LANSING, IA

Lansing, IA

Legend

| 0 | 0.125 | 0.25 | 0.5 | 0.75 | 1 Miles |

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 Lansing 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 9% of Lansing'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 505 trees inventoried.

- Lansing's trees provide $74,205 of benefits annually, an average of $147 a tree
- There are over 43 species of trees
- The top three genus are: Maple-19%, Conifers-18%, and Hickory-15%
- 40% of trees are in need of some type of management
- 18 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 18 trees needing removal, 4 trees are over 24 inches in diameter at 4.5 ft and must be addressed immediately *City ownership of the trees recommended for removal should be verified prior to any removal*
- 8 of the 46 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, 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 Lansing 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 Lansing, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

Trees are an important component of Lansing'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 Lansing 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 Lansing'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 505 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. Lansing's trees reduce energy related costs by approximately $19,883 annually (Appendix A, Table 1). These savings are both in Electricity (96.3 MWh) and in Natural Gas (12,826.7 Therms).

Annual Stormwater Benefits

Lansing's trees intercept about 1,000,750 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $27,122 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 Lansing, it is estimated that trees remove 1,124 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 $3,082 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Lansing, trees sequester about 212,857 lbs of carbon a year with an associated value of $2,690 (Appendix A, Table 5). In addition, the trees store 3,268,025 lbs of carbon, with a yearly benefit of $24,510 (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. Lansing receives $21,428 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, Lansing's trees provide $74,205 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 505 trees in Lansing provide approximately $147 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Lansing has over 43 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
Maple	94	19
Conifers/Evergreens	90	18
Hickory	75	15
Black Walnut	66	13
Ash	46	9
Oak	41	8
Apple/Crabapple	20	4
Basswood/Linden	19	4
Cottonwood	13	3
Locust	7	1
Birch	6	1
Lilac	5	1
Hackberry	4	1
Willow	4	1
Catalpa	2	<1
Miscellaneous	13	
Total	505	

Age Class

Most of Lansing's trees (53%) are between 6 and 18 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 14 inches in diameter at 4.5 ft. Lansing'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 Lansing indicate that 90% of the trees are in good health, with only 4% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 77% of Lansing'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 9% of the population. This 9% 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	179	35%
Crown Raising	4	1%
Tree Staking	5	1%
Tree Removal	18	4%
Crown Reduction	2	<1%

Canopy Cover

The canopy cover of Lansing is approximately 10 acres (Appendix A, Figure 5).   According to the 2000 census, Lansing occupies 704 acres. Thus the canopy cover on city land is about 1.5%.

Land Use and Location

The majority of Lansing's city and park trees are in the city parks. (Appendix A, Figure 6 & Appendix A, Figure7). The following describes the land use and locations for the street and park trees.

Land Use

Park/vacant/other	73%
Single family residential	24%
Small commercial	3%
Multifamily residential	<1%

Location

Other maintained locations	71%
Planting strip	27%
Cutout (surrounded by pavement)	2%
Front yard	<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.

<u>Hazardous trees</u>
Lansing has 23 critical concern trees that need immediate removal. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). It is recommended to start with the large diameter critical concern trees first. There are 4 trees over 24 inches in diameter at 4.5 ft that should be addressed immediately. 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 11 trees with these needs.

<u>Poor tree species</u>
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). Of the 18 removals, 2 are ash trees. There are a total of 46 ash trees, and 8 of those have signs and symptoms that have been associated with EAB. Of the 18 removal trees, 17 trees are dead or dying, or have extreme 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 Lansing.

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 Maple (19%) and evergreens (18%) (Appendix A, Figure 1). Maples and evergreens 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. 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 they are infested with Emerald Ash Borer. Trees on private property are an important component of Lansing's urban forest. Private property owners should be educated as to the proper species to plant, proper location for new plantings, and proper maintenance of trees. The city tree ordinance for Lansing was developed in the 1960's in response to the Dutch Elm Disease. The ordinance needs to be updated so that citizens have valid guidelines to follow. I recommend that Lansing develop a new city tree ordinance. Emma Bruemmer, Urban Forester with the Iowa Department of Resources can help you develop a new tree ordinance for Lansing.

PROPOSED WORK SCHEDULE AND ESTIMATED COSTS

Year 1

Remove 9 critical concern trees, plus 2 ash trees $6,600
Plant 13 trees in open locations $2,600
Check for visual signs of Emerald Ash Borer

Year 2

Remove 9 critical concern trees and 2 ash trees $6,600
Plant 13 trees in open locations $2,600
Prune 1/3 of the city trees $2,500
Check for visual signs of EAB

Year 3

Remove 11 ash trees $6,600
Plant 13 trees in open locations $2,600
Check for visual signs of EAB

Year 4

Remove 11 ash trees $6,600
Plant 13 trees in open locations $2,600
Prune 1/3 of the city trees $2,500
Check for visual signs of EAB

Year 5

Remove 11 ash trees $6,600
Plant 13 trees in open locations $2,600
Check for visual signs of EAB

Year 6

Remove 7 ash trees $4,200
Plant 8 trees in open locations $1,600
Prune 1/3 of the city trees $2,500
Check for visual signs of EAB

Purposed Budget Increase

EAB could potentially kill all ash trees in Lansing within 4 years of its arrival. To remove all ash trees and critical concern trees, replant the open locations, and properly prune and maintain the trees in the city within 6 years, the budget would need to be increased to **$9,000 to $10,000** a year. It is recommended that Lansing 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.

Works Cited

Census Bureau. 2000. http://censtats.census.gov/data/IA/1601964290.pdf (April, 2010)

USDA Forest Service, et al. 2006. i-Tree Software Suite v1.0 User's Manual. Pp. 27-40.

McPherson EG, Simpson JR, Peper PJ, Gardner SL, Vargas KE, Ho J, Maco S, Xiao Q. 2005b. City of Charleston, South Carolina, municipal forest resource analysis. Internal Tech Rep. Davis, CA: U.S. Department of Agriculture, Center for Urban Forest Research. p. 57

Nowak, D.J. and J.F. Dwyer. 2007. Understanding the benefits and costs of urban forest ecosystems. In: Kuser, J. (ed.) Urban and Community Forestry in the Northeast. New York: Springer. Pp. 25-46.

Peper, Paula J.; McPherson, E. Gregory; Simpson, James R.; Vargas, Kelaine E.; Xiao, Qingfu 2009. Lower Midwest community tree guide: benefits, costs, and strategic planting. Gen. Tech. Rep. PSW-GTR-219. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. p.115

Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Annual Energy Benefits of Public Trees by Species
8/17/2010

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Hickory	12.8	973	1,626.6	1,594	2,567	(N/A)	14.9	12.9	34.23
Black walnut	14.9	1,130	1,923.9	1,885	3,016	(N/A)	13.1	15.2	45.69
Eastern white pine	8.8	669	1,156.0	1,133	1,802	(N/A)	12.9	9.1	27.72
Green ash	7.9	599	1,007.5	987	1,587	(N/A)	8.1	8.0	38.70
Sugar maple	5.7	435	737.4	723	1,158	(N/A)	5.4	5.8	42.89
Silver maple	7.7	581	999.8	980	1,561	(N/A)	4.4	7.9	70.95
Norway maple	5.0	382	728.9	714	1,097	(N/A)	4.2	5.5	52.23
Red maple	2.5	186	336.4	330	516	(N/A)	4.0	2.6	25.80
Apple	0.6	46	98.5	97	143	(N/A)	4.0	0.7	7.14
White oak	4.6	347	641.6	629	976	(N/A)	2.8	4.9	69.72
Eastern cottonwood	4.3	329	574.8	563	892	(N/A)	2.6	4.5	68.62
Bur oak	3.6	275	477.4	468	743	(N/A)	2.6	3.7	57.17
Pin oak	3.5	267	471.3	462	728	(N/A)	2.6	3.7	56.03
Littleleaf linden	1.5	114	198.4	194	309	(N/A)	2.4	1.6	25.74
Eastern red cedar	1.0	75	147.4	144	220	(N/A)	2.0	1.1	21.95
Honeylocust	1.5	110	207.9	204	314	(N/A)	1.4	1.6	44.88
American basswood	2.3	178	339.3	333	510	(N/A)	1.4	2.6	72.90
Northern white cedar	0.0	2	4.0	4	6	(N/A)	1.2	0.0	0.93
Other street trees	8.1	612	1,149.6	1,127	1,739	(N/A)	10.5	8.7	32.80
Citywide total	96.3	7,312	12,826.7	12,570	19,883	(N/A)	100.0	100.0	39.37

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees by Species
8/17/2010

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Hickory	88,247	2,392	(N/A)	14.9	8.8	31.89
Black walnut	118,798	3,220	(N/A)	13.1	11.9	48.78
Eastern white pine	174,631	4,733	(N/A)	12.9	17.5	72.81
Green ash	60,699	1,645	(N/A)	8.1	6.1	40.12
Sugar maple	52,281	1,417	(N/A)	5.4	5.2	52.48
Silver maple	116,694	3,163	(N/A)	4.4	11.7	143.76
Norway maple	45,563	1,235	(N/A)	4.2	4.6	58.80
Red maple	16,619	450	(N/A)	4.0	1.7	22.52
Apple	2,069	56	(N/A)	4.0	0.2	2.80
White oak	59,755	1,619	(N/A)	2.8	6.0	115.68
Eastern cottonwood	56,525	1,532	(N/A)	2.6	5.7	117.84
Bur oak	35,430	960	(N/A)	2.6	3.5	73.86
Pin oak	35,159	953	(N/A)	2.6	3.5	73.30
Littleleaf linden	9,155	248	(N/A)	2.4	0.9	20.68
Eastern red cedar	14,394	390	(N/A)	2.0	1.4	39.01
Honeylocust	11,224	304	(N/A)	1.4	1.1	43.45
American basswood	30,446	825	(N/A)	1.4	3.0	117.88
Northern white cedar	292	8	(N/A)	1.2	0.0	1.32
Other street trees	72,770	1,972	(N/A)	10.5	7.3	37.21
Citywide total	1,000,750	27,122	(N/A)	100.0	100.0	53.71

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees by Species

8/17/2010

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							
Hickory	6.5	1.0	3.9	0.3	37	60.0	8.8	8.4	58.1	377	0.0	0	147.2	414 (N/A)	14.9	5.52
Black walnut	10.9	1.7	5.9	0.5	60	70.1	10.3	9.8	67.5	439	0.0	0	176.7	499 (N/A)	13.1	7.56
Eastern white pine	20.6	4.1	16.7	2.5	135	41.5	6.1	5.8	39.9	260	-89.8	-337	47.4	58 (N/A)	12.9	0.89
Green ash	5.4	0.9	3.0	0.2	30	37.0	5.4	5.2	35.8	232	0.0	0	93.0	262 (N/A)	8.1	6.40
Sugar maple	6.8	1.2	3.5	0.3	37	26.9	4.0	3.8	26.0	169	-5.5	-21	66.9	185 (N/A)	5.3	6.87
Silver maple	22.1	3.7	10.7	1.0	119	36.0	5.3	5.0	34.6	226	-12.0	-45	106.6	300 (N/A)	4.4	13.62
Norway maple	9.1	1.6	4.5	0.4	49	24.4	3.5	3.4	22.9	151	-2.1	-8	67.6	192 (N/A)	4.2	9.17
Red maple	3.2	0.5	1.6	0.1	17	11.7	1.7	1.6	11.1	73	-1.2	-4	30.5	86 (N/A)	4.0	4.29
Apple	0.4	0.1	0.2	0.0	2	3.0	0.4	0.4	2.8	19	0.0	0	7.3	21 (N/A)	4.0	1.04
White oak	8.1	1.3	3.7	0.4	43	22.0	3.2	3.0	20.7	137	0.0	0	62.5	180 (N/A)	2.8	12.82
Eastern cottonwood	9.0	1.4	4.0	0.4	47	20.5	3.0	2.9	19.6	128	0.0	0	60.9	175 (N/A)	2.6	13.48
Bur oak	4.0	0.6	2.0	0.2	22	17.2	2.5	2.4	16.4	107	0.0	0	45.4	129 (N/A)	2.6	9.92
Pin oak	5.8	1.0	3.1	0.3	32	16.7	2.4	2.3	15.9	104	-11.1	-41	36.5	95 (N/A)	2.6	7.29
Littleleaf linden	1.0	0.2	0.6	0.0	6	7.1	1.0	1.0	6.8	45	-0.6	-2	17.3	48 (N/A)	2.4	4.02
Eastern red cedar	2.9	0.6	2.3	0.4	19	4.8	0.7	0.7	4.5	30	-7.9	-30	8.8	19 (N/A)	2.0	1.87
Honeylocust	1.9	0.3	0.9	0.1	10	7.0	1.0	1.0	6.6	43	-1.3	-5	17.5	49 (N/A)	1.4	6.99
American basswood	4.5	0.8	2.2	0.2	24	11.4	1.6	1.6	10.6	70	-3.7	-14	29.1	81 (N/A)	1.4	11.51
Northern white cedar	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	-0.1	0	0.1	0 (N/A)	1.2	0.05
Other street trees	13.4	2.3	7.0	0.7	73	38.9	5.6	5.4	36.5	241	-6.6	-25	103.1	290 (N/A)	10.5	5.47
Citywide total	135.5	23.3	75.8	8.0	762	456.5	66.7	63.7	436.6	2,852	-141.9	-532	1,124.2	3,082 (N/A)	100.0	6.10

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees by Species

8/17/2010

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Hickory	222,200	1,667	(N/A)	14.9	6.8	22.22
Black walnut	355,195	2,664	(N/A)	13.1	10.9	40.36
Eastern white pine	223,519	1,676	(N/A)	12.9	6.8	25.79
Green ash	180,839	1,356	(N/A)	8.1	5.5	33.08
Sugar maple	202,843	1,521	(N/A)	5.4	6.2	56.35
Silver maple	560,462	4,203	(N/A)	4.4	17.2	191.07
Norway maple	149,541	1,122	(N/A)	4.2	4.6	53.41
Red maple	37,375	280	(N/A)	4.0	1.1	14.02
Apple	7,293	55	(N/A)	4.0	0.2	2.74
White oak	264,939	1,987	(N/A)	2.8	8.1	141.93
Eastern	303,742	2,278	(N/A)	2.6	9.3	175.24
Bur oak	130,836	981	(N/A)	2.6	4.0	75.48
Pin oak	152,915	1,147	(N/A)	2.6	4.7	88.22
Littleleaf linden	24,309	182	(N/A)	2.4	0.7	15.19
Eastern red cedar	9,371	70	(N/A)	2.0	0.3	7.03
Honeylocust	23,860	179	(N/A)	1.4	0.7	25.56
American	169,474	1,271	(N/A)	1.4	5.2	181.58
Northern white	15	0	(N/A)	1.2	0.0	0.02
Other street trees	113,079	1,870	(N/A)	10.5	7.6	35.28
Citywide total	3,268,025	24,510	(N/A)	100.0	100.0	48.54

Table 5: Annual Carbon Sequestered

Annual CO$_2$ Benefits of Public Trees by Species
8/17/2010

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
Hickory	26,550	199	-1,067	-15	-8	21,501	161	46,970	352 (N/A)	14.9	13.1	4.70
Black walnut	32,492	244	-1,705	-13	-13	24,976	187	55,750	418 (N/A)	13.1	15.5	6.34
Eastern white pine	10,288	77	-1,073	-13	-8	14,786	111	23,989	180 (N/A)	12.9	6.7	2.77
Green ash	16,574	124	-868	-8	-7	13,247	99	28,944	217 (N/A)	8.1	8.1	5.29
Sugar maple	11,233	84	-974	-5	-7	9,619	72	19,873	149 (N/A)	5.4	5.5	5.52
Silver maple	36,537	274	-2,690	-4	-20	12,842	96	46,685	350 (N/A)	4.4	13.0	15.92
Norway maple	6,855	51	-718	-4	-5	8,452	63	14,585	109 (N/A)	4.2	4.1	5.21
Red maple	3,985	30	-179	-4	-1	4,118	31	7,920	59 (N/A)	4.0	2.2	2.97
Apple	982	7	-35	-4	0	1,023	8	1,967	15 (N/A)	4.0	0.6	0.74
White oak	11,388	85	-1,272	-3	-10	7,677	58	17,791	133 (N/A)	2.8	5.0	9.53
Eastern cottonwood	8,587	64	-1,458	-3	-11	7,266	54	14,393	108 (N/A)	2.6	4.0	8.30
Bur oak	8,284	62	-628	-3	-5	6,086	46	13,739	103 (N/A)	2.6	3.8	7.93
Pin oak	11,451	86	-734	-3	-6	5,891	44	16,605	125 (N/A)	2.6	4.6	9.58
Littleleaf linden	3,971	30	-117	-2	-1	2,529	19	6,381	48 (N/A)	2.4	1.8	3.99
Eastern red cedar	251	2	-45	-2	0	1,659	12	1,863	14 (N/A)	2.0	0.5	1.40
Honeylocust	3,615	27	-115	-1	-1	2,439	18	5,938	45 (N/A)	1.4	1.7	6.36
American basswood	9,304	70	-813	-1	-6	3,930	29	12,419	93 (N/A)	1.4	3.5	13.31
Northern white cedar	21	0	0	-1	0	36	0	56	0 (N/A)	1.2	0.0	0.07
Other street trees	10,488	79	-1,197	-10	-9	13,524	101	22,805	171 (N/A)	10.5	6.4	3.23
Citywide total	212,857	1,596	-15,687	-98	-118	161,601	1,212	358,673	2,690 (N/A)	100.0	100.0	5.33

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees by Species
8/17/2010

| Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Hickory	2,897	(N/A)	14.9	13.5	38.62
Black walnut	3,136	(N/A)	13.1	14.6	47.52
Eastern white pine	2,127	(N/A)	12.9	9.9	32.73
Green ash	1,696	(N/A)	8.1	7.9	41.37
Sugar maple	1,235	(N/A)	5.4	5.8	45.73
Silver maple	2,658	(N/A)	4.4	12.4	120.83
Norway maple	665	(N/A)	4.2	3.1	31.67
Red maple	597	(N/A)	4.0	2.8	29.86
Apple	51	(N/A)	4.0	0.2	2.57
White oak	849	(N/A)	2.8	4.0	60.67
Eastern cottonwood	649	(N/A)	2.6	3.0	49.94
Bur oak	713	(N/A)	2.6	3.3	54.81
Pin oak	961	(N/A)	2.6	4.5	73.89
Littleleaf linden	473	(N/A)	2.4	2.2	39.43
Eastern red cedar	97	(N/A)	2.0	0.5	9.74
Honeylocust	710	(N/A)	1.4	3.3	101.39
American basswood	617	(N/A)	1.4	2.9	88.17
Northern white cedar	35	(N/A)	1.2	0.2	5.76
Other street trees	1,261	(N/A)	10.5	5.9	23.80
Citywide total	21,428	(N/A)	100.0	100.0	42.43

Table 7: Summary of Benefits in Dollars

Total Annual Benefits of Public Trees by Species ($)
8/17/201

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Hickory	2,567	352	414	2,392	2,897	8,622	(±0)	11.6
Black walnut	3,016	418	499	3,220	3,136	10,288	(±0)	13.9
Eastern white pine	1,802	180	58	4,733	2,127	8,900	(±0)	12.0
Green ash	1,587	217	262	1,645	1,696	5,407	(±0)	7.3
Sugar maple	1,158	149	185	1,417	1,235	4,144	(±0)	5.6
Silver maple	1,561	350	300	3,163	2,658	8,031	(±0)	10.8
Norway maple	1,097	109	192	1,235	665	3,298	(±0)	4.4
Red maple	516	59	86	450	597	1,709	(±0)	2.3
Apple	143	15	21	56	51	286	(±0)	0.4
White oak	976	133	180	1,619	849	3,758	(±0)	5.1
Eastern cottonwood	892	108	175	1,532	649	3,356	(±0)	4.5
Bur oak	743	103	129	960	713	2,648	(±0)	3.6
Pin oak	728	125	95	953	961	2,861	(±0)	3.9
Littleleaf linden	309	48	48	248	473	1,126	(±0)	1.5
Eastern red cedar	220	14	19	390	97	740	(±0)	1.0
Honeylocust	314	45	49	304	710	1,422	(±0)	1.9
American basswood	510	93	81	825	617	2,126	(±0)	2.9
Northern white cedar	6	0	0	8	35	49	(±0)	0.1
Other street trees	1,739	171	290	1,972	1,261	5,433	(±0)	7.3
Citywide Total	19,882	2,690	3,082	27,122	21,428	74,205	(±0)	100.0

Figure 1: Species Distribution

Species Distribution of Public Trees (%)

8/17/2010
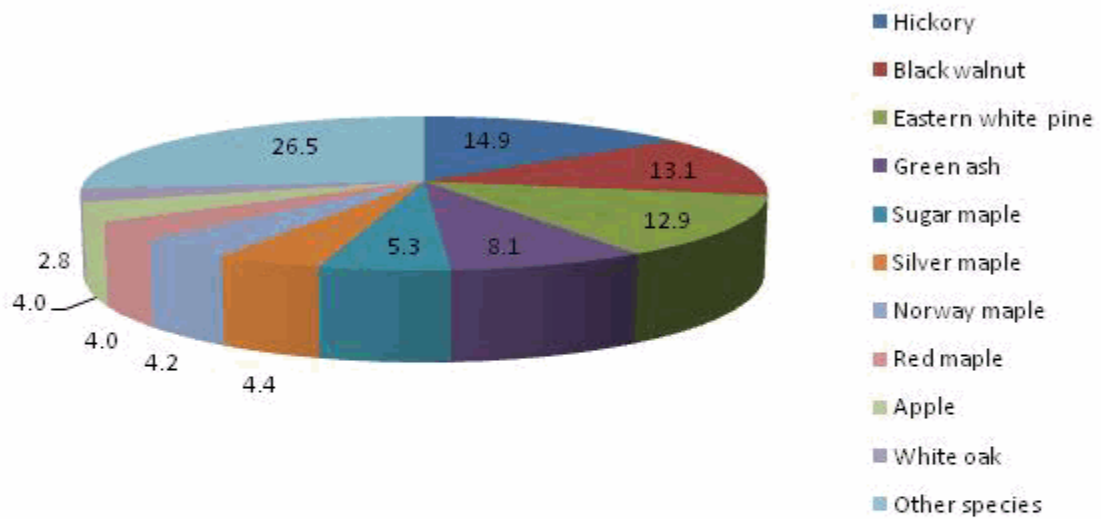
Species	Percent
Hickory	14.9
Black walnut	13.1
Eastern white pine	12.9
Green ash	8.1
Sugar maple	5.3
Silver maple	4.4
Norway maple	4.2
Red maple	4.0
Apple	4.0
White oak	2.8
Other species	26.5
Total	100.0

Figure 2: Relative Age Class

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

8/17/2010
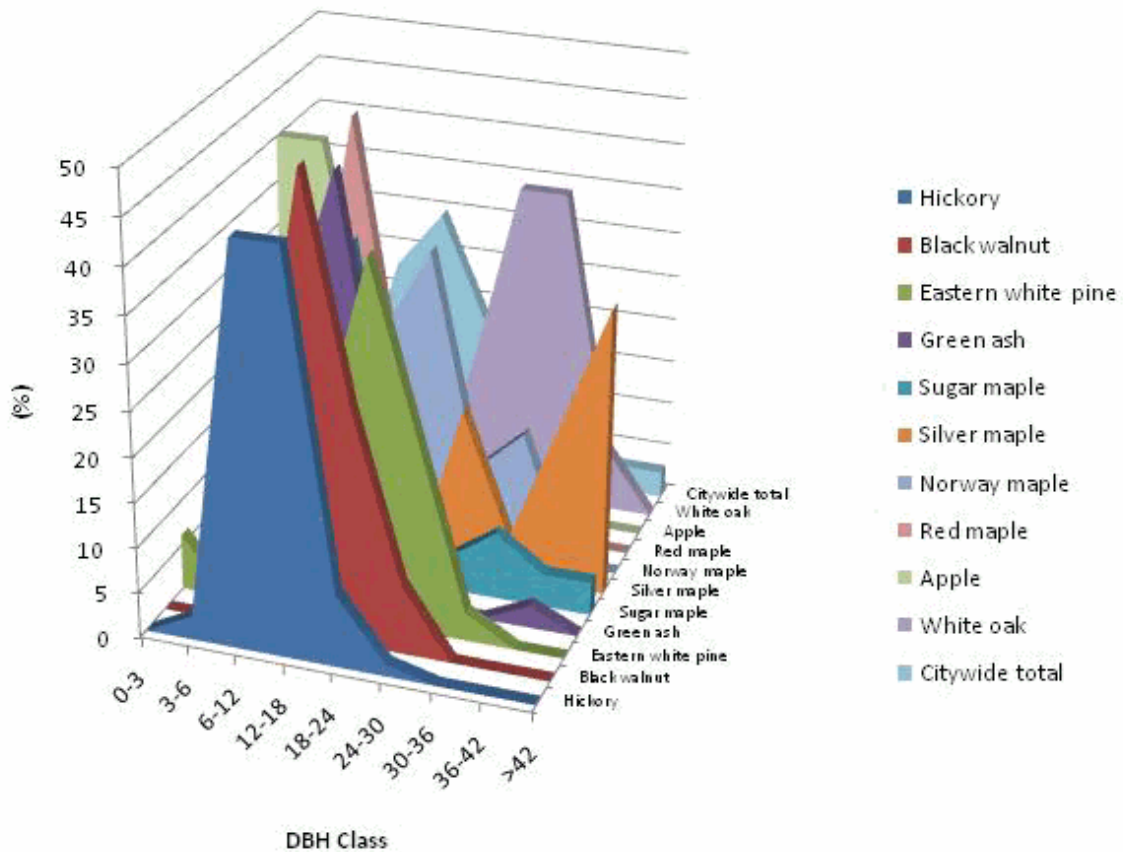
Species	DBH class (in)								
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Hickory	0.0	2.7	44.0	44.0	8.0	1.3	0.0	0.0	0.0
Black walnut	0.0	0.0	16.7	50.0	25.8	7.6	0.0	0.0	0.0
Eastern white pine	6.2	0.0	9.2	20.0	40.0	21.5	3.1	0.0	0.0
Green ash	2.4	2.4	29.3	46.3	17.1	0.0	0.0	2.4	0.0
Sugar maple	0.0	3.7	33.3	37.0	7.4	3.7	7.4	3.7	3.7
Silver maple	0.0	0.0	9.1	18.2	0.0	18.2	4.5	18.2	31.8
Norway maple	0.0	0.0	19.0	23.8	33.3	9.5	14.3	0.0	0.0
Red maple	15.0	15.0	45.0	15.0	5.0	5.0	0.0	0.0	0.0
Apple	40.0	40.0	15.0	5.0	0.0	0.0	0.0	0.0	0.0
White oak	0.0	7.1	0.0	0.0	14.3	35.7	35.7	7.1	0.0
Citywide total	5.5	4.8	23.2	29.7	17.8	8.5	4.6	3.0	3.0

Citywide total

Figure 3: Foliage Condition

Structural (Woody) Condition of Public Trees by Species (%)

8/17/2010
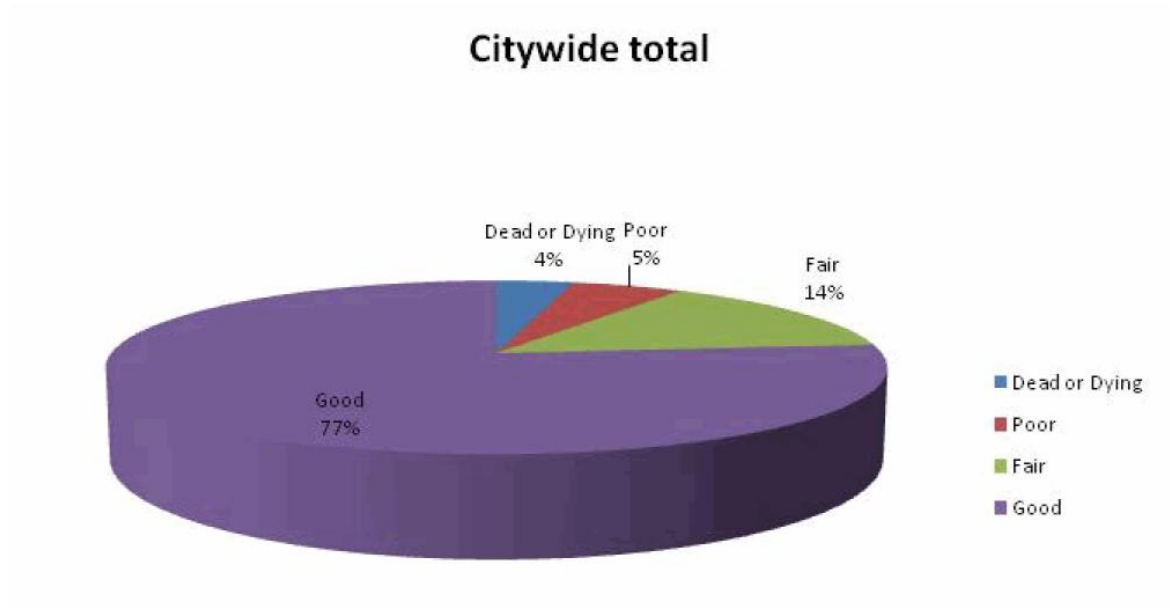
Citywide total

Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

8/17/2010
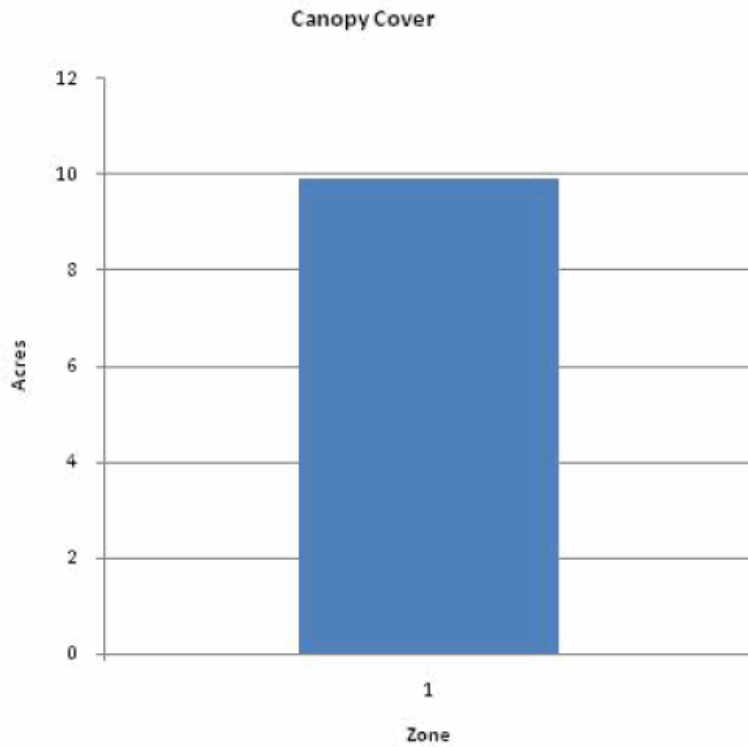
Zone	Acres	% of Total Canopy Cover
1	10	100.0
Citywide total	10	100.0

	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	10		

Figure 5: Canopy Cover in Acres

Land Use of Public Trees by Zone (%)

Zone	Single family residential	Multi-family residential	Industrial/ Large commercial	Park/vacant/ other	Small commercial
1	24.0	0.4	0.0	72.9	2.8
Citywide total	24.0	0.4	0.0	72.9	2.8

Figure 6: Land Use of city/park trees

Location of Public Trees by Zone (%)

8/17/2010

Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
1	0.4	26.5	2.0	0.0	70.9	0.2	0.0
Citywide total	0.4	26.5	2.0	0.0	70.9	0.2	0.0
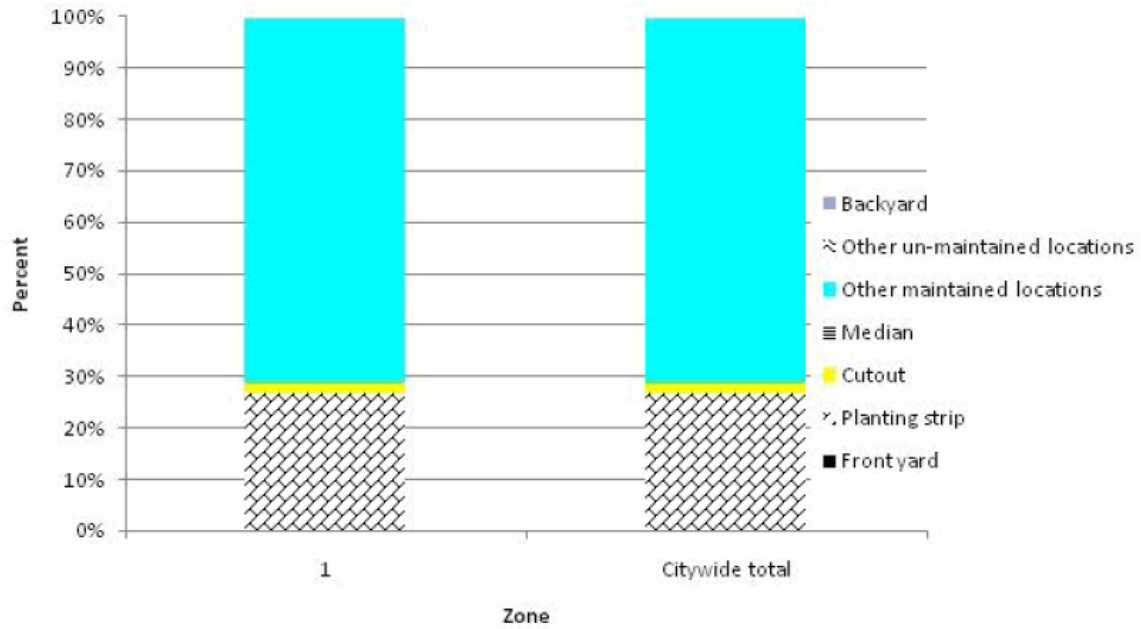
Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping
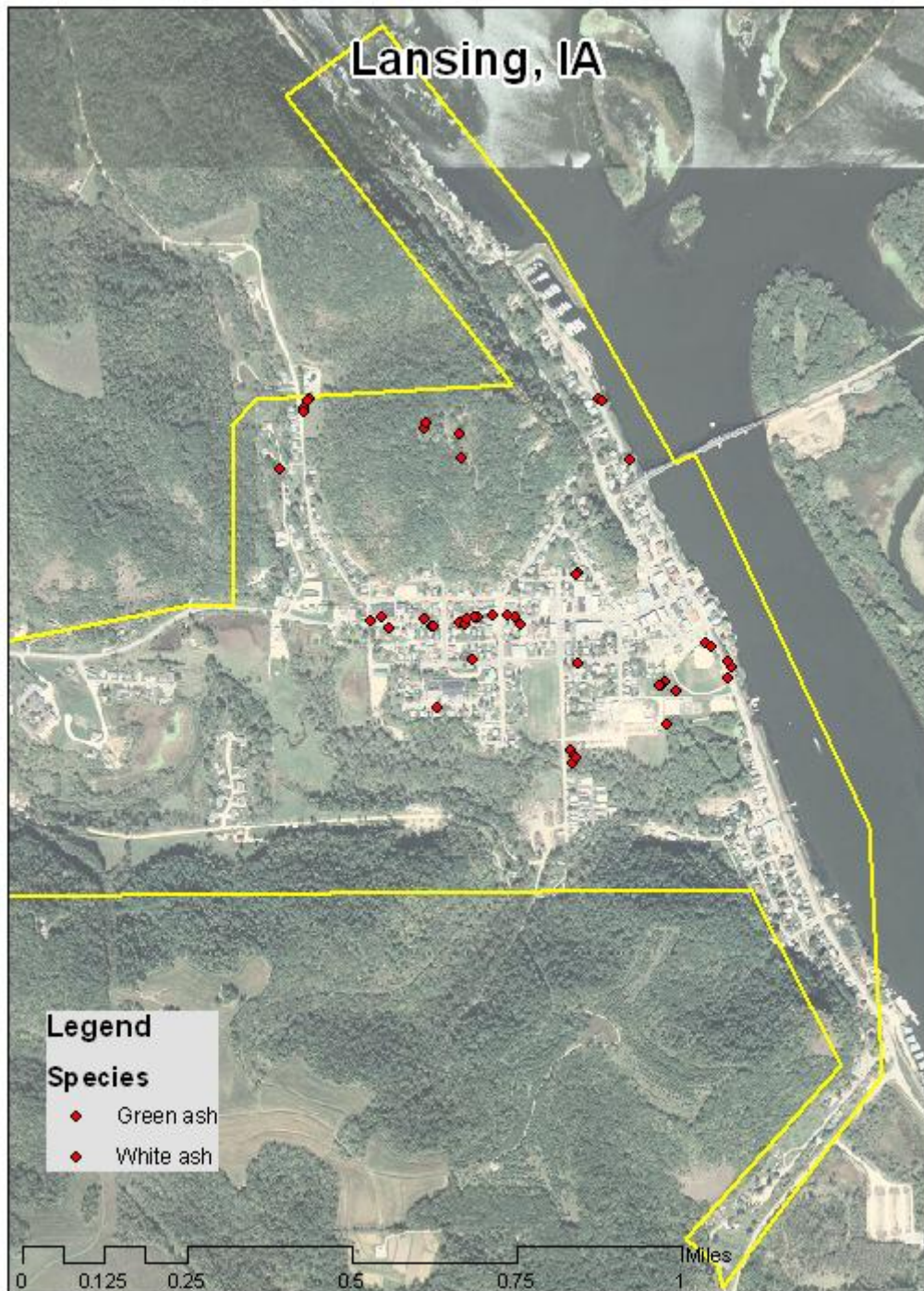
Figure 1: Location of Ash Trees
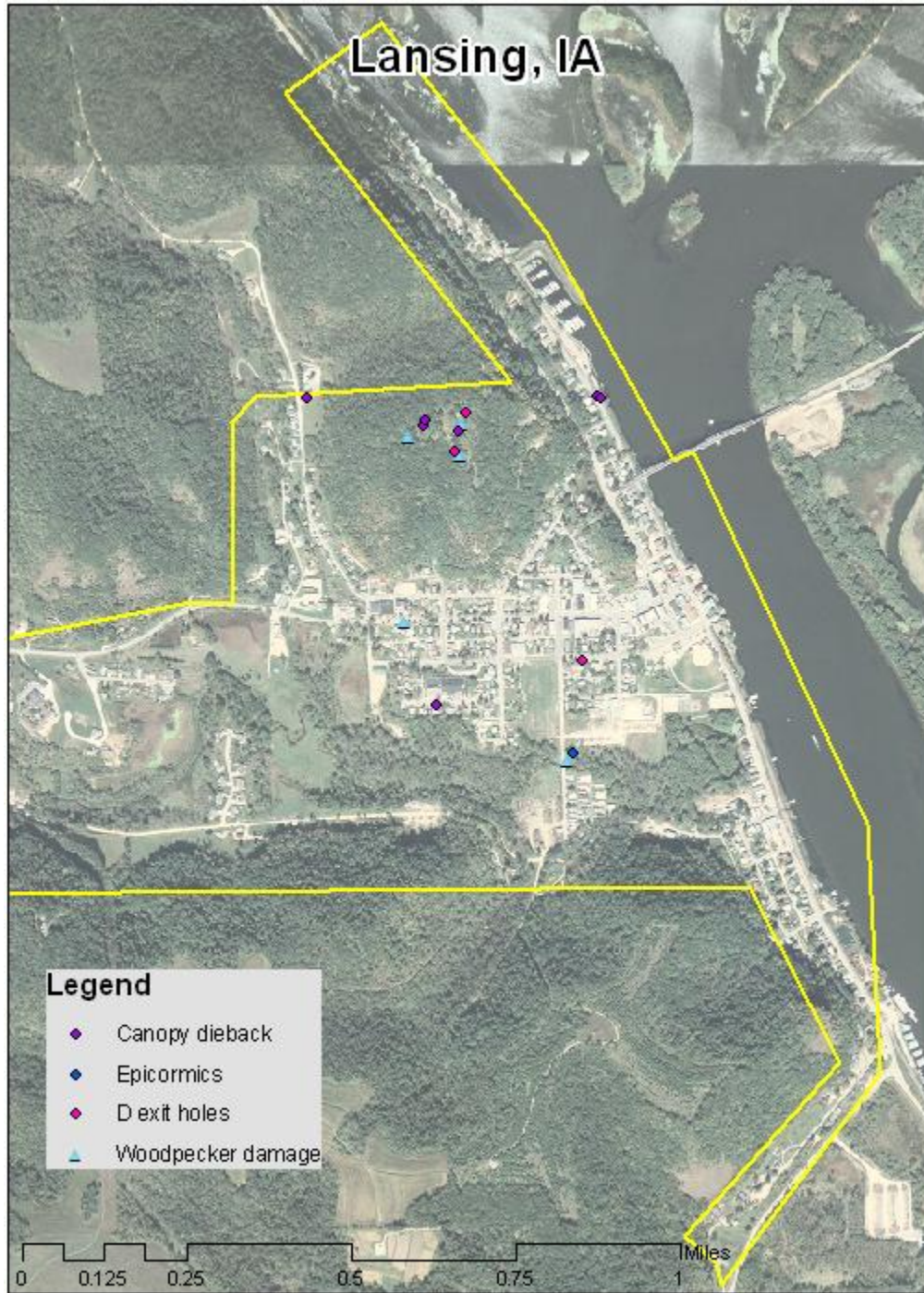
Figure 2: Location of EAB symptoms
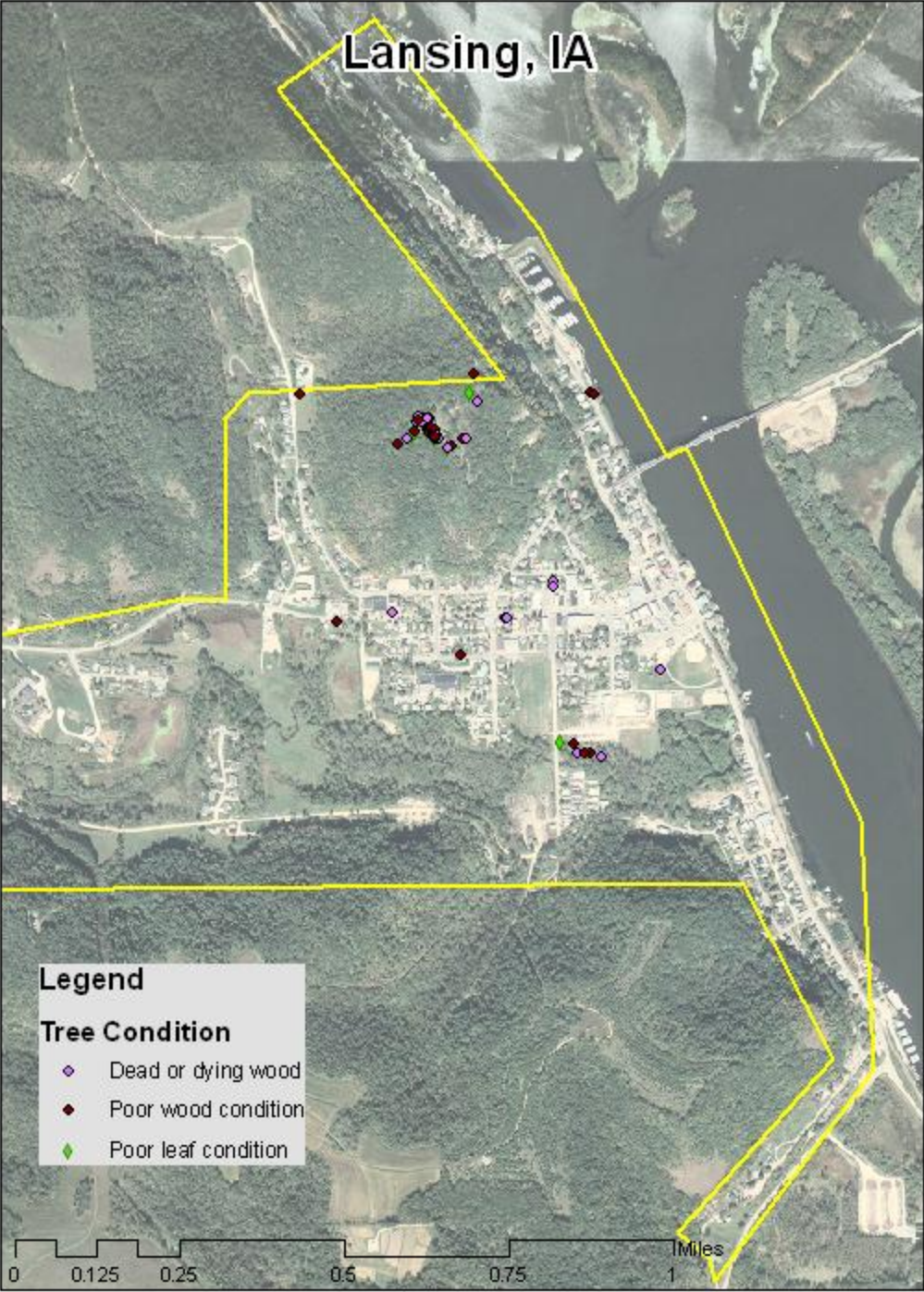
Figure 3: Location of Poor Condition Trees
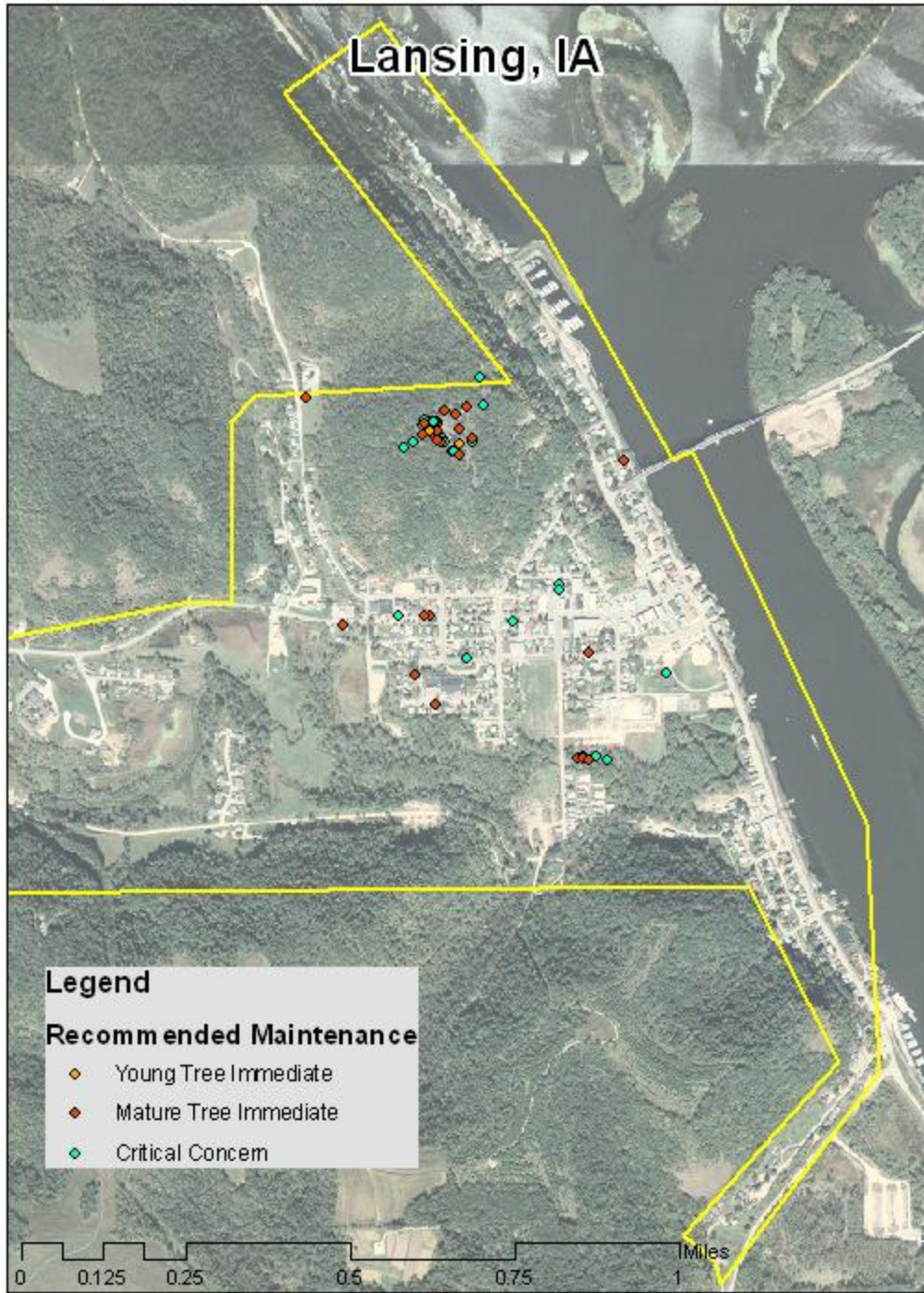
Figure 4: Location of Trees with Recommended Maintenance
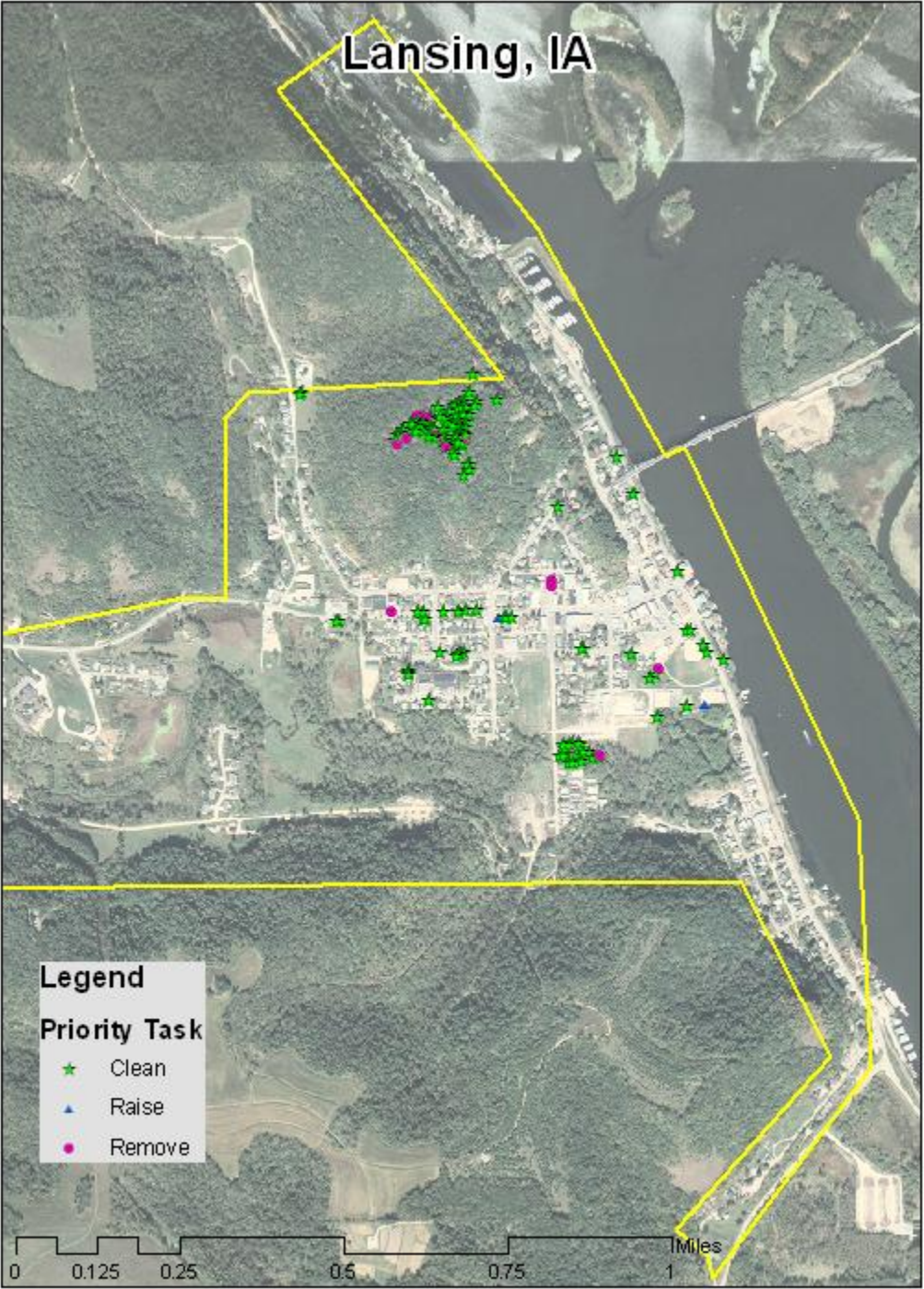
Figure 5: Maintenance Tasks *City ownership of the trees recommended for removal should be verified prior to any removal*