MARQUETTE, IA

2010 Management Plan

Provided by Northeast Iowa R,C&D

Prepared by Beyer Forestry Services

In cooperation with the Iowa DNR Forestry Bureau

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Executive Summary

Overview

This plan was developed to assist the City of Marquette 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 6% of Marquette'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 2009, 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 255 trees inventoried.

- Marquette's trees provide $11,153 of benefits annually, an average of $44 a tree
- There are over 29 species of trees
- The top three genus are: Apple/Crabapple 30%, Maple 22%, and Serviceberry 14%
- 9% of trees are in need of some type of management
- 1 tree is 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.

- The 1 tree needing removal is dead or dying and should be addressed immediately *City ownership of the trees recommended for removal should be verified prior to any removal*
- 2 of the 16 ash trees are in need of follow up because they are displaying signs and symptoms associated with EAB
- All trees should be pruned on a routine schedule- one third of the city every other year
- Plant a diverse mix of trees that do not include: ash, maple, crabapple, serviceberry, 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 Marquette 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 Marquette, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

Trees are an important component of Marquette'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 Marquette 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 Marquette's urban forestry goals.

Inventory

In 2009, a tree inventory was conducted that included 100% of the city owned trees on both streets and parks. 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 255 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. Marquette's trees reduce energy related costs by approximately $3,548 annually (Appendix A, Table 1). These savings are both in Electricity (16.4 MWh) and in Natural Gas (2,347.4 Therms).

Annual Stormwater Benefits

Marquette's trees intercept about 119,205 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $3,231 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 Marquette, it is estimated that trees remove 194.2 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 $541 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Marquette, trees sequester about 30,590 lbs of carbon a year with an associated value of $423 (Appendix A, Table 5). In addition, the trees store 353,033 lbs of carbon, with a yearly benefit of $2,648 (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. Marquette receives $3,410 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, Marquette's trees provide $11,153 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 255 trees in Marquette provide approximately $44 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Marquette has over 29 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
Apple/Crabapple	76	30
Maple	56	22
Serviceberry	35	14
Lilac	21	8
Evergreen/Conifer	17	7
Ash	16	6
Oak	8	3
Locust	6	2
Birch	6	2
Hackberry	5	2
Willow	2	1
Boxelder	2	1

Age Class

Most of Marquette's trees (66%) are between 1 and 6 inches in diameter at 4.5 ft (Appendix A, Figure 2). For age, a Bell Curve is preferred and shows the highest amount of trees around 3 inches in diameter at 4.5 ft. Marquette's size curve is on the smaller side, indicating a younger than average stand.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the overall health of the urban forest. The foliage condition results for Marquette indicate that 96% of the trees are in good health, with only 2% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 93% of Marquette'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 2% of the population. This 2% 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 Cleaning	19	7%
Crown Raising	2	1%
Tree Removal	1	<1%

Canopy Cover

The canopy cover of Marquette is approximately 2 acres (Appendix A, Figure 4). According to the 2000 census, Marquette occupies 768 acres. Thus the canopy cover on city land is less than 1%.

Land Use and Location

The majority of Marquette's city and park trees are in planting strips in single family residential neighborhoods (Appendix A, Figure 6 & Appendix A, Figure7). The following describes the land use and locations for the street and park trees.

Land Use	
Single family residential	51%
Park/vacant/other	48%
Small commercial	1%

Location	
Other maintained locations	55%
Front yard	41%
Planting strip	4%
Medium	<1%

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

Marquette has 1 critical concern tree that needs immediate removal. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). Please refer to the six year maintenance plan at the end of this section. After all of the critical concern

trees are addressed, there should be follow up on the trees marked as needing maintenance that do not include trimming. There are a total of 2 trees with these needs.

Poor tree species

After the removal of the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). There are a total of 16 ash trees, and 2 of those have signs and symptoms that have been associated with EAB. In addition, there are 4 trees that have major structural problems. *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 Marquette.

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 Crabapples (30%) and Maple (22%) (Appendix A, Figure 1). Crabapples and 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 city ordinance tree ordinance. The new plantings will be a diverse mix and will not include ash, maple, crabapple, 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

The trees on private property are a vital component of Marquette's urban forest. It is important that private property owners are educated to plant the proper species in the proper locations, and that they correctly manage their trees. It is strongly recommended that private property owners start removing ash trees on their property as trees are infested with Emerald Ash Borer. The private landowners should follow the same guidelines detailed in this plan.

Marquette is a Tree City USA and has a city tree ordinance that all citizens should be aware of and follow.

PROPOSED WORK SCHEDULE AND ESTIMATED COSTS_

Year 1 -

Remove 1 critical concern tree and 4 trees with major structural problems.	$3,125
Plant 6 trees in open locations	$1,560
Check for visual signs of Emerald Ash Borer	

Year 2 -

Remove 3 ash trees	$1,875
Plant 3 trees in open locations	$780
Prune 1/3 of city trees	$1,200
Check for visual signs of Emerald Ash Borer	

Year 3 -

Remove 4 ash trees	$2,500
Plant 4 trees in open locations	$1,040
Check for visual signs of EAB	

Year 4 -

Remove 3 ash trees	$1,875
Plant 3 trees in open locations	$780
Prune 1/3 of city trees	$1,200
Check for visual signs of EAB	

Year 5 -

Remove 3 ash trees	$1,875
Plant 3 trees in open locations	$780
Check for visual signs of EAB	

Year 6 -

Remove 3 ash trees	$1,875
Plant 3 trees in open locations	$780
Prune 1/3 of city trees	$1,200
Check for visual signs of EAB	

Purposed Budget Increase

EAB could potentially kill all ash trees in Marquette within 4 years of its arrival. To remove and replace all ash trees and critical concern trees within 6 years, and properly prune the city trees, the budget would need to be approximately **$3,800** per year. It is recommended that Marquette 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

7/7/2009

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Apple	2.1	160	354.6	348	508	(N/A)	29.8	14.3	6.68
Broadleaf Deciduous	0.4	32	70.9	69	102	(N/A)	13.7	2.9	2.90
Amur maple	0.5	37	83.4	82	118	(N/A)	7.5	3.3	6.23
Japanese tree lilac	0.6	42	92.7	91	133	(N/A)	7.5	3.7	6.98
Norway maple	1.8	136	265.6	260	396	(N/A)	6.3	11.2	24.74
Green ash	2.6	195	321.9	315	510	(N/A)	5.9	14.4	34.01
Red maple	0.3	26	50.9	50	76	(N/A)	3.1	2.1	9.47
Silver maple	1.7	126	221.8	217	344	(N/A)	3.1	9.7	42.97
Eastern white pine	0.8	62	101.7	100	161	(N/A)	3.1	4.6	20.18
Honeylocust	0.9	67	116.0	114	180	(N/A)	2.4	5.1	30.07
Northern white cedar	0.2	15	27.9	27	43	(N/A)	2.4	1.2	7.13
Northern hackberry	0.6	47	81.3	80	127	(N/A)	2.0	3.6	25.42
Swamp white oak	0.4	29	53.3	52	81	(N/A)	1.6	2.3	20.33
Maple	0.2	14	27.0	26	40	(N/A)	1.2	1.1	13.43
Birch	0.3	24	50.6	50	73	(N/A)	1.2	2.1	24.47
Red pine	0.4	29	43.9	43	72	(N/A)	1.2	2.0	24.14
White oak	0.0	3	4.6	5	7	(N/A)	1.2	0.2	2.38
Other street trees	2.7	204	379.5	372	575	(N/A)	7.1	16.2	31.97
Citywide total	16.4	1,247	2,347.4	2,300	3,548	(N/A)	100.0	100.0	13.91

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees by Species

7/7/2009

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Apple	7,471	202	(N/A)	29.8	6.3	2.66
Broadleaf Deciduous	1,631	44	(N/A)	13.7	1.4	1.26
Amur maple	1,586	43	(N/A)	7.5	1.3	2.26
Japanese tree lilac	2,312	63	(N/A)	7.5	1.9	3.30
Norway maple	11,967	324	(N/A)	6.3	10.0	20.27
Green ash	18,019	488	(N/A)	5.9	15.1	32.56
Red maple	1,697	46	(N/A)	3.1	1.4	5.75
Silver maple	20,926	567	(N/A)	3.1	17.6	70.89
Eastern white pine	9,479	257	(N/A)	3.1	8.0	32.11
Honeylocust	4,568	124	(N/A)	2.4	3.8	20.63
Northern white cedar	4,848	131	(N/A)	2.4	4.1	21.90
Northern hackberry	3,234	88	(N/A)	2.0	2.7	17.53
Swamp white oak	2,170	59	(N/A)	1.6	1.8	14.70
Maple	900	24	(N/A)	1.2	0.8	8.13
Birch	1,758	48	(N/A)	1.2	1.5	15.88
Red pine	4,616	125	(N/A)	1.2	3.9	41.70
White oak	207	6	(N/A)	1.2	0.2	1.87
Other street trees	21,816	591	(N/A)	7.1	18.3	32.85
Citywide total	119,205	3,231	(N/A)	100.0	100.0	12.67

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees by Species

7/7/2009

Species	Deposition (lb) O_3	NO_2	PM_{10}	SO_2	Total Depos. ($)	Avoided (lb) NO_2	PM_{10}	VOC	SO_2	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	Standard Error	% of Total Trees	Avg. $/tree
Apple	1.3	0.2	0.7	0.1	7	10.6	1.5	1.4	9.6	65	0.0	0	25.4	72	(N/A)	29.8	0.95
Broadleaf Deciduous	0.1	0.0	0.1	0.0	0	2.1	0.3	0.3	1.9	13	0.0	0	4.8	13	(N/A)	13.7	0.38
Amur maple	0.2	0.0	0.1	0.0	1	2.5	0.3	0.3	2.2	15	0.0	0	5.7	16	(N/A)	7.5	0.84
Japanese tree lilac	0.6	0.1	0.3	0.0	3	2.8	0.4	0.4	2.5	17	0.0	0	7.0	20	(N/A)	7.5	1.05
Norway maple	1.8	0.3	1.0	0.1	10	8.7	1.3	1.2	8.1	54	-0.5	-2	22.0	62	(N/A)	6.3	3.88
Green ash	1.4	0.2	0.8	0.1	8	12.0	1.8	1.7	11.6	75	0.0	0	29.6	83	(N/A)	5.9	5.55
Red maple	0.2	0.0	0.1	0.0	1	1.7	0.2	0.2	1.5	10	-0.1	0	3.9	11	(N/A)	3.1	1.38
Silver maple	3.4	0.6	1.7	0.2	18	7.9	1.2	1.1	7.5	49	-2.0	-7	21.5	60	(N/A)	3.1	7.52
Eastern white pine	1.0	0.2	0.9	0.1	7	3.8	0.6	0.5	3.7	24	-3.2	-12	7.6	19	(N/A)	3.1	2.32
Honeylocust	0.7	0.1	0.3	0.0	4	4.2	0.6	0.6	4.0	26	-0.4	-1	10.1	28	(N/A)	2.4	4.69
Northern white cedar	0.6	0.1	0.5	0.1	4	1.0	0.1	0.1	0.9	6	-3.0	-11	0.4	-1	(N/A)	2.4	-0.22
Northern hackberry	0.3	0.0	0.2	0.0	2	2.9	0.4	0.4	2.8	18	0.0	0	7.1	20	(N/A)	2.0	4.02
Swamp white oak	0.3	0.0	0.2	0.0	2	1.8	0.3	0.3	1.7	11	-0.1	0	4.5	13	(N/A)	1.6	3.18
Maple	0.1	0.0	0.1	0.0	1	0.9	0.1	0.1	0.8	5	0.0	0	2.1	6	(N/A)	1.2	1.96
Birch	0.2	0.0	0.1	0.0	1	1.6	0.2	0.2	1.4	10	-0.1	0	3.7	10	(N/A)	1.2	3.47
Red pine	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)	1.2	2.82
White oak	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.4	1	(N/A)	1.2	0.35
Other street trees	3.9	0.6	1.9	0.2	21	12.9	1.9	1.8	12.2	80	-0.4	-1	35.0	100	(N/A)	7.1	5.54
Citywide total	16.3	2.8	9.4	0.9	92	79.3	11.5	10.9	74.5	492	-11.3	-43	194.2	541	(N/A)	100.0	2.12

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees by Species

7/7/2009

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Apple	26,465	198	(N/A)	29.8	7.5	2.61
Broadleaf	2,202	17	(N/A)	13.7	0.6	0.47
Amur maple	4,748	36	(N/A)	7.5	1.4	1.87
Japanese tree lilac	10,091	76	(N/A)	7.5	2.9	3.98
Norway maple	30,650	230	(N/A)	6.3	8.7	14.37
Green ash	47,868	359	(N/A)	5.9	13.6	23.93
Red maple	2,907	22	(N/A)	3.1	0.8	2.73
Silver maple	84,916	637	(N/A)	3.1	24.1	79.61
Eastern white pine	6,621	50	(N/A)	3.1	1.9	6.21
Honeylocust	8,082	61	(N/A)	2.4	2.3	10.10
Northern white	7,503	56	(N/A)	2.4	2.1	9.38
Northern	3,502	26	(N/A)	2.0	1.0	5.25
Swamp white oak	4,960	37	(N/A)	1.6	1.4	9.30
Maple	1,538	12	(N/A)	1.2	0.4	3.84
Birch	3,302	25	(N/A)	1.2	0.9	8.26
Red pine	3,511	26	(N/A)	1.2	1.0	8.78
White oak	210	2	(N/A)	1.2	0.1	0.52
Other street trees	47,154	780	(N/A)	7.1	29.5	43.32
Citywide total	353,033	2,648	(N/A)	100.0	100.0	10.38

Table 5: Annual Carbon Sequestered

Annual CO Benefits of Public Trees by Species

7/7/2009

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
Apple	3,162	24	-127	-15	-1	3,539	27	6,558	49	(N/A)	29.8	11.6	0.65
Broadleaf Deciduous	911	7	-11	-7	0	710	5	1,604	12	(N/A)	13.7	2.8	0.34
Amur maple	802	6	-23	-4	0	810	6	1,585	12	(N/A)	7.5	2.8	0.63
Japanese tree lilac	1,079	8	-48	-4	0	926	7	1,953	15	(N/A)	7.5	3.5	0.77
Norway maple	3,449	26	-147	-3	-1	2,998	22	6,296	47	(N/A)	6.3	11.2	2.95
Green ash	5,301	40	-230	-3	-2	4,303	32	9,372	70	(N/A)	5.9	16.6	4.69
Red maple	455	3	-14	-2	0	573	4	1,012	8	(N/A)	3.1	1.8	0.95
Silver maple	6,632	50	-408	-2	-3	2,794	21	9,017	68	(N/A)	3.1	16.0	8.45
Eastern white pine	736	6	-32	-2	0	1,366	10	2,068	16	(N/A)	3.1	3.7	1.94
Honeylocust	1,407	11	-39	-1	0	1,474	11	2,841	21	(N/A)	2.4	5.0	3.55
Northern white cedar	274	2	-36	-1	0	341	3	578	4	(N/A)	2.4	1.0	0.72
Northern hackberry	452	3	-17	-1	0	1,047	8	1,482	11	(N/A)	2.0	2.6	2.22
Swamp white oak	711	5	-24	-1	0	643	5	1,329	10	(N/A)	1.6	2.4	2.49
Maple	243	2	-7	-1	0	306	2	541	4	(N/A)	1.2	1.0	1.35
Birch	672	5	-16	-1	0	528	4	1,183	9	(N/A)	1.2	2.1	2.96
Red pine	347	3	-17	-1	0	649	5	979	7	(N/A)	1.2	1.7	2.45
White oak	79	1	-1	-1	0	57	0	135	1	(N/A)	1.2	0.2	0.34
Other street trees	3,879	29	-499	-4	-4	4,499	34	7,875	59	(N/A)	7.1	14.0	3.28
Citywide total	30,590	229	-1,695	-50	-13	27,562	207	56,408	423	(N/A)	100.0	100.0	1.66

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees by Species

7/7/2009

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Apple	165	(N/A)	29.8	4.8	2.17
Broadleaf Deciduous	177	(N/A)	13.7	5.2	5.06
Amur maple	42	(N/A)	7.5	1.2	2.21
Japanese tree lilac	58	(N/A)	7.5	1.7	3.07
Norway maple	379	(N/A)	6.3	11.1	23.67
Green ash	573	(N/A)	5.9	16.8	38.18
Red maple	82	(N/A)	3.1	2.4	10.20
Silver maple	563	(N/A)	3.1	16.5	70.39
Eastern white pine	208	(N/A)	3.1	6.1	25.98
Honeylocust	276	(N/A)	2.4	8.1	46.06
Northern white cedar	55	(N/A)	2.4	1.6	9.18
Northern hackberry	105	(N/A)	2.0	3.1	20.95
Swamp white oak	81	(N/A)	1.6	2.4	20.25
Maple	44	(N/A)	1.2	1.3	14.80
Birch	79	(N/A)	1.2	2.3	26.22
Red pine	97	(N/A)	1.2	2.8	32.32
White oak	25	(N/A)	1.2	0.7	8.42
Other street trees	401	(N/A)	7.1	11.8	22.29
Citywide total	3,410	(N/A)	100.0	100.0	13.37

Table 7: Summary of Benefits in Dollars

Annual Benefits of Public Trees by Species ($/tree)

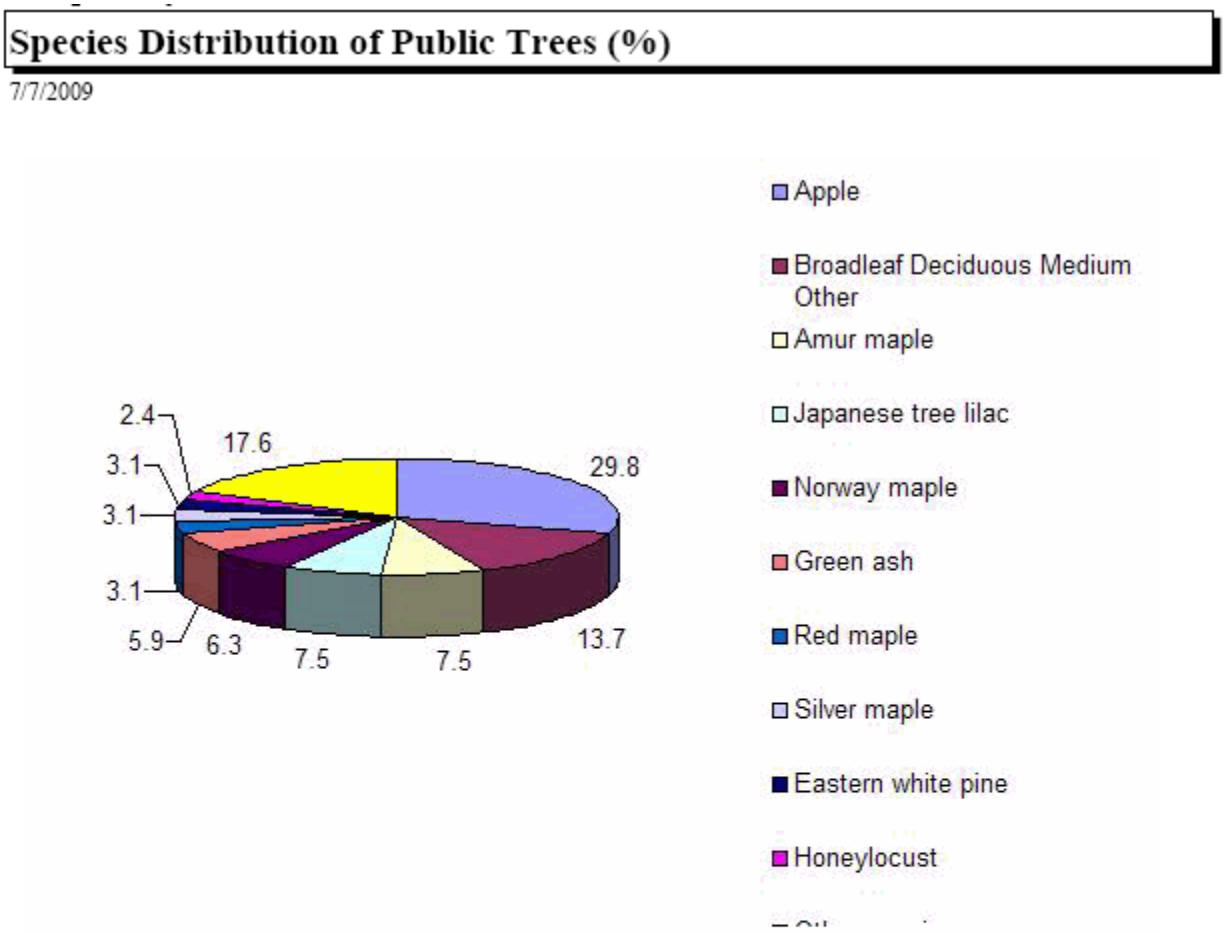
7/7/2009

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error
Apple	6.68	0.65	0.95	2.66	2.17	13.10	(N/A)
Broadleaf	2.90	0.34	0.38	1.26	5.06	9.95	(N/A)
Amur maple	6.23	0.63	0.84	2.26	2.21	12.17	(N/A)
Japanese tree lilac	6.98	0.77	1.05	3.30	3.07	15.17	(N/A)
Norway maple	24.74	2.95	3.88	20.27	23.67	75.52	(N/A)
Green ash	34.01	4.69	5.55	32.56	38.18	114.98	(N/A)
Red maple	9.47	0.95	1.38	5.75	10.20	27.76	(N/A)
Silver maple	42.97	8.45	7.52	70.89	70.39	200.22	(N/A)
Eastern white pine	20.18	1.94	2.32	32.11	25.98	82.53	(N/A)
Honeylocust	30.07	3.55	4.69	20.63	46.06	105.01	(N/A)
Northern white	7.13	0.72	-0.22	21.90	9.18	38.71	(N/A)
Northern hackberry	25.42	2.22	4.02	17.53	20.95	70.13	(N/A)
Swamp white oak	20.33	2.49	3.18	14.70	20.25	60.96	(N/A)
Maple	13.43	1.35	1.96	8.13	14.80	39.67	(N/A)
Birch	24.47	2.96	3.47	15.88	26.22	73.00	(N/A)
Red pine	24.14	2.45	2.82	41.70	32.32	103.42	(N/A)
White oak	2.38	0.34	0.35	1.87	8.42	13.35	(N/A)
Other street trees	31.97	3.28	5.54	32.85	22.29	95.93	(N/A)

Total Annual Benefits of Public Trees by Species ($)

7/7/2009

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Apple	508	49	72	202	165	996	(±0)	8.9
Broadleaf Deciduous	102	12	13	44	177	348	(±0)	3.1
Amur maple	118	12	16	43	42	231	(±0)	2.1
Japanese tree lilac	133	15	20	63	58	288	(±0)	2.6
Norway maple	396	47	62	324	379	1,208	(±0)	10.8
Green ash	510	70	83	488	573	1,725	(±0)	15.5
Red maple	76	8	11	46	82	222	(±0)	2.0
Silver maple	344	68	60	567	563	1,602	(±0)	14.4
Eastern white pine	161	16	19	257	208	660	(±0)	5.9
Honeylocust	180	21	28	124	276	630	(±0)	5.6
Northern white cedar	43	4	-1	131	55	232	(±0)	2.1
Northern hackberry	127	11	20	88	105	351	(±0)	3.1
Swamp white oak	81	10	13	59	81	244	(±0)	2.2
Maple	40	4	6	24	44	119	(±0)	1.1
Birch	73	9	10	48	79	219	(±0)	2.0
Red pine	72	7	8	125	97	310	(±0)	2.8
White oak	7	1	1	6	25	40	(±0)	0.4
Other street trees	575	59	100	591	401	1,727	(±0)	15.5
Citywide Total	3,548	423	541	3,231	3,410	11,153	(±0)	100.0

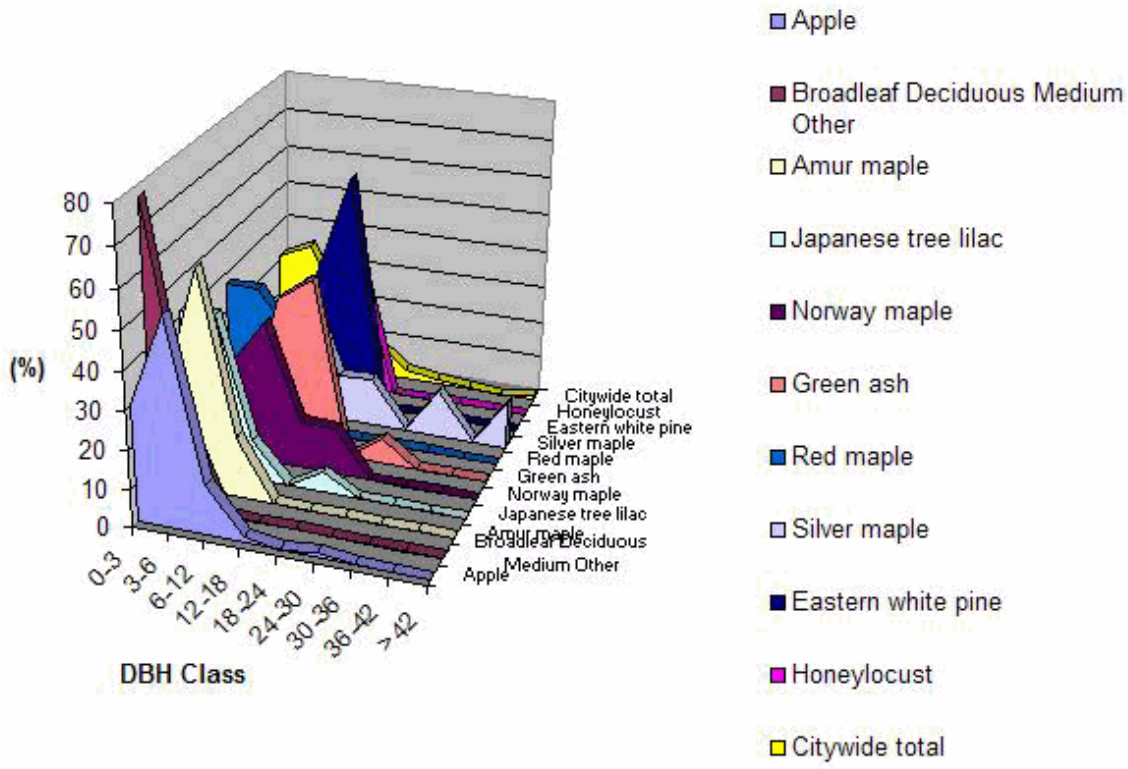


Species	Percent
Apple	29.8
Broadleaf Deciduous	13.7
Amur maple	7.5
Japanese tree lilac	7.5
Norway maple	6.3
Green ash	5.9
Red maple	3.1
Silver maple	3.1
Eastern white pine	3.1
Honeylocust	2.4
Other species	17.6
Total	100.0

Figure 1: Species Distribution

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

7/7/2009



	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Apple	30.3	53.9	13.2	1.3	0.0	1.3	0.0	0.0	0.0
Broadleaf Deciduous	77.1	22.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Amur maple	26.3	57.9	15.8	0.0	0.0	0.0	0.0	0.0	0.0
Japanese tree lilac	42.1	42.1	10.5	0.0	5.3	0.0	0.0	0.0	0.0
Norway maple	12.5	25.0	37.5	12.5	12.5	0.0	0.0	0.0	0.0
Green ash	0.0	6.7	40.0	46.7	0.0	6.7	0.0	0.0	0.0
Red maple	37.5	37.5	25.0	0.0	0.0	0.0	0.0	0.0	0.0
Silver maple	0.0	12.5	37.5	12.5	12.5	0.0	12.5	0.0	12.5
Eastern white pine	0.0	0.0	37.5	62.5	0.0	0.0	0.0	0.0	0.0
Honeylocust	16.7	16.7	33.3	33.3	0.0	0.0	0.0	0.0	0.0
Citywide total	31.0	34.9	18.0	10.2	2.7	1.6	0.4	0.0	1.2

Figure 2: Relative Age Class

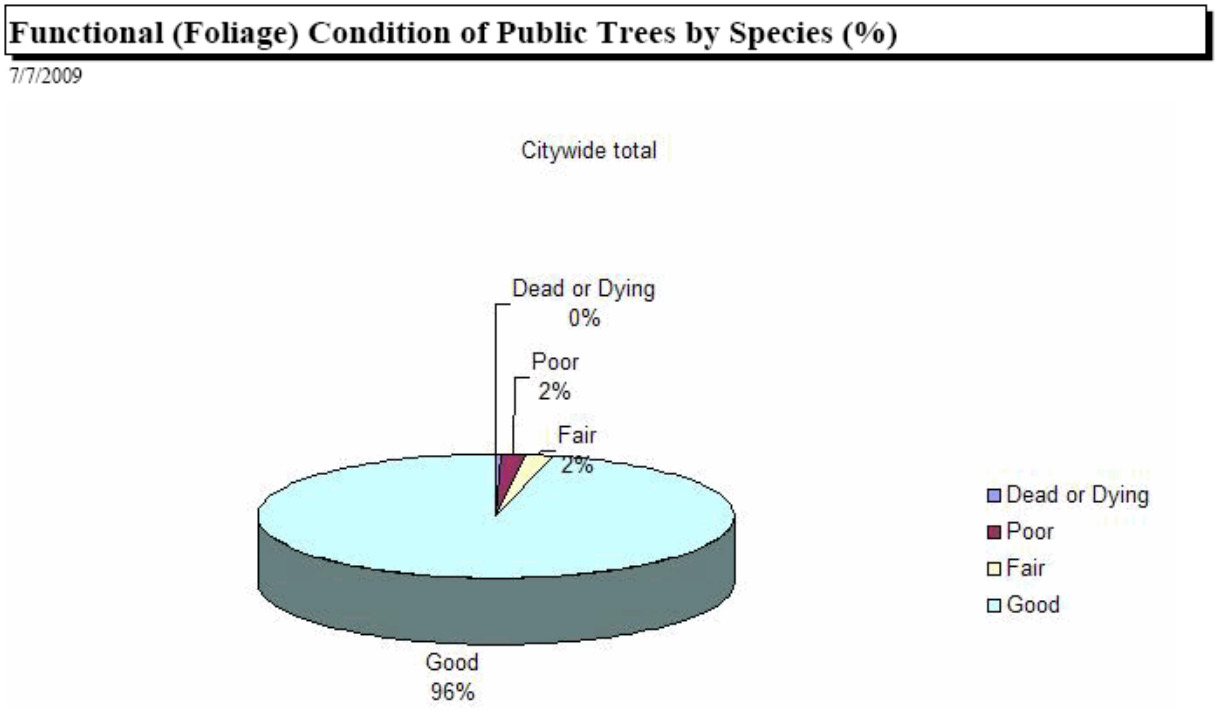


Figure 3: Foliage Condition

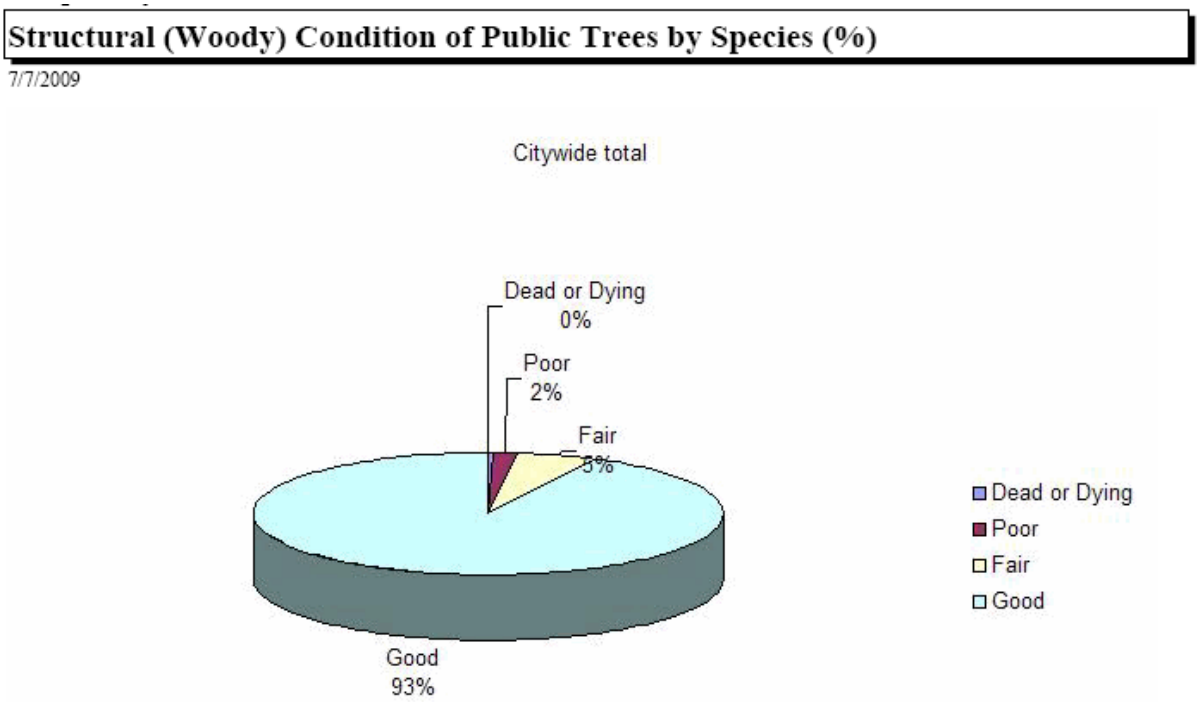
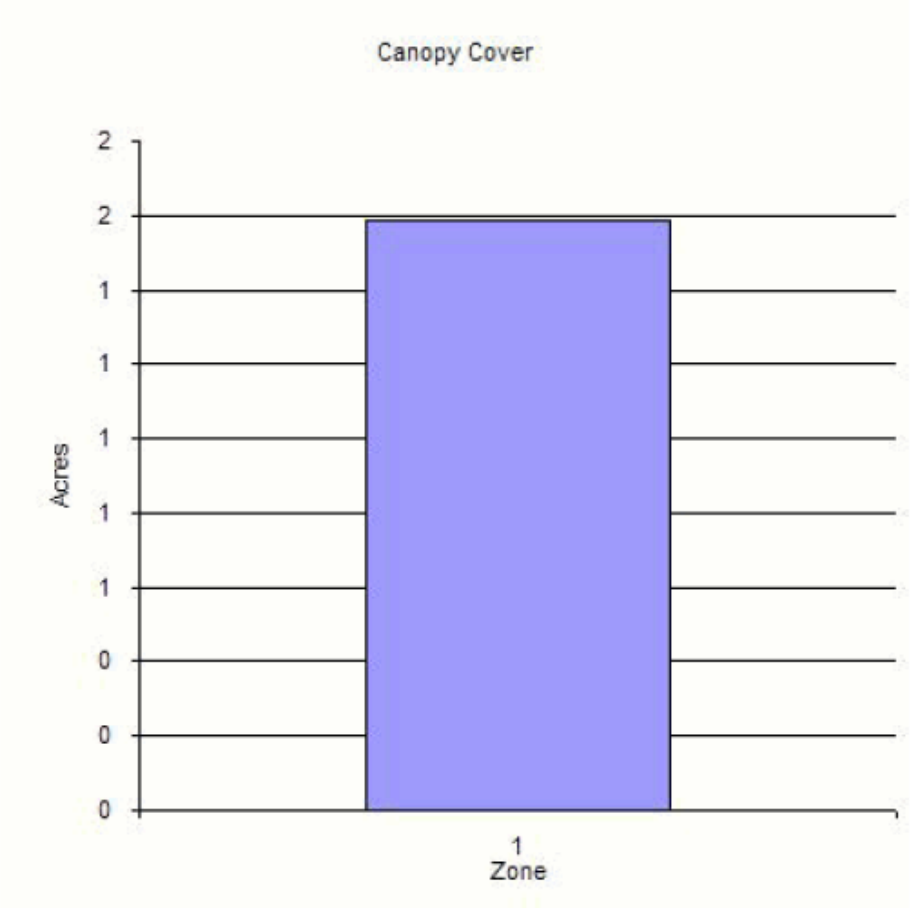


Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

7/7/2009



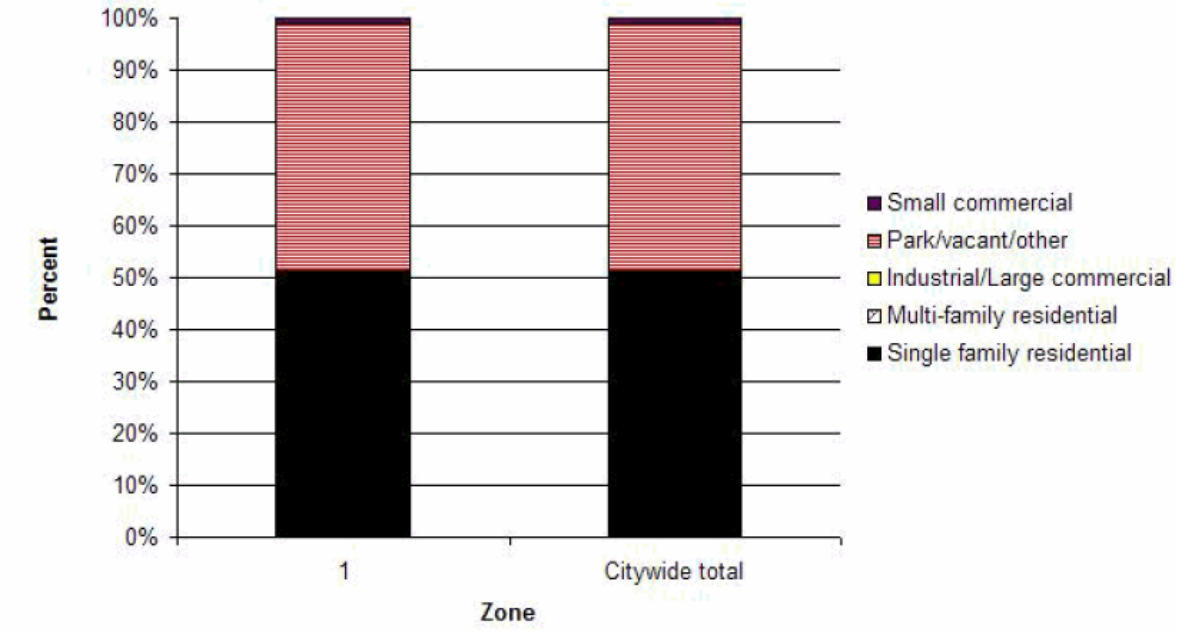
Zone	Acres	% of Total Canopy Cover
1	2	100.0
Citywide total	2	100.0

	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 (%)

7/7/2009

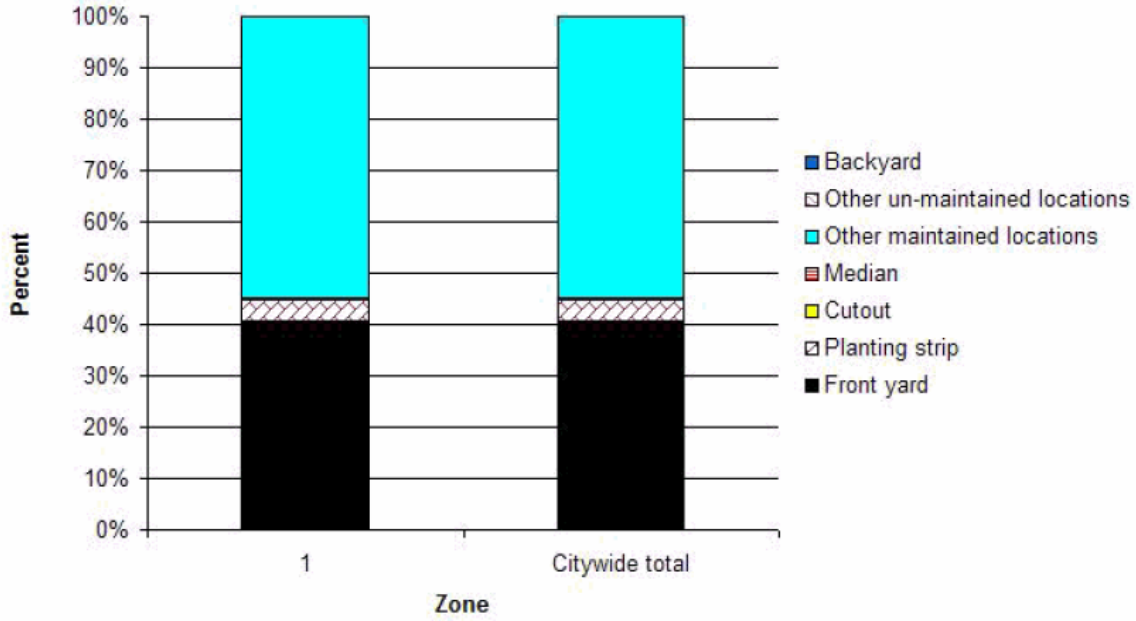


Zone	Single family residential	Multi-family residential	Industrial/ Large commercial	Park/vacant/ other	Small commercial
1	51.4	0.0	0.0	47.5	1.2
Citywide total	51.4	0.0	0.0	47.5	1.2

Figure 6: Land Use of city/park trees

Location of Public Trees by Zone (%)

7/7/2009



Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
1	40.9	3.9	0.0	0.4	54.9	0.0	0.0
Citywide total	40.9	3.9	0.0	0.4	54.9	0.0	0.0

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

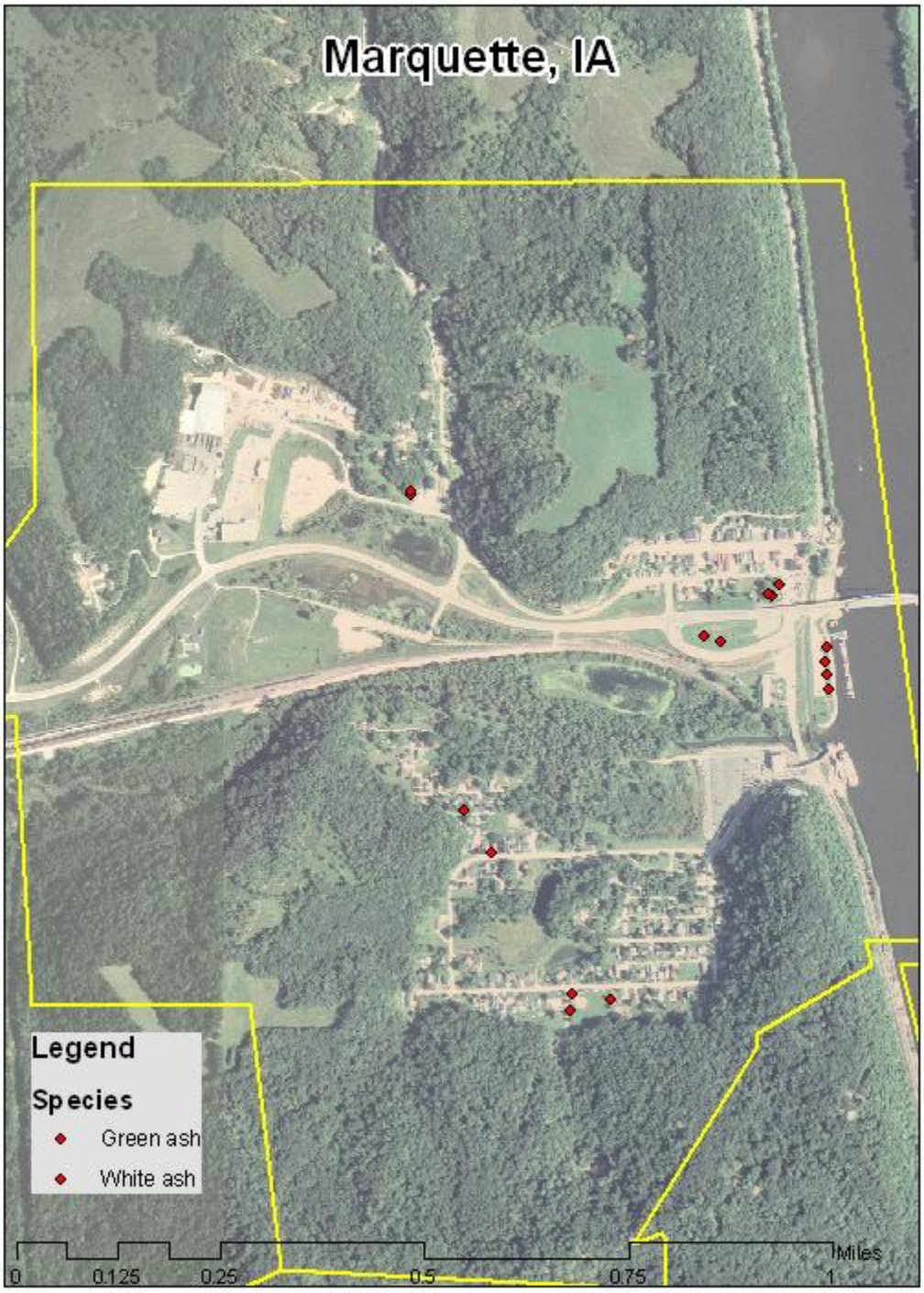


Figure 1: Location of Ash Trees

Figure 2: Location of EAB symptoms

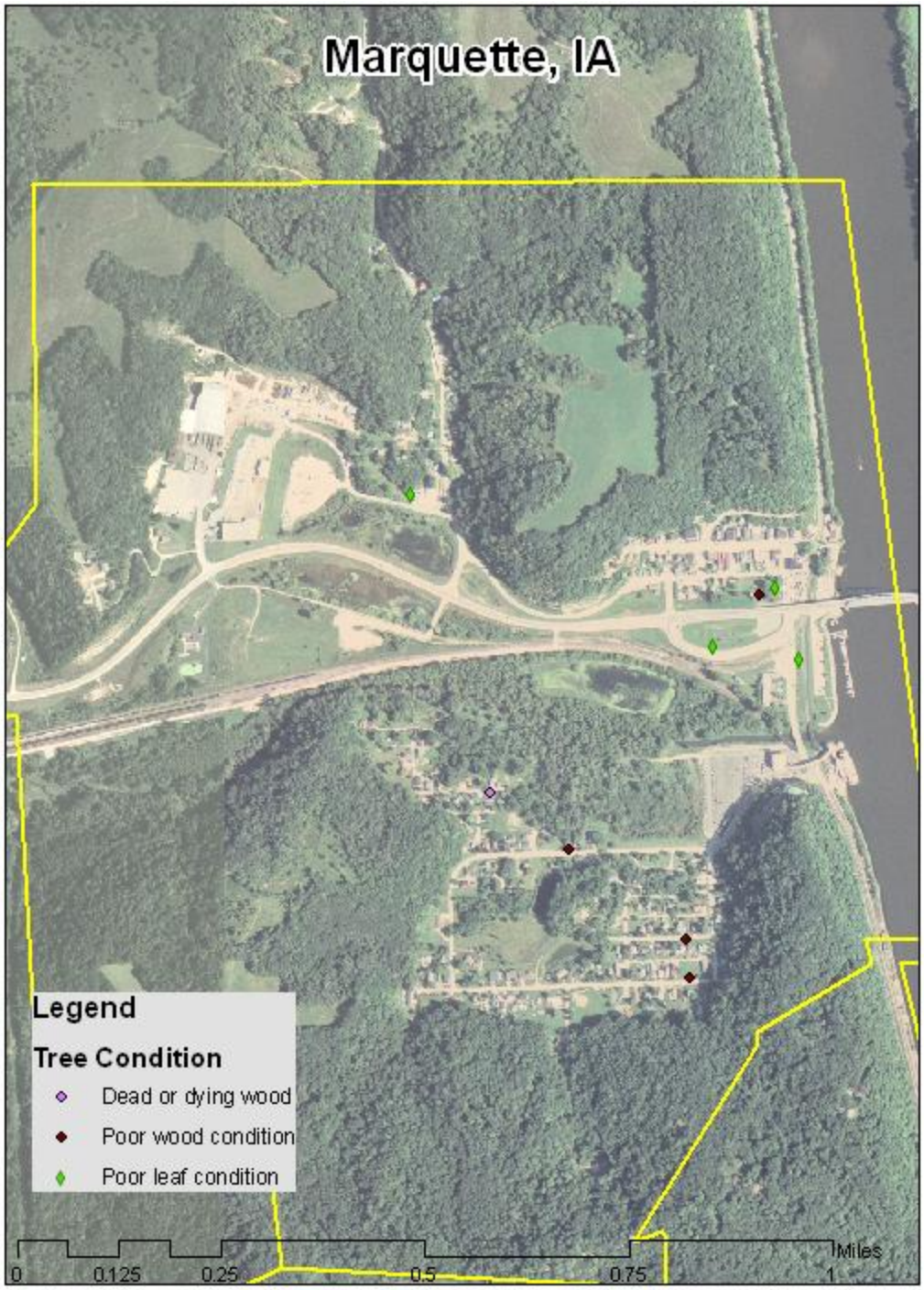


Figure 3: Location of Poor Condition Trees

Figure 4: Location of Trees with Recommended Maintenance

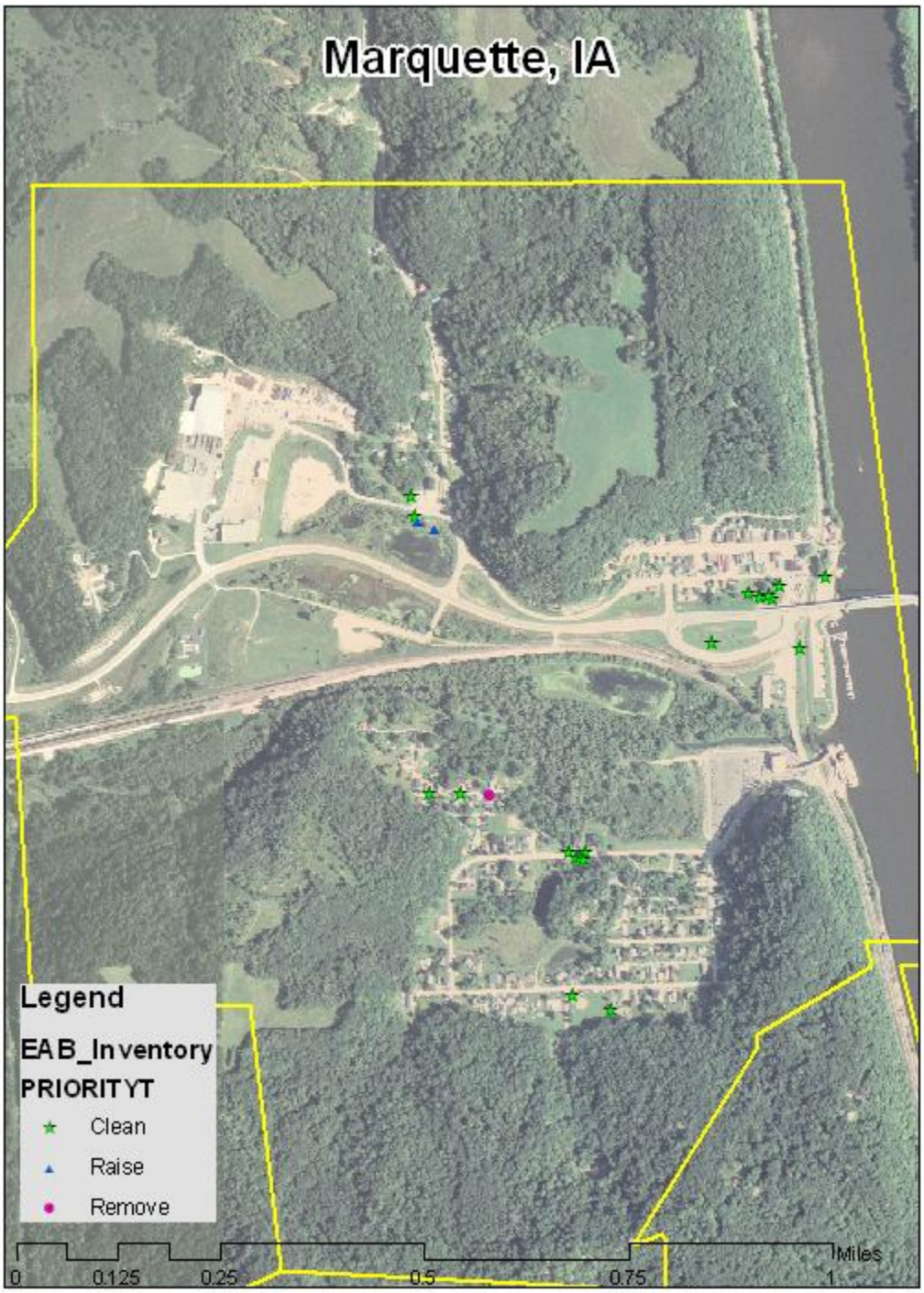


Figure 5: Maintenance Tasks *City ownership of the trees recommended for removal should be verified prior to any removal*

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