Urban Forestry Management Plan

City of Ypsilanti, Michigan

February, 2012

DAVEY RESOURCE GROUP

A Division of The Davey Tree Expert Company

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Acknowledgement

This project and publication was conducted for the City of Ypsilanti, Michigan and materials were prepared using Great Lakes Restoration Initiative funds received through the USDA Forest Service.

This project could not have been nearly as successful without Teresa Gillotti of the City of Ypsilanti and Therese Taylor of the Michigan Works! Older Youth Program.

Table of Contents

Figures

Tables

Appendices

A. Inventory Methodology

B. Tree Inventory Frequency Reports

C. Eight-Year Urban Forest Management Program

D. Tree Care Costs

E. Arboriculture Planning Chart

F. Work Specifications and Contracting Guidelines

G. Tree Pruning Guidelines

H. Davey® Technical Bulletins - Common Pests and Diseases

I. Suggested Species List

J. Tree Planting Guidelines

K. Urban Tree Canopy Methodology

L. Urban Tree Canopy GIS Maps

M. Directory of Michigan Seedling Nurseries

N. Nursery References

O. Definitions

Executive Summary

The City of Ypsilanti is a thriving college town that has a great atmosphere and arts scene. The beautiful neighborhoods, historic "Downtown" and "Depot Town", and large parks create an attractive community in which to live, work, play, and study. The economic health of Ypsilanti, as with many communities, is closely related to the ability of its municipal government to supply its citizens and visitors with efficient services, safe public spaces, and properly maintained infrastructure.

Managing natural resources in urban areas can be challenging. Providing adequate maintenance for public trees within a limited budget is a common concern among many communities. A successful urban forestry program requires a combination of organized leadership, comprehensive information about the tree population, dedicated personnel, and effective public relations.

The City of Ypsilanti has commissioned a study of its public trees to evaluate the current resource structure and establish an effective planning and management program for this valuable resource. This document will review current conditions, explore future management options, capture the current tree canopy, make city nursery recommendations, and discuss administration, budgeting, and funding.

Resource Structure

Ypsilanti's tree inventory includes 8,835 trees, stumps, and planting sites. The appraised value is equal to $10.7 million or about $1,800 per tree. In order to gain an understanding of management needs, an analysis of Ypsilanti's public tree resource has been performed. Species distribution, relative age, overall condition, maintenance needs, and recorded observations can be used to characterize Ypsilanti's resource as follows:

- There are 487.7 acres of street right-of-way and 148.5 acres (30.5 percent) are covered with tree canopy. There are also 149.3 acres of park and public space land, and within those parks and public spaces, 57.0 acres (38.2 percent) are covered with tree canopy. Ypsilanti's tree canopy covers 32.3 percent of public land and 36.6 percent of public and private land.
- The street tree stocking level is 61.5 percent.
- There are 105 distinct species representing 46 genera. The predominant tree species are large-growing *Acer platanoides* (Norway maple), *Acer saccharinum* (silver maple) *Geditsia triancanthos inermis (*honeylocust), *Acer saccharum* (sugar maple), and *Acer rubrum* (red maple). The genus *Acer* (maple) comprises 55.2 percent of the tree population.
- The age structure of Ypsilanti's public trees is not an ideal distribution as it is skewed towards a maturing population of trees. Ypsilanti's age distribution is 19:19:43:19 (percentages of young: established: maturing: mature trees). An ideal population has a greater percent of young trees with decreasing percentages of established, maturing, and mature populations.
- The majority (58.8 percent) of Ypsilanti's public trees (5,771 trees) are in Fair condition (3,395 trees). Trees classified in Very Good condition make up 0.9 percent (50 trees) of the population and Good condition make up 12.3 percent (708 trees) of the population; while trees in Poor condition make up 23.1 percent (1,335 trees) of the population and trees that are in Critical condition make up 3.4 percent (194 trees) of the population. There are 89 trees (1.5 percent) trees that are Dead.

- The total maintenance requirements indicate that 9.9 percent of the tree population needs removed and 14.1 percent needs pruned immediately. There are 295 Priority 1 Removals, 413 Priority 2 Removals, and 170 Priority 3 Removals. There are also 135 Priority 1 Prunes and 890 Priority 2 Prunes. There are 114 stumps and 2,950 vacant planting sites on record.
- The two most common observations recorded are cavity decay and poor structure. Frequencies show approximately 17.8 percent of the population (1,025 trees) have a cavity or decay present and 8.9 percent (511 trees) have grown to form poor structure among branches.

Recommendations

Maintaining Ypsilanti's public trees requires constant attention and commitment to achieve sustainability. Resource management recommendations described in this plan are proactive, cost-effective strategies of prioritized tree maintenance needs. Proactive tree maintenance will help achieve sustainability, increase public safety, and improve tree health. Establishing tree canopy goals is also crucial to achieving sustainability. The tree canopy assessment provides estimates of the amount of tree canopy currently present in the City. A city nursery will support the tree planting program and assist with meeting tree canopy goals by ensuring locally grown, adequate species availability and high-quality stock. An established city tree nursery will aid the growth and stability of the urban forestry program. However, none of this can happen without professional expertise, community support, consistent budget and additional funding, and effective public communication about the forestry program. The following are specific recommendations related to resource management, tree canopy, nursery establishment, and administrative support.

Resource Management

- Perform all high priority maintenance recommendations identified in the tree inventory during Years 1–4 of the eight-year management program. This will involve the removal of 878 trees and the pruning of 1,025 trees. Estimate cost for priority maintenances is approximately $522,775.
- Beginning in Year 4 of the eight-year management program, implement a routine pruning program to ensure all trees are pruned in seven years. This will involve the pruning of approximately 566 trees annually at an annual cost of approximately $74,901.
- Beginning in Year 4 of the seven-year management program, implement a young tree training pruning program to ensure all young and newly planted trees are pruned every three years. This will involve the pruning of 255 trees annually at an annual cost of approximately $6,467.
- Practice best management for maturing trees to maximize the cumulative survival rate. This includes training of tree crews, insect and disease control, fertilizing, mulching, watering, and cabling and bracing (when applicable).
- Maintain or potentially expand the population (if budget allows) through tree planting. Plant 60 trees in Years 1–4, 110 trees in Year 5, and 208 trees in Year 6–8 to replace identified tree removals and stumps, loss due to natural mortality, and fill vacant planting sites.
- Practice best management for planting trees to maximize the cumulative success rate. This includes selecting wide varieties of trees, selecting the right mature-size tree for site restrictions, purchasing good quality stock, proper installation, mulching, watering, fertilizing, and pruning.
- Update the inventory database on a daily, weekly, or monthly basis to provide accurate records and increase the opportunities for well-planned tree work.

- Conduct yearly inspections of the entire population and schedule required tree work appropriately. Also inspect the entire population after severe storm events.
- Annually check actual work performed versus benchmarks in the management program to monitor successes and discover areas for improvement.

Tree Canopy

- Increase canopy cover from 36.6 percent to 40 percent and budget adequately to maintain tree canopy.
- Concentrate planting efforts along streets in zones that need more trees to increase canopy cover.
- Identify opportune areas, such as parks with an abundance of pervious area, to plant trees using land cover information.

City Nursery

- Grow a more diverse palette of tree species to increase species diversity and ultimately the sustainability of the City's urban forest.
- Use the pot-in-pot method which combines the natural advantages of field-growing with the control and convenience of above-ground growing.

Administrative Support

- Hire enough city personnel or contract out tree work to implement the recommendations within this management plan.
- Encourage volunteers and build upon partnerships to help with nursery operations and plant and prune trees.
- Budget for and create funding sources to support a proactive urban forestry program.
- Implement a public relations program designed to educate the residents of Ypsilanti and to generate greater support for the urban forestry program.

Introduction

Trees are a significant component of Ypsilanti's urban environment. The street, park, and public space trees are an integral part of city infrastructure, no less so than its streets, utilities, buildings, and sidewalks. The actual landscape value of Ypsilanti's tree population is approximately $10.6 million. Unlike other infrastructure components, the tree population will actually increase in value as trees are planted, cared for, and mature over time.

A diverse and healthy urban forest is a valuable asset.

Trees return overall benefits and value to the community far in excess of the time and money invested in them for planting, pruning, and removal. Their shade and beauty contribute to the community's quality of life and soften the hard appearance of concrete structures and streets, moderating harsh urban conditions. They help stabilize the soil by controlling wind and water erosion. They provide shade and help reduce energy costs. Trees also help reduce noise levels, cleanse air of pollutants, produce oxygen, and absorb carbon dioxide. Additionally, they provide significant economic value, including increased real estate values and improved settings for business activities.

The residents and officials of Ypsilanti have recognized these benefits and realized the need to protect this investment with a comprehensive, urban forest management program for their public trees. Such a plan begins with an inventory of the public trees and their present status. This inventory has provided important information concerning the public trees. Other aspects of Ypsilanti's urban forestry program covered in this written plan include a tree canopy assessment, recommendations for a city nursery, and administrative support for the program. The tree canopy assessment has provided base line information for which the City can realistically set goals to increase canopy and know where tree canopy is needed compared to other areas. Recommendations for the development of a tree nursery have been provided so the City may reasonably establish and effectively manage the nursery. Yet, no success in managing public trees, tree canopy, and a city nursery will be possible without the support of city officials, well-trained city staff, volunteers, partnerships, consistent budget, additional funding, and effective public relations and education.

Statement of Purpose

The purpose of this *Urban Forestry Management Plan* is to analyze the current structure of the population and to develop a long-term plan of action for maintaining Ypsilanti's public trees. This management plan focuses on existing conditions that require immediate attention, while developing management guidelines that will help protect and preserve city-managed trees in a cost-effective and efficient manner.

Goals

This management plan intends to achieve the following goals:

- Gain an overall understanding of the inventoried tree population in terms of genus and species composition.
- Analyze the overall health and age sustainability of the inventoried tree population.
- Identify and take remedial action for trees with structural or other defects that could cause them to be or become potential risks to citizens, vehicles, and/or property.
- Mitigate all identified high-priority tree maintenance activities to improve public safety by planning tree maintenance.
- Develop and implement a routine pruning program, young tree training program, and a tree planting program designed to increase species diversity, better overall tree condition and age sustainability, and proactively manage the tree population.
- Define the status of tree canopy to set goals and make informed decisions about where trees are most needed.
- Make recommendation for the establishment and management of a city nursery.
- Establish administrative activities to support proactive and efficient maintenance, including staffing, budget, funding, and public relations and education.

Implementation

The recommendations made in this management plan are intended to be considered and implemented over a period of eight years. However, the results of the Plan's implementation, in relation to the overarching goal and final measurable result of achieving a sustainable public tree population through a proactive urban forestry program that is supported by the City of Ypsilanti and its citizens, may take 20 years or more.

Trees are long-lived organisms and managing them appropriately in the urban environment can be difficult. However, planting and routinely caring for trees today will provide an improved quality of life for future generations of citizens. By having systematic tree maintenance and planting programs, and by having adequate funding, staffing, policies, and public education resources, the future public tree population and overall urban forest will be expanded and sustainable.

Chapter 1: City of Ypsilanti's Tree Population

The urban forest, as a municipal asset, is as important to Ypsilanti's economic and political viability as are water and sewage facilities, transportation systems, and community support services. The quality and availability of all these assets are indicators of Ypsilanti's ability to encourage people to live and support businesses to prosper within the city limits. Ypsilanti's urban forest is a complex system of trees, site conditions, and maintenance recommendations. Understanding this system is important for proper decision-making regarding species selection and tree care practices. This chapter of the Urban Forest Management Plan provides insight about the tree population's characteristics that affect management. Specific trends and observations noted during data collection will be discussed. Information detailed in this chapter includes:

- Public Tree Totals
- Species Richness and Distribution
- Relative Age Distribution
- General Health and Condition
- Tree Maintenance Recommendations
- Observations

It is important to have comprehensive information about the public tree population. Tree species, size, and condition provide much information about the tree population's composition, relative age, and health. Species identification is essential to the population because species vary considerably in life expectancy, maintenance needs, and are targeted by different pests and diseases. The variety, maturity, and health of trees present along the streets and in parks and public spaces greatly affects tree maintenance activities and budgets.

All data for the following analysis were collected during the tree inventory conducted by Davey Resource Group (Davey) and assisted by Michigan Works! "Green Team". Davey Urban Foresters are International Society of Arboriculture (ISA) Certified Arborists. Davey trained and supervised the Green Team members. Training consisted of two days in class followed by in-the-field, hands-on learning the purpose for information they would be collecting, species identification, tree risk assessment, detailed explanation of data fields, proper use of equipment, and safety in the work place. Once the Green Team personnel were trained to conduct the inventory independently, Davey split the Green Team into two groups of three and assigned each group to specific areas. Each day, Davey supplied the needed equipment and materials for each Green Team member. Then each night, Davey coordinated with Green Team members to drop off equipment and assign a starting spot for the next day's work. Davey provided project oversight and quality control for each Green Team group to ensure that Ypsilanti received high-quality data.

Methodology for inventory work can be found in Appendix A, and all inventory frequency reports can be found in Appendix B. By accumulating and using this information, urban forest managers can forecast trends, anticipate maintenance needs, facilitate budgeting for tree-related expenditures, and develop a basis for long-range planning.

Public Tree Totals

Ypsilanti's inventory was started in September, 2011 and completed November, 2011. It includes all trees within the street rights-of-way and six of the nine total city parks. The inventoried population is composed of 8,835 public trees, stumps, and planting sites (7,934 or 89.8 percent are street trees and 901 or 10.2 percent are park trees). Davey inventoried 6,053 trees, stumps, and planting sites and the Green Team inventoried 2,782 trees, stumps, and planting sites (Table 1).

Table 1. Total Number of Trees Inventoried per Team

	Davey Team	Green Team	Total Sites
Trees	3,758	2,013	5,771
Stumps	78	36	114
Planting Sites	2,217	733	2,950
Total Sites	**6,053**	**2,782**	**8,835**

Using Davey's proprietary Tree Collector Interface (TCI) software, quality control checks were run to verify the accuracy and completeness of all inventoried data. These quality control checks included verification of proper addressing, illumination of duplicate sites and inconsistent sites, maintenance checks, and more. Quality control using TCI was conducted on 100 percent of the data. Additionally, Davey conducted field checks to ensure correctness and consistency within both Green Team groups. During field checks, verification of data fields included species identification, tree size and condition, maintenance recommendations, and other general observation. Approximately 50 percent of the Green Team's data was field checked. Any problems found during quality control and field checks were reported directly to that Davey team member or Green Team group. The entire Green Team learned the materials necessary for the job quickly and applied their training well.

A member of Michigan Works! Green Team identifies a *Thuja occidentalis* (eastern arborvitae) amongst a mixed row of herbaceous plants and shrubs along North Congress Street.

Species Richness and Distribution

Ypsilanti's inventoried tree population includes a mix of 105 species and 46 genera. Large-growing species make up the majority of the population representing 56.2 percent of the population (Table 2). Numerous considerations drive species choice including planting site restrictions, potential conflicts with infrastructure, maintenance, water availability, and design. In some cases, only small-growing species are best for certain sites. However, Ypsilanti's large tree lawns or parkways have provided a great foundation to host a large population of large-growing trees. Large-growing trees will provide Ypsilanti with the greatest environmental and economic benefits.

Table 2. Distribution of Mature Tree Size

Mature Tree Size	Number of Broadleaf Population	Number of Conifer Population	Number of Total Population	Percent of Total Population
Large-growing	3,099	142	3,241	56.2
Medium-growing	2,199	52	2,251	39.0
Small-growing	278	1	279	4.8
Total	**5,576**	**195**	**5,771**	**100.0**

Table 3 shows that *Acer platanoides* (Norway maple) and *Acer saccharinum* (silver maple) represent 28.6 percent and 13.7 percent of the total population, respectively. Figure 1 also shows that *Acer* (maple) is the dominate genera, comprising 55.2 percent of the total population. A general rule of thumb suggests that no single species should represent more than 10 percent of the total population and no single genus should represent more than 20 percent of the total population. Maple exceeds the genus rule and more specifically Norway maple and silver maple exceed the species rule.

Davey recommends Ypsilanti plant a wide range of species by including both native and non-native, urban-tolerant, and/or drought-resistant species. Tree populations with well-developed species richness and composition can decrease the impact of species-specific pests and diseases by limiting the number of trees that are susceptible. Managing species composition and establishing a wide variety of species that perform well in Ypsilanti will reduce the time and money spent on mitigating problems resulting from any such episodes.

Table 3. Top 10 Species Populations

Scientific Name	Common Name	Number of Total Population	Percent of Total Population
Acer platanoides	Norway maple	1,651	28.6
Acer saccharinum	silver maple	793	13.7
Gleditsia triacanthos inermis	thornless honeylocust	464	8.0
Acer saccharum	sugar maple	353	6.1
Acer rubrum	red maple	220	3.8
Tilia cordata	littleleaf linden	207	3.6
Ulmus pumila	Siberian elm	185	3.2
Pyrus calleryana	Callery pear	178	3.1
Malus spp.	flowering crabapple	123	2.1
Populus deltoids	eastern cottonwood	119	2.1
Total		**4,293**	**74.3**

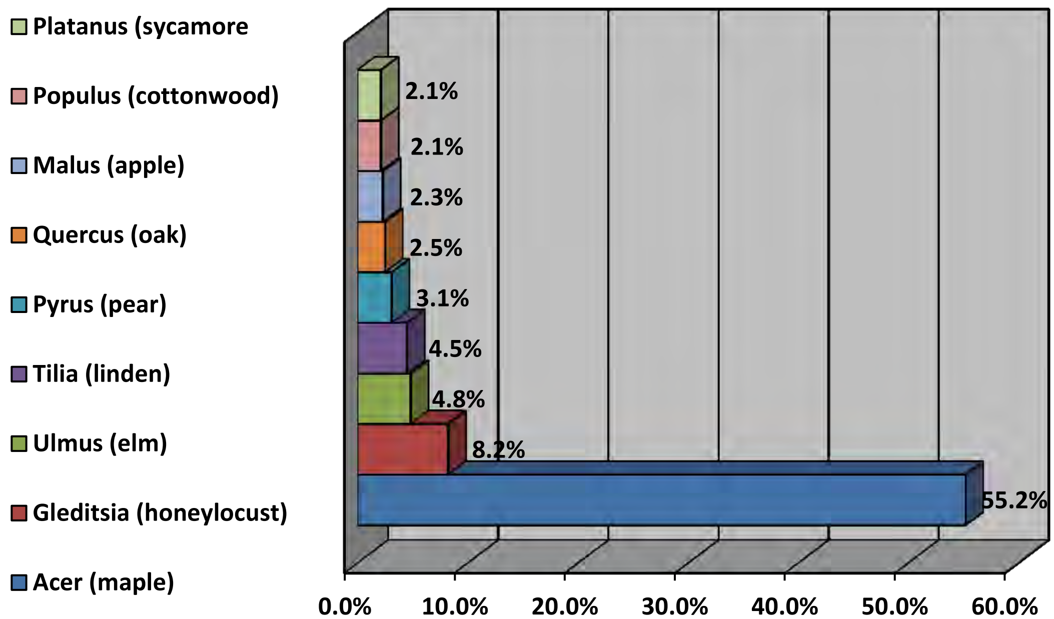


Figure 1. Distribution of Genera Representing Greater Than 2.0 Percent of the Population

Relative Age Distribution

Tree ages cannot be assumed from the diameter at breast height (DBH) alone because tree species have different lifespans and mature at different diameters, heights, and crown spreads. However, general classifications of size, such as young, established, maturing, and mature, can be used to describe the general characteristics of a tree population and can provide a general idea of the overall variability in the population. Young trees have 0- to 6-inch diameters, established trees have 7- to 12-inch diameters, maturing trees have 13- to 24-inch diameters, and mature trees have 25-inch and greater diameters.

A Davey urban forester measures a tree's diameter with the Biltmore® Cruiser™ stick.

The distribution of ages within a tree population influences present and future costs. A sustainable tree population has a higher percentage of young trees with a stair-stepped distribution of established, maturing, and mature trees to minimize fluctuations in maintenance costs. As trees mature and begin to decline, a tree population skewed towards young trees will allow urban forest managers to allocate annual maintenance costs uniformly over many years.

Figure 2 illustrates Ypsilanti's public tree population is not ideal as it is skewed towards a maturing population of trees. The relative age distribution is 19:19:43:19 (percentages of young; established; maturing; and mature trees). As the current tree population continues to mature, Ypsilanti will need to plant more trees and replace trees that are removed in efforts to maintain a sustainable age distribution. Ypsilanti should also make routine tree care a priority to ensure that trees mature and survive for as long as possible.

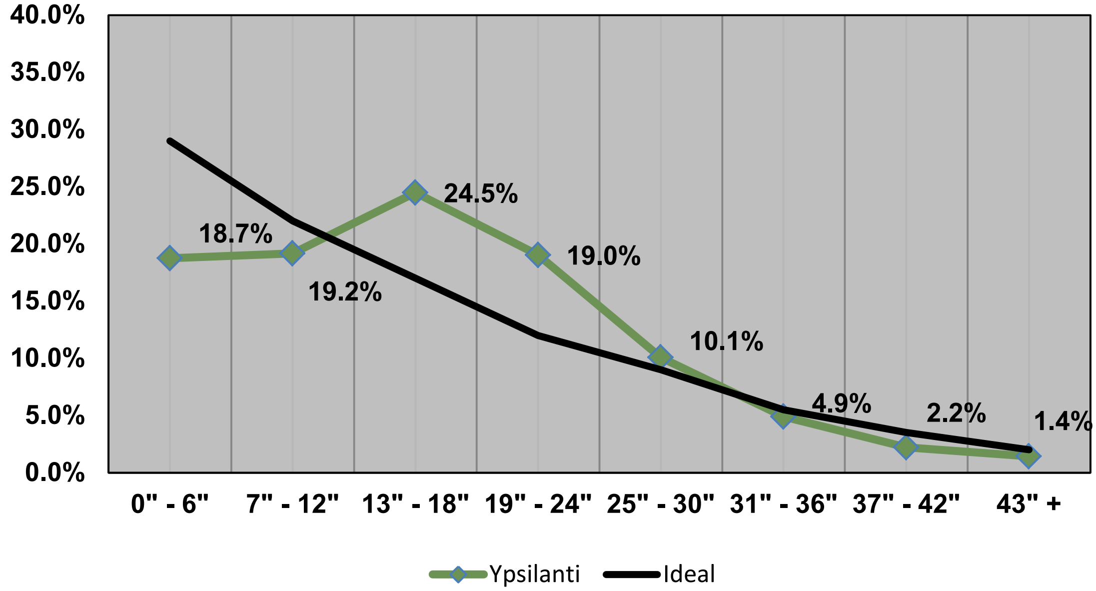


Figure 2. Ypsilanti's Size Class Distribution Compared to an Ideal Distribution

General Health and Condition

Tree condition indicates both how well trees are managed and how well they perform given site-specific conditions. The condition of a tree is evaluated by considering several factors, including, but not limited to, root characteristics, trunk, branch structure, canopy, foliage, and presence of pests and diseases. Based on these factors, each tree is given a condition rating defined by the ISA.

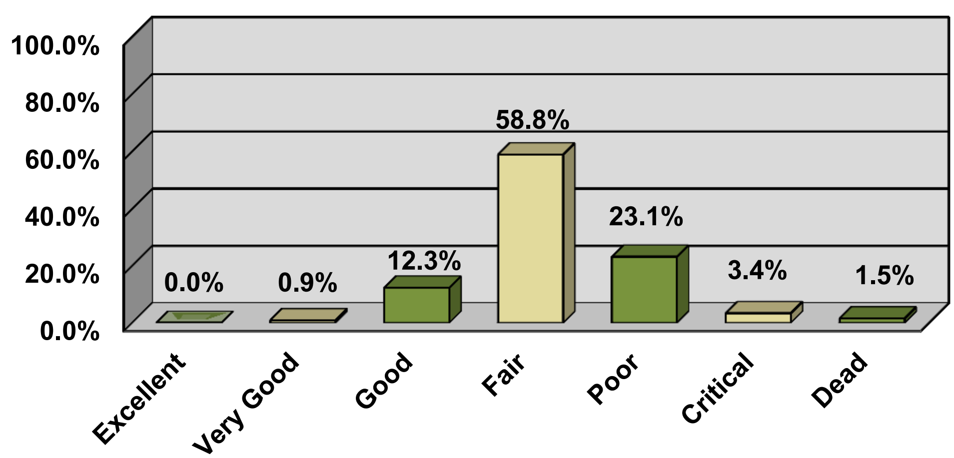


Figure 3. Ypsilanti's Tree Condition

Monitoring the condition of trees, and making efforts to maintain their health, is essential to cost-effective tree management. As can be seen in Figure 3, Ypsilanti's public tree population is mostly in a Fair state of health (3,395 trees or 58.8 percent). There were 758 (13.1 percent) trees rated in Good or better condition and 1,618 (28.0 percent) trees rated in Poor or worse condition. Compared to a grading scale, a tree population in Fair condition is a C (80-60 percent). The health improvement of Ypsilanti's tree population will be possible with the formation of a proactive maintenance and management program.

Tree Maintenance Recommendations

One objective of the tree inventory was to determine the current maintenance needs for the public tree population. The high-priority maintenance recommendations are specific to protecting public safety and reducing high-risk situations; nonetheless, all maintenance recommendations are directed at improving the overall health, safety, stability, and aesthetics of the urban forest, as well as the cost-effectiveness of the urban forestry program.

The high-priority maintenance activities associated with reducing the risk include:

- Priority 1 and Priority 2 Removal
- Priority 1 and Priority 2 Prune

Other recommended maintenance activities are:

- Priority 3 Removal
- Large Tree Routine Prune
- Small Tree Routine Prune
- Training Prune
- Stump Removal
- Plant Tree (vacant planting site)

Davey Resource Group has identified the maintenance activities that are of greatest importance to the overall management of the total tree population. The current maintenance recommendations have been determined from visual observations made from the ground. The structure and function of roots, trunk, scaffold branches, and canopy, as well as the tree's location relative to streets, sidewalks, utilities, signs, buildings, and traffic control devices, were all taken into consideration during each tree assessment.

A group of three from the Green Team looks at a tree along Ferris Street. Using a pen tablet computer and ArcPad™ software, they place the tree on the map along the street and identify the species, asses the condition, measure the size, recommend maintenance needs, and add other general observations. Data recorded for this tree include the species *Tilia cordata* (littleleaf linden), condition Good, size 7-inch diameter, maintenance Training Prune, and observation Poor Structure.

Table 4. Ypsilanti's Maintenance Recommendations

Maintenance Required	Number of Sites	Percent of Maintenance
Priority 1 Removal	295	3.3
Priority 2 Removal	413	4.7
Priority 3 Removal	170	1.9
Priority 1 Prune	351	4.0
Priority 2 Prune	890	10.1
Large Tree Clean	2,729	30.9
Small Tree Clean	100	1.1
Training Prune	823	9.3
Stump Removal	114	1.3
Plant Tree	2,950	33.4
Total	**8,835**	**100.0**

Ypsilanti's first priority is the safety of its citizens. Table 4 summarizes the maintenance recommendations for Ypsilanti's public tree population. Trees with Priority 1 or 2 maintenance recommendations should be pruned or removed immediately, thus, reducing the overall risk of the urban forest and increasing safety within the community. Making maintenance decisions based on risk enables urban forest managers to use available funds more efficiently. The use of these funds can be focused on the high-risk situations first, effectively contributing the highest gain in overall safety. Chapter 2 provides a detailed eight-year management program and budget for the maintenance of Ypsilanti's public tree population and discusses in detail the specific prioritization of maintenance work.

This *Acer saccharum* (sugar maple) along North Wallace Boulevard is in Critical condition and the maintenance is Priority 1 Removal. All Priority 1 and 2 maintenances should be performed as soon as possible to reduce the level of risk in the public tree population and increase public safety.

This *Acer platanoides* (Norway maple) along North Prospect Street is in Poor condition, the observation is Serious Decline, and the maintenance is Priority 2 Removal. The reason for the trees decline is the poor root system, better described as girdling roots.

Observations

Major objectives of this inventory were to capture the species distribution, relative age, general health, and reduce risk through prioritizing maintenance needs associated with public trees. However, other observations about the City's public tree population were also collected. These observations help paint a more complete picture of the state of Ypsilanti's tree population. This additional data will allow for better work planning and improved strategic planning for the urban forest. Table 5 lists the observations recorded during the inventory and the frequency of their occurrences.

Table 5. Frequencies of Observations Noted During Inventory

Observations	Number of Trees	Percent of Total Population =(X/5,771)*100
Cavity or Decay	1,025	17.8
Poor Structure	511	8.9
Poor Root System	192	3.3
Mechanical Damage	119	2.1
Poor Location	106	1.8
Serious Decline	99	1.7
Grate or Guard Present	67	1.2
Remove Hardware	51	0.9
Improperly Pruned	44	0.8
Pest Problem	38	0.7
Improperly Mulched	24	0.4
Improperly Installed	20	0.3
Nutrient Deficiency	17	0.3
Memorial Tree	2	0.0

Trees noted as having substantial amounts of cavity or decay (1,025 trees) or poor structure (511 trees) should be inspected on a regular basis and corrective actions should be taken when warranted. If their condition worsens, removal may be required. Of these 1,536 trees, 218 (14.2 percent) of them are Priority 1 Removal, 303 (19.7 percent) of them are Priority 2 Removal, 196 (12.8 percent) of them are Priority 1 Prune, and 329 (21.4 percent) of them are Priority 2 Prune. Proactive tree maintenance that mitigates these elevated-risk situations will increase public safety. All trees recorded as Priority 1 or 2 Prune should be examined closely during pruning operations for severe internal and external decay and/or dieback. If, upon closer inspection, these trees are found to be severely decayed, then they should be removed.

The observation poor root system was recorded often throughout the inventory; 192 trees were recorded with poor root systems. A considerable portion of these poor root systems include the presence of girdling roots, yet another portion is due to cutting of roots during sidewalk replacement. Girdling roots are roots which grow and apply pressure around another root or trunk, thus "choking" and compressing the water and nutrient conductive tissues. This compression of conductive tissue adds a great deal of stress to the tree and can result in decline and subsequent death, while it also creates a potential risk to nearby structures or pedestrians within the target zone. Trees with poorly developed root systems can fail when high wind, rain, snow, and/or ice loading events occur. One possible cause may be the high amount of soil compaction in tree lawns. In compacted soils, there is less area for the roots to grow into so roots begin to circle in search of available space. Another reason for girdling roots may be the tree species themselves. Certain species, such as Norway maple, are prone to developing girdling roots. Newly installed species prone to developing root problems should be inspected routinely for problems and root pruning should be implemented to alleviate any poor root conditions. It is also recommended that Ypsilanti evaluate its planting procedure in hopes that this will lessen future poor root system problems. Along with evaluating planting practices, the City should also reevaluate tree preservation and protection along public streets. Without a strong and enforced ordinance, contractors will not place a priority on protecting trees from excessive damage such as root pruning.

Trees can suffer injury from mechanical error; there were 119 trees in Ypsilanti's inventoried population with the observation of mechanical damage. Mechanical damage is the peeling, cutting, or bruising of outer bark causing a noticeable wound. Vehicles, construction equipment, and chainsaws can cause mechanical damage to trees, but most often damage is caused from mowers and weed trimmers. The best way to prevent damage is to mulch around the base of trees where mowing occurs often. Mulch should be applied around the base of a tree, but mulching up to the base of the tree trunk should be avoided. A 6-foot or larger diameter ring and a tapered depth from the inside out to 3 inches are best. See the Tree Mulching section in Chapter 2 under Best Management Practices for Tree Planting for another description of how to mulch.

At 501 East Forest Avenue along North Prospect Street, a 24-inch *Celtis occidentalis* (common hackberry) stands in critical condition due to the presence of poor structure and is a recommended Priority 1 Removal.

Many mature trees in Prospect Park have large surface roots. Mowers have hit these surface roots repeatedly. In the inventory, 19 trees in Prospect Park were recorded having mechanical damage. In the areas where surface roots are present, mulching may be a good option for the City to consider. Mulching will protect large mature trees from future root damage, decrease time and expenses mowing, and decrease future maintenances related to early decline in tree health.

Chapter 2: Urban Forest Management Program

This Urban Forest Management Program details the activities that constitute an eight-year tree maintenance program for the City of Ypsilanti. The maintenance data provided by the inventory will allow Ypsilanti to develop cost-effective strategies by assisting with prioritizing tree maintenance needs according to risk and accurately evaluate current and future tree-related expenditures. Management recommendations are based on current arboricultural standards and urban forest best management practices. These recommendations should be followed and used in the development of appropriate and realistic management goals, such as increased public safety, improved tree health, and sustainability of the city's public trees.

Headings in this chapter include:

- Urban Forest Management Program and Budget
- Priority Tree Maintenance Recommendations
- Cyclical Pruning Programs
- Best Management Practices for Maturing Trees
- Tree Planting Program
- Best Management Practices for Tree Planting
- Recommendations for Updating the Inventory
- Recommendations for Evaluating Work Progress

Specifically, information will be provided for:

- Development of an urban forestry program that implements critical strategies, actions, and tasks to increase public safety and improve tree health and population sustainability.
- Establishment of an eight-year routine pruning cycle for maturing large- and small-growing trees and a three-year training pruning cycle for young trees.
- Establishment of a tree planting program to increase species diversity and expand the population.
- Updating the inventory, evaluating work progress, and revising work plans to assure flexibility and respond to future changes in the community forest.

Urban Forest Management Program and Budget

The City of Ypsilanti's Department of Public Works is responsible for a variety of duties, including guiding the public tree maintenance program. The responsibilities of managing the described Urban Forest Management Program should be assigned to the appropriate position, such a General Foreman, in the Department of Public Works. This section consists of an eight-year program projection for all pertinent forestry activities and is intended to provide an example of the relative costs that could be incurred by the management recommendations in Chapter 1.

Table 6 is an overview of the Eight-Year Urban Forest Management Program, Appendix C contains a spreadsheet of the estimated budget for Ypsilanti's Eight-Year Urban Forest Management Program, and the inventory database provided in ESRI® shapefiles, Access™, and Excel™ spreadsheet provides a listing of all public trees inventoried including their location, address, species, condition, and maintenance recommendation. The management program is designed to address the highest-risk removal and pruning recommendations first. The intention is to reduce high-risk situations for the public and all associated liabilities, then implement routine, cyclical pruning and maintenance programs. The City may find it in its best interest plan and implement the suggested work activities in 2012.

The estimated budget, in Appendix C, does suggest a slight, short-term increase in spending on urban forestry. While accounting for current budgetary limitations, Ypsilanti must understand that these budgeting recommendations are only estimates and are based on the application of sound urban forestry management principles to municipal forestry operations. However, the City may find that they need to change the recommended amount of work to fit within annual budget funds. For these reasons, the budget table has been included on the CD-ROM as an Excel™ spreadsheet.

Tree maintenance activities in this management program are based on quotes from a large number of reputable North American tree care companies, and are averages extracted from bids received by communities in the Eastern United States. The figures are equivalent to average costs for the same activities by municipal in-house crews. These average costs are used to estimate budgets for the priority maintenances, routine pruning program, young tree training pruning program, and tree planting program projections described further on in this chapter. Appendix D provides a reference of the estimated costs for tree removals, pruning, stump removals, fertilization, and mulching.

The scheduling of most tree maintenance tasks, such as planting, pruning, or fertilizing, is dependent upon seasonal temperature and weather conditions. The maintenance tasks described in this management program should be scheduled for, and performed during, optimal biological periods to sustain vigorous health and to ensure the best chance for survival of public trees. The Arboriculture Planning Table in Appendix E has been provided in order to help Ypsilanti better organize maintenance activities recommended in the management program described in this chapter.

Short-term accomplishments should be measured in comparison to the management program's goals and recommendations, and long-term goals should be measured in comparison to the management plan's goals and recommendations. Table 6 and the budget spreadsheet in Appendix C should be used as general guidelines for implementation of the eight-year management program, planning of future tree care operations, and reviewing on-going forestry operations.

Table 6. Ypsilanti's Eight-Year Urban Forest Management Program

	Year	1	2	3	4	5	6	7	8
Tree Work Recommendations	Priority 1 Removals	73	222						
	Priority 1 Prunes	270	81						
	Priority 2 Removals			290	123				
	Priority 2 Prunes		80	458	352				
	Priority 3 Removals					170			
	Stump Removals					114			
	Routine Pruning Program, including Large and Small Tree Cleans (5-yr cycle)				567	567	567*	567*	567*
	Young Tree Training Program (3-yr cycle)				255*	255*	255*	255*	255*
	Tree Planting Program	60	60	60	60	110	208	208	208
Tree Work Beyond the Inventory	Tree Inspections	Inspect the entire urban forest annually.							
	New Removals and Prunes via Inspections	Number to be determined based on inspections.							
	Plant Health Care	To be determined based on inspections.							
Updates	Inventory Update (work performed daily)	Update inventory changes due to inspections and work performed.							
	Program Update (annual work against goals)	Compare annual work completed to goals established in this plan.							
	Plan Update (establish new goals and re-write plan)								

Numbers will need adjusted due to suggested routine pruning schedule. Mature trees pruned in Year 1 will need pruned again in Year 6. Young planted in Year 1 will receive their first training prune in Year 4.

Priority Tree Maintenance Recommendations

The following tree maintenance recommendations are based on the analysis of the City of Ypsilanti's inventoried tree population. These recommendations should be followed and used in the development of appropriate and realistic management goals. Implementation of these recommendations will allow the City to address first the highest risk maintenance recommendations related to public safety.

The maintenance priorities in the order of how they should be abated are:

- High-Priority Removals—Priority 1 and 2 Removals
- High-Priority Cleans—Priority 1 and 2 Prunes
- Low-Priority Removals—Priority 3 Removals an Stump Removals

The eight-year management program is designed to abate all high-priority maintenances identified during the tree inventory by Year 4. It is suggested that all Priority 1 Removals and Priority 1 Prunes be completed by Year 2, all Priority 2 Removals and Priority 2 Prunes be completed by Year 4, and all Priority 3 Removals and Stump Removals be completed in Year 5. Table 7 provides a summary of all priority maintenances broken down by diameter class.

Table 7. Priority Tree Maintenance Recommendations by Type and Size Class

Tree Diameter Size Class (inches)	Priority 1 Removals	Priority 1 Prunes	Priority 2 Removals	Priority 2 Prunes	Priority 3 Removals	Stump Removals
1-3	0	0	0	0	70	5
4-6	0	0	29	4	35	11
7-12	49	2	64	54	43	34
13-18	70	35	119	263	12	34
19-24	90	86	102	289	3	14
25-30	48	101	47	164	4	4
31-36	21	72	27	70	2	7
37-42	13	31	13	33	1	3
43+	4	24	12	13	0	2
Total	**295**	**351**	**413**	**890**	**170**	**114**

The City should schedule all high-priority maintenance recommendations to occur as soon as possible in order to abate potential risks. Davey recommends that the City remove and prune the largest trees first as they may pose the greatest risk. By doing so, the City will greatly decrease the potential of injury to the public, damage to property, and possible liability litigation. Although it is impossible to expect the City to perform all needed maintenance activities immediately due to budgetary concerns, an organized and systematic program will achieve the needed results in a timely manner, and will demonstrate the City's "good faith" effort to keep all streets, parks, and public spaces safe for its residents. The City will need to develop a system using the tree inventory that will help schedule and track work to be completed.

Where numerous high-priority removal or pruning recommendations exist in the same area of the city, the work should be performed at the same time in order to capture efficiencies like reduced travel time and costs. The City will also need to provide internal trained staff and correct equipment for the job or outsource tasks to complete the priority maintenance recommendations of this urban forestry management program. See Appendix F for example removal, stump removal, and pruning work specifications and guidelines for contracting tree work.

Risk tree maintenance is an inevitable and integral component of every urban forest program. The goal is to minimize risk and be efficient. It is critical that Ypsilanti continue to monitor public trees on an annual basis in order to identify high-priority removals and prunes as soon as possible. Davey recommends that Ypsilanti adopt an official methodology for actually evaluating high-priority maintenances and establish procedures for keeping the tree inventory information current. Keeping accurate records of tree inspections and work completed will help minimize risk and increase efficiency. As long as the tree information from inspections and work completed is kept up-to-date, Ypsilanti's tree inventory database will prove to be a valuable tool in organizing, scheduling, and routing the needed work to be accomplished.

Every day, Prospect Park (above) and many other parks around the City are filled with adults and children. They enjoy playing on playgrounds, playing sports, having picnics, taking leisure walks, and gardening in the local community gardens. Due to the heavy use of Ypsilanti's park system, the City should schedule all high-priority maintenance recommendations to occur as soon as possible in order to abate potential risks.

The tree inventory has highlighted many high-priority removals and prunes in Ypsilanti's park system. The number of high-priority maintenances in each inventoried park includes:

- **48 Frog Island Park**
- **16 Parkridge Park and Community Center**
- **72 Peninsular Park**
- **80 Prospect Park**
- **56 Recreation Park**
- **34 Riverside Park**

Cyclical Pruning Programs

Cyclical pruning is an activity that should take place on a regular basis because it is extremely beneficial for the overall health and longevity of trees and can prevent future problems requiring costly intervention. By cyclically pruning the entire population, most serious problems can be avoided when trees are closely inspected during pruning. Proper decisions can be made concerning declining trees and any trees that are becoming high risks can be managed appropriately before any serious incidents occur.

It is recommended that the Routine Pruning Programs described here be implemented beginning in Year 4 of the Urban Forest Management Program. It is also recommended that the Training Pruning Program described here be implemented beginning in Year 4. By routinely maintaining public trees, the potential for decay can be minimized and their vigor (condition) can be improved by retaining only strong, healthy branches. The City will need to provide internal trained staff and correct equipment for the job or outsource tasks to implement the cyclical pruning programs.

The City should develop an organized and documented approach to ensure cyclical tree maintenance. Centralized pruning will be most efficient, meaning that all trees within close proximity of each other requiring the same equipment are trimmed at the same time. Ypsilanti has divided the population into five zones (Figure 4). One zone of streets, parks, and public spaces should be designated for each year's work in order to meet the annual routine pruning goal.

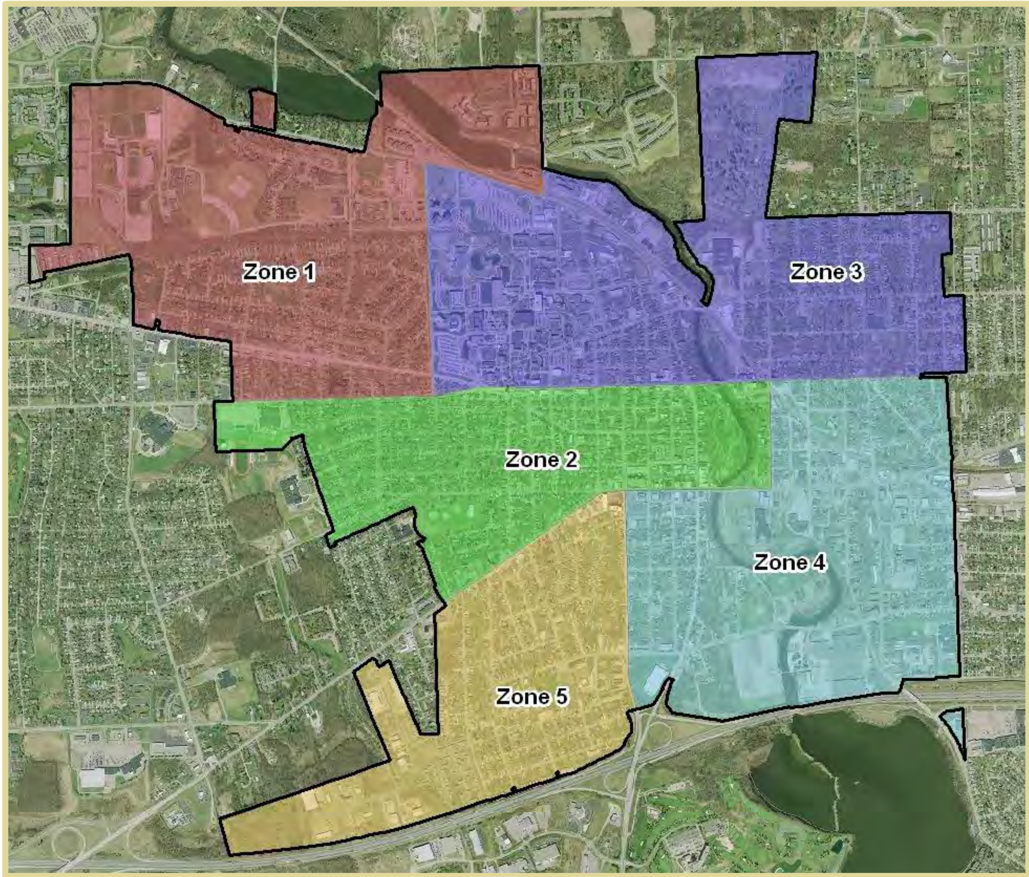


Figure 4. A Map of Ypsilanti's Five Zones

Large Tree Routine Pruning

Large Tree Routine Pruning includes large- and medium-growing trees (generally greater than 4-inch DBH and taller than 25 feet) requiring routine arboricultural pruning to correct growth patterns and remove dead, dying, and diseased branches. Additionally, crown raising and crown reduction pruning should be completed. Crown raising and reduction will allow vehicles to safely pass and park on streets or pedestrians to walk on sidewalks. Furthermore, the clearing of limbs away from signs and traffic signals can also be accomplished for increased public safety. Trees in this cyclical pruning program will likely require a bucket truck access or manual climbing gear, rigging gear, chain saws, pole saws, hand saws, chipper, and chip truck.

Small Tree Routine Pruning

Small Tree Routine Pruning includes small-growing trees (generally greater than 4-inch DBH and less than 25 feet tall) that can be evaluated and pruned from the ground to correct growth patterns and remove dead, dying, and diseased branches. A two-person crew will be able to easily perform this work with equipment such as pole saws, hand saws, hand pruners, and a truck to carry away tree debris. This crew would be responsible for the cyclical trimming of all small-growing trees. Additionally, they can perform clearance-trimming work, including crown raising and reduction to allow for vehicle and pedestrian traffic and increased public safety from the clearing of traffic signs and signals.

From left to right, the *Acer platanoides* (Norway maple) and *Malus* spp. (crabapple) are good examples of Large Tree Routine Prune and Small Tree Routine Prune maintenance recommendations.

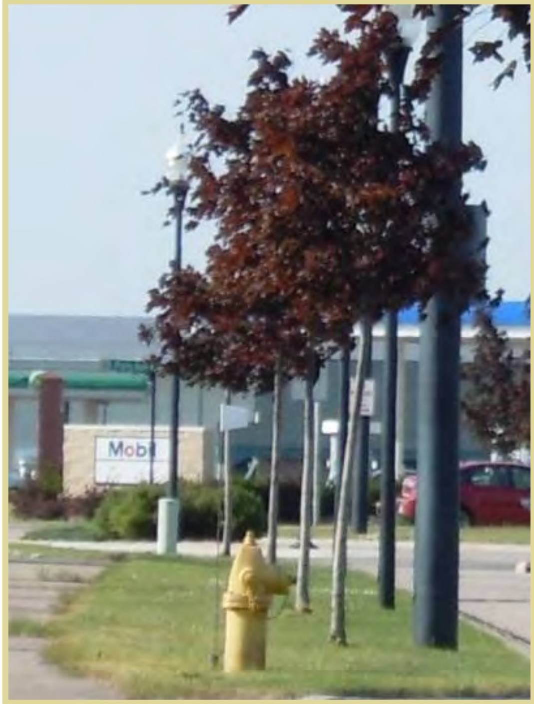
There are 2,829 trees needing Routine Pruning. Table 8 lists the number of trees in each diameter class and suggests that a five-year cycle be implemented so that approximately 567 trees are pruned each year. Additionally, 1,241 large-, medium-, and small-growing trees were identified as Priority 1 and 2 Prunes. Once these trees' needs are met, they, too, will fall into the Routine Pruning Program. In Year 9, this will potentially increase the total number of large-, medium-, and small-growing trees requiring cyclical pruning to 4,070 and approximately 814 trees (or 20 percent) being pruned annually.

Table 8. Routine Pruning Program by Diameter Size Class

Diameter Size Class (Inches)	Large Tree Routine (Total Trees Pruned in 5 Years)	Small Tree Routine (Total Trees Pruned in 5 Years)	Routine Pruning Program (Total Trees Pruned in 5 Years)	Routine Pruning Program (Approximate Trees Pruned/Year)
1 – 3	30	0	30	6
4 – 6	116	33	149	30
7 – 12	785	50	835	167
13 – 18	897	17	914	183
19 – 24	528	0	528	106
25 – 30	217	0	217	43
31 – 36	91	0	91	18
37 – 42	36	0	36	7
43+	29	0	29	6
Total	**2,729**	**100**	**2,829**	**566**

Training Pruning Program

Training pruning consists of the removal of dead, dying, diseased, interfering, conflicting, and/or weak branches, as well as selective trimming to direct future branch growth of young trees, including small-, medium-, and large-growing trees. The objective of Training Pruning is to increase the structural integrity by pruning the tree to one dominant leader; however, it is species-specific since many trees, such as *Amelanchier arborea* (downy serviceberry), can have more than one leader. Trees recommended for Training Pruning are generally young or newly planted trees with a canopy height less than 25 feet. Based on the generally small size of trees, a crew of two properly trained personnel would be capable of accomplishing all work from the ground with assistance of a pole pruner, hand pruners, and a truck to carry away tree debris.



These *Acer platanoides* (Norway maples) are good examples of a Young Tree Train primary maintenance recommendation.

The proposed Urban Forest Management Program recommends that the Training Pruning Program should be implemented in Year 4. There are 823 trees needing training in the public tree population. Table 9 lists the number of trees in each diameter class and suggests that a three-year cycle (rather than the five-year cycle because of the faster average growth rates of younger trees) be implemented so that approximately 255 trees (or 31 percent) are pruned each year. As these young, large- , medium-, small-growing trees mature, they will eventually become part of the Routine Pruning Program.

As trees are planted, all they should receive their first training prune three years following planting. No training pruning should be performed when a tree is first planted. The tree is already under stress from transplanting and needs as much of its leaf canopy as possible in order to manufacture food and increase root growth for proper establishment in its new site. Only dead or broken branches should be removed at the time of planting.

Table 9. Training Pruning Program by Diameter Size Class

Diameter Size Class (Inches)	Young Tree Train (Total Trees Pruned in 3 Years)	Young Tree Train (Approximate Trees/Year)
1 – 3	352	117
4 – 6	412	137
7 – 12	59	20
Total	**823**	**255**

Useful Life

The useful life of a public tree is ended when the cost of maintenance is greater than the value added by the tree to the community. This can be due to either the decline of the tree's condition and increasing maintenance activities or to the costs of repairing damage caused by the tree's presence.

Decline generally starts when the tree has reached a point where it cannot withstand the stresses imposed by its environment. Restrictive growing space, disease, insects, mechanical injury, pollution, and vandalism, among others, can cause stress. Although some species are more resistant to these urban stresses, all trees in urban settings will eventually decline, whether due to over stress or senescence.

The end of a tree's useful life can also be reached while the tree is still healthy if it is growing in a "limited" site. Useful life, in this instance, is the point at which the cost of related maintenance, such as the repair of hardscape damage, exceeds the value added by the tree. For example, a large, fast-growing tree used in a smaller tree lawn will cause hardscape damage at an early age and periodically throughout its lifetime. The useful life of this tree will be reached before it begins to decline. A smaller tree, on the other hand, would probably not exceed grow space dimensions at any point in its life. The end of its useful life would probably be reached only when it started to decline due to senescence. A smaller tree, as a result, would make better use of this example tree site.

Tree removals are unavoidable. National averages show annual mortality rates are about 1.0 percent for municipal tree populations. The mortality rate for Ypsilanti's public trees may represent approximately 58 trees per year. These anticipated tree removal costs are factored into the budget projection for the Eight-Year Urban Forest Management Program. The City should monitor public trees on an annual basis in order to identify removals, allocate funds in anticipation of these removals, and remove these trees as soon as possible.

The loss of trees over time is an inevitable natural process; however, the goal of the management process is to control the decline, removal, and replacement of trees in a timely and cost-effective manner. When maintaining trees in the municipal environment, the potential for loss is an important factor in prioritizing treatments and making effective use of available funds.

Best Management Practices for Maturing Trees

Tree Crew Training

Training about how to properly prune trees should be required for all tree crew personnel. Chapter 5 provides a recommendation that Ypsilanti should have one dedicated tree crew, consisting of two full-time employees, under the direction of a DPS General Foreman. If other DPS personnel or volunteers are utilized to help miscellaneous project they, too, should receive training. All crews need an understanding of the growth-habits of the various species being planted, as well as an understanding of basic tree anatomy and physiology. It is imperative to emphasize proper arboricultural and horticultural techniques and practices. The tremendous aesthetic and financial benefits to be gained in the years to come from the proper pruning of maturing, large-, medium-, and small-growing trees and training of young trees is a strong incentive for educating tree crews concerning proper pruning techniques. Appendix G contains guidelines for pruning trees.

Insect and Disease Control

Generally, trees do not have significant insect and disease problems if they are healthy and well cared for. However, some degree of insect infestation and disease incidence will always be present, as this is the norm for the natural world. It is only when particularly damaging insects are detected and the levels of insect populations are extremely high (such as emerald ash borer or Asian longhorned beetle) or when particularly virulent diseases are diagnosed (such as oak wilt) that action must be taken. The type and extent of action depends on the type and extent of the insect or disease problem.

The array of insects and diseases that can threaten the health of forest and urban trees and their treatments are too numerous to completely encompass within the scope of this document. However, a basic discussion on the fundamentals of an Integrated Pest Management (IPM) Program, and specifically monitoring, is covered in this section.

Fundamentals of an IPM Program are:

1. **Identification:** The proper identification of trees and their existing and potentially harmful pests is necessary to successfully manage a pest outbreak or occurrence. Additionally, understanding each pest's life cycle is important for a positive diagnosis. Knowledge of beneficial and incidental (non-threatening) organisms also plays an important role in the identification and diagnostic process. See Appendix H for more information about common pests and diseases.

2. **Monitoring:** Proactive, regular monitoring for potential threats is perhaps the most important part of an IPM Program. Monitoring for pest activity can be done using a variety of techniques, including visual inspection, and, in some cases, use of specialized traps. Regular contact with provincial and local plant health care officials can help to focus monitoring efforts and increase awareness of emerging threats. In most cases, Michigan's State Forester, local extension office services, Michigan Department of Natural Resources, or United States Department of Agriculture's state office can provide support for suspicions of potential pest infestations.

3. **Understanding the Economic Threshold Level:** The economic threshold is the level in which the costs involved in managing a pest infestation overshadow the value that a tree or plant is providing. In an urban situation, the economic value of a tree can be tied to the benefits that a tree provides. These benefits include, but are not limited to, aesthetic, environmental, and cultural benefits. This concept, on a general level, amounts to determining whether or not a tree is worth the costs of mitigating against a pest problem compared to its value to the community.

4. **Selecting the Correct Treatment:** Once a pest problem has been properly diagnosed and the decision has been made to treat the problem, selection of the correct treatment is the next step. Selecting treatment is a decision that requires a solid understanding of all the options, chemical or otherwise, for pest management material.

5. **Proper Timing of Management Strategies:** Once an appropriate treatment has been selected, it is important to carefully plan the timing and implementation to maximize effectiveness.

6. **Recordkeeping:** To facilitate future pest management decisions, accurate records should be kept concerning information on pests, treatments, locations, timing, weather conditions, and any other useful information.

7. **Evaluation:** A successful IPM Program must be evaluated based on experience, successes, and failures in order to focus efforts and resources for the future.

Fertilization

Unless a tree is a substantial tree in the area it is growing, municipal trees need not be placed on a scheduled fertilization program without a documented need. If soil analyses show a distinct and serious nutrient deficiency, or if the tree's root system or growing area has been damaged or contaminated, then the time and expense of fertilization may be worthwhile to save the tree. See Appendix F for an example of fertilization work specifications.

Irrigation

All trees need supplemental watering when there are drought conditions. This supplemental irrigation can be accomplished with a water truck and hose and/or deep root watering lance, or with watering aids, such as the widely used Treegator® Drip Irrigation Bags. The City of Ypsilanti is encouraged to water trees frequently during the summer, even when there are no drought conditions.

Cabling and Bracing

Rather than removing or severely pruning a mature tree if a structural defect is discovered, the use of structural support can reduce safety risks. Cabling and bracing are the two most common forms of structural support for trees. Other, less common forms of structural support are guying and propping. Structural support is infrequently recommended, but trees with special or historic significance can be spared from removal by using such techniques as cabling and bracing. 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, only use an ISA Certified Arborist who is knowledgeable and experienced in this area. Ask about the important technical aspects of correct cabling and bracing: the strength and material of the hardware; the arrangement of the cables (*e.g.,* simple, triangle, or box) or rods (*e.g.,* single or multiple); and the location, type, and size of the entries made into the tree. Be sure to specify in writing "all work and materials shall be in accordance with ANSI, A300 Tree Care Standards (Part 3), 2005".

Tree Planting Program

Tree planting enhances the aesthetic, environmental, and economic values of Ypsilanti's community; trees define the City's character and quality of life. As important infrastructure components, trees provide many vital services to Ypsilanti, including stormwater management, energy conservation, air quality improvement, carbon sequestration, and property value increase. It is because of these many benefits that it is important for the City to have a public tree planting program. Developing and following an efficient and effective planting program will allow the City to maintain its current tree population and increase it when it is most needed and where it would be most beneficial.

The inventory has identified 2,950 vacant sites available for trees along the streets of Ypsilanti. For example, North Wallace Boulevard, looking towards the address of house number 207, there is one vacant site (yellow dot) suitable for a large-growing shade tree, perhaps a *Liriodendron tulipifera* (tuliptree). In preparation of tree planning all site conditions should be evaluated carefully and proper species selections should be made before any tree planting activities occur.

During the public tree inventory, 2,950 potential planting sites were mapped and recorded. There are 1,484 Small Vacant Sites, 1,051 Large Vacant Sites, and 415 Medium Vacant Sites. The potential tree population of Ypsilanti's inventoried streets is 7,961 trees (4,897 existing street trees plus 2,950 vacant planting sites plus 114 stumps). Ypsilanti's street tree population is approximately 61.5 percent stocked. Stocking is a traditional forestry term for measuring the density and distribution of trees.

Full Stocking Potential

Full tree stocking (100 percent) is an elusive goal, since the mortality of young and old trees continues to make planting sites available. Furthermore, full stocking may require more resources than are available to purchase, plant, and properly maintain public trees. Nevertheless, it is worth the effort because the goal of working toward full stocking can help make other less glamorous aspects of urban forestry more palatable, especially removals.

It is the City's goal to fill as many vacant sites as they can to expand the tree population and increase canopy cover. Currently, the City plants an estimated 27 trees per year. Davey recommends that Ypsilanti continue to replace trees removed with new plantings, plant trees after new streetscape installations are completed, and fill as many vacant sites as their budget will allow, keeping in mind post-planting costs and maturing tree care budgets.

Here, we will apply a formula for determining the planting rate the City needs to reach the desired stocking rate. From the textbook *Urban Forestry: Planning and Managing Urban Greenspaces* (Miller, 1997), the formula is written as:

$$N = \frac{R + (V/G)}{S}$$

Where:

N = number of trees to be planted annually

R = number of trees to be removed annually

V = existing vacant sites

G = years remaining to achieve full stocking potential goal

S = expected planting survival rate

$$N = \frac{98 + (2{,}950/25)}{0.80} = 270 \text{ trees/year}$$

In the formula above, we assumed the City's goal to achieve full stocking is 25 years, the planting survival rate over that period is 80 percent, and 98 trees will be removed annually. The inventory shows there are 992 recommended removals (tree and stump removals) and the mortality rate is approximately 58 trees per year at 1 percent of the population per year. Under these assumptions, the formula estimates that more than 270 trees per year would need planted for 25 years in order to reach its full stocking potential. Davey Resource Group knows that budgetary constraints may prohibit the planting of so many trees per year; therefore, if it is the City's desire to use this to guage planting efforts, the formula can be manipulated until more acceptable figures are created. A desired stocking level and acceptable rate of planting will need decided in order to set a more realistic goal.

One major budget item this formula does not take into consideration is the added maintenance of the current population of trees. Therefore, along with needed tree maintenances, Davey presents the recommended number of trees to plant each year in Table 6 and a proposed budget is also presented in Appendix C. The management program recommends the City of Ypsilanti plant 60 trees in Years 1–4, 110 trees in Year 5, and increase to 208 trees in Years 6–8 to cover losses in the population due to recommended removals and natural mortality and expand the population. In following this recommendation, all recommended removals could be replaced in 24 years and all identified vacant planting sites could be filled in 32 years. Vacant park tree plantings are not included in Table 6 or the proposed budget; however, Davey recommends budgeting for an additional 100 trees per year for park tree plantings.

Street Tree Spacing Guidelines

Tree placement planning should be among the first action items of any tree planting project. To maximize the benefits that trees provide, the City should be committed to planning and planting the largest-growing tree that a given location can support without compromising the tree's natural form. Creating space for trees along streets and matching appropriate tree species to site conditions is an urban forestry principle called "the Right Tree in the Right Place". Choosing the right tree for the right place helps keep future maintenance costs low and ensures that the initial investment of planning and planting is well worth it. The City will need to develop streetscape design guidelines involved in tree installation. Davey's street tree placement standards are as follows:

- 35 feet from street corners
- 35 feet from front side of traffic signs and 10 feet from back side of traffic signs
- 10 to 15 feet from driveway cuts and alleys (dependent on speed of traffic)
- 15 feet from street lights and utility poles
- 15 feet from fire hydrants
- 10 feet from the edge of man-hole covers, storm drains, and all underground water or utilities features

The space available for a tree to be planted in and thrive is a major factor that dictates the type of species best suited for a given location. Potential planting sites are defined as areas suitable for tree planting within the existing right-of-way. All 2,950 planting sites were designated as small, medium, or large, primarily based on the growing space available and the presence of overhead wires. As the City continues to maintain the tree population and manages the inventory, future potential plantings sites should continue to be identified and the size of tree best suited for that space should also be recorded. The parameters for small, medium, and large planting sites used during the inventory are the following:

Small Planting Sites

Potential planting sites suitable for a small-growing tree; usually 4 feet growing space is a minimum requirement to allow for the tree to grow into its mature form. To maximize plant-able space, small-growing trees should be planted an average of 20 feet apart. When overhead utilities are present, only small-growing trees should be planted.

Medium Planting Sites

Potential planting sites suitable for a medium-growing tree; usually 6 to 8 feet growing space is a minimum requirement to allow for the tree to grow into its mature form. To maximize plant-able space, medium-growing trees should be planted an average of 30 feet apart. Planting medium-growing trees within 20 to 40 feet from primary overhead utility lines will help lessen future conflicts, improve future tree conditions, and lessen tree care costs.

Large Planting Sites

Potential planting sites suitable for a large-growing tree; usually 8+ feet growing space is a minimum requirement to allow for the tree to grow into its mature form. To maximize plant-able space, large-growing trees should be planted an average of 40 feet apart. Planting large-growing trees outside 40 feet from primary overhead utility lines will help lessen future conflicts, improve future tree conditions, and lessen tree care costs.

There are multiple, unnecessary maintenance costs associated with large-growing trees under overhead utilities. The size of growing space available, area between the sidewalk and curb, and the presence of overhead utility lines should be considered when choosing tree species for planting sites. For example, the left side of South Congress Street west of N Wallace Boulevard is suitable for large-growing trees and the right side is only suitable for small-growing trees due the presence of overhead utilities.

Best Management Practices for Tree Planting

The success of a tree planting program will be judged by the health of the trees' post-planting and the amount of money spent on planting and maintaining the new trees. With a small amount of planning, healthy trees with greater life expectancies can be established with minimal up-front investment and minor maintenance costs. See Appendix F for an example of tree planting work specifications.

The key elements for a successful tree-planting program are covered in this section and are primarily based on the exceptional reference, *Principles and Practice of Planting Trees and Shrubs* (Watson and Himelick, 1997).

Tree Species

The City of Ypsilanti must determine which tree species will be planted in each vacant site. The suggested species list in Appendix I considers maintenance recommendations, adaptability to specific planting site variables, mature size, and suitability to the restrictive conditions of the urban environment, among others. Careful planning is necessary to introduce a good level of variety into the street and park tree population.

Ypsilanti is located in USDA Hardiness Zone 5b, which identifies a climatic region where the average annual minimum temperature is between -15°F to -10°F. Tree species selected for planting in the City should be appropriate for this zone. Native trees to Southern Michigan will be more adaptable to weather conditions and other environmental forces, but may be more susceptible to exotic pests. Green ash is a perfect example of a tree that is native to the Ypsilanti area and is very susceptible to emerald ash borer. Therefore, Davey recommends that the City consider planting native and non-native trees that are capable of growing in Ypsilanti's weather and environmental conditions.

Along the south side of this photographed stretch of road, East Cross Street east of North River Road, there are four inventoried planting sites suitable for medium-growing species. The larger part of the project, along West Cross Street between North Normal Street and North Washington Street, has approximately 70 pre-planned tree planting locations. Streetscape improvement projects similar to this will provide a great opportunity for Ypsilanti to build on its character and quality of life. Efforts to incorporate trees into the landscape will add to the character of the City and benefit the City as the trees installed grow and mature with time. The City of Ypsilanti should continue to pre-plan the planting of trees into future streetscape projects.

In addition to considering site characteristics such as availability of space, soil pH, and irrigation, species-specific features must also be scrutinized. A major consideration for street trees is the amount of litter dropped by mature trees. Trees such as *Salix* spp. (willows) have weak wood and typically drop many small branches during a growing season. Others, such as *Juglans nigra* (black walnut), drop high volumes of syncarps (fruits). In certain species, such as *Ginkgo biloba* (ginkgo), female trees produce offensive/large fruit; male trees, however, produce no fruit. Furthermore, a few species of trees, including black locust, *Crataegus* spp. (hawthorns), and *Gleditsia triacanthos* (honeylocust), may have substantial thorns. These species should be avoided in high-traffic areas.

Seasonal color should also be a consideration 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.

Above all else, tree species should be selected for their durability and low-maintenance characteristics. These attributes are highly dependent on site characteristics as well as species characteristics. Matching a species to its favored climatic and 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.

Tree Purchasing

Tree prices vary based on the species selected, but many nurseries offer trees of 1.5- to 2.5-inch caliper for $100 to $150. As the City works at planting more trees annually, obtaining a good price for quality trees will become more important. Saving money on the cost per tree will allow a greater number of trees to be purchased and installed.

Davey believes that a good working relationship with a local nursery is very beneficial, but it is equally important that good prices and wide species availability be considered. It is recommended that Ypsilanti explore local and regional sources for trees and discuss pricing with the current nursery source(s). Due to the requirement to work towards species diversity, it may be necessary to use several nurseries as sources for trees.

The City of Ypsilanti is making great strides in establishing a tree nursery. Chapter 4 discusses in detail the nursery and recommendations made. Should the City be successful in establishing a functional nursery, it should experiment with different species and not species commonly available from commercial nurseries.

Tree Planting Process

Once the appropriate trees have been selected for planting in the appropriate location, the most important detail to ensure success is the preparation of the planting sites. All city staff charged with the task of planting should be well versed in proper planting techniques. Any contractors that plant trees in the city should also be properly trained in this procedure. Their work should be inspected and any tree not installed properly should be required to be replanted by the contractor at fault. In general, the tree-planting holes should be relatively shallow (typically slightly less deep than the height of the root ball) and quite wide (three times the diameter of the root ball). Care should be taken so that the root collars of the new trees are at the same level or slightly higher than the surrounding soil grade. In most situations, it is not recommended to add soil amendments to the planting holes, as this can lead to severe differences between texture and structure of soils inside the planting holes and the surrounding soil. Such differences can lead to either water being wicked away from or accumulating in planting holes. Appendix J explains the proper method of excavating a planting hole.

Tree staking hardware should be installed only when necessary to keep trees from leaning (windy sites) or to prevent damage from pedestrians and/or vandals. Stakes should be attached to trees with a loose, flexible material, and all staking material should be removed after one growing season. In areas of high vandalism, stakes can be retained for an additional year, but should be removed after two years to allow the tree trunk to develop its strength.

Tree Mulching

Mulch should be applied to the soil surface around newly planted trees. Mulch should never be piled up around the root collar (so-called mulch “volcanoes”), but rather should be pulled away from the root collar. Mulch that buries the root collar provides shelter for insects, fungi, and small mammals that could damage the tree. Mulch should be applied to an area three times the diameter of the root ball to a depth of two to four inches. Mulch not only suppresses competition from grass and weeds, but also provides a zone where turf maintenance is not needed, thereby keeping lawn mowers and string trimmers safely away and, thus, preventing mechanical damage. Mulch also helps to hold moisture in the surface of the soil where most of the feeder roots are to be established.

Tree Establishment

To establish themselves in a new environment, all trees need to be watered periodically. Irrigation can be accomplished with a water truck and hose and/or deep root watering lance, or with watering aids, such as the widely used Treegator® Drip Irrigation Bags.

Any fertilization process should not be thought of as "feeding" or "energizing" the trees; instead, arboricultural fertilizers should be understood as essentially replacing soil elements or minerals that are lacking or in short supply for a variety of reasons. Nutrients may be in adequate supply, but be unavailable for uptake by the trees because of extreme pH conditions. Application of fertilizer may not improve the situation until measures are taken to alter pH levels or to replace the trees with a species better suited for the existing soil conditions.

Fertilization may not be necessary for the first growing season unless specific nutrient deficiencies exist. At the beginning of the second growing season, fertilizers can be applied to the root zone. Nitrogen is usually the limiting nutrient for plant growth. Soil analysis, particularly when combined with a foliar analysis, can determine when other elements are in short supply. Slow-release fertilizers applied in autumn will help root growth and will still be available the following spring.

Pruning young trees to improve branch structure is the most effective method of reducing future maintenance costs as trees mature. At the time of planting, the only pruning that should be done is the removal of broken or dead branches. In the second growing season, minor pruning can be performed to remove branches with poor attachments, but it is still best to wait until the third growing season to perform the first young tree training. In subsequent years, selective pruning should be performed to achieve the proper spacing of branches.

Recommendations for Updating the Inventory

Monitoring tree conditions and making efforts to maintain their health and safety is essential. When maintaining public trees, the potential for loss is an important factor in prioritizing treatments and making effective use of available funds. The loss of trees over time is an inevitable natural process; however, controlling the decline, removal, and replacement of trees in a timely and cost-effective manner is the ultimate goal of the management process. It is recommended that the City conduct yearly inspections of all public trees and record any necessary changes in tree condition, maintenance, and risk. Any tree requiring removal should be scheduled and budgeted for accordingly. Any tree presenting a high-risk of limb failure should also be scheduled, budgeted for, and pruned accordingly. High-risk work should be done immediately or following the year work is recorded as required. It is also recommended that the City conduct inspections after severe storm events and record changes in tree conditions, maintenances, and risks of the inventoried tree population.

The best way to keep an up-to-date inventory is to commit to regular, routine data entry. On a daily, weekly, or monthly basis, the information collected should be entered into the inventory database. This task can be performed by the Department of Public Works staff, administrative support staff, seasonal staff, or trained volunteers. Any changes that occur in the City's tree population (removals, pruning, installations, etc.) should be updated regularly to reflect changes in maintenance requirements, tree conditions, and potential risk changes. Ypsilanti's tree inventory will prove to be an invaluable tool in organizing, scheduling, and routing the needed work to be accomplished. It is suggested that the City complete an inventory of all public trees after Year 8 and update the management plan.

Recommendations for Evaluating Work Progress

In order to measure the Eight-Year Urban Forest Management Program effectiveness, a method for evaluation should be followed. Specific accomplishments can be measured in comparison to the management program's goals and recommendations. These include:

- Compare the actual number of completed Priority 1 Removals and Prunes to the recommended number listed in each year, Years 1 and 2.
- Compare the actual number of completed Priority 2 Removals and Prunes to the recommended number listed in each year, Years 2 through 4.
- In Years 4 through 8, compare the number of trees pruned annually in the Routine Pruning Program to the annual goals of the seven-year maintenance cycle.
- Count the number of trees pruned annually in the Training Pruning Program and compare it to the recommended number in the three-year maintenance cycle.
- Compare the actual number of plantings to the recommended number in the management program.
- Compare annual forestry expenses to the budget projected in this management program. Modify the planned work or increase budget requests to accomplish urban forestry goals and objectives.

Chapter 3: Tree Canopy Assessment

Tree canopy (TC) is the layer of leaves, branches, and stems that cover the ground when trees are viewed from above. TC provides many benefits to communities, including improving water quality, saving energy, lowering city temperatures, reducing air pollution, enhancing property values, providing wildlife habitat, facilitating social and educational opportunities, and providing aesthetic benefits. Establishing a tree canopy goal is crucial for communities seeking to improve their environment and green infrastructure. A TC assessment provides estimates of the amount of tree canopy currently present in a community as well as the amount of tree canopy that could theoretically be established.

Davey used advanced GIS (geographic information systems) and remote sensing software to calculate TC and other land cover acreages and percentages for the overall city boundary, zones, street rights-of-way, and parks and public spaces. To capture TC and land cover, Davey used National Agricultural Imagery Program (NAIP) 4-band imagery acquired by the United States Department of Agriculture (USDA) in 2010. Further assessment and statistical breakdown were developed using GIS layers provided by the City of Ypsilanti. A detailed description of the imagery and processes used in this assessment can be found in Appendix K.

The data developed as a result of this assessment becomes a part of the City's GIS database, and provides a foundation for the development of long-term management goals and allows managers and residents to make informed decisions about budgetary and policy support and management priorities. The analysis also establishes benchmarks for measuring the success of future management strategies.

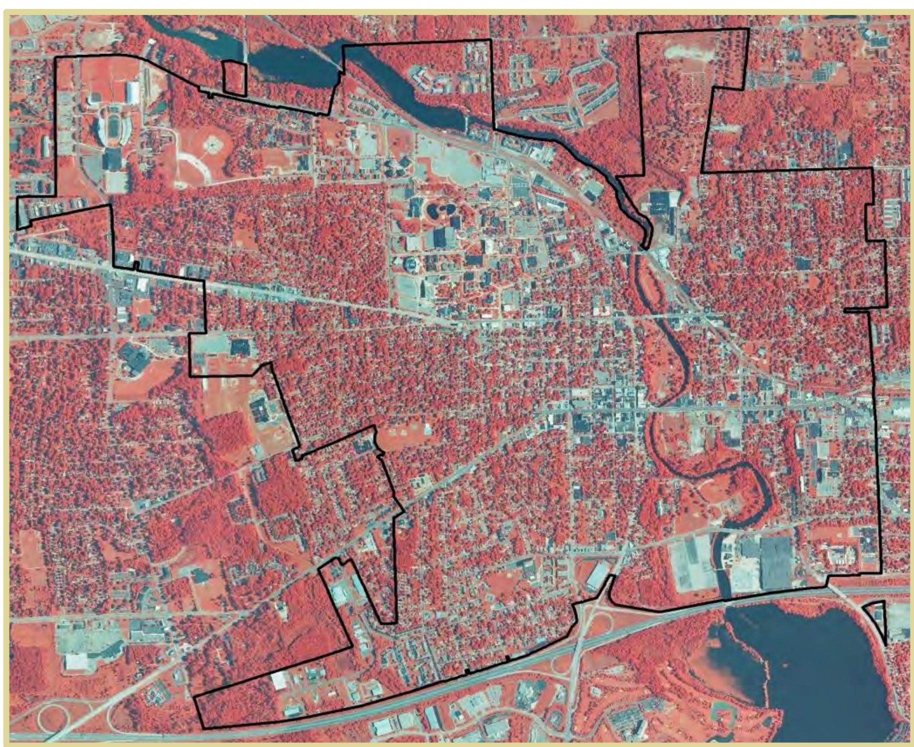


Figure 5. Ypsilanti's Tree Canopy and Other Land Cover Classifications Distinguished Using NAIP 4-band Aerial Imagery and Color Infrared

Land Cover Results

Ypsilanti's city limits encompasses just over 2,712 acres and the land cover is dominated by TC (36.6 percent) yet followed closely by impervious area (35.8 percent). Impervious areas include streets, building, parking lots, and driveways. Pervious area, including grass and low-lying vegetation, also covers a large percent of the project area, with 24.0 percent classified as pervious. Figure 6 shows the location of land cover within the project area, and Figure 7 presents the amount of acreage and percent for each of the 5 land cover types classified.

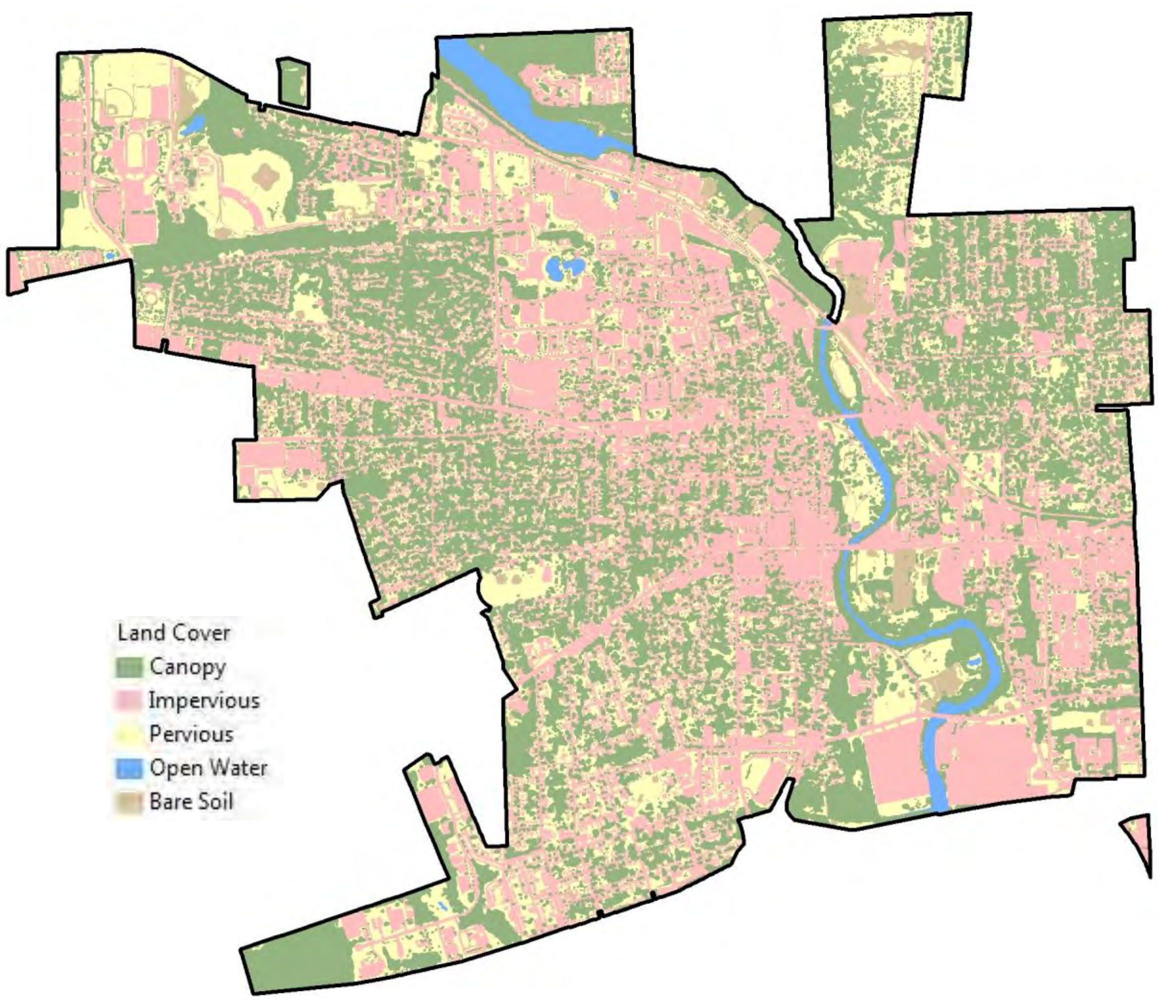


Figure 6. Ypsilanti's Land Cover Assessment

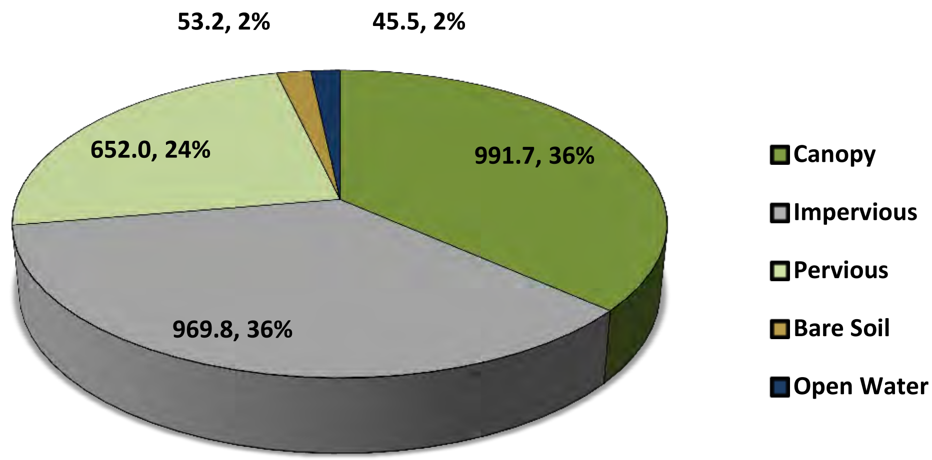


Figure 7. Ypsilanti's Distribution of Acreage and Percent Land Cover

Canopy Goals

One of the most important aspects of determining TC is setting canopy goals and creating a strategy to maintain or expand the current canopy. TC is managed in a variety of ways including preservation, conservation, proactive tree maintenance, and new tree planting. Based on the ability of a community to accomplish and sustain the goal, setting a canopy goal and managing the population so as to achieve that goal will ensure the quality of life and sustainability of the community.

American Forests, a recognized leader in conservation and urban forestry, has established canopy goals for metropolitan areas. These goals are an accepted standard and can be used as a general guideline. For metropolitan cities east of the Mississippi River, American Forests suggests the following canopy goals:

- 40 percent tree canopy overall (all areas and zones)
- 50 percent tree canopy in suburban residential
- 25 percent tree canopy in urban residential
- 15 percent tree canopy in central business districts

Possible Tree Canopy

Another important section of this TC assessment is the ability to estimate possible TC. In Figure 8, the assessment of Ypsilanti's land cover found that 991.7 acres of the City were covered by TC (termed Existing TC), representing 36 percent of all land within the city limits. In addition, another 1,142.2 acres or 42 percent of the City could theoretically be modified (termed Possible TC) to accommodate TC. Adding the total Possible TC to the total Existing TC provides an estimate of the overall possible TC. Ypsilanti could have 78.7 percent TC if all "plant-able space" (*i.e.,* areas where trees could be planted) were planted and no changes in existing canopy occur.

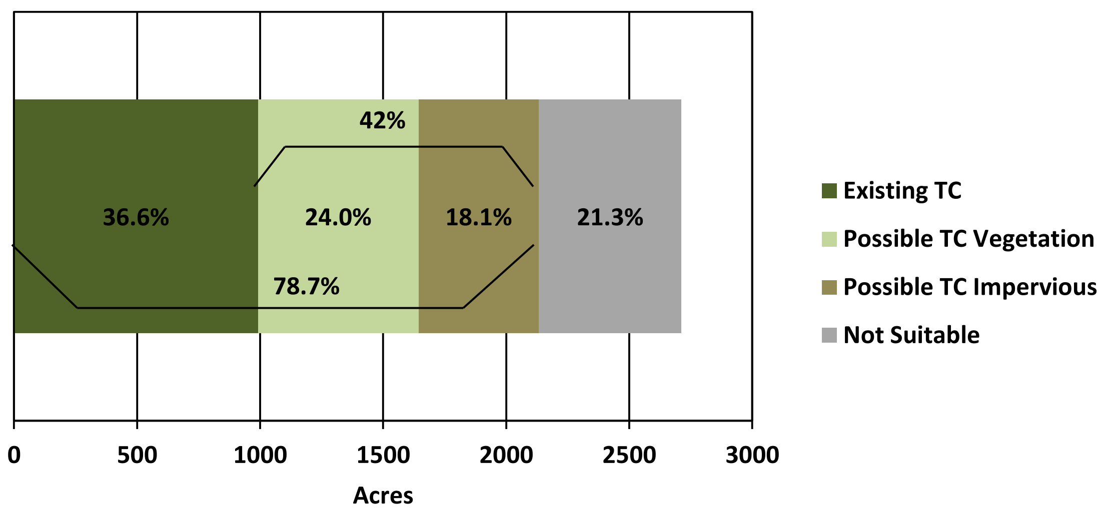


Figure 8. Ypsilanti's Possible Tree Canopy

In the Possible TC category, 24 percent (652.0 acres) of the City was classified as Vegetated Possible TC and another 18 percent (8,406 acres) was Impervious Possible TC. Vegetated Possible TC are areas of grass and shrubs. Impervious Possible TC are areas where Davey used the impervious and bare soils land cover data and additional GIS footprints (for buildings, streets, etc.) to project areas that are plant-able space within impervious cover. Vegetated Possible TC is more conducive to establishing new tree canopy; however, establishing tree canopy on areas classified as Impervious Possible TC will have a greater impact on rainwater runoff and summer temperatures that affect stormwater management, energy usage, and air quality.

Tree Canopy Distribution by Zone

Ypsilanti has identified five zones. Figure 9 shows each zone's contribution of TC. The majority of TC (26 percent) is in Zone 1 followed by Zone 3 (24 percent), Zone 4 (18 percent), and Zone 2 (17 percent). Zone 5 contributes the least amount of TC (15 percent).

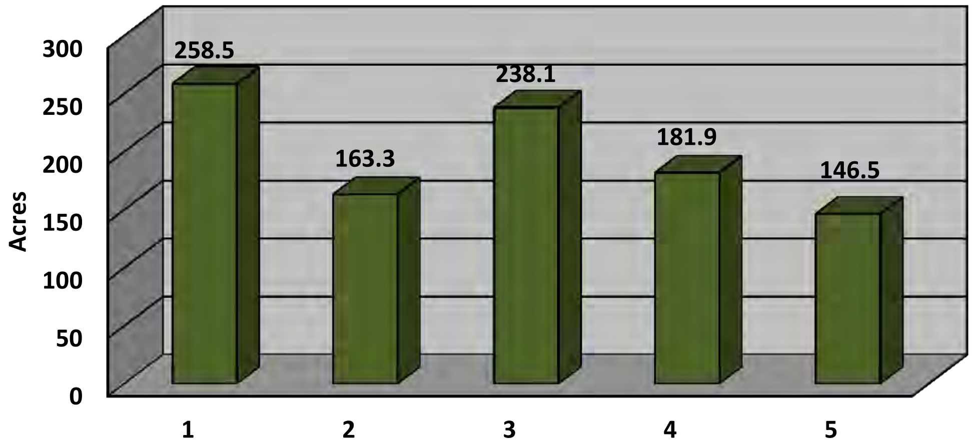


Figure 9. Distribution of Tree Canopy by Zone

There are 487.7 acres of street right-of-way and 148.5 acres (30.5 percent) are covered with TC. Figure 10 shows an index of TC and concentrations of plantings sites identified during the inventory for each Zone. Ypsilanti should concentrate on new tree plantings in zones with the least amount of TC. Appendix L contains more GIS maps to further guide tree plantings within each zone. These maps show TC and potential planting sites on a per parcel basis.

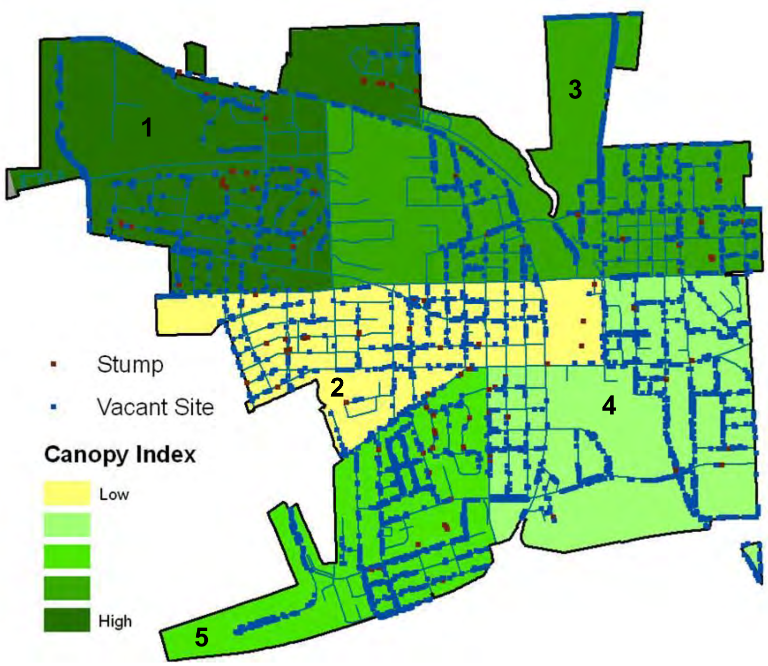


Figure 10. Planting Site and Tree Canopy Index by Zone

Tree Canopy in Parks and Public Spaces

Overall, Ypsilanti has 149.3 acres of park and public space land and within those parks and public spaces, there are 57.0 acres of TC; 38.2 percent of park public space land area has TC. Figure 11 illustrates the distribution of TC in parks and public spaces. Water Street Redevelopment Area contributes the most TC (23 percent) followed by Waterworks Park (14 percent), Peninsula Park (11 percent), and Prospect Park (9 percent). Charles Tot Lot and Carrie Mattingly Tot Lot contribute the least amount of TC (each less than 0.1 percent)

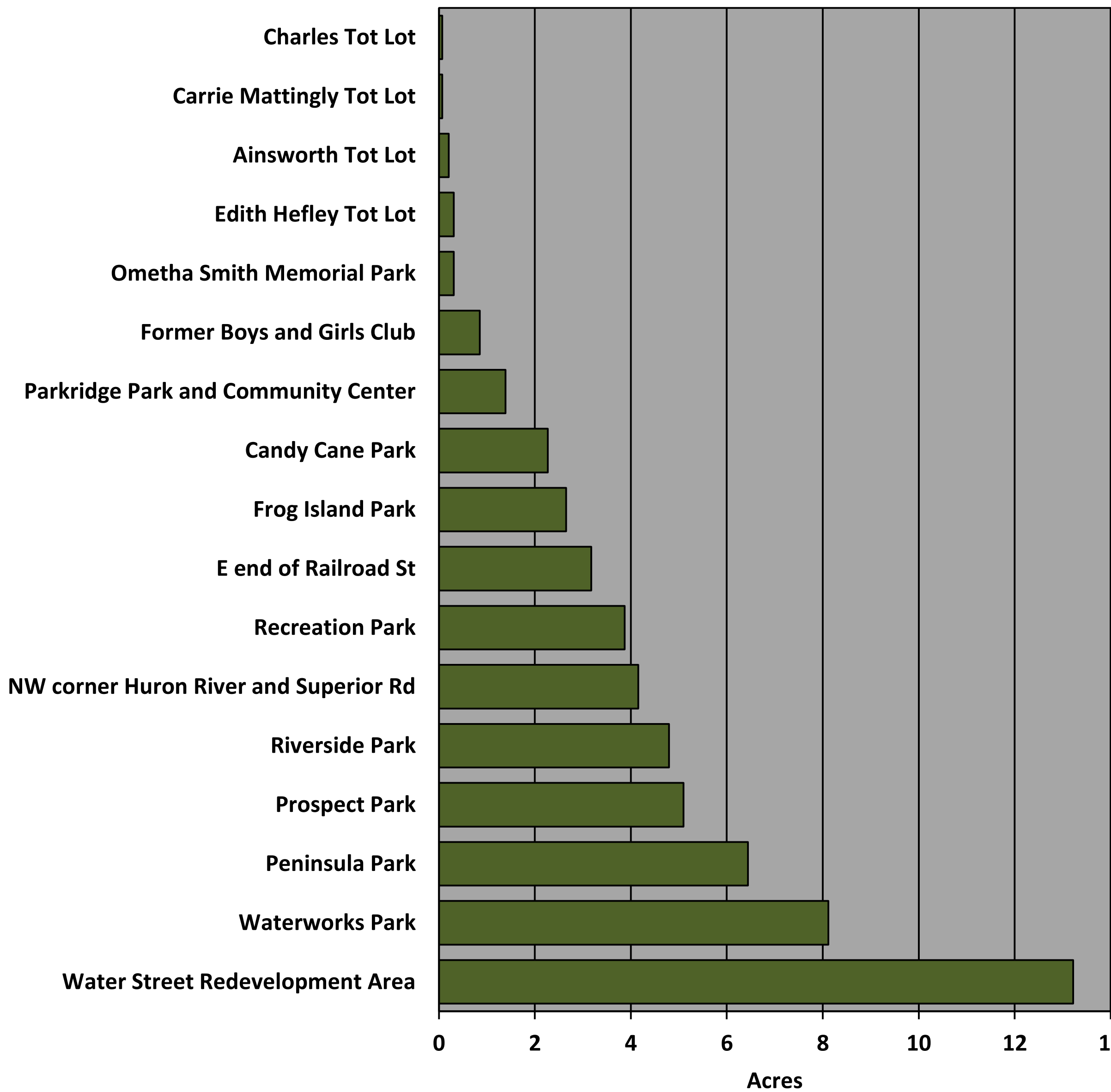


Figure 11. Distribution of Tree Canopy Among Parks and Public Spaces

One public property may contribute more TC than another; however, another way to look at it is what public property contributes more TC per acre? Table 10 indicates that the property E end of Railroad St has 100 percent TC per acre followed by Peninsula Park having 87 percent, NW Corner Huron River and Superior Rd having 76 percent, and Edith Hefley Tot Lot having 73 percent. On a per acre basis, these public properties provide more TC than Water Street Redevelopment Area (36 percent), Waterworks Park (42 percent), and Prospect Park (51 percent). The public properties with greater TC per acre tend to be heavily forested, underdeveloped properties, or are less than an acre in size. It is recommended that Ypsilanti preserve forested areas within public properties.

Riverside Park is 16.9 acres and its tree canopy covers 4.8 acres. Only 28 percent of Riverside Park has canopy cover.

Parkridge Park and Community Center has the lowest amount of TC per acre (13 percent) followed by Carrie Mattingly Tot Lot (16 percent), Former Boys and Girls Club (20 percent), and Recreation Park (22 percent). These parks with less TC per acre tend to have playgrounds, sports fields or large buildings located on their premise. It may not be socially desirable to plant trees on these parks regardless of the TC percentages.

Table 10. Tree Canopy per Acre of Land for Parks and Public Spaces

Property Name	Land Area (Acres)	Tree Canopy Area (Acres)	Tree Canopy Percent
E end of Railroad St	3.2	3.2	100
Peninsula Park	7.4	6.4	87
NW corner Huron River and Superior Rd	5.5	4.2	76
Edith Hefley Tot Lot	0.4	0.3	73
Prospect Park	10.0	5.1	51
Charles Tot Lot	0.2	0.1	44
Ometha Smith Memorial Park	0.7	0.3	42
Waterworks Park	19.4	8.1	42
Ainsworth Tot Lot	0.6	0.2	37
Water Street Redevelopment Area	37.2	13.2	36
Candy Cane Park	6.7	2.3	34
Frog Island Park	8.6	2.6	31
Riverside Park	16.9	4.8	28
Recreation Park	17.3	3.9	22
Former Boys and Girls Club	4.3	0.9	20
Carrie Mattingly Tot Lot	0.5	0.1	16
Parkridge Park and Community Center	10.4	1.4	13

Parks and public space areas are generally good locations to augment TC because they often can support a higher percentage of TC per acre than other locations. Furthermore, maximizing TC in parks and public spaces can help offset lower amounts of TC in high-density urban areas. Figure 13 shows which parks and public spaces in Ypsilanti have the greatest ability to support a higher percentage of TC per acre. Figure 12 further illustrates that if many more trees were planted in Riverside Park and Recreation Park, then TC in Zone 2 could increase.

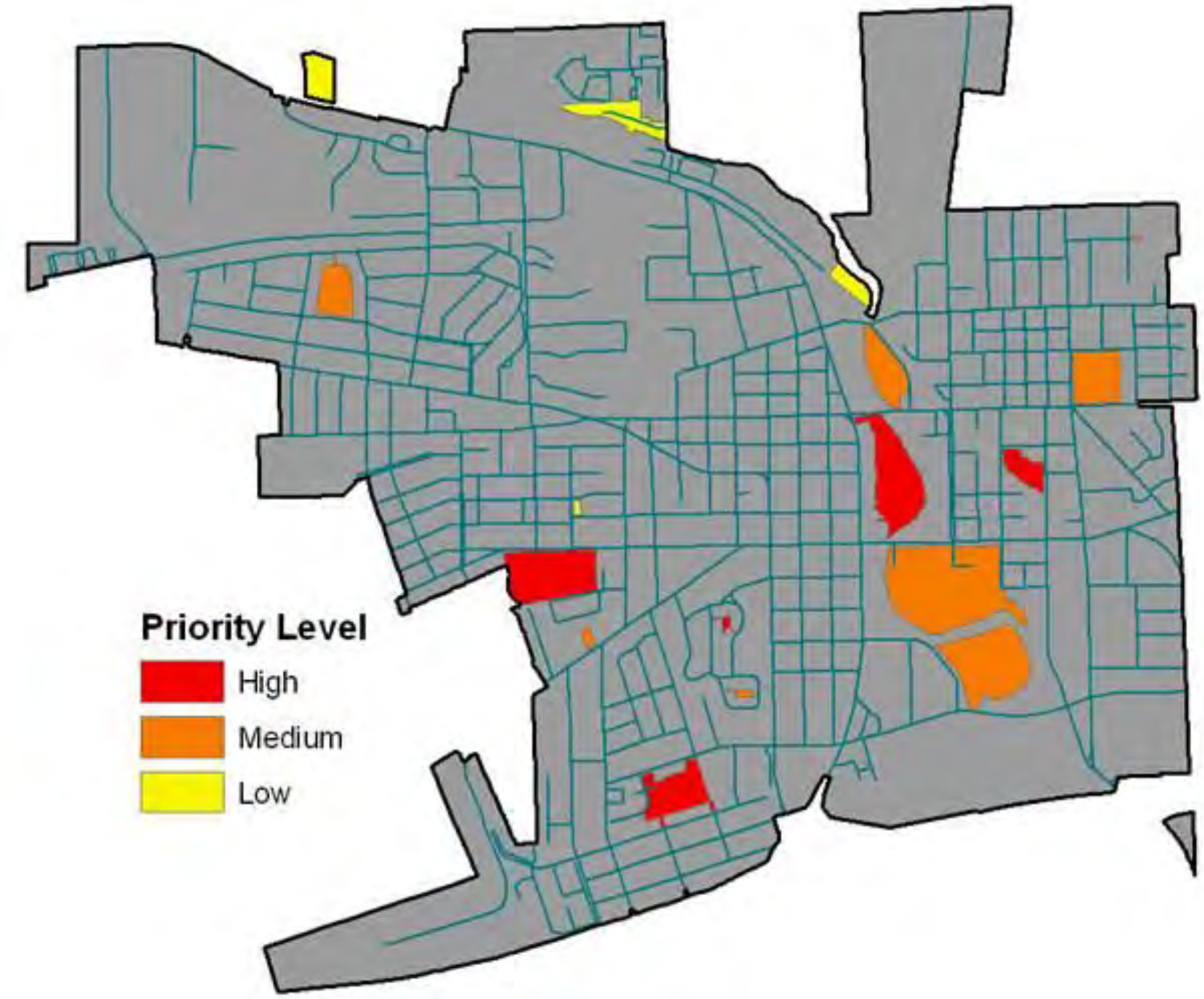


Figure 12. Prioritization of Tree Planting within Parks and Public Spaces

TC is important to the overall health of Ypsilanti. Trees work around the clock to clean air, reduce energy needs, and intercept stormwater. Additionally, trees contribute significantly to the character, history, and permanency of community and they positively affect property values. TC drives these benefits. With this assessment of TC, Ypsilanti can establish TC goals, support policy affecting TC, and strategically plant new trees to maintain/increase TC for the future.

Ypsilanti has beautiful parks filled with trees. As the City continues to plant streets, parks, and public space areas with trees, they should be properly cared for so that future generations of residents may enjoy them as well.

Chapter 4: City Tree Nursery

The City of Ypsilanti is committed to having a fully stocked urban forest with a good mix of species by undertaking the establishment of a city-managed tree nursery. The purpose of the city nursery is to ensure locally grown, adequate species availability, and high-quality stock for restoration and reforestation of the city. Many economic gains in the growth and stability of the city forestry program can be made from having an established city tree nursery. Ultimately, having a city nursery will leverage constant tree planting capabilities, maximize environmental and psychological benefits, and enhance both landscape and property values. There is also a potential to get money back by selling quality, yet uncommon, nursery stock in the commercial market to other municipalities, contractors, and homeowners.

Establishing, managing, and producing a healthy nursery tree stock is both an art and a science. While starting up a city nursery may seem simple, the operation is very complex. Before any investment in facilities or operations are made, it is strongly recommended and encouraged that much time, energy, and money are spent learning as much as possible about modern nurseries, options available in tree production, and site evaluation and setup. This chapter will provide a discussion about the importance of species diversity in the nursery, advantages and disadvantages to the suggested growing methods, and details about the enter workings of those suggestions.

Nursery Diversity

The ultimate goal of establishing a city tree nursery is to ensure an ongoing supply of trees which perform well in Ypsilanti's urban environment, meet city standards, and foster the health and diversity of Ypsilanti's public tree population. A city nursery will not be growing trees for today; it will be growing trees for three to five years in the future. The nursery manager will need to determine what tree species he will need three to five years from now. Tree species choices can vary from native to non-native trees, large-growing shade trees, small-growing fruit bearing trees, trees with showy flowers, or trees that produce autumn color. Trees come in all shapes and sizes, but the purpose behind growing those nursery trees is what drives the type of species produced.

Ypsilanti should collaborate with local businesses, such as nurseries, and not compete with them. It is suggested that commonly available stock continue to be purchased from local nurseries and the City invest and grow nursery stock that is more difficult to obtain from local commercial growers. Table 11 lists 10 common species in the 2011 commercial market and 10 species Ypsilanti may consider growing in their nursery. Reasons that commercial growers may not grow certain tree species are generally due to the amount of time and care it takes to grow a usable tree for market sale and the perceived lack of demand on the commercial market.

When purchasing trees from local nurseries for direct planting in the landscape, standards should be established. Ypsilanti should create specifications for trees which they purchase from other local nurseries. Planting specifications should also be created when trees are planted by contracts. These established standards will create an understanding between the city and the contract from which to operate. Appendix F contains example specifications for purchasing and planting which Ypsilanti may customize as needed.

Additionally, there are set standards commercial nurseries follow and Ypsilanti should acknowledge when growing their own trees. Those standards are found in the *American Standard for Nursery Stock: ANSI Z60.1-2004*. These nursery stock standards provide buyers, growers, and sellers common terminology to facilitate quality transactions. There are established techniques to measure trees, specify and state size of trees, determine proper tree height/width and caliper relationship, and determine the required size of root ball or container for the particular tree. When growing trees in the city nursery, these standards should be followed and, when customizing purchasing specifications, these standards should be utilized.

Managing a tree nursery enables the city to act according to their current and future needs, especially with regards to increased biodiversity. The drastic loss of tree species such as American elm, ash, and other species from city streets and parks has raised the interest and activity in urban forestry programs across the nation. When one species or genus dominates a tree population (monoculture), loss of tree population from invasive pests or diseases leaves large gaps in tree canopy. Urban forest managers have been trying to fill these gaps for years. Unfortunately, we have not learned our lesson and overplanting of one particular species persists. It should be Ypsilanti's goal to have no species with a population greater than 10 percent and no genus with a population greater than 20 percent. Currently, the species Norway maple and silver maple make up 28.6 percent and 13.7 percent, respectively, of the public tree population. The genus *Acer* (maple) makes up more than 50 percent of the entire population. Trees purchased and grown in the city nursery should be chosen to help offset this major monoculture issue within Ypsilanti. Table 11 is a list of readily available stock in commercial nurseries and stock which is suggested Ypsilanti grow in the city nursery. Appendix I provides a more thorough list of suggested species for Ypsilanti's urban forest.

Table 11. Nursery Stock

Readily Available Stock		Not Readily Available Stock	
Acer rubrum	red maple*	*Alnus glutinosa*	European alder
Pyrus calleryana	callery pear	*Carya glabra*	pignut hickory
Taxodium distichum	baldcypress	*Celtis occidentalis*	common hackberry
Acer platanoides	Norway maple*	*Corylus colurna*	Turkish filbert
Acer saccharum	sugar maple*	*Ginkgo biloba*	Ginkgo
Malus spp.	flowering crabapple	*Gymnocladus dioicus*	Kentucky coffeetree
Acer saccharinum	silver maple*	*Nyssa sylvatica*	black tupelo
Gleditsia triacanthos inermis	thornless honeylocust*	*Platanus x acerifolia*	London planetree
Tilia cordata	littleleaf linden	*Quercus alba*	white oak
Syringa reticulata	Japanese treelilac	*Tilia tomentosa*	silver leaf linden

* Common trees in Ypsilanti's inventory. Plant these species at a minimum to expand species diversity.

Many environmental variables drive species choice. Soil compaction, poor drainage and aeration, high soil pH, road salt, and limited root space are all common issues affecting tree health. Forestry managers must be mindful of the variables by choosing the "right tree for the right place". There are certain trees more suited for particular circumstances. For example, trees that are tolerant of poor drainage include *Nyssa sylvatica* (blackgum), *Quercus bicolor* (swamp white oak), and *Taxodium distichum* (common baldcypress). Another common example is the intolerance of high soil pH (greater than 7.5). Species that tolerate high soil pH include *Corylus colurna* (Turkish filbert), *Quercus macrocarpa* (bur oak), and *Tilia tomentosa* (silver leaf linden). Species more tolerant of common urban stressors should make up the majority of nursery stock. A good reference for species selection is the TreeSelector located on the Northern Trees website (http://lyra.ifas.ufl.edu/NorthernTrees/) hosted by the University of Florida, Rutgers Cooperative Extension, and the USDA Forest Service. This site will help develop a list of trees by choosing soil, site, and plant attributes.

Ypsilanti can build diversity into the nursery stock multiple ways. It all depends on what works best for the city's budget, resources, and practice. One way to build diversity into the nursery would be to collect local seeds from other public trees or surrounding organizations and grow them from seed. To grow trees from seeds, it is suggested that Ypsilanti invest in bottomless pots. Air-pruning will encourage branching of tap roots that form small-diameter bottom roots and abundant lateral roots near the surface (Gilman & Kempf, 2009). Another way to build diversity into the nursery would be to purchase seedlings, liners, grafts, or whip stems from wholesale organizations. Appendix M contains the directory Michigan DNR provides as a list of nurseries offering good seedling stock. Additionally, some communities and organizations have had the opportunity to partner with nurseries as their interest may be to research, breed, and evaluate new tree species for the future. Nurseries such as Oregon based wholesaler J. Frank Schmidt & Son Company and North Carolina based wholesaler Worthington Farms are innovative nurseries that sell young, specialty ornamentals, shade trees, and flowering trees as liners.

Nursery Operation

There is much research, education, and planning involved in establishing a nursery and growing trees. Personnel involved in the development of a city nursery will need to think critically about efficient use of the nursery site and its characteristics and tree care practices. Beginning a nursery will require a large upfront investment in equipment, supplies, plant material, and infrastructure. Additional costs will include labor, utilities, and possibly insurance, licenses, and inspections. Once the operation is set up, it may take an additional three to five years before any returns may be realized. This is due to the allowed time for the trees to grow to the desired size. There is also a great deal of risk in the loss of nursery stock due to weather and other potential problems including insects, diseases, animal damage, and theft. Each year, the city tree nursery will experience some loss; however, much of this can be neutralized upfront by extensive research, education, and planning. With a strong purpose, much resourcefulness, and good management, the City may succeed in nursery establishment and tree production. Davey recommends that Ypsilanti visit other experienced industry and community tree nurseries to observe their operations and ask what they do well or would do differently. Some city nurseries may include City of Milwaukee, Wisconsin; Tree Pittsburgh in Pittsburgh, Pennsylvania; City of Lansing, Michigan; and the Village of Prentice, Wisconsin. A successful self-sustaining city tree nursery will contribute to the quality and sustainability of Ypsilanti's urban forestry program.

An efficient use of small amount of acreage and beneficial for the environment the pot-in-pot field-grown method is an innovative way to grow trees. (Photo courtesy of Connon Nurseries, C.B. Vanderkruk Holdings)

There are two types of nursery operations, container-grown trees and field-grown trees, which have evolved through 200 plus years of landscape nursery history. Landscape trees produced in the 1800s were field-grown trees dug bare root. In later years, field-grown trees too large to bare root were hand dug and balled-in-burlap (B&B). Starting after World War II, the nursery industry progressed to growing trees in metal, wood, and then plastic containers. It was not until 1956, that a hydraulic tree lift was used to dig trees and ship them B&B (Appleton & Flott). Today, there are several methods within these two nursery operations to choose and choosing the method is dependent upon the resources available.

Ypsilanti's proposed nursery site is located within the Water Street Redevelopment Area (consisting of 37.2 acres) along East Michigan Avenue east of City Hall. The southern border of the nursery follows the Huron River. The shaded area in Figure 13 is the proposed site and is approximately 3.5 acres. Access to the site was previously installed prior to interest in a city nursery. The numbers and writing on this figure are projections provided by the City of Ypsilanti. Using estimations in Figure 13, this area will accommodate more than 890 nursery stock trees. The proposed nursery's current size is only best for container-grown trees. Field-grown trees require greater space between trees and between aisles than container-grown trees, and soil characteristics (proper drainage, nutrients, soil type, soil structure, pH, etc.) would need to be ideal to optimize tree-growth and save on annual nursery stock maintenance costs. Considerations for both container-grown and field-grown operations are listed in Table 12 (Appleton & Gregory, 2009).

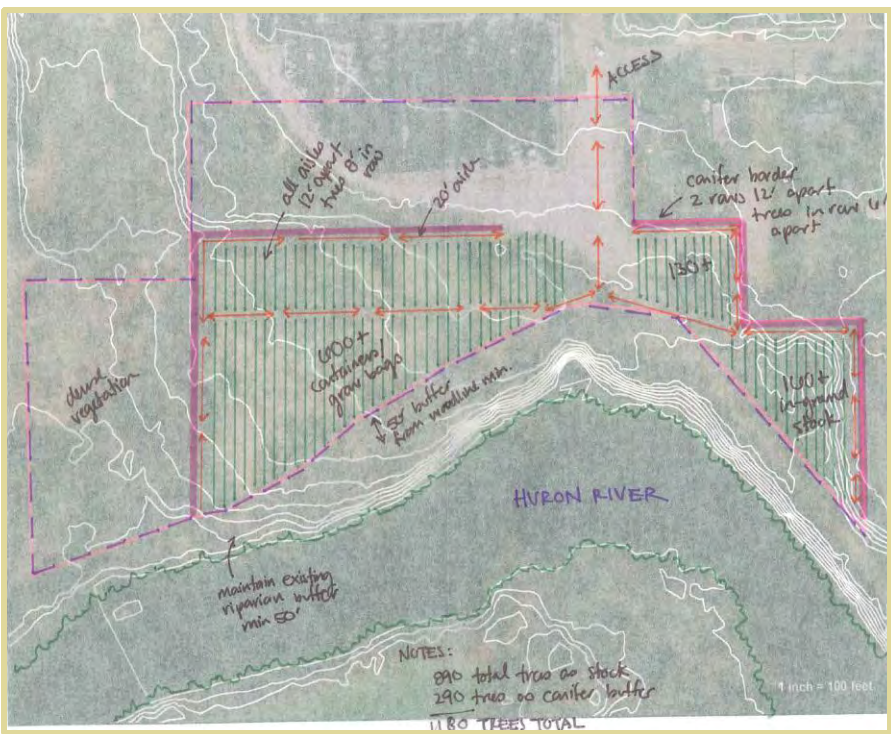


Figure 13. Ypsilanti's Proposed Nursery

Table 12. Nursery Operation Method Considerations

	Container-Grown	Field-Grown
Land Area Requirement	Small	Large
Soil Characteristics	Not Dependent	Dependent
Number of Staff	More (seasonal increases)	Less (seasonal increases)
Costs per Acre	More	Less
Equipment Needs	Planting Media and Containers	Expensive Machinery
Production per Acre	More (33%)	Less
Production Cycle	Shorter (6 months to 2 years)	Longer (1 to 6 years)
Management Intensity	Daily (less during dormancy)	Weekly (less during dormancy)
Tree Size Production	Smaller Caliper (≤2-inch)	Larger Caliper
Species Diversity	More	Less
Irrigation	Daily	Site Dependent
Irrigation System	Drip or Manual	Broadcast, Drip, or Manual
Fertilizer	Planting Media Dependent	Site Dependent
Fertilizer Application	Topdressing or Fertigation	Broadcast or Fertigation
Site Preparation	More	Less
Site Concerns	Drainage	Soil Conditions and Drainage
Weed Control	Manual	Mechanical
Insect and Disease Control	More Intensive	Less Intensive
Blow-over	Possibility	None
Root Structure	More of an Issue	Less of an Issue
Overwintering	More Protection Required	Little Protection Required
Harvesting Season	Little to No Restrictions	Restrictions (weather and dormancy)

Ypsilanti should choose one operation method and concentrate producing trees solely within that method. Davey suggests the container-grown method due primarily to the lack of space for a field-grown operation and the following advantages:

- Control over factors affecting plant growth
- Grow large number of trees per acre
- On-site soil type, soil pH, and soil nutrients not a factor
- Planting and harvesting not weather dependent
- Some species easier to grow and/or harvest
- Lightweight for handling
- Less root loss
- Greater chance of survival

When choosing which type of container some factors to keep in mind include cost, design, root growth, moisture and temperature regimen, durability, reuse, and ease of use. Davey recommends Ypsilanti use the pot-in-pot method. Pot-in-pot containers combine the natural advantages of field-growing with the control and convenience of above-ground growing. Natural advantages include stock stability and less extreme temperature and moisture changes. Generally, the stock holder pot (SH in Figure 14) is buried in ground with the top rim setting just above ground level. Positioning of the SH pot helps with stability, overwintering, and prevents surface water from entering the pot. Then another pot, known as a liner holder pot (LH in Figure 14), is placed inside the holder pot. The LH pot contains the tree and planting media. It is suggested that a root barrier cloth be placed between the SH pot and the LH pot so that roots may not extend through the SH pot's drainage holes. The expectation is that the SH pot is left in place during harvesting and reused time and time again. It is also recommended for overwintering that mulch or an insulating material like it be laid on the ground just outside the pots and some mulch is topdressed in the pot away from the trunk. For an illustration, the exposed soil area in Figure 14's photo would be covered with mulch. Purchasing costs and time involved with installation of pot-in-pots are high; however, savings experienced in the reduction of labor costs over time should outweigh the initial purchasing and installation costs.

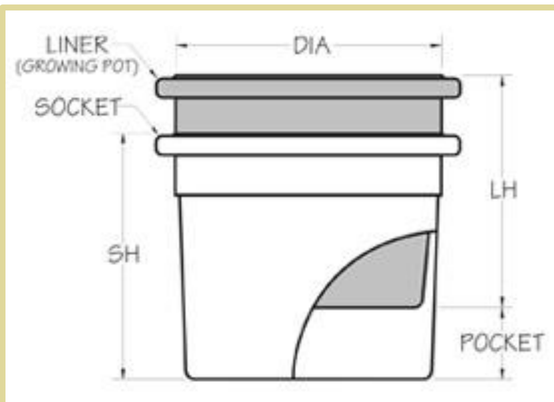


Figure 14. Illustration of Pot-in-Pot Container Method
(Illustrations courtesy or Nursery Supplies, Inc.)

Ypsilanti should have an array of different sized pots installed on site to accommodate healthy, vigorous, well-rooted, and established nursery stock. Many sizes of pot-in-pots are available to accommodate small and large nursery stock. Container specifications for growing trees can be found in Section 1.7 of "American Standard for Nursery Stock: ANSI Z60.1-2004". Ypsilanti should use these guidelines to guage the quality of stock they produce. Table 13 is taken directly from these standards and describes minimum and maximum tree heights for each container class/size dependent on tree type. This table will be useful when determining which container should grow a tree to a particular height or caliper. Tree type is described in Section 1.2 of "American Standard for Nursery Stock: ANSI Z60.1-2004".

In the nursery, if container-grown trees are not managed properly, poor root systems may form and cause serious issues after transplanting in the landscape. Issues include poor vigor or tree failure. Well-established root systems shall reach the sides of the containers to maintain a firm ball when the container is removed and be free of circling, girdling, descending, ascending, and bottom-matted roots. Annually, Ypsilanti will need to "up-pot" their nursery stock. Trees will need to be removed from one container to a larger container to allow more growing media for new roots. As trees are up-potted, Ypsilanti will need to practice root pruning. Root pruning includes removing some of the outer roots and substrate from top, sides, and bottom of the root ball. Straight roots are retained. Roughly, the outer one inch of substrate will contain the majority of root defects. Teasing apart the outer surface will encourage new roots to grow radially away from the trunk. It is imperative that Ypsilanti inspect and correct root defects each time trees are shifted from one container to a larger container (Gilman & Kempf, 2009).

New container products and nursery practices pertaining to container production continue to evolve that encourage more fibrous roots. One product for pot-in-pot systems, not recommended for Ypsilanti, is SpinOut produced by SePRO. The active ingredient is copper hydroxide which is designed to control root growth. As roots come into contact with a SpinOut-treated container, they become inhibited, not damaged. Elongation stops and stimulates the development of secondary and lateral roots promoting a fibrous and healthy root system. The reason Davey suggests Yplisanti not use this product is due to the proximity and potential use of water from the Huron River. SpinOut is toxic to fish and aquatic invertebrates and may contaminate water through runoff. Poorly drained soils and soils with shallow water tables are more prone to produce runoff (Welcome to SePRO!, 1998-2012). In the future, there may come an environmental friendly product. Until then, it is suggested that Ypsilanti manually prune roots when up-potting to create well-structured root systems and healthy trees.

Table 13. Container Class Guidelines

Types 1 & 2 Shade Trees		Types 3 & 4 Small Upright and Small Spreading Trees		Shrub Form and Multistem Trees		
Minimum Plant Size (Height in Feet/ Caliper in Inches)	Maximum Plant Size (Height in Feet/ Caliper in Inches)	Minimum Plant Size (Height in Feet/ Caliper in Inches)	Maximum Plant Size (Height in Feet/ Caliper in Inches)	Minimum Plant Size (Height in Feet)	Maximum Plant Size (Height in Feet)	Container Class
1 foot	4 feet	1 foot	3 feet	N/A	N/A	1
2 feet	6 feet	1 ½ feet	4 feet	N/A	N/A	2
3 feet	6 feet	2 ½ feet	6 feet / 1 in.	2 feet	5 feet	3
4 feet	7 feet	4 feet	7 feet / 1 ¼ in	3 feet	6 feet	5
5 feet	8 feet /1 ¼ inches	5 feet	1 ½ inches	4 feet	7 feet	7
6 feet	1 ½ inches	6 feet /¾ inches	1 ¾ inches	5 feet	8 feet	10
8 feet / ¾ inch	2 inches	1 inch	2 inches	6 feet	10 feet	15
1 inch	2 ½ inches	1 ¼ inches	2 ½ inches	7 feet	12 feet	20
1 ¼ inches	3 inches	1 ½ inches	3 inches	8 feet	14 feet	25
1 ¾ inches	3 ½ inches	2 inches	3 ½ inches	10 feet	16 feet	45
2 inches	4 inches	2 ½ inches	4 inches	12 feet	18 feet	65
2 ½ inches	5 inches	3 inches	5 inches	14 feet	20 feet	95/100

Nursery Layout

The number of pots in Ypsilanti's nursery will depend upon the tree type, expected size of trees for harvest, and the in row and between row spacing. Spacing for shade trees (Types 1 and 2) is commonly 4 to 6 feet. Davey recommends grouping trees by species and by pot size, creating blocks of one species all one size. Aisles for harvesting and maintenance use should be wide enough to allow easy access. For truck/tractor and trailer access, three feet each side of widest points should suffice. Aisles between rows and between blocks can be kept in sod or mulch and aisles for harvest access can be kept in sod or gravel. For sites with poor drainage sod is recommended for aid in improvement. Figure 15 (not to scale) is a rough drawing illustrating spacing of a pot-in-pot system.

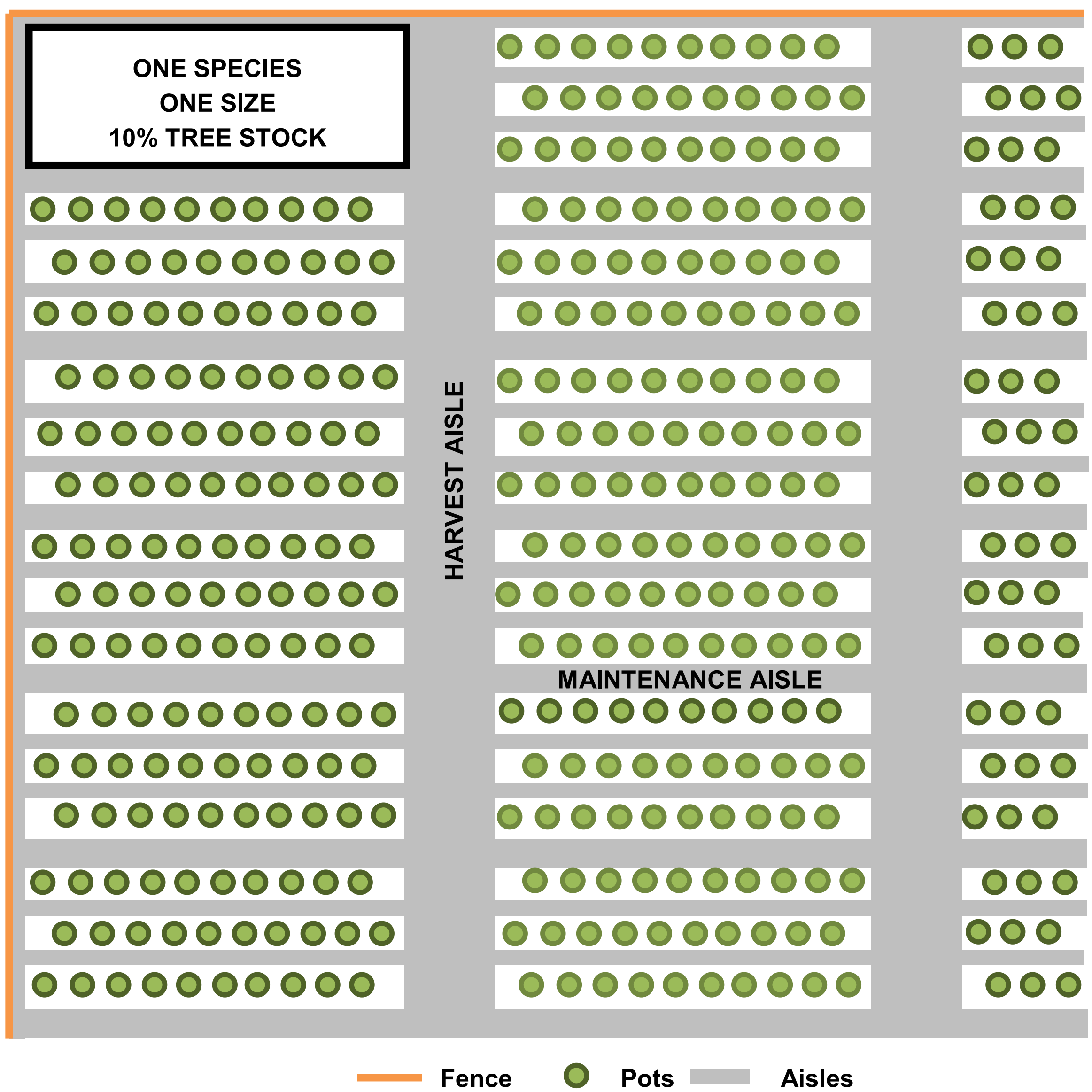


Figure 15. Drawing of Described Nursery Layout

The length of time required to produce a desired tree stock for planting in the landscape and how to schedule tree stock plantings so proper numbers of desired species are available when needed is a very important and difficult task. Depending on the initial size and condition of seedlings, liners, grafts, or whip stems, generally it could take two years to grow tree stock plantings to the desired size and height. The landscape planting program described in Chapter 2 of this management plan recommends that Ypsilanti plant 60 street trees in Years 1–4, 110 street trees in Year 5, and increase to 208 street trees starting in Year 6 for the next 24 years. Davey also recommends budgeting for an additional 100 trees per year for park tree plantings. Overall, Ypsilanti will want to plant enough nursery stock that first year of operation so there are approximately 308 trees for harvest two years later. Each year later, another group of seedlings, liners, grafts, or whip stems will need planted to create a continuation of available nursery stock. Simply planting 308 seedlings will not suffice. Ypsilanti will need to manage the nursery stock so that trees remain healthy, establish quickly, and mortality rates are minimized. In a typical year, a mortality rate of 5 to 10 percent can be expected. Each year, Ypsilanti will need to plant approximately 340 stock trees to maintain the needed amount (308) for street and park trees. To help establish a diverse street and park tree population, a single species within the tree stock should represent less than 10 percent and a single genus within the tree stock should represent less than 20 percent.

Nursery Production

General production related considerations for the pot-in-pot system include the following:

Site Selection and Prep

Site selection for pot-in-pot fields is not too critical because trees grow in pots that are buried and native soil is used as infrastructure instead of a resource. Drainage is the important aspect for container beds. The ideal site would slope moderately (no more than 2 to 5 percent) to create air movement and drain water away from aisles so personnel and their equipment have access year-round (Gill, Hanson & Ross). The need to aid drainage by grading container beds will depend on the slope of the land and rate water percolates through soil. Other options to improve drainage, if needed, include establishing a thick ground cover or installing an underground drainage system.

There are also some design aspects to consider when planning for a pot-in-pot system. Those include equipment storage, planting and harvesting prep areas, supply storage areas (for planting media, mulch, and containers), security, irrigation lines, water collection system, and aisles. An area approximation 100 by 100 feet should be adequate for equipment storage, planting, and harvesting prep areas, and supply storage areas in Ypsilanti's nursery. For security and protection from deer damage, Davey recommends a fence surround the entire operation. This fence should be 6 foot in height or higher. Ypsilanti proposes to use water from the Huron River to irrigate nursery stock. A drip irrigation system will require clean water free of seeds, sediment, and other likely mineral deposits to avoid clogging water emitters. One sustainability goal should be to recycle rain and excess water. This may require the construction of a catch basin or holding pond. Then to help lessen erosion and runoff, aisles should be seeded with sod or packed with gravel.

The City of Milwaukee recently installed a fence surrounding the field-grown, tree nursery operation. They had an issue with deer rubbing on 2-inch caliper trees and eating buds. To remediate the issue, two miles of 6-foot-high fencing was installed. (Photo courtesy of David Sivyer, Forestry Services Manager, City of Milwaukee)

Installation

Stock and liner holder pots should be manufactured specifically for each other and for the purpose of a pot-in-pot production system. Pot-in-pot layouts mimic field production but at a smaller scale. Generally, spacing between rows and each pot is 4 to 6 feet. Spacing should be dependent on the species of tree planted and size of tree desired.

Trees are spaced four feet apart in row and six feet apart row by row. Pots are also staggered to allow for even canopy growth. (Photo courtesy of Connon Nurseries, C.B. Vanderkruk Holdings)

Labor Requirements

Labor is required for potting, pruning, weed control, irrigation, staking, pest control, and harvesting. On a per tree basis, estimate length of activity times include 10 minutes for potting, 30 minutes for pruning, 30 minutes for maintenance (checking irrigation lines, staking, pest control), and 5 minutes to harvest (University of Kentucky-College of Agriculture, 2009[2]). Potting /up-potting and pruning should occur in spring before bud break or fall during dormancy. Checking irrigation lines, staking, pest control, and other monitoring tasks should occur on a weekly or biweekly basis depending on time of year and need for maintenance. Harvest may occur year around, yet greatest success for landscape plantings occurs in spring and fall.

A common rule among container nurseries is to employ at least one person per acre (University of Kentucky-College of Agriculture, 2009[1]). Ypsilanti's proposed nursery is 3.5 acres. One manager from the Department of Public Services should oversee the operation and 4 nursery workers should conduct and lead routine maintenances. The nursery may need to bring on more workers during planting/up-potting and harvesting periods. Ypsilanti should seek help from community volunteers and other organizations such as schools, girl scouts, boy scouts, garden clubs, and 4-H groups. Partnerships, as in the Michigan Works! Work Experience Initiative program, will also bring much help to the nursery operation.

Equipment

This is a short list of equipment which may be needed for the production of container-grown trees. This is not a complete list, but it is a start. This list was compiled from two references—Maryland Cooperative Extension and University of Tennessee Agricultural Extension Service.

- 6- to 12-foot mower
- Assorted hand tools: shovels, rakes, hand pruners, loppers, and pole pruner
- Auger
- Backpack sprayer
- Central office
- First aid and safety equipment
- Miscellaneous mechanic, electrical, and plumbing tools.
- Narrow, 4-wheel drive tractor or flatbed truck
- One-ton truck
- Pallets
- Pesticide and fertilizer storage
- Potting table and shelter
- Skidloader
- Tool storage
- Trailer or wagon
- Tree holding facility (shaded structure with irrigation)
- Truck/tractor and trailer storage

Growing Media

The success of container-grown trees is highly dependent on the chemical and physical properties of growing media. Growing media should be free of weed seeds and soil-borne diseases, heavy enough to avoid uprooting, and light enough for handling. Media should drain well, yet maintain a sufficient amount of moisture level to reduce irrigation. Other factors to consider include cost, availability of components, and stability over time. Potential components of growing media include peat moss, sphagnum moss, reed-sedge peat, coir (coconut fiber), pine bark, softwood bark, hardwood bark, sawdust, wood chips, spent mushroom compost, paper mill sludge, apple pomace, shredded newspaper, compost, animal manures, rice hulls, processed alfalfa, processed kenaf, cotton gin trash, recycled cardboard, and composted municipal yard waste. Some inorganic amendments include perlite, vermiculite, sand, soil, rock wood, pumice, calcined clay, diatomite, and zeolites (Robbins) (Diver & Greer, 2000). Media mix should be customized to meet the needs of Ypsilanti and promote a healthy, well-established tree stock. Local Cooperative Extension Service offices may help design a media mix.

Irrigation

Irrigation is the redistribution of water from other pooled sources including lakes, ponds, streams, retention basins, or wells. During spring, summer, and fall months, container-grown trees will require water on a daily basis. When rainfall is insufficient, irrigation will be needed. The nursery stock may require 1 to 2 inches of water per week. Generally, 27,000 gallons of water will cover 1 acre with 1 inch of water (UMass Extension, 2009).

All pot-in-pot stock should be drip irrigated. Davey suggests a cyclical irrigation system which delivers water more than once a day by dividing needed amount into timed intervals (Southern Nurserymen's Association Publication, 1997). Ypsilanti should consult with a knowledgeable professional when designing and installing this system.

Drip irrigation will require regular maintenance. Drip emitters are prone to damage by animals and clogging. Drip irrigation will require very clean water free from seeds, sediments, and minerals.

Fertilization

Nutrients must be maintained for optimum tree growth. All container-grown trees will need fertilized since few nutrients may be available in planting media and levels of soluble nutrients may be significantly reduced due to limited container volume and frequent watering. Slow-release granule or liquid fertilizer should be used because essential plan nutrients remain for an extended period of time. Fertilizer contains nitrogen (N), phosphorus (P), potassium (K), and micronutrients. Granule fertilizer may be amended with the growing media prior to planting and/or topdressed over the surface of the potted trees in the field. Liquid fertilizer may be applied through drip irrigation, termed "fertigation'. Nitrogen is the main nutrient supplied by fertilizer. Suggested application rates vary from product to product and depend on species and container size. Fertilizers should be applied at the manufacturer's recommended rate. Local Cooperative Extension Service offices may help design a fertilization program.

Nutrient levels in growing media should be monitored every two to four weeks during growing season and two to three times during dormancy. A relative indicator of nutritional status is electrical conductivity (EC). Desired levels of EC are 0.5 to 1.0 mmhos/cm for solution fertilizer only or combined use of slow-release and solution fertilizer. Desired levels of EC are 0.2 to 0.5 mmhos/cm for slow-release fertilizer only. Levels of EC must be adjusted for trees sensitive to fertilizer. Monitoring nutrient levels is important because excessive nutrients may injure roots and rainfall or excessive may leach nutrients from the container (Southern Nurserymen's Association Publication, 1997).

Weed Control

Weed control is extremely important because weeds compete for water and nutrients. In the pot and just outside the pot, a combination of spraying a pre-emergent herbicide and hand weeding is the least costly method. A pre-emergent herbicide should be applied once in the spring and once in the fall. Any weeds missed by the herbicide should be hand pulled. Mulching the area around the pot is considered a sustainable way to eliminate weeds (at the same winterizes containers). Aisles should be seeded with sod then routinely mowed and treated to keep out broadleaf weeds.

Insects and Diseases

Throughout the growing season trees should be inspected for insect and disease problems. Davey suggests weekly inspections of leaves, twigs, trunk, and surface roots. Personnel should be trained to identify potential pests. If detected and treated early, control may be established with little damage to nursery stock.

Pruning

Pruning should be accomplished throughout the production cycle to create quality, well-structured landscape trees. Personnel should be trained on how to properly prune nursery trees to produce strong straight trunks and learn the different growth characteristics of species grown in the nursery to promote proper branch structure. Excessive removal of leaves and buds will delay growth. Chapters 2 and 3 in the publication *Strategies for Growing a High-Quality, Root System, Trunk, and Crown in a Container Nursery* is an excellent guide for reference.

Overwintering

Pot-in-pot systems are designed to use the natural buffering ability of the soil to help insulate the roots in the container. For added insulation during winter months, Davey suggests spreading approximately 5 inches of mulch around the pot to insulate the surrounding soil and about 2 inches of mulch in the pot to insulate the surface roots. Mulch should be tapered from 0 to 2 inches starting at the trunk. Mulch in pots should be removed the following spring.

Harvest

The time it takes trees to reach their desired form, size, branching, and trunk size varies depending on species, type of nursery stock, growing media, and annual maintenances. Pot-in-pot trees may be harvested any day of the year; however, in Michigan since planting in the landscape is generally restricted due to frozen ground, trees will likely only be harvested in spring, summer, or fall. During post-production handling, the roots will be susceptible to changes in temperature and moisture. Containers after harvesting trees will need to be protected from potential heat stress. While storing trees in containers, it is suggested they are grouped together insulated by mulch. Mulch should not be applied over growing media in the container.

Recycling Plastic

Pot-in-pot designed containers are constructed so they can be reused many times. However, there comes a time with stock and liner holder pots are unusable and should be recycled. Most hard plastics are either No. 6 polystyrene or No. 2 high-density polyethylene. This distinction is important because some recycling companies can only recycle certain plastics. Recyclers may not pay the nursery for the plastic, but they will allow you to drop it off or come get it themselves. Whatever way the transfer is made, it is likely that a certain weight of gathered plastic will be needed before they take it. Ypsilanti may have trouble storing a large amount of unusable plastic. If this is true, plastic for recycling could be combined with other nurseries in the community or surrounding area who need to recycle plastic or have the space to store it until amount needed is met (Diver & Greer, 2000).

Case Study – Tree Pittsburgh Nursery

Tree Pittsburgh's nursery is located in the residential neighborhood Point Breeze in Pittsburgh, Pennsylvania. Tree Pittsburgh is an environmental, non-profit organization dedicated to enhancing the City's vitality by restoring and protecting city trees. According to Mr. Matt Erb, Director of Urban Forestry for Tree Pittsburgh, the nursery is a new endeavor. The purpose is not to compete with local nurseries more than it is to grow trees that are not widely available or require a lot of effort to grow. After a few years of growing seedlings on Tree Pittsburgh's office's back steps, Tree Pittsburgh officially established nursery grounds for mass tree production in 2010. The Sprout Fund, a local grant opportunity to increase biodiversity, helped make the financial end of establishing this nursery possible. The purpose of this nursery is to propagate and grow genetically local, native trees for restoration and reforestation projects on river banks, hillsides, parks, and vacant lots.

Several steps were involved in the establishment of the nursery. Three vacant lots, approximately 7,000 square feet, were purchased. Licenses were obtained and legality agreements were satisfied. A gravel drive was installed. A fence for security was erected. Access to water was established through the water authority. A shed for storing small tools and a poly tunnel for growing and storing small stock were built. Two nursery personnel were employed and trained to care for tree stock.

A custom mixed planting media was formulated, purchased, and delivered. The nursery utilizes the container method to grow trees. Containers are purchased and donated, seeds and seedlings are planted, and mulch from city tree maintenance is spread and mounded around containers for insulation and stabilization. In one year, 4,000 to 5,000 saplings now grow in Tree Pittsburgh's nursery. Annually, the stock will be up-potted to accommodate new growth in the root systems. Saplings will be pulled from their old pots, roots will be pruned, saplings will be placed in a larger container, and planting media will be refreshed. The current intention is to maintain a crop of approximately 10,000 saplings and transplant when 2 to 3 feet tall.

Pots are grouped together by species and pot size. The left photo is of the site in the summer and the right photo is of the site in the winter. In the winter, mulch is piled around the containers to provide insulation from freezing temperatures.

(Continued)

Concerns for the investment are present. Rabbits may girdle saplings and termites may eat stock. Native tree stock, such as black walnut (*Juglans nigra*), may be lost due to future invasive pests or diseases introductions, such as thousand cankers disease (caused by fungus *Geosmithia morbida*). Soil structure and poor drainage due to history of nursery site may inhibit certain activities like installation of in-ground, pot-in-pot system or field-grown trees. Certain species respond differently to planting media (pine bark, peat moss, perlite, and lime). Osmocote, a slow-release fertilizer, is top dressed and some species require additional soluble fertilizer. Excessive fertilizer, poor drainage and soil structure, and overwatering may cause runoff. Harsh winters or early and late frosts may cause morality and loss of stock. However, the most threatening concern is efficiency of production and continuous funding. The possibility of losing stock and funding the nursery will always be an issue; however, the community and other similar organizations support Tree Pittsburgh's work to establish a nursery growing local, native trees for restoration and reforestation.

The response from the community and connections with key partners is encouraging. Tree Pittsburgh uses social media and their website to announce volunteer opportunities. These jobs would include potting trees, root pruning, and mulching. The nursery is fostering pride within the local community by creating opportunities for citizens to gain a sense of good from growing trees to beautify their city. Partners are supporting Tree Pittsburgh's commitment. Other community nursery managers, local extension officers, suppliers, local nurserymen, and local foresters show support by providing education, guidance, and some donated supplies. There is a great potential for other green organizations, like Tree Pittsburgh, to purchase these trees using them in their projects.

Chapter 5: Administrative Support

Trees are unique from other assets that municipal departments manage in that they are living, growing organisms that have potentially very long service lives, provide multiple benefits, and have public safety implications. The care and management of this natural resource requires professional expertise with a unique set of work skills, a volunteer workforce to assist with special projects and program needs, a budget and additional funding that supports the needs to maintain a proactive, sustainable urban forestry program, and strong public support made by effective communication about the forestry program.

The City of Ypsilanti is a Tree City USA and has been for seven years. Currently, the Department of Public Services (DPS) is responsible for the planting and care of all public trees and responds to all public tree-related complaints, requests, and inspections. However, there is no dedicated forestry crew; DPS workers do forestry related work only as time allows. Much of their training comes from on the job and training seminars. Ypsilanti's forestry program worked with a budget of $146,372 in 2011 and bi-annually has received a $3,000 grant from DTE Energy to plant trees. The DPS holds annual Arbor Day celebrations, yet there are no other forms of public relations involving the community in the urban forestry program. The Arbor Day celebrations and the recent dealings with removal of dying ash trees due to emerald ash borer are considered great successes for Ypsilanti's urban forestry program. Challenges for the forestry program are funding to support a dedicated forestry crew that would plant new trees, maintain existing trees, and remove trees that are dead, dying, or determined to be unsafe.

Professional Staff

An adequate complement of professionals who individually or collectively understand the technical, operational, and administrative factors in urban forest management is needed to prescribe and monitor the city's urban forestry activities, enforce policies and regulations, apply technical standards and practices, perform tree planting and maintenance, review plans that affect the forest resource, and manage the city nursery. Without this professional component in sufficient numbers, urban forest management decisions and actions often default to inadequately prepared decision-makers, which can have long-term, negative consequences for the forest resource.

Generally, an urban forestry program should have both supervision and operational employees supported by administrative and other management employees within a municipal department. On average, municipalities the size of Ypsilanti have two full-time employees in their urban forestry programs. This is reported by the USDA Forest Service and the ISA in the *Urban Forestry Best Management Practices for Public Works Manager: Staffing* guidelines (http://www2.apwa.net/documents/About/CoopAgreements/UrbanForestry/UrbanForestry-2.pdf).

The recommendation for Ypsilanti is to have one dedicated operational tree crew under the direction of a DPS General Foreman. Other DPS personnel may join the crew if more workers are needed for specific jobs. However, a crew leader and a trimmer or groundworker would have divided, routine responsibilities. The crew leader would be responsible for the crew daily activities, ensure safety and efficiency, apply standards and organize policy, complete paperwork, communicate with DPS General Forman, and perform public relation duties. The groundworker or trimmer would assist with work site setup, feed brush into chipper or stack for pick-up, flag traffic, perform duties of crew leader in their absence, drive and operate bucket truck, and maintain equipment. The General Foreman or other positions within the DPS would prepare tree maintenance plans, prepare tree planting plans, direct in-house and contract crews, respond to citizen request and emergencies, write reports and grants, and coordinate with other organizations or departments.

For the city nursery, there should be one full-time manager and other workers depending on the season and planting and harvesting periods. During the growing season, it is recommended that there be one worker per acre to maintain nursery tree stock. Ypsilanti's proposed nursery is 3.5 acres. There should be approximately four workers during the growing season. During potting and harvesting periods, additional workers (volunteers) will be needed to meet the needs of the tree planting program. Then during the dormancy of winter, two part-time workers should be sufficient in maintaining nursery stock.

The City should provide educational training for personnel involved in the urban forestry program, including the DPS General Foreman, in-house tree crew, nursery manager, and nursery workers. Urban forestry and nursery management is a skilled trade and training is needed for not only employee safety but to ensure that irreparable damage is not done to a tree and the nursery is growing tree stock to standards. The following is a list of organizations that may hold annual conferences, workshops, and training events which urban forestry staff should be aware of and encouraged to attend:

- Arboriculture Society of Michigan (ASM), www.asm-isa.org
- Michigan Nursery and Landscape Association (MNLA), http://www.mnla.org/
- Michigan Green Industry Association (MGIA), http://www.landscape.org/
- ReLeaf Michigan, http://releafmichigan.org
- Great Lakes Trade Expo (GLTE), http://www.glte.org/
- Michigan State University Extension, http://msue.anr.msu.edu/
- Greening of Detroit, http://greeningofdetroit.com/
- Michigan Arbor Day Alliance, http://www.miarbordayalliance.com/home.html

The City should also provide the opportunity for urban forestry personnel to obtain certifications and attend trainings to maintain certifications. The General Foreman and tree crew should attend national conferences that provide extended education in urban forestry. Organizations providing educational opportunities include the International Arborist Association, Arbor Day Foundation, Society of Municipal Arborists, and Tree Care Industry Association.

Volunteer Resources

Volunteers are the backbone of any community initiative. The management, protection, and enhancement of Ypsilanti's urban forest can be advanced with the inclusion of volunteers in many aspects of the urban forestry program. Volunteers may help maintain trees in the city nursery, plant new trees along the streets and in parks, prune young or small-growing trees, trim trees that inhibit traffic or pedestrians, mulch, and water.

Increasing program cost-effectiveness is an important aspect of any tree management program. Volunteers are a great advantage that Ypsilanti should utilize because they can save money. Organizing and training volunteers will require time and resources; however, overall costs will usually be less and large tasks could be completed quicker. Many communities to man volunteer efforts often use organizations including schools, girl scouts, boy scouts, garden clubs, and 4-H groups. As an example of one such effort, the Village of Prentice, Wisconsin and Prentice High School have ventured into a cooperative effort or growing trees for the Village's use. One spring day in 2010 using the pot-in-pot container method, 20 students planted over 1,000 seedlings, added slow-release fertilizer, and mulched every pot. Then in the fall, the students culled dead trees, weeded around healthy trees, and added another layer of mulch. The following spring, the trees that made it through the winter were moved into larger pot-in-pot containers dug by the Village and installed by the students. Yet once again, fall, 2011 students weeded and mulched the pot-in-pot system. The trees had an 80 percent success rate, the students left with hands-on experience, and the Village saved much money in the cost of labor.

Partnerships will also bring Ypsilanti much success. The Michigan Works! Work Experience Initiative is a partnership the City should continue to seek out. This same program provided staff for the inventory work. The Village could create seasonal openings, staff those positions with the low-income youth, and provide them the opportunity to gain valuable work experience while earning a paycheck. Seasonal positions could be created within the nursery or tree maintenance crew.

The reason volunteers can be so valuable is that they are a part of, live in, and are concerned with the urban forestry issues that affect themselves and the City. Ypsilanti's urban forestry program could benefit from using volunteers to build support through fund-raising and performing public education. Greater volunteer involvement will build support for Ypsilanti's urban forestry program and volunteer enthusiasm due to pride of contribution will encourage others to also get involved.

Budget Discussion

There is no "magic" formula for determining how much funding is needed for an urban forestry program. Every urban forest is different and urban forestry programs may be at differing stages of development. The simple answer is that there should be sufficient funding to carry out tree maintenance, conduct adequate planting, and perform emergency response, as well as for support management, staff, equipment, contractual services, and a city nursery.

There are some national guidelines and statistics that can be used as a general indicator of whether an urban forestry program is adequately funded. The following information can be used to gauge a local urban forestry program's level of funding as compared to national averages, statistical research, and general funding guidelines. This information is only provided for qualitative comparisons, and should not be considered in any way as a rule for adequate levels of funding for the City of Ypsilanti.

- The National Arbor Day Foundation (NADF) requires that a community forestry program be supported by an annual budget of at least $2 per capita as one qualification for its Tree City USA program. The NADF believes this is a minimum amount necessary to provide tree maintenance, planting, and management services to the public.
- A common generalization is that a more realistic average urban forestry budget is $5 per capita.
- Based on reports submitted to the NADF for Tree City USA certification, communities with a similar population level as Ypsilanti have an average municipal urban forestry budget of $172,465 and an average per capita expenditure for urban forestry activities of $9.57.

In 2010, the budget was approximately $145,372. Dedicated and consistent funding needs to be made available for public tree planting, routine maintenance, insect and disease monitoring and control, and other necessary tasks. Generally, an urban forestry budget is allocated towards 58 percent maintenance, 14 percent planting, and 8 percent management. This is reported by Jim Kielbaso and Vincent Cotrone from Michigan State University in the *Urban Forestry Best Management Practices for Public Works Manager: Budgeting and Funding* guidelines (http://www2.apwa.net/documents/About/CoopAgreements/UrbanForestry/UrbanForestry-1.pdf). It is recommended that a detailed budget analysis be performed, that includes:

- Identifying all city resources spent on urban forestry activities to clearly understand the current level of funding for urban forestry related activities.
- Determining if future budget reallocations and efficiencies can occur.
- Determining the amount of shortfall to achieve stated goals.
- Identifying potential and best sources of increased financial resources.

Sources of Funding

Urban forest management is a recognized function of the City of Ypsilanti and receives some dedicated funding. However, with greater funding levels, the City could move from a reactive to a proactive management approach, provide greater services, and increase the public tree population if the security of funds to sustain all activities, programs, and initiatives are available.

There are various funding mechanisms and sources the City can consider to support increasing staff levels, tree maintenance, planting activities, a city nursery, public education efforts, and other components of a truly progressive, comprehensive urban forestry management program.

Change in Policy

To increase tree planting and the overall canopy of the City, it is recommended that the City work with developers during the initial phases of site plan development to require trees be planted as part of re-development and new development projects. This may require changes to the City's ordinance to ensure enforcement of this policy.

Establish a Ypsilanti Tree Bank

A special account could be created to deposit funds from various sources, which are restricted for use by the urban forestry program. The funds in this account are managed by the City, subject to the annual budget process, and expenditures follow normal purchasing policies and procedures. This innovative funding mechanism does not rely on city general funds but, instead, on the collection and deposit of monies from various sources. Suggested sources included, but are not limited to, the following:

Damage Compensation. Although this source may not generate a great deal of money, it is a legitimate and often under-pursued source of funds. When an automobile damages a public tree or when construction equipment destroys a group of public trees, the City should seek compensation for the landscape value of that tree(s). The City can rightly seek compensation for the total damages, including: the value of the tree(s); the cost of repair or clean-up; and the cost of the administrative time used during the resolution of the situation. The receipt of $500 from a minor car accident to $5,000 for a major damage claim can add up over time. Generally, the compensation is collected from the insurance company of the person responsible for the damage or directly from the business that caused the damage to public trees. The compensation funds can be used to remedy the specific damage, or be used for other legitimate urban forestry functions throughout the City.

Permit and Plan Review and Inspection Fees. It is not uncommon for municipalities to require private developers and businesses to support the administrative time needed for proper and professional plan review and site inspection tasks. Charging specifically for the time and arboricultural expertise needed to approve permit applications, review plans, and make site inspections might be a viable option to support the salary and benefits of additional full- or part-time urban forestry positions. The City may need to perform a job analysis to determine the time spent performing review and inspection tasks, and could investigate what other communities in the region, or of a similar size, are charging for such a task.

Developers Fees. In lieu of, or in addition to, tree-related plan and inspection fees, developers could be required to pay a set amount to support Ypsilanti's overall urban forestry program. In effect, it would be a cost of doing business within the city limits. The fee could be a percentage of the total project cost, based on the number of housing units built, or based on the area of land being developed. The City's Planning and Development Department may have better information upon which to base this fee. It is suggested that this fee would be paid and deposited in the Tree Bank before the project is approved.

Utility Company Fees. Non-municipal utility companies perform new construction, maintenance, and repair work on an annual basis in the City. This work may affect the aboveground and belowground portions of public trees. It is prudent and reasonable to assess a fee to such utility companies when their work affects public trees. Utility companies with aerial facilities might be required to provide the City an anticipated annual work plan and maps with an appropriate fee attached to provide for inspection and monitoring. Any compensation for documented damage to public trees during utility work would be collected separately on a case-by-case basis, and the utility company should be responsible for the costs for any remediation necessary (*e.g.,* pruning, fertilization, or temporary irrigation) above and beyond the fees and compensatory payment. The same conditions would apply for companies installing or maintaining underground utilities.

Private Donations/Corporate Sponsorships. Private donations could support some tree planting, tree care, nursery activities, and public education events. A major source of donations could be from businesses and corporations who wish to sponsor non-profit, environmental activities. All potential contributors should be reminded that any donations might be tax-deductible when they file their federal income tax return if their financial situation allows. These types of programs usually require signage and recognition throughout the partnership but are oftentimes more sustainable.

Fund-Raising Activities. With a support of volunteers, the City can hold various fund-raising events throughout the year. Popular large events include competitive and social runs and walks. Volunteers can staff food and drink booths at local fairs and festivals. Tree and Ypsilanti-related merchandise could be commissioned and sold. Restaurants can have special Tree Nights where a small percentage of the patrons' bills are donated back to the City for tree maintenance and planting. Even small efforts, such as school and church bake sales and yard sales, can be encouraged to raise funds for trees in the community.

Firewood/Mulch/Wood Sales. Wood waste from tree maintenance and storm damage repairs can be a source of funds for the Tree Bank. Other municipalities have been successful in selling split and un-split firewood, hardwood timber, and rough wood chips to the general public and commercial businesses. Rather than pay for proper removal and disposal, municipalities sell these excess wood products. A new trend is when a significant or historic public tree must be removed, the logs and useable wood are given to local craftsmen who then create furniture, sculpture, and other collectibles from the wood. These are sold and all or portions of the proceeds are returned to the City.

Memorial and Honor Tree Park Program

Ypsilanti's park tree planting program can be partially funded and enhanced by creating and advertising a Memorial and Honor Tree Planting Program. Citizens at times of loss and at times of celebration often choose to plant a tree to remember special people and mark a special achievement. Municipalities across the country successfully use this funding technique not only for program support but also for generating good public relations for the urban forestry program. A prudent approach to implementing such a program is to set a level of funding that will not only purchase and plant a tree of a certain size, but that will also collect funds to pay for maintenance for three years.

Utility Bill Donations

The City bills property owners directly for water and sewer services. These municipal invoices could be a source for needed funds for the urban forestry program. A small fixed amount from $0.25 to $1.00 could be automatically added to each bill; the property owner would then have the option to voluntarily include it with their utility payment. Another option is to ask the bill payers to round the invoice amount up to a higher figure of their choice. Using this voluntary and "painless" funding mechanism can potentially raise thousands of dollars. It will require the cooperation of the Financial Services Department to implement this program.

Information about the stormwater benefits public trees provide should be included along with the bill asking for donations. Informational pamphlets should inform owners of how trees “Pay Us Back” and where their donation will go.

Obtain Grants

As a municipality and a non-profit with existing support structures and staff, Ypsilanti is in a good position to apply for and receive grants to support urban forestry activities. The City has previously received grants for urban forestry projects, but with the investment in time and a person skilled in grant writing, there are likely multitudes of grant opportunities for Ypsilanti. These opportunities can be found with the State and Federal governments, non-profit organizations, large corporate and private business foundations, and private charitable foundations. If Ypsilanti establishes a Tree Bank, there will be a ready source of matching funds to leverage even more grant dollars.

Public Relations and Education

Through years of experience and research, Davey has found that public education is the true key to reaching the goals of an urban forestry program in a community. Only by educating citizens, city officials, municipal staff, developers, and all contractors working within the City will Ypsilanti be able to achieve urban forest preservation and proactive management goals. It is recommended that various public outreach campaigns, aimed at educating the citizens, city officials, municipal staff, developers, and contractors of Ypsilanti and gaining their support for the urban forestry program, be implemented. Based on public relations efforts by urban foresters in other communities, the following types of activities are suggested for communicating broadly the need for Ypsilanti to be engaged with and thoughtful about the urban forest:

- Hold a seminar or public meeting to discuss the tree inventory project and management plan and its importance for the future sustainability of Ypsilanti’s community.
- Develop monthly evening or weekend workshops and training seminars with community leaders, advisory groups, contractors, homebuilders, and municipal staff. Bring in guest experts from various disciplines in the green industry.
- Require that various community stakeholders attend educational sessions to learn about the community's urban forest, urban forest preservation, and the importance of it all to the future of the community, Ypsilanti will begin to see much greater cooperation from all concerned parties.
- Host monthly *Tree Talks* on local radio stations or at community centers.
- Write a monthly *Tree Talk* article for local newspapers.
- Develop publications including direct mailings, newsletters, and forestry and arboricultural handouts. All publications should be available in electronic format and included on the City’s website.
- Develop a webpage on the City’s website strictly highlighting the urban forestry program. Include information about the purpose, current progress, past projects, achievements, need-to-know information, and ways to get involved.
- Send letters to residents in areas of the City where pruning and planting will be conducted each year and describe each program’s goals and achievements.

- Develop a *Tree Care* brochure to go to each residence where new trees are planted; this could help eliminate trunk damage and improper mulching and pruning of new trees by educating residents about proper tree care.
- Utilize social networks such as Facebook and Twitter.
- Expand on the annual Arbor Day celebration. Refer to the NADF (visit www.arborday.org or call 402-474-5655) for publications that provide great Arbor Day ideas to assist in planning this event.
- Develop a tree walk utilizing the inventory to promote species identification skills and benefits trees provide. A second function of this walk would be serving educational curriculum needs for visual representations of various morphologies of different tree species. The inventory could be incorporated into and serve as a teaching tool for several educational programs.

Conclusions

Ypsilanti is on the right path to a sustainable urban forest. The results of this analysis can be used to improve the City's public tree management strategy, promoting a valuable asset with invaluable qualities. By strengthening its urban forest program and its network of partners, Ypsilanti will develop the resources and relationships it needs to achieve its urban forestry goals.

Ypsilanti has a tree population that adds to the beauty and livability of the City. However, as trees get older, they become increasingly inefficient in withstanding the inherent stresses of an urban environment and are subject to decline without professional and regular management. Keeping that in mind, Ypsilanti should strive to achieve the goals of this management plan.

Generally stated, Ypsilanti's goals include:

- **Understand the inventoried public tree population in terms of species and genus.** Currently, the genus *Acer* (maple) comprises approximately 55 percent of the tree population; and Norway maple and silver maple represent 29 and 14 percent of the total population. The City must begin planting different species to increase its overall diversity. Species diversity will help avoid potential catastrophic tree losses due to disease outbreaks and/or insect infestations. Additionally, different tree species can add to the City's aesthetic appeal. Every effort must be made to budget enough money each year for new tree plantings, and these new plantings should include many different species of trees suited to the local climate.
- **Assess the relative age of the inventoried tree population.** The distribution of ages within a tree population influences present and future costs. The relative age distribution is 19:19:43:19 (percentages of young; established; maturing; and mature trees). This is a relatively even-aged population skewed towards maturing trees. A sustainable tree population has a higher percentage of young trees with a stair-stepped distribution of established, maturing, and mature trees to minimize fluctuations in maintenance costs.
- **Evaluate the condition of the inventoried tree population.** Tree management and site conditions will influence the general health and longevity of the tree population. Although 59 percent of the public tree population is in Fair condition, more than 13 percent of the inventoried trees are in Good condition and 28 percent are in Poor condition or worse condition. Controlling the decline, removal, and replacement of trees in a timely and cost-effective manner is the ultimate goal of a sustainable urban forestry management process.

- **Establish priority pruning and removal programs.** One of the primary concerns in Ypsilanti must be public safety. Tree removals and pruning are a vital part of risk mitigation.
- **Establish routine pruning programs for all large- and small-growing trees.** The City should refine and prioritize the current cycle to maximize productivity and the health of the urban forest. This cycle allows for maintenance of all trees in the urban forest, thus decreasing the occurrence of structural problems and potential risks in the City's tree population.
- **Establish a training pruning program for all newly planted trees.** Many young trees may have branch structure that can lead to potential problems as they grow, but these problems can be remedied easily and inexpensively through training pruning. Training young trees will inexpensively help decrease the occurrence of structural problems and future potential risks in the City as trees mature in the future.
- **Establish a tree planting program to replace trees that are removed and vacant sites.** Ypsilanti's streets are 61.5 percent stocked. Full stocking it an elusive goal, however, it should continue to be a goal set by the City. Choosing the right tree for the right place will help keep future maintenance costs low and ensure that the entail investment of planning and planting is well worth it.
- **Annually evaluate tree work completed.** Recognizing the successes and failures of the urban forest program will help identify strengths and weaknesses in the operation. Isolate these strengths and weaknesses to determine what is needed in maintaining that success or working through failures.
- **Establish tree canopy goals and policies that work to increase current canopy.** Ypsilanti must strive to maintain a healthy tree canopy through tree planting and routine, cyclic tree maintenance. Ypsilanti's canopy cover is 37 percent overall. While the City's overall canopy cover is quite good, there are 2,950 vacant sites along the streets and many parks have canopy cover percentages less than 40 percent. Tree planting efforts should focus on filling vacant sites, increasing canopy in parks, and species diversity as these will provide more environmental and economic benefits. Ypsilanti must also continue to plant trees to account for losses from natural mortality, accidents, inevitable storms, and potential invasive threats.
- **Establish a city nursery that can support the needs of the planting program.** The City nursery should offset tree species readily available in the commercial market. Creating more diversity in the city nursery stock will help create diversity along the streets and in parks. Pot-in-pot is the recommended system to nursery stock.
- **Execute Needed Changes in Support of the Urban Forestry Management Program.** Enough staff should be employed to complete the programs and establish the nursery described in this management plan. Volunteers may be needed to help plant and prune landscape trees and complete miscellaneous tasks in the city nursery. Staff and volunteers should be trained to complete tasks accordingly and a steady budget/additional funding will be needed to support the recommended programs and nursery establishment. Public relations will be extremely valuable as it will promote the value of quality trees produced in the nursery and quality tree care made possible by a proactive maintenance program.

The management of trees in a municipality is challenging. Balancing the recommendations of experts; the wishes of council members and other elected officials; the needs of residents; the pressures of local economics; the concerns for 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 met simultaneously is quite a daunting task. Ypsilanti urban forestry managers must carefully consider each specific issue and balance these pressures with a knowledgeable understanding of sustainability and tree needs. If balance is achieved, the City's beauty will flourish and the health and safety of its trees and citizens will be maintained.

Appendix A
Inventory Methodology

Data Collection

All trees were individually examined, identified, measured, and recorded by Davey Resource Group's urban foresters and Michigan Works! Green Team members. Data were recorded for the following public tree variables, which are described in further detail below:

- Tree Location
- Tree Genus and Species
- Tree Size
- Tree Trunks
- Tree Condition
- Tree Maintenance Recommendation
- Observations
- Additional Comments (Field Notes)

Tree Location

The inventory was conducted using pen-based data collection units along with global positioning system (GPS) receivers. The City of Ypsilanti provided Davey Resource Group with all basemap layers used in customizing the geographic information system (GIS) for pen-based computers. These layers consisted of ROW information, parcels, addresses, park boundaries, and digital orthophotographs. The combination of GPS with GIS seamlessly facilitates an efficient map-based data collection system. This system allowed Davey Resource Group to populate a tree layer in the field as each tree's location and data attributes were recorded. During the course of the inventory, the tree layers were imported into ArcView® and Davey's Tree Collector Interface® for quality control review. Upon completion of all data collection, the files were merged into a final tree layer for delivery as the current public tree inventory.

Street Tree Location Methodology

Individual sites (sites refer to trees) are inventoried by *street* name, *address* number, and by *site* number. Each *site* location is also assigned lot side and block side information. In order to be consistent in the assignment of *site* location information, Davey Resource Group has developed a protocol for determining *addresses*, *site numbers*, and *block side definitions*. This protocol is designed so that urban foresters, contractors, or maintenance personnel will be able to identify the correct site using Davey Resource Group's location information.

Each **address** includes a *street name* and *address number*. Addresses are determined from the actual address number posted on buildings. In instances where (A) there is no posted street number on a building; or (B) sites are located on vacant lots with no GIS addressing data, addressing is matched as closely as possible to opposite or adjacent addresses by the data collector(s). An '**X**' is entered in the address number *assigned* field for these fictitious addresses. For example, 37X Choice Avenue means that an address had to be assigned to a parcel.

Each site at an address is assigned a **side code** based on whether it is located at the front (F), side (S), or rear (R) of the addressed lot. Median or Island sites (M) are also identified and assigned a fictitious address closest to an address on the right side of the street in the direction of collection. Each median segment is collected and numbered with an assigned address that is interpolated from addresses facing that median/island. If there are multiple median areas between two cross streets, each segment is given its own assigned address.

Multiple sites at the same address are distinguished from one another by assigning each site a separate **site number**. The basis of this location methodology is that the sites are collected and assigned site numbers in the direction of vehicular traffic flow. (This is only false in the case of one-way streets; one-way streets are collected and assigned site numbers as if they were actually normal two-way streets.) At each address, a separate number sequence is used for each side (front, side, rear, and median/island). This means that the trees at the front may be numbered 1 through 999 and, if trees are located on the side, rear, or median/island of that same address, each side is also numbered consecutively, again beginning with the number 1 and always in the direction of vehicular traffic flow.

The block side information is composed of an **on** street, a **from** street, and a **to** street:

- The *on* street is the street that the site is actually located on. Be aware that some sites, *e.g.*, 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 the data collector is moving away from when moving in the direction of traffic flow.
- The *to* street is the cross street the data collector is moving toward when moving in the direction of traffic flow.

As mentioned earlier, the *on* street may not be the same as the address street. For example, a corner house may have sites along the sides and those sites would actually be on a side street. The *from* street is the cross street the data collector is moving away from when moving in the direction of traffic flow. The *to* street is the cross street the data collector is moving toward when moving in the direction of traffic flow.

The corner lots (labeled as 1 and 2 in Diagram 2) have location information similar to the following:

Corner Lot 1

Address:	205		
Street:	Hoover St.		
Side:	Front		
Site:	1		
Block:	On:	Hoover St.	
	From:	Taft St.	
	To:	Davis St.	
Address:	205		
Street:	Hoover St.		
Side:	Side To		
Site:	1		
Block:	On:	Taft St.	
	From:	E Mac Arthur St.	
	To:	Hoover St.	
Address:	205		
Street:	Hoover St.		
Side:	Side To		
Site:	2		
Block:	On:	Taft St.	
	From:	E Mac Arthur St.	
	To:	Hoover St.	
Address:	205		
Street:	Hoover St.		
Side:	Side To		
Site:	3		
Block:	On:	Taft St.	
	From:	19^{th} St.	
	To:	Hoover St.	

Corner Lot 2

Address:	226	
Street:	E Mac Arthur St.	
Side:	Side To	
Site:	1	
Block:	On:	Davis St.
	From:	Hoover St.
	To:	E Mac Arthur St.
Address:	226	
Street:	E Mac Arthur St.	
Side:	Front	
Site:	1	
Block:	On:	E Mac Arthur St.
	From:	Davis St.
	To:	Taft St.
Address:	226	
Street:	E Mac Arthur St.	
Side:	Front	
Site:	2	
Block:	On:	E Mac Arthur St.
	From:	Davis St.
	To:	Taft St.

Park/Public Space Tree Location Methodology

Trees in selected park/public space areas were inventoried using the contract parameters for the street tree portion of the inventory. Specifically, inventoried park/public space include:

- Frog Island Park
- Parkridge Park and Community Center
- Peninsular Park
- Prospect Park
- Recreation Park
- Riverside Park

Park/public space tree locations were collected using the same methodology as the street tree portion of the inventory with one exception: the on, from, and to streets that comprise the block side information were entered with the park/public space's name, not individual streets. All park/public space were assigned 1 as the address numbers.

Tree Genus and Species Identification

Trees are identified by genus and species and by cultivars where appropriate (cultivar names are recorded in the Assigned Cultivar section of each tree record, when applicable). The identification of trees by botanical names ensures the correct scientific identification of each tree species.

Tree Diameter

Diameter at breast height (DBH) is a standard forestry measurement taken at 4.5 feet above the ground. Each tree diameter was measured to the nearest inch with a 25-inch reach Biltmore® Cruiser™ stick.

Tree Trunks

During the inventory, each tree was evaluated for the total number of trunks present. For trees with multiple trunks, the largest trunk DBH was measured and recorded.

Tree Condition

Condition indicates the current state of a tree's health, structural soundness, overall shape, and growth rate. Symptoms of poor condition include discoloration, decay, dieback, decreased internodal length, and/or disfigured or necrotic stems or roots. To some extent, condition class is also a reflection of the life expectancy of the tree. Crown development, trunk condition, major branch structure, twig growth rate, insects/diseases, and root condition are all considered. In general, the condition of each tree is recorded as one of the following categories adapted from the rating system established by the ISA®:

Excellent

100% condition class. This tree has no structural, aesthetic, insect, or disease problems.

Very Good

90% condition class. Overall, the tree is healthy and satisfactory in condition, vigor, and form. The tree has no major structural problems, no mechanical damage, and may only have insignificant aesthetic, insect, or disease problems.

Good

80% condition class. The tree has no major structural problems, no significant mechanical damage, may have only minor aesthetic insect, disease, or structure problems, and yet is in good health.

Fair

60% condition class. The tree may exhibit the following characteristics: minor structural problems and/or mechanical damage, significant damage from non-fatal or disfiguring diseases, minor crown imbalance or thin crown, or stunted growth compared to adjacent trees. This condition also includes trees that have been topped but show reasonable vitality and show no obvious signs of decay.

Poor

40% condition class. The tree appears unhealthy and may have structural defects, such as co-dominant stems, severe included bark, or severe trunk and/or limb decay. A tree in this category may also have severe mechanical damage, crown dieback, or poor vigor threatening its ability to thrive. Trees in poor condition may respond to appropriate maintenance procedures, although these procedures may be cost-prohibitive to undertake.

Critical

20% condition class. The tree has a major structural problem that presents an unacceptable risk, has very little vigor, and/or has an insect or disease problem that is fatal and, if not corrected, may threaten other trees on the property.

Dead

0% condition class. This category refers to dead trees only.

Tree Maintenance Recommendations

Maintenance recommendation information is collected to provide a basis for determining and prioritizing the primary maintenance needs of the City's inventoried tree population The Primary Maintenance Recommendations are the main maintenance needs of the urban forest and should be addressed first; the Secondary Maintenance Recommendations are not High Risk safety pruning activities, but rather practices directed at improving the overall health, stability, and aesthetics of the urban forest. Davey Resource Group has identified maintenance activities that are of greatest importance to the overall management of the public tree population. This information is useful for preparing accurate budgets and for developing maintenance schedules, whether the work is performed by in-house crews or contracted out to local tree care companies. The following terms, based on the ANSI A300 Standards for Tree Pruning (2nd edition, 2001), are used to describe the maintenance requirements of each tree:

Priority 1 Removal

Trees designated for removal have defects that cannot be cost-effectively or practically treated. The majority of the trees in this category have a large percentage of dead crown and pose an elevated level of risk for failure. Any hazards that could be seen as potential dangers to persons or property and seen as potential liabilities to the client would be in this category. Large dead and dying trees that are high liability risks are included in this category. These trees are the first ones that should be removed.

Priority 2 Removal

Trees that should be removed but do not pose a liability as great as the first priority will be identified here. This category would need attention as soon as "Priority One" trees are removed.

Priority 3 Removal

Trees that should be removed, but that pose minimal liability to persons or property, will be identified in this category.

Priority 1 Prune

Trees that require priority one pruning are recommended for trimming to remove hazardous deadwood, hangers, or broken branches. These trees have broken or hanging limbs, hazardous deadwood, and dead, dying, or diseased limbs or leaders greater than four inches in diameter.

Priority 2 Prune

These trees have dead, dying, diseased, or weakened branches between two and four inches in diameter and are potential safety hazards.

Large Tree Routine Prune

These trees require routine horticultural pruning to correct structural problems or growth patterns which would eventually obstruct traffic or interfere with utility wires or buildings. Trees in this category are large enough to require bucket truck access or manual climbing.

Small Tree Routine Prune

These trees require routine horticultural pruning to correct structural problems or growth patterns which would eventually obstruct traffic or interfere with utility wires or buildings. These trees are small growing, mature trees that can be evaluated and pruned from the ground.

Training Prune

Young, large-growing trees that are still small must be pruned to correct or eliminate weak, interfering, or objectionable branches in order to minimize future maintenance requirements. These trees, up to 20 feet in height, can be worked with a pole pruner by a person standing on the ground.

Stump Removal

This category indicates a stump that should be removed.

Plant Tree

During the inventory, vacant planting sites will be identified by street and address. The size of the site is designated 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. Planting sites are determined based on standard specifications set forth in accepted technical journals and by the arboriculture industry.

Observations

General observations concerning tree health, structure, and location have been recorded for each tree in the inventory, when applicable. Observation types include *Cavity or Decay*, *Grate or Guard*, *Improperly Installed*, *Improperly Mulched*, *Improperly Pruned*, *Mechanical Damage*, *Memorial Tree*, *Nutrient Deficiency*, *Pest Problem*, *Poor Location*, *Poor Root System*, *Poor Structure*, *Remove Hardware,* and *Serious Decline*. *None* means no observation types were recorded.

Additional Comments (Field Notes)

Any additional comments regarding maintenance, cultivars, condition, disease, location, etc. are included for each tree, when applicable.

Appendix B
Tree Inventory Frequency Reports

Species Composition

Common	Total	Percentage of Entire Population
maple, Norway (Acer platanoides)	1651	28.61%
maple, silver (Acer saccharinum)	793	13.74%
honeylocust, thornless (Gleditsia triacanthos inermis)	464	8.04%
maple, sugar (Acer saccharum)	353	6.12%
maple, red (Acer rubrum)	220	3.81%
linden, littleleaf (Tilia cordata)	207	3.59%
elm, Siberian (Ulmus pumila)	185	3.21%
pear, Callery (Pyrus calleryana)	178	3.08%
crabapple, flowering (Malus spp.)	123	2.13%
cottonwood, eastern (Populus deltoides)	119	2.06%
walnut, black (Juglans nigra)	90	1.56%
planetree, London (Platanus x acerifolia)	79	1.37%
elm, American (Ulmus americana)	71	1.23%
maple, Freeman (Acer x freemanii)	67	1.16%
boxelder (Acer negundo)	64	1.11%
oak, northern red (Quercus rubra)	61	1.06%
locust, black (Robinia pseudoacacia)	58	1.01%
spruce, Colorado (Picea pungens)	46	0.80%
mulberry, white (Morus alba)	45	0.78%
ash, green (Fraxinus pennsylvanica)	45	0.78%
linden, American (Tilia americana)	43	0.75%
sycamore, American (Platanus occidentalis)	42	0.73%
oak, white (Quercus alba)	40	0.69%
pine, Scotch (Pinus sylvestris)	36	0.62%
tree of heaven (Ailanthus altissima)	34	0.59%
cherry/plum, spp. (Prunus spp.)	32	0.55%
tuliptree (Liriodendron tulipifera)	29	0.50%
redbud, eastern (Cercis canadensis)	27	0.47%
maple, black (Acer nigrum)	25	0.43%
catalpa, northern (Catalpa speciosa)	25	0.43%
oak, swamp white (Quercus bicolor)	24	0.42%
ash, white (Fraxinus americana)	24	0.42%
arborvitae spp. (Thuja spp.)	23	0.40%
hackberry, common (Celtis occidentalis)	22	0.38%
sweetgum, American (Liquidambar styraciflua)	20	0.35%

Common	Total	Percentage of Entire Population
spruce, Norway (Picea abies)	20	0.35%
elm, slippery (Ulmus rubra)	20	0.35%
cherry, black (Prunus serotina)	20	0.35%
zelkova, Japanese (Zelkova serrata)	18	0.31%
hawthorn, spp. (Crataegus spp.)	18	0.31%
spruce, white (Picea glauca)	15	0.26%
pine, Austrian (Pinus nigra)	15	0.26%
mulberry, red (Morus rubra)	14	0.24%
buckthorn, spp. (Rhamnus spp.)	14	0.24%
serviceberry, spp. (Amelanchier spp.)	13	0.23%
pine, eastern white (Pinus strobus)	13	0.23%
hickory, shellbark (Carya laciniosa)	13	0.23%
birch, river (Betula nigra)	13	0.23%
linden, silver (Tilia tomentosa)	12	0.21%
ginkgo (Ginkgo biloba)	12	0.21%
arborvitae, eastern (Thuja occidentalis)	12	0.21%
hickory, shagbark (Carya ovata)	10	0.17%
horsechestnut (Aesculus hippocastanum)	9	0.16%
apple, common (Malus pumila)	9	0.16%
lilac, spp. (Syringa spp.)	8	0.14%
hickory, mockernut (Carya tomentosa)	8	0.14%
redcedar, eastern (Juniperus virginiana)	7	0.12%
honeylocust (Gleditsia triacanthos)	7	0.12%
cherry, Japanese flowering (Prunus serrulata)	7	0.12%
oak, bur (Quercus macrocarpa)	6	0.10%
maple, hedge (Acer campestre)	6	0.10%
yellowwood (Cladrastis kentukea)	5	0.09%
unknown tree (unknown tree)	5	0.09%
willow, weeping (Salix babylonica)	4	0.07%
maple, Japanese (Acer palmatum)	4	0.07%
dogwood, flowering (Cornus florida)	4	0.07%
serviceberry, downy (Amelanchier arborea)	3	0.05%
royal paulownia (Paulownia tomentosa)	3	0.05%
plum, cherry (Prunus cerasifera)	3	0.05%
oak, pin (Quercus palustris)	3	0.05%
oak, black (Quercus velutina)	3	0.05%
douglas-fir (Pseudotsuga menziesii)	3	0.05%
willow, pussy (Salix discolor)	2	0.03%

Common	Total	Percentage of Entire Population
willow, corkscrew (Salix matsudana)	2	0.03%
poplar, white (Populus alba)	2	0.03%
pear, common (Pyrus communis)	2	0.03%
oak, Shumard (Quercus shumardii)	2	0.03%
oak, English (Quercus robur)	2	0.03%
maple, Amur (Acer tataricum ginnala)	2	0.03%
magnolia, saucer (Magnolia x soulangiana)	2	0.03%
hickory, bitternut (Carya cordiformis)	2	0.03%
goldenraintree (Koelreuteria paniculata)	2	0.03%
cherry, sweet (Prunus avium)	2	0.03%
beech, American (Fagus grandifolia)	2	0.03%
aspen, quaking (Populus tremuloides)	2	0.03%
willow, spp. (Salix spp.)	1	0.02%
sumac, spp. (Rhus spp.)	1	0.02%
smoketree, American (Cotinus coggygria)	1	0.02%
serviceberry, shadblow (Amelanchier canadensis)	1	0.02%
pine, red (Pinus resinosa)	1	0.02%
pine, mugo (Pinus mugo)	1	0.02%
osage-orange (Maclura pomifera)	1	0.02%
oak, shingle (Quercus imbricaria)	1	0.02%
oak, sawtooth (Quercus acutissima)	1	0.02%
magnolia, cucumbertree (Magnolia acuminata)	1	0.02%
juniper, spp. (Juniperus spp.)	1	0.02%
hophornbeam, American (Ostrya virginiana)	1	0.02%
hickory, pignut (Carya glabra)	1	0.02%
fir, white (Abies concolor)	1	0.02%
elm, Chinese (Ulmus parvifolia)	1	0.02%
dogwood, pagoda (Cornus alternifolia)	1	0.02%
dogwood, gray (Cornus racemosa)	1	0.02%
dawn redwood (Metasequoia glyptostroboides)	1	0.02%
birch, paper (Betula papyrifera)	1	0.02%
beech, European (Fagus sylvatica)	1	0.02%
arborvitae, western (Thuja plicata)	1	0.02%
Grand Total	*5771*	*100%*

Ypsilanti, MI

Quantity Report: Botanical

Botanical	*Total*	*Percentage of Entire Population*
Acer platanoides (maple, Norway)	1651	28.61%
Acer saccharinum (maple, silver)	793	13.74%
Gleditsia triacanthos inermis (honeylocust, thornless)	464	8.04%
Acer saccharum (maple, sugar)	353	6.12%
Acer rubrum (maple, red)	220	3.81%
Tilia cordata (linden, littleleaf)	207	3.59%
Ulmus pumila (elm, Siberian)	185	3.21%
Pyrus calleryana (pear, Callery)	178	3.08%
Malus spp. (crabapple, flowering)	123	2.13%
Populus deltoides (cottonwood, eastern)	119	2.06%
Juglans nigra (walnut, black)	90	1.56%
Platanus x acerifolia (planetree, London)	79	1.37%
Ulmus americana (elm, American)	71	1.23%
Acer x freemanii (maple, Freeman)	67	1.16%
Acer negundo (boxelder)	64	1.11%
Quercus rubra (oak, northern red)	61	1.06%
Robinia pseudoacacia (locust, black)	58	1.01%
Picea pungens (spruce, Colorado)	46	0.80%
Morus alba (mulberry, white)	45	0.78%
Fraxinus pennsylvanica (ash, green)	45	0.78%
Tilia americana (linden, American)	43	0.75%
Platanus occidentalis (sycamore, American)	42	0.73%
Quercus alba (oak, white)	40	0.69%
Pinus sylvestris (pine, Scotch)	36	0.62%
Ailanthus altissima (tree of heaven)	34	0.59%
Prunus spp. (cherry/plum, spp.)	32	0.55%
Liriodendron tulipifera (tuliptree)	29	0.50%
Cercis canadensis (redbud, eastern)	27	0.47%
Catalpa speciosa (catalpa, northern)	25	0.43%
Acer nigrum (maple, black)	25	0.43%
Quercus bicolor (oak, swamp white)	24	0.42%
Fraxinus americana (ash, white)	24	0.42%
Thuja spp. (arborvitae spp.)	23	0.40%
Celtis occidentalis (hackberry, common)	22	0.38%
Ulmus rubra (elm, slippery)	20	0.35%

Botanical	*Total*	*Percentage of Entire Population*
Prunus serotina (cherry, black)	20	0.35%
Picea abies (spruce, Norway)	20	0.35%
Liquidambar styraciflua (sweetgum, American)	20	0.35%
Zelkova serrata (zelkova, Japanese)	18	0.31%
Crataegus spp. (hawthorn, spp.)	18	0.31%
Pinus nigra (pine, Austrian)	15	0.26%
Picea glauca (spruce, white)	15	0.26%
Rhamnus spp. (buckthorn, spp.)	14	0.24%
Morus rubra (mulberry, red)	14	0.24%
Pinus strobus (pine, eastern white)	13	0.23%
Carya laciniosa (hickory, shellbark)	13	0.23%
Betula nigra (birch, river)	13	0.23%
Amelanchier spp. (serviceberry, spp.)	13	0.23%
Tilia tomentosa (linden, silver)	12	0.21%
Thuja occidentalis (arborvitae, eastern)	12	0.21%
Ginkgo biloba (ginkgo)	12	0.21%
Carya ovata (hickory, shagbark)	10	0.17%
Malus pumila (apple, common)	9	0.16%
Aesculus hippocastanum (horsechestnut)	9	0.16%
Syringa spp. (lilac, spp.)	8	0.14%
Carya tomentosa (hickory, mockernut)	8	0.14%
Prunus serrulata (cherry, Japanese flowering)	7	0.12%
Juniperus virginiana (redcedar, eastern)	7	0.12%
Gleditsia triacanthos (honeylocust)	7	0.12%
Quercus macrocarpa (oak, bur)	6	0.10%
Acer campestre (maple, hedge)	6	0.10%
unknown tree (unknown tree)	5	0.09%
Cladrastis kentukea (yellowwood)	5	0.09%
Salix babylonica (willow, weeping)	4	0.07%
Cornus florida (dogwood, flowering)	4	0.07%
Acer palmatum (maple, Japanese)	4	0.07%
Quercus velutina (oak, black)	3	0.05%
Quercus palustris (oak, pin)	3	0.05%
Pseudotsuga menziesii (douglas-fir)	3	0.05%
Prunus cerasifera (plum, cherry)	3	0.05%
Paulownia tomentosa (royal paulownia)	3	0.05%
Amelanchier arborea (serviceberry, downy)	3	0.05%
Salix matsudana (willow, corkscrew)	2	0.03%

Botanical	*Total*	*Percentage of Entire Population*
Salix discolor (willow, pussy)	2	0.03%
Quercus shumardii (oak, Shumard)	2	0.03%
Quercus robur (oak, English)	2	0.03%
Pyrus communis (pear, common)	2	0.03%
Prunus avium (cherry, sweet)	2	0.03%
Populus tremuloides (aspen, quaking)	2	0.03%
Populus alba (poplar, white)	2	0.03%
Magnolia x soulangiana (magnolia, saucer)	2	0.03%
Koelreuteria paniculata (goldenraintree)	2	0.03%
Fagus grandifolia (beech, American)	2	0.03%
Carya cordiformis (hickory, bitternut)	2	0.03%
Acer tataricum ginnala (maple, Amur)	2	0.03%
Ulmus parvifolia (elm, Chinese)	1	0.02%
Thuja plicata (arborvitae, western)	1	0.02%
Salix spp. (willow, spp.)	1	0.02%
Rhus spp. (sumac, spp.)	1	0.02%
Quercus imbricaria (oak, shingle)	1	0.02%
Quercus acutissima (oak, sawtooth)	1	0.02%
Pinus resinosa (pine, red)	1	0.02%
Pinus mugo (pine, mugo)	1	0.02%
Ostrya virginiana (hophornbeam, American)	1	0.02%
Metasequoia glyptostroboides (dawn redwood)	1	0.02%
Magnolia acuminata (magnolia, cucumbertree)	1	0.02%
Maclura pomifera (osage-orange)	1	0.02%
Juniperus spp. (juniper, spp.)	1	0.02%
Fagus sylvatica (beech, European)	1	0.02%
Cotinus coggygria (smoketree, American)	1	0.02%
Cornus racemosa (dogwood, gray)	1	0.02%
Cornus alternifolia (dogwood, pagoda)	1	0.02%
Carya glabra (hickory, pignut)	1	0.02%
Betula papyrifera (birch, paper)	1	0.02%
Amelanchier canadensis (serviceberry, shadblow)	1	0.02%
Abies concolor (fir, white)	1	0.02%
Grand Total	*5771*	*100%*

DAVEY

Ypsilanti, MI

Quantity Report: Common

Common	*Total*	*Percentage of Entire Population*
apple, common (Malus pumila)	9	0.16%
arborvitae spp. (Thuja spp.)	23	0.40%
arborvitae, eastern (Thuja occidentalis)	12	0.21%
arborvitae, western (Thuja plicata)	1	0.02%
ash, green (Fraxinus pennsylvanica)	45	0.78%
ash, white (Fraxinus americana)	24	0.42%
aspen, quaking (Populus tremuloides)	2	0.03%
beech, American (Fagus grandifolia)	2	0.03%
beech, European (Fagus sylvatica)	1	0.02%
birch, paper (Betula papyrifera)	1	0.02%
birch, river (Betula nigra)	13	0.23%
boxelder (Acer negundo)	64	1.11%
buckthorn, spp. (Rhamnus spp.)	14	0.24%
catalpa, northern (Catalpa speciosa)	25	0.43%
cherry, black (Prunus serotina)	20	0.35%
cherry, Japanese flowering (Prunus serrulata)	7	0.12%
cherry, sweet (Prunus avium)	2	0.03%
cherry/plum, spp. (Prunus spp.)	32	0.55%
cottonwood, eastern (Populus deltoides)	119	2.06%
crabapple, flowering (Malus spp.)	123	2.13%
dawn redwood (Metasequoia glyptostroboides)	1	0.02%
dogwood, flowering (Cornus florida)	4	0.07%
dogwood, gray (Cornus racemosa)	1	0.02%
dogwood, pagoda (Cornus alternifolia)	1	0.02%
douglas-fir (Pseudotsuga menziesii)	3	0.05%
elm, American (Ulmus americana)	71	1.23%
elm, Chinese (Ulmus parvifolia)	1	0.02%
elm, Siberian (Ulmus pumila)	185	3.21%
elm, slippery (Ulmus rubra)	20	0.35%
fir, white (Abies concolor)	1	0.02%
ginkgo (Ginkgo biloba)	12	0.21%
goldenraintree (Koelreuteria paniculata)	2	0.03%
hackberry, common (Celtis occidentalis)	22	0.38%
hawthorn, spp. (Crataegus spp.)	18	0.31%
hickory, bitternut (Carya cordiformis)	2	0.03%

Common	***Total***	***Percentage of Entire Population***
hickory, mockernut (Carya tomentosa)	8	0.14%
hickory, pignut (Carya glabra)	1	0.02%
hickory, shagbark (Carya ovata)	10	0.17%
hickory, shellbark (Carya laciniosa)	13	0.23%
honeylocust (Gleditsia triacanthos)	7	0.12%
honeylocust, thornless (Gleditsia triacanthos inermis)	464	8.04%
hophornbeam, American (Ostrya virginiana)	1	0.02%
horsechestnut (Aesculus hippocastanum)	9	0.16%
juniper, spp. (Juniperus spp.)	1	0.02%
lilac, spp. (Syringa spp.)	8	0.14%
linden, American (Tilia americana)	43	0.75%
linden, littleleaf (Tilia cordata)	207	3.59%
linden, silver (Tilia tomentosa)	12	0.21%
locust, black (Robinia pseudoacacia)	58	1.01%
magnolia, cucumbertree (Magnolia acuminata)	1	0.02%
magnolia, saucer (Magnolia x soulangiana)	2	0.03%
maple, Amur (Acer tataricum ginnala)	2	0.03%
maple, black (Acer nigrum)	25	0.43%
maple, Freeman (Acer x freemanii)	67	1.16%
maple, hedge (Acer campestre)	6	0.10%
maple, Japanese (Acer palmatum)	4	0.07%
maple, Norway (Acer platanoides)	1651	28.61%
maple, red (Acer rubrum)	220	3.81%
maple, silver (Acer saccharinum)	793	13.74%
maple, sugar (Acer saccharum)	353	6.12%
mulberry, red (Morus rubra)	14	0.24%
mulberry, white (Morus alba)	45	0.78%
oak, black (Quercus velutina)	3	0.05%
oak, bur (Quercus macrocarpa)	6	0.10%
oak, English (Quercus robur)	2	0.03%
oak, northern red (Quercus rubra)	61	1.06%
oak, pin (Quercus palustris)	3	0.05%
oak, sawtooth (Quercus acutissima)	1	0.02%
oak, shingle (Quercus imbricaria)	1	0.02%
oak, Shumard (Quercus shumardii)	2	0.03%
oak, swamp white (Quercus bicolor)	24	0.42%
oak, white (Quercus alba)	40	0.69%
osage-orange (Maclura pomifera)	1	0.02%

Common	Total	Percentage of Entire Population
pear, Callery (Pyrus calleryana)	178	3.08%
pear, common (Pyrus communis)	2	0.03%
pine, Austrian (Pinus nigra)	15	0.26%
pine, eastern white (Pinus strobus)	13	0.23%
pine, mugo (Pinus mugo)	1	0.02%
pine, red (Pinus resinosa)	1	0.02%
pine, Scotch (Pinus sylvestris)	36	0.62%
planetree, London (Platanus x acerifolia)	79	1.37%
plum, cherry (Prunus cerasifera)	3	0.05%
poplar, white (Populus alba)	2	0.03%
redbud, eastern (Cercis canadensis)	27	0.47%
redcedar, eastern (Juniperus virginiana)	7	0.12%
royal paulownia (Paulownia tomentosa)	3	0.05%
serviceberry, downy (Amelanchier arborea)	3	0.05%
serviceberry, shadblow (Amelanchier canadensis)	1	0.02%
serviceberry, spp. (Amelanchier spp.)	13	0.23%
smoketree, American (Cotinus coggygria)	1	0.02%
spruce, Colorado (Picea pungens)	46	0.80%
spruce, Norway (Picea abies)	20	0.35%
spruce, white (Picea glauca)	15	0.26%
sumac, spp. (Rhus spp.)	1	0.02%
sweetgum, American (Liquidambar styraciflua)	20	0.35%
sycamore, American (Platanus occidentalis)	42	0.73%
tree of heaven (Ailanthus altissima)	34	0.59%
tuliptree (Liriodendron tulipifera)	29	0.50%
unknown tree (unknown tree)	5	0.09%
walnut, black (Juglans nigra)	90	1.56%
willow, corkscrew (Salix matsudana)	2	0.03%
willow, pussy (Salix discolor)	2	0.03%
willow, spp. (Salix spp.)	1	0.02%
willow, weeping (Salix babylonica)	4	0.07%
yellowwood (Cladrastis kentukea)	5	0.09%
zelkova, Japanese (Zelkova serrata)	18	0.31%
Grand Total	*5771*	*100%*

Botanical	*Total*	*Percentage of Entire Population*
Abies concolor (fir, white)	1	0.02%
Acer campestre (maple, hedge)	6	0.10%
Acer negundo (boxelder)	64	1.11%
Acer nigrum (maple, black)	25	0.43%
Acer palmatum (maple, Japanese)	4	0.07%
Acer platanoides (maple, Norway)	1651	28.61%
Acer rubrum (maple, red)	220	3.81%
Acer saccharinum (maple, silver)	793	13.74%
Acer saccharum (maple, sugar)	353	6.12%
Acer tataricum ginnala (maple, Amur)	2	0.03%
Acer x freemanii (maple, Freeman)	67	1.16%
Aesculus hippocastanum (horsechestnut)	9	0.16%
Ailanthus altissima (tree of heaven)	34	0.59%
Amelanchier arborea (serviceberry, downy)	3	0.05%
Amelanchier canadensis (serviceberry, shadblow)	1	0.02%
Amelanchier spp. (serviceberry, spp.)	13	0.23%
Betula nigra (birch, river)	13	0.23%
Betula papyrifera (birch, paper)	1	0.02%
Carya cordiformis (hickory, bitternut)	2	0.03%
Carya glabra (hickory, pignut)	1	0.02%
Carya laciniosa (hickory, shellbark)	13	0.23%
Carya ovata (hickory, shagbark)	10	0.17%
Carya tomentosa (hickory, mockernut)	8	0.14%
Catalpa speciosa (catalpa, northern)	25	0.43%
Celtis occidentalis (hackberry, common)	22	0.38%
Cercis canadensis (redbud, eastern)	27	0.47%
Cladrastis kentukea (yellowwood)	5	0.09%
Cornus alternifolia (dogwood, pagoda)	1	0.02%
Cornus florida (dogwood, flowering)	4	0.07%
Cornus racemosa (dogwood, gray)	1	0.02%
Cotinus coggygria (smoketree, American)	1	0.02%
Crataegus spp. (hawthorn, spp.)	18	0.31%
Fagus grandifolia (beech, American)	2	0.03%
Fagus sylvatica (beech, European)	1	0.02%
Fraxinus americana (ash, white)	24	0.42%

Botanical	Total	Percentage of Entire Population
Fraxinus pennsylvanica (ash, green)	45	0.78%
Ginkgo biloba (ginkgo)	12	0.21%
Gleditsia triacanthos (honeylocust)	7	0.12%
Gleditsia triacanthos inermis (honeylocust, thornless)	464	8.04%
Juglans nigra (walnut, black)	90	1.56%
Juniperus spp. (juniper, spp.)	1	0.02%
Juniperus virginiana (redcedar, eastern)	7	0.12%
Koelreuteria paniculata (goldenraintree)	2	0.03%
Liquidambar styraciflua (sweetgum, American)	20	0.35%
Liriodendron tulipifera (tuliptree)	29	0.50%
Maclura pomifera (osage-orange)	1	0.02%
Magnolia acuminata (magnolia, cucumbertree)	1	0.02%
Magnolia x soulangiana (magnolia, saucer)	2	0.03%
Malus pumila (apple, common)	9	0.16%
Malus spp. (crabapple, flowering)	123	2.13%
Metasequoia glyptostroboides (dawn redwood)	1	0.02%
Morus alba (mulberry, white)	45	0.78%
Morus rubra (mulberry, red)	14	0.24%
Ostrya virginiana (hophornbeam, American)	1	0.02%
Paulownia tomentosa (royal paulownia)	3	0.05%
Picea abies (spruce, Norway)	20	0.35%
Picea glauca (spruce, white)	15	0.26%
Picea pungens (spruce, Colorado)	46	0.80%
Pinus mugo (pine, mugo)	1	0.02%
Pinus nigra (pine, Austrian)	15	0.26%
Pinus resinosa (pine, red)	1	0.02%
Pinus strobus (pine, eastern white)	13	0.23%
Pinus sylvestris (pine, Scotch)	36	0.62%
Platanus occidentalis (sycamore, American)	42	0.73%
Platanus x acerifolia (planetree, London)	79	1.37%
Populus alba (poplar, white)	2	0.03%
Populus deltoides (cottonwood, eastern)	119	2.06%
Populus tremuloides (aspen, quaking)	2	0.03%
Prunus avium (cherry, sweet)	2	0.03%
Prunus cerasifera (plum, cherry)	3	0.05%
Prunus serotina (cherry, black)	20	0.35%
Prunus serrulata (cherry, Japanese flowering)	7	0.12%
Prunus spp. (cherry/plum, spp.)	32	0.55%

Botanical	*Total*	*Percentage of Entire Population*
Pseudotsuga menziesii (douglas-fir)	3	0.05%
Pyrus calleryana (pear, Callery)	178	3.08%
Pyrus communis (pear, common)	2	0.03%
Quercus acutissima (oak, sawtooth)	1	0.02%
Quercus alba (oak, white)	40	0.69%
Quercus bicolor (oak, swamp white)	24	0.42%
Quercus imbricaria (oak, shingle)	1	0.02%
Quercus macrocarpa (oak, bur)	6	0.10%
Quercus palustris (oak, pin)	3	0.05%
Quercus robur (oak, English)	2	0.03%
Quercus rubra (oak, northern red)	61	1.06%
Quercus shumardii (oak, Shumard)	2	0.03%
Quercus velutina (oak, black)	3	0.05%
Rhamnus spp. (buckthorn, spp.)	14	0.24%
Rhus spp. (sumac, spp.)	1	0.02%
Robinia pseudoacacia (locust, black)	58	1.01%
Salix babylonica (willow, weeping)	4	0.07%
Salix discolor (willow, pussy)	2	0.03%
Salix matsudana (willow, corkscrew)	2	0.03%
Salix spp. (willow, spp.)	1	0.02%
Syringa spp. (lilac, spp.)	8	0.14%
Thuja occidentalis (arborvitae, eastern)	12	0.21%
Thuja plicata (arborvitae, western)	1	0.02%
Thuja spp. (arborvitae spp.)	23	0.40%
Tilia americana (linden, American)	43	0.75%
Tilia cordata (linden, littleleaf)	207	3.59%
Tilia tomentosa (linden, silver)	12	0.21%
Ulmus americana (elm, American)	71	1.23%
Ulmus parvifolia (elm, Chinese)	1	0.02%
Ulmus pumila (elm, Siberian)	185	3.21%
Ulmus rubra (elm, slippery)	20	0.35%
unknown tree (unknown tree)	5	0.09%
Zelkova serrata (zelkova, Japanese)	18	0.31%
Grand Total	*5771*	*100%*

DAVEY

Ypsilanti, MI

Quantity Report: Common

Common	*Total*	*Percentage of Entire Population*
stump (stump)	114	3.72%
vacant site, large (vacant site large)	1051	34.30%
vacant site, medium (vacant site medium)	415	13.54%
vacant site, small (vacant site small)	1484	48.43%
Grand Total	*3064*	*100%*

Common	*Total*	*Percent of Sub-Category Pop.*	*Percent of Entire Population*
1			
maple, Norway (Acer platanoides)	521	35.61%	9.03%
maple, silver (Acer saccharinum)	97	6.63%	1.68%
honeylocust, thornless (Gleditsia triacanthos inermis)	91	6.22%	1.58%
maple, sugar (Acer saccharum)	71	4.85%	1.23%
maple, red (Acer rubrum)	65	4.44%	1.13%
cottonwood, eastern (Populus deltoides)	64	4.37%	1.11%
linden, littleleaf (Tilia cordata)	49	3.35%	0.85%
pear, Callery (Pyrus calleryana)	42	2.87%	0.73%
crabapple, flowering (Malus spp.)	42	2.87%	0.73%
oak, northern red (Quercus rubra)	36	2.46%	0.62%
maple, Freeman (Acer x freemanii)	36	2.46%	0.62%
elm, American (Ulmus americana)	33	2.26%	0.57%
walnut, black (Juglans nigra)	28	1.91%	0.49%
locust, black (Robinia pseudoacacia)	24	1.64%	0.42%
ash, green (Fraxinus pennsylvanica)	22	1.50%	0.38%
spruce, Colorado (Picea pungens)	20	1.37%	0.35%
elm, Siberian (Ulmus pumila)	18	1.23%	0.31%
boxelder (Acer negundo)	17	1.16%	0.29%
hickory, shellbark (Carya laciniosa)	13	0.89%	0.23%
linden, American (Tilia americana)	12	0.82%	0.21%
planetree, London (Platanus x acerifolia)	11	0.75%	0.19%
oak, white (Quercus alba)	9	0.62%	0.16%
mulberry, white (Morus alba)	9	0.62%	0.16%
spruce, white (Picea glauca)	8	0.55%	0.14%
cherry, black (Prunus serotina)	8	0.55%	0.14%
sweetgum, American (Liquidambar styraciflua)	7	0.48%	0.12%
pine, Scotch (Pinus sylvestris)	7	0.48%	0.12%
pine, Austrian (Pinus nigra)	7	0.48%	0.12%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
hickory, mockernut (Carya tomentosa)	7	0.48%	0.12%
tuliptree (Liriodendron tulipifera)	6	0.41%	0.10%
spruce, Norway (Picea abies)	6	0.41%	0.10%
ginkgo (Ginkgo biloba)	6	0.41%	0.10%
redbud, eastern (Cercis canadensis)	5	0.34%	0.09%
sycamore, American (Platanus occidentalis)	4	0.27%	0.07%
pine, eastern white (Pinus strobus)	4	0.27%	0.07%
honeylocust (Gleditsia triacanthos)	4	0.27%	0.07%
zelkova, Japanese (Zelkova serrata)	3	0.21%	0.05%
yellowwood (Cladrastis kentukea)	3	0.21%	0.05%
serviceberry, spp. (Amelanchier spp.)	3	0.21%	0.05%
linden, silver (Tilia tomentosa)	3	0.21%	0.05%
hickory, shagbark (Carya ovata)	3	0.21%	0.05%
cherry/plum, spp. (Prunus spp.)	3	0.21%	0.05%
ash, white (Fraxinus americana)	3	0.21%	0.05%
apple, common (Malus pumila)	3	0.21%	0.05%
oak, bur (Quercus macrocarpa)	2	0.14%	0.03%
maple, black (Acer nigrum)	2	0.14%	0.03%
horsechestnut (Aesculus hippocastanum)	2	0.14%	0.03%
hickory, bitternut (Carya cordiformis)	2	0.14%	0.03%
douglas-fir (Pseudotsuga menziesii)	2	0.14%	0.03%
catalpa, northern (Catalpa speciosa)	2	0.14%	0.03%
arborvitae, eastern (Thuja occidentalis)	2	0.14%	0.03%
willow, corkscrew (Salix matsudana)	1	0.07%	0.02%
tree of heaven (Ailanthus altissima)	1	0.07%	0.02%
pine, mugo (Pinus mugo)	1	0.07%	0.02%
oak, swamp white (Quercus bicolor)	1	0.07%	0.02%
oak, pin (Quercus palustris)	1	0.07%	0.02%
oak, black (Quercus velutina)	1	0.07%	0.02%
maple, Japanese (Acer palmatum)	1	0.07%	0.02%
maple, Amur (Acer tataricum ginnala)	1	0.07%	0.02%
hickory, pignut (Carya glabra)	1	0.07%	0.02%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
hawthorn, spp. (Crataegus spp.)	1	0.07%	0.02%
elm, slippery (Ulmus rubra)	1	0.07%	0.02%
dogwood, flowering (Cornus florida)	1	0.07%	0.02%
birch, river (Betula nigra)	1	0.07%	0.02%
beech, European (Fagus sylvatica)	1	0.07%	0.02%
arborvitae, western (Thuja plicata)	1	0.07%	0.02%
arborvitae spp. (Thuja spp.)	1	0.07%	0.02%
Summary for 1 (67 items)			
Sum	*1463*	*100%*	*25.35%*
2			
maple, Norway (Acer platanoides)	407	25.05%	7.05%
maple, silver (Acer saccharinum)	316	19.45%	5.48%
honeylocust, thornless (Gleditsia triacanthos inermis)	124	7.63%	2.15%
maple, sugar (Acer saccharum)	73	4.49%	1.26%
maple, red (Acer rubrum)	65	4.00%	1.13%
linden, littleleaf (Tilia cordata)	54	3.32%	0.94%
pear, Callery (Pyrus calleryana)	53	3.26%	0.92%
crabapple, flowering (Malus spp.)	43	2.65%	0.75%
elm, Siberian (Ulmus pumila)	39	2.40%	0.68%
planetree, London (Platanus x acerifolia)	29	1.78%	0.50%
oak, white (Quercus alba)	26	1.60%	0.45%
pine, Scotch (Pinus sylvestris)	22	1.35%	0.38%
oak, swamp white (Quercus bicolor)	20	1.23%	0.35%
maple, Freeman (Acer x freemanii)	20	1.23%	0.35%
walnut, black (Juglans nigra)	17	1.05%	0.29%
cherry/plum, spp. (Prunus spp.)	17	1.05%	0.29%
sycamore, American (Platanus occidentalis)	16	0.98%	0.28%
redbud, eastern (Cercis canadensis)	16	0.98%	0.28%
oak, northern red (Quercus rubra)	15	0.92%	0.26%
buckthorn, spp. (Rhamnus spp.)	13	0.80%	0.23%
maple, black (Acer nigrum)	12	0.74%	0.21%
elm, American (Ulmus americana)	12	0.74%	0.21%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
linden, American (Tilia americana)	11	0.68%	0.19%
elm, slippery (Ulmus rubra)	11	0.68%	0.19%
tuliptree (Liriodendron tulipifera)	10	0.62%	0.17%
sweetgum, American (Liquidambar styraciflua)	10	0.62%	0.17%
spruce, Colorado (Picea pungens)	10	0.62%	0.17%
locust, black (Robinia pseudoacacia)	10	0.62%	0.17%
tree of heaven (Ailanthus altissima)	9	0.55%	0.16%
cottonwood, eastern (Populus deltoides)	9	0.55%	0.16%
cherry, black (Prunus serotina)	9	0.55%	0.16%
catalpa, northern (Catalpa speciosa)	9	0.55%	0.16%
birch, river (Betula nigra)	9	0.55%	0.16%
mulberry, white (Morus alba)	8	0.49%	0.14%
ash, white (Fraxinus americana)	8	0.49%	0.14%
boxelder (Acer negundo)	7	0.43%	0.12%
linden, silver (Tilia tomentosa)	6	0.37%	0.10%
cherry, Japanese flowering (Prunus serrulata)	6	0.37%	0.10%
spruce, white (Picea glauca)	5	0.31%	0.09%
spruce, Norway (Picea abies)	5	0.31%	0.09%
hickory, shagbark (Carya ovata)	5	0.31%	0.09%
zelkova, Japanese (Zelkova serrata)	4	0.25%	0.07%
pine, Austrian (Pinus nigra)	4	0.25%	0.07%
hawthorn, spp. (Crataegus spp.)	4	0.25%	0.07%
unknown tree (unknown tree)	3	0.18%	0.05%
serviceberry, downy (Amelanchier arborea)	3	0.18%	0.05%
redcedar, eastern (Juniperus virginiana)	3	0.18%	0.05%
pine, eastern white (Pinus strobus)	3	0.18%	0.05%
maple, hedge (Acer campestre)	3	0.18%	0.05%
oak, English (Quercus robur)	2	0.12%	0.03%
oak, bur (Quercus macrocarpa)	2	0.12%	0.03%
oak, black (Quercus velutina)	2	0.12%	0.03%
horsechestnut (Aesculus hippocastanum)	2	0.12%	0.03%
ginkgo (Ginkgo biloba)	2	0.12%	0.03%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
dogwood, flowering (Cornus florida)	2	0.12%	0.03%
cherry, sweet (Prunus avium)	2	0.12%	0.03%
arborvitae spp. (Thuja spp.)	2	0.12%	0.03%
willow, spp. (Salix spp.)	1	0.06%	0.02%
willow, pussy (Salix discolor)	1	0.06%	0.02%
willow, corkscrew (Salix matsudana)	1	0.06%	0.02%
smoketree, American (Cotinus coggygria)	1	0.06%	0.02%
serviceberry, spp. (Amelanchier spp.)	1	0.06%	0.02%
oak, sawtooth (Quercus acutissima)	1	0.06%	0.02%
oak, pin (Quercus palustris)	1	0.06%	0.02%
mulberry, red (Morus rubra)	1	0.06%	0.02%
maple, Japanese (Acer palmatum)	1	0.06%	0.02%
magnolia, saucer (Magnolia x soulangiana)	1	0.06%	0.02%
fir, white (Abies concolor)	1	0.06%	0.02%
douglas-fir (Pseudotsuga menziesii)	1	0.06%	0.02%
dawn redwood (Metasequoia glyptostroboides)	1	0.06%	0.02%
birch, paper (Betula papyrifera)	1	0.06%	0.02%
ash, green (Fraxinus pennsylvanica)	1	0.06%	0.02%
arborvitae, eastern (Thuja occidentalis)	1	0.06%	0.02%
Summary for 2 (73 items)			
Sum	*1625*	*100%*	*28.16%*
3			
maple, Norway (Acer platanoides)	299	25.71%	5.18%
maple, silver (Acer saccharinum)	181	15.56%	3.14%
maple, sugar (Acer saccharum)	152	13.07%	2.63%
honeylocust, thornless (Gleditsia triacanthos inermis)	63	5.42%	1.09%
maple, red (Acer rubrum)	47	4.04%	0.81%
pear, Callery (Pyrus calleryana)	42	3.61%	0.73%
linden, littleleaf (Tilia cordata)	41	3.53%	0.71%
elm, Siberian (Ulmus pumila)	38	3.27%	0.66%
cottonwood, eastern (Populus deltoides)	37	3.18%	0.64%
walnut, black (Juglans nigra)	28	2.41%	0.49%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
locust, black (Robinia pseudoacacia)	20	1.72%	0.35%
planetree, London (Platanus x acerifolia)	17	1.46%	0.29%
tree of heaven (Ailanthus altissima)	14	1.20%	0.24%
boxelder (Acer negundo)	13	1.12%	0.23%
linden, American (Tilia americana)	12	1.03%	0.21%
mulberry, red (Morus rubra)	11	0.95%	0.19%
crabapple, flowering (Malus spp.)	11	0.95%	0.19%
oak, northern red (Quercus rubra)	9	0.77%	0.16%
maple, black (Acer nigrum)	7	0.60%	0.12%
elm, American (Ulmus americana)	7	0.60%	0.12%
sycamore, American (Platanus occidentalis)	6	0.52%	0.10%
spruce, Norway (Picea abies)	6	0.52%	0.10%
elm, slippery (Ulmus rubra)	6	0.52%	0.10%
ash, green (Fraxinus pennsylvanica)	6	0.52%	0.10%
redbud, eastern (Cercis canadensis)	5	0.43%	0.09%
mulberry, white (Morus alba)	5	0.43%	0.09%
cherry/plum, spp. (Prunus spp.)	5	0.43%	0.09%
ash, white (Fraxinus americana)	5	0.43%	0.09%
oak, white (Quercus alba)	4	0.34%	0.07%
hackberry, common (Celtis occidentalis)	4	0.34%	0.07%
zelkova, Japanese (Zelkova serrata)	3	0.26%	0.05%
royal paulownia (Paulownia tomentosa)	3	0.26%	0.05%
redcedar, eastern (Juniperus virginiana)	3	0.26%	0.05%
horsechestnut (Aesculus hippocastanum)	3	0.26%	0.05%
cherry, black (Prunus serotina)	3	0.26%	0.05%
catalpa, northern (Catalpa speciosa)	3	0.26%	0.05%
birch, river (Betula nigra)	3	0.26%	0.05%
willow, weeping (Salix babylonica)	2	0.17%	0.03%
spruce, Colorado (Picea pungens)	2	0.17%	0.03%
pine, Austrian (Pinus nigra)	2	0.17%	0.03%
oak, swamp white (Quercus bicolor)	2	0.17%	0.03%
maple, hedge (Acer campestre)	2	0.17%	0.03%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
maple, Freeman (Acer x freemanii)	2	0.17%	0.03%
linden, silver (Tilia tomentosa)	2	0.17%	0.03%
beech, American (Fagus grandifolia)	2	0.17%	0.03%
aspen, quaking (Populus tremuloides)	2	0.17%	0.03%
apple, common (Malus pumila)	2	0.17%	0.03%
willow, pussy (Salix discolor)	1	0.09%	0.02%
tuliptree (Liriodendron tulipifera)	1	0.09%	0.02%
sweetgum, American (Liquidambar styraciflua)	1	0.09%	0.02%
sumac, spp. (Rhus spp.)	1	0.09%	0.02%
spruce, white (Picea glauca)	1	0.09%	0.02%
pine, Scotch (Pinus sylvestris)	1	0.09%	0.02%
pine, red (Pinus resinosa)	1	0.09%	0.02%
osage-orange (Maclura pomifera)	1	0.09%	0.02%
oak, shingle (Quercus imbricaria)	1	0.09%	0.02%
magnolia, saucer (Magnolia x soulangiana)	1	0.09%	0.02%
hophornbeam, American (Ostrya virginiana)	1	0.09%	0.02%
honeylocust (Gleditsia triacanthos)	1	0.09%	0.02%
hickory, shagbark (Carya ovata)	1	0.09%	0.02%
hickory, mockernut (Carya tomentosa)	1	0.09%	0.02%
goldenraintree (Koelreuteria paniculata)	1	0.09%	0.02%
ginkgo (Ginkgo biloba)	1	0.09%	0.02%
elm, Chinese (Ulmus parvifolia)	1	0.09%	0.02%
dogwood, gray (Cornus racemosa)	1	0.09%	0.02%
dogwood, flowering (Cornus florida)	1	0.09%	0.02%
buckthorn, spp. (Rhamnus spp.)	1	0.09%	0.02%
arborvitae, eastern (Thuja occidentalis)	1	0.09%	0.02%
Summary for 3 (68 items)			
Sum	*1163*	*100%*	*20.15%*
4			
maple, Norway (Acer platanoides)	228	28.64%	3.95%
honeylocust, thornless (Gleditsia triacanthos inermis)	121	15.20%	2.10%
maple, silver (Acer saccharinum)	118	14.82%	2.04%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
elm, Siberian (Ulmus pumila)	57	7.16%	0.99%
pear, Callery (Pyrus calleryana)	21	2.64%	0.36%
maple, sugar (Acer saccharum)	21	2.64%	0.36%
linden, littleleaf (Tilia cordata)	21	2.64%	0.36%
maple, red (Acer rubrum)	20	2.51%	0.35%
hackberry, common (Celtis occidentalis)	15	1.88%	0.26%
crabapple, flowering (Malus spp.)	15	1.88%	0.26%
tree of heaven (Ailanthus altissima)	10	1.26%	0.17%
planetree, London (Platanus x acerifolia)	10	1.26%	0.17%
mulberry, white (Morus alba)	10	1.26%	0.17%
elm, American (Ulmus americana)	10	1.26%	0.17%
spruce, Colorado (Picea pungens)	9	1.13%	0.16%
walnut, black (Juglans nigra)	8	1.01%	0.14%
maple, Freeman (Acer x freemanii)	8	1.01%	0.14%
ash, green (Fraxinus pennsylvanica)	8	1.01%	0.14%
boxelder (Acer negundo)	7	0.88%	0.12%
cottonwood, eastern (Populus deltoides)	6	0.75%	0.10%
zelkova, Japanese (Zelkova serrata)	5	0.63%	0.09%
sycamore, American (Platanus occidentalis)	5	0.63%	0.09%
cherry/plum, spp. (Prunus spp.)	5	0.63%	0.09%
catalpa, northern (Catalpa speciosa)	5	0.63%	0.09%
ash, white (Fraxinus americana)	5	0.63%	0.09%
tuliptree (Liriodendron tulipifera)	4	0.50%	0.07%
serviceberry, spp. (Amelanchier spp.)	4	0.50%	0.07%
locust, black (Robinia pseudoacacia)	4	0.50%	0.07%
plum, cherry (Prunus cerasifera)	3	0.38%	0.05%
linden, American (Tilia americana)	3	0.38%	0.05%
ginkgo (Ginkgo biloba)	3	0.38%	0.05%
willow, weeping (Salix babylonica)	2	0.25%	0.03%
unknown tree (unknown tree)	2	0.25%	0.03%
spruce, Norway (Picea abies)	2	0.25%	0.03%
oak, bur (Quercus macrocarpa)	2	0.25%	0.03%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
mulberry, red (Morus rubra)	2	0.25%	0.03%
horsechestnut (Aesculus hippocastanum)	2	0.25%	0.03%
honeylocust (Gleditsia triacanthos)	2	0.25%	0.03%
elm, slippery (Ulmus rubra)	2	0.25%	0.03%
yellowwood (Cladrastis kentukea)	1	0.13%	0.02%
sweetgum, American (Liquidambar styraciflua)	1	0.13%	0.02%
redcedar, eastern (Juniperus virginiana)	1	0.13%	0.02%
poplar, white (Populus alba)	1	0.13%	0.02%
pear, common (Pyrus communis)	1	0.13%	0.02%
oak, Shumard (Quercus shumardii)	1	0.13%	0.02%
maple, Japanese (Acer palmatum)	1	0.13%	0.02%
maple, black (Acer nigrum)	1	0.13%	0.02%
hickory, shagbark (Carya ovata)	1	0.13%	0.02%
hawthorn, spp. (Crataegus spp.)	1	0.13%	0.02%
dogwood, pagoda (Cornus alternifolia)	1	0.13%	0.02%
Summary for 4 (50 items)			
Sum	*796*	*100%*	*13.79%*
5			
maple, Norway (Acer platanoides)	196	27.07%	3.40%
maple, silver (Acer saccharinum)	81	11.19%	1.40%
honeylocust, thornless (Gleditsia triacanthos inermis)	65	8.98%	1.13%
linden, littleleaf (Tilia cordata)	42	5.80%	0.73%
maple, sugar (Acer saccharum)	36	4.97%	0.62%
elm, Siberian (Ulmus pumila)	33	4.56%	0.57%
maple, red (Acer rubrum)	23	3.18%	0.40%
pear, Callery (Pyrus calleryana)	20	2.76%	0.35%
boxelder (Acer negundo)	20	2.76%	0.35%
arborvitae spp. (Thuja spp.)	20	2.76%	0.35%
mulberry, white (Morus alba)	13	1.80%	0.23%
planetree, London (Platanus x acerifolia)	12	1.66%	0.21%
hawthorn, spp. (Crataegus spp.)	12	1.66%	0.21%
crabapple, flowering (Malus spp.)	12	1.66%	0.21%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
sycamore, American (Platanus occidentalis)	11	1.52%	0.19%
walnut, black (Juglans nigra)	9	1.24%	0.16%
elm, American (Ulmus americana)	9	1.24%	0.16%
tuliptree (Liriodendron tulipifera)	8	1.10%	0.14%
lilac, spp. (Syringa spp.)	8	1.10%	0.14%
ash, green (Fraxinus pennsylvanica)	8	1.10%	0.14%
arborvitae, eastern (Thuja occidentalis)	8	1.10%	0.14%
pine, Scotch (Pinus sylvestris)	6	0.83%	0.10%
pine, eastern white (Pinus strobus)	6	0.83%	0.10%
catalpa, northern (Catalpa speciosa)	6	0.83%	0.10%
spruce, Colorado (Picea pungens)	5	0.69%	0.09%
serviceberry, spp. (Amelanchier spp.)	5	0.69%	0.09%
linden, American (Tilia americana)	5	0.69%	0.09%
apple, common (Malus pumila)	4	0.55%	0.07%
zelkova, Japanese (Zelkova serrata)	3	0.41%	0.05%
maple, black (Acer nigrum)	3	0.41%	0.05%
hackberry, common (Celtis occidentalis)	3	0.41%	0.05%
cottonwood, eastern (Populus deltoides)	3	0.41%	0.05%
ash, white (Fraxinus americana)	3	0.41%	0.05%
pine, Austrian (Pinus nigra)	2	0.28%	0.03%
cherry/plum, spp. (Prunus spp.)	2	0.28%	0.03%
yellowwood (Cladrastis kentukea)	1	0.14%	0.02%
sweetgum, American (Liquidambar styraciflua)	1	0.14%	0.02%
spruce, white (Picea glauca)	1	0.14%	0.02%
spruce, Norway (Picea abies)	1	0.14%	0.02%
serviceberry, shadblow (Amelanchier canadensis)	1	0.14%	0.02%
redbud, eastern (Cercis canadensis)	1	0.14%	0.02%
poplar, white (Populus alba)	1	0.14%	0.02%
pear, common (Pyrus communis)	1	0.14%	0.02%
oak, white (Quercus alba)	1	0.14%	0.02%
oak, swamp white (Quercus bicolor)	1	0.14%	0.02%
oak, Shumard (Quercus shumardii)	1	0.14%	0.02%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
oak, pin (Quercus palustris)	1	0.14%	0.02%
oak, northern red (Quercus rubra)	1	0.14%	0.02%
maple, Japanese (Acer palmatum)	1	0.14%	0.02%
maple, hedge (Acer campestre)	1	0.14%	0.02%
maple, Freeman (Acer x freemanii)	1	0.14%	0.02%
maple, Amur (Acer tataricum ginnala)	1	0.14%	0.02%
magnolia, cucumbertree (Magnolia acuminata)	1	0.14%	0.02%
linden, silver (Tilia tomentosa)	1	0.14%	0.02%
juniper, spp. (Juniperus spp.)	1	0.14%	0.02%
goldenraintree (Koelreuteria paniculata)	1	0.14%	0.02%
cherry, Japanese flowering (Prunus serrulata)	1	0.14%	0.02%
Summary for 5 (57 items)			
Sum	*724*	*100%*	*12.55%*
Grand Total	*5771*		

Botanical	Total	Percent of Sub-Category Pop.	Percent of Entire Population
1			
Acer platanoides (maple, Norway)	521	35.61%	9.03%
Acer saccharinum (maple, silver)	97	6.63%	1.68%
Gleditsia triacanthos inermis (honeylocust, thornless)	91	6.22%	1.58%
Acer saccharum (maple, sugar)	71	4.85%	1.23%
Acer rubrum (maple, red)	65	4.44%	1.13%
Populus deltoides (cottonwood, eastern)	64	4.37%	1.11%
Tilia cordata (linden, littleleaf)	49	3.35%	0.85%
Pyrus calleryana (pear, Callery)	42	2.87%	0.73%
Malus spp. (crabapple, flowering)	42	2.87%	0.73%
Quercus rubra (oak, northern red)	36	2.46%	0.62%
Acer x freemanii (maple, Freeman)	36	2.46%	0.62%
Ulmus americana (elm, American)	33	2.26%	0.57%
Juglans nigra (walnut, black)	28	1.91%	0.49%
Robinia pseudoacacia (locust, black)	24	1.64%	0.42%
Fraxinus pennsylvanica (ash, green)	22	1.50%	0.38%
Picea pungens (spruce, Colorado)	20	1.37%	0.35%
Ulmus pumila (elm, Siberian)	18	1.23%	0.31%
Acer negundo (boxelder)	17	1.16%	0.29%
Carya laciniosa (hickory, shellbark)	13	0.89%	0.23%
Tilia americana (linden, American)	12	0.82%	0.21%
Platanus x acerifolia (planetree, London)	11	0.75%	0.19%
Quercus alba (oak, white)	9	0.62%	0.16%
Morus alba (mulberry, white)	9	0.62%	0.16%
Prunus serotina (cherry, black)	8	0.55%	0.14%
Picea glauca (spruce, white)	8	0.55%	0.14%
Pinus sylvestris (pine, Scotch)	7	0.48%	0.12%
Pinus nigra (pine, Austrian)	7	0.48%	0.12%
Liquidambar styraciflua (sweetgum, American)	7	0.48%	0.12%

Botanical	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Carya tomentosa (hickory, mockernut)	7	0.48%	0.12%
Picea abies (spruce, Norway)	6	0.41%	0.10%
Liriodendron tulipifera (tuliptree)	6	0.41%	0.10%
Ginkgo biloba (ginkgo)	6	0.41%	0.10%
Cercis canadensis (redbud, eastern)	5	0.34%	0.09%
Platanus occidentalis (sycamore, American)	4	0.27%	0.07%
Pinus strobus (pine, eastern white)	4	0.27%	0.07%
Gleditsia triacanthos (honeylocust)	4	0.27%	0.07%
Zelkova serrata (zelkova, Japanese)	3	0.21%	0.05%
Tilia tomentosa (linden, silver)	3	0.21%	0.05%
Prunus spp. (cherry/plum, spp.)	3	0.21%	0.05%
Malus pumila (apple, common)	3	0.21%	0.05%
Fraxinus americana (ash, white)	3	0.21%	0.05%
Cladrastis kentukea (yellowwood)	3	0.21%	0.05%
Carya ovata (hickory, shagbark)	3	0.21%	0.05%
Amelanchier spp. (serviceberry, spp.)	3	0.21%	0.05%
Thuja occidentalis (arborvitae, eastern)	2	0.14%	0.03%
Quercus macrocarpa (oak, bur)	2	0.14%	0.03%
Pseudotsuga menziesii (douglas-fir)	2	0.14%	0.03%
Catalpa speciosa (catalpa, northern)	2	0.14%	0.03%
Carya cordiformis (hickory, bitternut)	2	0.14%	0.03%
Aesculus hippocastanum (horsechestnut)	2	0.14%	0.03%
Acer nigrum (maple, black)	2	0.14%	0.03%
Ulmus rubra (elm, slippery)	1	0.07%	0.02%
Thuja spp. (arborvitae spp.)	1	0.07%	0.02%
Thuja plicata (arborvitae, western)	1	0.07%	0.02%
Salix matsudana (willow, corkscrew)	1	0.07%	0.02%
Quercus velutina (oak, black)	1	0.07%	0.02%
Quercus palustris (oak, pin)	1	0.07%	0.02%
Quercus bicolor (oak, swamp white)	1	0.07%	0.02%
Pinus mugo (pine, mugo)	1	0.07%	0.02%
Fagus sylvatica (beech, European)	1	0.07%	0.02%

Botanical	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Crataegus spp. (hawthorn, spp.)	1	0.07%	0.02%
Cornus florida (dogwood, flowering)	1	0.07%	0.02%
Carya glabra (hickory, pignut)	1	0.07%	0.02%
Betula nigra (birch, river)	1	0.07%	0.02%
Ailanthus altissima (tree of heaven)	1	0.07%	0.02%
Acer tataricum ginnala (maple, Amur)	1	0.07%	0.02%
Acer palmatum (maple, Japanese)	1	0.07%	0.02%
Summary for 1 (67 items)			
Sum	*1463*	*100%*	*25.35%*
2			
Acer platanoides (maple, Norway)	407	25.05%	7.05%
Acer saccharinum (maple, silver)	316	19.45%	5.48%
Gleditsia triacanthos inermis (honeylocust, thornless)	124	7.63%	2.15%
Acer saccharum (maple, sugar)	73	4.49%	1.26%
Acer rubrum (maple, red)	65	4.00%	1.13%
Tilia cordata (linden, littleleaf)	54	3.32%	0.94%
Pyrus calleryana (pear, Callery)	53	3.26%	0.92%
Malus spp. (crabapple, flowering)	43	2.65%	0.75%
Ulmus pumila (elm, Siberian)	39	2.40%	0.68%
Platanus x acerifolia (planetree, London)	29	1.78%	0.50%
Quercus alba (oak, white)	26	1.60%	0.45%
Pinus sylvestris (pine, Scotch)	22	1.35%	0.38%
Quercus bicolor (oak, swamp white)	20	1.23%	0.35%
Acer x freemanii (maple, Freeman)	20	1.23%	0.35%
Prunus spp. (cherry/plum, spp.)	17	1.05%	0.29%
Juglans nigra (walnut, black)	17	1.05%	0.29%
Platanus occidentalis (sycamore, American)	16	0.98%	0.28%
Cercis canadensis (redbud, eastern)	16	0.98%	0.28%
Quercus rubra (oak, northern red)	15	0.92%	0.26%
Rhamnus spp. (buckthorn, spp.)	13	0.80%	0.23%
Ulmus americana (elm, American)	12	0.74%	0.21%
Acer nigrum (maple, black)	12	0.74%	0.21%

Botanical	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Ulmus rubra (elm, slippery)	11	0.68%	0.19%
Tilia americana (linden, American)	11	0.68%	0.19%
Robinia pseudoacacia (locust, black)	10	0.62%	0.17%
Picea pungens (spruce, Colorado)	10	0.62%	0.17%
Liriodendron tulipifera (tuliptree)	10	0.62%	0.17%
Liquidambar styraciflua (sweetgum, American)	10	0.62%	0.17%
Prunus serotina (cherry, black)	9	0.55%	0.16%
Populus deltoides (cottonwood, eastern)	9	0.55%	0.16%
Catalpa speciosa (catalpa, northern)	9	0.55%	0.16%
Betula nigra (birch, river)	9	0.55%	0.16%
Ailanthus altissima (tree of heaven)	9	0.55%	0.16%
Morus alba (mulberry, white)	8	0.49%	0.14%
Fraxinus americana (ash, white)	8	0.49%	0.14%
Acer negundo (boxelder)	7	0.43%	0.12%
Tilia tomentosa (linden, silver)	6	0.37%	0.10%
Prunus serrulata (cherry, Japanese flowering)	6	0.37%	0.10%
Picea glauca (spruce, white)	5	0.31%	0.09%
Picea abies (spruce, Norway)	5	0.31%	0.09%
Carya ovata (hickory, shagbark)	5	0.31%	0.09%
Zelkova serrata (zelkova, Japanese)	4	0.25%	0.07%
Pinus nigra (pine, Austrian)	4	0.25%	0.07%
Crataegus spp. (hawthorn, spp.)	4	0.25%	0.07%
unknown tree (unknown tree)	3	0.18%	0.05%
Pinus strobus (pine, eastern white)	3	0.18%	0.05%
Juniperus virginiana (redcedar, eastern)	3	0.18%	0.05%
Amelanchier arborea (serviceberry, downy)	3	0.18%	0.05%
Acer campestre (maple, hedge)	3	0.18%	0.05%
Thuja spp. (arborvitae spp.)	2	0.12%	0.03%
Quercus velutina (oak, black)	2	0.12%	0.03%
Quercus robur (oak, English)	2	0.12%	0.03%
Quercus macrocarpa (oak, bur)	2	0.12%	0.03%
Prunus avium (cherry, sweet)	2	0.12%	0.03%

Botanical	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Ginkgo biloba (ginkgo)	2	0.12%	0.03%
Cornus florida (dogwood, flowering)	2	0.12%	0.03%
Aesculus hippocastanum (horsechestnut)	2	0.12%	0.03%
Thuja occidentalis (arborvitae, eastern)	1	0.06%	0.02%
Salix spp. (willow, spp.)	1	0.06%	0.02%
Salix matsudana (willow, corkscrew)	1	0.06%	0.02%
Salix discolor (willow, pussy)	1	0.06%	0.02%
Quercus palustris (oak, pin)	1	0.06%	0.02%
Quercus acutissima (oak, sawtooth)	1	0.06%	0.02%
Pseudotsuga menziesii (douglas-fir)	1	0.06%	0.02%
Morus rubra (mulberry, red)	1	0.06%	0.02%
Metasequoia glyptostroboides (dawn redwood)	1	0.06%	0.02%
Magnolia x soulangiana (magnolia, saucer)	1	0.06%	0.02%
Fraxinus pennsylvanica (ash, green)	1	0.06%	0.02%
Cotinus coggygria (smoketree, American)	1	0.06%	0.02%
Betula papyrifera (birch, paper)	1	0.06%	0.02%
Amelanchier spp. (serviceberry, spp.)	1	0.06%	0.02%
Acer palmatum (maple, Japanese)	1	0.06%	0.02%
Abies concolor (fir, white)	1	0.06%	0.02%
Summary for 2 (73 items)			
Sum	*1625*	*100%*	*28.16%*
3			
Acer platanoides (maple, Norway)	299	25.71%	5.18%
Acer saccharinum (maple, silver)	181	15.56%	3.14%
Acer saccharum (maple, sugar)	152	13.07%	2.63%
Gleditsia triacanthos inermis (honeylocust, thornless)	63	5.42%	1.09%
Acer rubrum (maple, red)	47	4.04%	0.81%
Pyrus calleryana (pear, Callery)	42	3.61%	0.73%
Tilia cordata (linden, littleleaf)	41	3.53%	0.71%
Ulmus pumila (elm, Siberian)	38	3.27%	0.66%
Populus deltoides (cottonwood, eastern)	37	3.18%	0.64%
Juglans nigra (walnut, black)	28	2.41%	0.49%

Botanical	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Robinia pseudoacacia (locust, black)	20	1.72%	0.35%
Platanus x acerifolia (planetree, London)	17	1.46%	0.29%
Ailanthus altissima (tree of heaven)	14	1.20%	0.24%
Acer negundo (boxelder)	13	1.12%	0.23%
Tilia americana (linden, American)	12	1.03%	0.21%
Morus rubra (mulberry, red)	11	0.95%	0.19%
Malus spp. (crabapple, flowering)	11	0.95%	0.19%
Quercus rubra (oak, northern red)	9	0.77%	0.16%
Ulmus americana (elm, American)	7	0.60%	0.12%
Acer nigrum (maple, black)	7	0.60%	0.12%
Ulmus rubra (elm, slippery)	6	0.52%	0.10%
Platanus occidentalis (sycamore, American)	6	0.52%	0.10%
Picea abies (spruce, Norway)	6	0.52%	0.10%
Fraxinus pennsylvanica (ash, green)	6	0.52%	0.10%
Prunus spp. (cherry/plum, spp.)	5	0.43%	0.09%
Morus alba (mulberry, white)	5	0.43%	0.09%
Fraxinus americana (ash, white)	5	0.43%	0.09%
Cercis canadensis (redbud, eastern)	5	0.43%	0.09%
Quercus alba (oak, white)	4	0.34%	0.07%
Celtis occidentalis (hackberry, common)	4	0.34%	0.07%
Zelkova serrata (zelkova, Japanese)	3	0.26%	0.05%
Prunus serotina (cherry, black)	3	0.26%	0.05%
Paulownia tomentosa (royal paulownia)	3	0.26%	0.05%
Juniperus virginiana (redcedar, eastern)	3	0.26%	0.05%
Catalpa speciosa (catalpa, northern)	3	0.26%	0.05%
Betula nigra (birch, river)	3	0.26%	0.05%
Aesculus hippocastanum (horsechestnut)	3	0.26%	0.05%
Tilia tomentosa (linden, silver)	2	0.17%	0.03%
Salix babylonica (willow, weeping)	2	0.17%	0.03%
Quercus bicolor (oak, swamp white)	2	0.17%	0.03%
Populus tremuloides (aspen, quaking)	2	0.17%	0.03%
Pinus nigra (pine, Austrian)	2	0.17%	0.03%

Botanical	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Picea pungens (spruce, Colorado)	2	0.17%	0.03%
Malus pumila (apple, common)	2	0.17%	0.03%
Fagus grandifolia (beech, American)	2	0.17%	0.03%
Acer x freemanii (maple, Freeman)	2	0.17%	0.03%
Acer campestre (maple, hedge)	2	0.17%	0.03%
Ulmus parvifolia (elm, Chinese)	1	0.09%	0.02%
Thuja occidentalis (arborvitae, eastern)	1	0.09%	0.02%
Salix discolor (willow, pussy)	1	0.09%	0.02%
Rhus spp. (sumac, spp.)	1	0.09%	0.02%
Rhamnus spp. (buckthorn, spp.)	1	0.09%	0.02%
Quercus imbricaria (oak, shingle)	1	0.09%	0.02%
Pinus sylvestris (pine, Scotch)	1	0.09%	0.02%
Pinus resinosa (pine, red)	1	0.09%	0.02%
Picea glauca (spruce, white)	1	0.09%	0.02%
Ostrya virginiana (hophornbeam, American)	1	0.09%	0.02%
Magnolia x soulangiana (magnolia, saucer)	1	0.09%	0.02%
Maclura pomifera (osage-orange)	1	0.09%	0.02%
Liriodendron tulipifera (tuliptree)	1	0.09%	0.02%
Liquidambar styraciflua (sweetgum, American)	1	0.09%	0.02%
Koelreuteria paniculata (goldenraintree)	1	0.09%	0.02%
Gleditsia triacanthos (honeylocust)	1	0.09%	0.02%
Ginkgo biloba (ginkgo)	1	0.09%	0.02%
Cornus racemosa (dogwood, gray)	1	0.09%	0.02%
Cornus florida (dogwood, flowering)	1	0.09%	0.02%
Carya tomentosa (hickory, mockernut)	1	0.09%	0.02%
Carya ovata (hickory, shagbark)	1	0.09%	0.02%
Summary for 3 (68 items)			
Sum	*1163*	*100%*	*20.15%*
4			
Acer platanoides (maple, Norway)	228	28.64%	3.95%
Gleditsia triacanthos inermis (honeylocust, thornless)	121	15.20%	2.10%
Acer saccharinum (maple, silver)	118	14.82%	2.04%

Botanical	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Ulmus pumila (elm, Siberian)	57	7.16%	0.99%
Tilia cordata (linden, littleleaf)	21	2.64%	0.36%
Pyrus calleryana (pear, Callery)	21	2.64%	0.36%
Acer saccharum (maple, sugar)	21	2.64%	0.36%
Acer rubrum (maple, red)	20	2.51%	0.35%
Malus spp. (crabapple, flowering)	15	1.88%	0.26%
Celtis occidentalis (hackberry, common)	15	1.88%	0.26%
Ulmus americana (elm, American)	10	1.26%	0.17%
Platanus x acerifolia (planetree, London)	10	1.26%	0.17%
Morus alba (mulberry, white)	10	1.26%	0.17%
Ailanthus altissima (tree of heaven)	10	1.26%	0.17%
Picea pungens (spruce, Colorado)	9	1.13%	0.16%
Juglans nigra (walnut, black)	8	1.01%	0.14%
Fraxinus pennsylvanica (ash, green)	8	1.01%	0.14%
Acer x freemanii (maple, Freeman)	8	1.01%	0.14%
Acer negundo (boxelder)	7	0.88%	0.12%
Populus deltoides (cottonwood, eastern)	6	0.75%	0.10%
Zelkova serrata (zelkova, Japanese)	5	0.63%	0.09%
Prunus spp. (cherry/plum, spp.)	5	0.63%	0.09%
Platanus occidentalis (sycamore, American)	5	0.63%	0.09%
Fraxinus americana (ash, white)	5	0.63%	0.09%
Catalpa speciosa (catalpa, northern)	5	0.63%	0.09%
Robinia pseudoacacia (locust, black)	4	0.50%	0.07%
Liriodendron tulipifera (tuliptree)	4	0.50%	0.07%
Amelanchier spp. (serviceberry, spp.)	4	0.50%	0.07%
Tilia americana (linden, American)	3	0.38%	0.05%
Prunus cerasifera (plum, cherry)	3	0.38%	0.05%
Ginkgo biloba (ginkgo)	3	0.38%	0.05%
unknown tree (unknown tree)	2	0.25%	0.03%
Ulmus rubra (elm, slippery)	2	0.25%	0.03%
Salix babylonica (willow, weeping)	2	0.25%	0.03%
Quercus macrocarpa (oak, bur)	2	0.25%	0.03%

Botanical	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Picea abies (spruce, Norway)	2	0.25%	0.03%
Morus rubra (mulberry, red)	2	0.25%	0.03%
Gleditsia triacanthos (honeylocust)	2	0.25%	0.03%
Aesculus hippocastanum (horsechestnut)	2	0.25%	0.03%
Quercus shumardii (oak, Shumard)	1	0.13%	0.02%
Pyrus communis (pear, common)	1	0.13%	0.02%
Populus alba (poplar, white)	1	0.13%	0.02%
Liquidambar styraciflua (sweetgum, American)	1	0.13%	0.02%
Juniperus virginiana (redcedar, eastern)	1	0.13%	0.02%
Crataegus spp. (hawthorn, spp.)	1	0.13%	0.02%
Cornus alternifolia (dogwood, pagoda)	1	0.13%	0.02%
Cladrastis kentukea (yellowwood)	1	0.13%	0.02%
Carya ovata (hickory, shagbark)	1	0.13%	0.02%
Acer palmatum (maple, Japanese)	1	0.13%	0.02%
Acer nigrum (maple, black)	1	0.13%	0.02%
Summary for 4 (50 items)			
Sum	*796*	*100%*	*13.79%*
5			
Acer platanoides (maple, Norway)	196	27.07%	3.40%
Acer saccharinum (maple, silver)	81	11.19%	1.40%
Gleditsia triacanthos inermis (honeylocust, thornless)	65	8.98%	1.13%
Tilia cordata (linden, littleleaf)	42	5.80%	0.73%
Acer saccharum (maple, sugar)	36	4.97%	0.62%
Ulmus pumila (elm, Siberian)	33	4.56%	0.57%
Acer rubrum (maple, red)	23	3.18%	0.40%
Thuja spp. (arborvitae spp.)	20	2.76%	0.35%
Pyrus calleryana (pear, Callery)	20	2.76%	0.35%
Acer negundo (boxelder)	20	2.76%	0.35%
Morus alba (mulberry, white)	13	1.80%	0.23%
Platanus x acerifolia (planetree, London)	12	1.66%	0.21%
Malus spp. (crabapple, flowering)	12	1.66%	0.21%
Crataegus spp. (hawthorn, spp.)	12	1.66%	0.21%

Botanical	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Platanus occidentalis (sycamore, American)	11	1.52%	0.19%
Ulmus americana (elm, American)	9	1.24%	0.16%
Juglans nigra (walnut, black)	9	1.24%	0.16%
Thuja occidentalis (arborvitae, eastern)	8	1.10%	0.14%
Syringa spp. (lilac, spp.)	8	1.10%	0.14%
Liriodendron tulipifera (tuliptree)	8	1.10%	0.14%
Fraxinus pennsylvanica (ash, green)	8	1.10%	0.14%
Pinus sylvestris (pine, Scotch)	6	0.83%	0.10%
Pinus strobus (pine, eastern white)	6	0.83%	0.10%
Catalpa speciosa (catalpa, northern)	6	0.83%	0.10%
Tilia americana (linden, American)	5	0.69%	0.09%
Picea pungens (spruce, Colorado)	5	0.69%	0.09%
Amelanchier spp. (serviceberry, spp.)	5	0.69%	0.09%
Malus pumila (apple, common)	4	0.55%	0.07%
Zelkova serrata (zelkova, Japanese)	3	0.41%	0.05%
Populus deltoides (cottonwood, eastern)	3	0.41%	0.05%
Fraxinus americana (ash, white)	3	0.41%	0.05%
Celtis occidentalis (hackberry, common)	3	0.41%	0.05%
Acer nigrum (maple, black)	3	0.41%	0.05%
Prunus spp. (cherry/plum, spp.)	2	0.28%	0.03%
Pinus nigra (pine, Austrian)	2	0.28%	0.03%
Tilia tomentosa (linden, silver)	1	0.14%	0.02%
Quercus shumardii (oak, Shumard)	1	0.14%	0.02%
Quercus rubra (oak, northern red)	1	0.14%	0.02%
Quercus palustris (oak, pin)	1	0.14%	0.02%
Quercus bicolor (oak, swamp white)	1	0.14%	0.02%
Quercus alba (oak, white)	1	0.14%	0.02%
Pyrus communis (pear, common)	1	0.14%	0.02%
Prunus serrulata (cherry, Japanese flowering)	1	0.14%	0.02%
Populus alba (poplar, white)	1	0.14%	0.02%
Picea glauca (spruce, white)	1	0.14%	0.02%
Picea abies (spruce, Norway)	1	0.14%	0.02%

Botanical	*Total*	*Percent of Sub-Category Pop.*	*Percent of Entire Population*
Magnolia acuminata (magnolia, cucumbertree)	1	0.14%	0.02%
Liquidambar styraciflua (sweetgum, American)	1	0.14%	0.02%
Koelreuteria paniculata (goldenraintree)	1	0.14%	0.02%
Juniperus spp. (juniper, spp.)	1	0.14%	0.02%
Cladrastis kentukea (yellowwood)	1	0.14%	0.02%
Cercis canadensis (redbud, eastern)	1	0.14%	0.02%
Amelanchier canadensis (serviceberry, shadblow)	1	0.14%	0.02%
Acer x freemanii (maple, Freeman)	1	0.14%	0.02%
Acer tataricum ginnala (maple, Amur)	1	0.14%	0.02%
Acer palmatum (maple, Japanese)	1	0.14%	0.02%
Acer campestre (maple, hedge)	1	0.14%	0.02%
Summary for 5 (57 items)			
Sum	*724*	*100%*	*12.55%*
Grand Total	*5771*		

Size Distribution

DAVEY

Ypsilanti, MI

Quantity Report: Diameter Class

Diameter Class	*Total*	*Percentage of Entire Population*
1 - 3	452	7.83%
4 - 6	629	10.90%
7 - 12	1106	19.16%
13 - 18	1413	24.48%
19 - 24	1098	19.03%
25 - 30	581	10.07%
31 - 36	283	4.90%
37 - 42	127	2.20%
43 +	82	1.42%
Grand Total	*5771*	*100%*

DAVEY

Ypsilanti, MI

Species/Diameter Frequency Matrix

Species	N/A	1 - 3	4 - 6	7 - 12	13 - 18	19 - 24	25 - 30	31 - 36	37 - 42	43 +	TOTAL
apple, common		2	3	3	1						9
arborvitae spp.		11	10	2							23
arborvitae, eastern		5	6	1							12
arborvitae, western		1									1
ash, green		6	15	18	3	2	1				45
ash, white			3	13	4	2	2				24
aspen, quaking				2							2
beech, American			1	1							2
beech, European									1		1
birch, paper				1							1
birch, river		10	1	2							13
boxelder		4	12	28	16	3			1		64
buckthorn, spp.			2	8	4						14
catalpa, northern		6	1	2	5	6	2	3			25
cherry, black		3		7	3	7					20
cherry, Japanese flowering				3	4						7
cherry, sweet		2									2
cherry/plum, spp.		12	9	9	1		1				32
cottonwood, eastern		2	2	16	38	20	17	9	4	11	119
crabapple, flowering		32	46	33	12						123
dawn redwood		1									1
dogwood, flowering		3	1								4

Species	N/A	1 - 3	4 - 6	7 - 12	13 - 18	19 - 24	25 - 30	31 - 36	37 - 42	43 +	TOTAL
dogwood, gray		1									1
dogwood, pagoda			1								1
douglas-fir			1	2							3
elm, American		8	4	27	12	7	5	5	3		71
elm, Chinese		1									1
elm, Siberian		26	28	45	28	21	16	13	5	3	185
elm, slippery		3		1	3	3	4	3	2	1	20
fir, white						1					1
ginkgo		4	3	3	1	1					12
goldenraintree				2							2
hackberry, common		4	3	6	2	1	3	1		2	22
hawthorn, spp.		6	8	3	1						18
hickory, bitternut					2						2
hickory, mockernut					2	4	2				8
hickory, pignut				1							1
hickory, shagbark					2	6	2				10
hickory, shellbark			3	5		2	2	1			13
honeylocust			1	4	1	1					7
honeylocust, thornless		20	66	106	150	91	27	2	2		464
hophornbeam, American					1						1
horsechestnut		1		1	2	3	2				9
juniper, spp.		1									1
lilac, spp.		4	4								8
linden, American		3	12	11	4	3	6	4			43

Species	N/A	1 - 3	4 - 6	7 - 12	13 - 18	19 - 24	25 - 30	31 - 36	37 - 42	43 +	TOTAL
linden, littleleaf		11	24	72	41	38	13	6	2		207
linden, silver			9	3							12
locust, black		3	2	22	23	5	1	1	1		58
magnolia, cucumbertree		1									1
magnolia, saucer		1	1								2
maple, Amur		2									2
maple, black		1		3	5	10	3	2		1	25
maple, Freeman		3	11	8	21	13	4	6	1		67
maple, hedge			1	2	1	2					6
maple, Japanese		4									4
maple, Norway		19	43	281	718	485	91	11	3		1651
maple, red		31	41	62	43	26	10	1	5	1	220
maple, silver		34	28	39	55	130	214	169	73	51	793
maple, sugar		11	5	25	80	129	78	19	3	3	353
mulberry, red		3		5	3		1		2		14
mulberry, white		9	8	12	8	3	1	2		2	45
oak, black		1		1			1				3
oak, bur		2			2				2		6
oak, English					1					1	2
oak, northern red		3	24	10	4	2	10	3	4	1	61
oak, pin			1		1	1					3
oak, sawtooth			1								1
oak, shingle				1							1
oak, Shumard				1					1		2

Species	*N/A*	*1 - 3*	*4 - 6*	*7 - 12*	*13 - 18*	*19 - 24*	*25 - 30*	*31 - 36*	*37 - 42*	*43 +*	*TOTAL*
oak, swamp white		4		2	1	4	9	2	1	1	24
oak, white		2	2	1	2	9	14	4	4	2	40
osage-orange							1				1
pear, Callery		37	89	42	8	1			1		178
pear, common		1	1								2
pine, Austrian			1	8	4	2					15
pine, eastern white			1	6	6						13
pine, mugo				1							1
pine, red			1								1
pine, Scotch			1	13	12	9	1				36
planetree, London		2	14	39	10	9	1	3		1	79
plum, cherry		1	2								3
poplar, white					1	1					2
redbud, eastern		11	9	7							27
redcedar, eastern		1		2	3	1					7
royal paulownia			3								3
serviceberry, downy		2	1								3
serviceberry, shadblow		1									1
serviceberry, spp.		11	1	1							13
smoketree, American			1								1
spruce, Colorado		8	13	10	12	3					46
spruce, Norway		3	1	5	4	5	2				20
spruce, white		6	4	2	2	1					15
stump		5	11	34	34	14	4	7	3	2	114

Species	N/A	1 - 3	4 - 6	7 - 12	13 - 18	19 - 24	25 - 30	31 - 36	37 - 42	43 +	TOTAL
sumac, spp.			1								1
sweetgum, American			3	9	4	3	1				20
sycamore, American		3	10	3	5	8	5	5	3		42
tree of heaven		3	5	7	4	4	9	1	1		34
tuliptree		15	5	5	3	1					29
unknown tree		3		1		1					5
vacant site, large	1051										1051
vacant site, medium	415										415
vacant site, small	1484										1484
walnut, black		2	4	27	22	7	19	7	1	1	90
willow, corkscrew		1			1						2
willow, pussy		1	1								2
willow, spp.									1		1
willow, weeping		2			1	1					4
yellowwood		5									5
zelkova, Japanese		6	10	2							18
Grand Total	2950	457	640	1140	1447	1112	585	290	130	84	8835

Relative Condition

DAVEY

Ypsilanti, MI

Quantity Report: Condition

Condition	*Total*	*Percentage of Entire Population*
Fair	3395	58.83%
Poor	1335	23.13%
Good	708	12.27%
Critical	194	3.36%
Dead	89	1.54%
Very Good	50	0.87%
Grand Total	*5771*	*100%*

Ypsilanti, MI

Species/Condition Frequency Matrix

Common Name	N/A	Dead	Critical	Poor	Fair	Good	Very Good	Excellent	TOTAL
apple, common					7		2		9
arborvitae spp.					19	4			23
arborvitae, eastern				1	9	1	1		12
arborvitae, western						1			1
ash, green		25	8	8	4				45
ash, white		10	8	4	2				24
aspen, quaking					2				2
beech, American						2			2
beech, European						1			1
birch, paper					1				1
birch, river			1	1	6	5			13
boxelder		8	5	18	32	1			64
buckthorn, spp.		1		10	3				14
catalpa, northern			3	8	12		2		25
cherry, black			1	8	8	3			20
cherry, Japanese flowering				5	2				7
cherry, sweet						2			2
cherry/plum, spp.		1	1	4	20	6			32
cottonwood, eastern		2	8	8	81	20			119
crabapple, flowering		1	2	18	65	37			123
dawn redwood							1		1
dogwood, flowering		1			2	1			4
dogwood, gray					1				1
dogwood, pagoda				1					1
douglas-fir					2	1			3
elm, American		8		5	51	7			71

Common Name	N/A	Dead	Critical	Poor	Fair	Good	Very Good	Excellent	TOTAL
elm, Chinese					1				1
elm, Siberian		6	2	49	124	4			185
elm, slippery				4	16				20
fir, white					1				1
ginkgo				1	4	5	2		12
goldenraintree					1	1			2
hackberry, common			2	5	13	2			22
hawthorn, spp.				2	15	1			18
hickory, bitternut						2			2
hickory, mockernut				2	3	3			8
hickory, pignut					1				1
hickory, shagbark		1			7	2			10
hickory, shellbark		1		1	7	4			13
honeylocust				1	5	1			7
honeylocust, thornless			1	32	365	66			464
hophornbeam, American					1				1
horsechestnut			1	2	5	1			9
juniper, spp.					1				1
lilac, spp.					7	1			8
linden, American			2	8	22	10	1		43
linden, littleleaf			7	31	131	38			207
linden, silver				1	9	2			12
locust, black		3	2	11	39	3			58
magnolia, cucumbertree					1				1
magnolia, saucer					1	1			2
maple, Amur					2				2
maple, black			1	9	13	2			25
maple, Freeman				8	40	19			67
maple, hedge				2	2	1	1		6
maple, Japanese					3	1			4

Common Name	N/A	Dead	Critical	Poor	Fair	Good	Very Good	Excellent	TOTAL
maple, Norway		4	68	485	1010	84			1651
maple, red		2	6	38	129	41	4		220
maple, silver		2	23	286	439	40	3		793
maple, sugar		1	26	145	163	16	2		353
mulberry, red			3	2	6	3			14
mulberry, white		2	4	23	16				45
oak, black					1	2			3
oak, bur				1	2	3			6
oak, English					1	1			2
oak, northern red			1	4	38	16	2		61
oak, pin					1	2			3
oak, sawtooth						1			1
oak, shingle						1			1
oak, Shumard			1		1				2
oak, swamp white				3	17	3	1		24
oak, white				7	26	7			40
osage-orange					1				1
pear, Callery			1	9	103	58	7		178
pear, common					2				2
pine, Austrian				3	8	4			15
pine, eastern white				2	5	6			13
pine, mugo							1		1
pine, red						1			1
pine, Scotch		1		3	24	8			36
planetree, London				2	28	39	10		79
plum, cherry				2	1				3
poplar, white				1	1				2
redbud, eastern			1		21	5			27
redcedar, eastern					6	1			7
royal paulownia					2	1			3

Common Name	N/A	Dead	Critical	Poor	Fair	Good	Very Good	Excellent	TOTAL
serviceberry, downy						3			3
serviceberry, shadblow						1			1
serviceberry, spp.				1	8	3	1		13
smoketree, American					1				1
spruce, Colorado					19	26	1		46
spruce, Norway				1	9	9	1		20
spruce, white				2	7	6			15
stump	114								114
sumac, spp.						1			1
sweetgum, American					10	5	5		20
sycamore, American			2	12	20	7	1		42
tree of heaven		2	2	19	9	2			34
tuliptree		1	1	1	15	10	1		29
unknown tree		5							5
vacant site, large	1051								1051
vacant site, medium	415								415
vacant site, small	1484								1484
walnut, black		1		10	63	16			90
willow, corkscrew					2				2
willow, pussy					1	1			2
willow, spp.				1					1
willow, weeping				3		1			4
yellowwood					2	3			5
zelkova, Japanese				1	8	9			18
Grand Total:	3064	89	194	1335	3395	708	50		8835

Condition	Total	Percent of Sub-Category Pop.	Percent of Entire Population
1			
Fair	857	58.58%	14.85%
Poor	292	19.96%	5.06%
Good	214	14.63%	3.71%
Dead	43	2.94%	0.75%
Critical	41	2.80%	0.71%
Very Good	16	1.09%	0.28%
Summary for 1 (6 items)			
Sum	*1463*	*100%*	*25.35%*
2			
Fair	954	58.71%	16.53%
Poor	412	25.35%	7.14%
Good	178	10.95%	3.08%
Critical	53	3.26%	0.92%
Dead	15	0.92%	0.26%
Very Good	13	0.80%	0.23%
Summary for 2 (6 items)			
Sum	*1625*	*100%*	*28.16%*
3			
Fair	721	61.99%	12.49%
Poor	256	22.01%	4.44%
Good	120	10.32%	2.08%
Critical	38	3.27%	0.66%
Very Good	17	1.46%	0.29%
Dead	11	0.95%	0.19%
Summary for 3 (6 items)			
Sum	*1163*	*100%*	*20.15%*
4			
Fair	432	54.27%	7.49%
Poor	186	23.37%	3.22%

Condition	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Good	129	16.21%	2.24%
Critical	32	4.02%	0.55%
Dead	17	2.14%	0.29%
Summary for 4 (5 items)			
Sum	*796*	*100%*	*13.79%*
5			
Fair	431	59.53%	7.47%
Poor	189	26.10%	3.27%
Good	67	9.25%	1.16%
Critical	30	4.14%	0.52%
Very Good	4	0.55%	0.07%
Dead	3	0.41%	0.05%
Summary for 5 (6 items)			
Sum	*724*	*100%*	*12.55%*
Grand Total	*5771*		

Maintenance Recommendations

DAVEY

Ypsilanti, MI

Quantity Report: Primary Maintenance

Primary Maintenance	*Total*	*Percentage of Entire Population*
Plant Tree	2950	33.39%
Large Tree Routine Prune	2729	30.89%
Priority 2 Prune	890	10.07%
Training Prune	823	9.32%
Priority 2 Removal	413	4.67%
Priority 1 Prune	351	3.97%
Priority 1 Removal	295	3.34%
Priority 3 Removal	170	1.92%
Stump Removal	114	1.29%
Small Tree Routine Prune	100	1.13%
Grand Total	*8835*	*100%*

DAVEY

Ypsilanti, MI

Primary Maintenance/DBH Class Matrix Report

Primary Maintenance	*N/A*	*1 - 3*	*4 - 6*	*7 - 12*	*13 - 18*	*19 - 24*	*25 - 30*	*31 - 36*	*37 - 42*	*43 +*	*TOTAL*
Large Tree Routine Prune		30	116	785	897	528	217	91	36	29	2729
Plant Tree	2950										2950
Priority 1 Prune				2	35	86	101	72	31	24	351
Priority 1 Removal				49	70	90	48	21	13	4	295
Priority 2 Prune			4	54	263	289	164	70	33	13	890
Priority 2 Removal			29	64	119	102	47	27	13	12	413
Priority 3 Removal		70	35	43	12	3	4	2	1		170
Small Tree Routine Prune			33	50	17						100
Stump Removal		5	11	34	34	14	4	7	3	2	114
Training Prune		352	412	59							823
Grand Total	*2950*	*457*	*640*	*1140*	*1447*	*1112*	*585*	*290*	*130*	*84*	*8835*

DAVEY

Ypsilanti, MI

Species/Primary Maintenance Frequency Report

Common Name	Priority 1 Removal	Priority 2 Removal	Priority 3 Removal	Priority 1 Prune	Priority 2 Prune	Large Tree Routine Prune	Small Tree Routine Prune	Training Prune	Stump Removal	Plant Tree	TOTAL
apple, common			1				4	4			9
arborvitae spp.						23					23
arborvitae, eastern						12					12
arborvitae, western						1					1
ash, green	21	16	4					4			45
ash, white	14	8	1					1			24
aspen, quaking						2					2
beech, American								2			2
beech, European						1					1
birch, paper						1					1
birch, river			1			2		10			13
boxelder	11	9	8	1	7	17		11			64
buckthorn, spp.		4	1		1		8				14
catalpa, northern	3	2	3	1	3	8		5			25
cherry, black	2	2	4	2	3	7					20
cherry, Japanese flowering		3					4				7
cherry, sweet								2			2
cherry/plum, spp.	1	1	1		1		11	17			32

Common Name	Priority 1 Removal	Priority 2 Removal	Priority 3 Removal	Priority 1 Prune	Priority 2 Prune	Large Tree Routine Prune	Small Tree Routine Prune	Training Prune	Stump Removal	Plant Tree	TOTAL
cottonwood, eastern	13	4		5	18	75		4			119
crabapple, flowering		3	7		4		47	62			123
dawn redwood								1			1
dogwood, flowering			1				1	2			4
dogwood, gray								1			1
dogwood, pagoda			1								1
douglas-fir						3					3
elm, American	8		4	4	5	43		7			71
elm, Chinese								1			1
elm, Siberian	5	9	29	17	26	72		27			185
elm, slippery			1	4	6	6		3			20
fir, white						1					1
ginkgo						3		9			12
goldenraintree						1		1			2
hackberry, common	1	4	1	1	1	9		5			22
hawthorn, spp.					1		4	13			18
hickory, bitternut						2					2
hickory, mockernut	2					6					8
hickory, pignut						1					1
hickory, shagbark	1			1	1	7					10

Common Name	Priority 1 Removal	Priority 2 Removal	Priority 3 Removal	Priority 1 Prune	Priority 2 Prune	Large Tree Routine Prune	Small Tree Routine Prune	Training Prune	Stump Removal	Plant Tree	TOTAL
hickory, shellbark	1		1			11					13
honeylocust		1				5		1			7
honeylocust, thornless		5	8	21	73	275		82			464
hophornbeam, American							1				1
horsechestnut	1				3	4		1			9
juniper, spp.						1					1
lilac, spp.			1		1			6			8
linden, American	2		1	2	6	16		16			43
linden, littleleaf	4	10	4	2	14	131		42			207
linden, silver			1			4		7			12
locust, black	5	6		3	14	27		3			58
magnolia, cucumbertree								1			1
magnolia, saucer							1	1			2
maple, Amur								2			2
maple, black	2	4		1	5	12		1			25
maple, Freeman		3	1	2	4	46		11			67
maple, hedge		2	1				3				6
maple, Japanese								4			4
maple, Norway	75	150	8	69	397	901		51			1651
maple, red	6	9	6	5	15	117		62			220

Common Name	Priority 1 Removal	Priority 2 Removal	Priority 3 Removal	Priority 1 Prune	Priority 2 Prune	Large Tree Routine Prune	Small Tree Routine Prune	Training Prune	Stump Removal	Plant Tree	TOTAL
maple, silver	44	75	6	139	158	318		53			793
maple, sugar	53	54		36	71	125		14			353
mulberry, red	3	2	3			6					14
mulberry, white	3	7	21	2		6		6			45
oak, black						2		1			3
oak, bur				1		3		2			6
oak, English						2					2
oak, northern red	1		1	5	10	18		26			61
oak, pin					1	1		1			3
oak, sawtooth								1			1
oak, shingle						1					1
oak, Shumard	1					1					2
oak, swamp white		1		8	7	4		4			24
oak, white				17	13	7		3			40
osage-orange						1					1
pear, Callery		1	3			60		114			178
pear, common								2			2
pine, Austrian					1	14					15
pine, eastern white		1				11		1			13
pine, mugo							1				1

Common Name	Priority 1 Removal	Priority 2 Removal	Priority 3 Removal	Priority 1 Prune	Priority 2 Prune	Large Tree Routine Prune	Small Tree Routine Prune	Training Prune	Stump Removal	Plant Tree	TOTAL
pine, red						1					1
pine, Scotch		2				34					36
planetree, London			1	1	1	66		10			79
plum, cherry							2	1			3
poplar, white			1		1						2
redbud, eastern		1					9	17			27
redcedar, eastern						6		1			7
royal paulownia						1		2			3
serviceberry, downy								3			3
serviceberry, shadblow								1			1
serviceberry, spp.		1					1	11			13
smoketree, American							1				1
spruce, Colorado						41		5			46
spruce, Norway					1	19					20
spruce, white						13		2			15
stump									114		114
sumac, spp.							1				1
sweetgum, American					2	15		3			20
sycamore, American	4	5			2	21		10			42
tree of heaven	2	5	24		2	1					34

Common Name	Priority 1 Removal	Priority 2 Removal	Priority 3 Removal	Priority 1 Prune	Priority 2 Prune	Large Tree Routine Prune	Small Tree Routine Prune	Training Prune	Stump Removal	Plant Tree	TOTAL
tuliptree			2		1	8		18			29
unknown tree	2		3								5
vacant site, large										1051	1051
vacant site, medium										415	415
vacant site, small										1484	1484
walnut, black	3	3	2	1	10	66		5			90
willow, corkscrew						1		1			2
willow, pussy							1	1			2
willow, spp.	1										1
willow, weeping			2			2					4
yellowwood								5			5
zelkova, Japanese			1			1		16			18
Grand Total	295	413	170	351	890	2729	100	823	114	2950	8835

Primary Maintenance	Total	Percent of Sub-Category Pop.	Percent of Entire Population
1			
Large Tree Routine Prune	797	41.21%	9.02%
Plant Tree	437	22.60%	4.95%
Priority 2 Prune	214	11.07%	2.42%
Training Prune	171	8.84%	1.94%
Priority 2 Removal	93	4.81%	1.05%
Priority 1 Removal	84	4.34%	0.95%
Priority 1 Prune	57	2.95%	0.65%
Stump Removal	34	1.76%	0.38%
Priority 3 Removal	24	1.24%	0.27%
Small Tree Routine Prune	23	1.19%	0.26%
Summary for 1 (10 items)			
Sum	*1934*	*100%*	*21.89%*
2			
Large Tree Routine Prune	683	33.48%	7.73%
Plant Tree	390	19.12%	4.41%
Priority 2 Prune	262	12.84%	2.97%
Training Prune	241	11.81%	2.73%
Priority 1 Prune	160	7.84%	1.81%
Priority 2 Removal	125	6.13%	1.41%
Priority 1 Removal	81	3.97%	0.92%
Small Tree Routine Prune	40	1.96%	0.45%
Priority 3 Removal	33	1.62%	0.37%
Stump Removal	25	1.23%	0.28%
Summary for 2 (10 items)			
Sum	*2040*	*100%*	*23.09%*
3			
Plant Tree	737	38.39%	8.34%
Large Tree Routine Prune	567	29.53%	6.42%
Priority 2 Prune	204	10.63%	2.31%

Primary Maintenance	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Training Prune	137	7.14%	1.55%
Priority 1 Prune	74	3.85%	0.84%
Priority 2 Removal	72	3.75%	0.81%
Priority 1 Removal	62	3.23%	0.70%
Priority 3 Removal	38	1.98%	0.43%
Stump Removal	20	1.04%	0.23%
Small Tree Routine Prune	9	0.47%	0.10%
Summary for 3 (10 items)			
Sum	*1920*	*100%*	*21.73%*
4			
Plant Tree	754	48.21%	8.53%
Large Tree Routine Prune	383	24.49%	4.34%
Training Prune	136	8.70%	1.54%
Priority 2 Prune	87	5.56%	0.98%
Priority 2 Removal	70	4.48%	0.79%
Priority 1 Removal	41	2.62%	0.46%
Priority 3 Removal	33	2.11%	0.37%
Priority 1 Prune	30	1.92%	0.34%
Small Tree Routine Prune	16	1.02%	0.18%
Stump Removal	14	0.90%	0.16%
Summary for 4 (10 items)			
Sum	*1564*	*100%*	*17.70%*
5			
Plant Tree	632	45.90%	7.15%
Large Tree Routine Prune	299	21.71%	3.38%
Training Prune	138	10.02%	1.56%
Priority 2 Prune	123	8.93%	1.39%
Priority 2 Removal	53	3.85%	0.60%
Priority 3 Removal	42	3.05%	0.48%
Priority 1 Prune	30	2.18%	0.34%
Priority 1 Removal	27	1.96%	0.31%
Stump Removal	21	1.53%	0.24%

Primary Maintenance	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Small Tree Routine Prune	12	0.87%	0.14%
Summary for 5 (10 items)			
Sum	*1377*	*100%*	*15.59%*
Grand Total	*8835*		

Observations

Ypsilanti, MI

Quantity Report: Observations

Observations	*Total*	*Percentage of Entire Population*
None	3456	59.89%
Cavity or Decay	1025	17.76%
Poor Structure	511	8.85%
Poor Root System	192	3.33%
Mechanical Damage	119	2.06%
Poor Location	106	1.84%
Serious Decline	99	1.72%
Grate or Guard	67	1.16%
Remove Hardware	51	0.88%
Improperly Pruned	44	0.76%
Pest Problem	38	0.66%
Improperly Mulched	24	0.42%
Improperly Installed	20	0.35%
Nutrient Deficiency	17	0.29%
Memorial Tree	2	0.03%
Grand Total	*5771*	*100%*

DAVEY

Ypsilanti, MI

Frequency Report: Observations by Condition

Condition	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Cavity or Decay			
Poor	715	69.76%	12.39%
Fair	152	14.83%	2.63%
Critical	104	10.15%	1.80%
Dead	54	5.27%	0.94%
Summary for Cavity or Decay (4 items)			
Sum	*1025*	*100%*	*17.76%*
Grate or Guard			
Fair	66	98.51%	1.14%
Poor	1	1.49%	0.02%
Summary for Grate or Guard (2 items)			
Sum	*67*	*100%*	*1.16%*
Improperly Installed			
Fair	12	60.00%	0.21%
Good	5	25.00%	0.09%
Poor	3	15.00%	0.05%
Summary for Improperly Installed (3 items)			
Sum	*20*	*100%*	*0.35%*
Improperly Mulched			
Fair	11	45.83%	0.19%
Good	9	37.50%	0.16%
Very Good	2	8.33%	0.03%
Poor	2	8.33%	0.03%
Summary for Improperly Mulched (4 items)			
Sum	*24*	*100%*	*0.42%*
Improperly Pruned			
Fair	24	54.55%	0.42%
Poor	18	40.91%	0.31%
Good	1	2.27%	0.02%
Critical	1	2.27%	0.02%

Condition	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Summary for Improperly Pruned (4 items)			
Sum	*44*	*100%*	*0.76%*
Mechanical Damage			
Fair	80	67.23%	1.39%
Poor	34	28.57%	0.59%
Good	5	4.20%	0.09%
Summary for Mechanical Damage (3 items)			
Sum	*119*	*100%*	*2.06%*
Memorial Tree			
Good	1	50.00%	0.02%
Dead	1	50.00%	0.02%
Summary for Memorial Tree (2 items)			
Sum	*2*	*100%*	*0.03%*
None			
Fair	2478	71.70%	42.94%
Good	649	18.78%	11.25%
Poor	245	7.09%	4.25%
Very Good	46	1.33%	0.80%
Dead	26	0.75%	0.45%
Critical	12	0.35%	0.21%
Summary for None (6 items)			
Sum	*3456*	*100%*	*59.89%*
Nutrient Deficiency			
Fair	13	76.47%	0.23%
Good	4	23.53%	0.07%
Summary for Nutrient Deficiency (2 items)			
Sum	*17*	*100%*	*0.29%*
Pest Problem			
Critical	15	39.47%	0.26%
Poor	9	23.68%	0.16%
Dead	8	21.05%	0.14%
Fair	6	15.79%	0.10%

Condition	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Summary for Pest Problem (4 items)			
Sum	*38*	*100%*	*0.66%*
Poor Location			
Fair	51	48.11%	0.88%
Poor	39	36.79%	0.68%
Good	13	12.26%	0.23%
Critical	3	2.83%	0.05%
Summary for Poor Location (4 items)			
Sum	*106*	*100%*	*1.84%*
Poor Root System			
Fair	118	61.46%	2.04%
Poor	72	37.50%	1.25%
Good	2	1.04%	0.03%
Summary for Poor Root System (3 items)			
Sum	*192*	*100%*	*3.33%*
Poor Structure			
Fair	353	69.08%	6.12%
Poor	147	28.77%	2.55%
Critical	6	1.17%	0.10%
Good	5	0.98%	0.09%
Summary for Poor Structure (4 items)			
Sum	*511*	*100%*	*8.85%*
Remove Hardware			
Fair	30	58.82%	0.52%
Good	14	27.45%	0.24%
Poor	4	7.84%	0.07%
Very Good	2	3.92%	0.03%
Critical	1	1.96%	0.02%
Summary for Remove Hardware (5 items)			
Sum	*51*	*100%*	*0.88%*
Serious Decline			
Critical	52	52.53%	0.90%
Poor	46	46.46%	0.80%

Condition	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Fair	1	1.01%	0.02%
Summary for Serious Decline (3 items)			
Sum	*99*	*100%*	*1.72%*
Grand Total	*5771*		

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Cavity or Decay			
maple, Norway (Acer platanoides)	329	32.10%	5.70%
maple, silver (Acer saccharinum)	248	24.20%	4.30%
maple, sugar (Acer saccharum)	127	12.39%	2.20%
maple, red (Acer rubrum)	29	2.83%	0.50%
elm, Siberian (Ulmus pumila)	23	2.24%	0.40%
ash, green (Fraxinus pennsylvanica)	22	2.15%	0.38%
honeylocust, thornless (Gleditsia triacanthos inermis)	19	1.85%	0.33%
cottonwood, eastern (Populus deltoides)	18	1.76%	0.31%
boxelder (Acer negundo)	18	1.76%	0.31%
linden, littleleaf (Tilia cordata)	16	1.56%	0.28%
walnut, black (Juglans nigra)	14	1.37%	0.24%
locust, black (Robinia pseudoacacia)	14	1.37%	0.24%
sycamore, American (Platanus occidentalis)	10	0.98%	0.17%
mulberry, white (Morus alba)	10	0.98%	0.17%
linden, American (Tilia americana)	10	0.98%	0.17%
catalpa, northern (Catalpa speciosa)	10	0.98%	0.17%
maple, Freeman (Acer x freemanii)	9	0.88%	0.16%
crabapple, flowering (Malus spp.)	9	0.88%	0.16%
tree of heaven (Ailanthus altissima)	8	0.78%	0.14%
mulberry, red (Morus rubra)	6	0.59%	0.10%
maple, black (Acer nigrum)	6	0.59%	0.10%
ash, white (Fraxinus americana)	6	0.59%	0.10%
oak, northern red (Quercus rubra)	5	0.49%	0.09%
cherry, Japanese flowering (Prunus serrulata)	5	0.49%	0.09%
cherry, black (Prunus serotina)	5	0.49%	0.09%
pear, Callery (Pyrus calleryana)	4	0.39%	0.07%
hackberry, common (Celtis occidentalis)	4	0.39%	0.07%
elm, American (Ulmus americana)	4	0.39%	0.07%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
planetree, London (Platanus x acerifolia)	2	0.20%	0.03%
pine, Scotch (Pinus sylvestris)	2	0.20%	0.03%
oak, white (Quercus alba)	2	0.20%	0.03%
maple, hedge (Acer campestre)	2	0.20%	0.03%
horsechestnut (Aesculus hippocastanum)	2	0.20%	0.03%
hickory, shellbark (Carya laciniosa)	2	0.20%	0.03%
hickory, shagbark (Carya ovata)	2	0.20%	0.03%
hickory, mockernut (Carya tomentosa)	2	0.20%	0.03%
hawthorn, spp. (Crataegus spp.)	2	0.20%	0.03%
cherry/plum, spp. (Prunus spp.)	2	0.20%	0.03%
willow, weeping (Salix babylonica)	1	0.10%	0.02%
willow, spp. (Salix spp.)	1	0.10%	0.02%
tuliptree (Liriodendron tulipifera)	1	0.10%	0.02%
serviceberry, spp. (Amelanchier spp.)	1	0.10%	0.02%
redbud, eastern (Cercis canadensis)	1	0.10%	0.02%
poplar, white (Populus alba)	1	0.10%	0.02%
pine, eastern white (Pinus strobus)	1	0.10%	0.02%
pine, Austrian (Pinus nigra)	1	0.10%	0.02%
oak, Shumard (Quercus shumardii)	1	0.10%	0.02%
oak, bur (Quercus macrocarpa)	1	0.10%	0.02%
lilac, spp. (Syringa spp.)	1	0.10%	0.02%
honeylocust (Gleditsia triacanthos)	1	0.10%	0.02%
goldenraintree (Koelreuteria paniculata)	1	0.10%	0.02%
elm, slippery (Ulmus rubra)	1	0.10%	0.02%
dogwood, pagoda (Cornus alternifolia)	1	0.10%	0.02%
buckthorn, spp. (Rhamnus spp.)	1	0.10%	0.02%
arborvitae, eastern (Thuja occidentalis)	1	0.10%	0.02%
Summary for Cavity or Decay (55 items)			
Sum	*1025*	*100%*	*17.76%*
Grate or Guard			
honeylocust, thornless (Gleditsia triacanthos inermis)	57	85.07%	0.99%
pear, Callery (Pyrus calleryana)	8	11.94%	0.14%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
maple, sugar (Acer saccharum)	1	1.49%	0.02%
maple, silver (Acer saccharinum)	1	1.49%	0.02%
Summary for Grate or Guard (4 items)			
Sum	*67*	*100%*	*1.16%*
Improperly Installed			
honeylocust, thornless (Gleditsia triacanthos inermis)	7	35.00%	0.12%
linden, littleleaf (Tilia cordata)	3	15.00%	0.05%
tuliptree (Liriodendron tulipifera)	2	10.00%	0.03%
linden, American (Tilia americana)	2	10.00%	0.03%
zelkova, Japanese (Zelkova serrata)	1	5.00%	0.02%
yellowwood (Cladrastis kentukea)	1	5.00%	0.02%
pear, Callery (Pyrus calleryana)	1	5.00%	0.02%
maple, sugar (Acer saccharum)	1	5.00%	0.02%
maple, red (Acer rubrum)	1	5.00%	0.02%
crabapple, flowering (Malus spp.)	1	5.00%	0.02%
Summary for Improperly Installed (10 items)			
Sum	*20*	*100%*	*0.35%*
Improperly Mulched			
maple, red (Acer rubrum)	5	20.83%	0.09%
maple, Norway (Acer platanoides)	5	20.83%	0.09%
pear, Callery (Pyrus calleryana)	4	16.67%	0.07%
yellowwood (Cladrastis kentukea)	1	4.17%	0.02%
tuliptree (Liriodendron tulipifera)	1	4.17%	0.02%
serviceberry, spp. (Amelanchier spp.)	1	4.17%	0.02%
redbud, eastern (Cercis canadensis)	1	4.17%	0.02%
oak, swamp white (Quercus bicolor)	1	4.17%	0.02%
maple, sugar (Acer saccharum)	1	4.17%	0.02%
maple, silver (Acer saccharinum)	1	4.17%	0.02%
maple, Freeman (Acer x freemanii)	1	4.17%	0.02%
linden, silver (Tilia tomentosa)	1	4.17%	0.02%
linden, littleleaf (Tilia cordata)	1	4.17%	0.02%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Summary for Improperly Mulched (13 items)			
Sum	*24*	*100%*	*0.42%*
Improperly Pruned			
maple, Norway (Acer platanoides)	21	47.73%	0.36%
honeylocust, thornless (Gleditsia triacanthos inermis)	6	13.64%	0.10%
crabapple, flowering (Malus spp.)	3	6.82%	0.05%
maple, silver (Acer saccharinum)	2	4.55%	0.03%
linden, littleleaf (Tilia cordata)	2	4.55%	0.03%
birch, river (Betula nigra)	2	4.55%	0.03%
sycamore, American (Platanus occidentalis)	1	2.27%	0.02%
planetree, London (Platanus x acerifolia)	1	2.27%	0.02%
pine, Scotch (Pinus sylvestris)	1	2.27%	0.02%
pear, Callery (Pyrus calleryana)	1	2.27%	0.02%
maple, sugar (Acer saccharum)	1	2.27%	0.02%
maple, red (Acer rubrum)	1	2.27%	0.02%
linden, American (Tilia americana)	1	2.27%	0.02%
elm, Siberian (Ulmus pumila)	1	2.27%	0.02%
Summary for Improperly Pruned (14 items)			
Sum	*44*	*100%*	*0.76%*
Mechanical Damage			
maple, red (Acer rubrum)	17	14.29%	0.29%
maple, sugar (Acer saccharum)	14	11.76%	0.24%
maple, Norway (Acer platanoides)	13	10.92%	0.23%
maple, silver (Acer saccharinum)	11	9.24%	0.19%
pear, Callery (Pyrus calleryana)	10	8.40%	0.17%
honeylocust, thornless (Gleditsia triacanthos inermis)	9	7.56%	0.16%
oak, northern red (Quercus rubra)	8	6.72%	0.14%
oak, white (Quercus alba)	7	5.88%	0.12%
walnut, black (Juglans nigra)	3	2.52%	0.05%
locust, black (Robinia pseudoacacia)	3	2.52%	0.05%
linden, littleleaf (Tilia cordata)	3	2.52%	0.05%
crabapple, flowering (Malus spp.)	3	2.52%	0.05%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
cottonwood, eastern (Populus deltoides)	3	2.52%	0.05%
redbud, eastern (Cercis canadensis)	2	1.68%	0.03%
planetree, London (Platanus x acerifolia)	2	1.68%	0.03%
pine, Scotch (Pinus sylvestris)	2	1.68%	0.03%
maple, Freeman (Acer x freemanii)	2	1.68%	0.03%
tuliptree (Liriodendron tulipifera)	1	0.84%	0.02%
sycamore, American (Platanus occidentalis)	1	0.84%	0.02%
maple, Japanese (Acer palmatum)	1	0.84%	0.02%
hickory, shellbark (Carya laciniosa)	1	0.84%	0.02%
elm, Siberian (Ulmus pumila)	1	0.84%	0.02%
elm, American (Ulmus americana)	1	0.84%	0.02%
catalpa, northern (Catalpa speciosa)	1	0.84%	0.02%
Summary for Mechanical Damage (24 items)			
Sum	*119*	*100%*	*2.06%*
Memorial Tree			
zelkova, Japanese (Zelkova serrata)	1	50.00%	0.02%
maple, red (Acer rubrum)	1	50.00%	0.02%
Summary for Memorial Tree (2 items)			
Sum	*2*	*100%*	*0.03%*
None			
maple, Norway (Acer platanoides)	923	26.71%	15.99%
maple, silver (Acer saccharinum)	424	12.27%	7.35%
honeylocust, thornless (Gleditsia triacanthos inermis)	329	9.52%	5.70%
maple, sugar (Acer saccharum)	128	3.70%	2.22%
maple, red (Acer rubrum)	122	3.53%	2.11%
pear, Callery (Pyrus calleryana)	121	3.50%	2.10%
elm, Siberian (Ulmus pumila)	107	3.10%	1.85%
crabapple, flowering (Malus spp.)	99	2.86%	1.72%
cottonwood, eastern (Populus deltoides)	93	2.69%	1.61%
linden, littleleaf (Tilia cordata)	92	2.66%	1.59%
walnut, black (Juglans nigra)	69	2.00%	1.20%
planetree, London (Platanus x acerifolia)	67	1.94%	1.16%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
elm, American (Ulmus americana)	56	1.62%	0.97%
maple, Freeman (Acer x freemanii)	49	1.42%	0.85%
oak, northern red (Quercus rubra)	45	1.30%	0.78%
spruce, Colorado (Picea pungens)	42	1.22%	0.73%
locust, black (Robinia pseudoacacia)	37	1.07%	0.64%
boxelder (Acer negundo)	32	0.93%	0.55%
pine, Scotch (Pinus sylvestris)	30	0.87%	0.52%
oak, white (Quercus alba)	30	0.87%	0.52%
cherry/plum, spp. (Prunus spp.)	27	0.78%	0.47%
linden, American (Tilia americana)	24	0.69%	0.42%
tree of heaven (Ailanthus altissima)	23	0.67%	0.40%
sycamore, American (Platanus occidentalis)	22	0.64%	0.38%
arborvitae spp. (Thuja spp.)	22	0.64%	0.38%
redbud, eastern (Cercis canadensis)	21	0.61%	0.36%
tuliptree (Liriodendron tulipifera)	20	0.58%	0.35%
sweetgum, American (Liquidambar styraciflua)	20	0.58%	0.35%
oak, swamp white (Quercus bicolor)	20	0.58%	0.35%
spruce, Norway (Picea abies)	19	0.55%	0.33%
mulberry, white (Morus alba)	18	0.52%	0.31%
maple, black (Acer nigrum)	17	0.49%	0.29%
hawthorn, spp. (Crataegus spp.)	16	0.46%	0.28%
spruce, white (Picea glauca)	15	0.43%	0.26%
pine, Austrian (Pinus nigra)	13	0.38%	0.23%
hackberry, common (Celtis occidentalis)	13	0.38%	0.23%
zelkova, Japanese (Zelkova serrata)	12	0.35%	0.21%
pine, eastern white (Pinus strobus)	12	0.35%	0.21%
ginkgo (Ginkgo biloba)	12	0.35%	0.21%
elm, slippery (Ulmus rubra)	12	0.35%	0.21%
serviceberry, spp. (Amelanchier spp.)	11	0.32%	0.19%
cherry, black (Prunus serotina)	11	0.32%	0.19%
arborvitae, eastern (Thuja occidentalis)	11	0.32%	0.19%
buckthorn, spp. (Rhamnus spp.)	10	0.29%	0.17%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
birch, river (Betula nigra)	10	0.29%	0.17%
hickory, shellbark (Carya laciniosa)	9	0.26%	0.16%
apple, common (Malus pumila)	9	0.26%	0.16%
linden, silver (Tilia tomentosa)	7	0.20%	0.12%
lilac, spp. (Syringa spp.)	7	0.20%	0.12%
horsechestnut (Aesculus hippocastanum)	7	0.20%	0.12%
hickory, shagbark (Carya ovata)	7	0.20%	0.12%
catalpa, northern (Catalpa speciosa)	7	0.20%	0.12%
redcedar, eastern (Juniperus virginiana)	6	0.17%	0.10%
honeylocust (Gleditsia triacanthos)	6	0.17%	0.10%
hickory, mockernut (Carya tomentosa)	6	0.17%	0.10%
unknown tree (unknown tree)	5	0.14%	0.09%
oak, bur (Quercus macrocarpa)	5	0.14%	0.09%
mulberry, red (Morus rubra)	4	0.12%	0.07%
dogwood, flowering (Cornus florida)	4	0.12%	0.07%
ash, green (Fraxinus pennsylvanica)	4	0.12%	0.07%
serviceberry, downy (Amelanchier arborea)	3	0.09%	0.05%
royal paulownia (Paulownia tomentosa)	3	0.09%	0.05%
oak, pin (Quercus palustris)	3	0.09%	0.05%
oak, black (Quercus velutina)	3	0.09%	0.05%
douglas-fir (Pseudotsuga menziesii)	3	0.09%	0.05%
willow, pussy (Salix discolor)	2	0.06%	0.03%
willow, corkscrew (Salix matsudana)	2	0.06%	0.03%
maple, Japanese (Acer palmatum)	2	0.06%	0.03%
magnolia, saucer (Magnolia x soulangiana)	2	0.06%	0.03%
hickory, bitternut (Carya cordiformis)	2	0.06%	0.03%
cherry, sweet (Prunus avium)	2	0.06%	0.03%
beech, American (Fagus grandifolia)	2	0.06%	0.03%
aspen, quaking (Populus tremuloides)	2	0.06%	0.03%
yellowwood (Cladrastis kentukea)	1	0.03%	0.02%
willow, weeping (Salix babylonica)	1	0.03%	0.02%
sumac, spp. (Rhus spp.)	1	0.03%	0.02%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
smoketree, American (Cotinus coggygria)	1	0.03%	0.02%
serviceberry, shadblow (Amelanchier canadensis)	1	0.03%	0.02%
plum, cherry (Prunus cerasifera)	1	0.03%	0.02%
pine, red (Pinus resinosa)	1	0.03%	0.02%
pine, mugo (Pinus mugo)	1	0.03%	0.02%
pear, common (Pyrus communis)	1	0.03%	0.02%
osage-orange (Maclura pomifera)	1	0.03%	0.02%
oak, Shumard (Quercus shumardii)	1	0.03%	0.02%
oak, shingle (Quercus imbricaria)	1	0.03%	0.02%
oak, sawtooth (Quercus acutissima)	1	0.03%	0.02%
maple, hedge (Acer campestre)	1	0.03%	0.02%
maple, Amur (Acer tataricum ginnala)	1	0.03%	0.02%
magnolia, cucumbertree (Magnolia acuminata)	1	0.03%	0.02%
juniper, spp. (Juniperus spp.)	1	0.03%	0.02%
hophornbeam, American (Ostrya virginiana)	1	0.03%	0.02%
hickory, pignut (Carya glabra)	1	0.03%	0.02%
goldenraintree (Koelreuteria paniculata)	1	0.03%	0.02%
dogwood, gray (Cornus racemosa)	1	0.03%	0.02%
dawn redwood (Metasequoia glyptostroboides)	1	0.03%	0.02%
birch, paper (Betula papyrifera)	1	0.03%	0.02%
beech, European (Fagus sylvatica)	1	0.03%	0.02%
ash, white (Fraxinus americana)	1	0.03%	0.02%
arborvitae, western (Thuja plicata)	1	0.03%	0.02%
Summary for None (99 items)			
Sum	*3456*	*100%*	*59.89%*
Nutrient Deficiency			
maple, red (Acer rubrum)	16	94.12%	0.28%
maple, Norway (Acer platanoides)	1	5.88%	0.02%
Summary for Nutrient Deficiency (2 items)			
Sum	*17*	*100%*	*0.29%*
Pest Problem			
ash, white (Fraxinus americana)	17	44.74%	0.29%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
ash, green (Fraxinus pennsylvanica)	13	34.21%	0.23%
sycamore, American (Platanus occidentalis)	4	10.53%	0.07%
plum, cherry (Prunus cerasifera)	2	5.26%	0.03%
planetree, London (Platanus x acerifolia)	1	2.63%	0.02%
maple, silver (Acer saccharinum)	1	2.63%	0.02%

Summary for Pest Problem (6 items)

Sum	*38*	*100%*	*0.66%*

Poor Location

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
elm, Siberian (Ulmus pumila)	29	27.36%	0.50%
maple, Norway (Acer platanoides)	13	12.26%	0.23%
honeylocust, thornless (Gleditsia triacanthos inermis)	12	11.32%	0.21%
mulberry, white (Morus alba)	9	8.49%	0.16%
boxelder (Acer negundo)	7	6.60%	0.12%
elm, American (Ulmus americana)	5	4.72%	0.09%
walnut, black (Juglans nigra)	3	2.83%	0.05%
tree of heaven (Ailanthus altissima)	3	2.83%	0.05%
spruce, Colorado (Picea pungens)	3	2.83%	0.05%
mulberry, red (Morus rubra)	3	2.83%	0.05%
hackberry, common (Celtis occidentalis)	3	2.83%	0.05%
maple, silver (Acer saccharinum)	2	1.89%	0.03%
linden, littleleaf (Tilia cordata)	2	1.89%	0.03%
cherry, black (Prunus serotina)	2	1.89%	0.03%
catalpa, northern (Catalpa speciosa)	2	1.89%	0.03%
poplar, white (Populus alba)	1	0.94%	0.02%
maple, sugar (Acer saccharum)	1	0.94%	0.02%
maple, red (Acer rubrum)	1	0.94%	0.02%
maple, hedge (Acer campestre)	1	0.94%	0.02%
maple, Freeman (Acer x freemanii)	1	0.94%	0.02%
cottonwood, eastern (Populus deltoides)	1	0.94%	0.02%
buckthorn, spp. (Rhamnus spp.)	1	0.94%	0.02%
ash, green (Fraxinus pennsylvanica)	1	0.94%	0.02%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Summary for Poor Location (23 items)			
Sum	*106*	*100%*	*1.84%*
Poor Root System			
maple, Norway (Acer platanoides)	148	77.08%	2.56%
maple, silver (Acer saccharinum)	10	5.21%	0.17%
maple, sugar (Acer saccharum)	9	4.69%	0.16%
maple, red (Acer rubrum)	6	3.13%	0.10%
linden, littleleaf (Tilia cordata)	6	3.13%	0.10%
sycamore, American (Platanus occidentalis)	2	1.04%	0.03%
maple, Freeman (Acer x freemanii)	2	1.04%	0.03%
elm, Siberian (Ulmus pumila)	2	1.04%	0.03%
planetree, London (Platanus x acerifolia)	1	0.52%	0.02%
pear, Callery (Pyrus calleryana)	1	0.52%	0.02%
oak, swamp white (Quercus bicolor)	1	0.52%	0.02%
mulberry, white (Morus alba)	1	0.52%	0.02%
maple, black (Acer nigrum)	1	0.52%	0.02%
crabapple, flowering (Malus spp.)	1	0.52%	0.02%
cherry, black (Prunus serotina)	1	0.52%	0.02%
Summary for Poor Root System (15 items)			
Sum	*192*	*100%*	*3.33%*
Poor Structure			
maple, Norway (Acer platanoides)	142	27.79%	2.46%
maple, silver (Acer saccharinum)	77	15.07%	1.33%
linden, littleleaf (Tilia cordata)	76	14.87%	1.32%
maple, sugar (Acer saccharum)	49	9.59%	0.85%
pear, Callery (Pyrus calleryana)	24	4.70%	0.42%
elm, Siberian (Ulmus pumila)	21	4.11%	0.36%
honeylocust, thornless (Gleditsia triacanthos inermis)	19	3.72%	0.33%
maple, red (Acer rubrum)	13	2.54%	0.23%
mulberry, white (Morus alba)	7	1.37%	0.12%
boxelder (Acer negundo)	7	1.37%	0.12%
linden, American (Tilia americana)	6	1.17%	0.10%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
elm, slippery (Ulmus rubra)	6	1.17%	0.10%
elm, American (Ulmus americana)	5	0.98%	0.09%
catalpa, northern (Catalpa speciosa)	5	0.98%	0.09%
ash, green (Fraxinus pennsylvanica)	5	0.98%	0.09%
zelkova, Japanese (Zelkova serrata)	4	0.78%	0.07%
locust, black (Robinia pseudoacacia)	4	0.78%	0.07%
maple, Freeman (Acer x freemanii)	3	0.59%	0.05%
linden, silver (Tilia tomentosa)	3	0.59%	0.05%
cottonwood, eastern (Populus deltoides)	3	0.59%	0.05%
cherry/plum, spp. (Prunus spp.)	3	0.59%	0.05%
willow, weeping (Salix babylonica)	2	0.39%	0.03%
redbud, eastern (Cercis canadensis)	2	0.39%	0.03%
oak, northern red (Quercus rubra)	2	0.39%	0.03%
hackberry, common (Celtis occidentalis)	2	0.39%	0.03%
crabapple, flowering (Malus spp.)	2	0.39%	0.03%
cherry, Japanese flowering (Prunus serrulata)	2	0.39%	0.03%
buckthorn, spp. (Rhamnus spp.)	2	0.39%	0.03%
walnut, black (Juglans nigra)	1	0.20%	0.02%
tuliptree (Liriodendron tulipifera)	1	0.20%	0.02%
sycamore, American (Platanus occidentalis)	1	0.20%	0.02%
spruce, Norway (Picea abies)	1	0.20%	0.02%
planetree, London (Platanus x acerifolia)	1	0.20%	0.02%
pine, Scotch (Pinus sylvestris)	1	0.20%	0.02%
pear, common (Pyrus communis)	1	0.20%	0.02%
oak, white (Quercus alba)	1	0.20%	0.02%
oak, swamp white (Quercus bicolor)	1	0.20%	0.02%
oak, English (Quercus robur)	1	0.20%	0.02%
mulberry, red (Morus rubra)	1	0.20%	0.02%
maple, Amur (Acer tataricum ginnala)	1	0.20%	0.02%
hickory, shagbark (Carya ovata)	1	0.20%	0.02%
fir, white (Abies concolor)	1	0.20%	0.02%
arborvitae spp. (Thuja spp.)	1	0.20%	0.02%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Summary for Poor Structure (43 items)			
Sum	*511*	*100%*	*8.85%*
Remove Hardware			
maple, red (Acer rubrum)	7	13.73%	0.12%
maple, Norway (Acer platanoides)	7	13.73%	0.12%
honeylocust, thornless (Gleditsia triacanthos inermis)	6	11.76%	0.10%
planetree, London (Platanus x acerifolia)	4	7.84%	0.07%
pear, Callery (Pyrus calleryana)	4	7.84%	0.07%
yellowwood (Cladrastis kentukea)	2	3.92%	0.03%
tuliptree (Liriodendron tulipifera)	2	3.92%	0.03%
maple, silver (Acer saccharinum)	2	3.92%	0.03%
maple, hedge (Acer campestre)	2	3.92%	0.03%
linden, littleleaf (Tilia cordata)	2	3.92%	0.03%
sycamore, American (Platanus occidentalis)	1	1.96%	0.02%
spruce, Colorado (Picea pungens)	1	1.96%	0.02%
redcedar, eastern (Juniperus virginiana)	1	1.96%	0.02%
pine, Austrian (Pinus nigra)	1	1.96%	0.02%
oak, northern red (Quercus rubra)	1	1.96%	0.02%
oak, English (Quercus robur)	1	1.96%	0.02%
maple, Japanese (Acer palmatum)	1	1.96%	0.02%
hickory, shellbark (Carya laciniosa)	1	1.96%	0.02%
elm, slippery (Ulmus rubra)	1	1.96%	0.02%
elm, Chinese (Ulmus parvifolia)	1	1.96%	0.02%
crabapple, flowering (Malus spp.)	1	1.96%	0.02%
cottonwood, eastern (Populus deltoides)	1	1.96%	0.02%
birch, river (Betula nigra)	1	1.96%	0.02%
Summary for Remove Hardware (23 items)			
Sum	*51*	*100%*	*0.88%*
Serious Decline			
maple, Norway (Acer platanoides)	49	49.49%	0.85%
maple, sugar (Acer saccharum)	21	21.21%	0.36%
maple, silver (Acer saccharinum)	14	14.14%	0.24%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
linden, littleleaf (Tilia cordata)	4	4.04%	0.07%
crabapple, flowering (Malus spp.)	4	4.04%	0.07%
tuliptree (Liriodendron tulipifera)	1	1.01%	0.02%
oak, swamp white (Quercus bicolor)	1	1.01%	0.02%
maple, red (Acer rubrum)	1	1.01%	0.02%
maple, black (Acer nigrum)	1	1.01%	0.02%
linden, silver (Tilia tomentosa)	1	1.01%	0.02%
elm, Siberian (Ulmus pumila)	1	1.01%	0.02%
cherry, black (Prunus serotina)	1	1.01%	0.02%
Summary for Serious Decline (12 items)			
Sum	*99*	*100%*	*1.72%*
Grand Total	*5771*		

Appendix C
Eight-Year Urban Forest Management Program

Estimated Costs for Ypsilanti's Eight-Year Urban Forest Management Program

Estimated Costs for Each Activity			Year 1		Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Year 8		Eight-Year Cost
Activity	Diameter Class	Cost/Tree (dollars)	# 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	# of Trees	Total Cost	
Removal Program																			
Priority 1 Removals	1-3"	$25	0	$0	0	$0													$0
	4-6"	$105	0	$0	0	$0													$0
	7-12"	$220	0	$0	49	$10,780													$10,780
	13-18"	$355	0	$0	70	$24,850													$24,850
	19-24"	$525	23	$12,075	67	$35,175													$47,250
	25-30"	$845	12	$10,140	36	$30,420													$40,560
	31-36"	$1,140	21	$23,940	0	$0													$23,940
	37-42"	$1,470	13	$19,110	0	$0													$19,110
	43"+	$1,850	4	$7,400	0	$0													$7,400
Activity Total(s)			**73**	**$72,665**	**222**	**$101,225**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$173,890**
Priority 2 Removals	1-3"	$20					0	$0	0	$0									$0
	4-6"	$30					0	$0	29	$870									$870
	7-12"	$75					0	$0	64	$4,800									$4,800
	13-18"	$120					89	$10,680	30	$3,600									$14,280
	19-24"	$170					102	$17,340	0	$0									$17,340
	25-30"	$225					47	$10,575	0	$0									$10,575
	31-36"	$305					27	$8,235	0	$0									$8,235
	37-42"	$380					13	$4,940	0	$0									$4,940
	43"+	$590					12	$7,080	0	$0									$7,080
Activity Total(s)			**0**	**$0**	**0**	**$0**	**290**	**$58,850**	**123**	**$9,270**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$68,120**
Priority 3 Removals	1-3"	$25									70	$1,750							$1,750
	4-6"	$105									35	$3,675							$3,675
	7-12"	$220									43	$9,460							$9,460
	13-18"	$355									12	$4,260							$4,260
	19-24"	$525									3	$1,575							$1,575
	25-30"	$845									4	$3,380							$3,380
	31-36"	$1,140									2	$2,280							$2,280
	37-42"	$1,470									1	$1,470							$1,470
	43"+	$1,850									0	$0							$0
Activity Total(s)			**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**170**	**$27,850**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$27,850**
Stump Removals	1-3"	$25									5	$125							$125
	4-6"	$25									11	$275							$275
	7-12"	$25									34	$850							$850
	13-18"	$40									34	$1,360							$1,360
	19-24"	$60									14	$840							$840
	25-30"	$85									4	$340							$340
	31-36"	$110									7	$770							$770
	37-42"	$130									3	$390							$390
	43"+	$160									2	$320							$320
Activity Total(s)			**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**114**	**$5,270**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$5,270**
1% Natural Mortality	Removals	$260									58	$15,080	58	$15,080	58	$15,080	58	$15,080	$45,240
Activity Total(s)			**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**58**	**$15,080**	**58**	**$15,080**	**58**	**$15,080**	**58**	**$15,080**	**$60,320**
Removal Totals			**73**	**$72,665**	**222**	**$101,225**	**290**	**$58,850**	**123**	**$9,270**	**342**	**$48,200**	**58**	**$15,080**	**58**	**$15,080**	**58**	**$15,080**	**$335,450**
Pruning Program																			
Priority 1 Prunes	1-3"	$20	0	$0	0	$0													$0
	4-6"	$30	0	$0	0	$0													$0
	7-12"	$75	0	$0	2	$150													$150
	13-18"	$120	18	$2,160	17	$2,040													$4,200
	19-24"	$170	55	$9,350	31	$5,270													$14,620
	25-30"	$225	70	$15,750	31	$6,975													$22,725
	31-36"	$305	72	$21,960	0	$0													$21,960
	37-42"	$380	31	$11,780	0	$0													$11,780
	43"+	$590	24	$14,160	0	$0													$14,160
Activity Total(s)			**270**	**$75,160**	**81**	**$14,435**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$89,595**
Priority 2 Prunes	1-3"	$20			0	$0	0	$0	0	$0									$0
	4-6"	$30			0	$0	4	$120	0	$0									$120
	7-12"	$75			0	$0	54	$4,050	0	$0									$4,050
	13-18"	$120			0	$0	100	$12,000	163	$19,560									$31,560
	19-24"	$170			0	$0	100	$17,000	189	$32,130									$49,130
	25-30"	$225			15	$3,375	149	$33,525	0	$0									$36,900
	31-36"	$305			40	$12,200	30	$9,150	0	$0									$21,350
	37-42"	$380			12	$4,560	21	$7,980	0	$0									$12,540
	43"+	$590			13	$7,670	0	$0	0	$0									$7,670
Activity Total(s)			**0**	**$0**	**80**	**$27,805**	**458**	**$83,825**	**352**	**$51,690**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$163,320**
Routine Pruning Program[2] 5-year cycle	1-3"	$20							6	$120	6	$120	6	$120	6	$120	6	$120	$600
	4-6"	$30							30	$894	30	$894	30	$894	30	$894	30	$894	$4,470
	7-12"	$75							167	$12,525	167	$12,525	167	$12,525	167	$12,525	167	$12,525	$62,625
	13-18"	$120							183	$21,936	183	$21,936	183	$21,936	183	$21,936	183	$21,936	$109,680
	19-24"	$170							106	$17,952	106	$17,952	106	$17,952	106	$17,952	106	$17,952	$89,760
	25-30"	$225							44	$9,900	44	$9,900	44	$9,900	44	$9,900	44	$9,900	$49,500
	31-36"	$305							19	$5,795	19	$5,795	19	$5,795	19	$5,795	19	$5,795	$28,975
	37-42"	$380							8	$3,040	8	$3,040	8	$3,040	8	$3,040	8	$3,040	$15,200
	43"+	$590							5	$2,950	5	$2,950	5	$2,950	5	$2,950	5	$2,950	$14,750
Activity Total(s)			**0**	**$0**	**0**	**$0**	**0**	**$0**	**567**	**$75,112**	**567**	**$75,112**	**567**	**$75,112**	**567**	**$75,112**	**567**	**$75,112**	**$375,560**
Training Pruning Program[1] 3-year cycle	1-3"	$20							117	$2,347	117	$2,347	117	$2,347	117	$2,347	117	$2,347	$11,733
	4-6"	$30							137	$4,120	137	$4,120	137	$4,120	137	$4,120	137	$4,120	$20,600
	7-12"	$75							20	$1,475	20	$1,475	20	$1,475	20	$1,475	20	$1,475	$7,375
Activity Total(s)			**0**	**$0**	**0**	**$0**	**0**	**$0**	**255**	**$6,467**	**255**	**$6,467**	**255**	**$6,467**	**255**	**$6,467**	**255**	**$6,467**	**$32,333**
Pruning Totals			**270**	**$75,160**	**161**	**$42,240**	**458**	**$83,825**	**1174**	**$133,269**	**822**	**$81,579**	**822**	**$81,579**	**822**	**$81,579**	**822**	**$81,579**	**$660,808**
Planting Prgram																			
Recommended Planting Sites	Purchasing	$110	50	$5,500	50	$5,500	50	$5,500	50	$5,500	100	$11,000	100	$11,000	100	$11,000	100	$11,000	$66,000
	Planting	$110	50	$5,500	50	$5,500	50	$5,500	50	$5,500	100	$11,000	100	$11,000	100	$11,000	100	$11,000	$66,000
Activity Total(s)			**100**	**$11,000**	**100**	**$11,000**	**100**	**$11,000**	**100**	**$11,000**	**200**	**$22,000**	**200**	**$22,000**	**200**	**$22,000**	**200**	**$22,000**	**$132,000**
Recommended Removal Replacement	Purchasing	$110	10	$1,100	10	$1,100	10	$1,100	10	$1,100	10	$1,100	50	$5,500	50	$5,500	50	$5,500	$22,000
	Planting	$110	10	$1,100	10	$1,100	10	$1,100	10	$1,100	10	$1,100	50	$5,500	50	$5,500	50	$5,500	$22,000
Activity Total(s)			**20**	**$2,200**	**20**	**$2,200**	**20**	**$2,200**	**20**	**$2,200**	**20**	**$2,200**	**100**	**$11,000**	**100**	**$11,000**	**100**	**$11,000**	**$44,000**
Mortality Replacement	Purchasing	$110											58	$6,380	58	$6,380	58	$6,380	$19,140
	Planting	$110											58	$6,380	58	$6,380	58	$6,380	$19,140
Activity Total(s)			**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**116**	**$12,760**	**116**	**$12,760**	**116**	**$12,760**	**$38,280**
Planting Totals			**120**	**$13,200**	**120**	**$13,200**	**120**	**$13,200**	**120**	**$13,200**	**220**	**$24,200**	**416**	**$45,760**	**416**	**$45,760**	**416**	**$45,760**	**$214,280**
Cost Grand Total				**$161,025**		**$156,665**		**$155,875**		**$155,739**		**$153,979**		**$142,419**		**$142,419**		**$142,419**	**$1,210,538**

[1] The number of prunings will need to be updated to reflect trees planted and trees moving into the Routine Pruning Program.

[2] Starting in Year 6 the number of prunings will need to be updated to include trees prior listed as a Priority Prune.

Appendix D
Tree Care Costs

Diameter Size Class (Inches)	Estimated Removal Cost/Tree	Estimated Pruning Cost/Tree	Estimated Stump Removal Cost/Stump	Estimated Fertilization Cost/Tree	Estimated Mulching Cost/Tree
1 – 3	$25	$20	$25	$5	$11
4 – 6	$105	$30	$25	$18	$11
7 – 12	$220	$75	$25	$22	$14
13 – 18	$355	$120	$40	$30	$14
19 – 24	$525	$170	$60	$50	$20
25 – 30	$845	$225	$85	$60	$20
31 – 36	$1,140	$305	$110	$90	$28
37 – 42	$1,470	$380	$130	$120	$28
43+	$1,850	$590	$160	$150	$28

Appendix E
Arboriculture Planning Chart

ACTIVITY/TREATMENT	YEAR*	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
REMOVALS													
High Priority (Severe and High Risk in Inventory)	1, 2, and 3	X	X	X							X	X	X
Low Priority (Moderate and Low Risk in Inventory)	3	X	X	X							X	X	X
Removals (Anticipated Mortality)	2A	X	X	X							X	X	X
Stump Removal	1A	X	X	X							X	X	X
PRUNING													
High Priority (Severe and High Risk in Inventory)	1, 2, and 3	X	X	X							X	X	X
Large Tree Routine Pruning (Seven- Year Rotation)	1A	X	X	X							X	X	X
Small Tree Routine Pruning (Seven- Year Rotation)	1A	X	X	X							X	X	X
Young Tree Training Pruning (Three-Year Rotation)	1A	X	X	X							X	X	X
FERTILIZATION													
Macronutrient (N-P-K; Fair and Poor Condition Trees)	1A			X	X						X	X	
Macronutrient (N-P-K; Excellent and Good Condition Trees)	2			X	X						X	X	
Micronutrient (Fe/Mn Trunk Injection)	N					X	X	X	X				
Micronutrient (Fe/Mn Soil Treatment)	N												
PEST MANAGEMENT													
Scouting	1A				X	X	X	X	X	X			
Pesticide Treatments	N				X	X	X	X	X	X			
Pest Pruning	N												
TREE PLANTING													
Site Assessment	1A												
Ball & Burlap Container	1A			X	X	X				X	X	X	
Bare Root	1A			X	X	X							
Watering (New Trees)	1A			X	X	X	X	X	X	X	X	X	
Cabling and Bracing	N	X	X	X								X	X
Mulching	1A												
Weed Control	1A			X	X	X							
Watering (Older Trees)	1A							X	X	X	X		
INVENTORY													
Update Inventory	1A	X	X								X	X	X
Update Program	1A												
Update Plan	7												

Notes: Shaded areas indicate months where tasks can be completed operationally
* = Year task is recommended to be initiated/completed
X = Optimal biological time (or for cost-efficiency)

A = Continue on an annual basis after task is initiated
N = Implement on an as-needed basis

Appendix F
Work Specifications and Contracting Guidelines

CITY-WIDE STREET TREE PLANTING SPECIFICATIONS CITY OF _______________________________________, _______________________________________

I. Scope of Work

To provide all supervision, material, labor, equipment, service operations, and expertise required to deliver, locate, plant, and guarantee for one year, street trees in the City of ___________ as specified herein. Contractor has responsibility to:

A) Furnish, transport, and plant trees;

B) Reserve workspace along streets;

C) Excavate in-place soil, plant, and backfill with topsoil approved by City Administrator;

D) Furnish and place mulch;

E) Remove excess material and clean up site;

F) Guarantee trees for one year and make appropriate replacement planting;

G) Keep work site safe at all times; and

H) Any work incidental to above.

II. Definitions

A) Reference is any other specifications or standards means the latest revision in effect on date of invitation to bid. This set of specifications governs when disagreement with a reference specification occurs.

B) Specified means specified in the invitation to bid and/or order or contract.

C) ANSI Z60.1-Standards are American Standard for Nursery Stock.

D) City Administrator is the city's representative who will administer the technical aspects of this tree planting contract. The City Administrator for this contract is: __________________________.

E) Contractor is a company that earns the majority of its annual revenue from planting or maintaining trees and/or shrubbery. Contractor must possess an ISA *Certified Arborist* License or Certified Landscapers License or Certificate.

III. Materials Specifications

Mention of any product name neither constitutes an endorsement of that product nor excludes the use of similar products meeting specifications.

A) Nursery Stock - All trees healthy, vigorous, and well-grown, showing evidence of proper root and top pruning, single-trunked, high-branched specimens suitable for use along streets. All trees 1-3/4 inch caliper unless otherwise noted. All trees grown at least one year in a currently active nursery having same climatic conditions as the City of ______________. All trees meet ANSI Z60.1-standards for top grade. Label attached to each tree at nursery indicating botanical name and common name. City Administrator will mark trees in the nursery and has final approval of species or variety used and nursery from which trees are obtained.

B) Root balls and burlap - All trees balled and burlapped with ball shape and size conforming to ANSI Z60.1 standards. Root flare will be easily visible on root balls. Only rottable burlap and rottable rope permitted. Root balls adequately protected at all times from sun, heat, freezing, and drying. City Administrator will reject any cracked or manufactured root balls.

C) Mulch - Year-old rough wood chips created by local tree service companies during brush chipping operations.

IV. Work Procedures

A) Source of supply - Contractor submits to City Administrator, within ten (10) days after receipt of notice of award of contract, complete and detailed information concerning the source of supply for each item of plant material specified in the planting list.

B) Tree location - All planting sites will be identified and marked by the City Administrator before planting begins. The appropriate utilities services will be notified of planting site locations by Contractor immediately after contract has been awarded. Contractor will also be responsible for notifying the appropriate utility authority prior to digging. Contractor will be responsible for any damage to utilities during the planting process. Sites will be marked by a white flag in the grass area and also with a white mark painted on the curb. All trees will be centered between curb and sidewalk, at least two feet from curb line unless otherwise specified by the City Administrator.

C) Delivery - Trees shall be transported and handled with adequate protection. Trees shall be covered with burlap or tarpaulin during transit or transported in a closed truck to prevent drying out of the tree. Trees in leaf shall be sprayed before shipping with "Wiltpruf" or other anti-desiccant approved by the City Administrator.

D) Temporary storage - Root balls of trees not immediately planted after delivery must be adequately protected by mulch or heeling-in and watering until planting occurs. Contractor assumes all risk and expense of temporary storage.

E) Planting holes - Holes may be dug by hand, backhoe, tree spade, or other approved equipment at specified location. An auger is not considered approved equipment. Walls of the planting hole shall be dug so that they are properly sloped and sufficiently loosened to remove the glazing effects of the digging. The planting hole shall be elliptical in shape with the top diameter two times that of the ball. The bottom of the hole shall be rough, flat, and deep enough to have the plant at its original planting depth or slightly higher. Holes shall be ground only on the day the tree is planted. Contractor is responsible to ensure all holes are safe until planted and covered with mulch.

F) Precautions during digging - When underground utilities are encountered, Contractor immediately calls the controlling agency or company and the City of ____________. The Contractor, at his expense, restores to original condition all structures, facilities, and other property damaged by his company's work.

G) Surplus excavation - Removed and disposed of by Contractor at his own expense.

H) Planting - Allowed only between the dates of _______________ and _______________. Planting is only allowed when the soil is not frozen. Balled and burlapped trees are set on tamped backfill, placing tree at same depth as in nursery or up to two (2) inches higher than that level. Planting height may be adjusted if unusual site situations are encountered after approval by City Administrator. Burlap should be pulled back one-third the depth of the root ball and rope or twine should be cut from trunk. Trees with forked top oriented with forked limbs shall be pointed parallel to street and not toward street. Planting is not allowed on days when temperatures fall below 30° F.

I) Root pruning - Ends of broken or damaged roots more than 1/4 inch in diameter should be pruned with a clean cut, removing only injured portion.

J) Backfilling - Planting holes shall be backfilled with approved topsoil. Mix soil amendments in mixture prior to filling the hole to prevent stratification. Incorporate a transplant inoculant that contains water-absorbing material such as polymers, root stimulants, and endo- and ecto-mycorrhizal fungi into the backfill. Backfill sides of the tree hole halfway with soil mixture and tamp as the hole is being filled. Cut and remove all rope, twine, burlap, and wires from the top half of the soil ball. Wire baskets should be cut and removed to a two-inch depth below the soil line. Burlap should be pulled back with one-half of the soil ball exposed after plants are properly placed in the planting hole. Shape backfill and mulch in a water ring to facilitate watering.

K) Top pruning and wound treatment - Pruning to make trees shapely and typical of species shall be done according to recognized horticultural standards and instructions of the City Administrator. Accidental damage during planting not great enough to warrant branch removal or tree replacement should be promptly traced according to recognized horticultural practices. Pruning paint is not necessary.

L) Mulching - Place rough wood chips loosely around trees within 24 hours after planting to uniform depth of no more than four (4) inches and to a diameter of three (3) feet where possible.

M) Extra holes - Excess or improperly located planting holes are to be immediately backfilled and seeded with Kentucky bluegrass, and covered with two (2) inches of straw, at Contractor's expense.

N) Watering - Thoroughly water to settle backfill when one-half of backfill is in place and again after all backfill is placed. It is highly recommended that watering continue through the first growing season to increase chances of survival after planting.

O) Wrapping - Trees are not wrapped unless specified by the City Administrator. If wrapping is required, trunk and wrapping shall be treated with a 20 percent Lindane and water spray. Wrapping is crinkle-draft tree wrapping paper tied with rottable twine.

P) Productivity - Production schedule beginning and ending dates will be agreed upon in writing between the Contractor and the City Administrator.

Q) Supervision - Contractor is required to consult with the City Administrator concerning details and scheduling of all work. Contractor shall have a competent person in charge of work at all times to whom the City Administrator may issue directions and who is authorized to accept and act upon such directives. Supervisor calls the City Administrator before each day's work begins to provide work locations by street.

R) Public relations - An information sheet shall be supplied by the City Administrator to Contractor for distribution to property owner.

V. Substitutions

If a species or variety is used as a substitute with the approval of the City Administrator, the per tree price paid by the City is the lowest of:

A) The per tree price of the species or variety originally bid on; or

B) The lowest bid price for the substitute species or variety if it is specified elsewhere in this contract.

VI. Inspections

A) Nursery inspection - The City Administrator, at its discretion, will inspect and mark nursery stock purchased under this contract before digging.

B) Agency inspection - Federal, state, and other authorities inspect all trees before removal from nursery, as required by local law. Required certificates declaring trees free of all diseases and insects shall accompany each order or shipment of trees.

C) Planting inspection - The City Administrator, at its discretion, inspects progress of planting or temporarily stored trees to review the progress of the work and condition of trees.

D) Guarantee period inspection - The City Administrator inspects planting work to verify completion and begin guarantee period. Contractor requests this inspection in writing at least ten (10) days before its scheduled date. After inspection, the City Administrator notifies Contractor in writing of date of beginning of guarantee period or of deficiencies to correct before guarantee period begins.

E) Correction inspection - Two months before end of guarantee period, the City Administrator inspects work and notifies Contractor of replacement and other corrections required to make work acceptable.

F) Final inspection - At end of guarantee period, City Administrator inspects trees to determine final acceptance. Contractor requests this inspection in writing at least ten (10) days before the scheduled date.

G) Stock inspections - The City Administrator reserves right to inspect trees before they are removed from delivery truck at work site. Delivery truck driver or other agent or Contractor should call the City Administrator's office before leaving for work site each day to facilitate these on-truck inspections.

H) Other inspections - City Administrator reserves right to inspect on-site work at any time without notice. Contractor calls City Administrator on morning of each working day to provide work location.

VII. Guarantee

Contractor guarantees that all trees remain alive and healthy until the end of a one-(1) year guarantee period. Contractor replaces, as specified, and at his expense, any dead trees and any trees, that in the opinion of the City Administrator, have become unhealthy or unsightly or have lost their natural shape due to dead branches, improper pruning or maintenance, or any other cause due to the Contractor's negligence, or weather conditions. Contractor straightens any leaning trees, bearing the entire cost.

VIII. Rejection

Contractor disposes of any tree rejected by the City Administrator at the Contractor's expense.

IX. Items

Each entry (street name, estimated number of trees and species) within each section is considered a separate item. The City Administrator reserves the right to delete any item or items because of an inability to obtain specified trees or other reasonable cause.

TREE REMOVAL AND PRUNING SPECIFICATIONS CITY OF______________, ______________

I. Scope of Work

To provide all labor, supervision, equipment, services, and expertise necessary to perform urban forestry maintenance work in the City of _____________ as specified herein. Since this work is of a potentially dangerous nature, and requires special expertise, it is to be performed by a contractor that derives a majority of its annual income from arboricultural work and whose employees are highly trained and skilled in all phases of tree service work. Contractors must have been in business for at least five years. The City will require proof of Contractor's involvement in tree service work. The contractor has the responsibility to:

A. Remove or prune designated trees.

B. Reserve work space along streets.

C. Grind out stump when tree is to be removed.

D. Remove excess material and clean up site.

E. Guarantee that specifications be met.

F. Keep work site safe at all times.

II. Definitions

A. **Reference:** Reference to any other specifications or standards means the latest revision in effect on date of invitation to bid. This set of specifications governs when disagreement with a reference specification occurs.

B. **Specified:** Means specified in the invitation to bid.

C. **ANSI Z-133:** American Standard of Tree Worker Safety.

D. **ANSI A300:** Standard Practices for Trees, Shrubs, and Other Woody Plant Maintenance.

E. **City Administrator:** The City's representative who will administer the technical aspects of this tree pruning and removal contract. The City administrator for this contract is: __________________________.

F. **Contractor:** A company that earns the majority of its annual revenue for pruning, removing, or maintaining trees and/or shrubbery. Contractor must possess an ISA *Certified Arborist* License.

III. *Work Procedures*

A. **Equipment:** All bidders must have in their possession or available to them by formal agreement at the time of bidding: trucks, devices, chippers, hand tools, aerial, and other equipment and supplies which are necessary to perform the work as outlined in these specifications. The City may inspect such equipment or agreements prior to the awarding of a contract.

B. **Tree Location:** Work limited to trees located on all public rights-of-way and City-owned property. All work under this contract shall be assigned by supplying the Contractor with a list of trees that have been marked with blue paint for priority pruning or red paint if tree is to be removed. All other trees on list are to be pruned for vehicular and pedestrian traffic. The City reserves the right to change, add, or delete areas or quantities to be pruned or removed as it deems to be in its best interest. Pruning and removal operations will commence no later than thirty (30) days after the contract has been awarded and will be completed no later than 90 days after work has begun. The Contractor will be responsible for notifying the appropriate utility authority before removing trees growing in the utility wires. Contractor will be responsible for any damage to utilities during the removal or pruning process.

C. **Public Relations:** An information sheet will be sent by the City Administrator to the property owners.

D. **Supervision:** Contractor consults with the City concerning details of scheduling of all work. Contractor has a competent person in charge of his work at all times to whom the City may issue directives and who shall accept and act upon such directives, and who reads, speaks, and writes English competently. Failure for the supervisor to act on said directives shall be sufficient cause to give notice that the Contractor is in default of contract unless such directives would create potential personal injury of safety hazards. The City requires a *Certified Arborist* on the job site, and requires the arborist's certification number in this bid.

E. **Inspections:** The City is called at #____________ before 8:30 a.m. on mornings of each working day and told exact location of that day's work. The City inspects work at its discretion and is requested by letter, five days in advance of the completion of this contract, to provide a final inspection.

F. **Tree Damage:** Climbing irons, spurs, or spikes are not used on trees to be pruned. Any tree damage caused by contractor is repaired immediately at no additional expense to the satisfaction of the City Administrator. Trees damaged beyond repair, as judged by the City Administrator, are removed at no expense to the City and replaced by a tree of size and species designated by the City Administrator at no additional expense to the City or the dollar value of such damaged trees, as determined by the City Administrator, is deducted from the monies owed the Contractor.

G: **Pruning Specifications:** Conforms to latest revision of standards of National Arborist Association, ANSI A300. All cuts shall be made as close as possible to the trunk or parent limb, without cutting into the branch collar or leaving a protruding stub. Bark at the edge of all pruning cuts should remain firmly attached. All branches too large to support with one hand shall be precut to avoid splitting or tearing of the bark. Where necessary, ropes or other equipment should be used to lower large branches or stubs to the ground. Treatment of cuts and wounds with wound dressing or paints has not been shown to be effective in preventing or reducing decay and is not generally recommended for this reason. Wound dressing over infected wood may stimulate the decay process. If wounds are painted for cosmetic or other reasons, then material non-toxic to the cambium layer of meristematic tissue must be used.

Care must be taken to apply a thin coating of material only to exposed wood.

Old injuries are to be inspected. Those not closing properly and where the callus growth is not already completely established should be bark traced if the bark appears loose or damaged. Such tracing shall not penetrate the xylem (sapwood), and margins shall be kept rounded.

Equipment that will damage the bark and cambium layer should not be used on or in the trees. For example, the use of climbing spurs (hooks or irons) is not an acceptable work practice for pruning operations on live trees. Sharp tools shall be used so that clean cuts will be made at all times.

All cut limbs shall be removed from the crown upon completion of the pruning. Clean-up of branches, logs, or any other debris resulting from any tree pruning shall be promptly and properly accomplished. The work area shall be kept safe at all times until the clean-up operation is completed. Under no condition shall the accumulation of brush, branches, logs, or other debris be allowed upon a public property in such a manner as to result in a public hazard.

Trees impeding vehicle or pedestrian traffic should be raised up a least 13 feet over streets and 8 feet over sidewalks. Trees obstructing control devices (stop signs, yield signs, and traffic lights) should be trimmed to allow for adequate visibility.

H. **Removal Specifications:** Removals will include topping and other operations necessary to safely remove the assigned trees. No trees or trunks are felled onto pavement. Work includes removal of basal sprout and brush and weeds within three feet of the trunk. The tree stump will be ground out to a depth of six (6) inches below the normal surface level including all surface roots. Immediately after grinding each stump, the grindings must be removed from the work area. Adjacent sidewalks, lawns, streets, and gutters will be cleaned. Backfill consisting of clean earthen soil should be used to fill the cavity, free of debris, to normal ground level and seeded with an approved seeding mix. Do not backfill with wood chips. All labor, supervision, equipment, materials, and supplies necessary for the execution of this work must be provided for by the contractor at no additional cost to the city. All debris disposal must be provided by the contractor at no additional cost to the city. The chosen contractor will be required to follow the ANSI Z-133 Standards for tree worker safety. If a contractor is not aware of these standards, copies can be provided by the City of ____________.

I. **Traffic Control:** Is total responsibility of Contractor and is coordinated with the proper department of the City of _____________.

The contractor shall be solely responsible for pedestrian and vehicular safety and control within the work site and shall provide the necessary warning devices, barricades, and personnel needed to give safety, protection, and warning to persons and vehicular traffic within the area.

Blocking of public streets shall not be permitted unless prior arrangements have been made with the City and is coordinated with the appropriate departments. Traffic control is the responsibility of the Contractor and shall be accomplished in conformance with State, County, and Local highway construction codes.

J. **Utility Agencies:** Are contacted by Contractor any time assistance is needed to work safely around overhead or underground installations. The City provides a list of principal contacts and telephone numbers for public and private utility organizations.

Tree trimming and removal operations may be conducted in areas where overhead electric, telephone, and cable television facilities exist. The Contractor shall protect all utilities from damage, shall immediately contact the appropriate utility if damage should occur, and shall be responsible for all claims for damage due to his operations.

The Contractor shall make arrangements with the utility for removal of all necessary limbs and branches that may conflict with or create a personal injury hazard in conducting the operations of this contract. If the Contractor has properly contacted the utility in sufficient time to arrange for the required work by the utility, delays encountered by the Contractor in waiting for the utility to complete its work will not be the responsibility of the Contractor.

K. **Safety:** Work conforms to the latest revision of American National Standards Institute Standard Z-133.1 (Safety Requirement for Pruning, Trimming, Repairing, Maintaining, Removing Trees, and for Cutting Brush).

At the time a contract is entered into, the Contractor shall certify in writing to the City that all Contractor's employees working on this job are either ‘Qualified Line Clearance Tree Trimmers’ or ‘Qualified Line Clearance Tree Trimmer Trainees’, as defined in the above ANSI Z-133.1 Standards.

L. **Clean-Up:** Clean-up procedures are completed within two hours after debris have been placed around the site of each tree requiring pruning or removal. The work site is left equal to or cleaner than pre-work conditions. Tree parts dropped or lowered from trees are kept off private property.

It shall be the responsibility of the Contractor to remove and dispose in a proper and acceptable manner all logs, brush, and debris resulting from the tree maintenance operations. Wood may be left for residents, but that not taken must be disposed.

M. **Damages:** Done by the Contractor to any person or property, public or private, are the total responsibility of the Contractor and are repaired or compensated for by the Contractor to the satisfaction of both injured party and the City at no cost to the City.

N. **Insurance:** Contractor shall be fully insured as specified and shall be completely covered by State Workers' Compensation during the life of this contract. The Contractor shall have liability insurance in the amount of $1,000,000.00 for each occurrence and shall name the City as an additional insured on its policy for the work being performed in the City of ____________.

O. **Payments:** Partial billings are acceptable, but not more frequently than every two weeks. Payment is made according to actual number of stumps removed. Ten percent (10%) of each invoice is withheld until Contractor's work is completed to the satisfaction of the City. Billing for work along any street may not be made until Contractor completes all work on that street. At the discretion of the city, one-half of the ten percent (10%) retainer may be held until spring if enough snow is on the ground that a proper inspection of sites cannot be conducted. When an inspection is done and the Contractor, as directed by the City, corrects any problem that may occur, the remainder of the retainer will be paid.

P. **Working Hours:** The Contractor will schedule work between the hours of 7:00 a.m. and 6:00 p.m. Monday through Friday unless authorized by the City to do otherwise.

Q. **Subcontracts:** The Contractor will not be allowed to subcontract work under this contract unless written approval is granted by the City. The Subcontractor, as approved, shall be bound by the conditions of the contract between the City and the Contractor. The authorization of a Subcontractor is to perform in accordance with all terms of the contract and specifications. All directions given to the Subcontractor in the field shall bind the Contractors as if the notice had been given directly to the Contractor.

R. **Execution of Contract:** The successful Bidder shall, within five (5) calendar days of the mailing of written notice of selection as the successful bidder, enter into contract with the City on forms included within the bidding documents for the performance of work awarded him and shall simultaneously provide the appropriate bonds, indemnities, and insurance required hereunder.

The contract, when executed, shall be deemed to include the entire agreement between the parties; the Contractor shall not base any claim for modification of the contract upon any prior representation or promises made by representatives of the City, or other persons.

S. **Discontinuance of Work:** Any practice obviously hazardous as determined by the City shall be immediately discontinued by the Contractor upon receipt of either written or oral notice to discontinue such practice.

T. **Observance of Laws, Ordinances, and Regulations:** The Contractor, at all times during the term of this contract, shall observe and abide by all Federal, State, and Local laws which in any way affect the conduct of the work and shall comply with all decrees and orders of courts and competent jurisdiction. The Contractor shall comply fully and completely with any and all applicable State and Federal Statutes, rules, and regulations as they relate to hiring, wages, and other applicable conditions of employment.

U. **Supervision:** This contract will be under the direct supervision of the City or its authorized representatives. Any alteration or modifications of the work performed under this contract shall be made only in written agreement between the Contractor and the City-authorized representative and shall be made prior to commencement of the altered or modified work. No claims for extra work or materials shall be allowed unless covered by written agreement.

V. **Bidding Specification and Contractual Terms:** Tree maintenance work done under the direction of this contract shall be bid on forms as provided by the City.

W. **References:** Municipal tree pruning and removal experience is required. The bidder will provide a list of municipal governments that it has serviced in the past five years with a contact person listed.

X. **Award:** For a bid to be considered, prices must be quoted for the entire pruning and removal project.

Y. **Contract Termination:** The City shall have the right to terminate a contract or a part thereof before the work is completed in the event:

i. Previous unknown circumstances arise making it desirable in the public interest to void the contract;

ii. The Contractor is not adequately complying with the specifications;

iii. Proper arboricultural techniques are not being followed after warning notification by the City or its authorized representatives;

iv. The Contractor refuses, neglects, or fails to supply properly trained or skilled supervisory personnel and/or workers or proper equipment of the specified quality and quantity;

v. The Contractor in the judgment of the City is unnecessarily or willfully delaying the performance and completion of the work;

vi. The Contractor refuses to proceed with work when as directed by the City; or

vii. The Contractor abandons the work.

Z. **Indemnification:** I, the Contractor, agree to indemnify, hold harmless, and defend the City from and against any and all loss, damage, or expense which the City may suffer or for which the City may be liable by reason of any injury (including death) or damage to any property arising out of negligence on the part of the Contractor in the execution of the work to be performed hereunder.

This indemnity provision shall not apply in cases where the Contractor has not been provided with timely notice, nor shall the Contractor be liable to the City for any settlement of any complaint affected without the prior written consent of the Contractor. This indemnity provision also specifically does not apply to loss, damage, or expense arising out of contact with the City's trees by persons (other than employees of the Contractor engaged in the work contemplated by this agreement) who are around such trees.

STUMP REMOVAL SPECIFICATIONS
FOR DEPARTMENT OF PUBLIC SERVICE
CITY OF ________________, _________________

I. Scope of Work

To provide all labor, supervision, equipment, services, and expertise necessary for grinding of stumps, disposal of grindings and debris, and backfilling of stump holes in the City of ____________ as specified herein. Since the work is potentially dangerous, and requires special expertise, it is to be performed by a Contractor that derives a majority of its annual income from arboricultural work and whose employees are highly trained and skilled in all phases of tree service work. Contractors must have been in business for at least five years. The City may require proof of the Contractor's involvement in tree service work.

The Contractor has the responsibility to:

A. Reserve work space along streets;

B. Grind out designated stumps;

C. Remove excess material and clean up the work site;

D. Guarantee the specifications will be met; and

E. Keep work site safe at all times.

All bidders must have in their possession or available to them by formal agreement at the time of bidding: trucks, stump grinders, hand tools, and other equipment and supplies that are necessary to perform the work as outlined in these specifications.

II. Location

Work is limited to stumps located on all public rights-of-way and City-owned property. All work under this contract shall be assigned by supplying the Contractor with a list of stumps that have been marked with the diameter of the stump.

The City reserves the right to change, add, or delete areas or quantities of stumps to be removed as it deems necessary. Stumping operations will commence no later than five (5) days after the contract has been awarded and will be completed no later than _____________.

III. Supervision

Contractor consults with the City concerning details of scheduling of all work. Contractor has a competent person in charge of his work at all times to whom the City may issue directives and who shall accept and act upon such directives, and who reads, speaks, and writes English competently.

Failure for the supervisor to act on said directives shall be sufficient cause to give notice that the Contractor is in default of contract unless such directives would create potential personal injury of safety hazards. The City requires a *Certified Arborist* on the job site, and requires the arborist's certification number in this bid.

IV. Inspections

The City is called at #______________ before 8:30 a.m. on mornings of each working day and told exact location of that day’s work. The City inspects work at its discretion and is requested by letter, five days in advance of the completion of this contract, to provide a final inspection.

V. Stump Grinding

The tree stumps will be ground out to a depth of six (6) inches below the normal surface level including all surface roots. Immediately after grinding each stump, the grindings must be removed from the work area. Adjacent sidewalks, lawns, streets, and gutters will be cleaned. Holes are not to be left open overnight. Backfill consisting of clean earthen soil should be used to fill in the cavity, free of debris, to four (4) inches above the existing lawn grade surrounding the stump site (to allow for settling) and seeded with an approved seeding mix. Do not backfill with wood chips.

All labor, supervision, equipment, material, and supplies necessary for the execution of the work must be provided for by the Contractor at no additional cost to the City. All debris disposal must be provided by the Contractor at no additional cost to the City.

The chosen Contractor will be required to follow the ANSI Z-133 Standards for tree worker safety. If a Contractor is not aware of these standards, copies can be provided by the City of _____________.

VI. Traffic Control

Is total responsibility of Contractor and is coordinated with the proper department of the City of _____________.

The Contractor shall be solely responsible for pedestrian and vehicular safety and control within the work site and shall provide the necessary warning devices, barricades, and personnel needed to give safety, protection, and warning to persons and vehicular traffic within the area.

Blocking of public streets shall not be permitted unless prior arrangements have been made with the City and is coordinated with the appropriate departments. Traffic control is the responsibility of the Contractor and shall be accomplished in conformance with State, County, and Local highway construction codes.

VII. Utility Agencies

Are contacted by Contractor any time assistance is needed to work safely around overhead or underground installations. The City provides list of principal contacts and telephone numbers for public and private utility organizations.

The Contractor shall protect all utilities from damage, shall immediately contact the appropriate utility if damage should occur, and shall be responsible for all claims for damage due to his operations. It is left to the Contractor's discretion to notify the appropriate utility authority before stump removal begins. If the Contractor has properly contacted the utility in sufficient time to arrange for the required work by the utility, delays encountered by the Contractor in waiting for the utility to complete its work will not be the responsibility of the Contractor.

VIII. Damages

Done by the Contractor to any person or property, public or private, are the total responsibility of the Contractor and are repaired or compensated for by the Contractor to the satisfaction of both injured party and the City at no cost to the City.

IX. Insurance

Contractor shall be fully insured as specified and shall be completely covered by State Workers' Compensation during the life of this contract. The Contractor shall have liability insurance in the amount of $1,000,000.00 for each occurrence and shall name the City as an additional insured on its policy for the work being performed in the City of ____________.

X. Payments

Partial billings are acceptable, not more frequently than every two weeks. Payment is made according to actual number of stumps removed. Ten percent (10%) of each invoice is withheld until Contractor's work is completed to the satisfaction of the City. Billing for work along any street may not be made until Contractor completes all work on that street. At the discretion of the city, one-half of the ten percent (10%) retainer may be held until spring if enough snow is on the ground that a proper inspection of sites cannot be conducted. When an inspection is done and the Contractor, as directed by the City, corrects any problem that may occur, the remainder of the retainer will be paid.

XI. Working Hours

The Contractor will schedule work between the hours of 7:00 a.m. and 6:00 p.m. Monday through Friday unless authorized by the City to do otherwise.

XII. Subcontracts

The Contractor will not be allowed to subcontract work under this contract unless written approval is granted by the City. The Subcontractor, as approved, shall be bound by the conditions of the contract between the City and the Contractor. The authorization of a Subcontractor is to perform in accordance with all terms of the contract and specifications. All directions given to the Subcontractor in the field shall bind the Contractors as if the notice had been given directly to the Contractor.

XIII. Execution of Contract

The successful Bidder shall, within five (5) calendar days of the mailing of written notice of selection as the successful bidder, enter into contract with the City on forms included within the bidding documents for the performance of work awarded him and shall simultaneously provide the appropriate bonds, indemnities, and insurance required hereunder. The contract, when executed, shall be deemed to include the entire agreement between the parties; the Contractor shall not base any claim for modification of the contract upon any prior representation or promises made by representatives of the City, or other persons.

XIV. Discontinuance of Work

Any practice obviously hazardous as determined by the City shall be immediately discontinued by the Contractor upon receipt of either written or oral notice to discontinue such practice.

XV. Observance of Laws, Ordinances, and Regulations

The Contractor, at all times during the term of this contract, shall observe and abide by all Federal, State, and Local laws which in any way affect the conduct of the work and shall comply with all decrees and orders of courts and competent jurisdiction. The Contractor shall comply fully and completely with any and all applicable State and Federal Statutes, rules, and regulations as they relate to hiring, wages, and other applicable conditions of employment.

XVI. Supervision

This contract will be under the direct supervision of the City or its authorized representatives. Any alteration or modifications of the work performed under this contract shall be made only in written agreement between the Contractor and the City-authorized representative and shall be made prior to commencement of the altered or modified work. No claims for extra work or materials shall be allowed unless covered by written agreement.

XVII. Bidding Specification and Contractual Terms

Stump work done under the direction of this contract shall be bid on forms as provided by the City.

XVIII. Award

For a bid to be considered, prices must be quoted for the entire stump removal project.

XIX. Contract Termination

The City shall have the right to terminate a contract or a part thereof before the work is completed in the event:

A. Previous unknown circumstances arise making it desirable in the public interest to void the contract;

B. The Contractor is not adequately complying with the specifications;

C. Proper arboricultural techniques are not being followed after warning notification by the City or its authorized representatives;

D. The Contractor refuses, neglects, or fails to supply properly trained or skilled supervisory personnel and/or workers or proper equipment of the specified quality and quantity;

E. The Contractor in the judgment of the City is unnecessarily or willfully delaying the performance and completion of the work;

F. The Contractor refuses to proceed with work when as directed by the City; or

G. The Contractor abandons the work.

XX. Indemnification

I, the Contractor, agree to indemnify, hold harmless, and defend the City from and against any and all loss, damage, or expense which the City may suffer or for which the City may be liable by reason of any injury (including death) or damage to any property arising out of negligence on the part of the Contractor in the execution of the work to be performed hereunder.

This indemnity provision shall not apply in cases where the Contractor has not been provided with timely notice, nor shall the Contractor be liable to the City for any settlement of any complaint affected without the prior written consent of the Contractor. This indemnity provision also specifically does not apply to loss, damage, or expense arising out of contact with the City's stumps by persons (other than employees of the Contractor engaged in the work contemplated by this agreement) who are around such stumps.

CITY WIDE STREET TREE FERTILIZATION SPECIFICATIONS
CITY OF ______________, ______________

I. Scope of Work

To provide all supervision, material, labor, equipment, service operations, and expertise required to fertilize street trees in the City of ____________ as specified herein. Contractor has responsibility to:

A) Furnish, transport, and apply water-soluble fertilizer;

B) Reserve work space along streets;

C) Use hydraulic sprayer and soil probe or lance at 100-200 PSI;

D) Remove excess material and clean up site;

E) Keep work site safe at all times; and

F) Any work incidental to above.

II. Material Specifications

Section A: Types of Fertilizer to be Used

1. Inorganic Fertilizer (Chemical) - Is that derived from chemical sources. These nutrients are readily available in the soil and are rapidly soluble, with a short residual period.
2. Soluble Fertilizer - Is mixed with water and applied in liquid form. Soluble fertilizers may be applied via the deep root feeding method. Soluble fertilizers are usually inorganic and readily available. Materials with a limited solubility that dissolve slowly are often listed on fertilizer labels as water-insoluble nitrogen (WIN).

Section B: Fertilizer Analysis

1. Established Plantings - use fertilizers with N-P-K ratios of 3-1-2 or 3-1-1 for best response. These formulations may have slight variations.
2. Inorganic (water-soluble) nitrogen should be supplemented with synthetic or organic nitrogen (WIN) for the slow availability characteristics of the insoluble form of the material.

Section C: Rates of Application

1. For optimum plant growth, apply 4-6 lbs. of actual nitrogen per 1,000 sq. ft. every two years.
2. Diameter at Breast Height (DBH) - Measure the trunk diameter at 4.5 feet above grade. Generally for optimum growth, apply 1/4 lb. actual nitrogen per inch DBH to trees under 6 inches in diameter. The rate can be increased to 1/2 lb. N per inch DBH for most trees over 6 inches DBH. The majority of the trees to be fertilized in this project will be 2- to 4-inch DBH. Using a 3-inch DBH tree and fertilizing with 1/4 lb. actual N per inch DBH would require 4.2 lbs. of an 18-5-11 complete fertilizer:

   3 inches (dia) x 0.25 lb/inch (rate) = 0.75 lb. (amount of N).

   0.75 lb. (amount of N) / 0.18 (%N in 18-5-11) = 4.166 lbs of 18-5-11.

3. Liquid application - Diluted fertilizer solutions should be applied at the rate recommended by the manufacturer according to operating pressure and flow rate of the equipment to be used. Apply sufficient liquid mixture to supply the required rate of fertilizer as determined by the surface area of DBH method. It is suggested that one apply 150 gallons to each 2,000 sq. ft. of surface area. Inject approximately 1/2 gallon of fertilizer solution per injection at 2.5-ft. spacings.

Section D: Timing of Fertilizer Applications

Early spring before budbreak is the recommended time for fertilizing. Fertilizing should not be done after leaves have fully expanded.

Section E: Method of Fertilizer Application

Liquid Injection - Injections using a soil probe or lance should be 2.5 feet apart, and 6-12 inches deep for trees. Begin lance injection 2-3 feet from the tree trunk and work out about 8 feet beyond the trunk or to the sidewalk or other hardscape obstacle, whichever is farthest. Use a hydraulic sprayer at 100-200 lbs. pressure and soil lance designed for liquid fertilizer with a manual shut-off valve and three or four horizontal discharge holes at 90 degrees in its point. Inject one-half a gallon of fertilizer solution into each hole. The addition of water to dry soil as occurs during the liquid injection process is an excellent side-benefit.

Section F: Additional Guidelines

1. Undesirable tree species that could be found on tree lawns or on public rights-of-way should not be fertilized. These are: silver maple, boxelder, alder, birch, catalpa, redbud, Russian-olive, osage-orange, apple, mulberry, poplar, cottonwood, cherry plum, black cherry, black locust, sassafras, willow, and elm.

2. Be aware that overfertilizing small trees such as flowering crabapple can result in excessive succulent growth. Succulent growth is more prone to fireblight symptoms on susceptible plants such as pear, crabapple, and mountain ash.

3. Fertilize in moist soils - Fertilizer should always be applied in moist soils to enhance fertilizer uptake and reduce fertilizer injury to plants and aid in soil injection treatment. If soils are not moist, irrigation should precede fertilization to moisten the plant root zone area. The liquid injection method of fertilizing trees will help moisten the soil in the root zone while applying desired nutrients.

4. Fertilizing Excessively Wet Soils - Avoid fertilizing trees growing in soil that is excessively wet. The roots in wet soil are often damaged from lack of oxygen caused by the accumulation of toxic gases. Adding fertilizer in any form may contribute to root injury.

5. Read the Label - Read the entire label of any fertilizer product before application and apply per label recommendations.

Contracting Tree Work

Tree care companies can be utilized to perform work beyond the capabilities of municipal manpower and equipment. Some of the advantages of using contracted crews to do tree work are:

- Does not require an increase in municipality personnel or re-training of existing personnel.
- Does not require large capital expenditures on equipment.
- Allows for greater flexibility in scheduling tree care operations.
- Allows the amount of work performed on an annual basis to be adjusted based on available municipality budget, without laying off municipality personnel.

A municipality can most cost-effectively contract tree work by:

- Scheduling work in the winter months, since this is traditionally the slow season for tree care companies. Companies may offer reduced rates (10% to 20%) for off-season work to keep their employees on the payroll.
- Performing work on a project basis. In this way, the tree care company is guaranteed a certain dollar volume of work, and the municipality is guaranteed specific work rates. Tree companies may offer a reduced rate (5% to 15%) for fixed-volume business.

Contracting of Tree Care on a Project Basis

To secure the best possible prices, Davey Resource Group recommends contracting on a project-by-project basis. Projects can include work on an individual tree or work on a group of trees, based on either the type of maintenance to be performed or by location of work. In the first example, all of the removals can be identified as a project, and bids can be solicited for the performance of the removals alone within a specific timeframe. Ideally, bids for work should be on a per tree basis by diameter class. In the second example, the maintenance for all trees on several streets can be identified as a single project and bids solicited for the entire project. There are many variations of this concept for contracting tree care, and the municipality can select the method that best suits its requirements. Project planning should focus on the efficient use of workers and equipment by the selected contractor. This will aid the municipality in obtaining the best pricing for tree care projects.

It is important to consider more than just pricing when selecting a tree care contractor. Contractors should be required to post performance bonds on projects over a certain dollar amount; should show proof of adequate general liability and workers' compensation insurance; should be able to demonstrate sufficient ability to perform the work as specified; should hold all necessary licenses, such as pesticide application certification; and should be able to provide references to past work that is similar to the work specified for the project. In addition, the municipality should maintain awareness of any public relations problems involving the contractor's work procedures, equipment, and personnel appearance. Such problems or potential problems should be remedied as soon as possible.

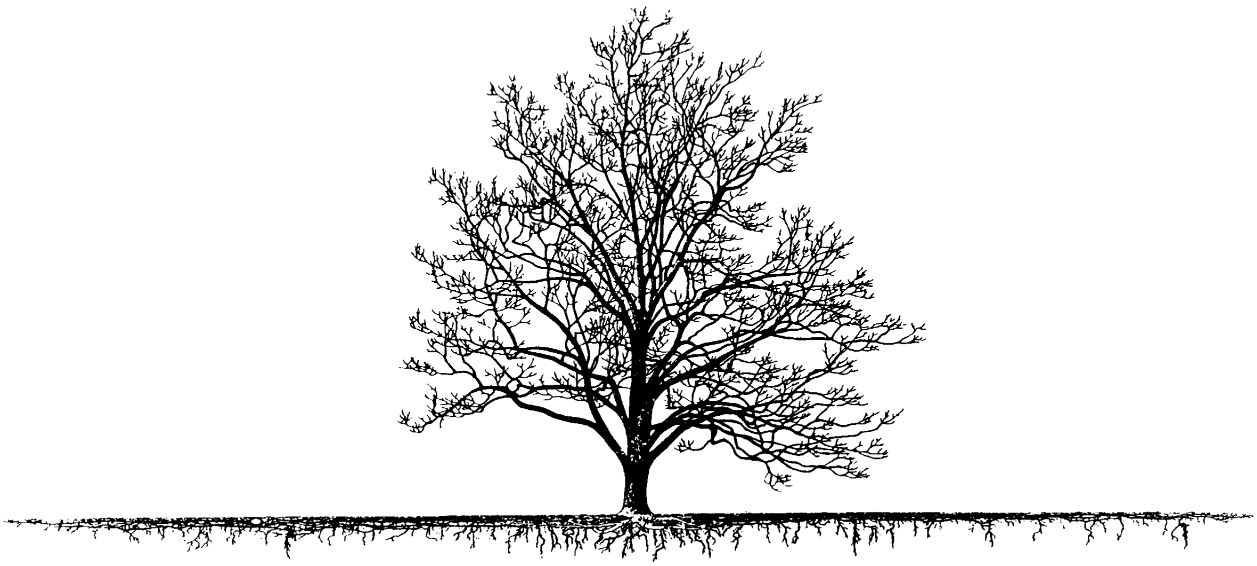
Recommendations for Contractor Crew Inspection

When inspecting contractor tree crew operations, the municipality should make sure the crews follow the guidelines set forth in contract specifications for the work being performed. These specifications should be developed and approved by the municipality to ensure quality performance by contractors. Following these guidelines should result in improved pruning procedures and safe work practices. The inspection process should ensure that the contractual procedures are followed. Examples include:

- Climbing crews do not use climbing spikes except for tree removals.
- All pruning cuts are made according to specifications. Pollarding, framing, or rounding over is not acceptable practice.
- Work operations are properly protected with traffic cones, pedestrian barriers, and flaggers to prevent injury to crew personnel and the general public, and to prevent damage to adjacent property.

Appendix G
Tree Pruning Guidelines

Tree Pruning Guidelines



Introduction

Pruning consists of *selectively* removing branches (living and dead) from woody plants, ranging from pinching off a bud at the end of a twig to removing large limbs.

Proper pruning benefits trees, shrubs, and vines, and the associates of woody plants (including humans). Pruning branches can be one of the most beneficial or the most damaging practices arborists do to trees.

A basic principle of pruning is that the removal of any live stems, branches, twigs, and buds affects growth of the plant. Proper pruning prevents and corrects defective form that could result in branch or stem failure. Thus, knowledge of plant biology is essential for the correct methods of Davey pruning.

Most tree species evolved in competitive forest communities. Consequently, trees developed efficient branching systems to capture the energy of available light for photosynthesis.

Woody plants also evolved the ability to get rid of inefficient energy resources by *shedding* shaded branches (cladaptosis). A branch is naturally shed from its base. As natural shedding occurs, the wood tissue around the branch core within the stem protects against decay. Davey's limb removal cuts imitate natural branch shedding (natural target pruning).

Many people equate woody plant pruning to amputation, but there should be no fear of wise and careful use of pruning equipment. A properly pruned tree, shrub, or vine is a combination of art, science, and skill.

Davey Tree surgeons adhere to Davey and industry pruning standards. In the arboriculture industry, the current standard approved by the ISA and the NAA is *The American National Standards Institute* (ANSI) A300 issued in 1995. Davey Residential Operations adhere to the National Arborist Association (NAA) *Pruning Standards for Shade Trees* (revised 1988) where four classes of pruning are defined. The NAA classes appear in a condensed version on the back of the Davey Plant Health Care quote/work order forms printed before 1996.

Reasons for Pruning

The first rule in pruning is **do not cut without a reason**. Too often arborists tend to over-prune to meet client expectations. Proper pruning is an effort to *direct* new growth rather than ‘control’ growth.

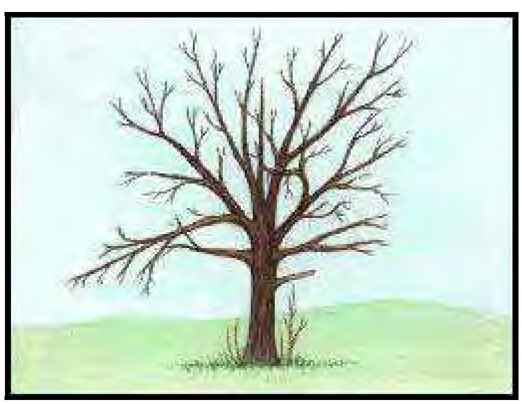
Most pruning cuts are of a *preventive* or *corrective* nature to be beneficial to woody plant health.

Health

- *Sanitation* by removing dead, broken, decayed, diseased, or insect-infested wood (crown cleaning).
- *Thinning* to improve penetration of light and air, and to reduce wind resistance and potential storm damage.
- Reduction of the number of poorly attached *epicormic branches.*
- *Girdling root* removal.
- Correct and/or redirect *structural growth* that may cause future problems (weak crotches, branches growing out of proportion, etc.).

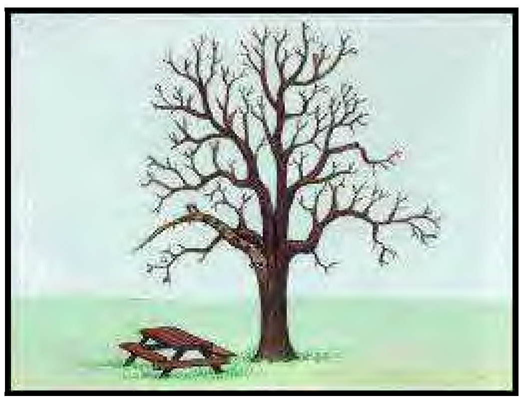
Appearance

- Shape for aesthetic purpose, natural forms, growth habit (training).
- Influence flowering, fruiting, promotion of shoots, canes, bark color.
- Direct new growth and/or correct improper prior pruning (crown restoration).



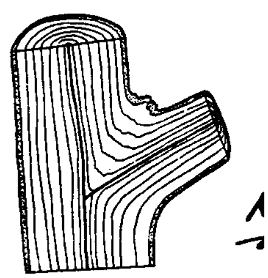
Convenience or Safety of Property and People

- Correct or modify storm-damaged, neglected, or poorly pruned woody plants.
- Identify and remove potential hazard limbs, stems, and deadwood (hazard reduction pruning).
- Line clearance (directional pruning).
- Raise or lower obstructive canopies over or near roads, sidewalks, playgrounds, buildings, pools, satellite dishes, etc. by removing interfering limbs (crown reduction and/or crown raising).
- Provide access to more light for understory plants and turf (crown thinning).
- Vista pruning (alter crowns to allow views of something beyond tree screens).



Pruning Methods and Techniques

Branch Attachment to Stems



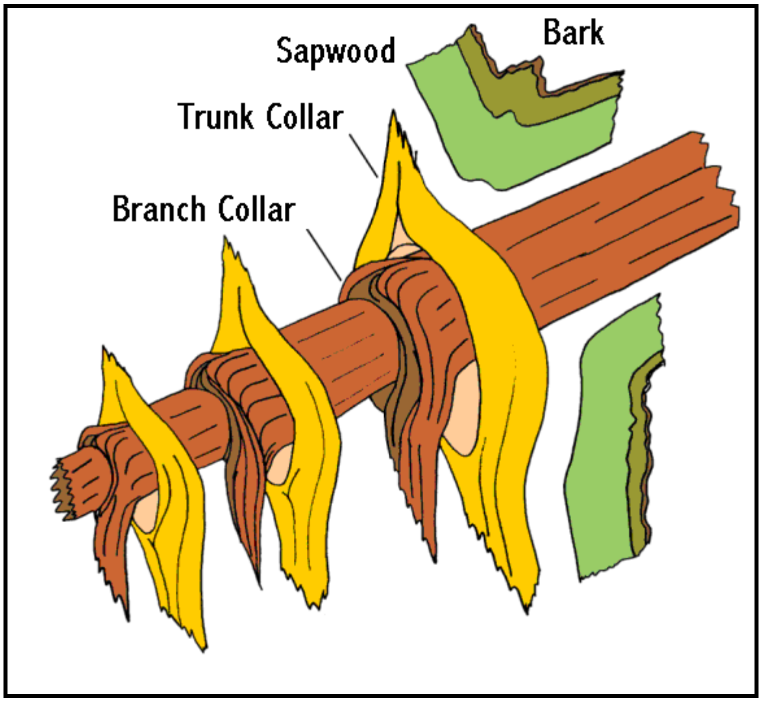
New branch tissues generated by the vascular cambium usually start growth before trunk tissues. As current-year branch tissue develops from branch ends toward the trunk, it turns abruptly downward at the branch base to form a *collar*.

Trunk branch tissues grow later and form a trunk collar over the branch collar (trunk collars and branch collars are collectively called the *branch collar*).

The collar is where wood and bark of the branch and the trunk come together, like an overlapping tissue 'switching zone'. All true branches on woody plants have branch collars.

The *branch bark ridge* (BBR) is raised bark developing in the branch crotch and shows the angle of the branch core in the tree.

If a branch dies or is removed, the trunk collar continues to grow over the thin belt of branch tissue below the collar junction. The wood core of the branch is walled off (compartmentalized) in the trunk.



Proper Pruning Cuts (Natural Target Pruning)

Location of *branch bark ridges* and *branch collars* determines the location of a pruning cut. Cuts must be made *outside* of the branch bark ridge, angling away from the trunk outward as close as possible to the collar.

- There is no set or standard angle for a proper collar cut.
- The proper angle depends on the shape of the collar.
- Conifers often have flat collars where a straight cut close to the collar is correct.
- Sometimes the angle of the cut will necessitate an *upstroke* cut with a handsaw or chainsaw.

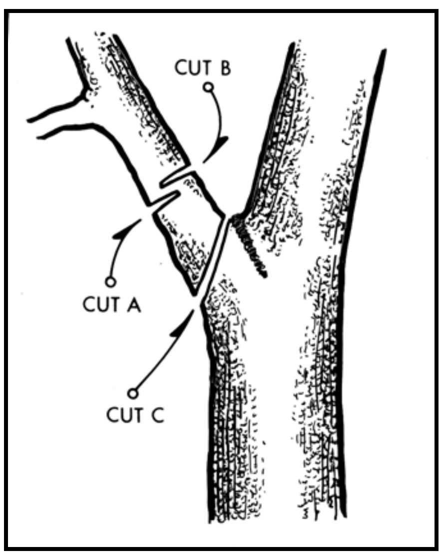
Do not cut into the collar to stimulate callus production and rapid closure. Although closure is desirable for appearance, such a cut promotes decay and future hazards. Never put a pruning tool behind the branch bark ridge.

Whether a branch collar is obvious or not, the position of the final or finish cut should:

- Minimize the branch stub that is an entryway for decay fungi.
- Retain the natural decay protection present in the branch core. The intact branch collar is the first line of defense in preventing decay within the trunk.
- Minimize the overall size of the pruning wound and direct damage to the stem.

Always **stub cut** the branch first. Limbs that cannot be controlled must be removed using at least **three** cuts. Roping of limbs may be necessary to prevent damage to other parts of the tree if they cannot be controlled by hand.

1. The first cut (Cut A) **undercuts** the limb one or two feet out from the parent branch or trunk. A properly made undercut will eliminate the chance of the branch 'peeling' or tearing bark as it is removed.
2. The second cut (Cut B) is the **top cut** which is usually made slightly further out on the limb than the undercut. This allows the limb to drop smoothly when the weight is released.
3. The third cut (Cut C) or **finish cut** is to remove the stub.



Each finish cut should be made carefully, outside of the branch bark ridge and the evident collar, leaving a smooth surface with no jagged edges or torn bark.

There are some situations where the cambium dies back beneath a branch collar after a correct cut:

- The trunk collar did not join the branch collar directly below the branch. Sunken spots under branches are a sign of this condition.
- Winter cuts may result in undercollar dieback.
- Problem tends to increase with size of branches removed.

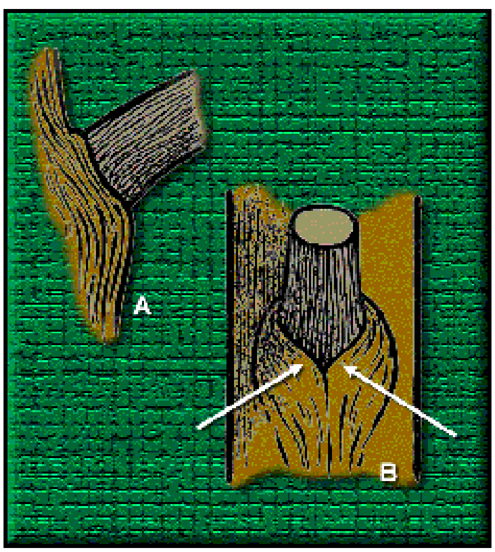
Callus and Woundwood

Callus is undifferentiated meristematic tissue that forms at wound margins from the cambium.

Callus differentiates into *woundwood* over time. Woundwood is 'new wood' and has the different cell components of periderm, cambium, phloem, and xylem.

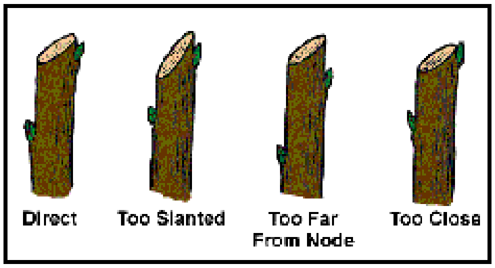
A *complete* ring of callus and subsequent woundwood will develop around and eventually over proper cuts. Woundwood forms only to the sides of improper cuts (flush cuts), which means the collar and branch protection zone is damaged and the trunk is wounded.

A proper pruning cut results in a smaller wound area, and more rapid callus and woundwood movement over the wound. Cuts on dead limbs that have trunk collars moving up the dead branch wood must also be made just outside of the evident collar.



- Appropriate only for small woody plants or one- to two-year-old branches (twigs, branchlets) on trees.
- Cut back to a bud (lateral bud) or lateral branchlet, slanting at a 45° angle above the bud *node* on alternately arranged branches and stems.

- Two or more buds at a node (opposite, whorled) require a *transverse* cut just above the bud tips or a 45° angle cut, removing one of the buds and leaving the other(s) to elongate in a desired direction.
- Cut 1/8" higher above the bud tips when pruning in cold weather to prevent winter injury to the bud (tissue around a winter cut is more vulnerable to desiccation).



- Leaving a majority of *inward* facing buds produces growth towards center.
- Leaving a majority of *outward* facing buds results in more open growth.

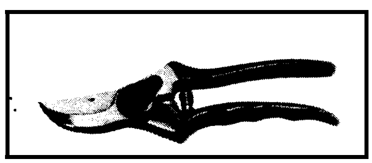
Pruning Tools

Use **well-sharpened** tools for both your safety and to help reduce tearing of wood and cambial tissues. Wear specified protective equipment.

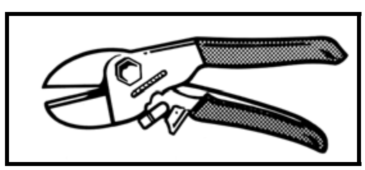
Pruning Shears

Hand shears, secateurs, hand pruners, one-hand shears:

- Remove branches, stems up to 1/2" diameter.
- By-pass (hook and blade, scissors, drop-forge, curve blade): make closer cuts than anvil-type.



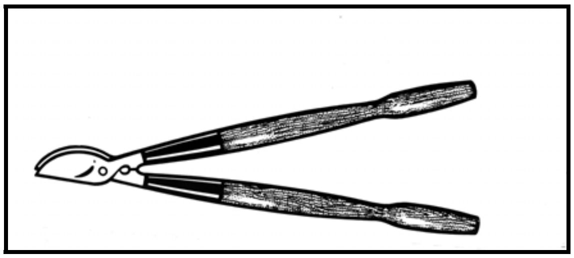
- Anvil (straight-blade): good for only soft-tissued wood; will crush harder wood (inappropriate per A300 standards).



Lopping shears

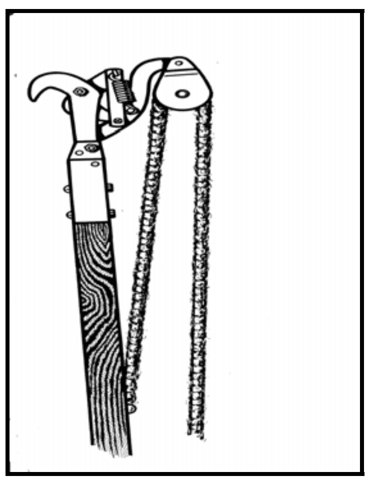
Two-hand shears:

- Remove branches, stems up to 1-3/4" diameter.
- Most useful in rejuvenation.
- By-pass, hook, and blade, etc.
- Anvil, straight-blade.
- Ratcheting.



Pole Pruners

- Wood and insulated poles (round and squared).
- Cut like by-pass shears.
- Important to keep blade side in toward the cut.



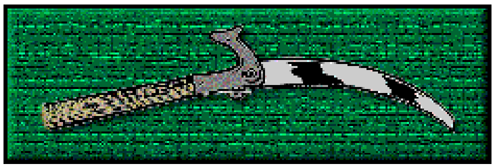
Cut at the outer side of the branch bark ridge at a slightly outward angle so as not to injure or remove the branch collar. Hook the pruner head around the limb to be cut with the blade side against the lateral branch or stem to remain. The arborist must be in a safe working position and the pruner handle positioned so the blade will not jam in the wood. You should not cut off a limb directly above yourself if there is any chance that it could fall and hit you.

Change your working position before completing the cut; place the hook so you have a straight pull on the rope and the lever arm can move far enough to complete the cut. An experienced tree surgeon can give a limb a flip with the side of the pruner head, just as the cut is completed, so that the limb will fall in the desired direction.

Saws

Pole saws:

- Hook cast onto pole-head.
- Wood poles (round and squared).
- Insulated poles (foam core).
- Difficult to make clean, accurate cuts.



Fine-tooth saw blades (more points per inch):

- On folding, rigid, and grip handles.
- *Needlepoint* teeth.
- Razor-tooth, Japanese, or *tri-edge*-style teeth (*Fanno*™ 1311, *Felco*™, *Corona*™); narrow, curved blades facilitate getting into tight spots.

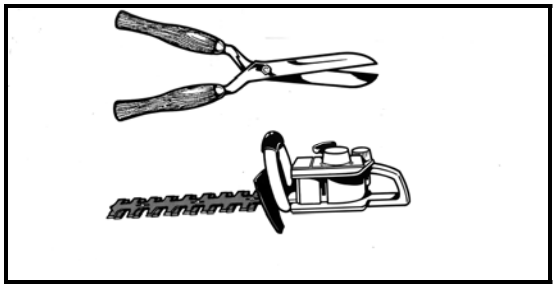
Arborist saws cut on the *pull* stroke:

- Davey-issue speed saw.
- Raker and gullet saws.
- Needle-tooth saws Fanno™ series.
- Scabbards, blade lengths.
- Pole saw blades now available with tri-edge teeth.

Hedge Shears

Clippers/trimmers:

- Manual (sometimes called 'pruning' shears).



- Powered (electric, gasoline).
- Cut off growth ‘in line’ with no regard for node locations or branch bark ridges.
- Provide time and labor savings at expense of overall plant health.
- Dull blades compound problems and make you work harder!

Crown Thinning and Cleaning

A proper thinning cut removes a branch at its point of attachment, or back to a lateral branch large enough to assume a terminal role.

Learn to foresee the need for removing live branches while they are small. Avoid large cuts. Direction can be influenced by removal of short portions of growth or even by removal of individual buds.

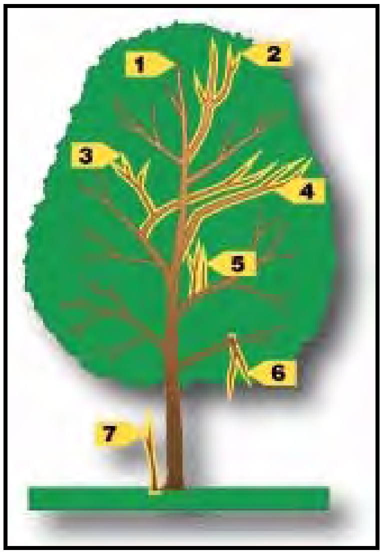
Thinning of lower branches can ‘raise’ a limb. If, after crown raising, the remaining leaf material is insufficient for limb size, consider complete removal. The client's opinion is important.

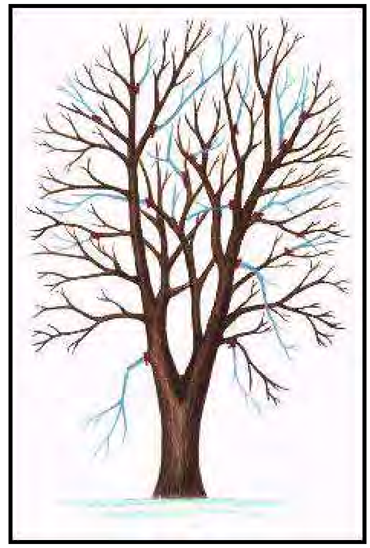
Never perform excessive thinning, which is stressful, especially on thin-barked or young trees prone to sunscald.

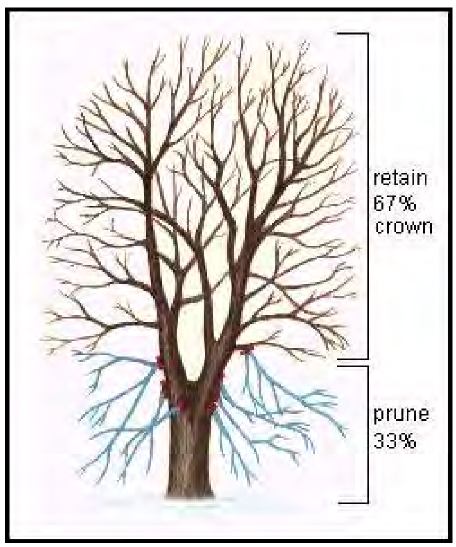
Avoid removing more than 1/4 of the live branches on a tree. Older or overmature trees should have an absolute minimum of living branches removed.

Always avoid ‘skinning’ or ‘hollowing' out the center of a tree's canopy. The majority of thinning cuts should be made along the outer crown. Proper thinning requires a good deal of limb-walking and deft use of a pole-pruner when and where aerial lifts are not used.

When thinning laterals from a limb, maintain well-spaced inner branches to achieve more distribution of foliage along the branch.

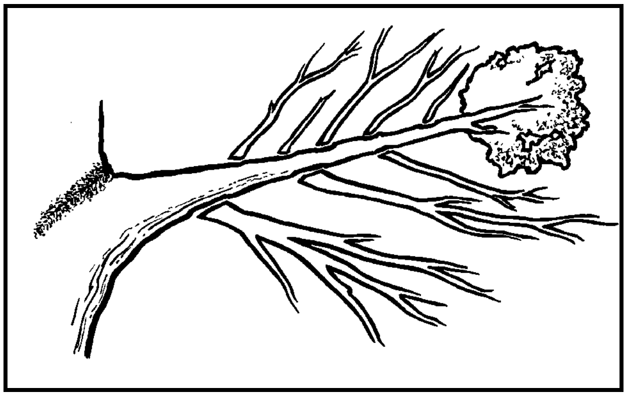






Caution must be taken to avoid creating an effect known as *lion-tailing*:

- Caused by removing all of the inner laterals and foliage.
- Displaces foliar weight to the ends of the branches.
- May result in sunburned bark tissue, renewed and excessive epicormic branches, weakened branch structure, and breakage.
- Wind whippage.



Lion-tailing

Removal of Diseased or Insect-Infested Branches

Sanitation or 'eradicative' pruning (crown cleaning):

- Cut out diseased limbs back to collars, appropriate lateral branches, or a scaffold branch at least one foot below infected portion.
- Disinfect tools *during or after* pruning diseased branches with bleach solution (1 part bleach to 10 parts water) or Lysol.
- Do not use any form of alcohol to sterilize pruning tools *during* the work. Use alcohol to disinfect auger-bits, injection tees, or pruning tools *after* the job, especially plants with wetwood or fireblight bacterial infections.

Removal of Weak, Rubbing, or Competing Stems

Remove, if possible, but avoid large holes in the canopy.

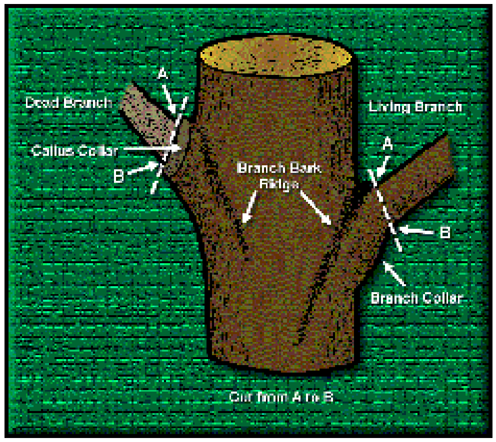
The life of large limbs, weakened by decay or cracks, can often be extended by "shortening" or weight removal using highly selective thinning cuts. Cabling and/or rigid bracing may be required to secure limbs or codominant stems if removal is not possible.

Deadwood Removal

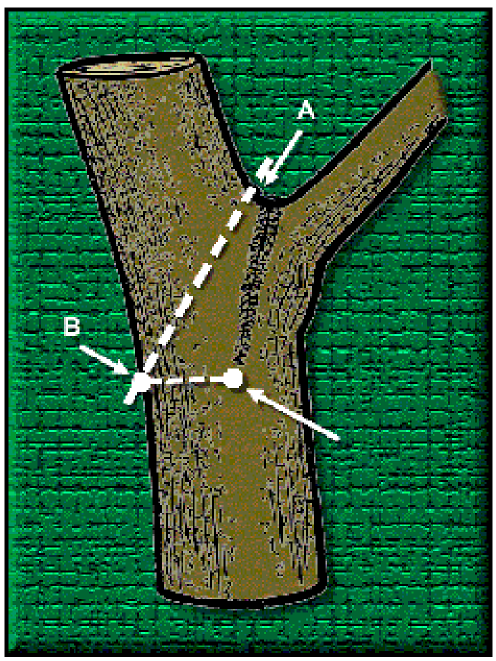
Sanitation and hazard reduction pruning:

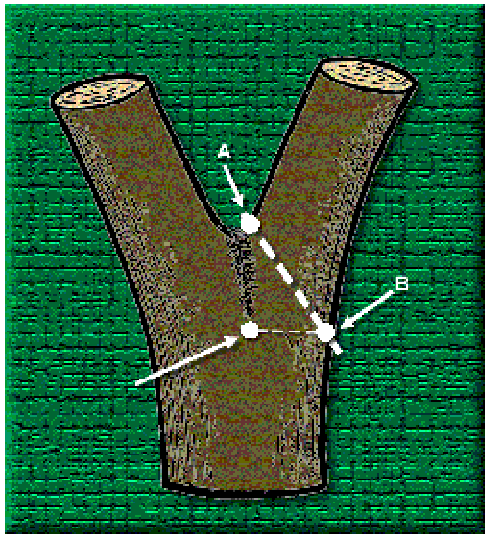
- Dead branches and stubs are an energy source (cellulose, glucose).
- Decay fungi.
- Boring insects.

Again, do not remove the branch collar around dead branches. Cut as close as possible to the collar of good wood surrounding the branch base.



Locate Target Points





Codominant Stem or Branch Removal

Always *stub cut* the stem to be removed, and then make the *finish* cut with care.

Some defect (discoloration) will develop in the remnant stem 'core' in the main stem:

- Usually not attached like a true branch with protective collar.
- Barrier zone should develop and confine defect if correct cut is performed.

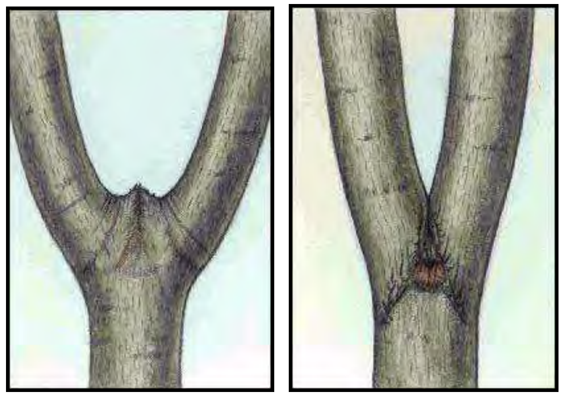
Never remove both stems!

When the bark plates on the stem bark ridge turn upward, the union of the stems is usually *strong.*

When the bark between the stems turns inward, the union of the stems is *weak.*

It is the *union* of the stems or upright branches more than the *angle* that determines whether attachment is weak or strong.

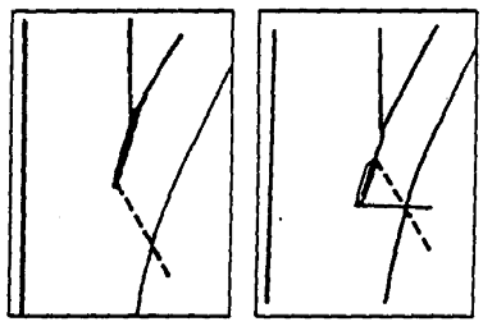
The stems have *included bark* squeezed or embedded *between* them.



Remedies:

To *remove*, stub cut the stem first and then cut where the dotted line is with care; avoid cutting into the remaining stem.

If the saw cannot complete this cut, tap a small wedge into the kerf and cut the remainder of the wood with a flat chisel and mallet.



To *strengthen* stems on older trees, a cable can be attached; place at a point approximately two-thirds of the distance from the crotch to the ends of the stems.

When a cable is used to strengthen stems, the cable and hardware must be checked regularly. When the risk of stem fracture becomes high, the weaker stem should be removed.

Davey Residential Operations employs four general classes of pruning. Classes 1, 2, and 3 are classified as maintenance pruning, which is recommended when the primary objective is to maintain or improve tree health and structure, including hazard reduction pruning:

- Class #1 - *Fine Pruning*: consists of the removal of dead, dying, diseased, interfering, objectionable, and weak branches (crown cleaning), as well as selective thinning to lessen wind resistance. Some deadwood up to ½ inch in diameter may remain within the main leaf area where it is not practical to remove such. Girdling roots will be monitored and removed where possible.

- Class #2 - *Medium Pruning*: consists of the removal of dead, dying, diseased, interfering, objectionable, and weak branches (crown cleaning). Some deadwood up to one inch in diameter may remain within the leaf canopy.
- Class #3 - *Hazard reduction*: pruning is recommended when the primary objective is to reduce the danger to a specific target, caused by visibly defined hazards in a tree, by removing dead, diseased, or obviously weak branches two inches in diameter or greater.
- Class #4 - *Crown Reduction Pruning*: consists of reducing canopy tops, sides, under branches, or individual limbs at appropriate lateral limbs and stems for purposes of clearance of storm damage repair. Some crown reduction pruning incorporates hazard reduction pruning.

Epicormic Branches

Epicormic branches may be needed to fill in the canopy where trees have been excessively thinned or storm damage has occurred (crown restoration).

Epicormic branches (shoots, watersprouts, suckers) arise from two types of "buds":

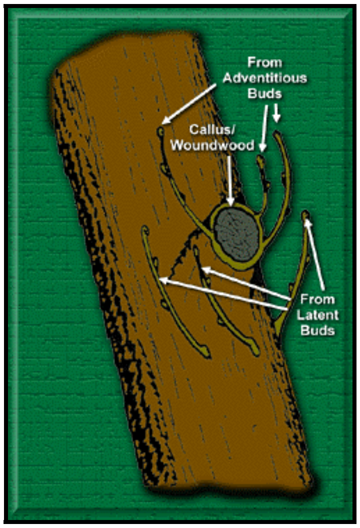
- Adventitious buds.
- Latent (dormant) buds or meristematic points.

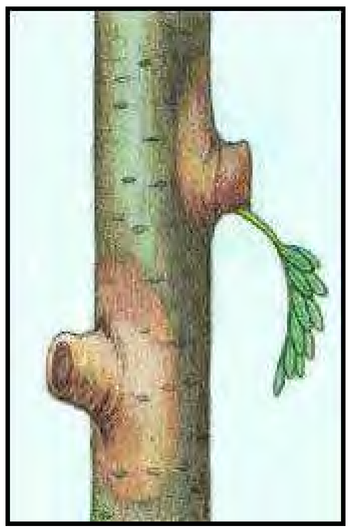
Adventitious epicormics come from meristematic tissue generated anew by the cambium. Most adventitious buds develop from callus tissues moving over a wound, or from root tissue.

Latent (dormant) buds or *meristematic points* are formed at an earlier time in the life of a woody plant but do not 'release' or grow. Latent buds are 'carried along' in rays in the cambial zone year after year, as the tree increases girth, and are usually released upon injury or stress. Epicormic sprouts from latent meristematic points are often found in the vicinity of pruning cuts, usually below the wound.

Epicormic branches are *stimulated* on a much larger scale by winter or early spring pruning rather than by late spring-summer pruning (desirable in shrub renewal or rejuvenation).

A *watersprout* is an epicormic branch growing from branch and stem parts, or above a graft union.





A *sucker* is an epicormic branch growing from root tissue or below a graft union.

Apical Dominance and Control

Woody plant natural shapes, forms, or habits are governed by species' inherent (genetic) determination of:

- Leaf and flower bud locations.
- Budbreak patterns along stems.
- Branching angles.
- How buds and branches elongate.

Apical dominance = terminal bud(s) suppress lateral buds along an elongating shoot.

Excurrent and *decurrent* branching patterns:

- Decurrent woody plants have overall weak apical control, but strong apical dominance while shoots are elongating.
- Random-branching excurrent plants have weak apical dominance and overall strong apical control.
- Whorl-branching excurrent trees have both strong apical dominance and control.

Excurrent

Decurrent

Plant growth regulators are substances that enhance or alter the growth and development process of a plant. In most cases, these chemicals either increase or decrease normal growth, flowering, and/or fruiting of plants.

Selective growth control and/or branch release by natural growth regulators:

- Auxins
- Abscisic acid (ABA)
- Cytokinins
- Gibberellins (gibberellic acid = GA)
- Ethylene

Branch terminals – auxin source
Roots – cytokinin source

Low auxin High cytokinin	=	axillary bud release, energy storage drain
High auxin Low cytokinin	=	bud suppression, initiate new roots

Plant growth regulators are substances that enhance or alter the growth and development process of a plant. In most cases, these chemicals either increase or decrease normal growth, flowering, and/or fruiting of plants.

Utility arborists use synthetic growth regulators to *control* the growth of trees and other vegetation beneath utility lines. Growth *inhibitors* can be:

- Sprayed on the foliage.
- Painted on pruning wounds.
- Banded on the bark.
- Soil applied.
- Injected into trees.

Antigibberellins are growth regulators that counter the effects of naturally occurring *cell-elongation* hormones (gibberellin). Ideal formulations are being sought that would minimize phytotoxicity while reducing utilities' pruning expenses.

Another use of growth inhibitors is to suppress epicormic branch production on trees:

- Not yet widely used by arborists.
- Must be applied annually.
- Client concern over the use of chemicals.
- Applicator safety concerns.
- Epicormic branch growth can be minimized with proper cuts.
- Retarded woundwood development.

Painting of Cuts

Proper cuts negate the "need" for wound dressings. Wound dressings will not *prevent* decay; wound dressings have been evaluated to often *promote* wood decay or cause cambium damage.

Cuts or wounds in certain species during the growing season may attract insects that carry diseases or allow fungus invasion. Native oaks or elms and European elms should be pruned during dormant periods in regions where wilt disease conditions are known to exist.

If pruned in summer, pruning wounds on wilt-susceptible oaks and elms should be treated with the current wound dressing recommended by The Davey Institute.

Pruning Phenology

The ideal or optimal times to prune most woody plants are:

- Late in the dormant season.
- After leaves are fully formed and expanded.

Client concerns with excessive *sap flow* (birches, maples):

- Avoid pruning during height of sap flow (just before growing season) if possible.
- Sap flow may be unsightly but does not cause definite injury.
- Prune immediately after leaves are fully expanded if client cannot be convinced.

Avoid pruning birches after leaf expansion, as the wounds may be attractive to boring insects.

Dead, broken, or weak limbs may be removed at any time with little effect, except in wilt-susceptible oaks and elms.

Pruning before the spring leaf budbreak period can enhance stimulated growth and rapid wound closure. Pruning during the period after leaf expansion will result in suppressed growth and maximum ‘dwarfing’.

Avoid pruning those woody plants undergoing budbreak and early leaf expansion, especially in the period where bark ‘slips’ (cambial development of unlignified wood).

Flowering can be reduced or enhanced by pruning at the appropriate time of the year. Woody plants that bloom on current season's growth (‘summer-flowering’ such as crapemyrtle or butterfly-bush) are best pruned to enhance flowering:

- During the dormant season.
- Just prior to or immediately after leaf expansion.
- In late summer (post-bloom).

Plants that bloom on last season's wood ('spring-flowering') should be pruned *just after bloom.*

- Fruit trees are often pruned during the dormant season to enhance structure and distribute fruiting wood, and after bloom to thin fruit-load.

Pruning Selection

Ideal pruning technique begins with planting the right tree in the right place (PHC selection).

Maintaining tree size or allowing for limited crown growth is possible with a regular pruning schedule begun early in the tree's life.

- Consider the extent of mature branches and crown.
- Select good stock with proper growth form.
- Imagine how form will continue to develop; there is no way to turn a large tree back into a small tree.
- Don't expect to improve form with future prunings.

Avoid obtaining saplings with included bark; the stem union becomes weaker rather than stronger as the plant grows. Failure of one or both stems of the fork frequently occurs when the tree is mature, especially during snow and ice storms (loading events).

Structural Pruning

Structural pruning principles are used when training young woody plants or working with a tree that has not been pruned in many years. Properly trained shrubs and young trees will develop into structurally strong plants that should require little corrective pruning as they mature.

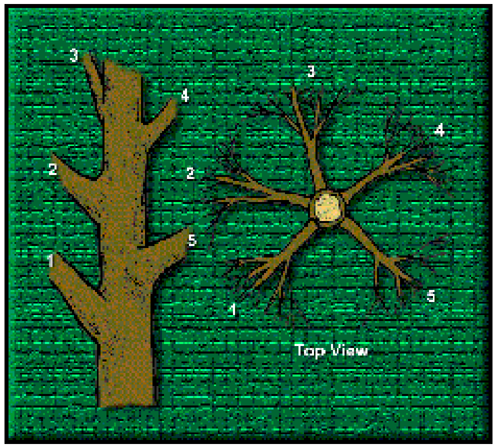
Trees that will be large at maturity should have a sturdy, tapered trunk, with well-spaced branches smaller in diameter than the trunk.

If two branches develop from apical buds at the tip of the same stem, they will form *codominant* branches or, eventually, codominant stems. Each codominant branch is a direct extension of the stem. It is best if one is removed when the tree is young.

Branches with narrow angles of attachment and codominant branches may tend to break if there is *included bark* that gets enclosed inside the crotch as the two branches develop girth and length.

The relative *size* of a branch in relation to the trunk is usually more important for strength of branch attachment than is the *angle* of attachment. Scaffold branches' diameters should not be more than 1/2 the stem or trunk diameter.

Select main branches to give *radial distribution*. Discourage branches growing directly over another unless spaced well apart.



On large-growing trees, except whorl-branching conifers, branches that are more than 1/3 the diameter of the trunk in size should be well spaced along the trunk (at least 18 inches apart).

Maintain one-half the foliage on branches arising in the lower 2/3 of younger trees.

- Increases trunk taper.
- More uniformly distributes weight and wind stress along the trunk.

This rule of thumb also holds true for an individual limb:

- Leave lower and inside branches along the limb.
- Limb can develop taper and strength.
- Stress and weight can be evenly distributed along the length.

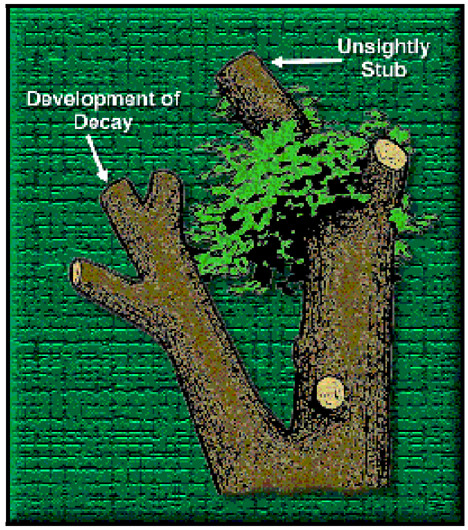
The height of the lowest scaffold branch will depend on the intended function of the tree: screen an unsightly view, provide a windbreak, shade a patio, installed as a walkway or street tree.

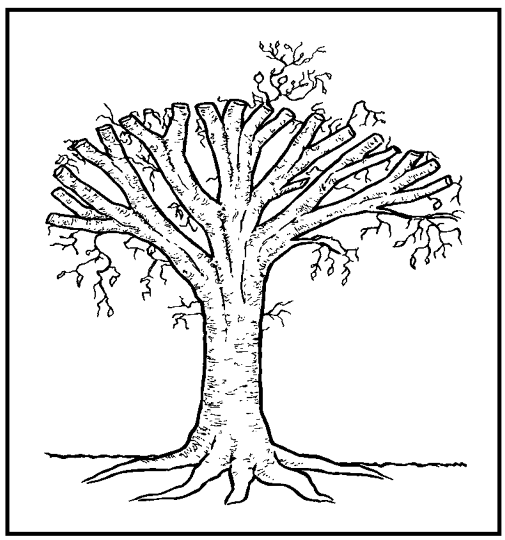
Pruning at Planting

For years, the conventional wisdom was that trees should be severely pruned at time of transplant to compensate for root loss and to "balance" the crown with the root system (especially bare-root trees). This practice has since been discovered to prolong *transplant shock.*

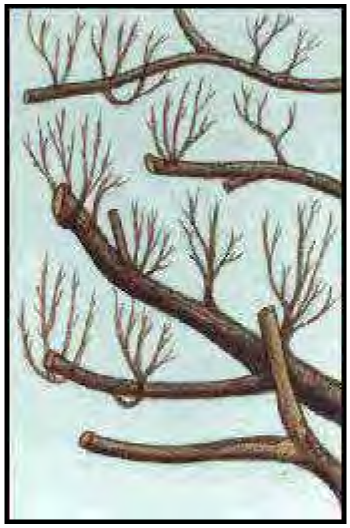
- Transplant pruning should be limited to removal of dead, broken, diseased, or interfering branches.
- Leave small shoots along the trunk for later removal.
- Protect the trunk from ‘sunburn’.
- Aid in development of proper trunk taper.
- Leave as many terminal buds as possible.
- Stimulate root growth triggered by hormones in these buds.

Topping, Tipping, and Roundover

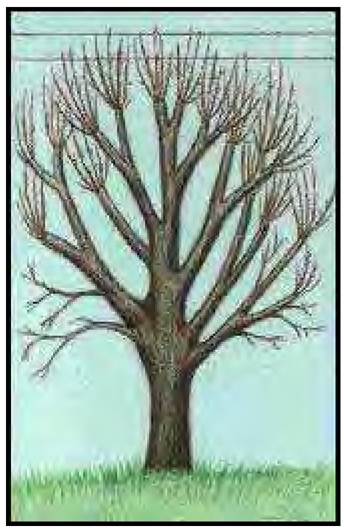




Topping: cutting vertical branches and stems back to inadequate nodes (heading) or to internodes (stubbing).



Tipping: heading side or horizontal branches to stubs or weak laterals.



Roundover: topping + tipping.

Many people have the misconception that cutting or heading the main branches of a tree back to stubs to 'reduce the height' is the proper way to prune.

Apparently, a short tree is thought to be safer and healthier than a tall tree regardless of how the result is attained. Heading back to stubs or inadequate laterals permanently disfigures and weakens a tree. Topping is one of the worst things humans do to trees.

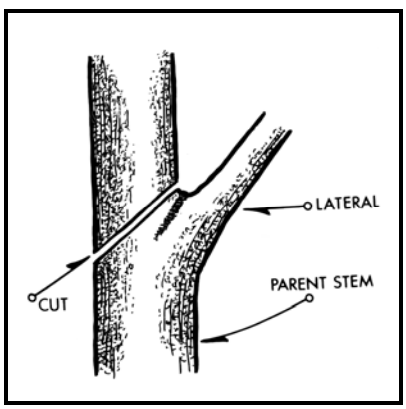
The International Society of Arboriculture (ISA) and the National Arborist Association (NAA) consider heading-back to stubs an unacceptable arboricultural practice. Modern pruning standards do not include heading-back as any sort of a recommended technique.

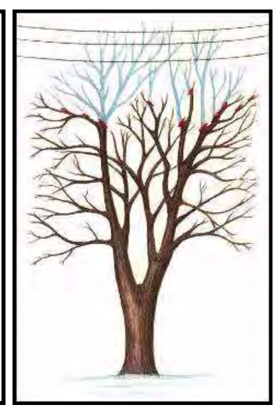
- Topping removes a major portion of a tree's leaves that are necessary for the production of carbohydrates.
- Stimulation of epicormic branches at or just below an internodal stub cut causes a topped tree to grow back to its original height faster and denser than a properly pruned tree. The sprouts are weakly attached and easily broken off in storms.
- Bark within the canopy can become scalded by sudden exposure to direct sunlight.
- Stubs attract wood-boring insects and sustain wood decay organisms.
- Topping, tipping, and roundover cuts permanently disfigure a tree.

Crown Reduction, Restoration, and Raising

If the height or width of a tree has to be reduced because of storm damage or interference with structures or utility lines, it is performed correctly by a method called *crown reduction* or *drop-crotch* pruning (NAA Class IV Crown Reduction). This procedure involves the removal of a main leader, scaffold, or branch at its point of attachment with a lateral branch large enough to assume a terminal or leader role.

The final cut should begin or end somewhat *parallel* to the remaining lateral branch and offset slightly above the branch bark ridge (without cutting into the bark ridge). The remaining lateral branch must be at least one-half to one-third the diameter of the branch or leader that is being removed.





If a tree has been topped previously and now has epicormic sprouts, *crown restoration* can improve its structure and appearance. Decayed, rotting stubs, and tipped branches are cut back to appropriate laterals or entirely removed. One to three sprouts on main branch stubs are retained to become permanent branches and reform a more natural appearing crown. Selected epicormic branches may need to be thinned to a lateral to control length and ensure adequate attachment for the size of the sprout. Restoration usually requires several prunings over a number of years.

Trees in urban and landscape settings may need to have lower limbs removed. *Crown raising* or elevating removes the lower branches of a tree in order to provide clearance for buildings, vehicles, pedestrians, and vistas. Excessive removal of lower limbs should be avoided so that the development of trunk taper is not affected and structural stability is maintained.

Definitions of Arboricultural Terms

Anvil-Type Pruning Tool – Pruning tool that has a straight sharp blade that cuts against a flat metal cutting surface (see *hook and blade-type pruning tool*).

Arborist – A professional who possesses the technical competence through experience and related training to provide for or supervise the management of trees and other woody plants in the residential, commercial, and public landscape.

Boundary Reaction Zone – A separating boundary between wood present at the time of wounding and wood that continues to form after wounding.

Branch – A secondary shoot or stem arising from one of the main axes (*i.e.*, trunk or leader) of a tree or woody plant.

Branch Collar – Trunk tissue that forms around the base of a branch between the main stem and the branch or a branch and a lateral. As a branch decreases in vigor or begins to die, the branch collar becomes more pronounced.

Branch Bark Ridge – Raised area of bark in the branch crotch that marks where the branch wood and trunk wood meet.

Callus – Undifferentiated tissue formed by the cambium layer around a wound.

Cambium – Dividing layer of cells that forms sapwood (xylem) to the inside and bark (phloem) to the outside.

Climbing Spurs – Sharp, pointed devices affixed to the climber's leg used to assist in climbing trees (also known as *gaffs, hooks, spurs, spikes, climbers).*

Closure – The process of woundwood covering a cut or other tree injury.

Crotch – The angle formed at the attachment between a branch and another branch, leader, or trunk of a woody plant.

Crown – The leaves and branches of a tree or shrub; the upper portion of a tree from the lowest branch on the trunk to the top.

Crown Cleaning – The removal of dead, dying, diseased, crowded, weakly attached, low-vigor branches, and watersprouts from a tree's crown.

Crown Raising – The removal of the lower branches of a tree in order to provide clearance.

Crown Reduction – The reduction of the top, sides, or individual limbs by the means of removal of the leader or longest portion of a limb to a lateral no less than one-third of the total diameter of the original limb removing no more than one-quarter of the leaf surface.

Crown Thinning – The selective removal of branches to increase light penetration and air movement, and to reduce weight.

Cut – The exposed wood area resulting from the removal of a branch or portion thereof.

Decay – Degradation of woody tissue caused by biological organisms.

Espalier Pruning – A combination of cutting and training branches that are oriented in one plane, formally or informally arranged, and usually supported on a wall, fence, or trellis. The patterns can be simple or complex, but the cutting and training is precise. Ties should be replaced every few years to prevent girdling the branches at the attachment site.

Facility – Equipment or structure used to deliver or provide protection for the delivery of an essential service such as electricity.

Girdling Roots – Roots located above or below ground whose circular growth around the base of the trunk or over individual roots applies pressure to the bark area, ultimately restricting sap flow and trunk/root growth. Frequently results in reduced vitality or stability of the plant.

Heading – Cutting a currently growing or one-year-old shoot back to a bud, or cutting an older branch or stem back to a stub or lateral branch not sufficiently large enough to assume the terminal role. Heading should rarely be used on mature trees.

Heartwood – The inactive xylem (wood) toward the center of a stem or root that provides structural support.

Hook and Blade Pruning Tool – A hand pruner that has a curved, sharpened blade that overlaps a supporting hook (in contrast to *an anvil-type pruning tool*).

Horizontal Plane (palms) – An imaginary level line that begins at the base of live frond petioles.

Lateral – A branch or twig growing from a parent branch or stem.

Leader – A dominant upright stem, usually the main trunk. There can be several leaders in one tree.

Limb – Same as *Branch,* but larger and more prominent.

Lopping – See *Heading.*

Mycellum – Growth mass of fungus tissue found under bark or in rotted wood.

Obstructing – To hinder, block, close off, or be in the way of; to hinder or retard a desired effect or shape.

Parent Branch or Stem – The tree trunk or a large limb from which lateral branches grow.

Petiole – The stalk of a leaf.

Phloem – Inner bark tissue through which primarily carbohydrates and other organic compounds move from regions of high concentration to low.

Pollarding – Pollarding is a training system used on some large-growing deciduous trees that are severely headed annually or every few years to hold them to modest size or to give them and the landscape a formal appearance. Pollarding is not synonymous with topping, lopping, or stubbing. Pollarding is severely heading some and removing other vigorous water sprouts back to a definite head or knob of latent buds at the branch ends.

Precut or Precutting – The two-step process to remove a branch before the finished cut is made so as to prevent splitting or bark tearing into the parent stem. The branch is first undercut, and then cut from the top before the final cut.

Pruning – Removal of plant parts.

Qualified Line Clearance Tree Trimmer – A tree worker who, through related training and on-the-job experience, is familiar with the techniques in line clearance and has demonstrated his/her ability in the performance of the special techniques involved. This qualified person may or may not be currently employed by a line clearance contractor.

Qualified Line Clearance Tree Trimmer Trainee – Any worker undergoing line-clearance tree trimming training, who, in the course of such training, is familiar with the techniques in line clearance and has demonstrated his/her ability in the performance of the special techniques involved. Such trainees shall be under the direct supervision of qualified personnel.

Qualified Person or Personnel – Workers who, through related training or on-the-job experience, or both, are familiar with the techniques and hazards of arboriculture work including training, trimming, maintaining, repairing, or removing trees, and the equipment used in such operations.

Qualified Tree Worker, Person, or Personnel – A person who, through related training and on-the-job experience, is familiar with the hazards of pruning, trimming, repairing, maintaining, or removing trees and with the equipment used in such operations and has demonstrated ability in the performance of the special techniques involved.

Qualified Tree Worker Trainee – Any worker undergoing on-the-job training who, in the course of such training, is familiar with the hazards of pruning, trimming, repairing, maintaining, or removing trees, with the equipment used in such operations and has demonstrated ability in the performance of the special techniques involved. Such trainees shall be under the direct supervision of qualified personnel.

Remote/Rural – Areas associated with very little human activity, land improvement, or development.

Sapwood – The active xylem (wood) that stores water and carbohydrates, and transports water and nutrients; a wood layer of variable thickness found immediately inside the cambium, comprised of water-conducting vessels or tracheids and living plant cells.

Shall – As used in this standard, denotes a mandatory requirement.

Should – As used in this standard, denotes an advisory recommendation.

Stub – An undesirable short length of a branch remaining after a break or incorrect pruning cut is made.

Stubbing – See *Heading.*

Target – A person, structure, or object that could sustain damage from the failure of a tree or portion of a tree.

Terminal Role – Branch that assumes the dominant vertical position on the top of a tree.

Thinning – The removal of a lateral branch at its point of origin or the shortening of a branch or stem by cutting to a lateral large enough to assume the terminal role.

Throwline – A small, lightweight line with a weighted end used to position a climber's rope in a tree.

Topping – See *Heading.*

Tracing – Shaping a wound by removing loose bark from in and around a wound.

Urban/Residential – Locations normally associated with human activity such as populated areas including public and private property.

Utility – An entity that delivers a public service such as electricity or communication.

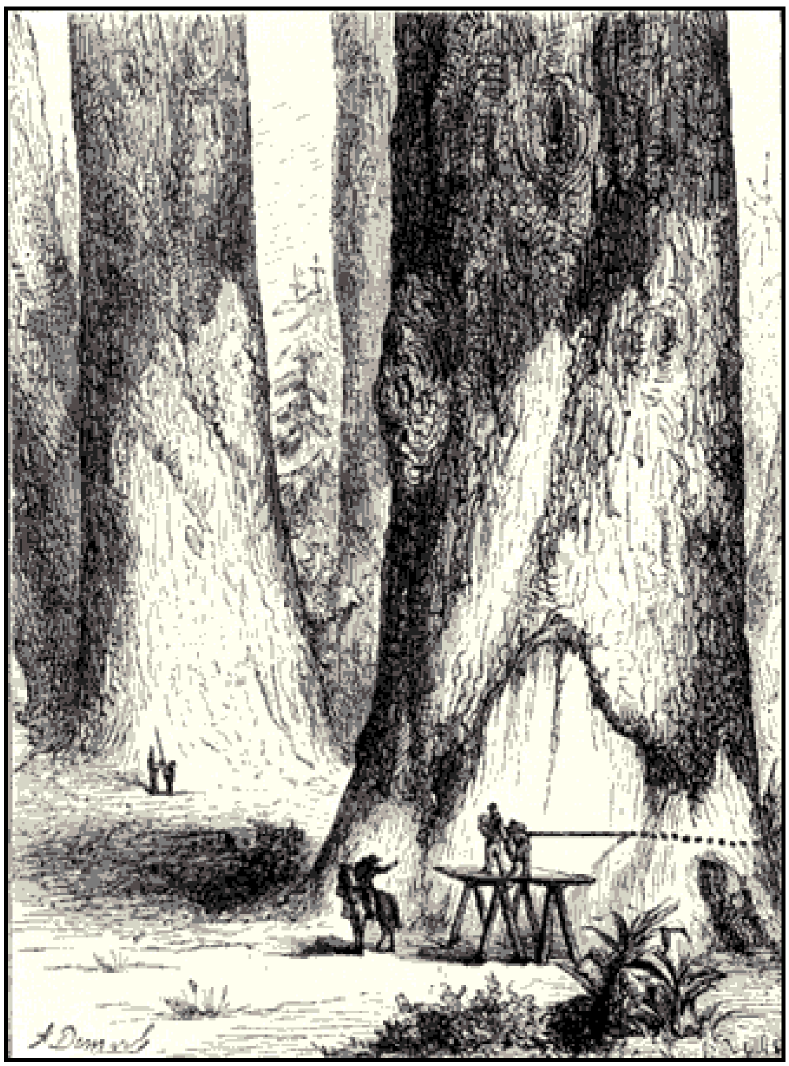
Utility Space – The physical area occupied by the utility's facilities and the additional space required, ensuring its operation.

Wound – An opening that is created any time the tree's protective bark covering is penetrated, cut, or removed, injuring or destroying living tissue. Pruning a live branch creates a wound, even when the cut is properly made.

Woundwood – Differentiated woody tissue that forms after the initial callus has formed around the margins of a wound. Wounds are closed primarily by woundwood.

Xylem – Wood tissue; active xylem is called *sapwood* and inactive xylem is called *heartwood.*

Young Tree – A tree young in age or a newly installed tree.



Appendix H
Davey® Technical Bulletins - Common Pests and Diseases

TECHNICAL BULLETIN

DAVEY

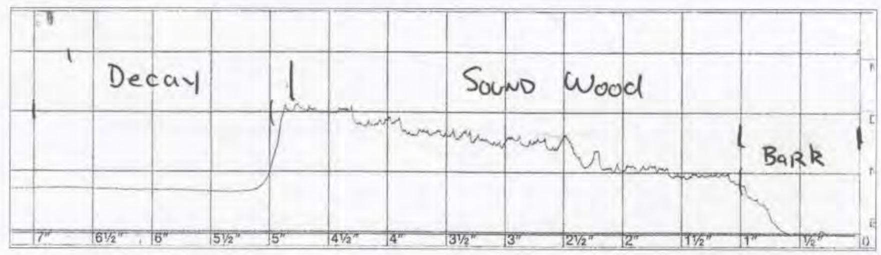
Prepared by The Davey Institute

ADVANCED DECAY DETECTION USING THE RESISTOGRAPH

WHY TEST FOR DECAY?

Wood decay in shade and ornamental trees is the most common disease in the urban forest. Decay and other tree defects can result in failure of branches, large stems or the entire tree. Importantly, not all trees with decay require treatment. The presence of decay does not necessarily mean that the tree is hazardous or requires treatment. More important than the presence of decay is the location and amount of decay.

In many cases, visual assessment of decay, simply sounding with a hammer, or probing with a sharp tool can provide adequate information to judge the amount of decay in a tree. However, because decay is often hidden internally by the bark, more advanced tools may be needed to make better judgments on how much decay is present.



Labeled Resistograph chart.

SYMPTOMS OF DECAY: There are many symptoms or indicators of decay in trees. A few examples include cavities; decayed branch stubs; loose or missing bark; fruiting bodies of wood decay fungi on roots, the trunk, or stems; or the presence of carpenter ants. These indicators do not tell how much decay might be present in a tree.

CAUSE: Wood decay in trees is caused by a closely related group of basidiomycete fungi that can digest the cellulose and lignin components of wood. These fungi may fruit on a tree in the area where the decay is present.

SOLUTION: The first step in the treatment of trees with indicators or symptoms of decay is to make an assessment of the amount of decay. If visual observation, sounding or probing techniques cannot adequately provide enough information, more advanced techniques may be needed.

The Resistograph is a relatively new tool in arboriculture that provides a means to assess and document hidden decay in a tree. This tool has a very small (3 mm), non-spiraled bit that can probe areas in the tree where decay is suspected. The distance the bit has traveled and the resistance to the bit are recorded on graphs. Reading these charts allows your Davey arborist to determine the presence and amount of decay in a particular location.

Once an evaluation of the amount of decay in a tree is made, treatment options can be developed. Unfortunately, there are no treatments to stop decay once it starts inside a tree. Treatments such as removal, pruning, cabling, bracing or moving of the target (what the tree might hit if it or a part of it fails) are potential options that can be developed with your Davey arborist.

Drilling into a sycamore with a Resistograph.

Fungal conks indicate internal decay in a tree.

Printed in the U.S.A.

T 15246 – 02/04

TECHNICAL BULLETIN

Prepared by The Davey Institute

ANTHRACNOSE DISEASES OF DECIDUOUS TREES

Gleosporium spp. *and Apiognomonia* spp.

Figure 1. Damage by ash anthracnose causes brown lesions. Leaves and leaflets drop early in the spring.

Figure 2. Symptoms of sycamore anthracnose disease are evident on newly expanding leaves.

Anthracnose diseases are caused by a common and destructive group of fungal pathogens that can attack various shade trees. Extended periods of cool, wet weather can make these diseases devastating and difficult to control with foliar applications of fungicides.

SYMPTOMS: Symptoms vary and are listed below by host.

Ash (*Fraxinum* spp.) – Brown areas with irregular shapes occur along the new leaves; brown blotches occur on leaf tips, veins and margins. Infected leaves drop prematurely in the spring (Figure 1). Twigs may be girdled and die, especially during cool, wet weather.

Maple (*Acer* spp.) – There are several fungi that cause anthracnose-type leaf spotting on maples. Foliar symptoms include brown vein lesions originating at the veins, to irregular browning of margins that extend inward.

Oak (*Quercus* spp.) – White oak is severely affected when new leaves are expanding and cool, moist weather occurs for a prolonged period. Leaves have large dead areas between the leaf veins, usually on lower branches. These leaves become twisted and droop with downward cupping. Twig and branch dieback may be evident the following spring.

Sycamore (*Platanus* spp.) – Areas along leaf veins turn tan to brown (Figure 2). As the fungus invades the leaf tissue it moves into petioles and stems. Buds turn gray-brown and wilt. Twigs and branches show discoloration around infected buds or exhibit dead sunken areas in the stems (cankers). Continuous years of infection cause severe canopy reduction and a witches'-broom stunting of branches.

CAUSE: The fungus generally overwinters in infected, dead leaves on the ground. With the sycamore disease, it also winters in the infected buds or twig and branch cankers. During cool wet springs, minute blister-like swelling in the infected tissues releases thousands of spores that are wind-dispersed to new leaves. These new infections cause death of the leaf tissues, which results in tan-to-brown dead areas. Varying amounts of leaf drop take place, depending upon the severity of the disease that season. The inoculum is present to repeat the cycle the following year.

SOLUTIONS: Current recommendations for preventing or correcting anthracnose diseases of shade trees include the following:

1. Fertilize trees that have become infected, and water during dry periods. This will help the tree overcome the stress brought on by the disease and the resulting defoliation.

2. Rake up and destroy infected leaves, and prune off cankered branches to reduce the potential for infection.

3. Usually, a fungicide applied to tree foliage during leaf expansion will aid in minimizing leaf infection and defoliation. However, if the weather is cool and wet for prolonged periods of time, foliar applications may not provide satisfactory results.

For management of sycamore anthracnose disease on trees greater than 2 feet in diameter, trunk injections of Arbotect® fungicide are recommended. This treatment provides two years of disease suppression from one application. The trunk injections are effective even when there is cool, wet weather that favors disease development.

Printed in the U.S.A.

T15065-9/2000

TECHNICAL BULLETIN

Prepared by The Davey Institute

APPLE SCAB DISEASE OF CRABAPPLES

Venturia inaequalis

Figure 1. *Leaf spots from infection by the apple scab fungus.*

Figure 2. *The 'Hopa' crabapple tree on the left was not treated the previous year. Due to defoliation caused by scab disease, it has very poor flowering. The tree on the right was treated and is contributing to the beauty of the landscape.*

SYMPTOMS: Olive-green or brown spots develop on leaves in May through early June. On older leaves the spots are slightly raised, velvety and dark colored (Figure 1). As the disease develops, the leaves turn yellow and drop prematurely. The symptoms on the blossoms and fruit are similar to those on the leaves. Fruit may be deformed if heavily infected. Typical fruit lesions are circular brown spots with black margins and a corky appearance.

CAUSE: Apple scab, caused by the fungus *Venturia inaequalis,* is one of the most devastating diseases of ornamental crabapples. It also can be a problem on cotoneaster, firethorn and mountainash. This fungus overwinters on infected fallen leaves, or, rarely, on twigs of the tree. Spores, which infect the new leaves in the spring, are produced on the fallen leaves during warm rains in April and May.

Trees can be defoliated by late June with only a few leaves remaining for the rest of the summer. Not only does this alter the aesthetic appeal of the property, but it also reduces the vigor of the tree making it more susceptible to other disorders. Flowering may be reduced the next season because of this year's defoliation. Defoliation minimizes carbohydrates available for flower bud production. Some varieties exhibit flower decline more than others (Figure 2).

SOLUTION: Fungicide treatments in the spring will help minimize infection. During prolonged, wet spring conditions, which favor fungal growth, some infections will occur but fungicide treatments will help keep leaves on the trees. Additional applications may be purchased if there is an unusually wet growing season.

Rake and remove infected fallen leaves in autumn to reduce the potential for infection the following spring. Also, many cultivars of crabapple are resistant to apple scab and should be planted whenever possible. Check with your local extension service or call your Davey technical advisor for a current listing.

Printed in the U.S.A. T15071-498

TECHNICAL BULLETIN

Prepared By The Davey Institute

Armillaria Root Rot

Armillaria melea

Hundreds of plant species, growing in sub-tropical to boreal forests, are affected by this disease. It is also a common problem in landscapes, gardens, and orchards in the Western part of the country. Armillaria root rot actually refers to a disease complex involving at least 11 species of fungi.

Armillaria root rot on root flares and base of trunk.

SYMPTOMS: Aboveground symptoms of Armillaria root rot include a reduction in growth, chlorotic undersized foliage, premature defoliation, and branch dieback in the upper crown. Wind throw of large trees has also been associated with Armillaria infection. Infection in coniferous trees stimulates heavy resin flow, which may saturate the bark.

The mushroom stage of the fungi develops annually in the fall. These mushrooms are called "honey mushrooms" and appear on or near decaying wood.

Below the ground, fanlike, veined white fans (mycelial sheets) can be seen under the bark of the roots. Black-brown fungal strands spread along root surfaces and also up the trunk of dead trees under the bark. The interior of the strand is white. These thick strands resemble shoestrings, leading to the name "shoestring root rot."

CAUSE: The fungus invades the bark and cambial regions of roots and root collars. Roots and trees of all sizes can be killed. Armillaria is a decay fungus and depends on woody material as a food source. Fungal infection progresses from the cambium into the sapwood.

SOLUTION: In general, plant susceptibility decreases as trees get older. Therefore, it is most important to keep trees healthy when they are younger. Even plants susceptible to Armillaria may survive infection if they are otherwise healthy and vigorous.

In orchards where the summers are hot and dry, some infected trees have been saved by excavating the soil away from the base of the trunk and root collar. Armillaria cannot survive the increased temperatures.

The most important strategies for the protection of shade and ornamental plants are to promote vigor, minimize stress, and to remove infected stump and roots. Armillaria can remain active in the soil for decades if sufficient woody material is available for growth.

TECHNICAL BULLETIN
Prepared by the Davey Institute

DAVEY

Botryosphaeria Canker and Dieback

(Botryosphaeria dothidea, B. obtusa, B. rhodina)

SYMPTOMS: Symptoms vary with the type of plant infected, but generally begin as small lesions on the bark or as dead leaf buds. Lesions on the bark develop as sunken areas or 'cankers' until the stem is completely encircled. At this time, smaller twigs wilt and die from the tip downward, while larger twigs or wood appear mottled. Trees may lose individual twigs and branches, while smaller shrubs may appear as though whole sections have died. Plants more commonly affected include rhododendron, azalea, camellia, giant sequoia, sweetgum, oak, Leyland cypress, mountain laurel, madrone, sycamore, redbud and wax myrtle.

CAUSE: *Botryospaeria* fungi enter the plant through cracks in the bark or buds soon after a freeze, during extreme hot, dry weather, or through pruning cuts when plants are under stress. Thus, any environmental condition that weakens shrubs or trees encourages infection by *Botryosphaeria* fungi.

SOLUTION: Plants that have experienced sudden cold temperatures should be inspected for bark cracks along exposed stems and at the soil line. Prune out cracked or split stems at least 6 inches below discolored areas during the dry season. A registered fungicide applied after pruning may protect wood until wounds begin to close. Be sure to water trees and shrubs deeply whenever the soil is dry, but ensure irrigation heads do not deposit water directly against the tree trunk.

Printed in the U.S.A.

T15076-3/00

Prepared by The Davey Institute

CABLING OF TREES

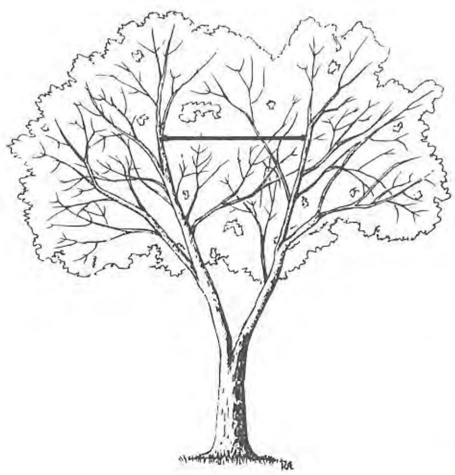


Figure 1.

Cabling is the installation of flexible steel strand cables in trees to reduce stress damage from high winds, the weight of ice or snow, and heavy foliage. Multi-stemmed trees or those with narrow V-shaped forks are especially susceptible to this type of damage (Figure 1). This procedure is used by arborists to improve your tree's chances to survive storms and minimize property damage when branches fail (Figure 2).

BENEFITS: The usefulness of a cable lies in its ability to transfer part of the weight of a weak branch or limb to a stronger one. In addition, a cable may provide mutual support to limbs that are joined by a narrow V-shaped fork. It is intended to prolong the life of the tree. Branches or trees that pose a potential threat to property or people are candidates for cabling.

EVALUATION: In determining whether cabling is warranted, the condition of the tree must first be assessed. The arborist and customer must then determine if cables will help to make the tree reasonably safe. If the root system is not structurally sound, or if the tree contains excessive decay, removal of the tree may be the better choice.

PROCEDURE: Before cables are installed, a tree should be pruned to remove hazardous branches, reduce foliage weight, and help improve the structure. This pruning will help reduce the weight of limbs to be cabled.

Figure 2. This damage was due to poor tree structure. Cabling would have minimized or avoided the damage.

After installation, cables should be inspected periodically for deterioration of materials and changes in the tree that may make adjustments necessary. In addition to pruning on a regular basis, the tree should be fertilized to help improve its health and vigor.

Our arborists adhere strictly to procedural and safety guidelines for cabling.

Printed in the U.S.A.

T15085-9/2000

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

CHERRY BARK TORTRIX

(Enarmonia formosana)

The cherry bark tortrix (CBT) is an introduced insect species from Eurasia that was first discovered in North America in 1990. Since then, this moth has become an important Pacific Northwest pest of rosaceous trees and shrubs, affecting plants such as apple, crabapple, hawthorn, Mountain ash, pear and *Photinia* species. *Prunus* species are the preferred hosts.

Adult moths have a wingspan of just over ½ inch.

SYMPTOMS: Initial larval feeding stimulates exudation of gum-like resin that is often mixed with silk and fecal material. Other signs of infestation include reddish-orange "frass tubes" that protrude from the bark, cracking and curling of bark, cankers and large swellings. Serious infestation results in branch dieback, followed by tree death.

LIFE CYCLE: CBT larvae overwinter under the bark of host trees, where they feed on living tissue. Mature larvae pupate in the frass tubes in spring, emerging as adult mothers from late April to early May (with flight activity in June). Less mature larvae pupate later, creating more flying activity in August. Females lay eggs on bark, in crevices and at graft and other wound sites. Upon hatching, the larvae feed in all directions just beneath the outer bark, then move into the cambium layer (but do not attack the wood). CBT has one generation per year.

Fully grown larvae are just under ½ inch in length with pale-gray to slightly pink bodies and dark heads. The pupae are about ½ inch in length, light brown and protrude from the bark or are found in bark cracks. The adult moths have a wingspan of just over ½ inch and are mottled-brown with coppery wing spots.

SOLUTIONS: Severely infested plants should be removed and destroyed. Monitor host species for the presence of pupal chambers. Remove chambers and loose bark. Set pheromone traps between May and September to trap adult moths. Invigorate trees with fertilization and watering during drought periods. Practice good pruning techniques, and prune during the dormant season. Cover injured bark and pruning wounds with pruning seal. Dormant oil and insecticide applications to trunk and branches may help reduce the populations of overwintering larvae.

Research for an effective biological control is being conducted.

Printed in the U.S.A.

TECHNICAL BULLETIN

Prepared By The Davey Institute

Construction Damage and Tree Protection

Preventing damage to trees is much more economical than trying to save a tree injured by careless activity.

Mature trees are valuable assets - they provide shade, wind protection, and enhance property value. Most construction damage impacts the root systems of native trees on new home sites. Tree roots systems are quite extensive, and vulnerable to disruption of the soil profile and mechanical injury.

A construction project accounts for existing trees on the drawing board. Trees that face serious impact may be removed or carefully transplanted. Trees that require special protection with barriers can be determined. The best approach for tree preservation is to have all trees properly fertilized with Arbor Green® before construction begins.

On very large projects, consulting arborists can be directly involved. They may post signs for protected zones, designate parking and storage areas away from trees and help supervise construction activity to minimize tree damage.

SOIL DISRUPTION: A common problem associated with construction is lack of soil aeration, often resulting from compaction. A few species withstand such conditions, but most will suffer. A barrier placed at the perimeter of the tree canopy (dripline) will direct construction workers away. If this is not feasible, construction workers should be advised not to lay equipment or materials under the tree or to trample the soil underneath.

Soil compaction can also be reduced by laying down a 12 -inch layer of wood chip mulch under the tree. If soil needs to be removed to lower the grade beyond the dripline of the tree, mulching with organic materials can retain moisture and stimulate root production. If extensive soil removal is needed, a retaining wall creating a terrace or the formation of a tree well will keep much of the original soil beneath the tree intact. Soil should never be added within the dripline of the tree. Even 1 -inch of additional soil can suffocate the root system.

(over)

ROOT DAMAGE: At a minimum, the root zone diameter is 1-1/2 times the height of the tree. This area normally extends passed the tree canopy. Any piles of sand, gravel, or excavated soil should be stored outside this zone. Lime or limestone should be kept away from roots to avoid raising soil alkalinity and caustic materials such as paint thinner should not be discarded over the root zone.

Utility trenching should be done as far away from tree roots as possible. Installation of driveways should be planned so as to minimize tree root damage. In the event of root damage, the tree should be mulched and watered.

MECHANICAL INJURY: Some type of fencing should be erected around the tree to protect its trunk and lower branches. At very least, trunks and large exposed roots should be covered with protective materials to prevent mechanical injury. Branches directly interfering with construction work should be properly pruned back.

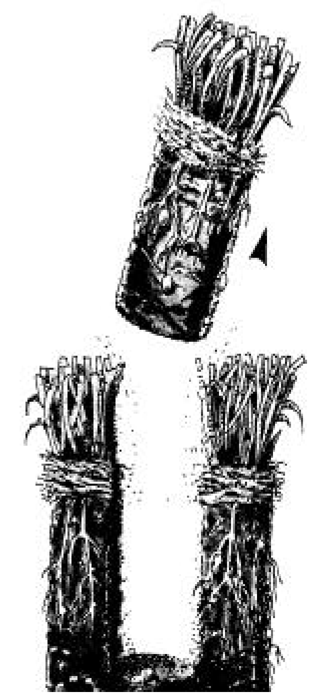
If a tree is severely injured it should be removed. Trees that are only slightly damaged may be restored to healthy condition by pruning out dead or dying portions, watering and fertilizing.

CORE AERIFICATION

Aerification is the mechanical means of removing small plugs of thatch and soil from a lawn to allow the exchange of air between soil and the atmosphere to occur. This process is recommended for most home lawns to:

1. relieve soil compaction
2. "knit" soil interfaces
3. reduce excessive thatch layers

Many turfgrass areas suffer from soil compaction due to rainfall and foot or vehicular traffic. Although compaction is most often associated with athletic fields, home lawns can also suffer from compacted soil layers. Reasons for home lawn compaction include: construction activity prior to lawn establishment and traffic on high clay content soils especially when wet.



Aerification improves penetration of air and water into the soil.

1. **Compaction** causes individual soil particles to press together tightly. This decreases the pore space where air and water are held. A compacted layer of soil forms a physical barrier which limits infiltration of water into the soil and availability of soil oxygen. Aerification will improve the penetration of air and water into the soil, which encourages deeper root growth and better turf quality.

2. Aerification is also useful where a **soil interface** exists. Soil interfaces another distinctly different soil type, in many instances, the sod used to establish a lawn is grown on soil which is organic in nature and is distinctly different from the soil over which it is placed. The interface that develops between these two layers resists uniform movement of water, air, and nutrients, resulting in irregular turf response. Aerifying breaks up the interface and promotes better conditions for turfgrass growth and development.

3. Another benefit of aerification is **the modification of excess thatch layers** (1/2 inch or more). Thatch is a layer of dead and living stems and roots of grass which accumulate between the green grass blades and the soil surface. Multiple aerifications that leave the cores on the lawn surface to break down will incorporate native soil into the thatch layer, thereby improving the water and nutrient holding capacities of the thatch. Microorganisms in the soil cores will also help decompose the thatch. Aerification is particularly useful on large turf areas where dethatching is impractical.

Annual aerification is beneficial for most lawns; however, lawns growing on heavy clay soils or lawns exposed to intense use may need more than one aerification per year. It should be performed during the period of most active root growth for a particular grass species. Spring and fall are ideal times to aerify most lawns.

TECHNICAL BULLETIN

Prepared by The Davey Institute

COTTONY MAPLE SCALE

The cottony maple scale is a large, flat, brown scale insect found on the twigs and branches of various trees. The white, cottony egg masses, which resemble popcorn, are the most distinguishing feature of this scale. A favored host is silver maple, but it will attack other species of maple as well. Other host preferences are: honeylocust, black locust, white ash, euonymus, oak, boxelder, dogwood, hackberry, sycamore, beech, elm, willow, basswood and poplar.

SYMPTOMS: Injury to trees is caused by the scale insect sucking juices from the twigs and branches. Small twigs begin to die first, followed by leaves becoming stunted and a black, sooty mold becoming evident on the tree itself and on objects beneath the tree. This mold grows on honeydew excreted from the scale. A heavy infestation for two or three years may result in the death of large branches.

CAUSES: The fertilized, immature females spend the winter on the twigs and small branches of the host. In the spring, they resume their feeding and development. In late May, the females begin producing eggs that are deposited in masses covered with white, silken fibers. The young scales, called "crawlers," begin hatching in mid-June through early July. The crawlers move up and down twigs and out onto leaves before settling down to suck juices and secrete a waxy coating over themselves. In late summer, adult males emerge, mate with females, and die. Just before leaf drop in the fall, the mated females migrate back to the branches, where they settle and overwinter.

During about the third year after cottony maple scales infest a tree, a population of small lady beetles may be found devouring the egg masses. If these larvae are found in over half of the egg masses, natural control is taking place and additional treatment may not be necessary.

SOLUTION: A horticultural oil treatment may be applied before growth starts in the spring or after leaf drop in the fall. An additional treatment may be applied in mid-August or September after all the crawlers have hatched and settled on the leaves. However, do not treat sugar maples with oil; this species reacts adversely to oil, and branches may die.

It is extremely important to restore plant vitality, because trees weakened by the scale are more susceptible to other insects, diseases and environmental stress. Fertilizing, mulching, and watering, especially during dry periods, are recommended to help maintain tree health.

Printed in the U.S.A.

T15051-9/03

TECHNICAL BULLETIN

Prepared by The Davey Institute

DAVEY KNOWS...SPIKING TREES IS *NOT* THE WAY TO GO

It is very important when pruning trees that the correct procedures be followed, in order to keep them looking healthy and strong. Spiking damages a tree, making it more susceptible to disease, insects and other stresses. Davey Tree wants to make you aware that spiking may *seem* to be an easy way for a tree trimmer to enter the tree and get the job done quickly, but in the long run, it will do much more harm than good.

The practice of using climbing spikes when pruning trees injures them, leaving entry sites for wood-rotting fungi. Climbing spurs (spikes) are steel gaffs attached to shanks that are strapped to the inside of a worker's leg. Workers secure their footing by driving the spurs into the trunk of the tree. With their spurs in the wood, workers are able to stand or walk along the vertical trunk or limb.

Spurs should only be used on trees that are dead or being removed. If necessary, spurs can be used on trees in an emergency rescue situation. According to the ANSI A300, which sets the proper pruning standards, a tree should not be pruned using spikes. Open wounds in the wood will be more likely to become infected with fungi (types of micro-organisms that can completely overwhelm a tree).

For more information on how to keep the trees on your property healthy and strong, contact Davey Tree today.

Printed in the U.S.A.

T15241-09/03

TECHNICAL BULLETIN

Prepared by The Davey Institute

DOGWOOD ANTHRACNOSE

Discula destructiva

Figure 1. *Trees infected with dogwood anthracnose develop tan, blotchy leaf spots on lower branches that progress up the tree.*

Figure 2. *Dead leaves often remain attached to the tree infected with dogwood anthracnose.*

Also referred to as lower branch dieback, dogwood anthracnose usually attacks flowering and pacific dogwood trees, which grow naturally in woodlands and home landscapes.

SYMPTOMS: This disease attacks twigs, branches and trunks as well as leaves, usually appearing during cool, wet weather in the spring. Initially, infected trees develop tan, blotchy leaf spots (Figure 1) on lower branches that progress up the tree. This fungus invades the main leaf vein causing total leaf and twig death. Dead leaves often remain attached to the tree (Figure 2). Eventually, the fungus moves into one and two year wood and forms elliptic cankers at the base of dead branches. In advanced stages of the disease, multiple shoots arise below dead branches along the main trunk.

CAUSE: Dogwood anthracnose is caused by the fungus Discula destructiva and is found naturally occurring on forested dogwood at higher elevations. Spores are spread through rain splash, primarily in cool, wet spring and fall weather. Hot, dry conditions will slow disease development. Drought, winter injury, and construction damage weaken trees and increase disease severity. Consecutive years of heavy infection have resulted in extensive destruction of both woodland and ornamental dogwoods.

SOLUTION: Selective pruning, preventive fungicide treatments, fertilization and watering are important preventive measures for controlling dogwood anthracnose. Effective management is possible if the disease is detected *before* extensive dieback occurs. Prune to improve air circulation and to dispose of diseased twigs and branches that are potential sources of inoculum. Do not transplant wild dogwoods into the landscape. Purchase healthy trees from reliable nurseries and consider borer applications to protect stressed trees.

Maintain healthy dogwood trees by improving water availability with mulch, avoid trunk injury, and fertilize with a slow release fertilizer such as Arbor Green.® Foliar fungicide treatments for dogwood anthracnose and other leafspot fungi should be applied in the spring during leaf expansion to keep disease incidence low.

Printed in the U.S.A.

L15093-299

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

DUTCH ELM DISEASE

Ophiostoma ulmi (syn. Ceratocystis ulmi)

Dutch elm disease is one of the most destructive shade tree diseases in the United States and Canada, and has killed millions of elm trees since its introduction from Europe in 1930. Despite this loss, many elms still remain as street trees or specimen shade trees providing grace and beauty to our landscapes.

SYMPTOMS: Infected elm trees display wilted leaves on one or a few branches in the crown of the tree – called flagging. The wilted leaves may turn yellow, curl, and/or turn brown. Leaves can remain attached to the stem or prematurely fall off. Stems exhibiting flagging typically die back.

If bark is peeled away from stems exhibiting yellow, brown or wilted leaves, brown streaking may be visible in the sapwood just under the bark. Sometimes streaking is embedded deeper in the wood, which indicates that the infection occurred in previous years.

CAUSE: The disease is caused by the fungus *Ophiostoma ulmi*. Both the smaller European elm bark beetle and native elm bark beetle can transfer fungal spores of the disease from infected elms to healthy elms. The fungus is transmitted to healthy trees when beetles carry fungal spores after feeding in stem crotches of diseased elms.

Direct transmission of the disease occurs when diseased trees and healthy trees in proximity to each other have connecting root grafts. Elms that are within 40 feet of each other have a good chance of having root grafts.

SOLUTIONS:

1. All infected elms and dead or dying branches on healthy elms should be promptly removed and destroyed to prevent build-up of beetle and fungal populations. Prompt removal of diseased branches can help stop the spread of the disease in a tree if it has not progressed within 10 feet of the main trunk.

2. To prevent root graft transmission of the disease from infected to healthy elm trees, trees suspected of having root grafts should have them severed by trenching or soil fumigation.

3. Systemic fungicides can be trunk injected for preventive and therapeutic treatment. Trees receiving therapeutic fungicide treatments have the best response if the crown has 5% or less infection.

4. Research indicates that attempts to manage the bark beetle with insecticides may not be effective. The feeding sites of beetles (stem crotches) must be protected with insecticides, which is difficult with current equipment, pesticides and technology. The alternate option is the protection of susceptible trees with preventative trunk injections of recommended fungicides.

5. Trees maintained with good cultural practices such as fertilization, watering, mulching and selective pruning will have the best health and vitality.

Eastern Tent Caterpillar

Malocosoma americanum

The eastern tent caterpillar is a pest native to the United States whose presence was first recorded in the mid-1600's. It is found in eastern and central United States and has been seen as far west as the Rocky Mountains. It appears in large numbers, generally every ten years. The tent caterpillar favors wild cherry, apple and crabapple. It also feeds on ash, birch, sweetgum, willow, maple, oak, poplar and various *Prunus* species. It is not considered a serious pest except when attacking black cherry. Wild cherry trees seem to withstand repeated infestations.


Eastern tent caterpillar webs on host tree.

SYMPTOMS: The larvae (caterpillars) spin a silken webbing as they move. They radiate out from a branch fork creating the so-called tent. When populations are large, trees can become unsightly with webbing, and most of the foliage may be devoured by the caterpillars.

During winter, egg masses encircle smaller twigs of the host tree. The egg mass looks as if it has been varnished and can be up to 3/4" in length and contain 150 to 350 eggs.

CAUSE: The adult stage is a reddish brown moth that deposits its eggs in summer. When the eggs hatch the following spring, serious damage begins as the caterpillars' voracious feeding can defoliate the host tree.

The fully grown caterpillar is black with a white stripe down the back with several bright blue spots along each side.


Eastern tent caterpillars spinning their webbing on host tree.

SOLUTION: Damage on smaller trees can be reduced by removing the egg masses during winter. Remove larvae by clipping and destroying the tents when they are still small and inside the tent.

A commercially available bacterium, *Bacillus thuringiensis (B.t.)*, can be used to control the larvae. Natural predators include various ground beetles and parasitic wasps. Chemical applications may also be used.

Printed in U.S.A. T15086/7-02

Prepared by The Davey Institute

EMERALD ASH BORER

(Agrilus planipennis)

The emerald ash borer is an exotic Asian insect pest whose presence has been confirmed in Michigan, Ohio, Maryland and Ontario, Canada. Infested trees have been found in urban areas, woodlots and nursery stock. This borer has killed millions of trees, from small, young specimens to established, mature specimens.

Figure 1. Adult borers grow to ⅝" in length.

HOSTS: In the United States, the borer has been detected only on ash tree species, including black ash (*Fraxinus nigra*), blue ash (*F. quadrangulata*), green ash (*F. pennsylvanica*) and white ash (*F. americana*).

IDENTIFICATION AND LIFE CYCLE: The adult beetle is elongate, metallic green and ⅜ to ⅝ inches long (Figure 1). In Michigan and Ohio, adults emerge from early to mid-June until early August, feeding on a small amount of foliage (this causes jagged leaf edges). Females lay one to two eggs deep into bark crevices and lower main branches. After eggs hatch, the larvae tunnel through the bark and feed on the phloem and outer sapwood for several months. The mature larvae are cream colored and 1 to 1¼ inches long (Figure 2). Fully-grown larvae overwinter under the bark or sometimes in pupal cells made of outer sapwood. There is one generation per year.

Figure 2. Larva (Photo credit: Michigan State University).

SYMPTOMS AND SIGNS: Initial symptoms include yellowing and/or thinning of the foliage and longitudinal bark splitting (Figure 3). The entire canopy may die back, or symptoms may be restricted to certain branches. Declining trees may sprout epicormic shoots at the tree base or on branches. Removal of bark reveals tissue callusing and frass-filled, serpentine tunneling. The S-shaped larval feeding tunnels are about ¼ inch in diameter. Tunneling may occur from upper branches to the trunk and root flare. Adults exit from the trunk and branches in a characteristic D-shaped exit hole about ⅛ inch in diameter. The intense tunneling disrupts water and nutrient flow, causing trees to lose between 30 and 50 percent of their canopies during the first year of infestation. Trees often die within two years following infestation.

Figure 3. Bark splitting.

MANAGEMENT: Removal and chipping or incineration of infested wood is recommended. Stumps should be ground out. Quarantines have been set up to prevent movement of untreated ash lumber, firewood or nursery stock from the affected areas. Those who are concerned about protecting valuable trees should contact a Davey arborist.

TECHNICAL BULLETIN

Prepared By The Davey Institute

Fire Blight

Erwinia amylovora

SYMPTOMS: Blights of blossoms, fruitlets, and leafy shoots are initial indications of fire blight. Individual flowers (or flower clusters) appear to be water-soaked and quickly droop, shrivel and turn brown or black. Lesions can move inward to the twigs. Subsequent formation of twig and branch cankers can cause dieback. Cankers caused by fire blight begin as small, slightly sunken, brown or black areas in twigs and branches. Affected plant tissue in pear is black, while brown in most other hosts. If many shoots are affected at the same time, the plant appears burned by fire, hence the name fire blight.

Fire blight damage to Bradford Pear.

An important diagnostic feature is that the sapwood of newly infected shoots or twigs is discolored reddish-brown. Infected twigs often produce a "shepherd crook" effect (inverted "U") with discolored leaves remaining on trees. Damage to ornamental plants caused by fire blight ranges from mild disfiguration to death.

CAUSE: Fire blight commonly attacks plants in the rose family (Rosaceae) including: apple, firethorn, mountain ash, cherry, cotoneaster, hawthorn, pear and quince.

Bacteria may infect blossoms or twig growth, or may infect branches and the trunk of trees via wounds. During moist weather, a bacterial ooze from recently infected plant parts leads to the dispersal of the disease. Under drier conditions, strands of bacteria are produced and may also be dispersed in water. Other transmitters of this disease are insects, birds and humans.

Infection and spread of the disease is promoted by warm, humid weather. Cultural practices such as sprinkler irrigation, use of quick-release, high nitrogen fertilization and severe pruning also favor the spread of this disease.

SOLUTION: Careful pruning of all blighted twigs and branches can delay the spread of fire blight. It is important to make cuts at least eight inches below the infected area. This tactic is most successful when done during cool, dry periods. Pruning tools must be disinfected after each cut.

Resistant varieties of apples, crabapples, pears, firethorn and cotoneasters are available. There is sometimes a trade-off, however, in that plants resistant to fire blight are susceptible to other diseases such as scab.

Quick-release, high nitrogen fertilizers should be avoided, especially in the spring when new growth is most susceptible. A program of proper fertilization, irrigation, mulching and pruning will maintain the vitality of plants and support their natural abilities to survive this disease. Management of the disease is difficult, although applications of such products as Streptomgein Sulfate or Aliette, may reduce disease severity.

Printed in U.S.A.

T15210/7-02

TECHNICAL BULLETIN

Prepared by The Davey Institute

GIRDLING ROOTS

The presence of girdling roots is a common landscape occurrence for some tree species, particularly Norway maple. Other species which have a tendency to develop girdling roots are: maples, American beech, elms, oaks, poplars, pines and certain littleleaf linden cultivars.

SYMPTOMS: Indications of girdling roots include: reduced canopy growth, thin crown, leaf scorching, reduced leaf size, early fall coloration, and early defoliation on all or part of the crown. At ground level, the trunk may lack a root flare where it joins the buttress roots or appear strikingly flattened on one side, rather than as a normal cylinder (Figure 1). Girdling roots may be visible at the soil surface. If long established, they may be fused to the main trunk or other roots. A tree afflicted with girdling roots may also be more susceptible to disease, pests and other environmental stresses.

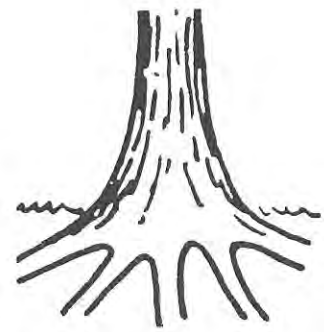


Figure 1. Normal tree trunk with flare or buttress at soil line.

CAUSE: Girdling roots are roots which grow around another root or trunk, putting pressure on the root or trunk, thus "choking" and compressing the water and nutrient conductive tissues (Figure 2). Girdling roots generally occur around or against larger roots and around or against the trunk, below, at or slightly above ground level. Because the nutrients flowing downward do not reach the roots, the root system will become stunted. This can result in decline and subsequent death and creates a hazardous situation if there are structures or pedestrians in striking range of the falling tree.

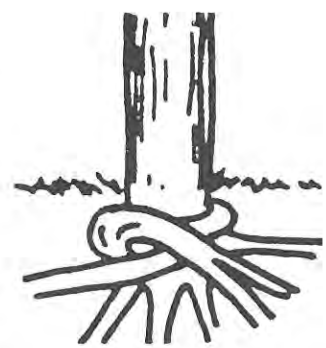


Figure 2. Girdling root. Trunk may grow straight up.

Girdling roots sometimes are initiated with container-grown (cans, pots) plants. Incorrect planting of bareroot stock can result in girdling roots or planting in soils where the difference between the soil of the root ball and the soil on-site are drastically different (Figure 3). It seems, however, that Norway maples will develop girdling roots regardless of cultural practices. Some experts believe that the most damaging girdling roots are those closest to the surface, in the first few inches of soil.

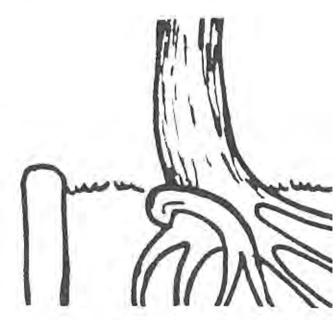


Figure 3. Girdling root caused by obstruction such as curb, sidewalk, wall or compacted soil.

SOLUTION: Recommendations vary with respect to the value and practicality of removing girdling roots. The girdling roots may be supplying a significant part of the tree with nutrients and water, and the removal of that root may further stress the tree. If the root is large enough that its removal may affect the structural stability of the tree or the root may be fused to the girdled root or stem, then nothing should be done. If a girdling root can be seen at the surface, it may be considered for removal but should not be more than ¼ of the diameter of the trunk. Removal of girdling roots on young Norway maples was actually found to result in increased girdling roots in later years, indicating that there are limits to what can be done with girdling roots of some tree species. It requires extreme caution in removing roots, as more damage than good can be done. Have a Davey expert examine the tree since there are surgery options that can be suggested. Some situations may require removal of a few roots over a period of several years so that new roots can be regenerated. Crown thinning may be required to reduce wind resistance to compensate for root removal. Deep root fertilizing with a slow release nitrogen source is also recommended.

TECHNICAL BULLETIN
DAVEY
Prepared by The Davey Institute

HAZARDOUS TREES

Tree Risk

No tree is absolutely safe. At times, even healthy trees fail. However, a tree is classified as high risk or potentially hazardous if any of these is true:

- It has a large defective part.
- The likelihood of that part failing is high.
- There is a target in proximity.

A target may be persons, pets or property (automobiles, homes, utility lines or other structures).

Tree Defects

Defective parts include roots, trunks or larger branches (see Figure 1 on the reverse side).

- Defective roots may be the result of construction nearby that has severed the large roots or may be caused by internal decay due to rot fungi. Root rot can result in tree failure, even though little evidence is seen in the above-ground parts of the tree.
- Defective trunks may be due to large internal or external cavities, cracks or seams in the wood, v-shaped or narrow branch crotches, or internal decay due to rot fungi.
- Defective branches may be due to broken or dead branches, large internal or external cavities, insect and disease activity, narrow or v-shaped crotches, or internal decay due to rot fungi.

Risk of tree failure increases when defects are left untreated or if two or more defects occur together, as when v-shaped branch crotches also contain decay. Trees that have been topped and those damaged during home construction are highly prone to decline and become hazardous in time.

Other symptoms of tree weakness are:

- Leaning of the tree, along with buckling and heaving up of the soil at the base of the tree on the side opposite the direction of the lean. This condition is caused by severed or decayed anchoring roots.
- An unbalanced or weak canopy with numerous staghorns (dead branches).
- Animals (birds, bats, bees) nesting in cavities within decayed trunks or branches.

Other Factors

The examples listed in the sketch (Figure 1) are not exhaustive. The species of the tree in question, soil conditions, exposure of the tree to wind, overall tree health and other factors need careful evaluation, along with the tree's defects, to determine how hazardous a tree is.

Evaluation and Care

Not all trees with defects need to be immediately removed. Some defects can be treated to prolong the life of the tree. In addition, not all hazards are visible or obvious. Advanced hazard tree analysis, either through the use of a tool such as the resistograph or through root crown excavation, may be necessary. Once a tree 4 has been documented as a hazardous tree, the owner of the tree may be responsible for any damage done by the tree. A certified Davey arborist should be consulted to evaluate the tree and determine the proper course of care and action.

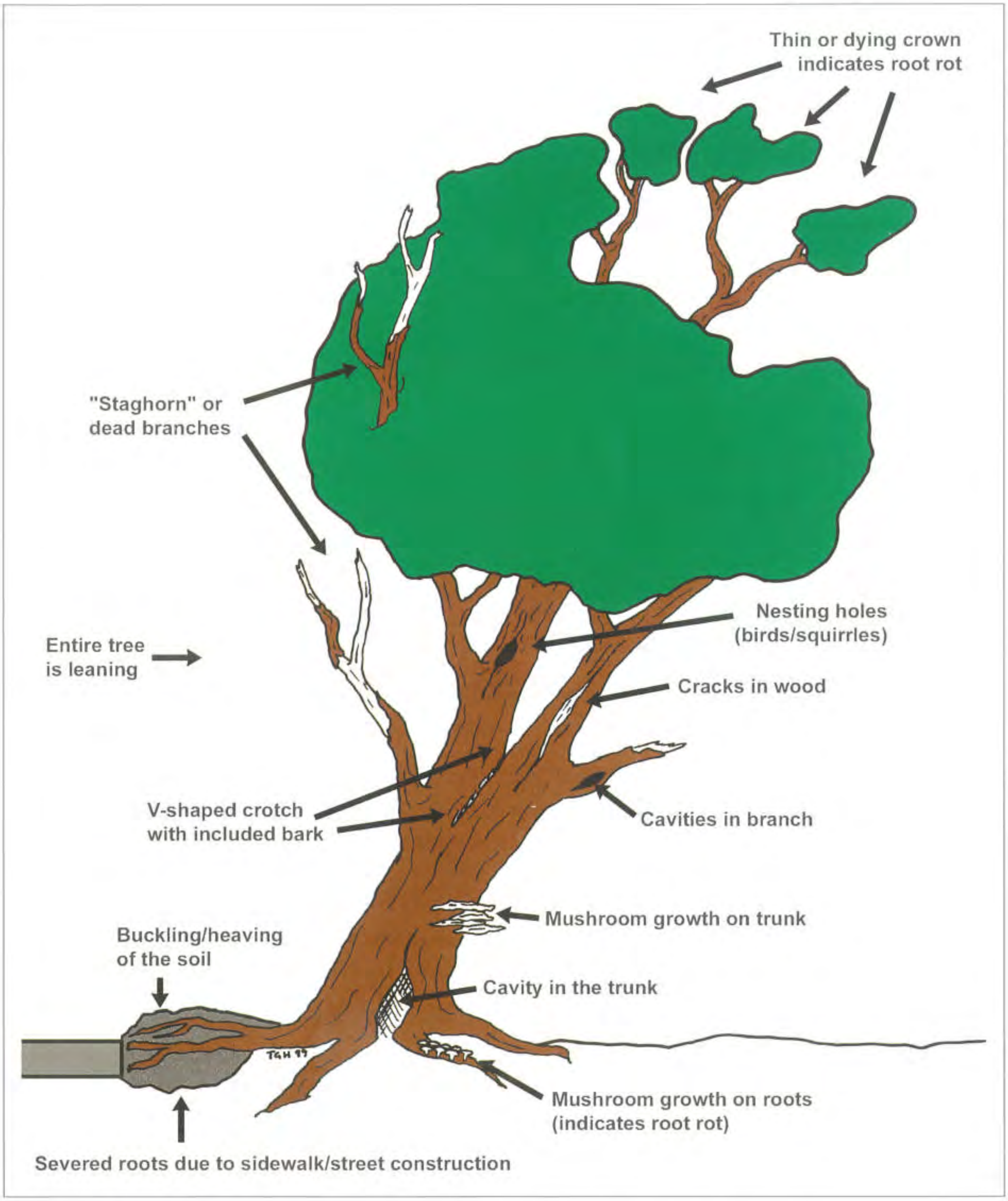


Figure 1. Any of these defective parts of a tree can make it hazardous.

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

HELP FOR DROUGHT-DAMAGED TREES

Dry soil conditions can significantly reduce the life span of valuable landscape trees. Because trees are both difficult and expensive to replace, they need attention both during and after a period of drought.

SYMPTOMS: Noticeable symptoms of drought stress include wilted foliage, a sparse canopy of off-color and undersized leaves, leaf scorch, yellowing, leaf drop, and premature fall coloration. Closer inspection will reveal limited twig growth and small, poorly formed buds. Growth the next season will be stunted even if there is sufficient rainfall later in the year.

Surface-rooted trees, such as maples and dogwoods, and newly transplanted trees are especially susceptible to damage resulting from dry soil conditions. However, even large established trees may show the effects of drought. Elm, maple, sycamore, ash, tuliptree and beech are often affected in forests as well as in urban landscapes. Other species may be injured if a drought is severe.

Figure 1. Symptoms of drought stress include wilting and yellowing of foliage. Tree in right foreground was not fertilized. Tree in left background was fed with Davey Arbor Green®.

Perhaps more life-threatening than anything to trees weakened by drought is invasion by borers and other secondary pests. Studies of trees' annual rings have shown that the growth of trees can be reduced for several years following a drought. During this recuperation period, trees are more susceptible to attack by various insects and disease-causing organisms. For example, elms subjected to drought are more likely to succumb to Dutch elm disease, sweetgums are more vulnerable to bleeding canker, and white-barked birches are extremely susceptible to bronze birch borer.

SOLUTION: The practices that have been saving drought-stressed trees for years are still valid today: watering whenever the soil is dry, fertilizing to enlarge root systems, mulching to conserve moisture, using pest management to control insects and diseases, and pruning to remove dead and dying branches.

- ***Water, Water, Water!*** Since most of a tree's active roots are within the top 12 inches of soil, a watering lance attached to a hose is the most efficient way of getting water directly to the roots while reducing evaporation and runoff. Apply 1 to 3 gallons of water using 3-foot spacings with the lance. If this is impractical, simply place a lawn sprinkler beneath the tree and let it run slowly until 2 inches of water has collected in a coffee can. Be sure to water the entire root zone beneath the tree canopy.

- ***Fertilize*** – Fertilizer will help reduce the severity of drought injury and enable trees to recover more quickly. Fertilizer enhances root development, and the expanded root system supplies more water to the tree. In addition, fertilizer helps promote the production of carbohydrates, which supply the energy necessary for growth and development.

  Because of the concentration of salts found in most fertilizers, drought-stressed trees are particularly sensitive to overfertilization. Davey Arbor Green® is specially formulated to avoid injury to trees weakened by drought. This unique deep-root fertilizer releases nutrients slowly to provide a continuous, uniform supply.

  Arbor Green is injected with a high pressure watering lance to a depth of 6 to 12 inches. This technique not only distributes the nutrients for more efficient absorption by roots but also improves the porosity of soil. Dry soils, particularly those subjected to high temperatures, often become compacted and resist both water and oxygen penetration, thereby restricting root growth and function. See Figure 1 for the difference fertilizer makes.

- ***Mulch*** – Mulching the soil surface around the root system will help reduce water loss and keep the soil cool. Use wood chips, bark shavings or other suitable material. Add the mulch to a depth of about 3 inches. Be careful not to mound mulch against the base of the trunk.

- ***Use Pest Management*** – Insect infestations and disease should be controlled to prevent further weakening or death of declining trees. Drought-weakened trees are particularly susceptible to wood-boring insects that can tunnel through the nutrient-conducting tissues and cause rapid death of the tree or shrub. Proper identification of a pest and its life cycle is necessary for effective control.

- ***Prune*** – Remove dead and dying branches that attract bark beetles and other wood-boring insects and that are susceptible to destructive fungal disease. Pruning will also enable tree roots to sustain the rest of the tree more efficiently.

Printed in the U.S.A. T15053-0300

TECHNICAL BULLETIN **DAVEY**

Prepared by The Davey Institute

HOW TO MINIMIZE STORM DAMAGE TO TREES

Storm damage due to poor branch structure.

Top heavy – entire root system failure.

Storm damage to trees can be caused by heavy, wet snow, freezing rain, lightning, or high winds. All of these put tremendous mechanical stresses on the leaves, branches, trunks, and root systems of trees on your property.

Proper tree maintenance can reduce the potential hazards that storms can cause to your safety, your property, and your trees. Proper pruning, cabling and bracing, a lightning protection system, proper tree selection, and cavity filling are all methods used by arborists to improve the chances of your trees to survive these storms.

PROPER PRUNING: Thinning the tree canopy allows wind to blow through the crown, instead of against it as though it were a sail. Properly pruned trees offer less resistance to high winds and are less likely to suffer breakage or to blow down. The removal of potentially hazardous dead or weak branches is an important safety practice.

CABLING AND BRACING: Strong metal cables and rods are used to relieve the strain that causes structurally weak trees to split and break in high winds, ice, and snow. Whether used in prevention or repair of structural damage to trees, cabling and bracing provides a support system to reduce the potential for fork splitting and branch breakage. Cabling and bracing your trees, along with thinning the crown, will reduce the chances of costly damage.

LIGHTNING PROTECTION: Lightning strikes trees because they provide better conduction of the electrical charge than the surrounding air. Lightning can severely blow apart a tree or it may only produce a spiraling dead area on the trunk. The installation of a lightning protection system in your valuable trees will prevent this destruction by harmlessly conducting the electrical charge to the ground and bypassing the tree itself.

TREE SELECTION: Certain tree species characteristically have weak wood and should not be considered for landscape situations. Although every tree has its place, quality landscapes should generally avoid weak-wooded trees such as silver maple, Siberian elm, willow, catalpa and poplar.

CAVITY FILLING: An open cavity in a tree's trunk is a weak point in its structural support system. Think of such a tree as a tube with a hole in its wall. This kind of tube can't support as much weight as an intact tube.

A cavity filling does not actually provide structural support, but rather a flat surface for callus tissue to grow over. Eventually, the continuity of the tree trunk is re-established and the trunk is better able to support the weight of its canopy. Fertilization with Davey's Arbor Green® helps promote the callusing process. A tree with strong, healthy wood is more likely to survive a destructive storm.

Printed in the U.S.A.

T63-5/2001

Prepared by The Davey Institute

IRON CHLOROSIS

SYMPTOMS: Leaves of susceptible trees and shrubs turn yellow (chlorotic) in the interveinal areas, but the leaf tissue along the veins remains green. In severe cases, the leaves will turn brown along the margins, leaves will be undersized, branches will die, and then the entire tree may fail.

CAUSE: Chlorosis is the yellowing of leaves due to a lack of chlorophyll, the green pigment in leaves that produces carbohydrates from carbon dioxide and light. The loss of chlorophyll reduces the nutrient-producing efficiency of the leaves. This leads to reduced vigor, stunting and death of susceptible trees and shrubs.

Iron deficiency chlorosis occurs in alkaline soils (those with a pH above 7.0), which makes the iron unavailable for root absorption. Iron is necessary for the formation of chlorophyll, and without it the leaves turn yellow. Iron chlorosis commonly occurs in species that are adapted to growing in more acidic soil, such as pin oak, white oak, red oak, willow oak, sweetgum, river birch, magnolia, pine, holly, rhododendron, camellia and azalea.

A pin oak leaf showing the typical symptoms of iron deficiency chlorosis.

Poor drainage, soil compaction and construction damage can aggravate the symptoms of iron deficiency chlorosis or mimic its symptoms, particularly in older trees.

SOLUTION: Soil incorporation of iron and/or acidifying compounds may be helpful for mildly chlorotic trees and shrubs. Soil treatments are slow in producing results and may take years of treatment before the plant will respond.

Trunk injection is another approach that can provide a rapid response, even with severely chlorotic trees that may otherwise die because of a lack of response to soil treatments. Injection of a liquid iron solution directly into the lower trunk will generally provide better leaf color the same season, although tree canopy response may not be uniform because of tree decline or irregular uptake. Blackening of foliage and leaf drop may occasionally occur. However, new leaves will be a normal dark green. Trees should not be injected annually.

Iron deficiency chlorosis treatments will not give permanent results and should be repeated periodically to maintain healthy trees and shrubs. In the Midwest and North, response to the treatment may be improved if the plants are also fertilized.

DAVEY

Lawn Herbicide Damage to Ornamentals

SYMPTOMS: Herbicide damage is usually noted in leaf tissue. Some plants, such as redbud, lilac, magnolia or petunias are especially sensitive to certain herbicides.

Herbicide exposure in the spring. Developing leaves and shoots of the plant will appear twisted, distorted, or cupped downward. The leaves usually remain green and attached to the plant, but may not fully develop. They are often narrow and thickened with veins that are close together (almost parallel rather than spreading out through the leaf blade). Blistering and dark green as well as yellowish areas may be noticed.

Herbicide exposure in the summer. Plants exposed to damaging herbicide quantities after leaf expansion will not show the same symptoms associated with leaf development. Twisting of the stalk that connects the leaf to the stem (petioles) may be the only symptom. However, leaf damage may appear the following spring if the herbicide material is long-lasting, such as dicamba.

On needle-bearing plants (conifers), symptoms of herbicide damage are also noticed in the new growth. Shoots become twisted and if the damage is severe, needles (young and old) may fall off the shoots. Dicamba may also cause new growth to turn brown and die.

Other Plant Disorders That Look Like Herbicide Damage:

Frost. Frost injury on needled plants (especially Taxus and spruce) can cause new growth to turn brown and die. On deciduous plants, cold can damage leaves as they are beginning to develop. Side effects are not noticed until the leaf enlarges and appears distorted and twisted or crumpled. This will not be noticed on younger leaves that developed after bud break and frost.

Viruses. Many viruses cause leaf distortion in plants. Virus symptoms are rare in woody ornamentals, but are often seen in herbaceous flowers as streaking and mottling of foliage and flowers.

Insect and Disease. Aphids and other sucking insects feed on the underside of leaves causing the leaf tissue to distort and become discolored. Both high and low temperatures can cause similar injury by killing newly expanding cells in leaves. Diseases which attack the leaves may also distort and discolor the new growth by injuring tissue during leaf expansion.

(over)

Nutrient deficiencies, air pollution, and excess salts should be taken into consideration in order to properly diagnose a plant problem.

CAUSES: Herbicides applied for control of broadleaf weeds in a lawn are similar to naturally occurring plant hormones that regulate growth. When applied at recommended rates, these growth regulators have a herbicidal effect by overstimulating young, rapidly expanding plant tissue, causing the weed to use up its food reserves and literally "grow itself to death." This rapid growth is responsible for the twisting and cupping characteristics of treated leaves. When carelessly or improperly applied, broadleaf herbicides also cause distortions in the new growth of sensitive ornamental plants although the effect is usually temporary.

SOLUTION: If herbicide damage is confirmed, the degree of injury should be assessed before damaged plants are treated. Most woody ornamentals resist the movement of broadleaf herbicides within the plant tissues and chemicals are normally broken down for the following season. Even severely affected plants may recover if care is taken to prevent further herbicide exposure. In general, most plants recover in time and replacement is unnecessary.

Activated charcoal will absorb certain herbicides and prevent further uptake from the soil. Pruning to remove the distorted plant tissue followed by judicious fertilization to promote new growth may help the plant recover more quickly. Other standard cultural practices such as supplemental watering and insect disease management will help maintain plant vigor and minimize the severity of herbicide damage.

Lightning Protection for Trees

It takes years and years to grow a large, magnificent tree. It takes only seconds for lightning to strike one down.

DAMAGE: More than half of the trees that are struck by lightning eventually die. For an unprotected tree, minimal damage may be evident of the trunk (cracking, peeling bark, etc.) while the roots have suffered considerable damage. Such a tree will probably soon wilt after being struck. For other trees, lightning may break off branches, trunks may split down the middle, or the entire tree may explode or burn. Even if lightning does not physically kill a tree, it is much more vulnerable to destruction by boring insects and decay fungi.

A damaged strip of bark resulting from a lightning strike. A tree lightning protection system would have prevented this from occurring.

CAUSE: Trees are attractive lightning targets because they provide a better conducting path than air for lightning to travel from the storm cloud to the earth. The tallest trees in a grove, trees in open areas, trees on the edge of a grove facing an approaching storm, trees on hilltops, and trees located close to buildings where wiring or plumbing might enhance ground conductivity are likely points of discharge for lightning bolts. Contrary to popular belief, lightning will often strike the same place more than once.

The tree species most often struck are: oak, elm, pine, tulip tree, cottonwood, ash, maple, sycamore, hemlock, and spruce.

SOLUTION: Although a tree lightning protection system does not prevent a tree from being struck by lightning, it is possible to equip a tree so that lightning will be conducted harmlessly into the soil. A system of heavy, copper cables is installed from the highest point in the tree and from the ends of the major branches, down the trunk, and into the soil beyond the tree's main root area.

(over)

Copper is a better conductor, making it more attractive to lightning than wood. If lightning were to strike the protected tree, it would actually strike only the copper and travel down the conductor cable into the ground where its energy would be safely dissipate, thus saving the tree from being damaged or destroyed.

An added benefit of a tree lightning protection system is called the cone of protection. This refers to an area beneath and around a tree that is protected from lightning strikes. Lightning that would normally strike anywhere within this area will be attracted instead to the copper protection system of the tree. The cone of protection reduces the chance of injury or damage for people, buildings, or animals within the cone.

TECHNICAL BULLETIN DAVEY

Prepared By The Davey Institute

Maple Decline

Maple decline affects primarily sugar maple, Norway maple, and red maple in the Northeast and Midwest. The problem is not a new one; stagheaded maples were described as early as 1917 in Massachusetts. At that time, dieback was attributed mainly to drought and poor conditions for tree growth afforded by the urban environment. These same conditions exist today, and reports of the incidence and severity of maple decline have increased markedly in recent years.

In urban sites, principle stress factors in maple decline include drought, de-icing salts, and/or road and sidewalk construction. These stresses also facilitate invasion by secondary organisms, including root rots, decays and twig blights, which greatly reduce chances of recovery from the original stress(es). When a healthy tree is stressed repeatedly, the stress alters the tree's internal chemistry to allow repeated attack by secondary organisms, and the tree declines and ultimately dies.

Maple decline affects upper portion of tree.

SYMPTOMS:

- **Reduced twig growth.** A general rule of thumb is that if the annual increase in twig length averages less than 5 cm., the tree may be in trouble.
- **Reduced foliage growth.** Sparse, light-green or scorched foliage signals that the tree may be declining.
- **Early fall coloration.** Maples normally begin showing fall color after the first frost or in mid to late September. When fall color develops earlier than normal, in late July or early August, the maple is definitely suffering from decline.
- **Dead branches in upper canopy.** Small dead branches seen in tree tops in late spring or early summer are indicative of decline. Over time, larger, more visible branches and limbs will die. The more numerous the dead twigs or branches are, the more severe the die-back decline conditions.
- **Poor root conditions.** If roots can be examined, look for reduced occurrence of small feeder rootlets; dead, brittle roots; and decaying buttress roots.

SOLUTIONS: The success of treatment to declining maples depends primarily on early detection of maple decline, the health of the tree prior to treatment, and its ability to respond to treatment.

(over)

Treatment for declining urban maples includes: watering, fertilizing, pruning dead branches, and reducing salt-laden spring water runoff over the roots.

Watering trees every week or two during dry weather is recommended. Trees should be watered slowly to soak the entire soil area under the tree canopy to a depth of 12 or more inches.

Fertilizing is best done with a slow-release fertilizer to minimize soil salts and safeguard the sensitive absorbing roots. Davey recommends Arbor Green injected into the root area to a depth of 12 inches. Proper fertilization will help stimulate new roots and improve the health and vigor of trees.

Dead branches should be pruned as well, to stimulate renewed vigorous shoot growth. Pruning, in addition to fertilization, helps revitalize declining trees and helps the tree ward off secondary organisms.

Road salt impact can be reduced by placing a barrier (curb, berm, ditch, etc.) to catch or divert the spring runoff water which often contains copious amounts of salt. If soil and foliar analyses have been run and high sodium or chloride concentrations were found, then leaching the soil with fresh water or applying gypsum to improve soil structure may be useful.

Printed in U.S.A. T69-92-2M

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.

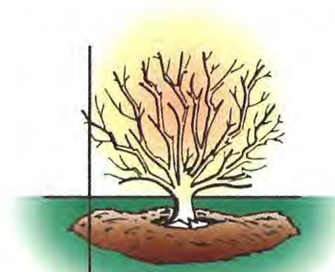
Mulch makes a layer of well-aerated soil near the surface available for long periods of almost continuous root activity. This layer is normally unavailable because of reoccurring periods of extreme dryness and fluctuating temperatures.

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.

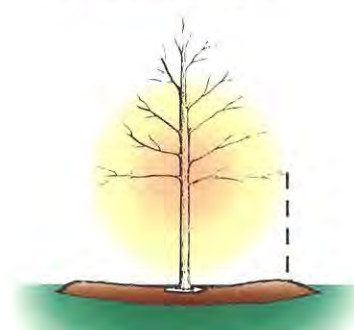
Most mulches need only be applied and maintained at 2- to 4-inch depths at the plants' dripline, ranging from 2 inches on heavy clay

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.

Printed in the U.S.A. T15089-09/03

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

PEST MANAGEMENT REDUCES STRESS

The complexities of survival in today's world create stressful situations not only for humans, but also for members of the plant world – your trees and shrubs.

Figure 1. *White malady is another name for pine needle scale.*

Figure 2. *Japanese beetles defoliate plants in hungry hoards.*

What causes stress?

Among the many stress factors which may affect your trees are air pollution, drought, mechanical injury, adverse soil conditions and winter injury. Two other major causes of stress are insects and diseases, which destroy or impair the function of leaves. Leaves are the important energy manufacturing system in trees.

Figure 3. *Borers are a serious threat as they sever vascular tissues, a plant's main nutrient pipeline.*

A variety of insect pests feed on trees. These include leafminers, scales (Figure 1), mites, weevils, leaf-chewing caterpillars and beetles (Figure 2), bark beetles and borers. Bark beetles and borers (Figure 3) are especially attracted to "stressed" trees. Research shows that trees defoliated two years in a row may be killed or thrown into an irreversible decline.

Leaf diseases such as apple scab (Figure 4), rust and anthracnose of ash, maple, oak and sycamore can weaken trees and subject them to attack by other insects or fungus. Many cankers and root rots can only become established upon stressed plant material. This stress often starts at planting and is due to selecting poorly drained planting sites, improper soil texture or pH.

Figure 4. *Apple scab is a fungal disease that can defoliate crab apple trees.*

What can be done to alleviate tree & shrub stress?

Spraying or soil injection treatments are effective techniques to reduce insect populations in trees and minimize plant damage. A preventive maintenance, "inspect and treat program" provides the best protection. Winter "dormant" oil applications suppress many scale insects, mites and eggs that overwinter on trees. These should be followed by three to four "inspect and treat" visits scheduled during the spring and summer or as needed. Applications may not be necessary every visit, but evaluation by a horticultural expert is necessary to ascertain the best option to avoid pest damage.

In conjunction with pest management, proper fertilization, mulching and watering also can help alleviate stress. By pre-scheduling your landscape plants' inspect and treat visits, you can help maximize the beauty and health of your valuable trees and shrubs.

Prepared By The Davey Institute

Davey Tree Plant Health Care for Your Landscape

Davey Tree Plant Health Care service provides a versatile approach that develops vigorous landscape plants through the use of property checkups, pest management, nutrition and cultural practices. This strategy strengthens the natural ability of trees, shrubs, and turfgrasses to resist certain insect and disease pests. This minimizes the need for pesticides.

Tradition...

Plant Health Care uses modern technology based on over 75 years of field experience and research. In 1987, Davey Tree implemented its Plant Health Care (PHC) service by recognizing and treating plant problems with technically supported pest control timing and with the least environmentally intrusive methods. PHC is currently promoted by many universities and the International Society of Arboriculture (ISA).

Unique Davey Technology...

Through extensive in-house research, we are continually creating new services as well as developing equipment, systems and materials that allow us to better service our customers. Davey Arbor Green®, our exclusive fertilizer, and our deep-root injection technique supplies nutrients that trees require for vigorous and healthy growth. This helps to strengthen the inherent (natural ability) of plants to tolerate and resist certain insect and disease pests better, as well as survive unfriendly environmental extremes.

Regular Checkups and Care...

Plants, as with people, should have regular checkups to ensure good health. This is where Plant Health Care really begins, with the checkup. The first step is the inspection of the lawn and/or all trees and shrubs. Thorough inspections pinpoint potential health problems so the technician can determine what action needs to be taken. Preventive health care measures will also be recommended at this time. These may include fertilization, pruning, cabling/bracing and lightning protection for trees and shrubs, as well as cultural practices such as fertilization, aerification, lime application, proper mowing and watering for lawns.

Prevention and Pest Management...

Because Plant Health Care emphasizes the benefits of cultural practices to plants, care through preventive measures and proper maintenance, pesticide use can be reduced. In addition to selective applications of pesticides, alternative materials such as horticultural oils or soap may be used. Davey Tree uses eco-smart products. That is, they have minimal residual and impact in the environment, such as B.t. *(Bacillus thuringiensis)*, a bacterium derived formulation that controls only caterpillars. In-house research at the Davey Institute gives us not only the best 'window-of-control' or the most vulnerable time in a pest's live cycle for maximum results, but also the most effective, eco-smart products to use.

Plant Health Care...care for Landscape Plants, the Environment and for our Customers

Printed in the U.S.A.

L1500-97-2M

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

POST-PLANTING CARE OF WOODY PLANTS

SYMPTOMS: Transplanted trees and shrubs frequently undergo a prolonged period (2 to 5 years) of slow growth and reduced vigor due to transplant shock.

CAUSE: Problems with transplant shock following successful tree or shrub planting are usually due to improper post-planting care.

SOLUTIONS: Proper site selection and good planting techniques help induce root growth into surrounding soil so that the original balance between roots and above-ground shoots is restored as quickly as possible, minimizing the severity and duration of transplant shock.

If the plant has been suitably matched to the environment in which it is placed and has been correctly planted, post-planting care to minimize transplant shock should include proper watering, mulching, staking, pruning and fertilizing.

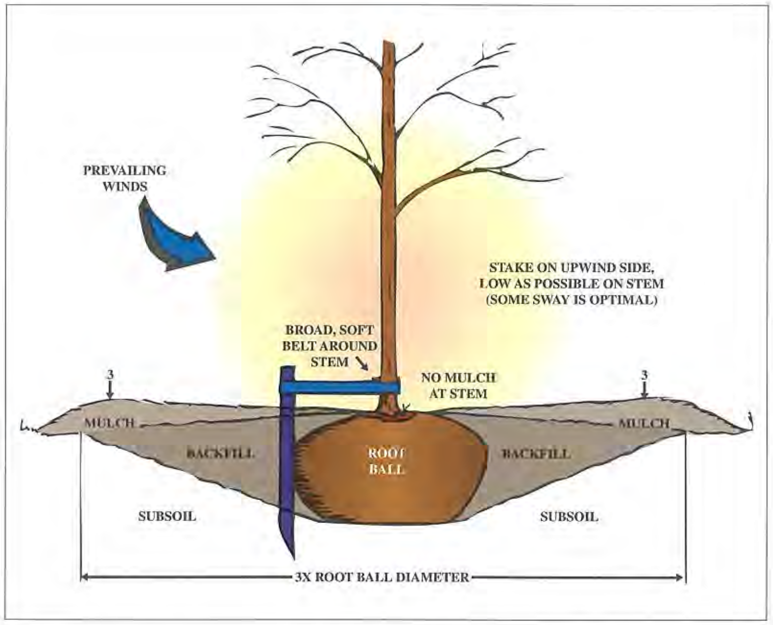


Figure 1. Some elements of good planting and post-planting care are illustrated.

Proper irrigation (**watering**) is crucial to balance water and oxygen supply to new roots. The most common problem with young trees and shrubs is either too little or too much water in the soil. Most woody plants do best with deep, but infrequent, watering. Soils should ideally contain 25% water and 25% air space.

Newly transplanted trees should be **mulched**. Good mulch beds replicate organic forest-litter "sponges" that buffer water, air and temperature extremes in nature. The ideal mulch pattern tapers from a two- to four-inch depth of well-composted organic matter at the dripline of trees and shrubs to bare soil at the trunk. Sandy soils need deeper mulch layers over the new root zone than clay soils.

Trees that are **staked** when installed in spring for protection from prevailing winds generally can have staking and banding material removed in fall; fall-planted trees can be freed late the following spring. Tree wrap should generally be removed at planting time; however, some fall-planted trees with thin, smooth bark may overwinter with wrap, as long as it is removed before leaf growth in the spring.

All injured, malformed, crossing and poorly attached branches should be **pruned** at the time of planting. Pruning to branch growth can be initiated after one full growing season has passed, but winter-killed and dead wood should be removed promptly. Avoid the practice of "balancing" above-ground shoot growth with the root system upon installation. Root systems require as many branch tips left intact to trigger other growth.

If the transplant was not fertilized at planting time, **fertilize** with a low-burn/low-salt-index material that will provide slow-release nitrogen. The nitrogen benefits shoot and root growth within the first growing season following application. Davey's Arbor Green® fertilizer is a superior source of controlled-release nutrients.

TECHNICAL BULLETIN

Prepared by The Davey Institute

POWDERY MILDEW OF WOODY ORNAMENTALS

Caused by several fungi, such as Microsphaera, Erysiphe and Sphaerotheca

Figure 1. White fungal growth of powdery mildew on lilac foliage.

Figure 2. Powdery mildew disease distorts dogwood leaves.

CAUSE: This disease is caused by several species of fungi. As the fungi grow on the upper leaf surfaces, they produce mats of white mycelium and powdery spores *(Figure 1)*, which give the disease its descriptive name. These pathogens are somewhat host-specific, so the powdery mildew on a sycamore tree will not be a threat to the bluegrass of the adjoining lawn. Powdery mildew is most severe in late spring and early fall or when the days are warm, the nights are cool, and the rainfall is light. Spore germination and infection development occur most rapidly on dry plant surfaces at mild temperatures and at a relative humidity of at least 95 percent. The heaviest coatings of powdery mildew occur in humid, shaded areas. Powdery mildew has become more of a problem on dogwoods *(Figure 2)* during the last four years or so.

Hosts are many. Commonly afflicted plants include azalea (Kurume types), crabapple, crapemyrtle, euonymus japonica, lilac, rose, sycamore, etc.

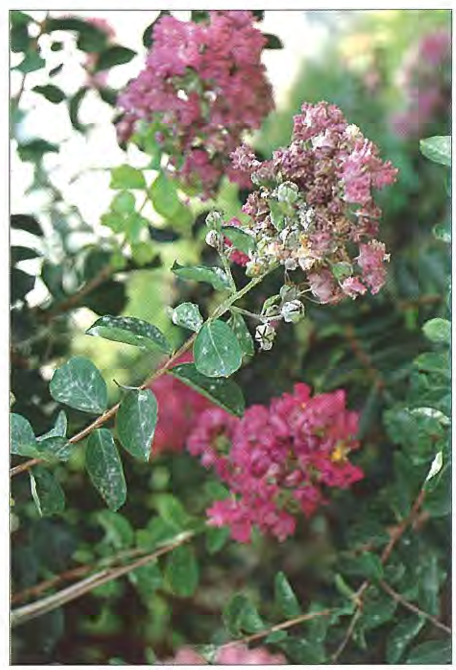


Figure 3. Crapemyrtle flower head, in center, is blighted by powdery mildew disease.

SYMPTOMS: Usually, powdery mildew is brushed off as being a late-season event that only attacks senescent leaves, and essentially, no big deal! However, powdery mildew attacks dogwoods and crapemyrtles earlier in the season. Also, powdery mildew invades the upper parenchyma layer of younger leaves and, to a lesser degree, mature leaves. The "sign" – mycelial fungal growth – shows first, which serves as a little white flag to get the fungicides before the symptoms show. Leaves then become distorted and exhibit marginal scorch, dead patches, reddish discoloration, yellowing and premature defoliation. When the fungus attacks flower buds of plants such as crapemyrtle *(Figure 3)*, flower set is reduced. Other plants, such as lilacs *(Figure 1)* and dogwoods, may fail to produce enough carbohydrates to yield flower buds due to the early leaf drop and because photosynthesis is limited.

SOLUTION: Fungicides are not usually recommended for trees. However, flowering shrubs such as crapemyrtles, lilacs and dogwoods that may lose flower production due to powdery mildew infection will benefit. Two to three applications will minimize the impact of this disease. Banner®, Bayleton or Cleary's 3336® are the products that do the best job. For dogwoods and lilacs, start applications about mid-June or when you first see the little white patches. For crapemyrtles, make applications as early as bud break, especially as flower buds appear.

Printed in the U.S.A.

T15212-12/2000

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

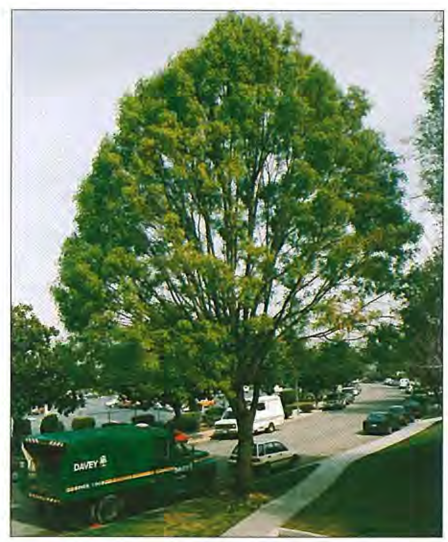
PROPER PRUNING OF TREES

Proper pruning improves the health and appearance of trees and prolongs their useful life by removing undesirable branches which are dead, weakened, interfering, diseased or insect-infested.

Before pruning

TYPES OF PRUNING: The Davey Tree Expert Company recognizes four general classes of pruning which define the type and degree of recommended pruning.

- Aesthetic or Fine Pruning is the thorough removal of undesirable branches over ½ inch in diameter. This includes selective thinning to lessen wind resistance (see photos).
- Maintenance or Standard Pruning is the removal of undesirable branches over 1 inch in diameter.
- Hazard Reduction Pruning is the removal of undesirable branches over 2 inch in diameter. This class is recommended where safety considerations are paramount.
- Crown Reduction Pruning, also called natural or drop crotch pruning, is the proper reduction in the height or spread of the tree canopy.
- Crown Raising is the removal of lower branches in order to provide clearance.



After fine pruning

TOPPING vs. THINNING: Proper pruning is not to be confused with the disfiguring practice of "topping." Topping (heading, stubbing, hat-rocking, etc.) is the indiscriminate removal of a tree's main leader and branches resulting in stubs. The cut surfaces of the stubs do not close readily, and accelerated internal decay develops. The resulting flush of multiple epicormic branches (watersprouts) from the stubbed branches form terminals that are very weak. Topping leaves a tree highly susceptible to damage from strong winds, sunscald, winter injury, insects and diseases.

Thinning is the correct method for removal of branches to their point of attachment to the trunk or another branch sufficient in size. This method eliminates unhealthy and unsightly stubs, resulting in an open, airy, natural appearance to trees. Thinning requires more skill and time to perform than does topping. Trees that are properly pruned and thinned will live longer and should not need to be pruned as often as trees that have been topped.

WHEN TO PRUNE: Maintenance pruning of most shade trees can be done anytime. Severe pruning, however, should be done in late winter or early spring before new growth begins. Pruning trees like birch and maple, which seep profusely from cut surfaces in the spring, is sometimes delayed until the fall, although the loss of sap is seldom injurious. Pruning of trees susceptible to certain vascular diseases, like American elm and certain oaks, should be avoided during the activity period of beetles that spread the diseases.

TECHNICAL BULLETIN

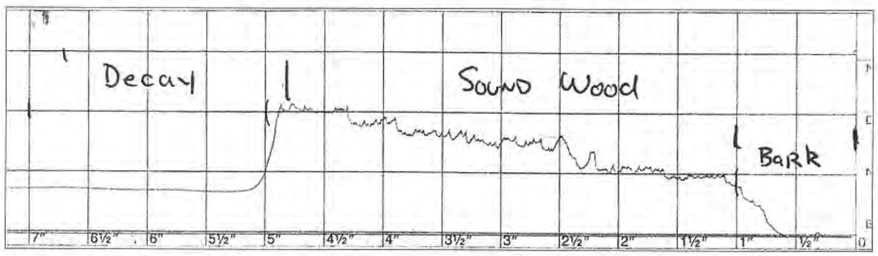
Prepared by The Davey Institute

ADVANCED DECAY DETECTION USING THE RESISTOGRAPH

WHY TEST FOR DECAY?

Wood decay in shade and ornamental trees is the most common disease in the urban forest. Decay and other tree defects can result in failure of branches, large stems or the entire tree. Importantly, not all trees with decay require treatment. The presence of decay does not necessarily mean that the tree is hazardous or requires treatment. More important than the presence of decay is the location and amount of decay.

In many cases, visual assessment of decay, simply sounding with a hammer, or probing with a sharp tool can provide adequate information to judge the amount of decay in a tree. However, because decay is often hidden internally by the bark, more advanced tools may be needed to make better judgments on how much decay is present.



Labeled Resistograph chart.

SYMPTOMS OF DECAY: There are many symptoms or indicators of decay in trees. A few examples include cavities; decayed branch stubs; loose or missing bark; fruiting bodies of wood decay fungi on roots, the trunk, or stems; or the presence of carpenter ants. These indicators do not tell how much decay might be present in a tree.

CAUSE: Wood decay in trees is caused by a closely related group of basidiomycete fungi that can digest the cellulose and lignin components of wood. These fungi may fruit on a tree in the area where the decay is present.


Drilling into a sycamore with a Resistograph.

SOLUTION: The first step in the treatment of trees with indicators or symptoms of decay is to make an assessment of the amount of decay. If visual observation, sounding or probing techniques cannot adequately provide enough information, more advanced techniques may be needed.

The Resistograph is a relatively new tool in arboriculture that provides a means to assess and document hidden decay in a tree. This tool has a very small (3 mm), non-spiraled bit that can probe areas in the tree where decay is suspected. The distance the bit has traveled and the resistance to the bit are recorded on graphs. Reading these charts allows your Davey arborist to determine the presence and amount of decay in a particular location.


Fungal conks indicate internal decay in a tree.

Once an evaluation of the amount of decay in a tree is made, treatment options can be developed. Unfortunately, there are no treatments to stop decay once it starts inside a tree. Treatments such as removal, pruning, cabling, bracing or moving of the target (what the tree might hit if it or a part of it fails) are potential options that can be developed with your Davey arborist.

Printed in the U.S.A.

T 15246 – 02/04

Prepared by The Davey Institute

Root Collar Excavation

Planting trees too deeply and excessively piling up mulch on the trunks of trees has become a chronic problem in urban landscapes. These practices can have a number of serious, negative, long-term effects on tree health. Deeply planted or buried trees are prone to stem girdling roots, poor growth performance, pest problems, and decline or death. Root collar excavation, or the removal of soil and mulch from against the trunk, is a simple, effective process that can correct deep planting, over mulching or fill.

A root crown excavation being performed on a deeply planted tree with a supersonic air tool. Note that the tree lacks a normal flare at the base.

SYMPTOMS: Normally, a tree should have a well-defined flare or expanded area where the soil meets the trunk. For example, most natural forest trees have a well-defined flare at their base. Trees that lack this flare or look similar to a utility pole at the base may be suffering from soil or mulch improperly placed against the trunk. These trees may also be showing symptoms of stress, such as yellowing of leaves, premature fall coloration, small or undersized leaves, reduced growth rates or increased attack by pests.

CAUSE: The lack of a normal root/stem flare can have a number of causes. Deep planting is a common cause (either in the tree nursery or in the landscape), as well as piling mulch up around the stem. Fill soil that has been moved in around the base of a tree during construction is another common cause.

Left untreated, deeply planted or over-mulched trees may be killed by wet soil and mulch piled against the stem of the tree.

SOLUTION: Exposure of the original root/stem flare or root collar is a process known as root collar excavation. In some cases, all trees on a property may require inspection and root collar excavation treatment.

While root collar excavation can be done manually, this is a time-consuming process. Davey arborists now have supersonic air tools that greatly reduce the time required for excavation. The air tools use compressed air to remove the soil from the base of the tree and expose the root flare. Use of the air tool also greatly reduces the potential for injuring large roots and tree trunks (this can happen when manual techniques are used).

After root collars are excavated, inspections can be made for root girdling, twine left behind from planting, decay and disease. The tree is then left with the root/stem flare exposed and a greatly increased potential for a normal, vigorous life.

Printed in the U.S.A.

T 15245 – 02/04

Prepared by The Davey Institute

SCALE INSECTS

Figure 1. Gloomy scale, *Melanaspis tenebricosa,* is an armored scale that infests silver maple. Armored scales are typically flattened and blend into the bark.

Figure 2. The bumps on this live oak twig are a lecanium scale, *Parthenolecanium* species, an example of a soft scale insect. These insects resemble miniature cowry shells.

SYMPTOMS: Look for undersized and sometimes, yellow-mottled leaves. A severe infestation will cause canopy thinning due to premature leaf drop and branch dieback. These insects can be found on bark, twigs, leaves or needles. Scale insects are a serious threat to plant health.

CAUSE: Scale insects are usually overlooked because they are small and blend into the bark or leaf tissue where they are feeding and they are not as mobile as larger insects. In fact, they are anchored into the plant's vascular tissue with their thread-like mouth parts, much like a button is sewn onto a shirt. There are two general groups of scale insects, the armored and soft scale insects.

Armored scales create a durable covering from wax pores on their body. This cover is like a lid which can be flipped off to reveal the vulnerable scale. This group of scales is flattened and smaller than soft scales, usually ⅛ to ¼ inch in length. Armored scales may have multiple generations each growing season, however, they only produce 10 to 50 eggs per female. There are around 300 species of armored scales in the United States such as the gloomy scale (Figure 1), pine needle scale, euonymus scale and oystershell scale.

Soft scales are larger (¼ to ½ inch long) and rounded in a profile with a flexible, waxy covering that is directly connected to the insect's body. Because these scales imbibe a large volume of sap, they excrete the excess as a sticky substance, politely referred to as "honeydew" or "ghost rain". People often complain that their trees are "weeping" or dripping, when it is actually the soft scale population in the tree that is dripping the honeydew. Due to the high sugar content of the honeydew, it is frequently colonized by the black growth of a fungus called a sooty mold. Females produce 1000 to 2000 eggs, another factor that makes them difficult to control as it does not take long for a plant to become re-infested if just a few females survive the pesticide applications. Fortunately, there is usually only one generation per year. There are about 85 soft scale species in the United States, such as oak lecanium (Figure 2), cottony maple scale, pine tortoise scale and magnolia scale.

SOLUTION: Scale insects are difficult to control or "manage". Winter applications of "dormant" oil can be effective for some species, such as most of the soft scale group. However, the armored group, the euonymus, gloomy and obscure scales are in a susceptible stage at that time. But, in the winter, the pine needle scale and oystershell scale are [redacted] in the egg stage and are not as vulnerable to "dormant" oil treatments. Management of some species requires pesticides that provide residual activity that will outlast the prolonged hatch periods of the crawlers (nymph that hatches from the egg) and the second instar stage. Reducing large populations of scales may take several applications per year and several years to achieve.

Printed in the U.S.A. T15079-1097

TECHNICAL BULLETIN DAVEY

Prepared by The Davey Institute

Soil Invigoration

Treatments for Declining Trees and Construction-Impacted Trees

Until recently, treating construction impact or tree decline (or the slow loss of vigor and gradual death of shade trees) was mostly unsuccessful. However, new treatment methods and tools have greatly expanded our ability to treat, and reverse, decline in our valuable shade trees.

SYMPTOMS: Trees affected by construction or decline can show a range of symptoms, including yellowing of leaves, premature fall coloration, undersized foliage and reduced shoot growth (which can give the overall crown of the tree a thin appearance), and eventually death of branches. Left untreated, these symptoms are often followed by death of the tree.

CAUSE: Decline can have many causes, but two of the most common are compacted or poor-quality soil. Soil compaction is so harmful that many trees cannot survive its effect. Compaction often follows construction activities or excessive foot or vehicle traffic. Poor soil conditions (little topsoil and compacted subsoil) are common in landscapes that are left behind after new homes are built. Other possible causes are root injury or cutting, drought, defoliation due to pest problems, lightning injury, or combinations of these factors.

SOLUTION: Treating the soil around large, established shade trees affected by decline is a process called soil invigoration. Supersonic air tools that use compressed air to break up compacted soil and replace it, if needed, are making the treatment of poor soil conditions possible without harming the roots of trees. Depending on the cause of the poor vigor or decline, one of the three techniques described below could be useful in modifying the soil around a tree:

VERTICAL MULCHING: Vertical mulching causes the least disturbance. It is most useful when a compacted layer of soil beneath the topsoil is inhibiting soil drainage and root growth. This process uses a grid pattern of circular holes in the tree's rooting zone. The holes are usually backfilled with a mixture of new soil and compost. Fertilization with Davey's Arbor Green® has proven beneficial with this treatment.

RADIAL TRENCHING: Radial trenching replaces existing soil and provides four or more trenches or channels for root growth. These trenches are created with the supersonic air tool, then filled with a compost/topsoil mixture. Radial trenching is often used when the topsoil is so compacted that it cannot be used again around the tree.

SOIL INVIGORATION: Soil invigoration breaks up soil compaction and adds organic matter (compost) to the existing soil without removing it. A large, powerful air tool is used to fracture the soil, and a smaller air tool is used to work the compost into the soil profile. Only a portion of the tree's rooting area is usually treated the first time.

After the soil invigoration treatments described above, the area can be mulched or returned to turf. Tree owners should be aware of the short-term disruption to the site in exchange for the potential saving of mature, valuable shade trees.

Vertical mulching installs vertical holes that are backfilled with soil and organic matter or other materials. This procedure works well when a compacted layer exists beneath the surface.

Radial trenches are used to replace poor soil and provide channels for root growth. The soil is replaced with a 50/50 mixture of topsoil and organic matter.

Soil invigoration leaves the soil in place and fractures it with the use of a large, supersonic air tool. Organic matter is then mixed into the soil profile.

Printed in the U.S.A.

T 15244 – 02/04

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

TOPPING vs. PROPER PRUNING

Many people have no idea that cutting large diameter main branches of a tree back to stubs in an effort to reduce the height is an unacceptable, and unskilled way to prune trees. This approach guarantees quick, visible results, but leaving stubs (also referred to as "hat-racking") permanently disfigures and essentially initiates the decline of that tree (see Figure 1 and 2).

The trees on this beautiful lot have been topped. The beauty and the value of this property have been greatly decreased.

Topping invites internal decay. When a branch is correctly pruned at its point of attachment (Figure 2) to the trunk just outside of the branch collar and the branch bark ridge, internal decay is usually stopped from progressing into the trunk by a barrier inside the collar. Also, a correct cut results in more rapid wound closure so that the bark quickly grows over the injury.

Branch stubs produced by topping harbor decay fungi which have an avenue to break through the protective barrier in the collar and then proceed into the main trunk. Whenever a cut is made in the main leader by topping, there is nothing to prevent decay from developing in the trunk. The tree may be structurally weakened and its useful life-span reduced. Other adverse effects of topping are:

1. Topping removes a major portion of a tree's leaves which are necessary for the production of carbohydrates.

2. Once-shaded bark in the canopy may be scalded by exposure to direct sunlight. This weakens the integrity of the protective bark and it is more prone to borers, diseases and decay fungi.

3. Stubbing stimulates the development of watersprouts just below the cut. These shoots grow rapidly, causing a topped tree to grow back to its original height faster and denser than a properly pruned tree. These watersprouts are weakly attached and are in danger of splitting out in a storm.

If the height of a tree has to be reduced because of storm damage or interference with electrical wires, it can be correctly done by a method called ***crown reduction or drop crotch pruning***. This procedure involves the removal of a main leader or main branch at the point of attachment of a lateral branch (see Figure 2). The final cut should be parallel to the lateral branch and the branch bark ridge without cutting into the bark ridge. The lateral branch should be at least one-third the diameter of the branch or leader that is being removed.

The National Arborists Association considers "topping back to stubs" as an unacceptable arboricultural practice and advises against it. The NAA has developed pruning standards which define the type and degree of recommended pruning.

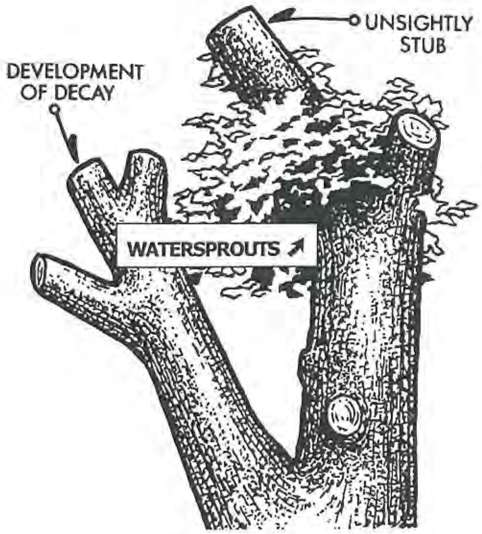


Figure 1. **Incorrect Topping**

Topping in this manner not only ruins the natural form of the tree but weakens the tree. The stubs are unsightly and invite the entrance of disease and decay. Weak watersprouts (new shoots) proliferate in a witches'-broom fashion.

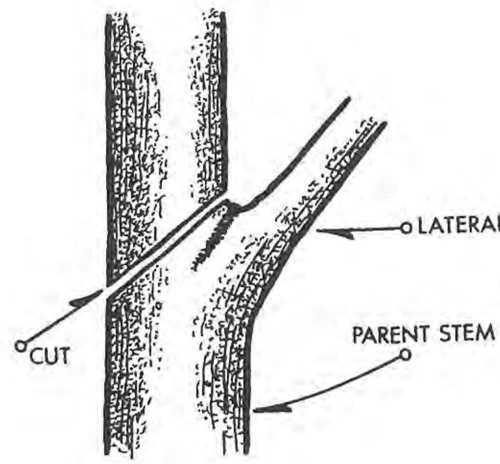


Figure 2. **Crown Reduction Pruning**

In reducing the crown of a tree, the main branch should be cut back to a lateral branch to reduce the possibility of decay and to encourage the growth of tissue over the wound.

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

TREE AND SHRUB FERTILIZATION

Why Fertilize Trees and Shrubs?

Forest trees usually thrive without the addition of fertilizer, which can give the erroneous impression that trees in general do not require it. However, while forest soils are rich in humus (organic matter) that is replenished by the decay of plant residues, urban soils are usually very low in humus and nutrients. Because leaves in home landscapes are removed (raked away), nature's recycling program for nutrients is interrupted. Because ornamental trees and shrubs are also subjected to harsh and unfavorable soil and environmental conditions, the need for fertilizer is even greater.

The addition of fertilizer not only improves the appearance and condition of trees and shrubs (Figures 1 and 2), but it helps them to better withstand minor insect and disease problems, drought, and other stresses. Fertilization is not a cure-all, but after years of research we have found that well-nourished trees do not have as many serious and costly problems as unfertilized trees.

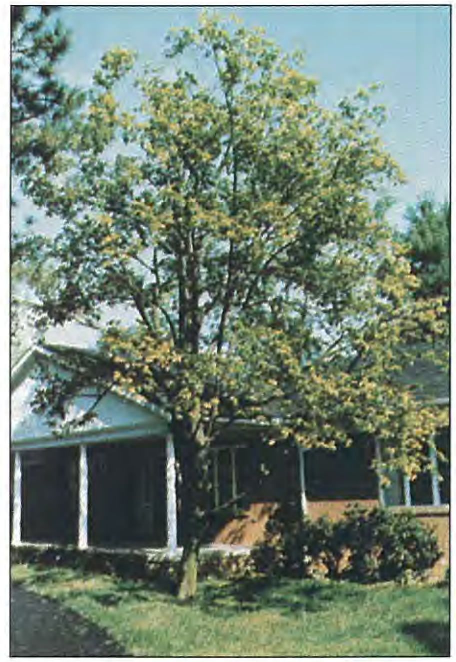


Figure 1. Before fertilizing

What is the Best Fertilizer to Use?

Davey's Arbor Green® 30-10-7 is a complete slow-release fertilizer, containing nitrogen, phosphorous and potassium. The nitrogen in Arbor Green® is bound in organic molecules and then released in soil by microorganisms. This provides a prolonged availability, and the plants become more vigorous.

Fertilizers with high levels of water-soluble nitrogen release quickly and leach away, offering little nutrient carryover from one season to the next. Due to the complex nature of the organic compounds found in Arbor Green, the release rate is slow and consistent, resulting in a uniform growth response and healthier plants.

The salt index, which measures the salt concentration and, thus, the burn potential of fertilizer, is very low for Arbor Green. This means that Arbor Green will not burn the roots of trees and shrubs that have low salt tolerance, stressed or declining landscape plants, or newly planted trees and shrubs.

Figure 2. The same tree, after fertilizing

How Should Trees and Shrubs be Fertilized?

Our trained professionals inject the proper amount of Arbor Green and water directly into the soil of the root zone. This technique, done under pressure, provides better distribution of the nutrients in the soil profile for more efficient contact and absorption by the roots. It also improves soil porosity and replenishes moisture within the root system. Our Davey fertilization technique will help plants develop a denser root system, which will improve nutrient and water uptake.

The health and appearance of trees and shrubs will noticeably improve with fertilization. Because prevention is the goal, trees should be fertilized before problems occur.

Printed in the U.S.A. T15081 – 8/2002

Vascular Wilt Diseases

Verticillium Wilt / Oak Wilt

These diseases are caused by separate fungi that attack the water-conducting (vascular) system of trees. A tree responds by blocking its vascular system to contain the disease and, in so doing, cuts off the water supply to its leaves.

SYMPTOMS:

VERTICILLIUM WILT - The first symptoms of this disease are sudden wilting and dying of leaves on scattered individual branches during the summer. In some cases, large areas in the tree may wilt and die. Infected branches often show an olive-green discoloration in the new sapwood. This disease is most commonly found in maples, but it also affects several other plant species. Some trees will recover if the disease is managed properly.

OAK WILT - Leaves in the upper crown turn a dull green, bronze, or tan beginning at the leaf margin. Soon the leaves wilt and drop off the tree with various degrees of discoloration. Brown streaks develop in the new sapwood. Trees in the red oak group (red, black, pin, and scarlet) are not known to recover once infected. The white oak group (white, bur) varies in species resistance to oak wilt, but these trees usually die slowly over a period of several years.

CAUSE: Verticillium wilt is a soil-borne fungus that invades susceptible trees through the roots. It does not readily move from tree to tree.

Oak wilt can be spread by insects that carry the pathogen on their bodies from an infected tree to an uninfected tree. It also spreads via the vascular system of grafted roots of adjacent trees.

SOLUTION: For trees with only a few branches affected by Verticillium wilt, prune the affected parts and then fertilize. Trees with vigorous growth can "wall-off" or contain the disease within the old wood tissue, producing new wood which is not infected. During dry periods, water and mulch the tree to help improve recovery.

The major strategy with oak wilt is to prevent its spread to healthy oaks. This can be an extensive project involving the prompt removal of infected trees and the disruption of root grafts. Without these measures, the disease will almost assuredly spread and kill more trees. If there is a healthy oak within 40 feet of the diseased one, fumigation or trenching should be done to prevent root graft transmission of this fungus at least 10-15 days prior to the removal of the diseased tree. Live oaks (only in Texas) infected with oak wilt can be injected with labeled fungicides to suppress the growth and spread of the disease-causing fungus.

Printed in U.S.A.

T80-01-2500

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

VERTICAL MULCHING

Soil in an ideal state for tree growth contains 50% solids (Figure 1). The solids in a soil are composed of mineral material (weathered rock) and organic matter (decayed plants and animals). In an optimum condition, a soil contains 45% mineral material and 5% organic matter.

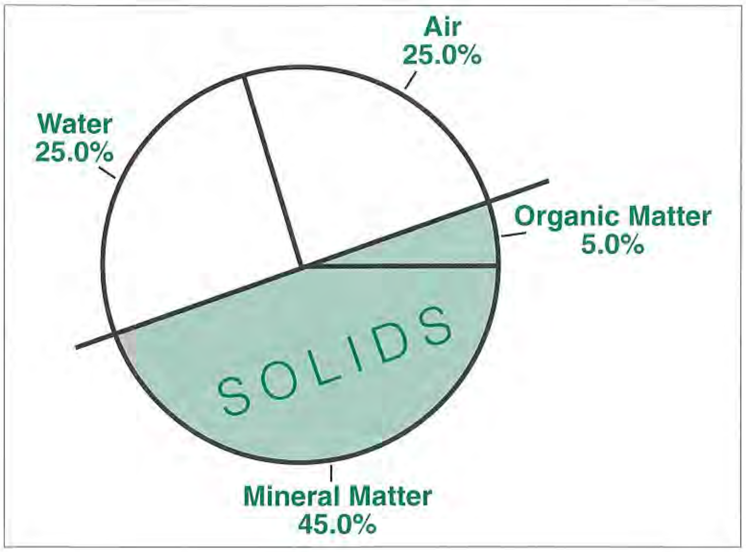


Figure 1

Figure 1

Individual solid particles in a soil combine into groups known as aggregates. Aggregates form the framework for the other 50% of a soil known as pore space. Pore space is the space between the solids and is occupied by air and water. In an ideal state, a soil's pore space contains 25% air and 25% water (Figure 1).

Compaction is the destruction of the aggregates in a soil. Compaction is caused when foot or vehicular traffic places downward pressure on a soil (Figure 2). When the solids in a soil are pressed together, pore space is lost. Eliminating pore space reduces the supply of air and water to trees.

Figure 2

The effect of soil compaction on tree growth is subtle. Symptoms include poor growth, susceptibility to pest problems and environmental stress, and failure of the tree to respond to proper care. The stress caused by soil compaction can lead to a gradual decline in tree health. If left untreated, soil compaction can cause premature death.

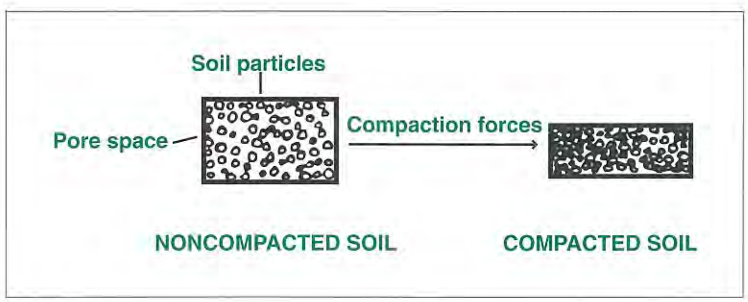


Figure 2: The influence of soil compaction on pore space.

Vertical mulching is sometimes practiced to relieve soil compaction. Vertical mulching involves using a gasoline or electrically powered auger to drill holes into soil (Figure 3). The holes generally measure 1-2 inches (2.5-5.0 centimeters) in diameter, drilled to a depth of 12-18 inches (30-45 centimeters) and are spaced 1-3 feet (0.3-1.0 meter) apart. The holes generally begin 2-3 feet (0.6-1.0 meter) from the trunk and are made in the soil underneath the canopy of the tree.

Figure 3

The holes are frequently backfilled with porous materials like gravel, sand, perlite or peat moss. Likewise, if appropriate, fertilizer may be placed in the holes.

Vertical mulching may also be used if the area underneath a tree's canopy has received "fill." During construction, soil or fill is sometimes placed over the existing soil surface. The fill can limit availability of air and water and adversely affect tree growth. Depending on the species and situation, as little as 2 inches (5.0 centimeters) of soil placed over the existing soil can cause tree decline and death.

Figure 3

Printed in the U.S.A.

15238-1/2002

TECHNICAL BULLETIN

DAVEY®

Prepared By The Davey Institute

Winter Injury To Ornamental Plants

The winter season can be particularly injurious to ornamental trees and shrubs, particularly if they have been stressed by poor growing conditions or are planted north of their hardiness zone.

Boxwood, camellia, crape myrtle, forsythia, Southern magnolia, mahonia, American holly, pyracantha, and rhododendron are commonly injured in the winter.

Winter injury to a broadleaf evergreen appears as a browning along the edge of the leaf.

CAUSES OF WINTER INJURY:

Winter injury is a catch-all for various kinds of injury which show up after the winter. Most so-called winter injury results from low temperatures, winter drying, or sunscald.

LOW TEMPERATURES

Damage caused by low temperatures can occur in early fall before leaf drop, in spring soon after leaf buds open, or in winter when dormant or semi-dormant plant tissue is subjected to abnormally low temperatures or wide temperature fluctuations. It is important to realize that there may be a delay of injury symptoms until several weeks after leaf and twig growth or until a water shortage and/or high temperatures occur.

WINTER DRYING

Broad and narrowleaf evergreens lose moisture even during the winter. If the soil is frozen or very dry, this moisture cannot be replaced and various parts of the tree or shrub, such as foliage, buds or twigs, are damaged. Symptoms of winter drying are browning of the margins of the broadleaf evergreens and the tips of the narrowleaf evergreens.

WINTER SUNSCALD

Winter sunscald is damage to the trunk where bark or cambium is killed. High temperatures on a sunny, bright winter day, followed by low temperatures after sunset, can lead to this sort of injury. In this instance, it is not simply the cold, but the rapid change in temperature, which destroys plant tissue. Winter sunscald is more often seen on thin-barked and transplanted trees and, of course, favors the south and west sides of the tree.

SOLUTIONS: To improve the appearance and health of the injured plant and to increase the chances for survival, follow these practices:

1. Prune out dead and dying tissue after the leaves emerge in the spring.
2. Help invigorate the plant through fertilization and proper watering.
3. Control insects and diseases to prevent further plant stress.
4. Protect stressed plants because they are attractive to bark beetles and borers.

Appendix I
Suggested Species List

Suggested Tree Species

Proper landscaping and tree planting are critical components of the atmosphere, livability, and ecological quality of a community's urban forest. The tree species listed below have been evaluated for factors such as size, disease and pest resistance, seed or fruit set, and availability. The following list is offered to assist all relevant city personnel in selecting appropriate tree species. These trees have been selected because of their aesthetic and functional characteristics and their ability to thrive in the majority of soil and climate conditions (USDA Hardiness Zone 5) found in Michigan.

Deciduous Trees

Large Trees: Greater than 50 Feet in Height When Mature

Scientific Name	Common Name	Cultivar
Acer rubrum	red maple	'Autumn Flame' 'Northwood' 'October Glory' 'Red Sunset'
Acer saccharum	sugar maple	'Crescendo' 'Green Mountain' 'Legacy'
Acer nigrum	black maple	'Greencolumn'
Aesculus hippocanstrum	horsechestnut	'Baumanii'
Aesculus octandra	yellow buckeye	
Alnus glutinosa	European alder	'Fastigiata' 'Pyramidalis'
Catalpa speciosa	northern catalpa	
Carya cordiformis	bitternut hickory	
Carya glabra	pignut hickory	
Carya ovata	shagbark hickory	
Carya tomentosa	mockernut hickory	
Celtis occidentalis	common hackberry	'Prairie Pride'
Cercidiphyllum japonicum	katsura tree	
Cladrastis kentukea	yellowwood	'Rosea'
Corylus colurna	Turkish filbert	
Eucommia ulmoides	hardy rubber tree	
Fagus grandifolia	American beech	
Fagus sylvatica	European beech	
Ginkgo biloba	ginkgo	(males only) 'Autumn Gold', 'Lakeview' 'Presidential Gold' 'Princeton Sentry'
Gleditsia triacanthos inermis	thornless honeylocust	'Northern Acclaim' 'Shademaster' 'Skyline'
Gymnocladus dioicus	Kentucky coffeetree	'Espresso' 'Prairie Titan'

Scientific Name	Common Name	Cultivar
Liquidambar styraciflua	American sweetgum	'Cherokee' 'Gold Dust' 'Grandmaster' 'Happidaze' 'Moraine'
Liriodendron tulipifera	tuliptree	'Arnold' 'Fastigiatum'
Magnolia acuminate	cucumbertree	'Variegata' *var.* subcordata
Metasequoia glyptostroboides	dawn redwood	'Emerald Feathers' 'National' 'Sheridan Spire'
Nyssa sylvatica	black tupelo	
Platanus x *aceriflolia*	London planetree	'Bloodgood' 'Columbia' 'Exclamation!' 'Liberty' 'Metroshade' 'Ovation' 'Yardwood'
Quecus alba	white oak	
Quercus bicolor	swamp white oak	'Regal Prince' 'Rosehill'
Quercus coccinea	scarlet oak	
Quercus ellipsoidalis	northern pin oak	
Quercus imbricaria	shingle oak	
Quercus macrocarpa	bur oak	
Quercus muehlenbergii	chinkapin oak	
Quercus palustris	pin oak	
Quercus robur	English oak	'Attention!' 'Crimson Spire' 'Regal Prince' 'Rosehill' 'Skymaster' 'Skyrocket'
Quercus rubra	northern red oak	'Splendens'
Quercus shumardii	shumard oak	
Styphnolobium japonicum	Japanese pagodatree	'Millstone' 'Princeton Upright' 'Regent'
Taxodium distichum	common baldcypress	'Shawnee Brave'
Tilia Americana	American linden	'American Sentry 'Boulevard' 'Fastigiata' 'Legend' 'Lincoln' 'Redmond'
Tilia tomentosa	silver linden	'Green Mountain' 'Satin Shadow' 'Sterling'
Tilia x *euchlora*	Crimean Linden	'Laurelhurst'
Ulmus Americana	American Elm Cultivars	'New Harmony' 'Valley Forge'

Scientific Name	Common Name	Cultivar
Ulmus x	Hybrid Elm	'Accolade' 'Commendation' 'Frontier' 'Homestead' 'Triumph'
Zelkova serrata	Japanese Zelkova	'Green Vase' 'Green Veil' 'Halka' 'Illinois Hardy' 'Musashino' 'Spring Grove' 'Village Green'

Medium Trees: 26 to 49 Feet in Height When Mature

Scientific Name	Common Name	Cultivar
Acer buergeranum	trident maple	
Acer campestre	hedge maple	'Postelense' 'Queen Elizabeth' 'Schichtel's Upright'
Acer x freemanii	Freeman maple	'Celzam' 'Marmo' 'Jeffersred' 'Sienna Glen'
Acer grandidentatum	bigtooth maple	'Schmidt'
Acer miyabei	miyabei maple	'State Street'
Acer truncatum	shantung maple	(hybrids with *A. platanoides*) 'Norwegian Sunset' 'Pacific Sunset'
Aesculus glabra	Ohio buckeye	
Aesculus x *carnea*	red horsechesnut	'Briotii' 'Fort McNair' 'O'Neill'
Betula nigra	river birch	'Heritage' 'Dura-Heat'
Betula populifolia	gray birch	'Whitespire Sr.'
Carpinus betulus	European hornbeam	'Columnaris' 'Fastigiata' 'Franz Fontaine'
Carpinus caroliniana	American hornbeam	
Gleditsia triacanthos inermis	thornless honeylocust	'Imperial'
Halesia tetraptera	Carolina silverbell	
Koelreuteria paniculata	goldenraintree	'Columnare' 'Fastigiata'
Maclura pomifera var. *inermis*	osage orange	(male only) 'Wichita' 'Whiteshield'
Ostrya virginiana	American hophornbeam	
Parrotia persica	Persian parrotia	'Ruby Vase' 'Vanessa'

Scientific Name	Common Name	Cultivar
Phellodendron amurense	Amur corktree	'Eye Stopper' 'His Majesty' 'Macho' 'Shademaster' 'Superfection'
Prunus sargentii	sargent cherry	'Accolade' 'Columnaris' 'Pink Flair'
Pyrus calleryana	callery pear	'Aristocrat' 'Chanticleer' 'Fauriei' 'Redspire' 'Valiant'
Quercus acutissima	sawtooth oak	
Robinia pseudoacacia	black locust	'Bessoniana'
Tilia cordata	littleleaf linden	'Chancellor' 'Corinthian' 'Glenleven' 'Greenspire' 'June Bride' 'Shamrock'
Ulmus parvifolia	lacebark elm	'Allee' 'Athena' 'Dynasty' 'Hallelujah' 'Matthew' 'Ohio' 'Pathfinder' 'Zettler'
Zelkova serrata	Japanese zelkova	Wireless®

Small Trees: 10 to 25 Feet in Height When Mature

Scientific Name	Common Name	Cultivar
Acer ginnala	Amur maple	'Beethoven' 'Embers' 'Flame' 'Mozart' 'Red Rhapsody'
Acer griseum	paperbark maple	
Acer tataricum	Tatarian maple	'Hotwings' 'Pattern Perfect' 'Rugged Charm'
Amelanchier arborea	common serviceberry	
Amelanchier canadensis	Canadian serviceberry	'Spring Glory' 'Tradition'
Amelanchier laevis	Allegheny serviceberry	'Cumulus' 'Snowcloud' 'Spring Flurry'
Amelanchier x *grandiflora*	apple serviceberry	'Autumn Brilliance' 'Cole's Select' 'Forest Prince' 'Princess Diana' 'Robin Hill' 'Rogers' 'Snowcloud'
Cercis canadensis	eastern redbud	'Appalachian Red' 'Forest Pansy' 'Northern Strain'
Chionanthus retusus	Chinese Fringetree	
Cornus florida	Flowering Dogwood	
Cornus kousa	kousa dogwood	'Milky Way' *var*. chinensis
Cornus mas	corneliancherry dogwood	'Golden Glory'
Cotinus obovatus	American smoketree	
Crataegus crus-galli *var.* inermis	thornless cockspur hawthorn	'Crusader'
Crataegus phaenopyrum	Washington hawthorn	'Presidential' 'Lustre' 'Washington Lustre'
Crataegus viridis	green hawthorn	'Winter King'
Maackia amurensis	Amur maackia	*var*. buergeri
Magnolia stellata	star magnolia	'Little Girl Hybrids'
Malus spp.	flowering crabapple	'Adams' , 'Adirondack' *baccata* var. 'Jackii' 'Dolgo' 'Donald Wyman' *floribunda,* 'Prairiefire' 'Professor Sprenger' 'Robinson'
Prunus serrulata	Japanese flowering cherry	'Snow Goose'
Prunus virginiana	chokecherry	'Canada Red' 'Schubert'

Scientific Name	Common Name	Cultivar
Pyrus calleryana	callery pear	'Jack' 'Jill'
Pyrus ussuriensis	prairie gem Ussurian pear	'MorDak'
Robinia pseudoacacia	black locust	'Globe'
Syringa reticulata	Japanese tree lilac	'Ivory Silk' 'Summer Snow' 'Regent'
Syringa pekinensis	peking lilac	'Beijing Gold' 'China Snow'
Tilia cordata	littleaf linden	'Halka'
Zelkova serrata	Japanese zelkova	City Sprite™

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 redceader	'Burkii' 'Canaertii' 'Glauca' 'Hillii'
Picea abies	Norway spruce	
Pinus banksiana	Jack pine	
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	Douglasfir	
Tsuga canadensis	eastern hemlock	

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Juniperus virginiana	eastern redcedar	
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), *Manual of Woody Landscape Plants (5th Edition)* (Dirr, 1998), *Recommneded Alternatives to Ash Tree for Michigan's Lower Peninsula* (Cregg & Schutzki, 2006), and *Recommended Urban Trees: Site Assessment and Tree Selection for Street Tolerance* (Cornell University).

Appendix J
Tree Planting Guidelines

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 forty-five 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 K
Urban Tree Canopy Methodology

Overview

As more communities focus attention on environmental sustainability, community forest management has become increasingly dependent on GIS for Urban Tree Canopy (UTC) Mapping and Analysis. Understanding the importance of existing urban tree canopy is a key measure for identifying various types of community forestry management opportunities.

Urban forestry research and applications aid in determining a balance between growth and preservation by identifying and assessing existing forestry opportunities. In order for urban planners, foresters, and elected officials to achieve a balance between development and conservation, a GIS based analysis must be completed to determine the amount of current canopy coverage in urban areas.

Methodology

Image Analysis

With advanced GIS and remote sensing software capabilities, in addition to advances in image acquisition, a top-down canopy assessment approach using remote sensing data is recommended to quantify the extent of tree canopy. Davey utilized an object based image analysis (OBIA) semi-automated feature extraction method to process and analyze current high resolution color infrared (CIR) aerial imagery, remotely-sensed data to identify tree canopy cover and land cover classifications. The use of imagery analysis is cost-effective and provides a highly accurate approach to assessing your community's existing tree canopy coverage, which supports responsible tree management, facilitates community forestry goal-setting, improves urban resource planning of healthier and more sustainable urban environments.

Davey acquired ancillary GIS data and high resolution aerial imagery from the six selected UTC cities. In addition, National Agricultural Imagery Program (NAIP) 4-band imagery acquired by the United States Department of Agriculture (USDA) in 2010 was also obtained. The NAIP, administered by the USDA's Farm Service Agency, acquired the imagery at a one-meter ground sample distance (GSD) with a horizontal accuracy that matched within six meters of photo identifiable ground control points (www.fsa.usda.gov). Acquired during the agricultural growing season (or leaf on), NAIP imagery provided the base layer for the object based image analysis.

Advanced image analysis method was used to classify, or separate, the land cover layers from the overall imagery. The semi-automated extraction process was completed using Feature Analyst®, an extension of ArcGIS®. Feature Analyst ® uses an object-oriented approach to cluster together objects with similar spectral (i.e. color) and spatial/contextual (e.g. texture, size, shape, pattern, and spatial association) characteristics. The land cover results of the extraction process was post-processed and clipped to each project boundary prior to the manual editing process in order to create smaller manageable and more efficient file sizes. Secondary source data, high resolution aerial imagery provided by each UTC city, and custom ArcGIS® tools were used to aid in the final manual editing, quality checking and quality assurance processes (QA/QC). The manual QA/QC process was implemented to identify, define, and correct any misclassifications or omission errors in the final land cover layer.

Accuracy Assessment

Random point locations were generated throughout the Ypsilanti city boundary to ensure that the automated mapping and data analysis performed by GIS specialists reflected the true nature and extent of the canopy cover. Sample points were created by using the Create Random Points tool within ArcGIS®. For this accuracy assessment, a sample of 200 random points was chosen relative to city size. Points were, then, compared with the NAIP and high resolution imagery to determine the accuracy of the final land cover layer. Results of the random point assessment were recorded in a classification matrix for further analysis.

To assess accuracy among individual land cover classes, a statistical metric called the Kappa coefficient was derived from the classification matrix. This metric was chosen because it represents the data more precisely (rather than using an overall accuracy percentage of correct land cover classifications) because it partly accounts for chance, or variance, among random sample sets. The Kappa does not yield a result in percentages but rather in terms of agreement with values ranging from zero to one. Although definitive ranges of the Kappa have not been established, it has been generally accepted that a value of 0.80 or higher results in "very good" agreement between layers. Davey used this statistic to measure agreement between the aerial imagery and extracted land cover. The city of Ypsilanti was considered statistically significant in terms of agreement according to the Kappa value of 0.9178 (Table 1); therefore, the results of the land cover feature extraction were deemed to sufficiently represent the true nature of the landscape.

Table 1. Ypsilanti Accuracy Assessment Summary Statistics

	Classification Data								
	Classes	Pervious	Canopy	Impervious	Water	Bare Soils	Row Total	Producer's Accuracy	Errors of Omission
Reference Data	Pervious	46	1	1	0	0	48	95.83%	4.17%
	Canopy	2	65	3	0	0	70	92.86%	7.14%
	Impervious	3	1	74	0	0	78	94.87%	5.13%
	Water	0	0	0	2	0	2	100.00%	0.00%
	Bare Soils	0	0	0	0	2	2	100.00%	0.00%
	Column Total	51	67	78	2	2	200		
	User's Accuracy	90.20%	97.01%	94.87%	100.00%	100.00%		**Overall Accuracy = 94.50%**	
	Errors of Commission	9.80%	2.99%	5.13%	0.00%	0.00%		**Kappa coefficient = 0.9178**	

GIS Analysis and Final Deliverables

All land cover classes were merged into a final 5-class land cover layer and acreage calculations were generated using ArcGIS® geoprocessing, analysis, and data management tools. Land cover acreages and percentages were calculated for the overall project boundary. Canopy summary statistics were also calculated for parks, management zones, and right-of-ways (ROW). Additional summaries were created for vacant site and planting zones.

The final 5-class land cover layer included:

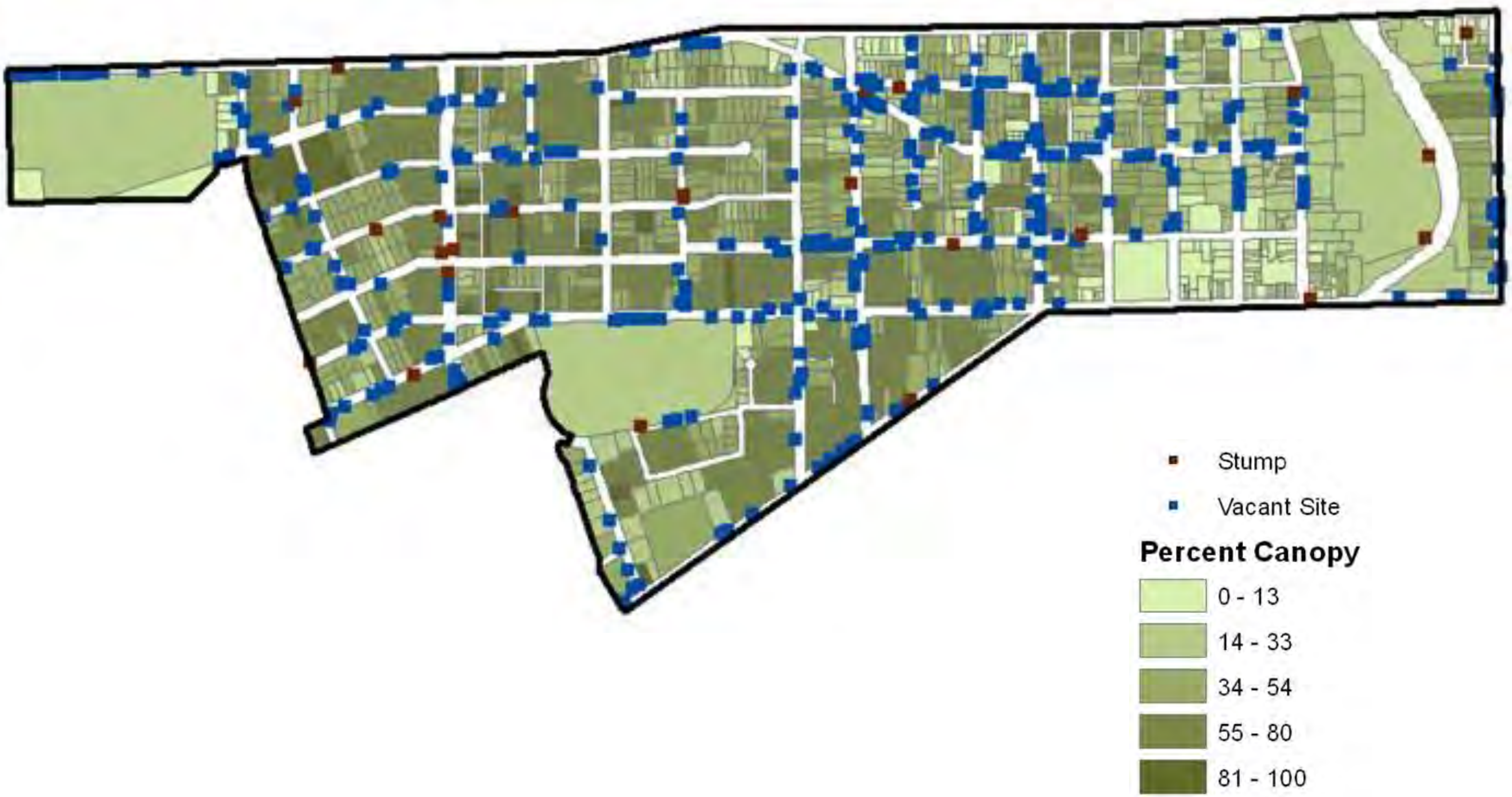
- Canopy Cover (includes trees and shrubs)
- Impervious surfaces (includes buildings, streets, driveways, and parking lots)
- Pervious surfaces (includes grass, low-lying vegetation)
- Bare Soils
- Open water

Land Cover Class	ACRES	LC PCT
Canopy	991.72	36.57%
Impervious	969.80	35.76%
Pervious	651.99	24.04%
Bare Soil	53.22	1.96%
Open Water	45.45	1.68%
Total	2712.19	100.00%

Appendix L
Urban Tree Canopy GIS Maps

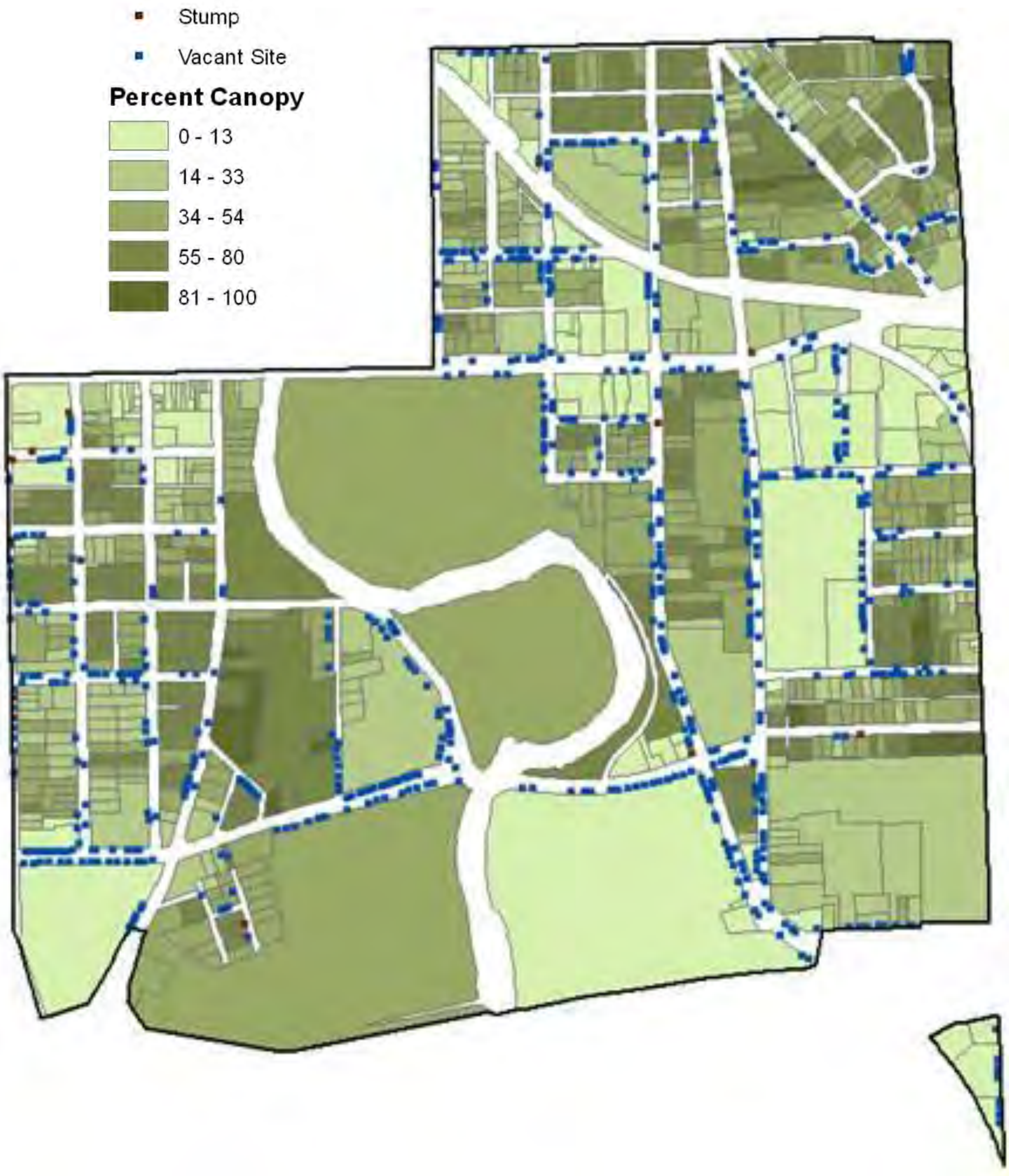
Zone 1 Management Area

Zone 2 Management Area



Zone 3 Management Area

Zone 4 Management Area



Zone 5 Management Area

Appendix M
Directory of Michigan Seedling Nurseries

Michigan Department of Natural Resources – Forest, Mineral & Fire Management

DIRECTORY OF MICHIGAN SEEDLING NURSERIES

This information is provided courtesy of the Michigan Department of Natural Resources.

The Department of Natural Resources ***no longer sells trees*** to the general public. This directory lists Michigan nurseries offering good stock. We encourage you to contact them for price lists.

Note: Your local *SOIL CONSERVATION DISTRICT* may also have trees for sale. For contact information, see the Michigan Association of Conservation Districts website at: www.macd.org

	Organization	Address	Phone	Fax	E-Mail / Website
1.	ALPHA NURSERIES INC.	3737 65th Street, Holland, MI 49423	(269) 857-7804	(269) 857-8162	info@alphanurseries.com www.alphanurseries.com
2.	ARNOLDLINK (JOHN) NURSERY	723 Old Orchard Road, Holland, MI 49423	(616) 335-9823	Same	johnarnoldlink@hotmail.com
3.	BADGER EVERGREEN NURSERY	902 26th Street, Allegan, MI 49010	(269) 673-5546	(269) 673-2263	
4.	BOSCH'S EVERGREEN NURSERY	10785 84th, Allendale, MI 49401	(616) 892-4090	(616) 892-4290	
5.	CHIPPEWA PLANTATION	515 Juniper, Fremont, MI 49412	(231) 924-4214		
6.	COLD STREAM FARM	2030 Freesoil Road, Freesoil, MI 49411	(231) 464-5809		csf@jackpine.com
7.	ENGEL'S NURSERY	2080 64th Street, Fennville, MI 49408	(269) 543-4123	Same	info@engelsnursery.com www.engelsnursery.com
8.	FAIRPLAINS NURSERY/ MATHISEN TREE FARM	6104 County Farm Road, Greenville, MI 48838	(616) 754-3200 OR (616) 754-5738	(616) 754-4580	Mtf@pathwaynet.com
9.	HILLTOP FRUIT TREES, LLC	P.O. Box 538, 60395 C.R. 681, Hartford, MI 49057	(269) 621-3135	(269) 621-2062	adam@hilltopfruittrees.com
10.	HRAMOR NURSERY	515 9th Street, Manistee, MI 49660	(231) 723-7000 OR (231) 723-4846	(231) 723-5580	hramor@jackpine.com
11.	KOBE NURSERIES	43624 County Road 653, Paw Paw, MI 49079	(269) 657-3094	Same	
12.	LAKE SUPERIOR NURSERY	Rt. #1, Box 360, Baraga, MI 49908	(906) 353-6906		
13.	LAND O' PINES	1056 N. Schoenherr Road, Custer, MI 49405	(231) 757-2141 OR (800) 554-9468		
14.	LUBBERS NURSERY	6995 54th Avenue, Hudsonville, MI 49426	(616) 669-3832	Same	
15.	NEEDLEFAST EVERGREENS, INC.	4075 Hansen Road, Ludington, MI 49431	(231) 843-8524	(231) 843-1887	nickel@needlefastevergreens.com www.needlefastevergreens.com
16.	NEW LIFE NURSERY	3720 64th Street, Holland, MI 49423	(269) 857-1209	(269) 857-1770	sgenzink@newlifenursery.com
17.	NEWAYGO CONSERVATION DISTRICT NURSERY	940 W. Rex Street, Fremont, MI 49412	(231) 652-7493	(231) 924-4140	nswcd@ncats.newaygo.mi.us
18.	NORTHERN PINES NURSERY	2300 S Morey Road, Lake City, MI 49651	(616) 839-3277 OR (616) 839-2865	(231) 839-3331	npn@voyager.net
19.	OIKOS TREE CROPS	PO Box 19425, Kalamazoo, MI 49019	(269) 624-6233	(269) 624-4019	oak24@aol.com www.oilostreecrops.com

20.	PETERSON'S RIVERVIEW NURSERY	873 26th Street, Allegan, MI 49010	(269) 673-2440	(269) 673-6250	jptrees@accn.org www.petersons-riverview.com
21.	STEMPKY NURSERY	5157 N. Straits Highway, Cheboygan, MI 49721	(231) 627-4814 OR (231) 627-9061	(231) 627-3087	
22.	VAN'S PINES NURSERY INC.	7550 144th Avenue, West Olive, MI 49460	(616) 399-1620 OR (800) 888-7337	(616) 399-1652	gvanslooten@egl.net www.vanspinesnursery.com
23.	WAHMHOFF FARMS	11121 M-40 Highway, Gobles, MI 49055	1-888-648-7337	(269) 628-4308	mitrees@accn.org www.mitrees.com
24.	WINDY HILLS FARM	1565 E. Wilson Road, Scottville, MI 49454	(231) 757-2373		windyhills@jackpine.com
25.	WOODLANDS SEEDLING PRODUCTION MEAD CORP.	PO Box 1008 Escanaba, MI 49829	(906) 786-1660	(906) 789-3253	
26.	ZELENKA EVERGREEN NURSERIES INC.	16127 Winans Street, Grand Haven, MI 49417-9652	(616) 842-1367	(616) 842-0304	

Appendix N
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Appendix O
Definitions

Definitions

Aesthetic/Other—measure of the tangible and intangible benefits trees provide reflected in increased property values due to those trees.

Air Quality—The sum of air pollutants (O_3, NO_2, SO_2, PM_{10}) deposited on tree surfaces and reduced emissions from power plants (NO_2, PM_{10}, VOCs, SO_2) due to reduced electricity use (measured in pounds/tree/year). The model accounts for potential negative effects of trees on air quality due to Biogenic Volatile Organic Compounds (BVOCs) emitted from vegetation into the air that contribute to the formation of smog and/or may themselves be toxic.

American National Standards Institute (ANSI) Standards—ANSI is a private, non-profit standards organization that serves as a facilitator for the standardization work of its members in the United States. It accredits standards developing organizations (SDOs) that meet a set of requirements and criteria governing the management of consensus standards development. Accredited SDOs can submit candidate documents to ANSI for consideration and approval as American National Standards (ANS). ANSI's goal is to promote and facilitate voluntary consensus standards and conformity assessment systems and maintain their integrity.

Cabling/Bracing—Cabling and bracing are processes that restore or improve the structural integrity of a tree that is worth preserving. Individual limbs or the entire tree may be cabled and braced. Fasteners are attached to the weakened limb and the main trunk. Using ropes or chains, tension is applied to the weakened limb. Heavy-duty cables are then prepared and attached to each fastener to provide the correct amount of support for the weakened limb.

Canopy—Branches and foliage which make up a trees crown.

Tree Canopy—Seen from above, the area of land surface that is covered by tree canopy. Used to express the relative importance of individual species within a population of trees or express the coverage of tree species.

Carbon Dioxide Sequestration—Annual net rate that a tree removes CO_2 from the atmosphere through the processes of photosynthesis and respiration. The model accounts for CO_2 released as trees die and decompose and CO_2 released during the care and maintenance of trees.

Central Leader—The central leader is the topmost vertical stem extending from the trunk.

Certified Arborist—A Certified Arborist is an individual who has achieved a level of knowledge in the art and science of tree care through at least three years' experience and who has passed a comprehensive examination developed by some of the nation's leading experts on tree care. A Certified Arborist must also continue his/her education to maintain his/her certification. Therefore, he/she should be up-to-date on the latest techniques in arboriculture. Certification is not a measure of standards of practice. Certification can attest to the tree knowledge of an individual, but cannot guarantee or ensure quality performance.

Codominant Leader and Stems—Codominant leaders and stems is a tree condition that occurs when two or more branches, trunks, or leaders of approximately the same size originate in close proximity to one another.

Condition Rating—Rating tree condition involves looking at the tree crown, foliage, trunk, and root characteristics. The condition of each tree is rated according to the following categories:

Good—Trees in this class are judged to be desirable and with proper maintenance can be returned to an excellent classification. They may be interfering with utility lines, planted in an overcrowded location, or have minor insect, pathogen, or nutritional deficiencies.

Fair—Most trees in this category have some or all of the following problems: large dead limbs with as much as one-half of the tree already dead, large cavities in the trunk, major deformities, girdling roots, obvious insect, pathogen, or nutritional problems. Immediate maintenance and proper care may be able to save the tree.

Poor—Trees in this group are in a degraded condition with irreversible problems. They have over 50% dead branches, drastic deformities, and severe insect, pathogen, or nutritional problems. They will have to be removed as soon as possible.

Dead—Trees in this category are either already dead or in such poor condition that removal is required. These trees have over 90% dead branches and have completely succumbed to either insects, pathogens, or nutritional deficiencies. It is important to conduct the installation tree inventory after spring growth has begun. This ensures that a dormant tree is not misidentified as dead.

Cultivar—A cultivar is a race or variety of a plant that has been created or selected intentionally and maintained through cultivation.

Coniferous Trees—Cone-bearing evergreen trees with needle-like leaves.

Diameter at Breast Height (DBH)—The DBH is the internationally accepted method of measuring tree diameter. Measurements are taken on the trunk of the tree 4.5 feet from the ground.

Deciduous—Deciduous trees or other plants lose their leaves at some time during the year and stay leafless during the cold season.

Energy—The sum of energy savings due to reduced natural gas use in winter and reduced electricity use for air conditioning in summer.

Established Trees—In this report, a group of trees can be referred to as established if they are 6 to 12 inches in diameter.

Genus—Genus is 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 Systems (GIS)—GIS is 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. You choose what layers to combine based on your purpose.

Global Positioning Systems (GPS)—GPS is a system of earth-orbiting satellites that make it possible for people with ground receivers to pinpoint their geographic location.

Grow Space—A tree’s grow space is the room needed for a plant’s leaves and roots to grow.

Growth Habit—The growth habit of a tree describes its growth form, comprising its size, shape, texture, and orientation.

Integrated Pest Management—Integrated pest management is an approach that relies primarily on non-chemical means (such as controlling climate, food sources, and building entry points) to prevent and manage pest infestation.

Large-Growing Tree—A tree that matures at the height of about 45 feet and can attain a heightg greater than 100 feet.

Mature tree—A tree that has reached a species' characteristic size In this report, a group of trees can be referred to as mature if they are greater than 24 inches in diameter.

Maturing tree—In this report, a group of trees can be referred to as maturing if they are 12 to 18 inches in diameter.

Medium-Growing Tree—A tree that matures at the height of about 25 feet and does not grow larger than about 45 feet.

Monoculture—A monoculture is a single, homogenous culture of species lacking diversity across a population or area.

Native Species—A native species is one which naturally exists at a given location or in a particular ecosystem, *i.e.*, it has not been moved there by humans.

Non-native Species—Species that occur outside of their native ranges in a given place as a result of actions by humans are non-native species.

Planting Site—A planting site is defined as an area that has the potential to host a tree of a certain size. Planting sites are only located within the street ROW and recommend tree size based on that site's restrictions.

Right-of-Way—The right-of-way is a strip of land over which facilities, such as highways, railroads, or power lines, are built.

Risk Tree—A risk tree has structural defects likely to cause failure of all or part of the tree, which could strike a target.

Routine Pruning—All other trees, except young and recent plantings, fall into the routine pruning category. They require removal of dead, dying, diseased, or obviously weak, heavy, or hazardous branches, and deadwood. Routine, ongoing pruning should be scheduled and programmed to ensure all tree pruning is accomplished on a minimum cycle of five to seven years. It is important to remember that low priority problems can become high priority if they are neglected for an extended period of time. Thinning of tree canopies to reduce crossing or unnecessary branches should be accomplished routinely. This reduces the potential for wind and ice-induced branch breakage and increases sunlight and air circulation within the crown. Thinning of tree canopies reduces substantially the incidence of insect and disease related problems.

Small-Growing Tree—A tree that matures at the height of about 15 feet and does not grow larger than about 30 feet.

Species—Species is a 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 uncapitalized Latin adjective or noun following a capitalized genus name.

Species Composition—A way in which to study the percentages of each identified tree species comprising the forested area based on species occurrence.

Species Diversity—the number of species, the variety in the area's plant and animal communities, the genetic variability of the animals or plants, or a combination of these elements

Species Richness—The number of different species in a given population.

Stocking Level—The number of trees in an area as compared to the desirable number of trees for best results, such as maximum wood production.

Street Tree—A street tree is defined as a tree or stump within the street ROW that was planted or removed by the City or its residents.

Stormwater Reduction—A measure of reduced annual stormwater runoff due to trees.

Training Pruning—Trees in this category are generally young, recent plantings. Minimum maintenance includes trimming root and trunk suckers, deadwood, crossing, diseased, or weak branches, and staking improvement or removal. Trees in this category need to be scheduled for maintenance and not neglected. Generally, young trees should be pruned to reflect their species' natural growth pattern or to a single leader or a strong central leader to promote the development of strong scaffold limbs. Certain species do not develop single leaders; therefore, the strongest leaders should be selected and allowed to shape the tree canopy. It is important to remember that minor problems can become major if they are neglected for an extended period of time.

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 Bank—A tree bank is a special account created to deposit funds from various sources, which are restricted for use by the urban forestry program. The funds in this account are managed by the City, subject to the annual budget process, and expenditures follow normal purchasing policies and procedures.

Transpiration—The loss of water vapor through the stomata of leaves.

Willingness to Pay—The maximum amount of money an individual would be willing to pay for nonmarket, public goods and services provided by environmental amenities such as trees and forests rather than do without.

Young Trees—In this report, a group of trees can be referred to as young if they are 0 to 6 inches in diameter.