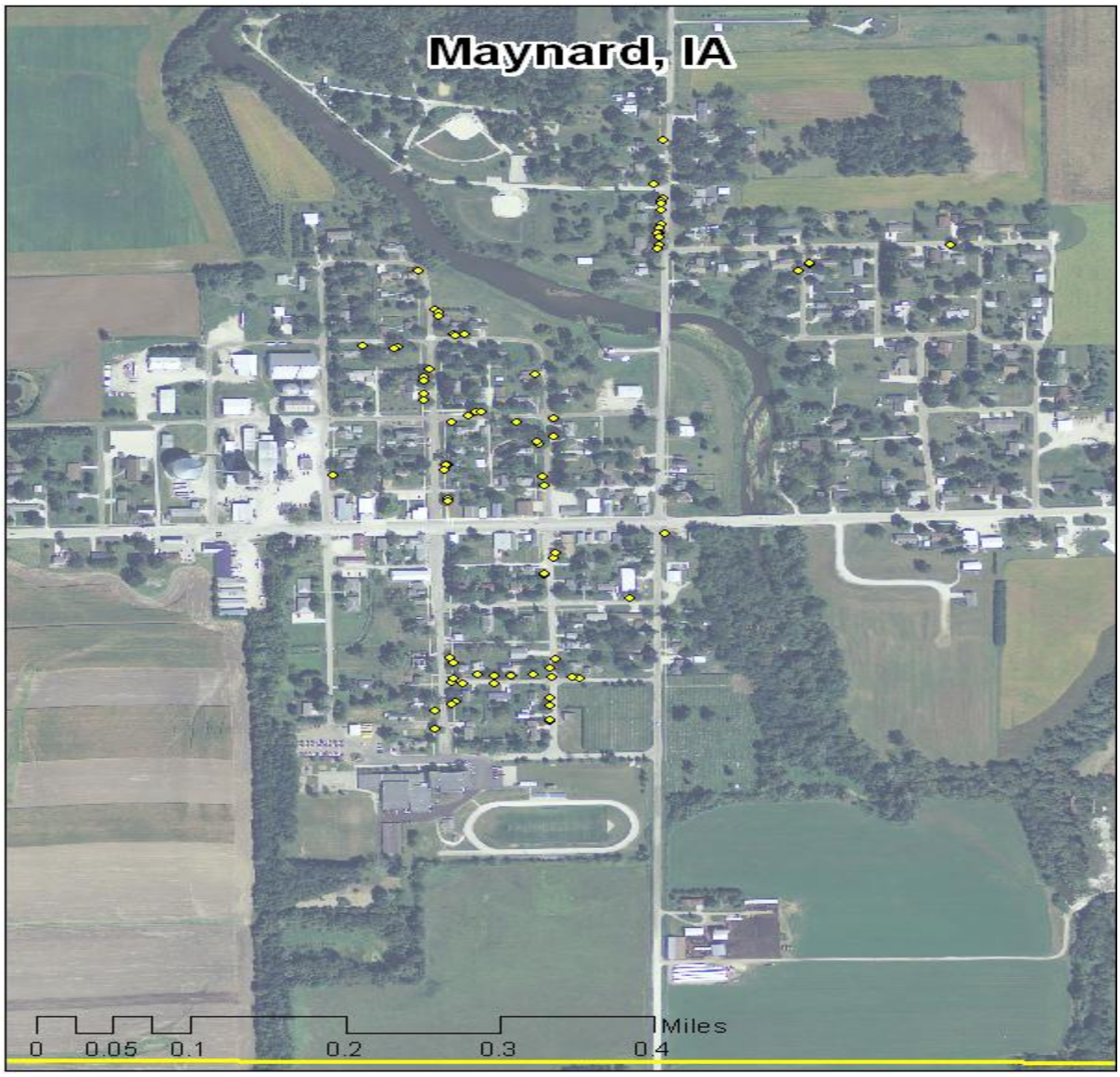
MAYNARD, IA



2011 Management Plan

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Executive Summary

Overview

This plan was developed to assist the City of Maynard with managing its urban forest, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management allows a community to best take advantage of these benefits. Management is especially important considering the serious threats posed by forest pests such as the emerald ash borer (EAB). EAB is an invasive insect imported from Eastern Asia on wood shipping crates that kills all species of ash trees (this does not include mountain ash). There is a strong possibility that 7.5% of Maynard's city owned trees (ash) will die once EAB becomes established in the community. With proper planning and management, the costs of removing dead and dying trees can be extended over years, mitigating public safety issues.

Inventory and Results

In 2010, a tree inventory was conducted using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street and park trees. Below are some key findings of the 80 trees inventoried.

- Maynard's trees provide $14,011 of benefits annually, an average of $175 a tree
- There are over 28 species of trees
- The top three species are: Norway Maple 17%, Hackberry 15%, and Blue Spruce 7%
- 41% of trees are in need of some type of management
- 7 trees are recommended for removal

Recommendations

The core recommendations are detailed in the Recommendations Section. The Emerald Ash Borer Plan includes management recommendations as well. Below are some key recommendations.

- Of the 7 trees needing removal, 4 trees are over 24 inches in diameter at 4.5 ft and should be addressed immediately *City ownership of the trees recommended for removal should be verified prior to any removal*
- There were no ash found that were displaying signs and symptoms associated with EAB
- All trees should be pruned on a routine schedule
- Plant a diverse mix of trees that do not include: ash, Norway maple, Silver maple, Blue spruce, Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven or willow.
- Check ash trees with a visual survey yearly

Introduction

This plan was developed to assist Maynard with the management, budgeting and future planning of their urban forest. Across the state, forestry budgets continue to decrease with more and more of that money spent on tree removal. With the anticipated arrival of Emerald Ash Borer (EAB), an invasive pest that kills native ash trees, it is time to prepare for the increased costs of tree removal and replacement planting. With proper planning and management of the current canopy in Maynard, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

Trees are an important component of Maynard's infrastructure and one of the greatest assets to the community. The benefits of trees are immense. Trees provide the community with improved air quality, stormwater runoff interception, energy conservation, lower traffic speeds, increased property values, reduced crime, improved mental health and create a desirable place to live, to name just a few benefits. It is essential that these benefits be maintained for the people of Maynard and future generations through good urban forestry management.

Good urban forestry management involves setting goals and developing management strategies to achieve these goals. An essential part of developing management strategies is a comprehensive public tree inventory. The inventory supplies information that will be used for maintenance, removal schedules, tree planting and budgeting. Basing actions on this information will help meet Maynard's urban forestry goals.

Inventory

In 2010, a tree inventory was conducted that included 100% of the city owned trees along the streets. The tree data was collected using a handheld Global Positioning System (GPS) receiver. The data collector gives Geographic Information Systems (GIS) coordinates with an accuracy of 3 meters, which can be used in Arc GIS as an active GIS data layer. Because the inventory is a digital document the data can be updated with new information and become a working document.

The programming used to collect tree information on the data collectors was written to be compatible with a state-of-the-art software suite called i-Tree. I-Tree was developed by the USDA Forest Service to quantify the structure of community trees and the environmental services that trees provide. The i-Tree suite is a public domain which can be accessed for free.

To quantify the urban forest structure and benefits, specific data is collected for each tree. This data includes: location, land use, species, diameter at 4.5 ft, recommended maintenance, priority of that maintenance, leaf health, and wood condition. Additionally, signs and symptoms of EAB were noted for all ash trees. The signs and symptoms noted were canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Inventory Results

The data collected for the 80 city trees was entered into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management (STRATUM), part of the i-Tree suite. The following are results from the i-Tree STRATUM analysis.

Annual Benefits

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Maynard's trees reduce energy related costs by approximately $3,885 annually (Appendix A, Table 1). These savings are both in Electricity (18 MWh) and in Natural Gas (2,538 Therms).

Annual Stormwater Benefits

Maynard's trees intercept about 193,548 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $5,246 of benefits to the city.

Annual Air Quality Benefits

Air quality is a persistent public health issue in Iowa. The urban forest improves air quality by removing pollutants, lowering air temperature, and reducing energy consumption, which in turn reduces emissions from power plants, and emitting volatile organic mater (ozone). In Maynard, it is estimated that trees remove 238.6 lbs. of air pollution (ozone (O_3), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $673 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Maynard, trees sequester about 33,904 lbs of carbon a year with an associated value of $254 (Appendix A, Table 5). In addition, the trees store 620,308 lbs of carbon, with a yearly benefit of $4652 (Appendix A, Table 4).

Annual Aesthetics Benefits

Social benefits of trees are hard to capture. The analysis does have a calculation for this area that includes: aesthetic value, property values, lowered rates of mental illness and crime, city livability and much more. Maynard receives $3,743 in annual social benefits from trees (Appendix A, Table 6).

Financial Summary of all Benefits

According to the USDA Forest Service i-Tree STRATUM analysis, Maynard's trees provide $14,011 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 80 trees in Maynard provide approximately $175 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Maynard has over 28 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genus is as follows:

Species	# of Trees	% of Total
Norway/Silver Maple	18	22.5
Hackberry	12	15
Ash	6	7.6
Blue Spruce	6	7.5
Lilac	5	6.3
Black Walnut	5	6.3
Black cherry	5	6.3
Conifer	3	3.8
Other species	20	27.5

Age Class

Most of Maynard's trees are between 12 and 18" in diameter (27%) and between 18 and 24 inches in diameter (23%) at 4.5 ft (Appendix A, Figure 2). For age, a Bell Curve is preferred and shows the highest amount of trees around 16 inches in diameter at 4.5 ft. Maynard's size curve is on the larger side, indicating an older stand. Only about 11% are 1" to 6" in diameter suggesting some new plantings will be needed in the near future to replace the older trees.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the overall health of the urban forest. The foliage that was present on trees appeared quite healthy (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 73% of Maynard's trees are in good health for wood condition (appendix A, Figure 4 & Appendix B, Figure 3). Wood condition that is in poor health, dead or dying is about 8% of the population. This 8% is an estimate of trees that need management follow up.

Management Needs

The following outlines the specific management needs of the street and park trees by number of trees and percent of canopy (Appendix B, Figure 3).

Crown Raising	26	32%
Tree Removal	7	8%

Canopy Cover

The canopy cover of Maynard is approximately 2 acres (Appendix A, Figure 4).

Recommendations

Risk Management

Hazardous trees can be a significant threat to both people and property. Trees that are dead or dying, or that have large issues such as trunk cracks longer than 18 inches should be removed. Broken branches and branches that interfere with motorist's vision of pedestrians, vehicles, traffic signs and signals, etc should be removed.

Hazardous trees

Maynard has 4 trees over 24 inches in diameter at 4.5 ft that should be addressed immediately for removal. After those trees are addressed, there are 3 trees under 24 inches that should be addressed for removal. After the removals, other trees in town are in need of various work to eliminate possible hazards (Appendix B, Figure 3 & Appendix B, Figure 4).

Ash trees

After the hazardous tree work is complete, ash trees in poor health should be assessed for removal. Of the 7 removals recommended, 0 of these are ash trees. There are a total of 6 ash trees, and 0 of those have signs and symptoms that have been associated with EAB. *City ownership of the trees recommended for removal should be verified prior to any removal*

Pruning Cycle

Proper pruning can extend the life and good health of trees, as well as reduce public safety issues. In the Management Needs section of the Findings there are four main maintenance issues to be addressed: routine pruning, crown cleaning, crown raising, and crown reduction. Crown cleaning removes dead, diseased, and damaged limbs. Crown raising is the removal of lower branches that are 2 inches in diameter or larger in the case of providing clearance for pedestrians or vehicles. Crown reduction is removing individual limbs from structures or utility wires. It is recommended that all trees be pruned on a routine schedule every five to seven years. Please refer to the six year maintenance plan for further information.

Planting

Most of the planting over the next 6 years will replace the trees that are removed. It is recommended to plant 1.2 trees for every tree removed, since survival rates will not be 100%. Please refer to the six year maintenance plan at the end of this section. It is not essential that the new trees be planted in the same location of the trees being removed. However, maintaining the same number of trees helps ensure continuation of the benefits of the existing forest in Maynard.

It is important to plant a diverse mix of species in the urban forest to maintain canopy health, since most insects and diseases target a genus (ash) or species (green ash) of trees. Current diversity recommendations advise that a genus (i.e. maple, oak) not make up more than 20% of the urban forest and a single species (i.e. silver maple, sugar maple, white oak, bur oak) not make up more than 10% of the total urban forest. Presently, the forest is heavily planted with Norway and Silver Maple (22.5%) (Appendix A, Figure 1). Maples should not be planted until this percentage can be lowered. Also, ash trees have not been recommended since 2002, due to the threat of EAB. Other species to avoid because they are public nuisances include: Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven, or willow.

Continual Monitoring

Due to the threat of EAB, it is important to continuously check the health of ash trees. It is recommended that ash trees be checked with a visual survey every year for tree death and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Emerald Ash Borer Plan

Ash Tree Removal

Tree removal will be prioritized with dead, dying, hazardous trees to be removed first (Appendix B, Figure 4). Next will be all ash in poor condition and displaying signs and symptoms of EAB (Appendix B, Figure 2 & Appendix B, Figure 3). *City ownership of the tree recommended for removal should be verified prior to any removal*

EAB Quarantines

EAB is an extremely destructive plant pest and it is responsible for the death and decline of over 25 million ash trees. Ash in both forested and urban settings constitute a significant portion of the canopy cover in the United States. Current tools to detect, control, suppress and eradicate this pest are not as robust as the USDA would desire. In order to stay ahead of this hard to detect beetle, the USDA is attempting to contain the beetle before it spreads beyond its known positions by regulating articles.

A regulated article under the USDA's quarantine includes any of the following items:

- emerald ash borer
- firewood of all hardwood species (for example ash, oak, maple and hickory)
- nursery stock and green lumber of ash
- any other ash material, whether living, dead, cut or fallen, including logs, stumps, roots, branches, as well as composted and not composted chips of the genus ash (Mountain ash is not included)

In addition, any other article, product or means of conveyance not listed above may be designated as a regulated article if a USDA inspector determines that it presents a risk of spreading EAB once a quarantine is in effect for your county.

Wood Disposal

A very important aspect of planning is determining how wood infested with EAB will be handled, keeping in mind that quarantines will restrict its movement. Consider who will cut and haul the dead and dying trees? Is there an accessible, secured site big enough to store and sort the hundreds of trees and the associated brush and chips? How will wood be disposed of or utilized? Do you have equipment capable of handling the amount and size of ash trees your tree inventory has identified? Once your county is under quarantine for EAB, contact USDA-APHIS-PPQ at 515-251-4083 or visit the website http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/regulatory.shtml. Wood waste can be disposed of as you normally would if your county is not part of a quarantine.

Canopy Replacement

As budget permits, all removed ash trees will be replaced. All trees will meet the restrictions in the city ordinance. The new plantings will be a diverse mix and will not include ash, maple, Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven, or willow.

Postponed Work

While finances, staffing and equipment are focused on the management of ash, usual services may be delayed. Tree removal requests on genus other than ash will be prioritized by hazardous or emergency situations only.

Monitoring

It is recommended that ash trees be checked with a visual survey every year for tree death and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Private Ash Trees

It is strongly recommended that private property owners start removing ash trees on their property as trees are infested with Emerald Ash Borer. Trees that are on private property are part of Maynard's urban forest. Private property owners should be given direction to the proper species to plant, spacing, and location.

Six Year Work Plan and Estimated Costs

Year 1:

Remove the 4 hazard trees over 24 inches	$2000
Plant 4 trees in open locations	$400
Visual survey of signs and symptoms of Emerald Ash Borer	

Year 2:

Remove 2 hazard trees	$1000
Plant 2 trees in open locations	$200
Maintenance of newly planted trees in city	
Visual survey of signs and symptoms of Emerald Ash Borer	

Year 3:

Appendix B, Figure 3 & Appendix B, Figure 4 tree work (raising)	$????
Remove 1 hazard tree	$500
Plant 1 tree in open location	$100
Maintenance of newly planted trees in city	
Visual survey of signs and symptoms of Emerald Ash Borer	

Year 4:

Remove 1 declining ash tree	$500
Plant 1 tree in open location	$100
Maintenance of newly planted trees in city	
Prune 1/3 of city trees	
Visual survey of signs and symptoms of Emerald Ash Borer	

Year 5:

Remove 1 declining ash tree	$500
Plant 1 tree in open location	$100
Maintenance of newly planted trees in city	
Prune 1/3 of city trees	
Visual survey of signs and symptoms of Emerald Ash Borer	

Year 6:

Maintenance of newly planted trees in city
Prune 1/3 of city trees
Visual survey of signs and symptoms of Emerald Ash Borer

** The ash removed in this six year plan is 25% of the total ash in Maynard.

Funding

Maynard can apply for grants to fund replacement trees. Utility Company grants are usually between $500 and $10,000 for community-based, tree-planting projects that include parks, gateways, cemeteries, nature trails, libraries, nursing homes, and schools.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Annual Energy Benefits of Public Trees by Species

12/12/2010

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Norway maple	3.7	279	532.4	522	800	(N/A)	17.5	20.6	57.16
Northern hackberry	4.2	317	601.0	589	906	(N/A)	15.0	23.3	75.52
Blue spruce	0.6	43	76.1	75	118	(N/A)	7.5	3.0	19.66
Lilac	0.1	8	19.0	19	27	(N/A)	6.3	0.7	5.40
Silver maple	1.4	107	187.1	183	290	(N/A)	5.0	7.5	72.60
Black walnut	1.0	78	127.8	125	204	(N/A)	5.0	5.2	50.90
Black cherry	0.8	59	119.5	117	177	(N/A)	5.0	4.5	44.14
Conifer Evergreen Large	0.4	29	43.9	43	72	(N/A)	3.8	1.9	24.14
White ash	1.1	87	152.0	149	236	(N/A)	3.8	6.1	78.71
Green ash	0.7	56	92.1	90	146	(N/A)	3.8	3.8	48.59
Apple	0.2	13	29.5	29	42	(N/A)	3.8	1.1	13.93
Eastern white pine	0.3	21	34.3	34	55	(N/A)	2.5	1.4	27.30
Scotch pine	0.3	20	29.3	29	48	(N/A)	2.5	1.2	24.14
Elm	0.7	49	91.8	90	139	(N/A)	2.5	3.6	69.67
Red maple	0.3	19	30.1	29	49	(N/A)	1.3	1.3	48.95
Sugar maple	0.3	24	44.2	43	68	(N/A)	1.3	1.7	67.52
Hickory	0.3	20	38.1	37	57	(N/A)	1.3	1.5	57.32
Catalpa	0.5	37	63.1	62	99	(N/A)	1.3	2.5	98.63
Ginkgo	0.0	0	0.4	0	1	(N/A)	1.3	0.0	0.57
Honeylocust	0.4	28	47.4	46	74	(N/A)	1.3	1.9	74.28
Kentucky coffeetree	0.4	33	59.0	58	91	(N/A)	1.3	2.3	91.02
Spruce	0.1	4	9.5	9	14	(N/A)	1.3	0.4	13.58
Austrian pine	0.1	10	14.6	14	24	(N/A)	1.3	0.6	24.14
Black poplar	0.0	2	3.7	4	6	(N/A)	1.3	0.2	5.82
Bur oak	0.4	33	59.0	58	91	(N/A)	1.3	2.3	91.02
Willow	0.2	18	29.5	29	47	(N/A)	1.3	1.2	46.78
Mountain ash	0.0	2	3.8	4	5	(N/A)	1.3	0.1	5.40
Other street trees	0.0	0	0.0	0	0	(N/A)	0.0	0.0	0.00
Citywide total	18.4	1,398	2,538.2	2,487	3,885	(N/A)	100.0	100.0	48.57

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees by Species

12/12/2010

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Norway maple	34,744	942	(N/A)	17.5	18.0	67.26
Northern hackberry	39,537	1,072	(N/A)	15.0	20.4	89.29
Blue spruce	6,899	187	(N/A)	7.5	3.6	31.16
Lilac	343	9	(N/A)	6.3	0.2	1.86
Silver maple	21,095	572	(N/A)	5.0	10.9	142.93
Black walnut	8,339	226	(N/A)	5.0	4.3	56.50
Black cherry	4,188	114	(N/A)	5.0	2.2	28.38
Conifer Evergreen Large	4,616	125	(N/A)	3.8	2.4	41.70
White ash	13,823	375	(N/A)	3.8	7.1	124.88
Green ash	5,521	150	(N/A)	3.8	2.9	49.88
Apple	598	16	(N/A)	3.8	0.3	5.40
Eastern white pine	4,507	122	(N/A)	2.5	2.3	61.08
Scotch pine	3,077	83	(N/A)	2.5	1.6	41.70
Elm	8,081	219	(N/A)	2.5	4.2	109.50
Red maple	1,604	43	(N/A)	1.3	0.8	43.46
Sugar maple	3,795	103	(N/A)	1.3	2.0	102.87
Hickory	2,591	70	(N/A)	1.3	1.3	70.21
Catalpa	7,238	196	(N/A)	1.3	3.7	196.17
Ginkgo	7	0	(N/A)	1.3	0.0	0.19
Honeylocust	4,684	127	(N/A)	1.3	2.4	126.96
Kentucky coffeetree	7,238	196	(N/A)	1.3	3.7	196.17
Spruce	595	16	(N/A)	1.3	0.3	16.14
Austrian pine	1,539	42	(N/A)	1.3	0.8	41.70
Black poplar	172	5	(N/A)	1.3	0.1	4.65
Bur oak	7,238	196	(N/A)	1.3	3.7	196.17
Willow	1,409	38	(N/A)	1.3	0.7	38.19
Mountain ash	69	2	(N/A)	1.3	0.0	1.86
Other street trees	0	0	(N/A)	0.0	0.0	0.00
Citywide total	193,548	5,246	(N/A)	100.0	100.0	65.57

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees by Species

12/12/2010

Species	Deposition (lb)				Total Depos. ($)	Avoided (lb)				Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	Standard Error	% of Total Trees	Avg. $/tree
	O_3	NO_2	PM_{10}	SO_2		NO_2	PM_{10}	VOC	SO_2								
Norway maple	7.1	1.2	3.5	0.3	38	17.8	2.6	2.4	16.6	110	-1.7	-6	50.0	142	(N/A)	17.5	10.18
Northern hackberry	6.0	1.0	3.1	0.3	33	20.2	2.9	2.8	19.0	125	0.0	0	55.3	158	(N/A)	15.0	13.19
Blue spruce	0.8	0.2	0.7	0.1	5	2.7	0.4	0.4	2.6	17	-2.4	-9	5.4	13	(N/A)	7.5	2.21
Lilac	0.0	0.0	0.0	0.0	0	0.6	0.1	0.1	0.5	3	0.0	0	1.3	4	(N/A)	6.3	0.71
Silver maple	3.6	0.6	1.8	0.2	19	6.7	1.0	0.9	6.4	42	-1.8	-7	19.3	54	(N/A)	5.0	13.56
Black walnut	0.8	0.1	0.4	0.0	4	4.8	0.7	0.7	4.7	30	0.0	0	12.3	35	(N/A)	5.0	8.68
Black cherry	1.5	0.2	0.7	0.1	8	3.8	0.6	0.5	3.5	24	0.0	0	11.0	32	(N/A)	5.0	7.90
Conifer Evergreen Large	0.5	0.1	0.4	0.1	3	1.8	0.3	0.3	1.8	11	-1.6	-6	3.5	8	(N/A)	3.8	2.82
White ash	2.2	0.4	1.0	0.1	12	5.4	0.8	0.8	5.2	34	0.0	0	15.9	46	(N/A)	3.8	15.19
Green ash	0.5	0.1	0.3	0.0	3	3.4	0.5	0.5	3.3	21	0.0	0	8.6	24	(N/A)	3.8	8.06
Apple	0.1	0.0	0.1	0.0	1	0.9	0.1	0.1	0.8	5	0.0	0	2.0	6	(N/A)	3.8	1.93
Eastern white pine	0.5	0.1	0.4	0.1	3	1.3	0.2	0.2	1.2	8	-1.9	-7	2.1	4	(N/A)	2.5	2.13
Scotch pine	0.3	0.1	0.3	0.0	2	1.2	0.2	0.2	1.2	7	-1.1	-4	2.3	6	(N/A)	2.5	2.82
Elm	1.1	0.2	0.5	0.0	6	3.1	0.5	0.4	2.9	19	0.0	0	8.7	25	(N/A)	2.5	12.53
Red maple	0.3	0.1	0.2	0.0	2	1.2	0.2	0.2	1.2	7	-0.1	0	3.1	9	(N/A)	1.3	8.75
Sugar maple	0.5	0.1	0.2	0.0	3	1.5	0.2	0.2	1.4	9	-0.4	-1	3.9	11	(N/A)	1.3	10.75
Hickory	0.3	0.0	0.1	0.0	1	1.3	0.2	0.2	1.2	8	0.0	0	3.3	9	(N/A)	1.3	9.34
Catalpa	1.6	0.3	0.7	0.1	8	2.3	0.3	0.3	2.2	14	0.0	0	7.7	23	(N/A)	1.3	22.55
Ginkgo	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	(N/A)	1.3	0.07
Honeylocust	0.9	0.2	0.4	0.0	5	1.7	0.3	0.2	1.7	11	-0.8	-3	4.7	13	(N/A)	1.3	12.87
Kentucky coffeetree	1.2	0.2	0.5	0.1	6	2.1	0.3	0.3	2.0	13	0.0	0	6.6	19	(N/A)	1.3	19.04
Spruce	0.1	0.0	0.1	0.0	0	0.3	0.0	0.0	0.3	2	-0.2	-1	0.6	1	(N/A)	1.3	1.48
Austrian pine	0.2	0.0	0.1	0.0	1	0.6	0.1	0.1	0.6	4	-0.5	-2	1.2	3	(N/A)	1.3	2.82
Black poplar	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.3	1	(N/A)	1.3	0.87
Bur oak	1.2	0.2	0.5	0.1	6	2.1	0.3	0.3	2.0	13	0.0	0	6.6	19	(N/A)	1.3	19.04
Willow	0.2	0.0	0.1	0.0	1	1.1	0.2	0.2	1.1	7	-0.1	0	2.8	8	(N/A)	1.3	7.92
Mountain ash	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.3	1	(N/A)	1.3	0.71
Other street trees	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	(N/A)	0.0	0.00
Citywide total	31.4	5.3	16.2	1.6	172	88.1	12.8	12.2	83.5	548	-12.6	-47	238.6	673	(N/A)	100.0	8.42

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees by Species

12/12/2010

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Norway maple	116,765	876	(N/A)	17.5	18.8	62.55
Northern	88,599	664	(N/A)	15.0	14.3	55.37
Blue spruce	4,207	32	(N/A)	7.5	0.7	5.26
Lilac	889	7	(N/A)	6.3	0.1	1.33
Silver maple	78,706	590	(N/A)	5.0	12.7	147.57
Black walnut	26,788	201	(N/A)	5.0	4.3	50.23
Black cherry	23,265	174	(N/A)	5.0	3.8	43.62
Conifer Evergreen	3,511	26	(N/A)	3.8	0.6	8.78
White ash	40,003	300	(N/A)	3.8	6.5	100.01
Green ash	15,801	119	(N/A)	3.8	2.6	39.50
Apple	1,994	15	(N/A)	3.8	0.3	4.98
Eastern white pine	4,513	34	(N/A)	2.5	0.7	16.92
Scotch pine	2,340	18	(N/A)	2.5	0.4	8.78
Elm	34,401	258	(N/A)	2.5	5.6	129.00
Red maple	3,624	27	(N/A)	1.3	0.6	27.18
Sugar maple	14,280	107	(N/A)	1.3	2.3	107.10
Hickory	8,458	63	(N/A)	1.3	1.4	63.43
Catalpa	55,982	420	(N/A)	1.3	9.0	419.86
Ginkgo	5	0	(N/A)	1.3	0.0	0.03
Honeylocust	12,245	92	(N/A)	1.3	2.0	91.84
Kentucky	39,259	294	(N/A)	1.3	6.3	294.44
Spruce	257	2	(N/A)	1.3	0.0	1.93
Austrian pine	1,170	9	(N/A)	1.3	0.2	8.78
Black poplar	185	1	(N/A)	1.3	0.0	1.39
Bur oak	39,259	294	(N/A)	1.3	6.3	294.44
Willow	3,624	27	(N/A)	1.3	0.6	27.18
Mountain ash	178	1	(N/A)	1.3	0.0	1.33
Other street trees	0	0	(N/A)	0.0	0.0	0.00
Citywide total	620,308	4,652	(N/A)	100.0	100.0	58.15

Table 5: Annual Carbon Sequestered

Annual CO_2 Benefits of Public Trees by Species

12/12/2010

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Norway maple	4,571	34	-560	-3	-4	6,155	46	10,163	76	(N/A)	17.5	16.4	5.44
Northern hackberry	5,293	40	-425	-2	-3	7,009	53	11,875	89	(N/A)	15.0	19.2	7.42
Blue spruce	388	3	-20	-1	0	957	7	1,324	10	(N/A)	7.5	2.1	1.65
Lilac	190	1	-4	-1	0	186	1	370	3	(N/A)	6.3	0.6	0.56
Silver maple	5,895	44	-378	-1	-3	2,366	18	7,882	59	(N/A)	5.0	12.8	14.78
Black walnut	2,193	16	-129	-1	-1	1,731	13	3,794	28	(N/A)	5.0	6.1	7.11
Black cherry	1,225	9	-112	-1	-1	1,313	10	2,425	18	(N/A)	5.0	3.9	4.55
Conifer Evergreen	347	3	-17	-1	0	649	5	979	7	(N/A)	3.8	1.6	2.45
White ash	3,475	26	-192	-1	-1	1,927	14	5,210	39	(N/A)	3.8	8.4	13.02
Green ash	1,550	12	-76	-1	-1	1,227	9	2,701	20	(N/A)	3.8	4.4	6.75
Apple	266	2	-10	-1	0	285	2	541	4	(N/A)	3.8	0.9	1.35
Eastern white pine	303	2	-22	0	0	463	3	744	6	(N/A)	2.5	1.2	2.79
Scotch pine	231	2	-11	0	0	433	3	652	5	(N/A)	2.5	1.1	2.45
Elm	1,619	12	-165	0	-1	1,091	8	2,545	19	(N/A)	2.5	4.1	9.54
Red maple	483	4	-17	0	0	431	3	896	7	(N/A)	1.3	1.5	6.72
Sugar maple	758	6	-69	0	-1	535	4	1,224	9	(N/A)	1.3	2.0	9.18
Hickory	660	5	-41	0	0	441	3	1,060	8	(N/A)	1.3	1.7	7.95
Catalpa	479	4	-269	0	-2	813	6	1,023	8	(N/A)	1.3	1.7	7.67
Ginkgo	2	0	0	0	0	4	0	6	0	(N/A)	1.3	0.0	0.04
Honeylocust	1,486	11	-59	0	0	615	5	2,042	15	(N/A)	1.3	3.3	15.31
Kentucky coffeetree	912	7	-188	0	-1	734	6	1,458	11	(N/A)	1.3	2.4	10.93
Spruce	53	0	-1	0	0	94	1	146	1	(N/A)	1.3	0.2	1.09
Austrian pine	116	1	-6	0	0	216	2	326	2	(N/A)	1.3	0.5	2.45
Black poplar	74	1	-1	0	0	49	0	122	1	(N/A)	1.3	0.2	0.91
Bur oak	912	7	-188	0	-1	734	6	1,458	11	(N/A)	1.3	2.4	10.93
Willow	386	3	-17	0	0	395	3	763	6	(N/A)	1.3	1.2	5.73
Mountain ash	38	0	-1	0	0	37	0	74	1	(N/A)	1.3	0.1	0.56
Other street trees	0	0	0	0	0	0	0	0	0	(N/A)	0.0	0.0	0.00
Citywide total	33,904	254	-2,977	-16	-22	30,893	232	61,803	464	(N/A)	100.0	100.0	5.79

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees by Species

12/12/2010

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Norway maple	433	(N/A)	17.5	11.6	30.96
Northern hackberry	706	(N/A)	15.0	18.9	58.85
Blue spruce	139	(N/A)	7.5	3.7	23.16
Lilac	10	(N/A)	6.3	0.3	2.06
Silver maple	456	(N/A)	5.0	12.2	114.02
Black walnut	203	(N/A)	5.0	5.4	50.79
Black cherry	73	(N/A)	5.0	2.0	18.27
Conifer Evergreen Large	97	(N/A)	3.8	2.6	32.32
White ash	354	(N/A)	3.8	9.5	118.02
Green ash	149	(N/A)	3.8	4.0	49.80
Apple	15	(N/A)	3.8	0.4	4.95
Eastern white pine	79	(N/A)	2.5	2.1	39.70
Scotch pine	65	(N/A)	2.5	1.7	32.32
Elm	124	(N/A)	2.5	3.3	62.14
Red maple	66	(N/A)	1.3	1.8	65.89
Sugar maple	76	(N/A)	1.3	2.0	76.42
Hickory	58	(N/A)	1.3	1.5	57.69
Catalpa	29	(N/A)	1.3	0.8	28.57
Ginkgo	0	(N/A)	1.3	0.0	0.37
Honeylocust	389	(N/A)	1.3	10.4	388.90
Kentucky coffeetree	58	(N/A)	1.3	1.6	58.34
Spruce	15	(N/A)	1.3	0.4	15.42
Austrian pine	32	(N/A)	1.3	0.9	32.32
Black poplar	15	(N/A)	1.3	0.4	14.73
Bur oak	58	(N/A)	1.3	1.6	58.34
Willow	39	(N/A)	1.3	1.1	39.16
Mountain ash	2	(N/A)	1.3	0.1	2.06
Other street trees	0	(±NaN)	0.0	0.0	0.00
Citywide total	3,743	(N/A)	100.0	100.0	46.79

Table 7: Summary of Benefits in Dollars

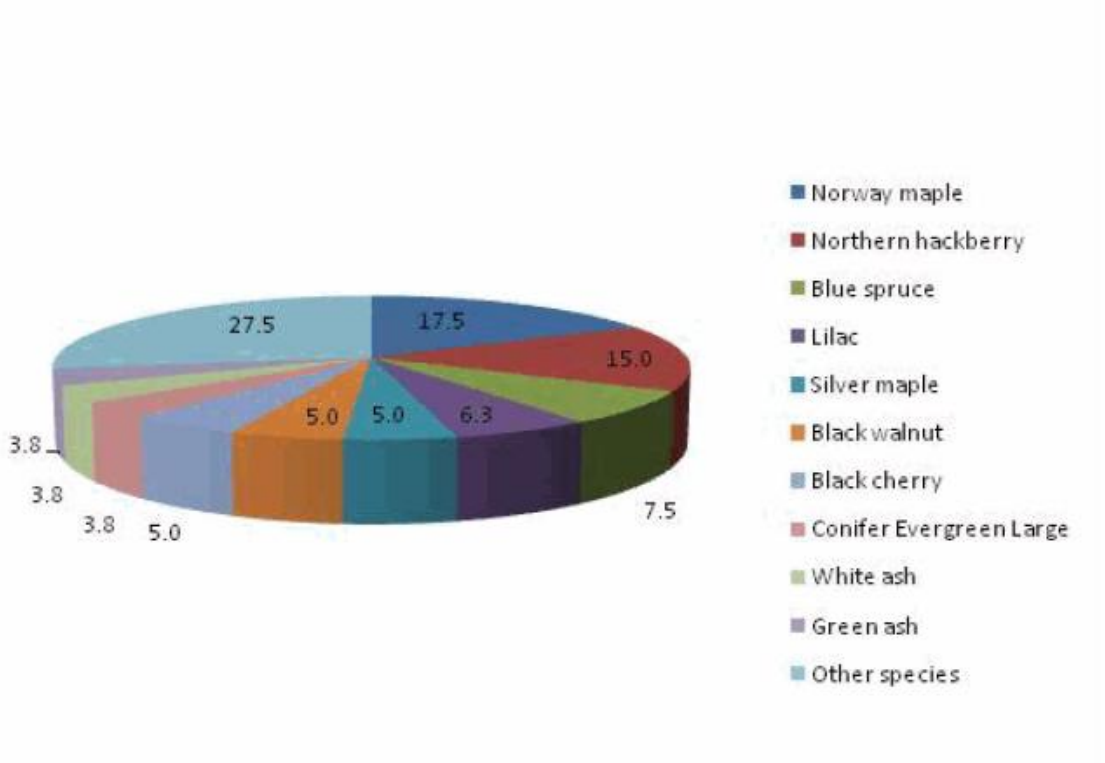
Total Annual Benefits of Public Trees by Species ($)

12/12/20

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Norway maple	800	76	142	942	433	2,394	(±0)	17.1
Northern hackberry	906	89	158	1,072	706	2,931	(±0)	20.9
Blue spruce	118	10	13	187	139	467	(±0)	3.3
Lilac	27	3	4	9	10	53	(±0)	0.4
Silver maple	290	59	54	572	456	1,432	(±0)	10.2
Black walnut	204	28	35	226	203	696	(±0)	5.0
Black cherry	177	18	32	114	73	413	(±0)	2.9
Conifer Evergreen	72	7	8	125	97	310	(±0)	2.2
White ash	236	39	46	375	354	1,049	(±0)	7.5
Green ash	146	20	24	150	149	489	(±0)	3.5
Apple	42	4	6	16	15	83	(±0)	0.6
Eastern white pine	55	6	4	122	79	266	(±0)	1.9
Scotch pine	48	5	6	83	65	207	(±0)	1.5
Elm	139	19	25	219	124	527	(±0)	3.8
Red maple	49	7	9	43	66	174	(±0)	1.2
Sugar maple	68	9	11	103	76	267	(±0)	1.9
Hickory	57	8	9	70	58	203	(±0)	1.4
Catalpa	99	8	23	196	29	354	(±0)	2.5
Ginkgo	1	0	0	0	0	1	(±0)	0.0
Honeylocust	74	15	13	127	389	618	(±0)	4.4
Kentucky coffeetree	91	11	19	196	58	376	(±0)	2.7
Spruce	14	1	1	16	15	48	(±0)	0.3
Austrian pine	24	2	3	42	32	103	(±0)	0.7
Black poplar	6	1	1	5	15	27	(±0)	0.2
Bur oak	91	11	19	196	58	376	(±0)	2.7
Willow	47	6	8	38	39	138	(±0)	1.0
Mountain ash	5	1	1	2	2	11	(±0)	0.1
Other street trees	0	0	0	0	0	0	(±0)	0.0
Citywide Total	3,885	464	673	5,246	3,743	14,011	(±0)	100.0

Species Distribution of Public Trees (%)

12/12/2010

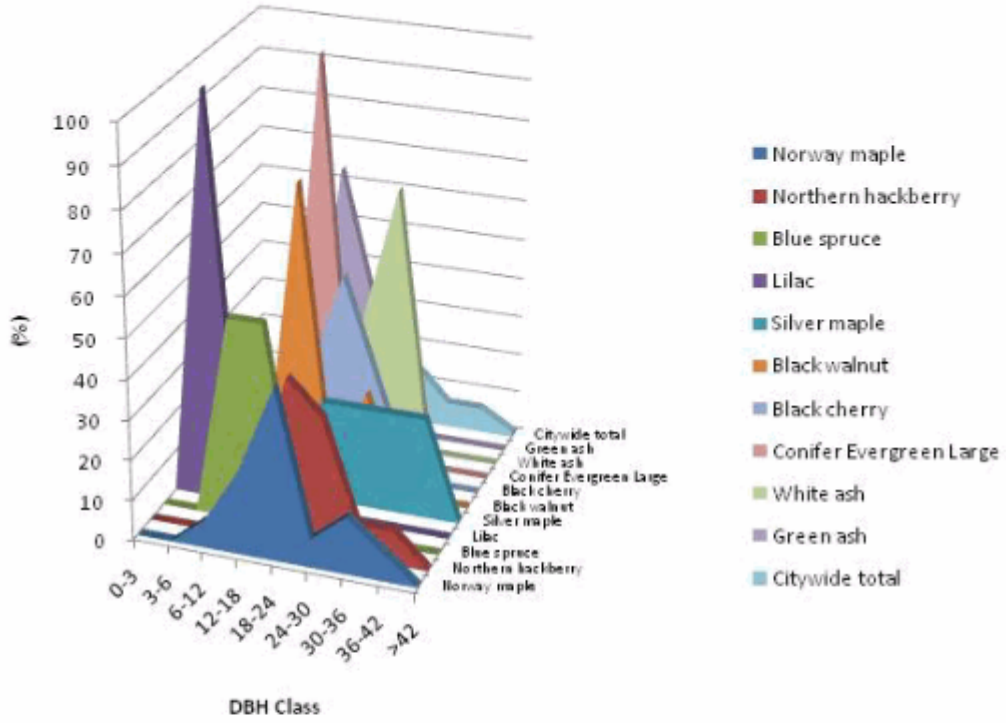


Species	Percent
Norway maple	17.5
Northern hackberry	15.0
Blue spruce	7.5
Lilac	6.3
Silver maple	5.0
Black walnut	5.0
Black cherry	5.0
Conifer Evergreen Large	3.8
White ash	3.8
Green ash	3.8
Other species	27.5
Total	100.0

Figure 1: Species Distribution

Relative Age Distribution of Top 10 Public Tree Species (%)

12/12/2010



	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Norway maple	0.0	0.0	7.1	21.4	42.9	7.1	14.3	7.1	0.0
Northern hackberry	0.0	0.0	0.0	8.3	41.7	33.3	8.3	8.3	0.0
Blue spruce	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0
Lilac	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Silver maple	0.0	0.0	0.0	0.0	25.0	25.0	25.0	25.0	0.0
Black walnut	0.0	0.0	0.0	75.0	0.0	25.0	0.0	0.0	0.0
Black cherry	0.0	0.0	0.0	25.0	50.0	25.0	0.0	0.0	0.0
Conifer Evergreen	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
White ash	0.0	0.0	0.0	0.0	33.3	66.7	0.0	0.0	0.0
Green ash	0.0	0.0	0.0	66.7	33.3	0.0	0.0	0.0	0.0
Citywide total	1.3	10.0	8.8	27.5	23.8	15.0	6.3	6.3	1.3

Figure 2: Relative Age Class

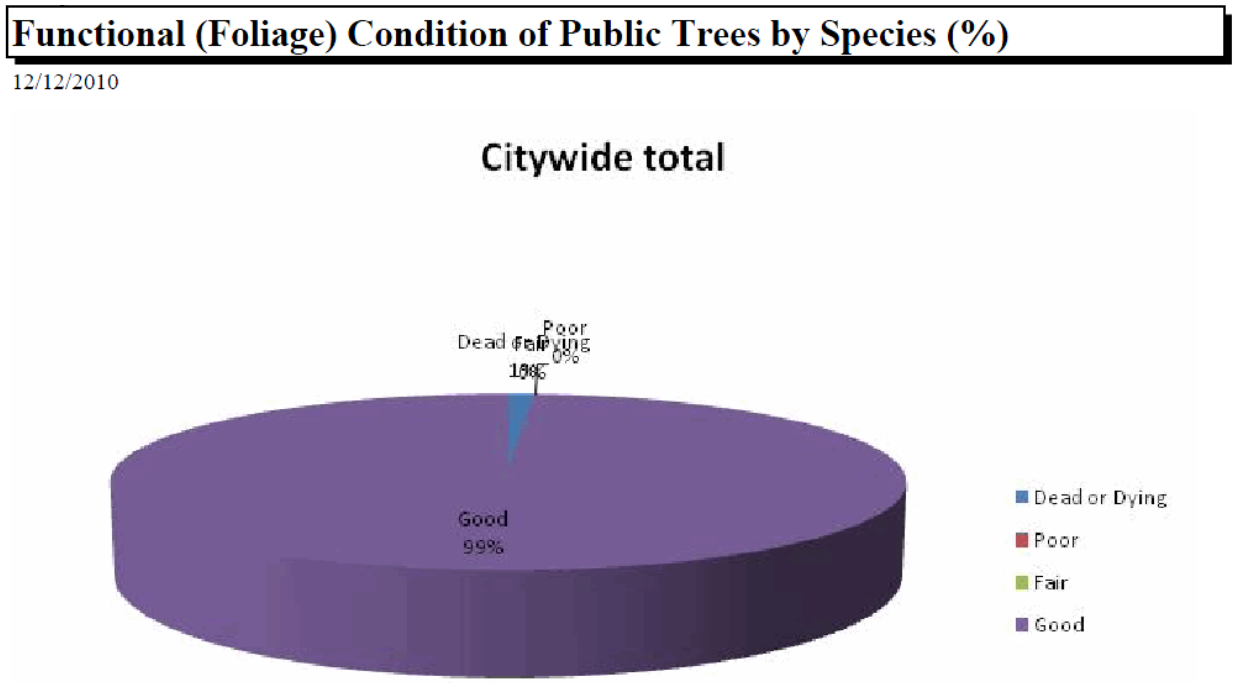


Figure 3: Foliage Condition

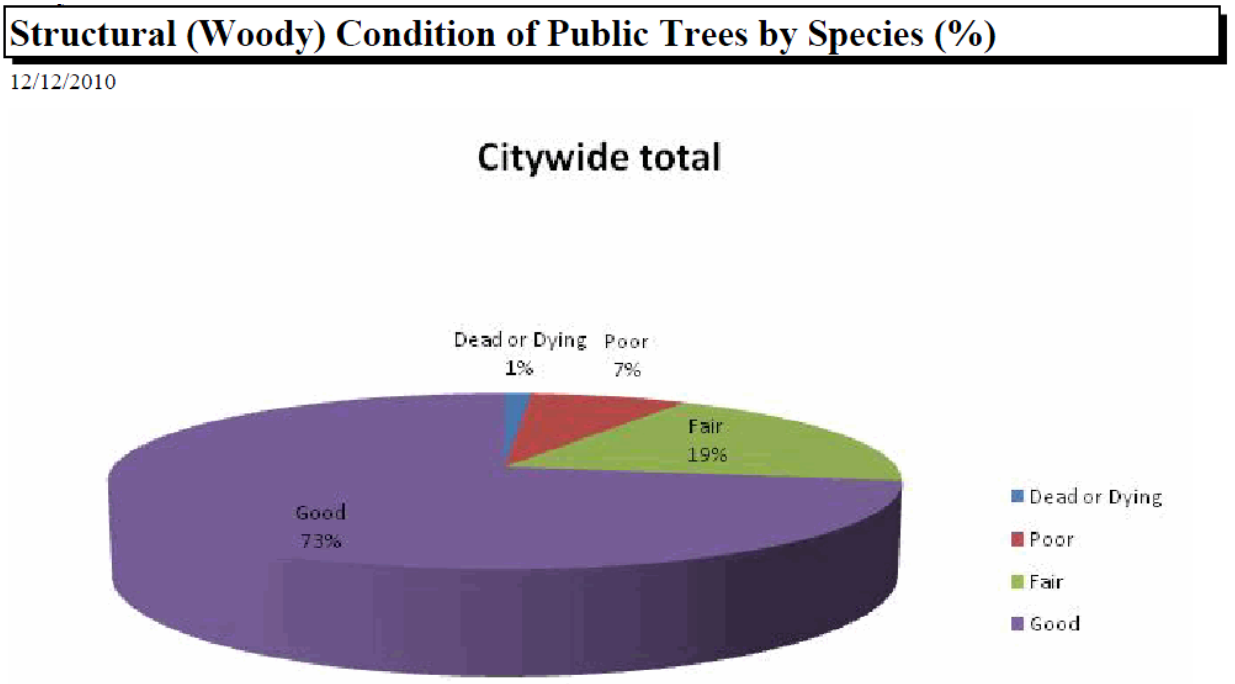
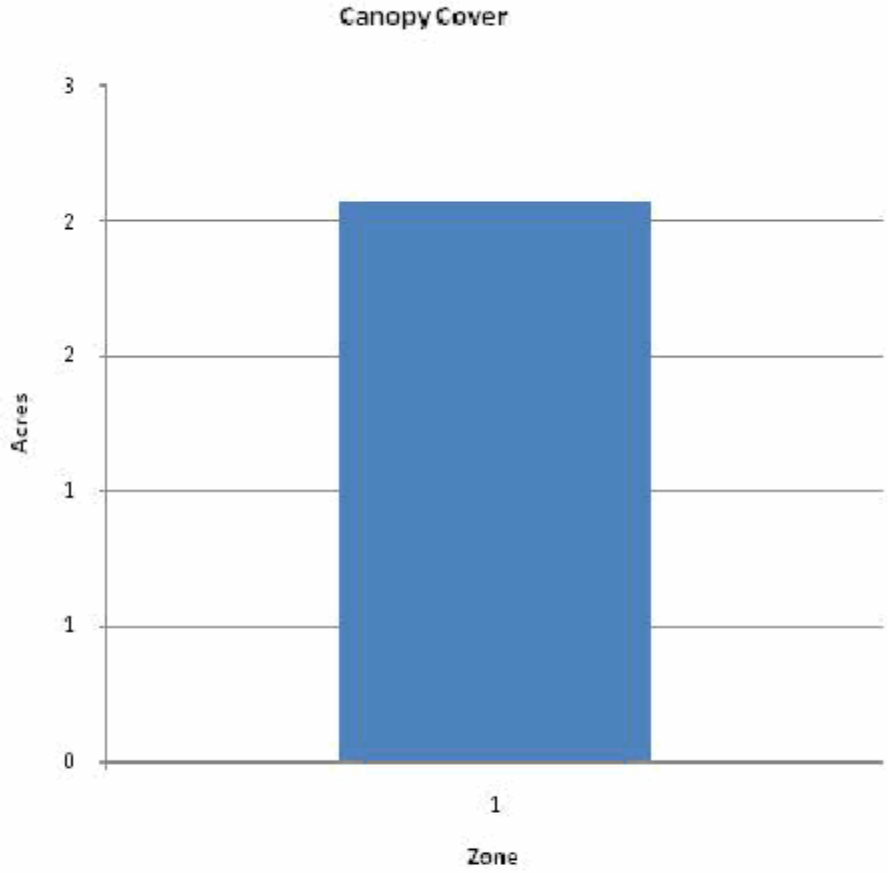


Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

12/12/2010



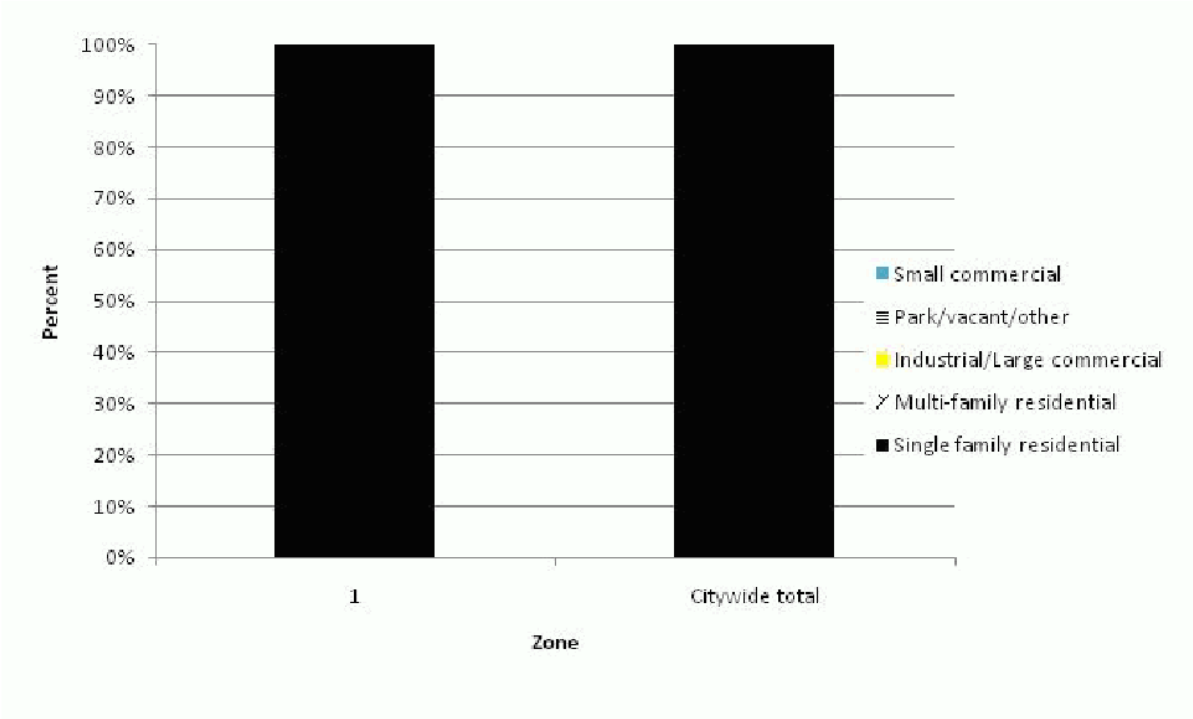
Zone	Acres	% of Total Canopy Cover
1	2	100.0
Citywide total	2	100.0

	Total Land Area	Total Street and Sidewalk Area	Total Canopy Cover	Canopy Cover as % of Total Land Area	Canopy Cover as % of Total Streets and Sidewalks
Citywide	0	0	2		

Figure 5: Canopy Cover in Acres

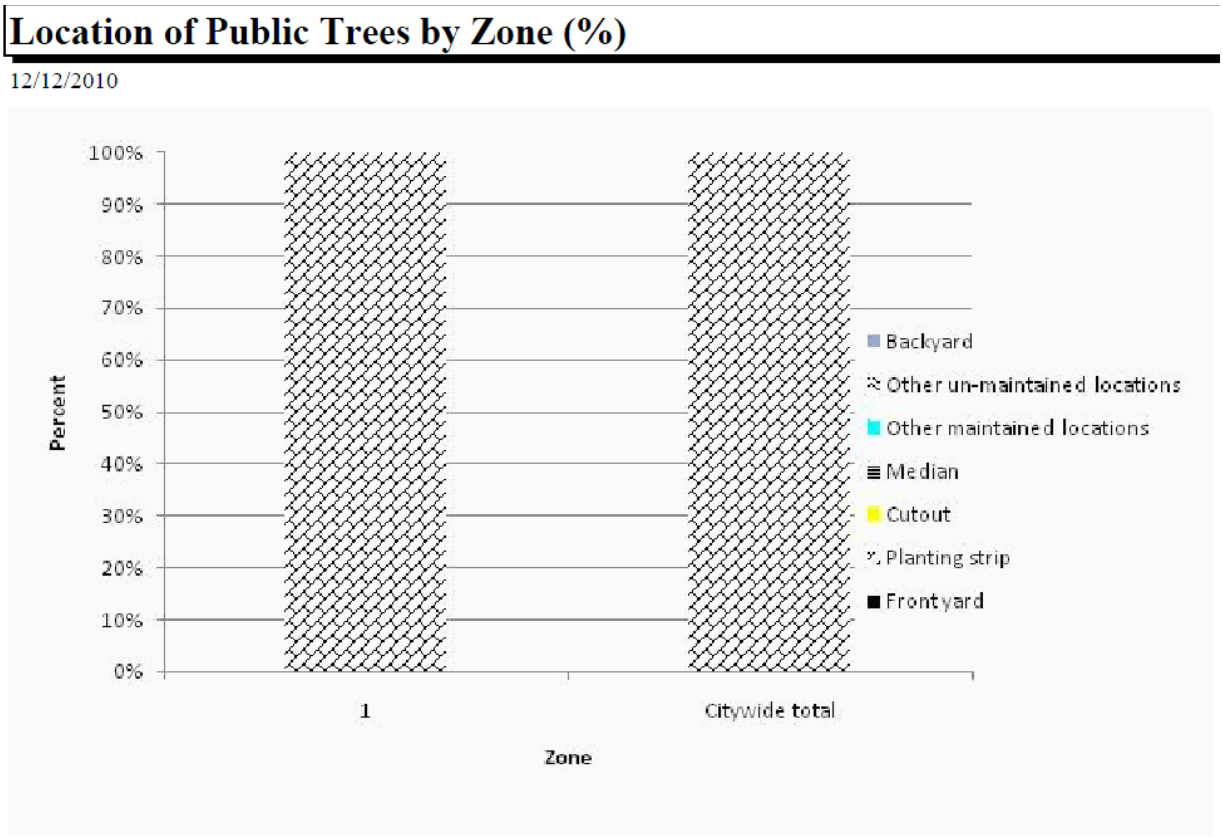
Land Use of Public Trees by Zone (%)

12/12/2010



Zone	Single family residential	Multi-family residential	Industrial/ Large commercial	Park/vacant/ other	Small commercial
1	100.0	0.0	0.0	0.0	0.0
Citywide total	100.0	0.0	0.0	0.0	0.0

Figure 6: Land Use of city/park trees



Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
1	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Citywide total	0.0	100.0	0.0	0.0	0.0	0.0	0.0

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

Figure 1: Location of Ash Trees

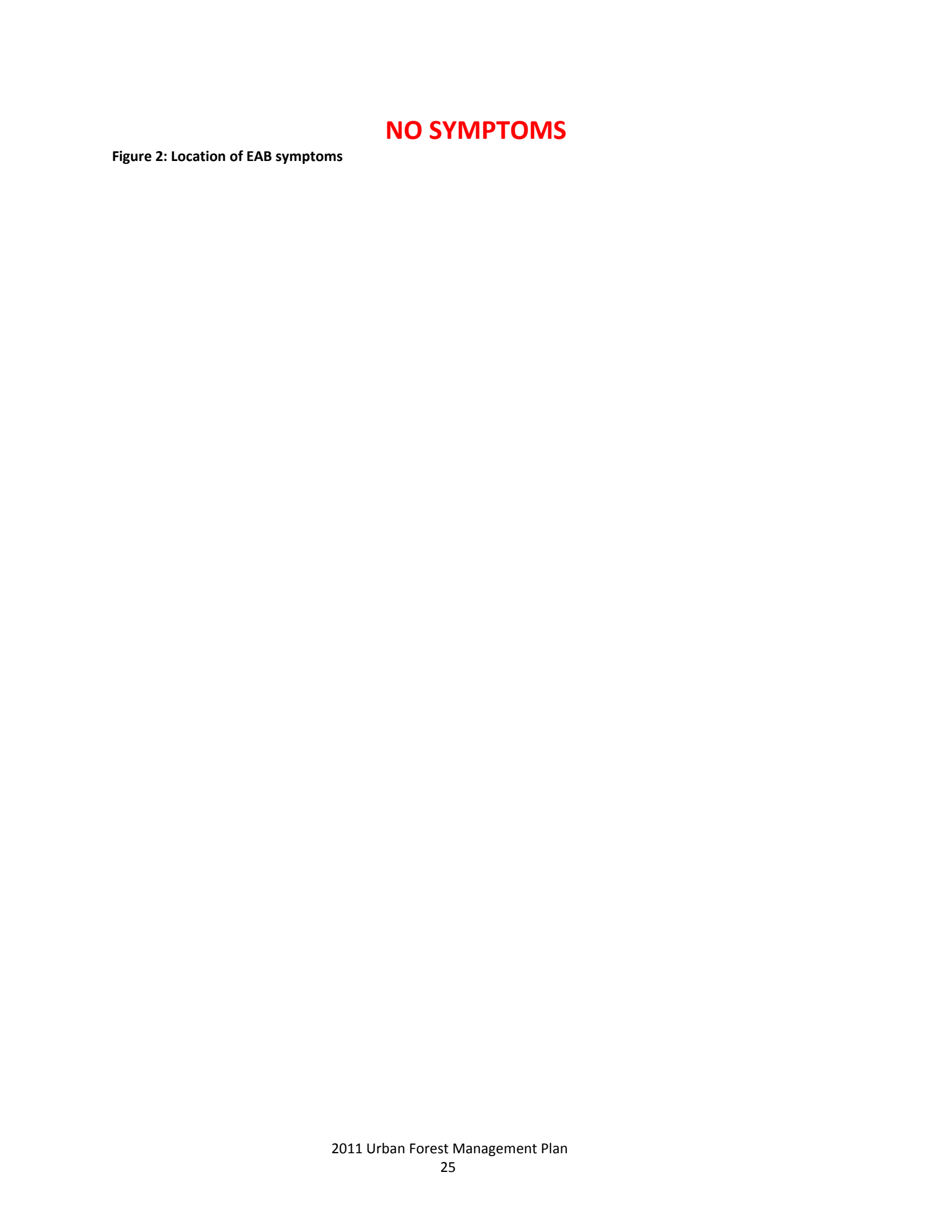


Figure 2: Location of EAB symptoms

Figure 3: Location of Poor Condition Trees

Figure 4: Location of Trees with Recommended Maintenance

Figure 5: Maintenance Tasks *City ownership of the trees recommended for removal should be verified prior to any removal*

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