open/Unrestricted*—open sites with unrestricted growing space on at least three sides.
- *Raised Planter*—in an above-grade or elevated planter.
- *Tree Lawn/Parkway*—located between the street curb and the public sidewalk.
- *Well/Pit*—at grade level and completely surrounded by sidewalk.

Findings

Most of the tree population (82%) was located in tree lawns that range between 4 and 20 feet wide with the greatest percentage (13%) in 10-foot tree lawns. Tree species located in 4-foot tree lawns varied among small-, medium- and large-stature trees. Most planting sites were located in tree lawns (87%); other planting sites were located in open/restricted sites (6%), open/unrestricted sites (6%), and islands and medians (1%).

Discussion/Recommendations

Growing space size should guide species choice for planting plans. To prolong the useful life of street trees, small-growing tree species should be planted in tree lawns 4–5 feet wide, medium-size tree species in tree lawns 6–7 feet wide, and large-growing tree species in tree lawns that are at least 8 feet wide. The useful life of a public tree is ended when the cost of maintenance is greater than the value added by the tree; this can be due to increased maintenance needed by a tree in decline or due to the costs of repairing damage caused by the tree's presence in a restricted site.

Other Observations

Observations were recorded during the inventory to further describe a tree's health, structure, or location when more detail was needed.

Findings

Cavity/decay, signs of stress, and poor structure were observed and recorded for ROW trees during the inventory (9%, 3%, and 3%, respectively). The primary species of concern is silver maple (*Acer saccharinum*); these trees show the most signs of cavity/decay, especially as they mature.

Table 2. Observations Recorded During the ROW Tree Inventory

Observation	Number	Percent
Cavity or Decay	1,348	9%
Grate or Guard	50	<1%
Improperly Installed	19	<1%
Improperly Mulched	120	1%
Improperly Pruned	93	1%
Mechanical Damage	296	2%
Memorial Tree	2	<1%
None	11,029	77%
Nutrient Deficiency	154	1%
Other – See Notes	116	1%
Pest Problem	83	1%
Poor Root System	81	1%
Poor Structure	403	3%
Remove Hardware	52	<1%
Serious Decline	222	2%
Signs of Stress	412	3%
Total	**14,480**	**100%**

Photograph 8. The silver maple pictured above has a large cavity with decay that increases the risk of this tree. With the location of the tree, size of defect, and potential for failture, this tree was recorded as a High Risk (risk rating of 7).

Discussion/Recommendations

Trees noted as having poor structure or cavity/decay should be inspected regularly and corrective actions should be taken when warranted. If their condition worsens, removal may be required. Continued proactive tree maintenance will mitigate elevated-risk trees and promote public safety.

Staking should only be installed when necessary to keep trees from leaning (windy sites) or to prevent damage from pedestrians and/or vandals. Stakes should only be attached to trees with a loose, flexible material. Installed hardware that has been attached to any tree for more than one year and hardware that may no longer be needed for its intended purposes should be inspected and removed as appropriate.

As the silver maples throughout Birmingham decline, it is suggested that another, more appropriate species be selected for planting for the specific site restrictions and conditions. Replanting with species other than maple will help improve species diversity.

Further Inspection

This data field indicates whether a particular tree requires further or periodic inspection due to particular conditions that may cause it to be a safety risk and, therefore, hazardous. If a tree was noted for further inspection, Birmingham staff should investigate as soon as possible to determine corrective actions.

Findings

Seven trees were recommended for further inspection: six had decay to an undetermined extent.

Discussion/Recommendations

An ISA Certified Arborist should perform additional inspections of the six trees with decay, with assistance of mechanical equipment. If it is determined that these trees exceed the limit for acceptable risk, the defective part(s) of the trees should be corrected or removed. In some cases, this may require complete removal of a tree.

The tree with possible symptoms of a pest threat should be monitored; if its presence is confirmed, the tree should be evaluated for possible removal or treatment, and the site inspected for potential replacement.

Potential Threats from Pests

Insects and diseases pose two of the most serious threats to tree health. The awareness of insects and diseases and early diagnosis of problems are crucial to ensuring the health and canopy continuity of the ROW trees. Appendix D provides information about some of the current potential threats to Birmingham's trees, including websites where more detailed information can be found.

Many pests target a single species or entire genera. The inventory data were analyzed to provide a general estimate of the percentage of trees susceptible to some of the known pests in Michigan. It is important to note that the figure presents data only from the inventory. Many more trees throughout Birmingham, including those on public and private property, may be susceptible to these invasive pests.

Findings

Asian longhorned beetle (ALB, *Anoplophora glabripennis*) is a known threat to a large percentage of the inventoried street trees. This pest was not detected during the inventory, but if it were to infest Birmingham's urban forest, the City could see severe losses in its tree population. According to 2011 Michigan Forest Health Highlights, ALB is present in Cincinnati, Ohio.

Emerald ash borer (EAB, *Agrilus planipennis*) and Dutch elm disease (DED, *Ophiostoma ulmi*) are present in Birmingham. Evidence was found of both EAB-infested ash (*Fraxinus* spp.) and DED-infested American elm (*Ulmus americana*). There were 137 ash trees inventoried within the street ROW, most of which show some signs of EAB. Of the 112 American elm trees recorded during the ROW tree inventory, only 5 were noted as showing signs of DED. Private trees that were not part of this inventory also showed symptoms.

Discussion/Recommendations

Birmingham has been aware of the signs and symptoms of potential infestations that could impact the health of their urban forest. If a severe threat is observed in their tree population or in a community nearby, action should be taken to mitigate the threat within Birmingham. An integrated pest management plan should be established that includes identifying and monitoring threats, understanding the economic threshold, selecting the correct treatment, properly timing management strategies, recordkeeping, and evaluating results.

With such a small population of ash trees (137 ROW trees, <1% of total) and no significant ash trees within the street ROW, it is suggested that Birmingham remove and replace infested ash trees with large-growing trees (where appropriate, based on restrictions). All remaining ash trees should be inspected annually and removals should be scheduled quickly due to ash wood becoming brittle once infested.

Section 3: Street ROW Tree Management Program

This ROW tree management program was developed to uphold Birmingham's comprehensive vision for preserving its urban forest. It is a seven-year program based on the ROW tree inventory data; it was designed to reduce risk through prioritized tree removal and pruning and to improve tree health and structure through pruning cycles. Other important parts of the program include public outreach and tree planting to mitigate removals and increase canopy cover.

Implementing a tree care program is an ongoing process; however, tree work must always be prioritized to reduce public safety risks. Davey recommends completing the work requirements identified during the inventory based on the risk rating assigned; however, it is also essential to routinely monitor the tree population to identify other High-Risk trees so that they may be systematically alleviated. Pruning cycles and tree planting should be completed regularly; however, priority work (especially trees rated as Severe or High Risk) must at times take precedence to ensure that risk is managed expediently.

How Risk Was Assessed During the Inventory

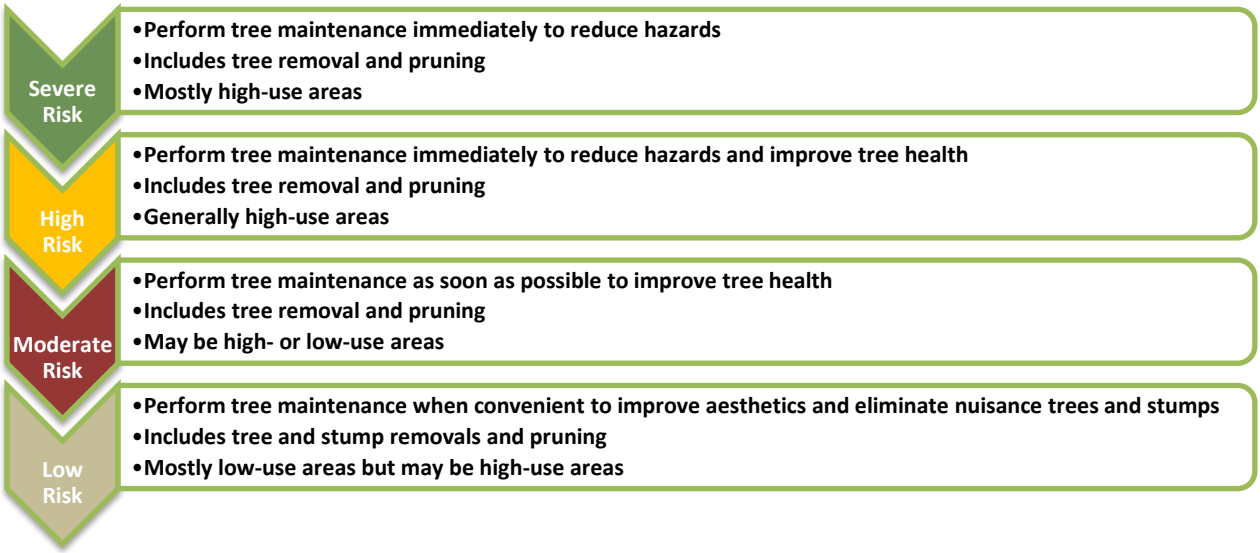
Every tree has an inherent risk of tree failure or defective tree part failure. During the inventory, Davey performed a risk assessment for each tree and assigned a risk rating following protocol based on the USDA Forest Service Community Tree Risk Rating System (Pokorny et al., 2003). The probability of failure, size of defective part, probability of target impact, and other risk factors were evaluated for each tree inventoried. Independent point values were assigned and summed to generate the risk rating.

- *Probability of Failure (1–4 points).* Identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure based on observed, current conditions.
- *Size of Defective Part (1–3 points).* Rates the size of the part most likely to fail.
- *Probability of Target Impact (1–3 points).* Rates the use and occupancy of the area that would be struck by the defective part.
- *Other Risk Factors (0–2 points).* This category is used if professional judgment suggests the need to increase the risk rating. It is especially helpful when growth characteristics become a factor in risk rating. For example, some tree species have growth patterns that make them more vulnerable to certain defects such as weak branch unions and branching shedding.

Once the risk rating is calculated, a level of risk is assigned to each tree based on its risk rating. Severe-Risk trees have a rating of 9 or 10; High-Risk trees, 7 or 8; Moderate-Risk trees, 5 or 6; and Low-Risk trees, 3 or 4. A rating of zero is used only for stumps or vacant planting sites. The assigned risk rating allows for effective prioritization of tree maintenance work.

Trees with elevated (Severe or High) risk levels are usually recommended for removal or for pruning to eliminate the defects that warranted their risk rating. However, in some situations, risk may be reduced by adding support (cabling or bracing) or by moving the target away from the tree. Davey recommends only removal or pruning to alleviate risk. In special situations, such as a significant or memorial tree or a tree in an historic area, Birmingham may decide that cabling, bracing, or moving the target may be an option for alleviating risk.

- *Severe Risk (rating of 9 or 10):* Trees described as Severe Risk have defects that cannot be cost-effectively or practically treated. Most of the trees in this category have multiple or significant defects present in the trunk, crown, or critical root zone. Defective trees and/or tree parts are generally larger than 20 inches in diameter, and these trees are found in areas of frequent occupation, such as a main thoroughfare, congested street, and/or near a school.
- *High Risk (rating of 7 or 8):* Trees designated as High Risk have defects that may or may not be cost-effectively or practically treated. Most of the trees in this category have multiple or significant defects affecting more than 40% of the trunk, crown, or critical root zone. Defective trees and/or tree parts are generally 4 to 20 inches in diameter, and these trees are found in areas of frequent occupation, such as a main thoroughfare, congested street, and/or near a school.
- *Moderate Risk (rating of 5 or 6):* Trees described as Moderate Risk have defects that may be cost-effectively or practically treated. Most of the trees in this category exhibit several moderate defects affecting less than 40% of a tree's trunk, crown, or critical root zone. These trees may be in high-, moderate-, or low-use areas.
- *Low Risk (rating of 3 or 4):* Trees designated as Low Risk have minor visible structural defects or wounds and are typically found in moderate- to low-use areas.
- *None (rating of 0):* Used only for planting sites and stumps (these types of sites were not included in the inventory).



Priority and Proactive Maintenance

For many communities, a proactive tree management program is considered to be a luxury, and an on-demand response to urgent situations is the norm. Research has shown that a proactive program that includes a routine pruning cycle will improve the overall health of a tree population (Miller and Sylvester, 1981). Proactive tree maintenance has many advantages over priority maintenance: the most significant advantage is reduced risk. When trees are assessed and pruned regularly in a proactive program, most defects will be found and eliminated before they escalate to a hazardous situation with an unacceptable level of risk. Other advantages of a proactive program are more predictable budgets and projectable workloads, reduced long-term tree maintenance costs, and increased environmental and economic benefits from trees.

Birmingham's ROW tree population already benefits from the positive results of regular maintenance and the pruning cycle that the City has implemented. The overall risk of the ROW tree population is at a low level: 7.14% of the inventoried ROW trees were rated to be Severe or High Risk, which correlates directly to the proactive techniques that Birmingham has put into practice. These trends will continue if the City maintains its commitment to preserving the urban forest and promoting public safety.

In this Plan, the recommended tree maintenance work was divided into priority or proactive maintenance. Priority maintenance includes removal and pruning of trees with an assessed risk rating of 7 or greater (High and Severe Risk). Proactive tree maintenance includes pruning of trees with an assessed risk of 6 or less (Moderate or Low Risk) and trees that are young. Tree planting, inspections, and community outreach are also considered proactive maintenance.

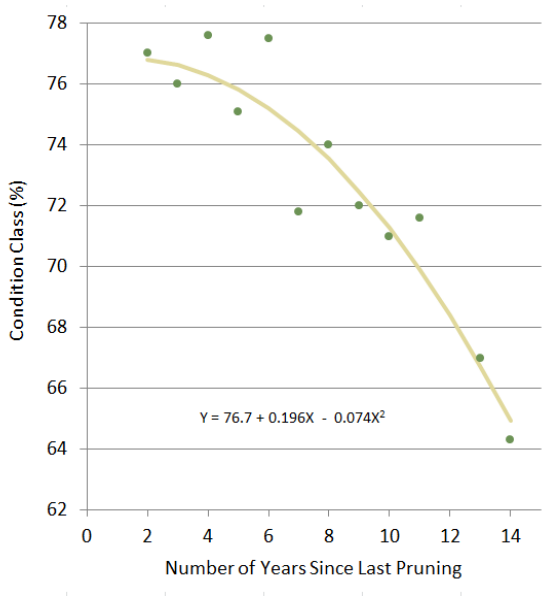


Figure 6. Relationship between average tree condition class and number of years since last pruning (adapted from Miller and Sylvester, 1981)

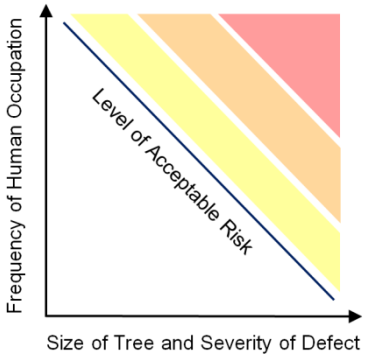
Why Prune Trees on a Cycle?
Miller and Sylvester (1981) examined the frequency of pruning for 40,000 street and boulevard trees in Milwaukee, Wisconsin. They documented a decline in tree health as the length of the pruning cycle increased. When pruning was not completed for more than 10 years, average tree condition was rated 10% lower than when trees had been pruned within the last several years. Miller and Sylvester suggested that a pruning cycle of five years is optimal for urban trees.

Priority Maintenance

Identifying and ranking maintenance needs of a tree population enables tree work to be assigned priority based on observed risk. Once tree work is prioritized, it can be accomplished systematically to eliminate the greatest risk and liability first (Stamen, 2011).

> *Determination of acceptable risk ultimately lies with park staff. Trees often have associated risks; the location of a tree is an important factor in the determination and the acceptability of risk for any given tree. The level of risk associated with a tree increases as the frequency of human occupation increases in the vicinity of the tree. For example, a tree located next to a heavily traveled street will have a higher level of risk than a similar tree in an open field.*

Risk is a graduated scale that measures potential tree-related hazardous conditions. A tree is considered hazardous when the potential risks associated with it exceed an acceptable level. Managing trees for risk reduction provides many benefits:



- Lower frequency and severity of accidents, damage, and injury.
- Less expenditure for claims and legal expenses.
- Healthier, long-lived trees.
- Over time, fewer tree removals.
- Over time, lower tree maintenance costs.

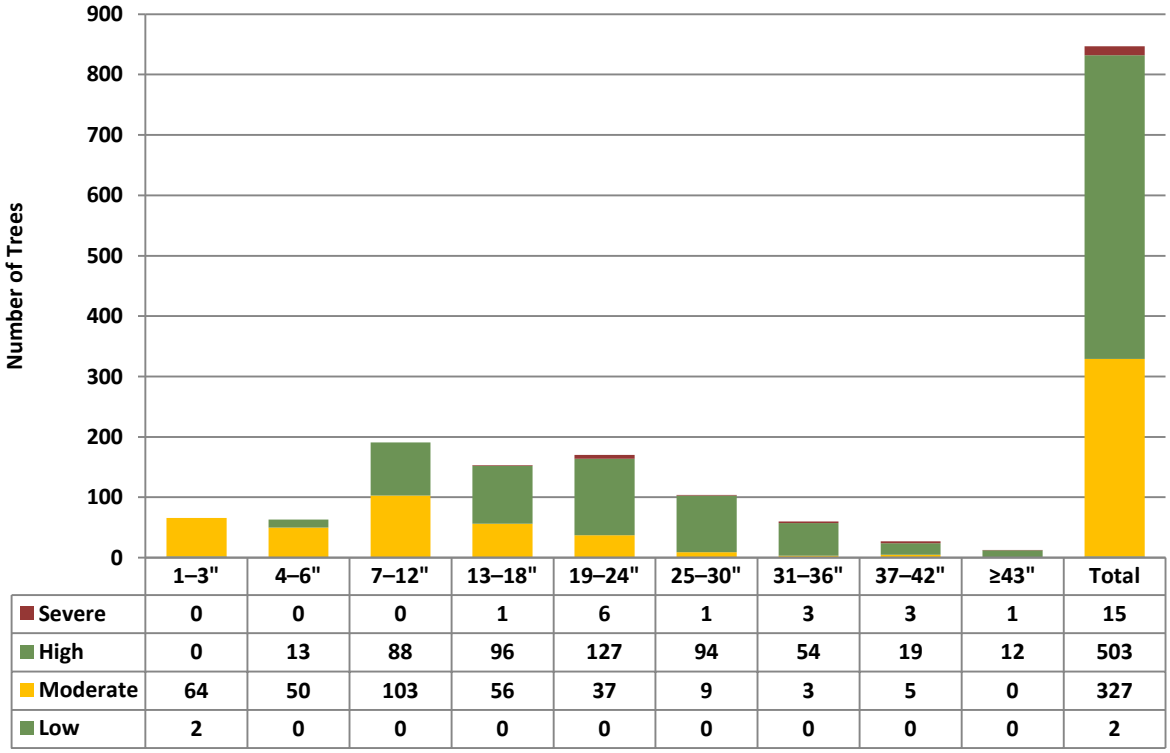
Regularly inspecting trees and establishing tree maintenance cycles generally reduces the risk of failure as problems can be found and addressed before they escalate.

In this plan, Severe- and High-Risk trees recommended for removal or pruning are included in the priority maintenance program.

Priority Tree Removal

Although tree removal is usually considered a last resort and might stir emotions from people in the community, there are circumstances when it is necessary. Trees fail from natural causes, such as diseases, insects, and weather conditions, and from physical injury due to vehicles, vandalism, and root disturbances. Davey recommends that trees be removed when corrective pruning will not adequately eliminate the hazard or when it is cost-prohibitive to correct problems. Trees causing obstructions or interfering with power lines or other infrastructure should be removed when their defects cannot be corrected through pruning or other maintenance practices. Nuisance trees and diseased trees also merit removal.

Even though large, short-term expenditures may often be required, funding and expediently completing priority tree removals is important to reduce risk and promote public safety.



	1–3"	4–6"	7–12"	13–18"	19–24"	25–30"	31–36"	37–42"	≥43"	Total
Severe	0	0	0	1	6	1	3	3	1	15
High	0	13	88	96	127	94	54	19	12	503
Moderate	64	50	103	56	37	9	3	5	0	327
Low	2	0	0	0	0	0	0	0	0	2

Figure 7. ROW trees recommended for removal, by diameter size class and risk rating

Severe Risk

The inventory identified 15 Severe-Risk ROW trees that were recommended for removal. The size of the defect, the probability of failure, or the location of the trees in relation to their surroundings were the reasons for their Severe Risk ratings. These trees are medium to large in size (over 13 inches DBH) and should be removed immediately to promote public safety. Severe-Risk removals can be performed concurrently with Severe-Risk pruning.

High Risk

High-Risk removals have observable and sizeable defects with elevated probabilities of failure. The location of these trees in relation to their surroundings also increases their risk. The inventory identified 503 High-Risk ROW trees recommended for removal. The diameter size classes for these trees ranged from 4–6 inches DBH to >43 inches DBH. These trees should be removed immediately because of their assigned risk. Severe- and High-Risk removals and prunings can be performed concurrently.

Moderate Risk

Tree removals in this category still pose some risk, but have a smaller size of defect and/or less potential for target impact. The inventory identified 327 Moderate-Risk ROW trees recommended for removal. Most Moderate-Risk trees were smaller than 25 inches DBH. These trees should be removed as soon as possible after all Severe- and High-Risk removals and prunings have been completed.

Low Risk

Low-Risk removals pose little threat; these trees are generally small, dead, invasive, or poorly formed trees that need to be removed. Eliminating these trees will reduce breeding site locations for insects and diseases and will increase the aesthetic value of the area. Healthy trees growing in poor locations or undesirable species are also included in this category.

The inventory identified 2 Low-Risk ROW trees recommended for removal; both of these trees were smaller than 3 inches DBH. All Low-Risk trees should be removed when convenient and after all Severe-, High-, and Moderate-Risk removals and prunings have been completed.

Discussion/Recommendations

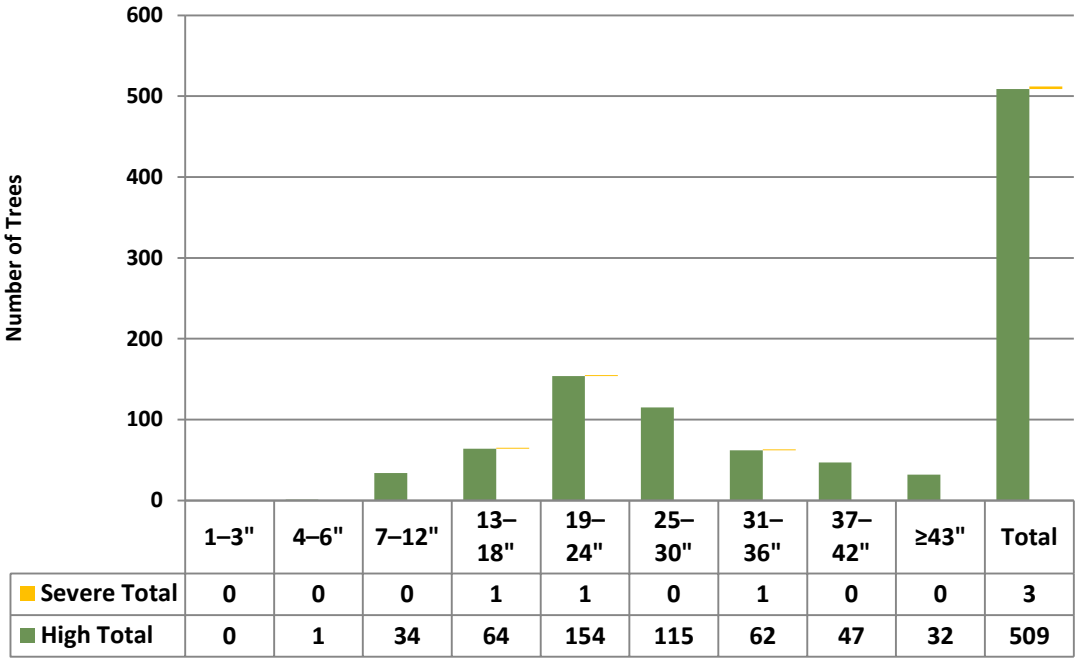
A total of 847 (5.85%) ROW trees were recommended for removal during the inventory. To keep these numbers to a minimum, the City should continue the proactive pruning program they currently have in place. Proactive tree maintenance mitigates elevated risks, increases the vitality of the urban forest, and promotes public safety.

Trees noted having poor structure (403 trees) or cavity or decay (1,348 trees) should be inspected on a regular basis and corrective actions should be taken when warranted. If their condition worsens, removal may be required.

The use of structural support can reduce risk for some trees observed to have poor structure. Cabling and bracing are the two most common forms of structural support for trees. Generally, this involves installing flexible cables or rigid rods to reduce the chances of failure of defective unions. If the decision is made that a tree needs structural support, there are a few basic considerations. First, an ISA Certified Arborist who is knowledgeable and experienced in this area should oversee or perform this work. Second, pertinent technical aspects of correct cabling and bracing must be followed: appropriate hardware material and strength; appropriate arrangement of cables (for example, simple, triangle, or box) or rods (for example, single or multiple); and the specific location, type, and size of entries made into the tree. Lastly and most importantly, it should be specified and documented that “all work and materials shall be in accordance with ANSI, A300 Tree Care Standards (Part 3), 2011.”

Priority Pruning

Priority pruning generally requires cleaning the canopy of both small and large trees to remove hazardous defects such as dead and/or broken branches that may be present even when the rest of the tree is sound. In these cases, pruning the branch or branches can correct the problem and alleviate risk associated with the tree. Priority pruning includes trees with Severe and High risk. Figure 8 presents the ROW trees recommended for pruning during the inventory, categorized by risk and by diameter size class.



	1–3"	4–6"	7–12"	13–18"	19–24"	25–30"	31–36"	37–42"	≥43"	Total
Severe Total	0	0	0	1	1	0	1	0	0	3
High Total	0	1	34	64	154	115	62	47	32	509

Figure 8. ROW trees recommended for pruning, by diameter size class and risk rating

Severe Risk

Only 3 Severe-Risk ROW trees were recommended for pruning during the inventory. The size of the defect, probability of failure, or location of the trees in relation to their surroundings were the reasons for their elevated risk ratings. This pruning should be performed at the same time as the Severe- and High-Risk removals.

High Risk

High-Risk trees recommended for pruning have observable and sizeable defects with elevated probabilities of failure. The location of these trees in relation to their surroundings also increases their risk. The inventory identified 509 High-Risk ROW trees recommended for pruning. The diameter size classes for these trees ranged from 4–6 inches DBH to >43 inches DBH. This pruning should be performed immediately because of assigned risk and may be done at the same time as other Severe and High-Risk removals and prunings.

Discussion/Recommendations

The ROW tree inventory identified only 512 Severe- and High-Risk trees for pruning; this is a good indication that Birmingham's proactive pruning program mitigates risk in the urban forest. Figure 8 illustrates the need for a proactive pruning cycle operation that the City has been performing.

Proactive Maintenance

Proactive tree maintenance requires that trees are managed and maintained under the responsibility of an individual, department, or agency. Typically, tree work is performed during a cycle. Individual tree health and form are routinely addressed during the cycle. When trees are planted, they are planted selectively and with purpose. Ultimately, proactive tree maintenance should reduce crisis situations in the urban forest as every tree in the managed population is visited, assessed, and maintained regularly. Davey recommends proactive tree maintenance that includes pruning cycles, inspections, and planned tree planting.

Pruning Cycles

The goals of pruning cycles are to visit, assess, and prune trees on a regular schedule to improve health and reduce risk. Typically, Davey recommends that pruning cycles begin after all Severe- and High-Risk trees are corrected through priority removal or pruning. However, because of the long-term benefit that will come from the continuation of Birmingham's routing pruning cycles, Davey recommends it continue to be implemented. To ensure all trees receive the type of pruning they need to mature with better structure and fewer hazards, two pruning cycles are recommended: the young tree training cycle (YTT Cycle) and the routine pruning cycle (RP Cycle). The cycles differ in the type of pruning, the general age of the tree they target, and the length of the cycle.

Photograph 9. Continued planting of young trees such as this Japanese zelkova* (Zelkova serrata) *will not only increase species diversity but will also ensure a lasting urban forest.

YTT Cycle

Young trees are generally 8 inches DBH or smaller. Young trees sometimes have branch structures that can lead to potential problems as the tree ages: codominant leaders, many limbs attaching at the same point on the trunk, or crossing/interfering limbs are common problems. If these problems are not corrected, they may worsen as the tree grows, increasing risk and creating potential liability.

YTT pruning is performed to improve tree form or structure; the recommended length of a YTT Cycle is three years because young trees tend to grow at faster rates (on average) than more mature trees.

The YTT Cycle differs from the RP Cycle in that these trees generally can be pruned from the ground with a pole pruner or pruning shear, with the objective to increase structural integrity by pruning for one dominant leader. Of course, this is species-specific since many trees such as river birch (*Betula nigra*) may naturally have more than one leader. For these trees, YTT pruning is used to develop a strong structural architecture of branches so that future growth will lead to a healthy, structurally sound tree.

Discussion/Recommendations

Davey recommends that ABC implement a three-year YTT Cycle to commence after all Severe- and High-Risk trees are removed or pruned. The YTT Cycle will include existing young trees and newly planted trees.

During the inventory, 4,989 (34%) young trees (up to 8 inches DBH) were inventoried and 150 trees were recommended for planting each year. Since the number of young trees present is relatively high and the City has a high stocking percent of approximately 95%, the benefit of maintaining a YTT Cycle is high.

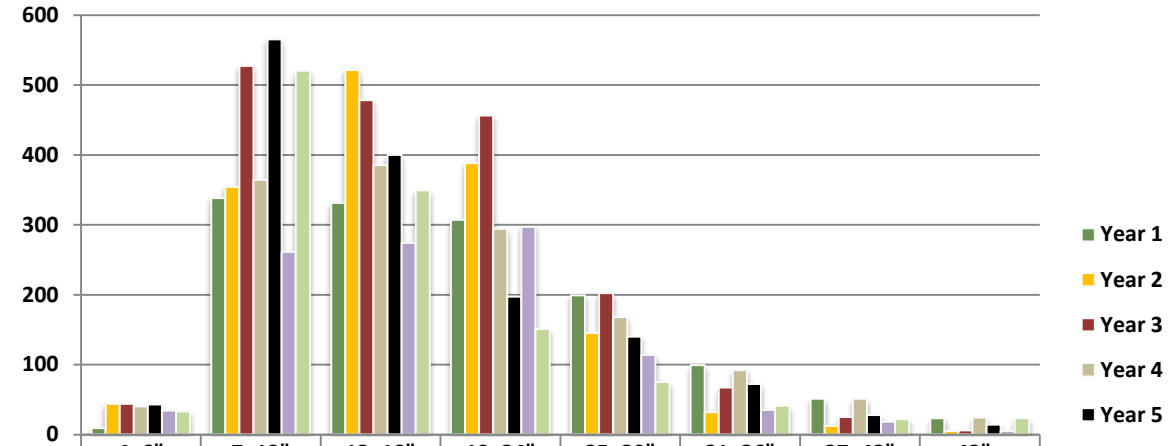
Davey recommends pruning start at the beginning of the program to promote healthy growth with structural integrity. In Year 1 of the program, 150 trees were recommended for planting. If accomplished, these newly planted trees will enter the YTT Cycle in Year 3 and, thus, the projected structural pruning needs for Year 3 will equal the number of trees planted in Year 1 and the 1,374 already recommended for a YTT.

In future years, the number of trees in the YTT Cycle will be based on tree planting efforts and growth rates of young trees. The City should strive to prune approximately one-third of its young and newly planted trees each year.

RP Cycle

The RP Cycle includes small and large trees (most trees >6 inches DBH) that need cleaning and crown raising and reducing to remove deadwood and to improve structure. It is important that the City continue the established proactive maintenance program to improve the overall health of the urban forest. Over time, routine pruning has improved tree health and reduced risk, as most problems with individual trees are corrected before they escalate into more costly priority tree work. Included in this cycle are Moderate- and Low-Risk trees that require pruning and that pose some risk but have a smaller size of defect and/or less potential for target impact. The hazards found within these trees can usually be remediated during the RP Cycle.

The length of the RP Cycle is based on the size of the tree population and what was assumed to be a reasonable number of trees for a program to prune per year. Generally, the RP Cycle recommended for a tree population is five years but may extend to seven years if the population is large, such as it is in Birmingham.



	4–6"	7–12"	13–18"	19–24"	25–30"	31–36"	37–42"	43"+
Year 1	9	338	331	307	199	99	51	23
Year 2	44	354	521	388	145	32	12	5
Year 3	44	527	478	456	202	67	25	6
Year 4	40	364	385	294	168	92	51	24
Year 5	43	565	400	197	140	72	28	14
Year 6	34	261	274	297	114	35	18	5
Year 7	33	520	349	151	75	41	22	23

Figure 9. ROW trees recommended for the RP Cycle by diameter size class

Discussion/Recommendations

The City has established pruning zones and they are represented in the recommended Plan. Davey recommends that the City continue its seven-year RP Cycle; approximately one-seventh of the street ROW trees should be pruned each year. Based on the designated maintenance pruning zones currently in use by the City, approximately 1,400 trees will need to be visited and pruned each year. Davey recommends that Birmingham expand its established cycle to include the completion of all severe- and High-Risk tree maintenance by the end of Year 2.

The inventory found most trees (67%) on the street ROW needed routine pruning, not including those in the YTT cycle. Figure 9 shows that a variety of tree sizes will require pruning; however, most trees that require routine pruning were smaller than 24 inches DBH. By continuing the RP cycle Birmingham will continue to see benefits of reduced risk throughout the City's urban forest.

Pruning Cycle Progression

The recommended number of trees in the pruning cycles will need to be modified to reflect changes in the tree population as trees are planted, age, and die. Newly planted trees will enter the YTT Cycle once they are established (generally one to two years after planting). As young trees reach maturity, they will be removed from the YTT Cycle and be included in the RP Cycle. When a tree reaches the end of its useful life, it should be removed and, thus, eliminated from the RP Cycle.

Inspections

Inspections are essential to unveiling potential problems with trees. Trees along the street ROW should be inspected regularly and attended to as needed based on the inspection findings. When trees need additional or new work, they should be added to the maintenance schedule and included in the budget as appropriate. In addition to locating new hazards, inspections are an opportunity to look for signs and symptoms of pests and diseases.

Birmingham has a large population of trees susceptible to pests and diseases, including a variety of maple species, a target for the ALB; oaks that are susceptible to oak wilt.

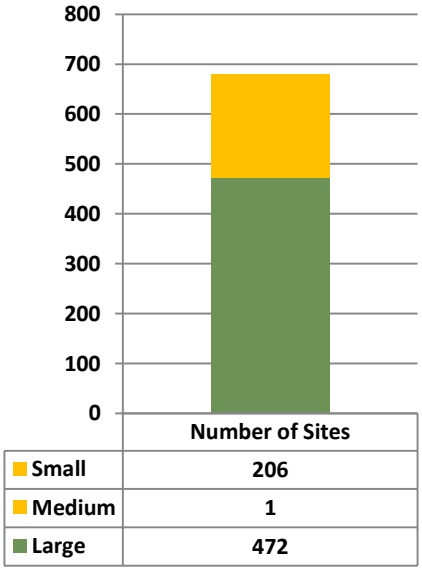


Figure 10. Planting sites identified by mature tree size

Tree Planting

Planting trees is a worthwhile goal as long as trees species are carefully selected and correctly planted. Without upfront planning and follow-up tree care, a newly planted tree may become a future problem instead of a benefit.

When planting trees:

- Consider the specific purpose of the tree planting.
- Assess the site and know its limitations, for example, overhead wires, confined spaces, soil type.
- Select the species or cultivar that best matches site conditions.
- Examine trees before buying them, and buy for quality.

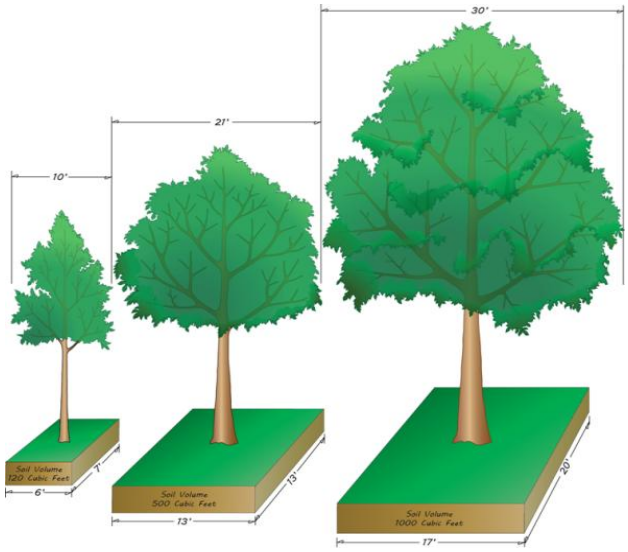


Illustration based on the work of Casey Trees, 2008.

Inventoried Street ROW Planting Space

The goal of tree planting is to have a vigorous, healthy tree that lives to the limits of its natural longevity. That can be difficult to achieve in an urban growing environment because the soils there are typically poor and irrigation is limited. However, proper planning, species selection, tree planting techniques, and follow-up tree maintenance will improve the chance of tree planting success.

Findings

During the inventory, 679 vacant planting spaces were noted with approximately 69% of those sites being for small-sized mature trees (Figure 10), 30% for large-sized trees, and less than 1% for medium-sized trees. Small-sized trees were recommended where the growing space was either too small for a medium- or large-sized species or where overhead utilities were present.

Tree Species Selection

Selecting a limited number of species could simplify decision-making processes; however, careful deliberation and selection of a wide variety of species will benefit all and save money. Planting a variety of species can decrease the impact of species-specific pests and diseases by limiting the number of susceptible trees in a population, which will reduce the time and money spent to mitigate the problem if such an event were to occur. A wide variety of tree species may help to limit the impacts from physical events such as strong storms, wind, ice, flooding, and drought, as different species react differently to stress.

Birmingham is located in USDA Hardiness Zone 6a, which identifies a climatic region where the average annual minimum temperature is between −10° and −5° Fahrenheit. Tree species selected for planting in Birmingham should be appropriate for this zone.

Tree species should be selected for their durability and low-maintenance characteristics. These attributes are highly dependent on site characteristics below ground (soil texture, soil structure, drainage, soil pH, nutrients, road salt, and root spacing). Matching a species to its favored soil conditions is the most important task when planning for a low-maintenance landscape. Plants that are well-matched to their environmental site conditions are much more likely to resist pathogens and insect pests and will, therefore, require less maintenance overall.

The relationship between species mature growth-habit and site restrictions should be carefully considered before planting. The size of each site is of great importance, including maximum desired height and spread due to overhead utilities, and proximity to buildings and infrastructure. Proper site selection can minimize costs, ensuring the most productive use of the City's resources.

A major consideration for street trees is the amount of litter dropped by mature trees. Trees such as Callery pear (*Pyrus calleryana*) have weak wood and typically drop many small branches during a growing season. Others, such as American sweetgum (*Liquidambar styraciflua*), drop high volumes of woody, multiple capsules (gumballs). In certain species, such as ginkgo, female trees produce offensive/large fruit, but male trees produce no fruit. Furthermore, a few species of trees, including honeylocust (*Gleditsia triacanthos*), and black locust (*Robinia pseudoacacia*), may have substantial thorns. These species should be avoided in high-traffic areas.

Seasonal color should also be considered when planning tree plantings. Flowering varieties are particularly welcome in the spring, and deciduous trees that display bright colors in autumn can add a great deal of interest to surrounding landscapes.

Appendix C lists tree species recommended for planting based on inventory findings; this list provides expected height at maturity for each species and is designed to promote species diversity.

Findings

Davey recommends restricting the planting of maple (*Acer*) until the species distribution normalizes. Maple species represent 47.6% of the street ROW trees, which is well in excess of the recommended maximum limit for a genus (20% of the population). Planting of other large-sized tree species will increase diversity and provide more benefits to the community.

Discussion/Recommendations

Planting of any maple species or honeylocust should be restricted throughout the City. Honeylocust and the maple species have exceeded diversity standards; together, they comprise 66% of the street ROW trees and 24.3% of the inventoried trees on the two golf courses. Maple is a target of ALB; adding to the maple population will only make the potential for loss greater if ALB invades Birmingham's urban forest. Planting a wide variety of hardwoods will help reduce the threat of ALB as the urban forest will be more diverse.

Tips for Planting Trees

To ensure a successful tree planting effort:

- Handle trees with care. Trees are living organisms and are perishable. Protect trees from damage during transport and when loading and unloading. Use care not to break branches, and do not lift it by the trunk.
- If trees are stored prior to planting, keep the roots moist.
- Dig the planting hole according to the climate. Generally, the planting hole is two to three times wider and not quite as deep as the root ball. The root flair is at or just above ground level.
- Fill the hole with native soil unless it is undesirable, in which case, add soil amendments as appropriate for local conditions. Gently tamp and add water during filling to reduce large air pockets to ensure a consistent medium of soil, oxygen, and water.

Photograph 10. Mulching that is piled too deep and touching the trunk will harm and could potentially kill the tree.

- Stake the tree as necessary to prevent it from shifting too much in the wind.
- Add a thin layer (1 to 2 inches) of mulch to help prevent weeds and keep the soil around the tree moist. Do not allow mulch to touch the trunk.

Newly Planted and Young Tree Maintenance

Equal in importance to planting trees is caring for them after they are planted. After a tree has been planted, it must receive maintenance for several years; Appendix E provides for planting guidelines.

Watering

Initially, watering is the key to survival; new trees typically require at least 60 days of watering to establish. Determine how often to irrigate trees based on time of planting, drought status, species selection, and site condition.

Mulching

Mulch can be applied to the growing space around a newly planted tree, or even a more mature tree, to ensure that no weeds grow, the tree is protected from mechanical damage, and the growing space is moist. Mulch should be applied in a thin layer, generally one to two inches, and the growing area covered. Mulch should not touch the tree trunk or be piled up around the tree.

During the inventory, it was noted that several trees were improperly mulched. In some cases, the mulch had decayed into an organic soil, promoting conditions for the formation of girdling roots. Davey suggests that any mulch piled up around a tree should be spread out into a thin layer over the growing space and moved away from the trunk. Appendix F discusses proper mulching techniques.

Community Outreach

The data that have been collected and analyzed to develop this Plan contribute significant information about the tree population and can be utilized to guide the proactive management of that resource. These data can also be utilized to promote the value of the urban forest and the tree management program:

- Tree inventory data can be utilized to justify needed priority and proactive tree maintenance activities as well as tree planting and preservation initiatives.
- Species data can be utilized to guide the development of tree species selection for planting projects with the objective to improve species diversity and limit the introduction of invasive species.
- Information in this Plan can be utilized to advise citizens about the presence of threats to urban trees such as ALB and EAB.

Various avenues for outreach exist. Maps can be created and posted on websites, in parks, or in business areas. Public service announcements can be developed. Articles can be written and programs developed about trees and the benefits they provide. Arbor Day or Earth Day celebrations can be publicized and signs can be hung from trees to show the contributions trees make to the community. Even contests can be created to make people aware that trees are important. It is a fact that because of trees, we have the oxygen we need to breathe, shade to cool our neighborhoods, and canopies to stand under to get out of the rain.

Birmingham has the data to provide solid, meaningful outreach about the urban forest.

Inventory and Plan Updates

Davey recommends that the inventory and the Plan be updated so that the Birmingham can sustain its program and accurately project future program and budget needs:

- Conduct inspections of trees after all severe weather events. Record changes in tree condition, maintenance needs, and risk rating/risk in the inventory database. Update the tree maintenance schedule and acquire the funds needed to promote public safety. Schedule work based on risk.
- Perform routine inspections of public trees as needed. “Windshield surveys” will help City staff stay current regarding changing conditions. Update the tree maintenance schedule and the budget as needed so that identified tree work may be performed efficiently. Schedule work based on risk.
- If the recommended work cannot be completed as suggested in the Plan, modify maintenance schedules and budgets accordingly.
- Update the inventory database as work is performed. Add new tree work to the schedule when work is identified through inspections or a citizen call process.
- Re-inventory the street ROW and golf courses in five to seven years, updating all data fields.
- Revise the Public Tree Management Plan after five or seven years when the re-inventory has been completed.

Maintenance Schedule

Utilizing data from the 2012 Birmingham street ROW tree inventory, an annual maintenance schedule was developed detailing the number and type of tasks recommended for completion each year. Budget projections were made by Davey utilizing industry knowledge and public bid tabulations; actual costs were not specified by the City of Birmingham. A summary of the maintenance schedule is presented below, and the complete projected work plan and estimated costs for the seven-year management plan for street ROW trees is presented in Appendix G.

The schedule provides a framework for completing the inventory maintenance recommendations in seven years. Following this schedule can help in alleviating any immediate risk while maintaining the current seven-year pruning cycle.

To implement the recommended maintenance schedule, the City's tree maintenance budget should be no less than $600,475 for the first year of implementation. However, to reduce costs during the first few years, the City has the option to suspend annual pruning until all Severe- and High-Risk maintenance has been completed. Annual budget funds are needed to ensure that hazard trees are remediated, that the critical RP Cycle may continue, and that the YTT Cycle can be established. With continued proper professional tree care, the safety, health, and beauty of the urban forest will continue to improve.

If routing efficiencies and/or contract specifications allow for the accomplishment of more tree work, or if the schedule requires modification to meet budgetary or other needs, then it should be modified accordingly. Unforeseen situations such as storms may arise and change the maintenance needs of trees. Should conditions or maintenance needs change, budgets and equipment will need to be adjusted to meet the new demands.

Year 1 $600,475

- 417 priority removals
- 3 priority prunings
- RP Cycle Zone 1: 1,357 trees cleaned
- YTT Cycle: 1,213 trees structurally pruned
- 150 trees recommended for planting
- Inclusion of newly found priority tree work (removal or pruning): costs to be determined

Year 2 $502,370

- 428 priority removals
- 509 priority prunings
- RP Cycle Zone 2: 1,501 trees cleaned
- YTT Cycle: 1,254 trees structurally pruned
- 150 trees recommended for planting
- Inclusion of newly found priority tree work (removal or pruning): costs to be determined

Year 3 $329,615

- 2 priority removals
- 19 stump removals
- RP Cycle Zone 3: 1,805 trees cleaned
- YTT Cycle: 1,374 trees structurally pruned
- 150 trees recommended for planting
- Inclusion of newly found priority tree work (removal or pruning): costs to be determined

Year 4 $292,605

- RP Cycle Zone 4: 1,418 trees cleaned
- YTT Cycle: 1,213 trees structurally pruned
- 150 trees recommended for planting
- Inclusion of newly found priority tree work (removal or pruning): costs to be determined

Year 5 $268,910

- RP Cycle Zone 5: 1,459 trees cleaned
- YTT Cycle: 1,255 trees structurally pruned
- 150 trees recommended for planting
- Inclusion of newly found priority tree work (removal or pruning): costs to be determined

Year 6 $224,260

- RP Cycle Zone 6: 1,038 trees cleaned
- YTT Cycle: 1,374 trees structurally pruned
- 150 trees recommended for planting
- Inclusion of newly found priority tree work (removal or pruning): costs to be determined

Year 7 $227,375

- RP Cycle Zone 7: 1,214 trees cleaned
- YTT Cycle: 1,213 trees structurally pruned
- 150 trees recommended for planting
- Inclusion of newly found priority tree work (removal or pruning): costs to be determined

Section 4: Golf Course Tree Management Program

During the inventory, Davey recorded trees located within two golf courses that are city owned and operated; a total of 834 trees were inventoried: 426 trees within Lincoln Hills Golf Course and 408 trees within Springdale Golf Course. Planting site recommendations were not recorded.

Tree removals and Severe- and High-Risk prunings are included in the priority maintenance program of this Plan.

Photograph 11. Birmingham's golf courses provide a unique area for trees to flourish and grow with minimal environmental stresses usually found in urban environments.

Priority Tree Removal

Tree removal is usually considered a last resort, but there are circumstances when it is necessary. Parks and Golf Courses provide a more natural area for trees to grow, and are typically presented with a lower level of stress than street ROW trees. Table 11 presents the golf course trees recommended for removal during the inventory, categorized by risk and by diameter size class.

Severe Risk

The golf course inventory identified only one Severe-Risk tree that was recommended for removal. The size of the defect, probability of failure, or location of the tree in relation to its surroundings were reasons for its Severe Risk rating. This large tree (in the 37–42-inches DBH size class) should be removed immediately to promote public safety. Severe-Risk removals can be performed concurrently with Severe-Risk pruning.

High Risk

High-Risk removals have observable and sizeable defects with elevated probabilities of failure. The location of these trees in relation to their surroundings also increases their risk. The golf course inventory identified 24 High-Risk trees recommended for removal. The diameter size classes for these trees ranged from 4–6 inches DBH to >43 inches DBH. These trees should be removed immediately because of their assigned risk. Severe- and High-Risk removals and prunings can be performed concurrently.

Moderate Risk

Tree removals in this category still pose some risk, but have a smaller size of defect and/or less potential for target impact. The golf course inventory identified 29 Moderate-Risk trees recommended for removal. Most Moderate-Risk trees were smaller than 19 inches DBH. These trees should be removed as soon as possible after all Severe- and High-Risk removals and prunings have been completed.

Table 3. Golf Course Trees Recommended for Removal, by Diameter Size Class and Risk Rating

Diameter Size Class (Inches)	Severe	High	Moderate	Low	Total
1–3"	0	0	6	0	6
4–6"	0	2	7	0	9
7–12"	0	5	12	0	17
13–18"	0	4	3	0	7
19–24"	0	7	0	0	7
25–30"	0	2	0	0	2
31–36"	0	0	1	0	1
37–42"	1	1	0	0	2
≥43"	0	3	0	0	3
Total	**1**	**24**	**29**	**0**	**54**

Discussion/Recommendations

The golf course inventory identified 54 trees (6.47% of the total golf course trees) recommended for removal. To keep these numbers to a minimum the City should implement a proactive pruning program such as the one that is used for the street ROW trees.

Trees that were noted as showing signs of stress (61 trees) or cavity/decay (53 trees) should be inspected on a regular basis and corrective actions should be taken when warranted. If their condition worsens, removal may be required.

During the golf course inventory, 21 trees were noted with mechanical damage. This stress factor is mainly due to damage from lawnmowers and string trimmers; to mitigate this risk, Davey recommends that mulch be applied around the bases of the trees. Proper mulching techniques are provided in Appendix F. By mulching trees in a golf course setting, the City will eliminate the need to mow around the trunks of the trees, thus alleviating the damage mowing would cause.

Priority Pruning

Priority pruning generally requires cleaning the canopy of both small and large trees to remove hazardous defects such as dead and/or broken branches that may be present even when the rest of the tree is sound. In these cases, pruning the branch or branches can correct the problem and alleviate risk associated with the tree. Priority pruning includes trees with Severe and High risk.

Table 4 presents golf course trees recommended for pruning during the inventory, categorized by risk and by diameter size class.

Table 4. Golf Course Trees Recommended for Pruning, by Diameter Size Class and Risk Rating

Diameter Size Class (Inches)	Severe Tree Clean	Severe Total	High Tree Clean	High Total
1" - 3"	0	0	0	0
4" - 6"	0	0	0	0
7" - 12"	0	0	3	3
13" - 18"	0	0	5	5
19" - 24"	0	0	6	6
25" - 30"	0	0	12	12
31" - 36"	0	0	7	7
37" - 42"	0	0	0	0
>43"	1	1	4	4
Total		**1**		**37**

Severe Risk

The golf course inventory identified only one Severe-Risk tree recommended for pruning. The size of the defect, probability of failure, or location of the tree in relation to its surroundings were reasons for its elevated risk rating. This pruning should be performed immediately, at the same time as the Severe- and High-Risk removals.

High Risk

High-Risk trees recommended for pruning have observable and sizeable defects with elevated probabilities of failure. The location of these trees in relation to their surroundings also increases their risk. The golf tree inventory identified 37 High-Risk trees recommended for pruning. The diameter size classes for these trees ranged from 7–12 inches DBH to >43 inches DBH. This pruning should be performed immediately because of assigned risk and may be done at the same time as other Severe- and High-Risk removals and prunings.

Discussion/Recommendations

The golf course tree inventory identified only 38 Severe- or High-Risk trees that were recommended for pruning; this number is relatively low, even though the City does not have an established pruning program for the golf courses. However, Davey recommends that the City initiate pruning cycles to keep this number to a minimum and to establish a healthy forest in its golf courses.

Proactive Maintenance

Proactive tree maintenance requires that trees are managed and maintained under the responsibility of an individual, department, or agency. As with the street ROW tree population, the golf course tree work should be performed during cycles, where individual tree health and form are routinely addressed during the cycle. When trees are planted, they are planted selectively and with purpose. Ultimately, proactive tree maintenance should reduce crisis situations in the urban forest as every tree in the managed population is visited, assessed, and maintained regularly and tree planting is planned.

Pruning Cycles

The three-year YTT Cycle recommended for golf course trees should commence during the first year of the Plan. During the golf course inventory, 270 (32.37%) young trees were inventoried and 10 trees were recommended for planting each year. The 10 trees recommended for planting represent the replacement of approximately 1% of the tree population for natural mortality. Since the number of young trees present is relatively high, the benefit of developing a YTT Cycle is key. Davey recommends pruning start at the beginning of the program to promote healthy growth with structural integrity. In Year 1 of the program, 10 trees were recommended for planting. If accomplished, these newly planted trees will enter the YTT Cycle in Year 3 and the projected structural pruning needs for Year 3 will equal about 100 young trees, these being the 90 already recommend for YTT and the 10 recommended to be planted.

In future years, the number of trees in the YTT Cycle will be based on tree planting efforts and growth rates of young trees. The City should strive to prune approximately one-third of the young and newly planted trees each year.

RP Cycle

The City has already established a seven-year RP Cycle for their ROW trees. The golf course trees do not need to be on such a long pruning cycle due to their lower numbers.

Discussion/Recommendations

The recommended length of the RP Cycle for the golf course trees is five years; approximately one-fifth of these trees should be pruned each year. Based on the designated maintenance pruning zones currently in use by the City, on average approximately 100 trees will need to be visited and pruned each year. Davey recommends that the City begin as soon as possible to increase the overall health of the trees throughout the golf courses. Starting the RP Cycle in Year One of the program, after the Severe- and High-Risk trees are managed will ensure a healthy forest.

Maintenance Schedule

Utilizing data from the golf course tree inventory, an annual maintenance schedule was developed detailing the number and type of tasks recommended for completion each year. Davey made budget projections utilizing industry knowledge and public bid tabulations; actual costs were not specified by the City. A summary of the maintenance schedule is presented below, and the complete projected work plan and estimated costs for the five-year management plan for golf course trees is presented in Appendix H.

The schedule provides a framework for completing the inventory maintenance recommendations in five years. Following this schedule can help in alleviating immediate risk as well as maintaining a healthy forest.

To implement the recommended maintenance schedule, the City's golf course tree maintenance budget should be no less than $43,505 for the first year of implementation. Annual budget funds are needed to ensure that hazard trees are remediated and that critical RP and YTT Cycles can be established. With proper professional tree care, the safety, health, and beauty of the urban forest within the golf courses will improve.

Photograph 12. Trees like this American sycamore (*Platanus occidentalis*) at Springdale Golf Course will benefit from a pruning cycle program. By maintaining these trees on a regular basis, Birmingham can maximize their benefits for many years into the future.

If routing efficiencies and/or contract specifications allow for the accomplishment of more tree work, or the schedule requires modification to meet budget or other needs, then it should be modified accordingly. Additionally, unforeseen situations such as storms may arise and change the maintenance needs of trees. Should conditions or maintenance needs change, budgets and equipment will need to be adjusted to meet the new demands.

Year 1

$43,505

- 25 priority removals
- 12 priority prunings
- RP Cycle: 103 trees cleaned
- YTT Cycle: 90 trees structurally pruned
- 10 trees recommended for planting
- Inclusion of newly found priority tree work (removal or pruning): costs to be determined

Year 2

$32,095

- 29 priority removals
- 26 priority prunings
- RP Cycle: 102 trees cleaned
- YTT Cycle: 90 trees structurally pruned
- 10 trees recommended for planting
- Inclusion of newly found priority tree work (removal or pruning): costs to be determined

Year 3

$21,975

- RP Cycle: 101 trees cleaned
- 7 stump removals
- YTT Cycle: 90 trees structurally pruned
- 10 trees recommended for planting
- Inclusion of newly found priority tree work (removal or pruning): costs to be determined

Year 4

$21,670

- RP Cycle: 100 trees cleaned
- YTT Cycle: 90 trees structurally pruned
- 10 trees recommended for planting
- Inclusion of newly found priority tree work (removal or pruning): costs to be determined

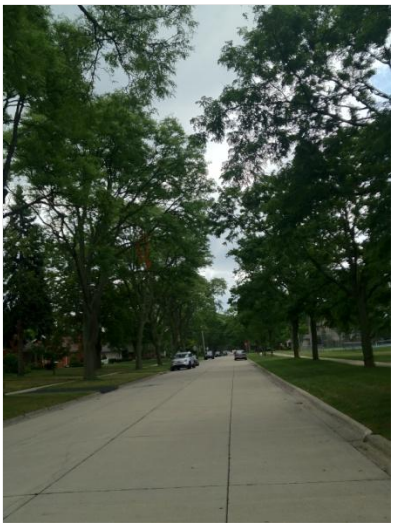
Year 5

$20,550

- RP Cycle: 97 trees cleaned
- YTT Cycle: 90 trees structurally pruned
- 10 trees recommended for planting
- Inclusion of newly found priority tree work (removal or pruning): costs to be determined

Conclusions

The management of trees in urban areas can be challenging. Balancing the recommendations of experts, the needs of residents, the pressures of local economics and politics, the concerns for public safety and liability issues, the physical aspects of trees, the forces of nature and severe weather events, and the desires for all of these factors to be dealt with simultaneously is quite a daunting task. The City must carefully consider each specific issue and balance these pressures with a knowledgeable understanding of trees and their needs. If balance is achieved, Birmingham's beauty will flourish and the health and safety of its trees and citizens will be maintained.



Photograph 13. With the continued use of the programs that Birmingham has in place, they can achieve balance throughout its street tree population and have the beauty and aesthetics as well as the safety for all its citizens.

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Glossary

aboveground utilities (data field): Shows the presence or absence of overhead utilities at the tree site.

address number (data field): The address number was recorded based on the visual observation by the Davey arborist at the time of the inventory of the actual address number posted on a building at the inventoried site. In instances where there was no posted address number on a building or sites were located by vacant lots with no GIS parcel addressing data available, the address number assigned was matched as closely as possible to opposite or adjacent addresses by the arborist(s) and an "X" was added to the number in the database to indicate that the address number was assigned.

American National Standards Institute (ANSI): ANSI is a private, nonprofit organization that facilitates the standardization work of its members in the United States. ANSI's goals are to promote and facilitate voluntary consensus standards and conformity assessment systems, and maintain their integrity.

ANSI A300 Standards: Tree care performance parameters established by ANSI; can be used to develop specifications for tree maintenance.

arboriculture: The art, science, technology, and business of commercial, public, and utility tree care.

block side (data field): Address information for a site that includes the on street, from street, and to street. The on street is the street that the site is actually located on. The from street is the cross street one is moving away from when moving in the direction of traffic flow. The to street is the cross street one is moving toward when moving in the direction of traffic flow.

canopy: Branches and foliage that make up a tree's crown.

canopy assessment: See **urban tree canopy (UTC) assessment**.

canopy cover: As seen from above, it is the area of land surface that is covered by tree canopy.

clearance requirements (data field): Illustrates the need for pruning to meet clearance standards over streets and sidewalks, or where branches are considered to be interfering with the movement of vehicles or pedestrians or where they are obstructing signs and street or traffic lights.

clean (data field): Based on ANSI A300 Standards, selective removal of dead, dying, broken, and/or diseased wood to minimize potential risk.

community forest: see **urban forest**.

condition (data field): The general condition of each tree rated during the inventory according to the following categories adapted from the International Society of Arboriculture's rating system: Excellent (100%), Very Good (90%), Good (80%), Fair (60%), Poor, (40%), Critical (20%), Dead (0%).

cycle: Planned length of time between vegetation maintenance activities.

diameter: See **tree size**.

diameter at breast height (DBH): See **tree size**.

failure: In terms of tree management, failure is the breakage of stem or branches, or loss of mechanical support of the tree's root system.

further inspection (data field): Notes that a specific tree may require an annual inspection for several years to make certain of its maintenance needs. A healthy tree obviously impacted by recent construction serves as a prime example. This tree will need annual evaluations to assess the impact of construction on its root system. Another example would be a tree with a defect requiring additional equipment for investigation.

genus: A taxonomic category ranking below a family and above a species and generally consisting of a group of species exhibiting similar characteristics. In taxonomic nomenclature, the genus name is used, either alone or followed by a Latin adjective or epithet, to form the name of a species.

geographic information system (GIS): A technology that is used to view and analyze data from a geographic perspective. The technology is a piece of an organization's overall information system framework. GIS links location to information (such as people to addresses, buildings to parcels, or streets within a network) and layers that information to give you a better understanding of how it all interrelates.

global positioning system (GPS): GPS is a system of earth-orbiting satellites that make it possible for people with ground receivers to pinpoint their geographic location.

growing space size (data field): Identifies the minimum width of the tree growing space for root development.

growing space type (data field): Best identifies the type of location a tree is growing. During the inventory, growing space types were categorized as island, raised planter, median, tree lawn/parkway, natural area, well pit, or open/unrestricted.

hardscape damage (data field): Indicates trees damaged by hardscape or hardscape damaged by trees (for example, damage to curbs, cracking, lifting of sidewalk pavement one inch or more).

high-risk tree: Trees that cannot be cost-effectively or practically treated. Most high-risk trees have multiple or significant defects affecting less than 40% of the trunk, crown, or critical root zone. Defective trees and/or tree parts are most likely between 4–20 inches in diameter and can be found in areas of frequent occupation, such as a main thoroughfare, congested streets, and/or near schools.

invasive, exotic tree: A tree species that is out of its original biological community. Its introduction into an area causes or is likely to cause economic or environmental harm, or harm to human health. An invasive, exotic tree has the ability to thrive and spread aggressively outside its natural range. An invasive species that colonizes a new area may gain an ecological edge since the insects, diseases, and foraging animals that naturally keep its growth in check in its native range are not present in its new habitat.

inventory: See Tree Inventory.

location (data fields): A collection of data fields collected during the inventory to aid in finding trees, including address number, street name, site number, side, and block side.

location rating (data field): Describes/rates the position of a tree based on existing land use of the site, the functional and aesthetic contributions of the tree to the site, and surrounding structures or landscapes.

Categories for location value include: Excellent, Good, Fair, and Poor. The location rating, along with species, size, and condition ratings, is used in determining a tree's value.

low-risk tree: Trees with minor visible structural defects or wounds in areas with moderate to low public access.

mapping coordinate (data field): Helps to locate a tree. An X and Y coordinate were generated using GPS for each tree.

moderate-risk tree: Trees with defects that may be cost-effectively or practically treated. Most Moderate-Risk trees exhibit several moderate defects affecting more than 40% of a tree's trunk, crown, or critical root zone.

monoculture: A population dominated by one single species or very few species.

nitrogen dioxide (NO_2): Nitrogen dioxide is a compound typically created during the combustion processes and is a major contributor to smog formation and acid deposition.

none (data field): Used to show that no secondary maintenance is recommended for the tree. Usually a vacant planting site or stump will have a secondary maintenance need of None.

none (risk rating): Used only for planting sites and stumps.

notes (data field): Describes any additional information of possible importance.

observations (data field): When conditions with a specific tree warrant recognition, it was described in this data field. Observations include cavity or decay, remove hardware, poor structure, mechanical damage, poor root system, improperly mulched, improperly pruned, poor location, pest problem, signs of stress, memorial tree, serious decline, storm damage, improperly installed tree, grate or guard.

ordinance: See **tree ordinance**.

ozone (O_3): A strong-smelling, pale blue, reactive toxic chemical gas with molecules of three oxygen atoms. It is a product of the photochemical process involving the sun's energy. Ozone exists in the upper layer of the atmosphere as well as at the earth's surface. Ozone at the earth's surface can cause numerous adverse human health effects. It is a major component of smog.

particulate matter (PM_{10}): A major class of air pollutants consisting of tiny solid or liquid particles of soot, dust, smoke, fumes, and mists.

plant tree (data field): If collected during an inventory, this data field identifies vacant planting sites as small, medium, or large (indicating the ultimate size that the tree will attain), depending on the growing space available and the presence of overhead wires.

primary maintenance need (data field): The type of tree work needed to reduce immediate risk.

pruning: The selective removal of plant parts to meet specific goals and objectives.

removal (data field): Data field collected during the inventory identifying the need to remove a tree. Trees designated for removal have defects that cannot be cost-effectively or practically treated. Most of the trees in this category have a large percentage of dead crown.

right-of-way (ROW): See **street right-of-way**.

risk: Combination of the probability of an event occurring and its consequence.

risk assessment (data fields): The risk assessment is a point-based assessment of each tree by an arborist using a protocol based on the USDA Forest Service Community Tree Risk Rating System. In the field, the probability of tree or tree part failure is assigned 1–4 points (identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure based on observed, current conditions), the size of defective tree part is assigned 1–3 points (rates the size of the part most likely to fail), the probability of target impact by the tree or tree part is assigned 1–3 points (rates the use and occupancy of the area that would be struck by the defective part), and other risk factors are assigned 0–2 points (used if professional judgment suggests the need to increase the risk rating). The data from the risk assessment is used to calculate the risk rating that is ultimately assigned to the tree.

risk rating: Calculated from the field risk assessment data (see Risk Assessment), this is the sum of risk assessment values. Risk ratings assigned from 3–10, with 3 being the lowest risk and 10 being the highest risk. In this Plan, the Risk Rating was used to identify the severity of risk assigned to a tree and to prioritize tree maintenance needs. The following categories were used:

- risk rating of 9 or 10 = severe-risk tree
- risk rating of 7 or 8 = high-risk tree
- risk rating of 5 or 6 = moderate-risk tree
- risk rating of 3 or 4 = low-risk tree
- risk rating of 0 = none (used only for planting sites and stumps)

severe-risk tree: Trees rated to be Severe Risk cannot be cost-effectively or practically treated. Most Severe-Risk trees have multiple and significant defects present in the trunk, crown, or critical root zone. Defective trees and/or tree parts are most likely larger than 20 inches in diameter and can be found in areas of frequent occupation, such as a main thoroughfare, congested streets, and/or near schools.

side value (data field): Each site is assigned a side value to aid in locating the site. Side values include: *front*, *side to*, *side away*, *median* (includes islands), and *rear* based on the site's location in relation the lot's street frontage. The *front* side is the side that faces the address street. *Side to* is the name of the street the arborist is walking towards as data is being collected. The *side from* is the name of the street the arborist is walking away from while collecting data. *Median* indicates a median or island. The *rear* is the side of the lot opposite the front.

site number (data field): All sites at an address are assigned a *site number*. Sites numbers are not unique; they are sequential to the side of the address only (the only unique number is the tree identification number assigned to each site). Site numbers are collected in the direction of vehicular traffic flow. The only exception is a one-way street. Site numbers along a one-way street are collected as if the street were actually a two-way street, so some site numbers will oppose traffic.

species: Fundamental category of taxonomic classification, ranking below a genus or subgenus and consisting of related organisms capable of interbreeding. An organism belonging to such a category, represented in binomial nomenclature by an un-capitalized Latin adjective or noun following a capitalized genus name.

stem: A woody structure bearing buds, foliage, and giving rise to other stems.

stems (data field): Identifies the number of stems or trunks splitting less than one foot above ground level.

street name (data field): The name of a street right-of-way or road identified using posted signage or parcel information.

street right-of-way (ROW): A strip of land generally owned by a public entity over which facilities, such as highways, railroads, or power lines, are built.

street tree: A street tree is defined as a tree within the right-of-way.

structural defect: A feature, condition, or deformity of a tree or tree part that indicates weak structure and contributes to the likelihood of failure.

stump removal (data field): Indicates a stump that should be removed.

sulfur dioxide (SO_2): A strong-smelling, colorless gas that is formed by the combustion of fossil fuels. Sulfur oxides contribute to the problem of acid rain.

topping: Topping, reducing tree size using internodal cuts without regard to tree health or structural integrity, is not an acceptable pruning practice.

tree: A tree is defined as a perennial woody plant that may grow more than 20 feet tall. Characteristically, it has one main stem, although many species may grow as multi-stemmed forms.

tree benefit: An economic, environmental, or social improvement that benefits the community and results mainly from the presence of a tree. The benefit received has real or intrinsic value associated with it.

tree height (data field): If collected during the inventory, it is the height of the tree estimated by the arborist and recorded in 10-foot increments.

tree inventory: Comprehensive database containing information or records about individual trees typically collected by an arborist.

tree ordinance: Tree ordinances are policy tools used by communities striving to attain a healthy, vigorous, and well-managed urban forest. Tree ordinances simply provide the authorization and standards for management activities.

tree size (data field): A tree's diameter measured to the nearest inch in one-inch size classes at 4.5 feet above ground, also known as diameter at breast height (DBH) or diameter.

urban forest: All of the trees within a municipality or a community. This can include the trees along streets or rights-of-way, parks and greenspaces, and forests.

utility (pruning): Selective pruning to prevent the loss of service, comply with mandated clearance laws, prevent damage to equipment, avoid access impairment, and uphold the intended usage of the facility/utility space.

young tree training (YTT) pruning (data field): Based on ANSI A300 Standards, pruning of young trees to correct or eliminate weak, interfering, or objectionable branches to improve structure. These trees, up to 20 feet in height, can be worked with a pole pruner by a person standing on the ground.

Appendix A
Tree Location Methods

Equipment and Base Maps

The inventory was conducted using CF-19 Panasonic Toughbook unit(s) along with the Trimble® global positioning system (GPS) Pathfinder™ ProXH receiver(s). This equipment was owned and operated by Davey.

Base map layers were loaded onto unit(s) to help locate sites during the inventory. Table 1 lists the base map layers utilized along with source and format information for each layer.

Table 1. Base Map Layers Utilized for Inventory

Imagery/Data Source	Date	Projection
GIS and Assessor Parcel Data provided by the City of Birmingham, Michigan	May 2012	NAD83 StatePlane Michigan South FIPS 2113 (feet)
2010 Orthoimagery/Oakland County, Michigan	May 2012	NAD83 StatePlane Michigan South FIPS 2113 (feet)

Street ROW Site Location

Generally, individual street ROW sites (trees, stumps, or vacant planting sites) were located used a methodology developed by Davey which identifies sites by *address number*, *street name, side, site number*, and *block side* information. This methodology allows for consistent assignment of location during the inventory as well as a protocol for inventory's user(s) to utilize for locating sites at any time in the future.

The following describes the Street ROW site location methodology used for this inventory.

Address Number and Street Name

Each site was located by an *address number* and *street name*. The address number was recorded based on the visual observation by the Davey arborist at the time of the inventory of the actual address number posted on a building at the inventoried site. In instances where there was no posted address number on a building or sites were located by vacant lots with no GIS parcel addressing data available, the address number assigned was matched as closely as possible to opposite or adjacent addresses by the arborist(s) and an "X" was added to the number in the database to indicate that the address number was assigned. For example the address, 37X Choice Avenue indicates that the address is fictitious and was assigned to the site based on the nearest parcel address number available. The street name assigned to a site is determined by street ROW parcel information and posted street name signage.

Sites in medians or islands were assigned a fictitious address number using the address on the right side of the street in the direction of collection closest to them. Each segment was numbered with an assigned address which was interpolated from addresses facing that median/island. If there were multiple median/islands between cross streets, each segment was given its own assigned address.

Side Value and Site Number

Each site was assigned a *side value* and *site number*.

Side values include: *front*, *side to*, *side away*, *median* (includes islands), or *rear* based on the site's location in relation the lot's street frontage (Figure 1). The *front side* is the side which faces the address street. *Side to* is the name of the street the arborist is walking towards as data is being collected. The *side from* is the name of the street the arborist is walking away from while collecting data. *Median* indicates and median or island. The *rear* is the side of the lot opposite of the front.

All sites at an address are assigned a *site number*. Sites numbers are not unique; they are sequential to the side of the address only (the only unique number is the tree identification number assigned to each site). Site numbers are collected in the direction of vehicular traffic flow. The only exception is a one-way street. Site numbers along a one-way street are collected as if the street were actually a two-way street; thus, some site numbers will one-way oppose traffic.

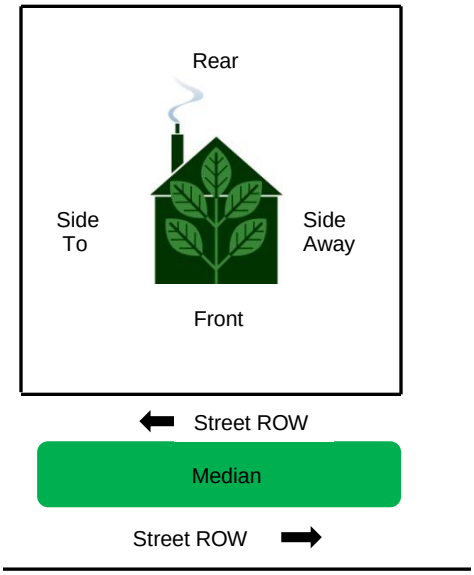


Figure 1. Illustration of possible side values for street ROW sites. Home represents one address number on a street.

A separate site number sequence is used for each side value of the address (front, side to, side away, median, or rear). For example, trees at the front of an address may have site numbers from 1 through 999 and, if trees are located on the side to, side away, median, or rear of that same address, each side will also be numbered consecutively beginning with the number 1 and always in the direction of vehicular traffic flow. Multiple site numbers may exist at an address and are distinguished from one another using side value.

Block Side

Block side information for a site includes the *on street*, *from street*, and *to street*.

- The *on street* is the street that the site is actually located on. (Be aware that some sites, such as those located on a side street, will be located on a street that is different from the actual address street. This means that the on street will not necessarily match the address street.)
- The *from street* is the cross street one is moving away from when moving in the direction of traffic flow.
- The *to street* is the cross street one is moving toward when moving in the direction of traffic flow.

Golf Course Site Location

Golf Course site locations were collected using the same methodology as street ROW sites; however, the "on street", "from street", and "to street" were entered with the golf course's name (not individual street names).

Site Location Examples

The following figures illustrate the location of a tree located on the side of a lot (Figure 2) and the progression of site numbers at different addresses along with several samples of tree locations (Figure 3).

In Figure 2, the tree trimming crew in the truck traveling westbound on East Mac Arthur Street is trying to locate an inventoried tree with the following location information:

Address No. and Street Name:	226 E. Mac Arthur Street
Side:	Side To
Site Number:	1
On Street:	Davis Street
From Street:	Taft Street
To Street:	E. Mac Arthur Street.

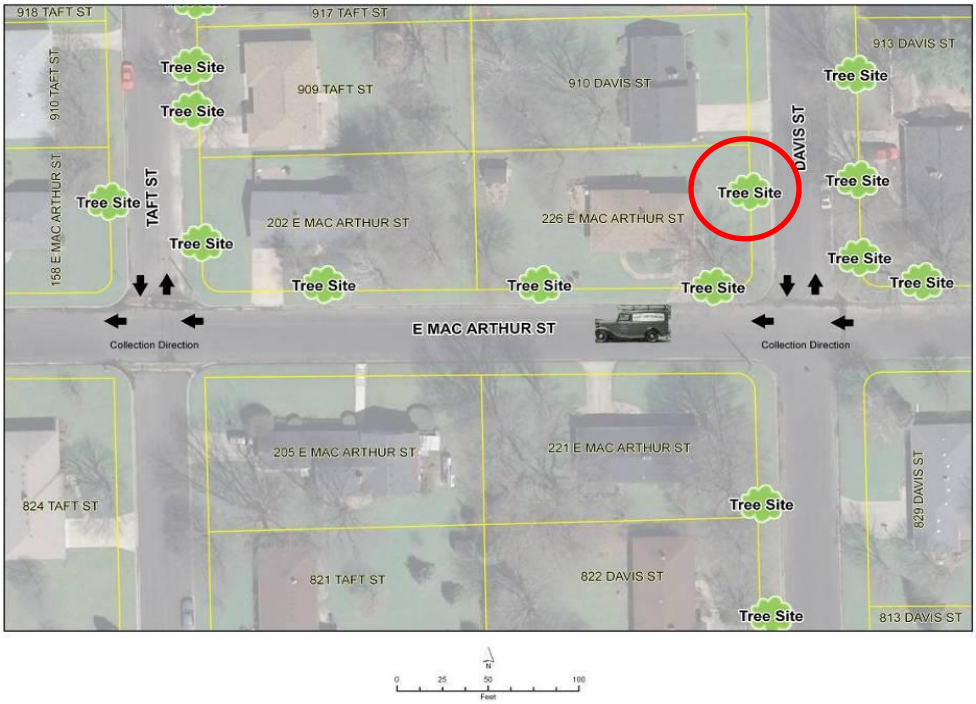


Figure 2. The tree site circled in red is the site for which the crew is looking

The tree the crew is on East Mac Arthur Street looking for and tree/site located on the side of the lot. Because the tree is located on the side of the lot, the on street is Davis Street even though it is addressed as 226 East Mac Arthur Street. Moving with the flow of traffic, the *from street* is Taft Street, and the *to street* is East Mac Arthur Street.

Figure 3 shows 27 trees (green tree symbol) with *site numbers* illustrated for each tree. Figure 2 also shows the *address number*, *street name*, and *block side* information for corner lots A and B and of sites which appear to be on the same street but have differing addresses or other location information.

Figure 3. Location information collected for inventoried trees

Corner Lot A

Address No. and Street Name: 205 Hoover St.
Side: Side To
Site No: 1
On Street: Taft St.
From Street: E Mac Arthur St.
To Street: Hoover St.

Address No. and Street Name: 205 Hoover St.
Side: Side To
Site No: 2
On Street: Taft St.
From Street: E Mac Arthur St.
To Street: Hoover St.

Address No. and Street Name: 205 Hoover St.
Side: Side To
Site No: 3
On Street: Taft St.
From Street: 19th St.
To Street: Hoover St.

Address No and Street Name: 205 Hoover St.
Side: Front
Site No: 1
On Street: Hoover St.
From Street: Taft St.
To Street: Davis St.

Corner Lot B

Address No and Street Name: 226 E. Mac Arthur St.
Side: Side To
Site No: 1
On Street: Davis St.
From Street: Hoover St.
To Street: E Mac Arthur St.

Address No and Street Name: 226 E. Mac Arthur St.
Side: Front
Site No: 1
On Street: E Mac Arthur St.
From Street: Davis St.
To Street: Taft St.

Address No and Street Name: 22 E. Mac Arthur St.
Side: Front
Site No: 2
On Street: E Mac Arthur St.
From Street: Davis St.
To Street: Taft St.

Appendix B
Species Diversity (Golf Courses and Street Trees)

Common	*Total*	*Percentage of Entire Population*
arborvitae spp. (Thuja spp.)	7	0.85%
arborvitae, eastern (Thuja occidentalis)	14	1.69%
ash, green (Fraxinus pennsylvanica)	1	0.12%
ash, white (Fraxinus americana)	8	0.97%
baldcypress, common (Taxodium distichum)	8	0.97%
beech, European (Fagus sylvatica)	1	0.12%
birch, European white (Betula pendula)	1	0.12%
birch, paper (Betula papyrifera)	1	0.12%
boxelder (Acer negundo)	1	0.12%
cherry, black (Prunus serotina)	5	0.60%
cherry/plum, spp. (Prunus spp.)	1	0.12%
cottonwood, eastern (Populus deltoides)	56	6.77%
crabapple, flowering (Malus spp.)	54	6.53%
dawn redwood (Metasequoia glyptostroboides)	10	1.21%
elm, American (Ulmus americana)	8	0.97%
elm, Chinese (Ulmus parvifolia)	1	0.12%
elm, hybrid (Ulmus x)	12	1.45%
elm, Siberian (Ulmus pumila)	4	0.48%
elm, slippery (Ulmus rubra)	3	0.36%
filbert, Turkish (Corylus colurna)	2	0.24%
fir, balsam (Abies balsamea)	1	0.12%
ginkgo (Ginkgo biloba)	1	0.12%
hackberry, common (Celtis occidentalis)	10	1.21%
hardy rubbertree (Eucommia ulmoides)	5	0.60%
hawthorn, spp. (Crataegus spp.)	18	2.18%
hemlock, eastern (Tsuga candensis)	13	1.57%
hickory, bitternut (Carya cordiformis)	3	0.36%
hickory, shagbark (Carya ovata)	29	3.51%
hickory, shellbark (Carya laciniosa)	2	0.24%
honeylocust, thornless (Gleditsia triacanthos inermis)	52	6.29%
hornbeam, American (Carpinus caroliniana)	6	0.73%
hornbeam, European (Carpinus betulus)	3	0.36%
horsechestnut, red (Aesculus x carnea)	2	0.24%
Japanese pagodatree (Styphnolobium japonicum)	1	0.12%
katsuratree (Cercidiphyllum japonicum)	1	0.12%

Common	*Total*	*Percentage of Entire Population*
Kentucky coffeetree (Gymnocladus dioicus)	6	0.73%
larch, American (Larix laricina)	3	0.36%
lilac, Japanese tree (Syringa reticulata)	1	0.12%
linden, American (Tilia americana)	15	1.81%
linden, littleleaf (Tilia cordata)	17	2.06%
linden, silver (Tilia tomentosa)	4	0.48%
maple, Amur (Acer tataricum ginnala)	1	0.12%
maple, black (Acer nigrum)	15	1.81%
maple, Freeman (Acer x freemanii)	27	3.26%
maple, hedge (Acer campestre)	1	0.12%
maple, Norway (Acer platanoides)	61	7.38%
maple, red (Acer rubrum)	20	2.42%
maple, silver (Acer saccharinum)	16	1.93%
maple, sugar (Acer saccharum)	7	0.85%
mulberry, white (Morus alba)	1	0.12%
oak, bur (Quercus macrocarpa)	16	1.93%
oak, northern red (Quercus rubra)	17	2.06%
oak, pin (Quercus palustris)	16	1.93%
oak, white (Quercus alba)	12	1.45%
pear, Callery (Pyrus calleryana)	19	2.30%
pine, Austrian (Pinus nigra)	34	4.11%
pine, eastern white (Pinus strobus)	37	4.47%
pine, Scotch (Pinus sylvestris)	3	0.36%
planetree, London (Platanus x acerifolia)	2	0.24%
redcedar, eastern (Juniperus virginiana)	17	2.06%
spruce, Colorado (Picea pungens)	34	4.11%
spruce, Norway (Picea abies)	23	2.78%
spruce, white (Picea glauca)	1	0.12%
sweetgum, American (Liquidambar styraciflua)	4	0.48%
sycamore, American (Platanus occidentalis)	5	0.60%
unknown tree (unknown tree)	1	0.12%
walnut, black (Juglans nigra)	38	4.59%
willow, black (Salix nigra)	1	0.12%
willow, weeping (Salix babylonica)	5	0.60%
yellowwood (Cladrastis kentukea)	2	0.24%
Grand Total	*827*	*100%*

Common	*Total*	*Percentage of Entire Population*
Amur corktree (Phellodendron amurense)	17	0.12%
apple, common (Malus pumila)	4	0.03%
arborvitae spp. (Thuja spp.)	18	0.12%
arborvitae, eastern (Thuja occidentalis)	5	0.03%
ash, black (Fraxinus nigra)	1	0.01%
ash, green (Fraxinus pennsylvanica)	53	0.37%
ash, spp. (Fraxinus spp.)	1	0.01%
ash, white (Fraxinus americana)	82	0.57%
aspen, quaking (Populus tremuloides)	5	0.03%
baldcypress, common (Taxodium distichum)	53	0.37%
beech, American (Fagus grandifolia)	5	0.03%
beech, European (Fagus sylvatica)	3	0.02%
birch, European white (Betula pendula)	1	0.01%
birch, paper (Betula papyrifera)	6	0.04%
birch, river (Betula nigra)	4	0.03%
blackgum (Nyssa sylvatica)	1	0.01%
boxelder (Acer negundo)	5	0.03%
butternut (Juglans cinerea)	2	0.01%
catalpa, northern (Catalpa speciosa)	30	0.21%
cherry, black (Prunus serotina)	10	0.07%
cherry, pin (Prunus pensylvanica)	2	0.01%
cherry/plum, spp. (Prunus spp.)	17	0.12%
chokecherry, common (Prunus virginiana)	10	0.07%
cottonwood, eastern (Populus deltoides)	12	0.08%
crabapple, flowering (Malus spp.)	186	1.28%
dawn redwood (Metasequoia glyptostroboides)	8	0.06%
dogwood, flowering (Cornus florida)	9	0.06%
dogwood, Kousa (Cornus kousa)	6	0.04%
dogwood, spp. (Cornus spp.)	1	0.01%
douglas-fir (Pseudotsuga menziesii)	4	0.03%
elm, American (Ulmus americana)	104	0.72%
elm, Chinese (Ulmus parvifolia)	47	0.32%
elm, hybrid (Ulmus x)	324	2.24%
elm, Siberian (Ulmus pumila)	38	0.26%
elm, slippery (Ulmus rubra)	64	0.44%

Common	*Total*	*Percentage of Entire Population*
filbert, Turkish (Corylus colurna)	22	0.15%
fir, balsam (Abies balsamea)	1	0.01%
ginkgo (Ginkgo biloba)	146	1.01%
hackberry, common (Celtis occidentalis)	53	0.37%
hardy rubbertree (Eucommia ulmoides)	107	0.74%
hawthorn, cockspur (Crataegus crusgalli)	1	0.01%
hawthorn, spp. (Crataegus spp.)	34	0.23%
hawthorn, Washington (Crataegus phaenopyrum)	1	0.01%
hemlock, eastern (Tsuga candensis)	7	0.05%
hickory, bitternut (Carya cordiformis)	17	0.12%
hickory, shagbark (Carya ovata)	18	0.12%
hickory, shellbark (Carya laciniosa)	1	0.01%
honeylocust, thornless (Gleditsia triacanthos inermis)	2686	18.55%
hophornbeam, American (Ostrya virginiana)	12	0.08%
hornbeam, American (Carpinus caroliniana)	54	0.37%
hornbeam, European (Carpinus betulus)	11	0.08%
horsechestnut (Aesculus hippocastanum)	42	0.29%
horsechestnut, red (Aesculus x carnea)	214	1.48%
Japanese pagodatree (Styphnolobium japonicum)	40	0.28%
katsuratree (Cercidiphyllum japonicum)	44	0.30%
Kentucky coffeetree (Gymnocladus dioicus)	90	0.62%
larch, American (Larix laricina)	1	0.01%
lilac, common (Syringa vulgaris)	5	0.03%
lilac, Japanese tree (Syringa reticulata)	70	0.48%
linden, American (Tilia americana)	121	0.84%
linden, littleleaf (Tilia cordata)	290	2.00%
linden, silver (Tilia tomentosa)	11	0.08%
locust, black (Robinia pseudoacacia)	3	0.02%
magnolia, cucumbertree (Magnolia acuminata)	1	0.01%
magnolia, saucer (Magnolia x soulangiana)	6	0.04%
maple, Amur (Acer tataricum ginnala)	13	0.09%
maple, black (Acer nigrum)	182	1.26%
maple, Freeman (Acer x freemanii)	1026	7.09%
maple, hedge (Acer campestre)	93	0.64%
maple, Japanese (Acer palmatum)	7	0.05%
maple, Norway (Acer platanoides)	2628	18.15%
maple, red (Acer rubrum)	558	3.85%
maple, silver (Acer saccharinum)	1157	7.99%

Common	*Total*	*Percentage of Entire Population*
maple, sugar (Acer saccharum)	1227	8.47%
mulberry, red (Morus rubra)	3	0.02%
mulberry, white (Morus alba)	19	0.13%
oak, bur (Quercus macrocarpa)	40	0.28%
oak, chinkapin (Quercus muehlenbergii)	2	0.01%
oak, English (Quercus robur)	1	0.01%
oak, northern red (Quercus rubra)	89	0.61%
oak, pin (Quercus palustris)	34	0.23%
oak, spp. (Quercus spp.)	3	0.02%
oak, swamp white (Quercus bicolor)	57	0.39%
oak, white (Quercus alba)	24	0.17%
peach, common (Prunus persica)	3	0.02%
pear, Callery (Pyrus calleryana)	767	5.30%
pine, Austrian (Pinus nigra)	24	0.17%
pine, eastern white (Pinus strobus)	32	0.22%
pine, jack (Pinus banksiana)	1	0.01%
pine, Scotch (Pinus sylvestris)	9	0.06%
pine, shortleaf (Pinus echinata)	2	0.01%
planetree, London (Platanus x acerifolia)	330	2.28%
redbud, eastern (Cercis canadensis)	8	0.06%
redcedar, eastern (Juniperus virginiana)	9	0.06%
Russian-olive (Elaeagnus angustifolia)	1	0.01%
serviceberry, Allegheny (Amelanchier laevis)	2	0.01%
serviceberry, downy (Amelanchier arborea)	13	0.09%
serviceberry, spp. (Amelanchier spp.)	42	0.29%
smoketree, American (Cotinus coggygria)	2	0.01%
spruce, Colorado (Picea pungens)	92	0.64%
spruce, Norway (Picea abies)	90	0.62%
spruce, spp. (Picea spp.)	1	0.01%
spruce, white (Picea glauca)	5	0.03%
sweetgum, American (Liquidambar styraciflua)	189	1.31%
sycamore, American (Platanus occidentalis)	30	0.21%
tree of heaven (Ailanthus altissima)	5	0.03%
tuliptree (Liriodendron tulipifera)	163	1.13%
unknown tree (unknown tree)	7	0.05%
walnut, black (Juglans nigra)	29	0.20%
willow, corkscrew (Salix matsudana)	1	0.01%
witchhazel, common (Hamamelis virginiana)	1	0.01%

Common	*Total*	*Percentage of Entire Population*
yellowwood (Cladrastis kentukea)	65	0.45%
yew, spp. (Taxus spp.)	1	0.01%
zelkova, Japanese (Zelkova serrata)	146	1.01%
Grand Total	*14480*	*100%*

Appendix C
Suggested Street Tree Species

The tree species listed are considered for such factors as: size, disease resistance, pest problems, location suitability, seed or fruit set, and visual appearance. Another factor that can be considered in species selection is which trees are presently doing well and are relatively free from insects and disease. While efforts have been made to make appropriate recommendations, nurseries may have further information as to specific cultivars or varieties, which may be more suitable for your location or climate.

Deciduous Trees

Large Trees: Greater Than 50 Feet In Height When Mature

Scientific Name	Common Name	Cultivar
Aesculus hippocanstrum	horsechestnut	'Baummanii'
Catalpa speciosa	northern catalpa	
Cercidiphyllum japonicum	katsuratree	
Cladastris kentukea	yellowwood	
Eucommia ulmoides	hardy rubber tree	
Ginkgo biloba	ginkgo	(Choose male trees only)
Gleditsia triacanthos inermis	thornless honeylocust	'Skyline'
Gymnocladus dioicus	Kentucky coffeetree	Prairie Titan®
Liriodendron tulipifera	tuliptree	
Liquidambar styraciflua	sweetgum	'Moraine'
Magnolia acuminate	cucumbertree	
Metasequoia glyptostroboides	dawn redwood	'Emerald Feathers'
Nyssa sylvatica	black tupelo	
Quercus bicolor	swamp white oak	
Quercus ellipsoidalis	northern pin oak	
Quercus imbricaria	shingle oak	
Quercus macrocarpa	bur oak	
Quercus rubra	northern red oak	'Splendens'
Taxodium distichum	common baldcypress	'Shawnee Brave'
Tilia tomentosa	silver linden	'Sterling'
Ulmus x	hybrid elm	'Frontier' 'Homestead' 'Pioneer' 'Regal' 'Urban'
Zelkova serrata	Japanese zelkova	'Green Vase' 'Halka' 'Village Green'

Medium Trees: 26 Yo 49 Feet In Height When Mature

Scientific Name	Common Name	Cultivar
Aesculus glabra	Ohio buckeye	
Aesculus x *carnea*	red horsechesnut	'Briotii'
Betulus nigra	river birch	'Heritage'
Carpinus betulus	European hornbeam	
Carpinus caroliniana	American hornbeam	
Cercidiphyllum japonicum	katsuratree	
Cladrastis kentukea	American yellowwood	'Rosea'
Corylus colurna	Turkish filbert	
Halesia tetraptera	Carolina silverbell	
Koelreuteria paniculata	goldenraintree	
Ostrya virginiana	American hophornbeam	
Parrotia persica	Persian parrotia	'Vanessa'
Phellodendron amurense	Amur corktree	'Macho'
Prunus sargentii	Sargent cherry	'Columnaris'
Ulmus parvifolia	lacebark elm	

Small Trees: 10 To 25 Feet In Height When Mature

Scientific Name	Common Name	Cultivar
Amelanchier spp.	serviceberry spp.	
Maackia amurensis	amur maackia	
Magnolia soulangiana	saucer magnolia	
Magnolia stellata	star magnolia	
Cercis canadensis	eastern redbud	'Forest Pansy'
Chionanthus retusus	Chinese fringetree	
Cornus florida	flowering dogwood	
Cornus kousa	Kousa dogwood	
Crataegus spp.	hawthorn spp.	
Prunus serrulata	Japanese flowering cherry	
Syringa reticulata	Japanese tree lilac	'Ivory Silk'

Special Use Trees

In certain areas of the City, such as the downtown business district or in areas of restricted aboveground space, the best tree choice may be those varieties that grow more upright in what is termed a fastigiate, or columnar, manner. This form achieves two purposes: (1) because of their tighter, upright habit, there is minimal storefront blockage; and (2) they will not be wide branching, thus avoiding sidewalk clearance concerns. The following tree species and varieties offer the described characteristics and should be considered for tight space situations:

Scientific Name	Common Name	Cultivar
Amelanchier arborea	downy serviceberry	'Cumulus' 'Robin Hill'
Carpinus betulus	European hornbeam	'Fastigiata'
Ginkgo biloba	ginkgo	'Lakeview' Princeton Sentry®
Malus spp.	flowering crabapple	'Centurion' 'Harvest Gold' Madonna™ 'Sentinel'
Prunus sargentii	Sargent cherry	'Columnaris'
Prunus serrulata	Japanese flowering cherry	'Amanogawa'
Pyrus calleryana	callery pear	'Chanticleer'
Quercus robur	English oak	Skyrocket™

Coniferous and Evergreen Trees

Large Trees: Greater Than 45 Feet In Height At Maturity

Scientific Name	Common Name	Cultivar
Abies concolor	white fir	
Juniperus virginiana	eastern red cedar	'Burkii', 'Canaertii', 'Glauca', 'Hillii'
Picea abies	Norway spruce	
Picea glauca	white spruce	'Black Hills Spruce'
Picea omorika	Serbian spruce	
Picea glauca var. *densata*	Colorado blue spruce	
Pinus cembra	Swiss stone pine	
Pinus nigra	Austrian pine	
Pinus resinosa	red pine	
Pinus strobus	eastern white pine	
Pinus sylvestris	Scotch pine	
Psedotsuga menziesii	Douglas-fir	
Tsuga canadensis	eastern hemlock	

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Juniperus virginiana	eastern red cedar	
Thuja occidentalis	eastern arborvitae	(numerous exist)

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Juniperus chinensis	Chinese juniper	'Iowa', 'Mountbatten'
Taxus cuspidate	Japanese yew	

Note: * denotes species recommended for use as street trees.

This suggested species list was compiled through the use of the excellent references *Dirr's Hardy Trees and Shrubs* (Dirr, 2003) and *Manual of Woody Landscape Plants (5th Edition)* (Dirr, 1998). Cultivar selections are only recommendations and are based on Davey Resource Group's experience and tree availability in the nursery trade.

Appendix D: Pests and Diseases

In today's worldwide marketplace, the volume of international trade brings increased potential for pests and diseases to invade our country. Many of these pests and diseases have seriously harmed rural and urban landscapes and have caused billions of dollars in lost revenue and millions of dollars in clean-up costs. Keeping these pests and diseases out of the country is the number one priority of the United States Department of Agriculture's Animal and Plant Inspection Service (APHIS).

Although some invasive species enter the United States naturally via wind, ocean currents, and other means, most enter with some help from human activities. Their introduction to our country is a byproduct of cultivation, commerce, tourism, and travel. Many species enter the United States each year in cargo, mail, baggage, or contaminants of commodities.

Once here, hungry pests grow and spread rapidly because controls, such as native predators, are lacking. Invasive pests disrupt the landscape by pushing out native species, reducing biological diversity, killing trees, altering wildfire intensity and frequency, and damaging crops. Some pests may even push species to extinction. Following are key pests and diseases at the time of Plan development that adversely affect trees in America. This list is not comprehensive and may not include all threats.

It is critical to the management of community trees to routinely check APHIS, United States Department of Agriculture Forest Service (USDA Forest Service) and other websites for updates about invasive species and diseases in your area and in our country so you can to be prepared to combat their attack.

APHIS, Plant Health, Plant Pest Program Information
- www.aphis.usda.gov/plant_health/plant_pest_info

The University of Georgia, Center for Invasive Species and Ecosystem Health
- www.bugwood.org

USDA National Agricultural Library
- www.invasivespeciesinfo.gov/microbes

USDA Northeastern Areas Forest Service, Forest Health Protection
- www.na.fs.fed.us/fhp

Asian Longhorned Beetle

The Asian longhorned beetle (ALB, *Anoplophora glabripennis*) is an exotic pest threatening a wide variety of hardwood trees in North America. The beetle was introduced in New York City, Chicago, and New Jersey and is believed to have been introduced in the United States from wood pallets and other wood packing material accompanying cargo shipments from Asia. ALB is a serious threat to America's hardwood tree species.

Adults are large (3/4- to 1/2-inch long) with very long, black and white banded antennae (Photograph 1). The body is glossy black with irregular, white spots. Adults can be seen from late spring to fall depending on the climate. ALB has a long list of host species; however, the beetle prefers hardwoods including several maple species (Norway [*Acer platanoides*], sugar maple [*Acer saccharum*], silver maple [*Acer saccharinum*], red maple [*Acer rubrum*]; and box elder [Acer negundo]), horsechestnut (*Aesculus hippocastanum*), buckeye (*Aesculus glabra*), London plane (*Platanus* x *acerifolia*), birch (*Betula)*, elm (*Ulmus*), and willow (*Salix*).

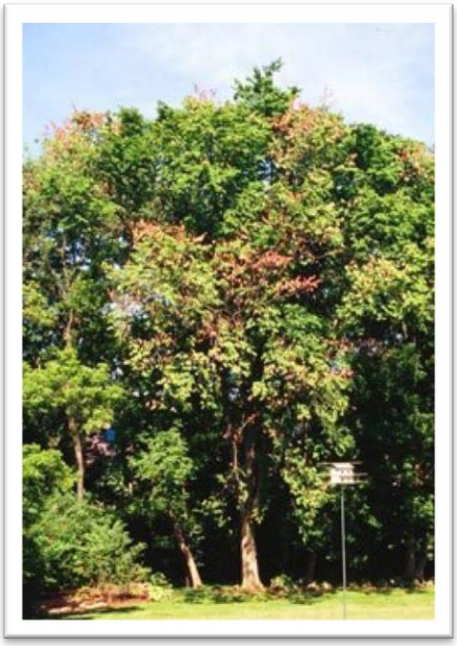
Photograph 1. Adult Asian longhorned beetle. Photograph from New Bedford Guide, 2011.

Dutch Elm Disease

Considered by many to be one of the most destructive, invasive diseases of shade trees in the United States, DED was first found in Ohio in 1930 and by 1933, in several East Coast cities. By 1959, it had killed thousands of elms. Today, DED covers about two-thirds of the eastern United States, including Illinois, and annually kills many of the remaining and newly planted elms. The disease is caused by a fungus that attacks the vascular system of elm trees, blocking the flow of water and nutrients, resulting in rapid leaf yellowing, tree decline, and death (Photograph 2).

There are two closely related fungi that are collectively referred to as DED. The most common is *Ophiostoma novo-ulmi*, and is thought to be responsible for most of the elm deaths since the 1970s. The fungus is transmitted to healthy elms by elm bark beetles. Two species carry the fungus, the native elm bark beetle (*Hylurgopinus rufipes*) and the European elm bark beetle (*Scolytus multistriatus*).

Trees most affected by DED are the American elm (*Ulmus americana*).



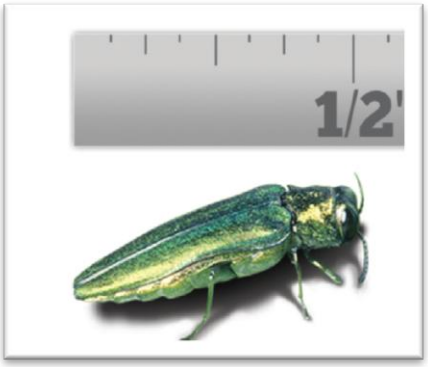
Photograph 2. Branch death, or flagging, at multiple locations in the crown of a diseased elm. Photograph from Steven Katovich, USDA Forest Service, Bugwood.org (Invasives. Org, Center for Invasive Species and Ecosystem Health, 2011)

Emerald Ash Borer

The emerald ash borer (*Agrilus planipennis* Fairmaire) is responsible for the death or decline of tens of millions of ash trees in 14 states in the American Midwest and Northeast. Native to Asia, it has been found in China, Korea, Japan, Mongolia, Taiwan, and eastern Russia. It likely arrived in the United States hidden in wood packing materials commonly used to ship consumer goods, auto parts, and other products. The first official United States identification of EAB was in southeastern Michigan in 2002.

Adult beetles are slender and 1/2-inch long. Males are smaller than females. Color varies but adults are usually bronze or golden green overall, with metallic, emerald green wing covers. The top of the abdomen under the wings is metallic, purplish red and can be seen when the wings are spread (Photograph 3).

The tree species preferred as hosts by the EAB are in the ash genus, *Fraxinus*.



Photograph 3. Close-up of the emerald ash borer. Photograph from APHIS (a), 2011

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USDA Northeastern Areas Forest Service. Forest Health Protection. www.na.fs.fed.us/fhp. Accessed April 24, 2012.

Appendix E. Planting Guidelines

The following guidelines to tree planting will help reduce transplanting shock and ensure that trees adapt to the new site. Keep in mind that spring and fall are the best times of the year to plant trees, but some trees do better when transplanted in spring rather than fall, and vice versa. Check with your nursery when planning tree-planting operations.

Site Conditions

A frequent cause of new tree failure is poor acclimation to site conditions. This includes not only the planting site, but also the climate conditions at the nursery and the similarity in the new tree location. For example, a tree raised in a nursery farther south than the planting site may have more difficulty in adapting than a tree grown in more similar climate conditions. Furthermore, the soil conditions of the site (pH, moisture, oxygen, and nutrient availability) should be sufficient to meet the specific requirements of the tree. It is more cost-effective to choose the right tree for a site than to modify the site after the tree has been planted or to have high maintenance costs because a poorly established tree is unhealthy.

Tree Selection

In addition to selecting trees that are tolerant of existing site conditions, select trees that show normal growth and are free of serious insect and disease problems. The trees should exhibit good vitality, appearing undamaged with a healthy root mass. Trees should have good leaf color, annual twig growth, and bud appearance. Careful nursery selection is essential.

Single-stemmed trees should not have the appearance of clumped foliage arising from the same point on the stem. Such a condition, while providing an initial tree form, will ultimately cause branching problems, such as weak crotches, and should be avoided. Trees with good potential for lower maintenance when mature will have a scaffold or ladder appearance with branch angles greater than 45 degrees. Some trees have this form naturally, while others need to be pruned when young to encourage such form.

Stock Type

Trees are delivered from the nursery in one of three states of preparation: balled-and-burlapped trees, with soil surrounding the root system; bare-root trees, without soil; and containerized trees, generally grown in the container in which they are delivered.

Bare-root is the least expensive and allows roots to be in contact with the native soil. However, care must be taken to keep the roots protected and moist before planting, as the fine roots can dry rapidly.

Balled-and-burlapped tree roots are slower to dry out than bare-root trees, as the roots are inside a soil ball. However, the burlap may cover dead or poorly pruned roots and should be inspected before planting. The type of soil surrounding the roots should not be too different from the soil on the site or the tree roots may not extend sufficiently into the surrounding soil from the root ball. In such a case, the backfill soil should be amended to provide a transition between the two types of soil.

Container-grown trees have an undisturbed root system and can be planted with the intact root system. If the tree has been in the container for too long; however, the tree may be pot-bound with the roots encircling the inside perimeter of the pot. The roots should be sliced or partially separated in order to improve the ability of the tree to extend the roots into the surrounding soil.

Tree Planting

The tree should be planted to the same depth or slightly higher than it was growing at the nursery. A high mound should be avoided as the soil can dry out quickly in the summer and freeze in the winter.

The hole should be dug shallow and wide. It should not be any deeper than the root ball but should be a wide hole, allowing for amendments, if necessary, or for loosening heavy clay soil to allow for improved oxygen availability and root penetration.

The backfill soil should be added gradually and watered carefully to settle the soil but not to saturate it. Balled-and-burlapped trees should have any untreated burlap pulled away from the top of the root ball and cut away—not buried—so that none of the burlap is exposed at the soil surface. Otherwise, the burlap can wick moisture away from the roots of the freshly planted tree.

Tree Staking

Stakes should only be used to support trees on windy sites or for smaller trees with weak trunks. The stakes should be placed before the backfill is added to avoid damaging any large roots. A stake is meant to provide a temporary support and should be removed within a year to allow the tree to develop trunk strength and to limit the potential for physical damage from the stakes and support ties.

Wooden stakes, metal pipe, fence stakes, and metal reinforcing bars may all be used for support. Anything used for a tie should have a flat, smooth surface and be somewhat elastic to allow for slight movement for the tree. Suitable materials include rubber strips or webbing and belting. Wire covered with hose or tubing **should not** be used.

Tree Irrigation

Because a newly transplanted tree may have lost much of its root system, watering is critical for successful establishment. Initial watering at planting should be followed with weekly watering, particularly during dry periods. A newly planted tree will benefit from at least an inch of water a week.

Mulching

Newly planted trees respond well to mulch placed around the tree. This reduces initial root competition with turf and limits the possibility of physical damage by mowers. These factors contribute to the health of the trees and increase the likelihood of survival.

The mulch should **not** be piled (mulch 'volcanoes') around the tree and should not actually touch the tree trunk. No more than a 2- to 3-inch depth of mulch should be added, with it being no more than ½ inch deep closest to the tree.

Pruning

When planting a tree, only dead or broken branches should be removed. All living branches should be left on the tree to help promote tree establishment. Once the tree has been established on the site, training pruning can be done to promote good branching patterns, but no more than 1/4 of the branches should be removed at any one time.

Fertilizing

Fertilizer is not generally necessary at the time of planting and, indeed, if placed improperly in the planting hole can injure roots. The addition of nitrogen, in a slow-release form, however, can benefit a newly planted tree, and it may be efficient to apply at the time of planting.

Appendix F
Mulch Installation and Renovation

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

MULCH INSTALLATION AND RENOVATION

Mulch, as a protective and ornamental feature among herbaceous and woody plants, has gained wide popularity in contemporary landscapes.

BENEFITS: Mulches promote root growth and plant survival in a number of ways.

- Mulch materials allow for the exchange of gases between the atmosphere and soil (oxygen into soil, carbon dioxide out).
- Mulches help provide for better water penetration into soil.
- Mulches reduce evaporation of soil water, conserving soil moisture for optimal root development.

The insulating effect of mulch is an important feature because it moderates extremes of soil temperature. Mulched soil does not get as cold in the winter or as hot in the summer as unmulched soil. This is important because the root systems of most plants are not effective in taking up water and elements at unusually low or high temperatures. Also, mulches cause soil temperatures to lag behind air temperatures. Thus, soil cools slowly in fall (allowing a longer period of high root activity) and warms slowly in spring.

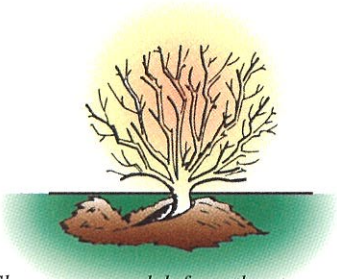
Mulches are also useful in suppressing weeds that compete with desirable plants for moisture and nutrients. However, they will not totally eliminate weeds. Maximum weed control can be achieved with the use of pre-emergent herbicides and/or landscape fabric (not sheet plastic) before applying mulch.

Mulch makes a layer of well-aerated soil near the surface available for long periods of almost continuous root activity. This layer is normally unavailable because of reoccurring periods of extreme dryness and fluctuating temperatures.

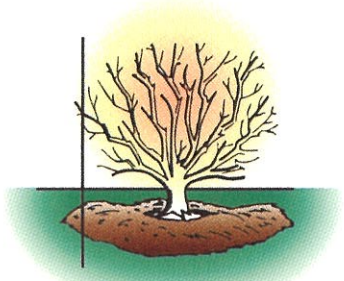
EVALUATION & PROCEDURE: Two common mistakes in mulch distribution are applying material too thickly or deeply and mounding up mulch on plant stems. Effects of too much mulch in planting areas include excessive moisture, reduced oxygen and fungal growth. Decay fungi are also promoted when mulch is piled on stems. Just outside of the stem, mulch dressing should be no more than ½ inch deep.

Most mulches need only be applied and maintained at 2- to 4-inch depths at the plants' dripline, ranging from 2 inches on heavy clay

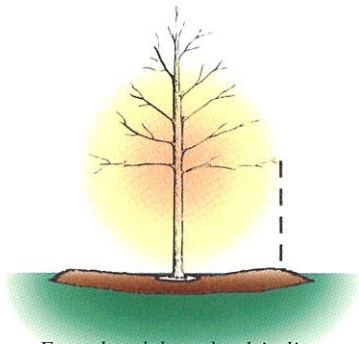
This shrub has outgrown its original mulch bed, and the mulch is piled up around the stem. Mulch should be no more than ½ inch deep just outside the stem.



Clear excess mulch from the stem area.



This shows the drip line.



Extend mulch to the drip line.

(over)

soils to 4 inches on sandy soils. One to 2 inches of mulch in maintained beds can be added every two to three years as original mulch decomposes.

As woody plants develop over subsequent growing seasons, mulch under the crowns can be annually raked out to the expanding drip lines. Use of this mulch management technique achieves several objectives. Mulch is brought out from under plants, stirred, fluffed, exposed to air and light, and arranged to continue to provide soil protection. At this time, the mulch can be evaluated for any redressing needs or removal. Waterlogged or compressed mulch material can be stirred, turned over, or broken up, if necessary, to improve aeration and water diffusion capability.

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Appendix G
Projected Work Plan and Estimated Costs: Seven-Year Management Plan for Street ROW Trees

Estimated Costs for Each Activity			Year 1		Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Seven-Year Cost
Activity		Cost/Tree	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	
Severe-Risk Removal	1-3"	$25	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$105	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	7-12"	$220	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	13-18"	$355	1	$355	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$355
	19-24"	$525	6	$3,150	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$3,150
	25-30"	$845	1	$845	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$845
	31-36"	$1,140	3	$3,420	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$3,420
	37-42"	$1,470	3	$4,410	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$4,410
	43"+	$1,850	1	$1,850	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$1,850
Activity Total(s)			**15**	**$14,030**	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	**$14,030**
High-Risk Removal	1-3"	$25	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$105	0	$0	13	$1,365	0	$0	0	$0	0	$0	0	$0	0	$0	$1,365
	7-12"	$220	0	$0	88	$19,360	0	$0	0	$0	0	$0	0	$0	0	$0	$19,360
	13-18"	$355	96	$34,080	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$34,080
	19-24"	$525	127	$66,675	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$66,675
	25-30"	$845	94	$79,430	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$79,430
	31-36"	$1,140	54	$61,560	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$61,560
	37-42"	$1,470	19	$27,930	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$27,930
	43"+	$1,850	12	$22,200	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$22,200
Activity Total(s)			**402**	**$291,875**	**101**	**$20,725**	0	$0	0	$0	0	$0	0	$0	0	$0	**$312,600**
Moderate-Risk Removal	1-3"	$25	0	$0	64	$1,600	0	$0	0	$0	0	$0	0	$0	0	$0	$1,600
	4-6"	$105	0	$0	50	$5,250	0	$0	0	$0	0	$0	0	$0	0	$0	$5,250
	7-12"	$220	0	$0	103	$22,660	0	$0	0	$0	0	$0	0	$0	0	$0	$22,660
	13-18"	$335	0	$0	56	$18,760	0	$0	0	$0	0	$0	0	$0	0	$0	$18,760
	19-24"	$525	0	$0	37	$19,425	0	$0	0	$0	0	$0	0	$0	0	$0	$19,425
	25-30"	$845	0	$0	9	$7,605	0	$0	0	$0	0	$0	0	$0	0	$0	$7,605
	31-36"	$1,140	0	$0	3	$3,420	0	$0	0	$0	0	$0	0	$0	0	$0	$3,420
	37-42"	$1,470	0	$0	5	$7,350	0	$0	0	$0	0	$0	0	$0	0	$0	$7,350
	43"+	$1,850	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			0	$0	**327**	**$86,070**	0	$0	0	$0	0	$0	0	$0	0	$0	**$86,070**
Low-Risk Removal	1-3"	$25	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$105	0	$0	0	$0	2	$210	0	$0	0	$0	0	$0	0	$0	$210
	7-12"	$220	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	13-18"	$335	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	19-24"	$525	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	25-30"	$845	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	31-36"	$1,140	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	37-42"	$1,470	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	43"+	$1,850	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			0	$0	0	$0	**2**	**$210**	0	$0	0	$0	0	$0	0	$0	**$210**
Stump Removal	1-3"	$25	0	$0	0	$0	1	$25	0	$0	0	$0	0	$0	0	$0	$25
	4-6"	$25	0	$0	0	$0	1	$25	0	$0	0	$0	0	$0	0	$0	$25
	7-12"	$25	0	$0	0	$0	9	$225	0	$0	0	$0	0	$0	0	$0	$225
	13-18"	$25	0	$0	0	$0	5	$125	0	$0	0	$0	0	$0	0	$0	$125
	19-24"	$25	0	$0	0	$0	1	$25	0	$0	0	$0	0	$0	0	$0	$25
	25-30"	$40	0	$0	0	$0	1	$40	0	$0	0	$0	0	$0	0	$0	$40
	31-36"	$40	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	37-42"	$110	0	$0	0	$0	1	$110	0	$0	0	$0	0	$0	0	$0	$110
	43"+	$1,850	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			0	$0	0	$0	**19**	**$575**	0	$0	0	$0	0	$0	0	$0	**$575**
Severe and High-Risk Prune	4-6"	$30	0	$0	1	$30	0	$0	0	$0	0	$0	0	$0	0	$0	$30
	7-12"	$75	0	$0	34	$2,550	0	$0	0	$0	0	$0	0	$0	0	$0	$2,550
	13-18"	$120	1	$120	64	$7,680	0	$0	0	$0	0	$0	0	$0	0	$0	$7,800
	19-24"	$170	1	$170	154	$26,180	0	$0	0	$0	0	$0	0	$0	0	$0	$26,350
	25-30"	$225	0	$0	115	$25,875	0	$0	0	$0	0	$0	0	$0	0	$0	$25,875
	31-36"	$305	1	$305	62	$18,910	0	$0	0	$0	0	$0	0	$0	0	$0	$19,215
	37-42"	$380	0	$0	47	$17,860	0	$0	0	$0	0	$0	0	$0	0	$0	$17,860
	43"+	$590	0	$0	32	$18,880	0	$0	0	$0	0	$0	0	$0	0	$0	$18,880
Activity Total(s)			**3**	**$595**	**509**	**$117,965**	0	$0	0	$0	0	$0	0	$0	0	$0	**$118,560**
Routine Pruning	1-3"	$20	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$30	9	$270	44	$1,320	44	$1,320	40	$1,200	43	$1,290	34	$1,020	33	$990	$7,410
	7-12"	$75	338	$25,350	354	$26,550	527	$39,525	364	$27,300	565	$42,375	261	$19,575	520	$39,000	$219,675
	13-18"	$120	331	$39,720	521	$62,520	478	$57,360	385	$46,200	400	$48,000	274	$32,880	349	$41,880	$328,560
	19-24"	$170	307	$52,190	388	$65,960	456	$77,520	294	$49,980	197	$33,490	297	$50,490	151	$25,670	$355,300
	25-30"	$225	199	$44,775	145	$32,625	202	$45,450	168	$37,800	140	$31,500	114	$25,650	75	$16,875	$234,675
	31-36"	$305	99	$30,195	32	$9,760	67	$20,435	92	$28,060	72	$21,960	35	$10,675	41	$12,505	$133,590
	37-42"	$380	51	$19,380	12	$4,560	25	$9,500	51	$19,380	28	$10,640	18	$6,840	22	$8,360	$78,660
	43"+	$590	23	$13,570	5	$2,950	6	$3,540	24	$14,160	14	$8,260	5	$2,950	23	$13,570	$59,000
Activity Total(s)			**1357**	**$225,450**	**1501**	**$206,245**	**1805**	**$254,650**	**1418**	**$224,080**	**1459**	**$197,515**	**1038**	**$150,080**	**1214**	**$158,850**	**$1,416,870**
Young Tree Training Pruning	1-3"	$20	559	$11,180	551	$11,020	580	$11,600	559	$11,180	551	$11,020	580	$11,600	559	$11,180	$78,780
	4-6"	$30	549	$16,470	564	$16,920	666	$19,980	549	$16,470	565	$16,950	666	$19,980	549	$16,470	$123,240
	7-12"	$75	105	$7,875	139	$10,425	128	$9,600	105	$7,875	139	$10,425	128	$9,600	105	$7,875	$63,675
Activity Total(s)			**1213**	**$35,525**	**1254**	**$38,365**	**1374**	**$41,180**	**1213**	**$35,525**	**1255**	**$38,395**	**1374**	**$41,180**	**1213**	**$35,525**	**$265,695**
Tree Planting	Purchasing	$110	150	$16,500	150	$16,500	150	$16,500	150	$16,500	150	$16,500	150	$16,500	150	$16,500	$115,500
	Planting	$110	150	$16,500	150	$16,500	150	$16,500	150	$16,500	150	$16,500	150	$16,500	150	$16,500	$115,500
Activity Total(s)			**300**	**$33,000**	**300**	**$33,000**	**300**	**$33,000**	**300**	**$33,000**	**300**	**$33,000**	**300**	**$33,000**	**300**	**$33,000**	**$231,000**
To Be Determined																	TBD
																	TBD
Activity Total(s)																	**TBD**
Activity Grand Total			**3290**		**3992**		**3500**		**2931**		**3014**		**2712**		**2727**		**$22,166**
Cost Grand Total				**$600,475**		**$502,370**		**$329,615**		**$292,605**		**$268,910**		**$224,260**		**$227,375**	**$2,445,610**

Appendix H.
Projected Work Plan and Estimated Costs: Five-Year Management Plan for Golf Course Trees

Estimated Costs for Each Activity			Year 1		Year 2		Year 3		Year 4		Year 5		Five-Year
Activity	Diameter	Cost/Tree	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	Cost
Severe-Risk Removal	1-3"	$25	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$105	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	7-12"	$220	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	13-18"	$355	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	19-24"	$525	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	25-30"	$845	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	31-36"	$1,140	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	37-42"	$1,470	1	$1,470	0	$0	0	$0	0	$0	0	$0	**$1,470**
	43"+	$1,850	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			**1**	**$1,470**	0	0	0	0	0	0	0	0	**$1,470**
High-Risk Removal	4-6"	$105	2	$210	0	$0	0	$0	0	$0	0	$0	$210
	7-12"	$220	5	$1,100	0	$0	0	$0	0	$0	0	$0	$1,100
	13-18"	$355	4	$1,420	0	$0	0	$0	0	$0	0	$0	$1,420
	19-24"	$525	7	$3,675	0	$0	0	$0	0	$0	0	$0	$3,675
	25-30"	$845	2	$1,690	0	$0	0	$0	0	$0	0	$0	$1,690
	37-42"	$1,470	1	$1,470	0	$0	0	$0	0	$0	0	$0	$1,470
	43"+	$1,850	3	$5,550	0	$0	0	$0	0	$0	0	$0	$5,550
Activity Total(s)			**24**	**$15,115**	0	$0	0	$0	0	$0	0	$0	**$15,115**
Moderate-Risk Removal	1-3"	$25	0	$0	6	$150	0	$0	0	$0	0	$0	$150
	4-6"	$105	0	$0	7	$735	0	$0	0	$0	0	$0	$735
	7-12"	$220	0	$0	12	$2,640	0	$0	0	$0	0	$0	$2,640
	13-18	$355	0	$0	3	$1,065	0	$0	0	$0	0	$0	$1,065
	31-36"	$1,140	0	$0	1	$1,140	0	$0	0	$0	0	$0	$1,140
Activity Total(s)			0	$0	**29**	**$5,730**	0	$0	0	$0	0	$0	**$5,730**
Low-Risk Removal	1-3"	$25	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$105	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			0	$0	0	$0	0	$0	0	$0	0	$0	$0
Stump Removal	4-6"	$25	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	7-12"	$25	0	$0	0	$0	2	$50	0	$0	0	$0	$50
	13-18"	$25	0	$0	0	$0	2	$50	0	$0	0	$0	$50
	19-24"	$25	0	$0	0	$0	1	$25	0	$0	0	$0	$25
	31-36"	$40	0	$0	0	$0	1	$40	0	$0	0	$0	$40
	37-42"	$110	0	$0	0	$0	1	$110	0	$0	0	$0	$110
Activity Total(s)			0	$0	0	$0	**7**	**$275**	0	$0	0	$0	**$275**
Severe/High-Risk Prune	7-12"	$75	0	$0	3	$225	0	$0	0	$0	0	$0	$225
	13-18"	$120	0	$0	5	$600	0	$0	0	$0	0	$0	$600
	19-24"	$170	0	$0	6	$1,020	0	$0	0	$0	0	$0	$1,020
	25-30"	$225	1	$225	12	$2,700	0	$0	0	$0	0	$0	$2,925
	31-36"	$305	7	$2,135	0	$0	0	$0	0	$0	0	$0	$2,135
	37-42"	$380	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	43"+	$590	4	$2,360	0	$0	0	$0	0	$0	0	$0	$2,360
Activity Total(s)			**12**	**$4,720**	**26**	**$4,545**	0	$0	0	$0	0	$0	**$9,265**
Routine Pruning	1-3"	$20	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$30	4	$120	4	$120	4	$120	3	$90	3	$90	$540
	7-12"	$75	23	$1,725	23	$1,725	23	$1,725	23	$1,725	23	$1,725	$8,625
	13-18"	$120	24	$2,880	24	$2,880	23	$2,760	23	$2,760	23	$2,760	$14,040
	19-24"	$170	23	$3,910	23	$3,910	23	$3,910	23	$3,910	23	$3,910	$19,550
	25-30"	$225	15	$3,375	15	$3,375	15	$3,375	15	$3,375	14	$3,150	$16,650
	31-36"	$305	7	$2,135	7	$2,135	7	$2,135	7	$2,135	6	$1,830	$10,370
	37-42"	$380	4	$1,520	3	$1,140	3	$1,140	3	$1,140	3	$1,140	$6,080
	43"+	$590	3	$1,770	3	$1,770	3	$1,770	3	$1,770	2	$1,180	$8,260
Activity Total(s)			**103**	**$17,435**	**102**	**$17,055**	**101**	**$16,935**	**100**	**$16,905**	**97**	**$15,785**	**$84,115**
Young Tree Training Pruning	1-3"	$20	36	$720	36	$720	36	$720	36	$720	36	$720	$3,600
	4-6"	$30	49	$1,470	49	$1,470	49	$1,470	49	$1,470	49	$1,470	$7,350
	7-12"	$75	5	$375	5	$375	5	$375	5	$375	5	$375	$1,875
Activity Total(s)			**90**	**$2,565**	**90**	**$2,565**	**90**	**$2,565**	**90**	**$2,565**	**90**	**$2,565**	**$12,825**
Tree Planting	Purchasing	$110	10	$1,100	10	$1,100	10	$1,100	10	$1,100	10	$1,100	$5,500
	Planting	$110	10	$1,100	10	$1,100	10	$1,100	10	$1,100	10	$1,100	$5,500
Activity Total(s)			**20**	**$2,200**	**20**	**$2,200**	**20**	**$2,200**	**20**	**$2,200**	**20**	**$2,200**	**$11,000**
To Be Determined													TBD
													TBD
Activity Total(s)													**TBD**
Activity Grand Total			**250**		**267**		**218**		**210**		**207**		**$1,152**
Cost Grand Total				**$43,505**		**$32,095**		**$21,975**		**$21,670**		**$20,550**	**$139,795**