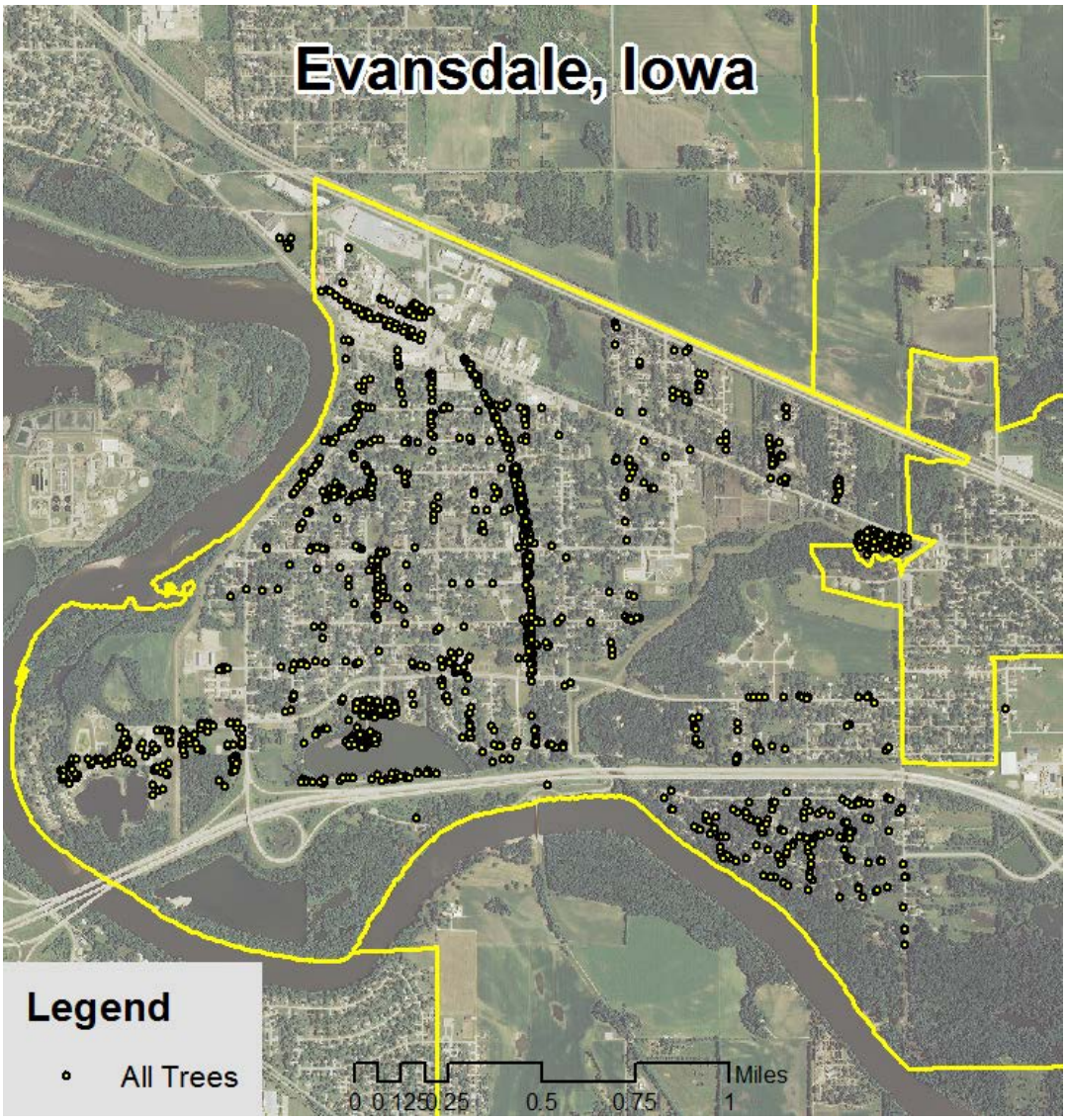
Evansdale, IA



2016 Urban Forest Management Plan
Prepared by Matt Brewer
Bureau of Forestry, Iowa DNR

Table of Contents

Executive Summary

Overview

This plan was developed to assist the City of Evansdale 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 16% of Evansdale's city owned trees (ash) will die once EAB becomes established in the community, unless preventative treatment is used. 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 2015, a tree inventory was conducted by Matt Brewer, Iowa DNR, 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 1,456 trees inventoried.

- Evansdale's trees provide $218,248 of benefits annually, an average of $150 a tree
- There are over 57 species of trees
- The top three genera are: Elm 19%, Maple 18%, and Ash 16%
- 8% of trees are in need of some type of management
- 33 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 33 trees needing removal, 7 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*
- 41 of the 238 ash trees should be carefully examined, as they have one or more symptoms that could be related to an EAB infestation
- 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, any fruit-bearing tree or any tree of the kinds commonly known as cottonwood, poplar, box elder, Chinese elm, evergreen, willow, or black walnut
- Check ash trees with a visual survey yearly
- With the current budget it could take 10 years to remove ash – Suggestion: request a budget increase to at least $35,700 annually and apply for grants to plant replacement trees

Introduction

This plan was developed to assist Evansdale 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 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 Evansdale, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

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

Inventory

In 2015, a tree inventory was conducted by Matt Brewer, Iowa DNR, 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 associated with 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 1,456 city trees was entered into the USDA Forest Service program i-Tree Streets, part of the i-Tree suite. The following are results from the i-Tree Streets analysis.

Annual Benefits

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Evansdale's trees reduce energy related costs by approximately $58,506 annually (Appendix A, Table 1). These savings are both in Electricity (279.3 MWh) and in Natural Gas (38,068.4 Therms).

Annual Stormwater Benefits

Evansdale's trees intercept about 3,027,285 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $82,039 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 matter (ozone). In Evansdale, it is estimated that trees remove 3,552.3 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 $10,007 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Evansdale, trees sequester about 667,539 lbs of carbon a year with an associated value of $5,007 (Appendix A, Table 4). In addition, the trees store 11,191,394 lbs of carbon, with a yearly benefit of $83,935 (Appendix A, Table 5).

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. Evansdale receives $59,602 in annual social benefits from trees (Appendix A, Table 6).

Financial Summary of all Benefits

According to the USDA Forest Service i-Tree Streets analysis, Evansdale's trees provide $218,248 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 1,456 trees in Evansdale provides approximately $150 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Evansdale has over 57 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Elm	279	19%
Maple	257	18%
Ash	238	16%
Oak	112	8%
Apple/Crabapple	82	6%
Aspen/Cottonwood	79	5%
Spruce	66	5%
Pear	41	3%
Pine	39	3%
Hackberry	38	3%
Black Walnut	31	2%
Northern White Cedar	31	2%
Linden/Basswood	31	2%
Honeylocust	23	2%
Eastern Red Cedar	18	1%
Birch	15	1%
Mulberry	8	1%
Cherry/Plum	8	1%
Willow	4	<1%
Catalpa	3	<1%
Eastern Redbud	3	<1%
Dogwood	3	<1%
Hickory	2	<1%
Kentucky Coffeetree	2	<1%
American Sycamore	2	<1%
Ohio Buckeye	1	<1%
Sumac	1	<1%
Black Locust	1	<1%
Lilac	1	<1%
Other Small Deciduous	17	1%
Other Large Evergreen	14	1%
Other Medium Deciduous	4	<1%
Other Medium Evergreen	1	<1%
Other Small Evergreen	1	<1%

Age Class

About a third of Evansdale's trees (33%) are between 18 and 36 inches in diameter at 4.5 ft (Appendix A, Figure 2). For age, it is preferred that a large number of trees are in the smallest size categories (a downward slope) to prepare for natural mortality and to maintain canopy cover. Evansdale will have an aging tree population as this 33% matures, and should consider new plantings (18% are under 6 inches in diameter) to develop the next generation of trees.

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 Evansdale indicate that 92% 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). Additionally, 79% of Evansdale'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 5% of the population. This 5% 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	93	6%
Tree Removal	33	2%

Canopy Cover

The total canopy with both private and public trees is 37% (981 acres). The canopy cover included in the Evansdale inventory includes approximately 32 acres (Appendix A, Figure 4).

Land Use and Location

The majority of Evansdale's city and park trees are in yard settings in 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	50%
Single family residential	43%
Small commercial	5%
Multifamily residential	2%

Location	
Front yard	94%
Planting strip	6%

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

Evansdale has 5 critical concern trees, 2 of which need immediate removal and 3 that need immediate cleaning. 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 5 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. There are a total of 126 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). Of the 33 removals, 9 are ash trees. There are a total of 238 ash trees, and 41 of those have signs and symptoms that have been associated with EAB. In addition, there are 25 ash trees that are in poor health. *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.

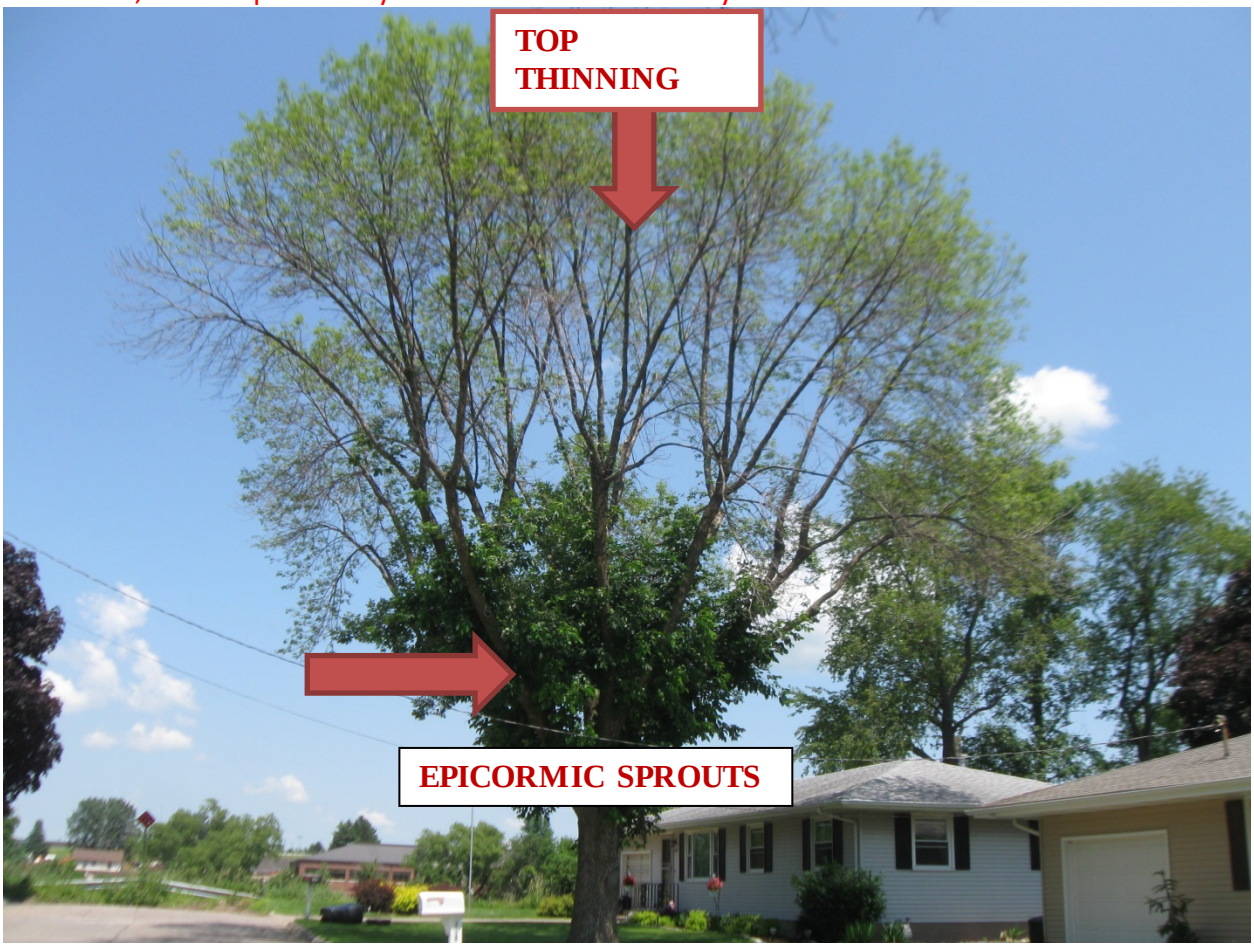
Planting

Most of the planting over the next 5 years will replace the trees that are removed. It is recommended to plant at least 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 or greater number of trees helps ensure continuation of the benefits of the existing forest in Evansdale.

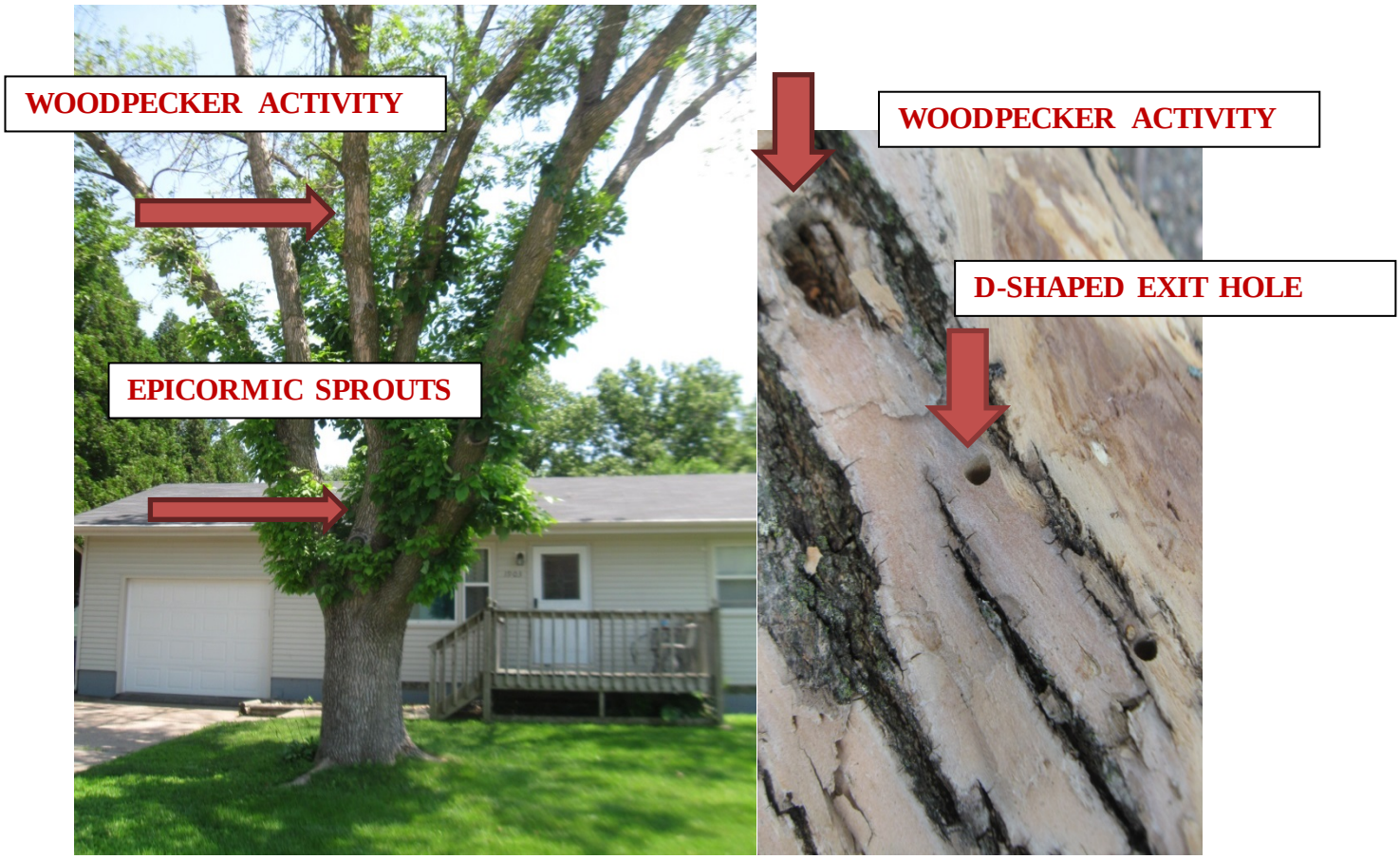
It is important to plant a diverse mix of species in the urban forest to maintain canopy health, since most insects and diseases target a genus (ash) or species (green ash) of trees. Current diversity recommendations advise that a genus (i.e. maple, oak) not make up more than 10% of the urban forest and a single species (i.e. silver maple, sugar maple, white oak, bur oak) not make up more than 5-10% of the total urban forest. Presently, the forest is heavily planted with maple (18%) (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: any fruit-bearing tree or any tree of the kinds commonly known as cottonwood, poplar, box elder, Chinese elm, evergreen, willow, or black walnut, as outlined in section 151.02 of the city ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance 151.02 (Appendix C).

Continual Monitoring For EAB

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 decline and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage (See examples below). Once EAB arrives in Evansdale, it could potentially kill all ash within 4 to 10 years of its arrival.



EAB infested tree in Muscatine with top thinning and many new green epicormic sprouts



EAB infested tree in Muscatine with sprouting, wood pecker activity, and D-shaped exit holes

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*

Treatment of Ash Trees

Chemical treatment can be an effective tool for communities to spread removal costs out over several years while allowing trees to continue to provide benefits. However, treatment is not recommended if EAB is more than 15 miles away from the community. For more information on the cost of treatment strategies visit http://extension.entm.purdue.edu/treecomputer/

EAB Quarantines

EAB is an extremely destructive plant pest and it is responsible for the death and decline of millions of 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.

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? The entire state of Iowa is under quarantine, so regulated articles may not be moved into non-quarantined states. For more information, please visit http://www.emeraldashborer.info/.

Canopy Replacement

As budget permits, all removed trees will be replaced. All trees will meet the restrictions in city ordinance 151.02 (Appendix C). The new plantings will be a diverse mix and will not include ash, maple, any fruit-bearing tree or any tree of the kinds commonly known as cottonwood, poplar, box elder, Chinese elm, evergreen, willow, or black walnut.

Postponed Work

While finances, staffing and equipment are focused on the management of ash, usual services may be delayed. Tree removal requests on genera 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 upon arrival of EAB. City Code 151.06 states "If it is determined with reasonable certainty that any such condition exists on private property and that danger to other trees or to adjoining property or passing motorists or pedestrians is imminent, the Council shall notify by certified mail the owner, occupant or person in charge of such property to correct such condition by treatment or removal within fourteen (14) days of said notification. If such owner, occupant, or person in charge of said property fails to comply within 14 days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property".

Six Year Maintenance Plan and Cost Estimates

Year 1 (FY 2016)

Remove 2 critical concern trees that need immediate attention	$1,800
Maintain 3 critical concern trees that need immediate attention (cleaning)	$900
Remove 15 trees (marked for removal)	$13,500
Plant and Maintain 21 trees in open locations (pursue grants)	$2,100
Ash tree treatment (if elected), 174 trees in good condition, average 18–24"	avg. $315/tree
-$15 per inch, treated every two years, see note	
*Or saving for future ash removal	
Visual Survey for signs and symptoms of EAB	

Year 2 (FY 2017)

Remove 16 trees (marked for removal)	$14,400
Plant and Maintain 20 trees in open locations (pursue grants)	$2,000
Ash tree treatment (if elected) or saving for future ash removal	
Routine trimming: Contract to trim 1/3 of the city trees (~$300 per tree)	
Visual Survey for signs and symptoms of EAB	

Year 3 (FY 2018)

Remove any new critical concern trees and ash in poor health	$900/tree
Plant and Maintain 25 trees in open locations (pursue grants)	$2,500
Ash tree treatment (if elected) or saving for future ash removal	
Visual Survey for signs and symptoms of EAB	

Year 4 (FY 2019)

Remove any new critical concern trees and ash in poor health	$900/tree
Plant and Maintain 25 trees in open locations (pursue grants)	$2,500
Ash tree treatment (if elected) or saving for future ash removal	
Routine trimming: Contract to trim 1/3 of the city trees (~$300 per tree)	
Visual Survey for signs and symptoms of EAB	

Year 5 (FY 2020)

Remove any new critical concern trees and ash in poor health	$900/tree
Plant and Maintain 25 trees in open locations (pursue grants)	$2,500
Ash tree treatment (if elected) or saving for future ash removal	
Visual Survey for signs and symptoms of EAB	

Year 6 (FY 2021)

Remove any new critical concern trees and ash in poor health	$900/tree
Plant and Maintain 25 trees in open locations (pursue grants)	$2,500
Ash tree treatment (if elected) or saving for future ash removal	
Routine trimming: Contract to trim 1/3 of the city trees (~$300 per tree)	
Visual Survey for signs and symptoms of EAB	

*****Reduction of ash in poor health will reduce exposure to Emerald Ash Borer over time. EAB could potentially kill all ash within 4-15 years of its arrival.
******Assuming a cost of $900 per tree for removal, the budget would need to be increased to $35,700 a year to remove all ash trees within 6 years.
*******Suggest a future (post ash removal and replacement) budget of at least $23,000. Currently, this amount would cover about 64% of what would be needed to remove EAB infested trees over a six year period. Suggest setting aside additional funds to prepare for the expected arrival of EAB. Planting would be at least partially dependent on receiving grant funds annually.

Proposed Budget Increase

EAB could potentially kill all ash trees in Evansdale within 4-15 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to $35,700 a year. If the budget stays at $23,000 a year and is dedicated almost entirely to ash removal, all ash could be removed within 10 years. Additionally, it is recommended that Evansdale 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.

Another option being considered by many communities is treating a number of selected trees, either to maintain those trees in the landscape or to delay their removal – to spread out the costs and number of trees needing removed all at once. Trunk injection is administered every two years for the life of the tree. If treatment is discontinued, the tree dies. For an example, if the average ash diameter is 20 inches and treatment costs $15 per inch, then treating 10 trees would cost about $3,000 (every other year treatment). This would be 10 trees selected for treatment, and Evansdale would still need to find $900 per tree for removal. Alternatively, if there are 15 treatable trees, it would cost approximately $4,500 every two years for treatment and leave five less trees for removal (for at least two more years). These are alternatives to straight removal of ash trees. However, whether or not the treatment option is selected, there will be an increased cost of dealing with ash trees if EAB is found in Evansdale. It is suggested to consider increasing the budget to plan for this.

Works Cited

Census Bureau. 2010. http://censtats.census.gov/data/IA/1601964290.pdf (April, 2013)

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

1/7/2016

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Siberian elm	59.8	4,537	7,991.4	7,832	12,369	(N/A)	17.5	21.1	48.50
Green ash	55.4	4,208	7,485.9	7,336	11,544	(N/A)	15.9	19.7	49.97
Silver maple	43.2	3,281	5,651.7	5,539	8,819	(N/A)	9.1	15.1	66.81
Apple	4.9	372	790.0	774	1,146	(N/A)	5.6	2.0	13.97
Spruce	2.8	212	416.0	408	619	(N/A)	3.8	1.1	11.26
Cottonwood	7.7	584	1,033.6	1,013	1,597	(N/A)	3.6	2.7	30.71
Norway maple	7.1	542	1,025.9	1,005	1,548	(N/A)	2.8	2.6	37.75
Pear	2.8	212	410.1	402	614	(N/A)	2.8	1.0	14.97
Northern hackberry	9.7	733	1,359.5	1,332	2,066	(N/A)	2.6	3.5	54.36
Oak	8.4	636	1,164.1	1,141	1,777	(N/A)	2.5	3.0	49.36
Northern white cedar	0.9	71	142.2	139	210	(N/A)	2.1	0.4	6.78
Black walnut	5.9	450	800.5	784	1,235	(N/A)	2.1	2.1	39.83
Maple	1.2	94	176.2	173	267	(N/A)	1.9	0.5	9.88
Eastern white pine	3.0	227	410.3	402	629	(N/A)	1.9	1.1	23.30
Bur oak	9.1	687	1,249.7	1,225	1,912	(N/A)	1.8	3.3	73.53
Quaking aspen	1.9	143	256.5	251	394	(N/A)	1.7	0.7	15.77
Elm	6.8	516	943.0	924	1,440	(N/A)	1.6	2.5	60.00
Honeylocust	4.3	329	572.7	561	891	(N/A)	1.6	1.5	38.73
White oak	7.3	554	1,023.8	1,003	1,557	(N/A)	1.6	2.7	67.70
Littleleaf linden	3.0	225	410.9	403	628	(N/A)	1.5	1.1	28.53
Red maple	1.3	97	181.6	178	275	(N/A)	1.3	0.5	14.49
Eastern red cedar	1.3	97	195.0	191	288	(N/A)	1.2	0.5	15.98
Sugar maple	3.9	295	525.0	515	810	(N/A)	1.2	1.4	45.00
Broadleaf Deciduous Small	0.8	60	116.7	114	175	(N/A)	1.2	0.3	10.28
Boxelder	3.6	271	482.6	473	744	(N/A)	1.0	1.3	49.58
Pin oak	5.0	382	673.1	660	1,042	(N/A)	1.0	1.8	69.45
Conifer Evergreen Large	1.9	143	249.6	245	388	(N/A)	1.0	0.7	27.69
Northern red oak	1.7	131	233.5	229	360	(N/A)	0.7	0.6	36.01
River birch	1.9	142	275.5	270	412	(N/A)	0.7	0.7	41.23
Blue spruce	0.8	61	103.6	101	162	(N/A)	0.7	0.3	16.24
American basswood	1.9	141	260.7	255	397	(N/A)	0.6	0.7	44.09
Scotch pine	0.6	45	86.2	85	130	(N/A)	0.5	0.2	16.22
Mulberry	0.8	64	134.0	131	196	(N/A)	0.5	0.3	24.47
White ash	0.8	58	99.3	97	155	(N/A)	0.5	0.3	22.18
Black cherry	1.1	80	164.0	161	241	(N/A)	0.4	0.4	40.15
Amur maple	0.2	19	42.9	42	61	(N/A)	0.3	0.1	12.17
Willow	0.5	36	71.2	70	105	(N/A)	0.3	0.2	26.35
Red pine	0.3	23	43.1	42	65	(N/A)	0.3	0.1	16.22
Broadleaf Deciduous Mediu	0.8	64	115.4	113	177	(N/A)	0.3	0.3	44.18
Birch	0.4	33	65.1	64	96	(N/A)	0.2	0.2	32.14
Eastern redbud	0.2	13	29.5	29	42	(N/A)	0.2	0.1	13.93
Catalpa	1.2	88	159.5	156	244	(N/A)	0.2	0.4	81.32
Dogwood	0.1	9	20.4	20	29	(N/A)	0.2	0.0	9.67
Kentucky coffeetree	0.4	32	60.6	59	92	(N/A)	0.1	0.2	45.77
Plum	0.2	16	28.5	28	44	(N/A)	0.1	0.1	21.77
Swamp white oak	0.3	26	46.3	45	71	(N/A)	0.1	0.1	35.62
Eastern cottonwood	0.9	66	118.0	116	182	(N/A)	0.1	0.3	91.02
American sycamore	0.4	32	60.6	59	92	(N/A)	0.1	0.2	45.77
Paper birch	0.3	20	30.7	30	50	(N/A)	0.1	0.1	25.02
Hickory	0.4	27	51.8	51	78	(N/A)	0.1	0.1	38.98
Norway spruce	0.1	4	9.5	9	14	(N/A)	0.1	0.0	13.58
Conifer Evergreen Small	0.0	4	7.9	8	11	(N/A)	0.1	0.0	11.47
Conifer Evergreen Medium	0.0	2	4.9	5	7	(N/A)	0.1	0.0	6.94
Black locust	0.0	0	0.8	1	1	(N/A)	0.1	0.0	1.10
Ohio buckeye	0.0	3	6.2	6	9	(N/A)	0.1	0.0	8.99
Sumac	0.0	0	0.6	1	1	(N/A)	0.1	0.0	0.87
Japanese tree lilac	0.0	0	0.6	1	1	(N/A)	0.1	0.0	0.87
Total	279.3	21,199	38,068.4	37,307	58,506	(N/A)	100.0	100.0	40.18

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees

1/7/2016

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Siberian elm	583,449	15,811	(N/A)	17.5	19.3	62.01
Green ash	546,682	14,815	(N/A)	15.9	18.1	64.13
Silver maple	630,372	17,083	(N/A)	9.1	20.8	129.42
Apple	18,712	507	(N/A)	5.6	0.6	6.18
Spruce	37,062	1,004	(N/A)	3.8	1.2	18.26
Cottonwood	68,578	1,858	(N/A)	3.6	2.3	35.74
Norway maple	58,513	1,586	(N/A)	2.8	1.9	38.68
Pear	10,437	283	(N/A)	2.8	0.3	6.90
Northern hackberry	76,394	2,070	(N/A)	2.6	2.5	54.48
Oak	117,356	3,180	(N/A)	2.5	3.9	88.34
Northern white cedar	12,943	351	(N/A)	2.1	0.4	11.31
Black walnut	50,506	1,369	(N/A)	2.1	1.7	44.15
Maple	8,082	219	(N/A)	1.9	0.3	8.11
Eastern white pine	59,150	1,603	(N/A)	1.9	2.0	59.37
Bur oak	129,667	3,514	(N/A)	1.8	4.3	135.15
Quaking aspen	11,935	323	(N/A)	1.7	0.4	12.94
Elm	90,054	2,440	(N/A)	1.6	3.0	101.69
Honeylocust	45,876	1,243	(N/A)	1.6	1.5	54.05
White oak	89,544	2,427	(N/A)	1.6	3.0	105.51
Littleleaf linden	22,827	619	(N/A)	1.5	0.8	28.12
Red maple	8,477	230	(N/A)	1.3	0.3	12.09
Eastern red cedar	18,058	489	(N/A)	1.2	0.6	27.19
Sugar maple	44,276	1,200	(N/A)	1.2	1.5	66.66
Broadleaf Deciduous Small	2,802	76	(N/A)	1.2	0.1	4.47
Boxelder	39,514	1,071	(N/A)	1.0	1.3	71.39
Pin oak	55,276	1,498	(N/A)	1.0	1.8	99.87
Conifer Evergreen Large	36,698	995	(N/A)	1.0	1.2	71.04
Northern red oak	14,795	401	(N/A)	0.7	0.5	40.09
River birch	18,434	500	(N/A)	0.7	0.6	49.96
Blue spruce	9,565	259	(N/A)	0.7	0.3	25.92
American basswood	20,650	560	(N/A)	0.6	0.7	62.18
Scotch pine	6,650	180	(N/A)	0.5	0.2	22.53
Mulberry	3,945	107	(N/A)	0.5	0.1	13.36
White ash	4,894	133	(N/A)	0.5	0.2	18.95
Black cherry	5,627	152	(N/A)	0.4	0.2	25.42
Amur maple	870	24	(N/A)	0.3	0.0	4.71
Willow	4,525	123	(N/A)	0.3	0.1	30.66
Red pine	3,325	90	(N/A)	0.3	0.1	22.53
Broadleaf Deciduous Medium	5,883	159	(N/A)	0.3	0.2	39.86
Birch	4,363	118	(N/A)	0.2	0.1	39.41
Eastern redbud	598	16	(N/A)	0.2	0.0	5.40
Catalpa	16,672	452	(N/A)	0.2	0.6	150.61
Dogwood	402	11	(N/A)	0.2	0.0	3.63
Kentucky coffeetree	4,551	123	(N/A)	0.1	0.2	61.66
Plum	735	20	(N/A)	0.1	0.0	9.96
Swamp white oak	1,995	54	(N/A)	0.1	0.1	27.03
Eastern cottonwood	14,478	392	(N/A)	0.1	0.5	196.17
American sycamore	4,551	123	(N/A)	0.1	0.2	61.66
Paper birch	1,637	44	(N/A)	0.1	0.1	22.18
Hickory	3,199	87	(N/A)	0.1	0.1	43.34
Norway spruce	596	16	(N/A)	0.1	0.0	16.14
Conifer Evergreen Small	659	18	(N/A)	0.1	0.0	17.86
Conifer Evergreen Medium	256	7	(N/A)	0.1	0.0	6.95
Black locust	12	0	(N/A)	0.1	0.0	0.33
Ohio buckeye	163	4	(N/A)	0.1	0.0	4.41
Sumac	7	0	(N/A)	0.1	0.0	0.20
Japanese tree lilac	7	0	(N/A)	0.1	0.0	0.20
Citywide total	3,027,285	82,039	(N/A)	100.0	100.0	56.35

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees

1/7/2016

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							
Siberian elm	89.7	15.3	44.9	4.0	486	283.4	41.4	39.5	270.8	1,770	0.0	0	789.0	2,256 (N/A)	17.5	8.85
Green ash	61.6	9.9	30.6	2.8	331	263.8	38.5	36.7	251.3	1,645	0.0	0	695.0	1,977 (N/A)	15.9	8.56
Silver maple	110.0	18.7	53.9	4.9	593	203.4	29.8	28.5	195.5	1,274	-57.0	-214	587.6	1,653 (N/A)	9.1	12.52
Apple	4.4	0.7	2.3	0.2	24	24.4	3.5	3.3	22.2	150	0.0	0	61.0	174 (N/A)	5.6	2.12
Spruce	3.6	0.7	3.3	0.4	25	13.6	2.0	1.9	12.6	84	-14.2	-53	24.0	56 (N/A)	3.8	1.01
Cottonwood	6.9	1.1	3.6	0.3	38	36.5	5.3	5.1	34.9	228	0.0	0	93.8	266 (N/A)	3.6	5.11
Norway maple	10.9	1.9	5.5	0.5	60	34.6	5.0	4.8	32.4	215	-2.7	-10	93.0	264 (N/A)	2.8	6.44
Pear	2.9	0.5	1.4	0.1	16	13.6	2.0	1.9	12.7	84	0.0	0	35.0	100 (N/A)	2.8	2.43
Northern hackberry	10.3	1.8	5.6	0.5	57	46.5	6.7	6.4	43.8	289	0.0	0	121.6	346 (N/A)	2.6	9.10
Oak	16.8	2.7	7.6	0.8	88	40.2	5.8	5.6	38.0	250	0.0	0	117.5	338 (N/A)	2.5	9.40
Northern white cedar	1.2	0.2	1.1	0.1	8	4.6	0.7	0.6	4.2	28	-4.9	-18	7.9	18 (N/A)	2.1	0.59
Black walnut	4.7	0.8	2.5	0.2	26	28.2	4.1	3.9	26.9	176	0.0	0	71.4	202 (N/A)	2.1	6.52
Maple	1.5	0.3	0.8	0.1	8	6.0	0.9	0.8	5.6	37	-0.5	-2	15.3	43 (N/A)	1.9	1.59
Eastern white pine	6.9	1.4	5.6	0.8	45	14.3	2.1	2.0	13.6	89	-30.6	-115	16.0	19 (N/A)	1.9	0.72
Bur oak	19.0	3.0	8.6	0.8	100	43.3	6.3	6.0	41.0	270	0.0	0	128.1	369 (N/A)	1.8	14.20
Quaking aspen	0.5	0.1	0.4	0.0	3	9.0	1.3	1.2	8.5	56	0.0	0	21.1	59 (N/A)	1.7	2.37
Elm	13.0	2.1	6.0	0.6	69	32.6	4.7	4.5	30.8	203	0.0	0	94.2	271 (N/A)	1.6	11.29
Honeylocust	8.8	1.5	4.0	0.4	47	20.5	3.0	2.9	19.6	128	-6.9	-26	53.8	149 (N/A)	1.6	6.47
White oak	11.7	1.9	5.5	0.5	62	35.1	5.1	4.8	33.1	218	0.0	0	97.6	280 (N/A)	1.6	12.16
Littleleaf linden	3.2	0.5	1.7	0.1	18	14.2	2.1	2.0	13.5	88	-1.7	-6	35.6	100 (N/A)	1.5	4.53
Red maple	1.5	0.3	0.8	0.1	8	6.2	0.9	0.9	5.8	38	-0.6	-2	15.8	45 (N/A)	1.3	2.34
Eastern red cedar	3.0	0.6	2.5	0.4	20	6.2	0.9	0.9	5.8	38	-9.8	-37	10.4	22 (N/A)	1.2	1.20
Sugar maple	5.9	1.0	3.0	0.3	32	18.5	2.7	2.6	17.6	115	-4.7	-17	46.9	130 (N/A)	1.2	7.23
Broadleaf Deciduous Small	0.7	0.1	0.4	0.0	4	3.9	0.6	0.5	3.6	24	0.0	0	9.8	28 (N/A)	1.2	1.64
Boxelder	5.3	0.8	2.5	0.2	28	17.0	2.5	2.4	16.2	106	-1.9	-7	44.8	126 (N/A)	1.0	8.43
Pin oak	9.7	1.7	5.0	0.4	53	23.9	3.5	3.3	22.8	149	-18.0	-67	52.3	135 (N/A)	1.0	8.97
Conifer Evergreen Large	4.3	0.9	3.5	0.5	28	8.9	1.3	1.2	8.5	56	-19.1	-72	10.1	12 (N/A)	1.0	0.88
Northern red oak	2.9	0.5	1.5	0.1	16	8.2	1.2	1.1	7.8	51	-4.2	-16	19.3	52 (N/A)	0.7	5.16
River birch	3.9	0.7	1.9	0.2	21	9.1	1.3	1.3	8.5	56	-0.9	-3	25.9	74 (N/A)	0.7	7.39
Blue spruce	1.1	0.2	1.0	0.1	7	3.8	0.6	0.5	3.6	24	-3.3	-12	7.6	19 (N/A)	0.7	1.86
American basswood	2.9	0.5	1.4	0.1	16	9.0	1.3	1.2	8.4	56	-2.4	-9	22.4	62 (N/A)	0.6	6.89
Scotch pine	0.6	0.1	0.6	0.1	4	2.9	0.4	0.4	2.7	18	-2.1	-8	5.8	15 (N/A)	0.5	1.81
Mulberry	1.2	0.2	0.6	0.1	6	4.2	0.6	0.6	3.8	26	0.0	0	11.3	32 (N/A)	0.5	4.04
White ash	0.2	0.0	0.2	0.0	1	3.6	0.5	0.5	3.5	23	0.0	0	8.5	24 (N/A)	0.5	3.41
Black cherry	2.0	0.3	0.9	0.1	10	5.2	0.7	0.7	4.8	32	0.0	0	14.8	42 (N/A)	0.4	7.08
Amur maple	0.1	0.0	0.1	0.0	1	1.3	0.2	0.2	1.1	8	0.0	0	3.0	8 (N/A)	0.3	1.69
Willow	0.9	0.2	0.5	0.0	5	2.3	0.3	0.3	2.1	14	-0.2	-1	6.4	18 (N/A)	0.3	4.60
Red pine	0.3	0.1	0.3	0.0	2	1.4	0.2	0.2	1.3	9	-1.0	-4	2.9	7 (N/A)	0.3	1.81
Broadleaf Deciduous Medium	1.0	0.2	0.5	0.0	5	4.0	0.6	0.6	3.8	25	-0.2	-1	10.4	29 (N/A)	0.3	7.37
Birch	0.9	0.2	0.5	0.0	5	2.1	0.3	0.3	2.0	13	-0.2	-1	6.0	17 (N/A)	0.2	5.73
Eastern redbud	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)	0.2	1.93
Catalpa	2.4	0.4	1.1	0.1	13	5.5	0.8	0.8	5.2	34	0.0	0	16.4	47 (N/A)	0.2	15.74
Dogwood	0.1	0.0	0.0	0.0	0	0.6	0.1	0.1	0.5	4	0.0	0	1.4	4 (N/A)	0.2	1.32
Kentucky coffeetree	0.5	0.1	0.3	0.0	3	2.0	0.3	0.3	1.9	13	0.0	0	5.4	15 (N/A)	0.1	7.73
Plum	0.2	0.0	0.1	0.0	1	1.0	0.1	0.1	0.9	6	0.0	0	2.6	7 (N/A)	0.1	3.63
Swamp white oak	0.3	0.0	0.2	0.0	2	1.6	0.2	0.2	1.5	10	-0.1	0	4.0	11 (N/A)	0.1	5.69
Eastern cottonwood	2.3	0.4	1.0	0.1	12	4.2	0.6	0.6	4.0	26	0.0	0	13.1	38 (N/A)	0.1	19.04
American sycamore	0.5	0.1	0.3	0.0	3	2.0	0.3	0.3	1.9	13	0.0	0	5.4	15 (N/A)	0.1	7.73
Paper birch	0.1	0.0	0.1	0.0	1	1.2	0.2	0.2	1.2	8	0.0	0	3.0	8 (N/A)	0.1	4.15
Hickory	0.3	0.0	0.2	0.0	2	1.7	0.3	0.2	1.6	11	0.0	0	4.4	12 (N/A)	0.1	6.17
Norway 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)	0.1	1.48
Conifer Evergreen Small	0.1	0.0	0.1	0.0	0	0.2	0.0	0.0	0.2	1	-0.3	-1	0.3	1 (N/A)	0.1	0.62
Conifer Evergreen Medium	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	-0.1	0	0.3	1 (N/A)	0.1	0.75
Black locust	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)	0.1	0.14
Ohio buckeye	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)	0.1	1.21
Sumac	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)	0.1	0.11
Japanese tree lilac	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)	0.1	0.11
Citywide total	443.4	74.5	225.6	21.4	2,415	1,331.0	193.9	184.9	1,265.3	8,297	-187.9	-705	3,552.3	10,007 (N/A)	100.0	6.87

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees

1/7/2016

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Siberian elm	2,218,419	16,638	(N/A)	17.5	19.8	65.25
Green ash	2,016,215	15,122	(N/A)	15.9	18.0	65.46
Silver maple	2,506,298	18,797	(N/A)	9.1	22.4	142.40
Apple	76,637	575	(N/A)	5.6	0.7	7.01
Spruce	29,286	220	(N/A)	3.8	0.3	3.99
Cottonwood	232,808	1,746	(N/A)	3.6	2.1	33.58
Norway maple	183,015	1,373	(N/A)	2.8	1.6	33.48
Pear	45,739	343	(N/A)	2.8	0.4	8.37
Northern hackberry	149,002	1,118	(N/A)	2.6	1.3	29.41
Oak	553,162	4,149	(N/A)	2.5	4.9	115.24
Northern white cedar	9,629	72	(N/A)	2.1	0.1	2.33
Black walnut	155,812	1,169	(N/A)	2.1	1.4	37.70
Maple	17,813	134	(N/A)	1.9	0.2	4.95
Eastern white pine	75,902	569	(N/A)	1.9	0.7	21.08
Bur oak	629,817	4,724	(N/A)	1.8	5.6	181.68
Quaking aspen	21,954	165	(N/A)	1.7	0.2	6.59
Elm	436,274	3,272	(N/A)	1.6	3.9	136.34
Honeylocust	113,952	855	(N/A)	1.6	1.0	37.16
White oak	379,697	2,848	(N/A)	1.6	3.4	123.81
Littleleaf linden	71,244	534	(N/A)	1.5	0.6	24.29
Red maple	18,560	139	(N/A)	1.3	0.2	7.33
Eastern red cedar	10,488	79	(N/A)	1.2	0.1	4.37
Sugar maple	172,946	1,297	(N/A)	1.2	1.5	72.06
Broadleaf Deciduous	11,585	87	(N/A)	1.2	0.1	5.11
Boxelder	181,170	1,359	(N/A)	1.0	1.6	90.58
Pin oak	252,482	1,894	(N/A)	1.0	2.3	126.24
Conifer Evergreen La	47,613	357	(N/A)	1.0	0.4	25.51
Northern red oak	59,761	448	(N/A)	0.7	0.5	44.82
River birch	63,708	478	(N/A)	0.7	0.6	47.78
Blue spruce	6,207	47	(N/A)	0.7	0.1	4.66
American basswood	110,115	826	(N/A)	0.6	1.0	91.76
Scotch pine	3,881	29	(N/A)	0.5	0.0	3.64
Mulberry	19,602	147	(N/A)	0.5	0.2	18.38
White ash	9,030	68	(N/A)	0.5	0.1	9.67
Black cherry	30,916	232	(N/A)	0.4	0.3	38.64
Amur maple	2,915	22	(N/A)	0.3	0.0	4.37
Willow	15,616	117	(N/A)	0.3	0.1	29.28
Red pine	1,940	15	(N/A)	0.3	0.0	3.64
Broadleaf Deciduous	16,294	122	(N/A)	0.3	0.1	30.55
Birch	15,398	115	(N/A)	0.2	0.1	38.49
Eastern redbud	1,994	15	(N/A)	0.2	0.0	4.98
Catalpa	80,974	607	(N/A)	0.2	0.7	202.44
Dogwood	1,263	9	(N/A)	0.2	0.0	3.16
Kentucky coffeetree	16,807	126	(N/A)	0.1	0.2	63.03
Plum	3,215	24	(N/A)	0.1	0.0	12.06
Swamp white oak	4,725	35	(N/A)	0.1	0.0	17.72
Eastern cottonwood	78,517	589	(N/A)	0.1	0.7	294.44
American sycamore	16,807	126	(N/A)	0.1	0.2	63.03
Paper birch	3,857	29	(N/A)	0.1	0.0	14.46
Hickory	9,492	71	(N/A)	0.1	0.1	35.60
Norway spruce	257	2	(N/A)	0.1	0.0	1.93
Conifer Evergreen Sn	277	2	(N/A)	0.1	0.0	2.08
Conifer Evergreen M	43	0	(N/A)	0.1	0.0	0.32
Black locust	17	0	(N/A)	0.1	0.0	0.13
Ohio buckeye	218	2	(N/A)	0.1	0.0	1.64
Sumac	14	0	(N/A)	0.1	0.0	0.10
Japanese tree lilac	14	0	(N/A)	0.1	0.0	0.10
Citywide total	11,191,394	83,935	(N/A)	100.0	100.0	57.65

Table 5: Annual Carbon Sequestered

Annual CO Benefits of Public Trees

1/7/2016

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
Siberian elm	109,458	821	-10,658	-641	-85	100,267	752	198,426	1,488 (N/A)	17.5	18.4	5.84
Green ash	127,858	959	-9,678	-566	-77	92,995	697	210,609	1,580 (N/A)	15.9	19.5	6.84
Silver maple	182,889	1,372	-12,031	-480	-94	72,503	544	242,880	1,822 (N/A)	9.1	22.5	13.80
Apple	7,594	57	-369	-76	-3	8,214	62	15,362	115 (N/A)	5.6	1.4	1.41
Spruce	2,777	21	-141	-56	-1	4,680	35	7,260	54 (N/A)	3.8	0.7	0.99
Cottonwood	17,066	128	-1,118	-82	-9	12,904	97	28,770	216 (N/A)	3.6	2.7	4.15
Norway maple	10,439	78	-881	-75	-7	11,989	90	21,472	161 (N/A)	2.8	2.0	3.93
Pear	4,391	33	-220	-37	-2	4,686	35	8,820	66 (N/A)	2.8	0.8	1.61
Northern hackberry	10,206	77	-716	-86	-6	16,204	122	25,609	192 (N/A)	2.6	2.4	5.05
Oak	20,310	152	-2,656	-95	-21	14,059	105	31,618	237 (N/A)	2.5	2.9	6.59
Northern white cedar	956	7	-46	-21	-1	1,568	12	2,457	18 (N/A)	2.1	0.2	0.59
Black walnut	13,528	101	-748	-61	-6	9,954	75	22,673	170 (N/A)	2.1	2.1	5.49
Maple	1,438	11	-86	-15	-1	2,079	16	3,415	26 (N/A)	1.9	0.3	0.95
Eastern white pine	3,422	26	-364	-57	-3	5,018	38	8,019	60 (N/A)	1.9	0.7	2.23
Bur oak	21,172	159	-3,023	-102	-23	15,183	114	33,230	249 (N/A)	1.8	3.1	9.59
Quaking aspen	4,060	30	-106	-23	-1	3,159	24	7,090	53 (N/A)	1.7	0.7	2.13
Elm	15,217	114	-2,094	-77	-16	11,397	85	24,444	183 (N/A)	1.6	2.3	7.64
Honeylocust	8,597	64	-548	-35	-4	7,281	55	15,294	115 (N/A)	1.6	1.4	4.99
White oak	17,987	135	-1,823	-78	-14	12,239	92	28,325	212 (N/A)	1.6	2.6	9.24
Littleleaf linden	8,760	66	-344	-36	-3	4,972	37	13,352	100 (N/A)	1.5	1.2	4.55
Red maple	2,465	18	-90	-14	-1	2,150	16	4,511	34 (N/A)	1.3	0.4	1.78
Eastern red cedar	571	4	-50	-26	-1	2,133	16	2,628	20 (N/A)	1.2	0.2	1.10
Sugar maple	8,817	66	-830	-43	-7	6,529	49	14,472	109 (N/A)	1.2	1.3	6.03
Broadleaf Deciduous Smal	1,223	9	-56	-12	-1	1,336	10	2,491	19 (N/A)	1.2	0.2	1.10
Boxelder	13,104	98	-870	-46	-7	5,983	45	18,171	136 (N/A)	1.0	1.7	9.09
Pin oak	23,348	175	-1,212	-53	-9	8,444	63	30,527	229 (N/A)	1.0	2.8	15.26
Conifer Evergreen Large	2,278	17	-229	-34	-2	3,162	24	5,177	39 (N/A)	1.0	0.5	2.77
Northern red oak	2,277	17	-287	-21	-2	2,900	22	4,870	37 (N/A)	0.7	0.5	3.65
River birch	2,766	21	-307	-20	-2	3,146	24	5,585	42 (N/A)	0.7	0.5	4.19
Blue spruce	546	4	-30	-13	0	1,346	10	1,849	14 (N/A)	0.7	0.2	1.39
American basswood	6,219	47	-529	-22	-4	3,124	23	8,792	66 (N/A)	0.6	0.8	7.33
Scotch pine	547	4	-19	-11	0	999	7	1,517	11 (N/A)	0.5	0.1	1.42
Mulberry	685	5	-94	-14	-1	1,425	11	2,002	15 (N/A)	0.5	0.2	1.88
White ash	1,470	11	-44	-8	0	1,282	10	2,699	20 (N/A)	0.5	0.3	2.89
Black cherry	382	3	-148	-17	-1	1,772	13	1,988	15 (N/A)	0.4	0.2	2.48
Amur maple	388	3	-14	-4	0	415	3	785	6 (N/A)	0.3	0.1	1.18
Willow	325	2	-76	-6	-1	786	6	1,029	8 (N/A)	0.3	0.1	1.93
Red pine	273	2	-9	-5	0	500	4	758	6 (N/A)	0.3	0.1	1.42
Broadleaf Deciduous Medi	1,466	11	-78	-8	-1	1,406	11	2,786	21 (N/A)	0.3	0.3	5.22
Birch	599	4	-74	-5	-1	722	5	1,242	9 (N/A)	0.2	0.1	3.11
Eastern redbud	266	2	-10	-3	0	285	2	539	4 (N/A)	0.2	0.0	1.35
Catalpa	2,729	20	-389	-13	-3	1,937	15	4,264	32 (N/A)	0.2	0.4	10.66
Dogwood	190	1	-6	-2	0	199	1	380	3 (N/A)	0.2	0.0	0.95
Kentucky coffeetree	1,066	8	-81	-5	-1	711	5	1,691	13 (N/A)	0.1	0.2	6.34
Plum	306	2	-15	-3	0	346	3	633	5 (N/A)	0.1	0.1	2.37
Swamp white oak	610	5	-23	-3	0	571	4	1,155	9 (N/A)	0.1	0.1	4.33
Eastern cottonwood	1,824	14	-377	-10	-3	1,469	11	2,906	22 (N/A)	0.1	0.3	10.90
American sycamore	1,066	8	-81	-5	-1	711	5	1,691	13 (N/A)	0.1	0.2	6.34
Paper birch	520	4	-19	-3	0	442	3	940	7 (N/A)	0.1	0.1	3.52
Hickory	868	7	-46	-4	0	600	5	1,419	11 (N/A)	0.1	0.1	5.32
Norway spruce	53	0	-1	-1	0	94	1	145	1 (N/A)	0.1	0.0	1.08
Conifer Evergreen Small	40	0	-1	-1	0	82	1	119	1 (N/A)	0.1	0.0	0.89
Conifer Evergreen Mediun	12	0	0	-1	0	48	0	60	0 (N/A)	0.1	0.0	0.45
Black locust	5	0	0	0	0	7	0	12	0 (N/A)	0.1	0.0	0.09
Ohio buckeye	96	1	-2	-1	0	65	0	158	1 (N/A)	0.1	0.0	1.18
Sumac	9	0	0	0	0	6	0	14	0 (N/A)	0.1	0.0	0.10
Japanese tree lilac	9	0	0	0	0	6	0	14	0 (N/A)	0.1	0.0	0.10
Citywide total	667,539	5,007	-53,744	-3,136	-427	468,486	3,514	1,079,146	8,094 (N/A)	100.0	100.0	5.56

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees

1/7/2016

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Siberian elm	8,872	(N/A)	17.5	14.9	34.79
Green ash	11,405	(N/A)	15.9	19.1	49.37
Silver maple	14,088	(N/A)	9.1	23.6	106.73
Apple	422	(N/A)	5.6	0.7	5.15
Spruce	811	(N/A)	3.8	1.4	14.74
Cottonwood	1,761	(N/A)	3.6	3.0	33.86
Norway maple	1,080	(N/A)	2.8	1.8	26.34
Pear	244	(N/A)	2.8	0.4	5.95
Northern hackberry	1,629	(N/A)	2.6	2.7	42.86
Oak	1,508	(N/A)	2.5	2.5	41.90
Northern white cedar	351	(N/A)	2.1	0.6	11.33
Black walnut	1,333	(N/A)	2.1	2.2	42.99
Maple	230	(N/A)	1.9	0.4	8.53
Eastern white pine	706	(N/A)	1.9	1.2	26.14
Bur oak	1,516	(N/A)	1.8	2.5	58.30
Quaking aspen	572	(N/A)	1.7	1.0	22.90
Elm	1,192	(N/A)	1.6	2.0	49.68
Honeylocust	2,068	(N/A)	1.6	3.5	89.91
White oak	1,394	(N/A)	1.6	2.3	60.61
Littleleaf linden	993	(N/A)	1.5	1.7	45.15
Red maple	362	(N/A)	1.3	0.6	19.03
Eastern red cedar	272	(N/A)	1.2	0.5	15.13
Sugar maple	925	(N/A)	1.2	1.6	51.40
Broadleaf Deciduous Small	66	(N/A)	1.2	0.1	3.87
Boxelder	867	(N/A)	1.0	1.5	57.80
Pin oak	1,793	(N/A)	1.0	3.0	119.56
Conifer Evergreen Large	437	(N/A)	1.0	0.7	31.18
Northern red oak	185	(N/A)	0.7	0.3	18.51
River birch	264	(N/A)	0.7	0.4	26.42
Blue spruce	191	(N/A)	0.7	0.3	19.07
American basswood	439	(N/A)	0.6	0.7	48.74
Scotch pine	157	(N/A)	0.5	0.3	19.65
Mulberry	39	(N/A)	0.5	0.1	4.85
White ash	244	(N/A)	0.5	0.4	34.80
Black cherry	22	(N/A)	0.4	0.0	3.65
Amur maple	21	(N/A)	0.3	0.0	4.26
Willow	42	(N/A)	0.3	0.1	10.46
Red pine	79	(N/A)	0.3	0.1	19.65
Broadleaf Deciduous Medium	148	(N/A)	0.3	0.2	36.90
Birch	60	(N/A)	0.2	0.1	20.14
Eastern redbud	15	(N/A)	0.2	0.0	4.95
Catalpa	191	(N/A)	0.2	0.3	63.51
Dogwood	11	(N/A)	0.2	0.0	3.51
Kentucky coffeetree	94	(N/A)	0.1	0.2	47.07
Plum	18	(N/A)	0.1	0.0	8.77
Swamp white oak	65	(N/A)	0.1	0.1	32.69
Eastern cottonwood	117	(N/A)	0.1	0.2	58.34
American sycamore	94	(N/A)	0.1	0.2	47.07
Paper birch	61	(N/A)	0.1	0.1	30.29
Hickory	86	(N/A)	0.1	0.1	43.12
Norway spruce	15	(N/A)	0.1	0.0	15.42
Conifer Evergreen Small	21	(N/A)	0.1	0.0	21.34
Conifer Evergreen Medium	12	(N/A)	0.1	0.0	12.31
Black locust	3	(N/A)	0.1	0.0	2.74
Ohio buckeye	13	(N/A)	0.1	0.0	12.89
Sumac	0	(N/A)	0.1	0.0	0.03
Japanese tree lilac	0	(N/A)	0.1	0.0	0.03
Citywide total	59,602	(N/A)	100.0	100.0	40.94

Table 7: Summary of Benefits in Dollars

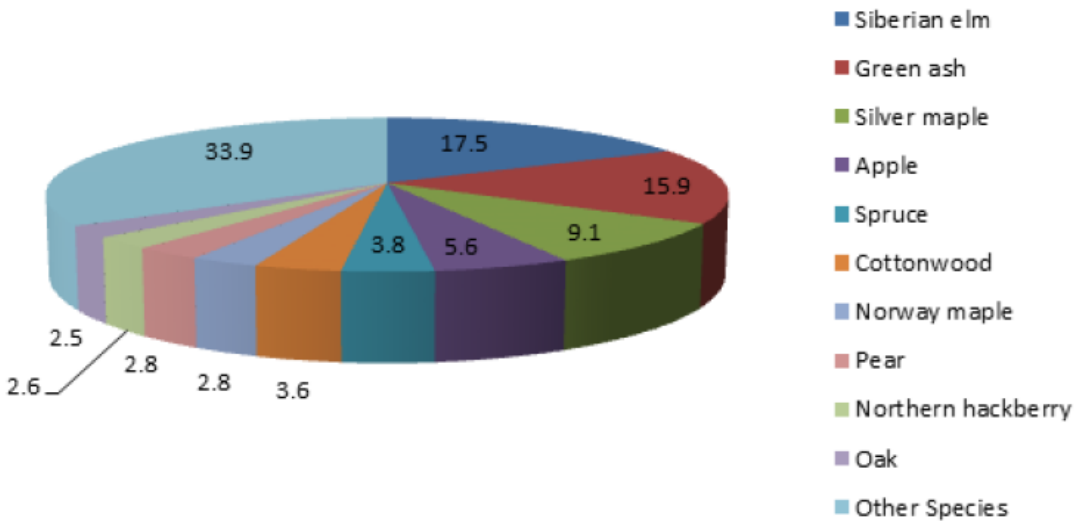
Total Annual Benefits of Public Trees by Species ($)

1/7/2016

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Siberian elm	12,369	1,488	2,256	15,811	8,872	40,797	(N/A)	18.7
Green ash	11,544	1,580	1,977	14,815	11,405	41,321	(N/A)	18.9
Silver maple	8,819	1,822	1,653	17,083	14,088	43,465	(N/A)	19.9
Apple	1,146	115	174	507	422	2,364	(N/A)	1.1
Spruce	619	54	56	1,004	811	2,545	(N/A)	1.2
Cottonwood	1,597	216	266	1,858	1,761	5,697	(N/A)	2.6
Norway maple	1,548	161	264	1,586	1,080	4,639	(N/A)	2.1
Pear	614	66	100	283	244	1,307	(N/A)	0.6
Northern hackberry	2,066	192	346	2,070	1,629	6,302	(N/A)	2.9
Oak	1,777	237	338	3,180	1,508	7,041	(N/A)	3.2
Northern white cedar	210	18	18	351	351	949	(N/A)	0.4
Black walnut	1,235	170	202	1,369	1,333	4,308	(N/A)	2.0
Maple	267	26	43	219	230	785	(N/A)	0.4
Eastern white pine	629	60	19	1,603	706	3,017	(N/A)	1.4
Bur oak	1,912	249	369	3,514	1,516	7,560	(N/A)	3.5
Quaking aspen	394	53	59	323	572	1,403	(N/A)	0.6
Elm	1,440	183	271	2,440	1,192	5,527	(N/A)	2.5
Honeylocust	891	115	149	1,243	2,068	4,465	(N/A)	2.0
White oak	1,557	212	280	2,427	1,394	5,870	(N/A)	2.7
Littleleaf linden	628	100	100	619	993	2,440	(N/A)	1.1
Red maple	275	34	45	230	362	945	(N/A)	0.4
Eastern red cedar	288	20	22	489	272	1,091	(N/A)	0.5
Sugar maple	810	109	130	1,200	925	3,174	(N/A)	1.5
Broadleaf Deciduous Sn	175	19	28	76	66	363	(N/A)	0.2
Boxelder	744	136	126	1,071	867	2,944	(N/A)	1.3
Pin oak	1,042	229	135	1,498	1,793	4,697	(N/A)	2.2
Conifer Evergreen Large	388	39	12	995	437	1,870	(N/A)	0.9
Northern red oak	360	37	52	401	185	1,034	(N/A)	0.5
River birch	412	42	74	500	264	1,292	(N/A)	0.6
Blue spruce	162	14	19	259	191	645	(N/A)	0.3
American basswood	397	66	62	560	439	1,523	(N/A)	0.7
Scotch pine	130	11	15	180	157	493	(N/A)	0.2
Mulberry	196	15	32	107	39	389	(N/A)	0.2
White ash	155	20	24	133	244	576	(N/A)	0.3
Black cherry	241	15	42	152	22	473	(N/A)	0.2
Amur maple	61	6	8	24	21	120	(N/A)	0.1
Willow	105	8	18	123	42	296	(N/A)	0.1
Red pine	65	6	7	90	79	247	(N/A)	0.1
Broadleaf Deciduous M	177	21	29	159	148	534	(N/A)	0.2
Birch	96	9	17	118	60	302	(N/A)	0.1
Eastern redbud	42	4	6	16	15	83	(N/A)	0.0
Catalpa	244	32	47	452	191	966	(N/A)	0.4
Dogwood	29	3	4	11	11	57	(N/A)	0.0
Kentucky coffeetree	92	13	15	123	94	337	(N/A)	0.2
Plum	44	5	7	20	18	93	(N/A)	0.0
Swamp white oak	71	9	11	54	65	211	(N/A)	0.1
Eastern cottonwood	182	22	38	392	117	751	(N/A)	0.3
American sycamore	92	13	15	123	94	337	(N/A)	0.2
Paper birch	50	7	8	44	61	170	(N/A)	0.1
Hickory	78	11	12	87	86	274	(N/A)	0.1
Norway spruce	14	1	1	16	15	48	(N/A)	0.0
Conifer Evergreen Smal	11	1	1	18	21	52	(N/A)	0.0
Conifer Evergreen Medi	7	0	1	7	12	27	(N/A)	0.0
Black locust	1	0	0	0	3	4	(N/A)	0.0
Ohio buckeye	9	1	1	4	13	29	(N/A)	0.0
Sumac	1	0	0	0	0	1	(N/A)	0.0
Japanese tree lilac	1	0	0	0	0	1	(N/A)	0.0
Citywide Total	58,506	8,094	10,007	82,039	59,602	218,248	(N/A)	100.0

Species Distribution of Public Trees

1/7/2016

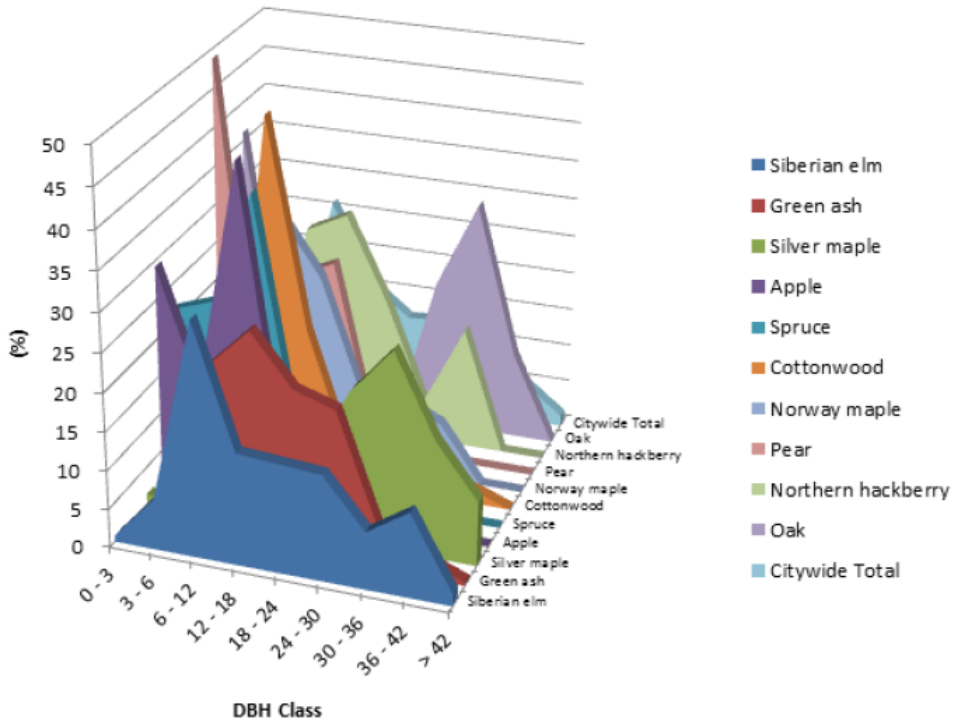


Species	Percent
Siberian elm	17.5
Green ash	15.9
Silver maple	9.1
Apple	5.6
Spruce	3.8
Cottonwood	3.6
Norway maple	2.8
Pear	2.8
Northern hackberry	2.6
Oak	2.5
Other Species	33.9
Total	100.0

Figure 1: Species Distribution

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

1/7/2016



	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Siberian elm	0.78	6.67	30.20	14.51	14.12	13.73	7.45	10.98	1.57
Green ash	0.00	0.87	22.51	27.71	21.21	19.48	5.19	2.60	0.43
Silver maple	1.52	0.76	7.58	11.36	9.85	19.70	25.76	15.15	8.33
Apple	29.27	14.63	43.90	8.54	2.44	1.22	0.00	0.00	0.00
Spruce	21.82	23.64	38.18	9.09	5.45	1.82	0.00	0.00	0.00
Cottonwood	17.31	0.00	46.15	19.23	3.85	7.69	3.85	1.92	0.00
Norway maple	9.76	7.32	31.71	24.39	9.76	9.76	7.32	0.00	0.00
Pear	48.78	2.44	21.95	24.39	2.44	0.00	0.00	0.00	0.00
Northern hackberry	0.00	5.26	26.32	28.95	18.42	5.26	15.79	0.00	0.00
Oak	36.11	2.78	0.00	0.00	0.00	19.44	30.56	11.11	0.00
Citywide Total	11.61	6.39	26.24	16.00	11.88	12.36	8.79	5.36	1.37

Figure 2: Relative Age Class

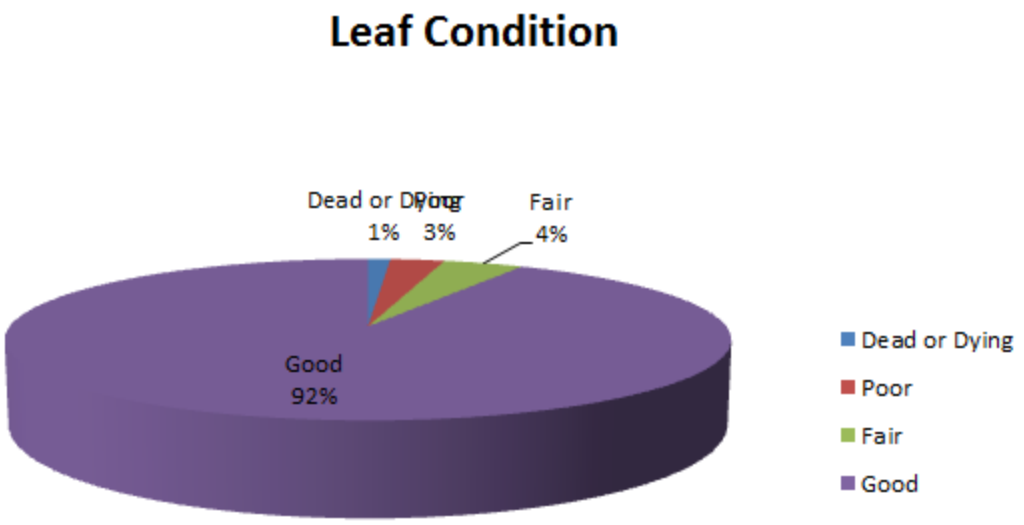


Figure 3: Foliage Condition

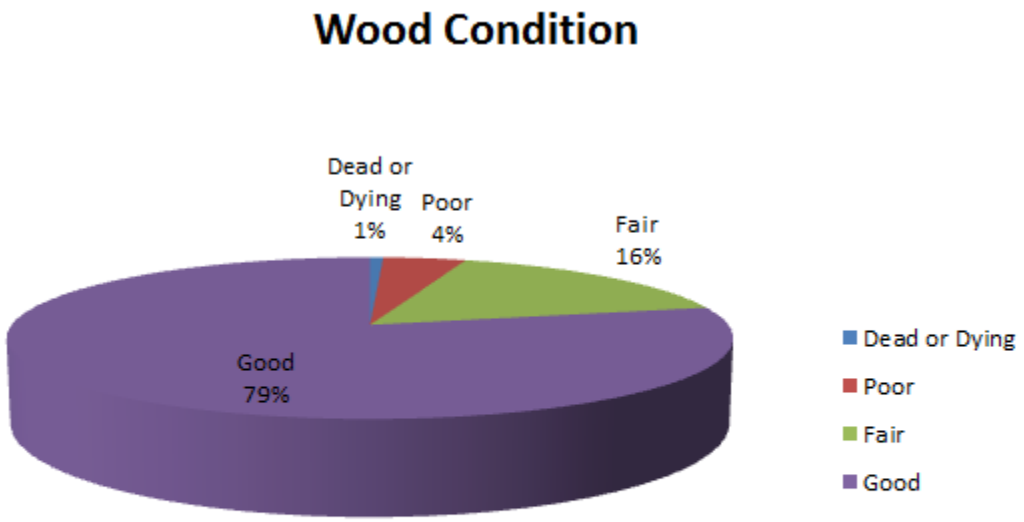
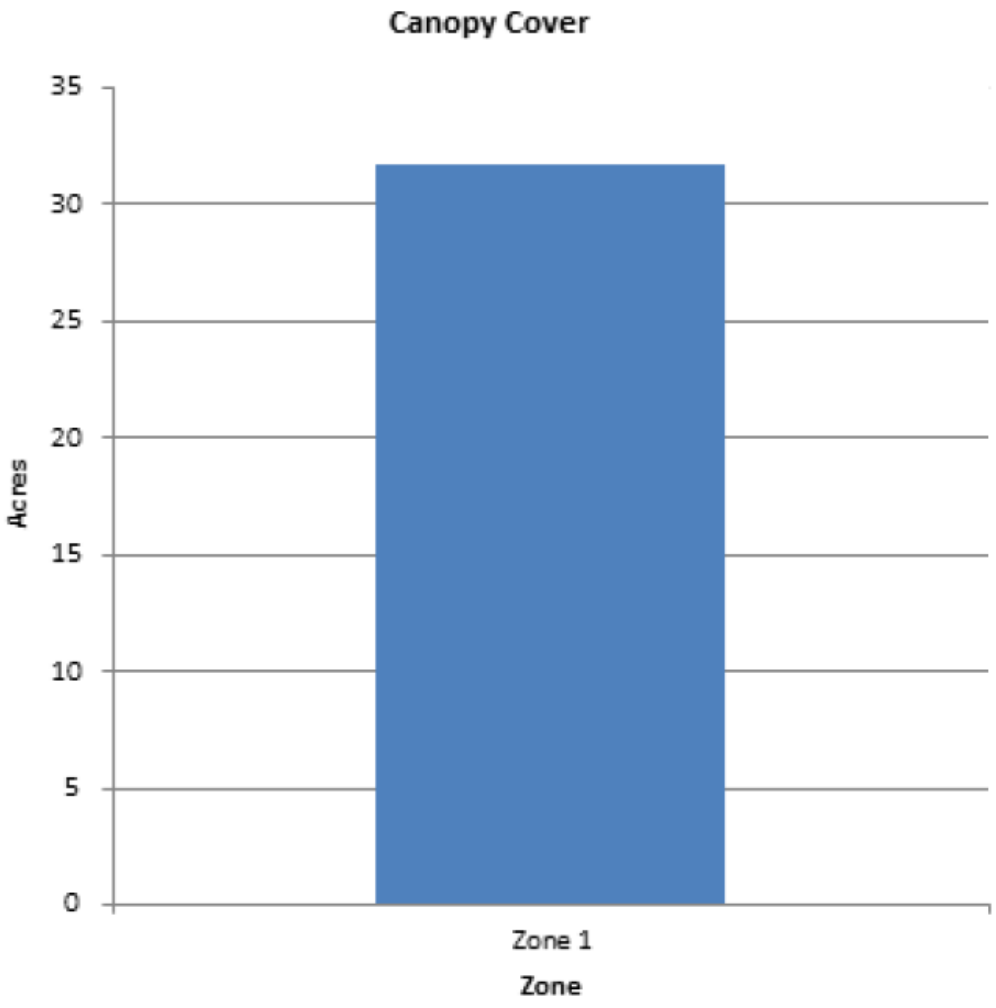


Figure 4: Wood Condition

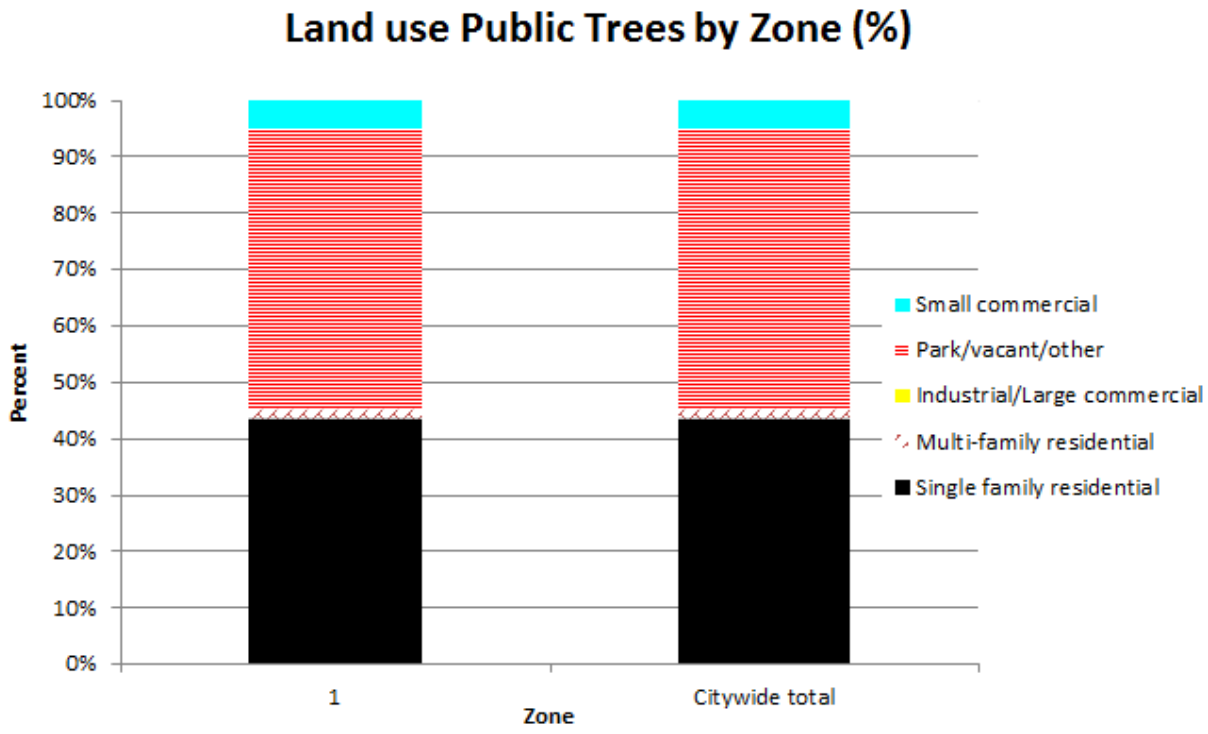
Canopy Cover of Public Trees (Acres)

1/7/2016



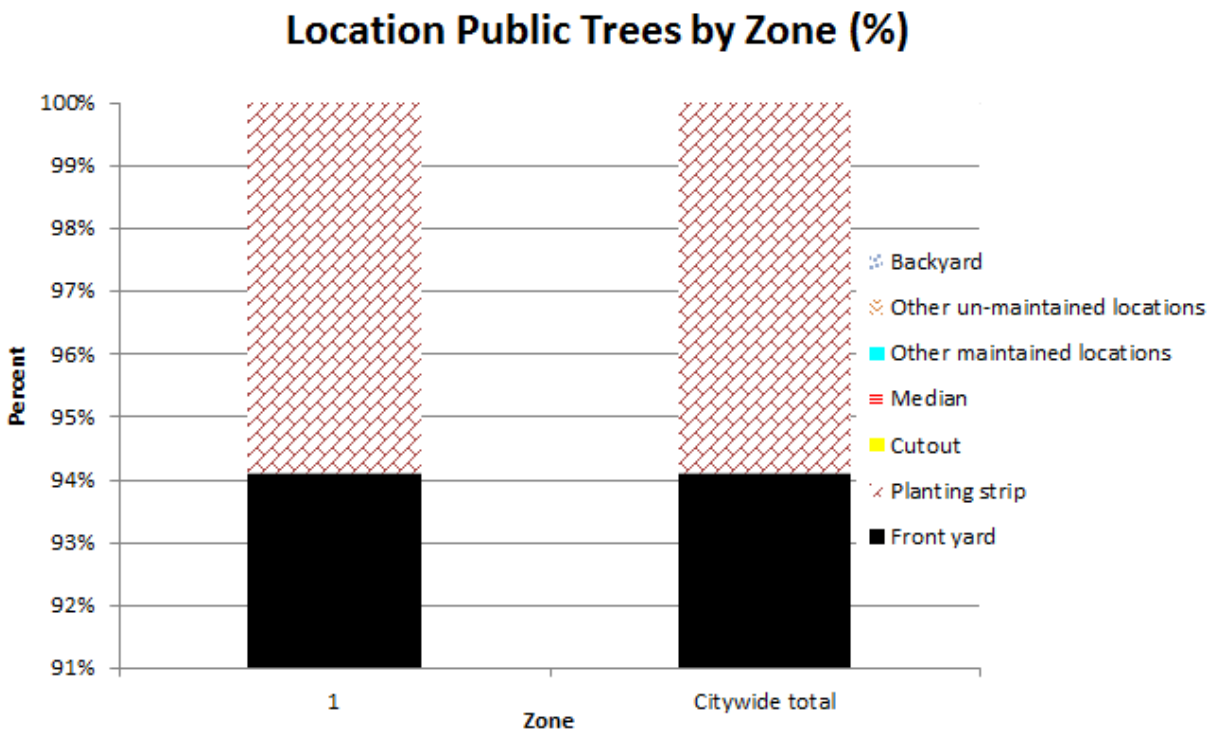
Zone	Acres	% of Total Canopy Cover
Zone 1	32	100.0
Citywide total	32	100.0

Figure 5: Canopy Cover in Acres



Zone	Single family residential	Multi-family residential	Industrial/Large commercial	Park/vacant /other	Small commercial
1	43.27	1.65	0.00	50.00	5.08
Citywide total	43.27	1.65	0.00	50.00	5.08

Figure 6: Land Use of city/park trees



Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
1	94.09	5.91	0.00	0.00	0.00	0.00	0.00
Citywide total	94.09	5.91	0.00	0.00	0.00	0.00	0.00

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

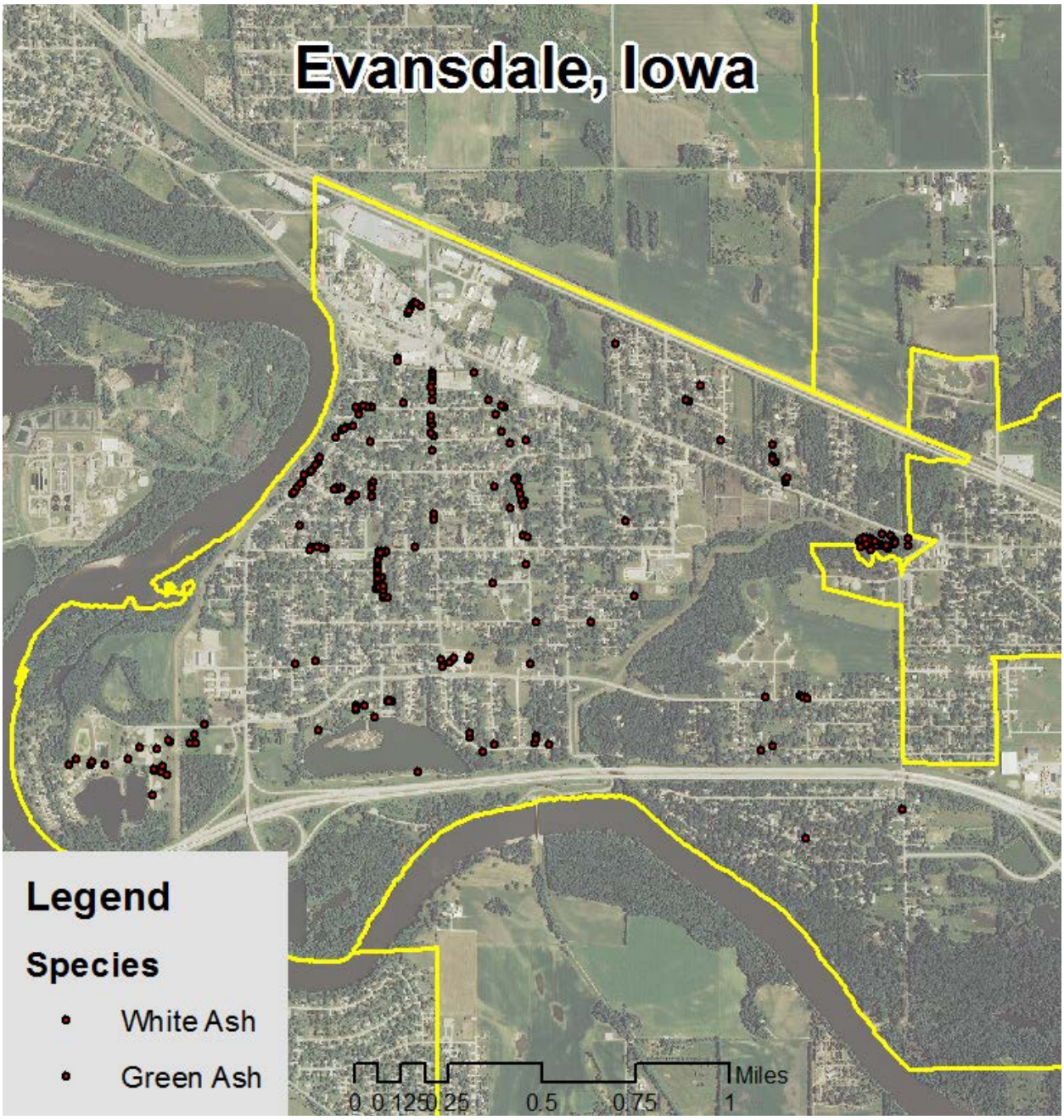


Figure 1: Location of Ash Trees

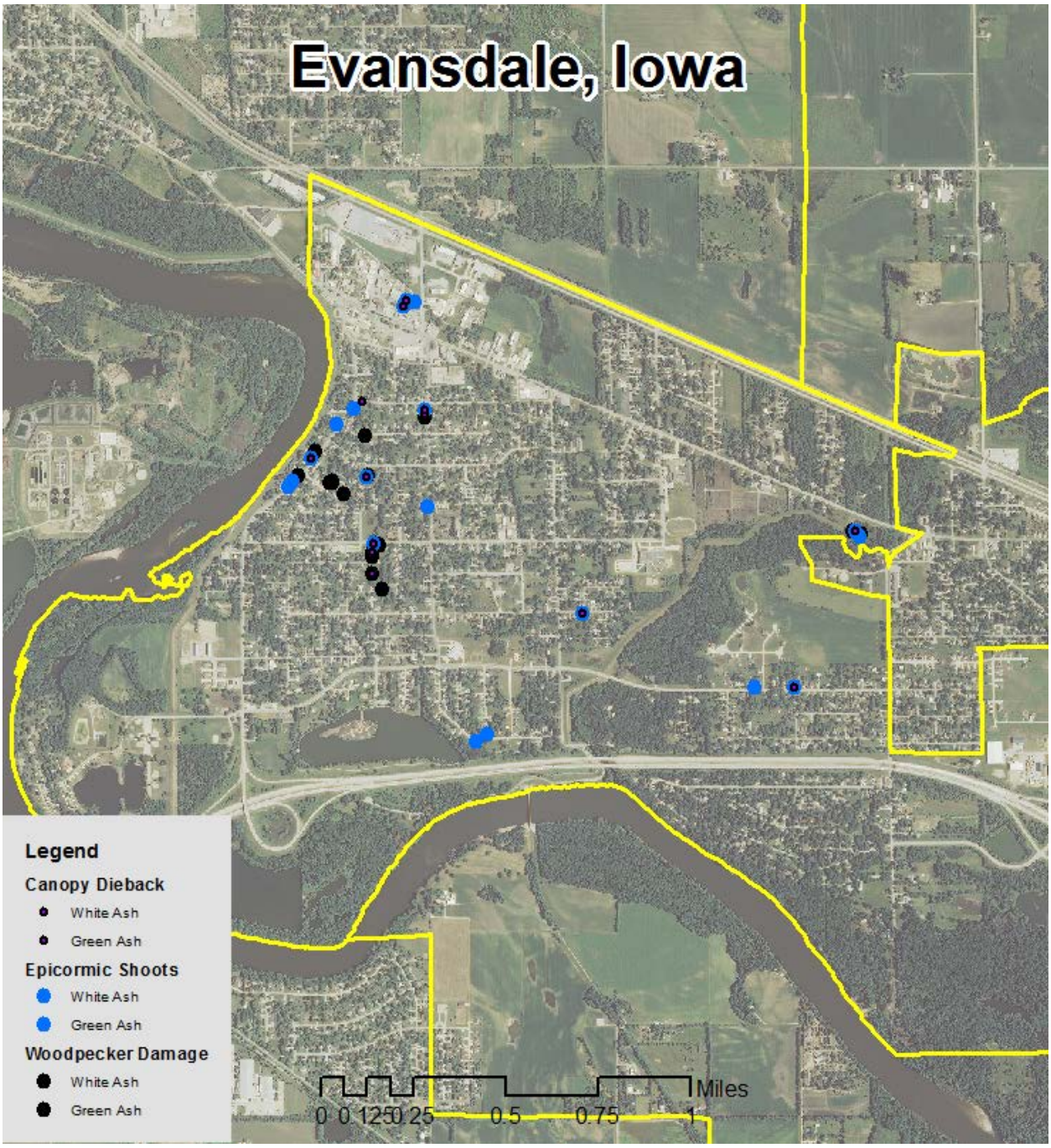


Figure 2: Location of EAB symptoms

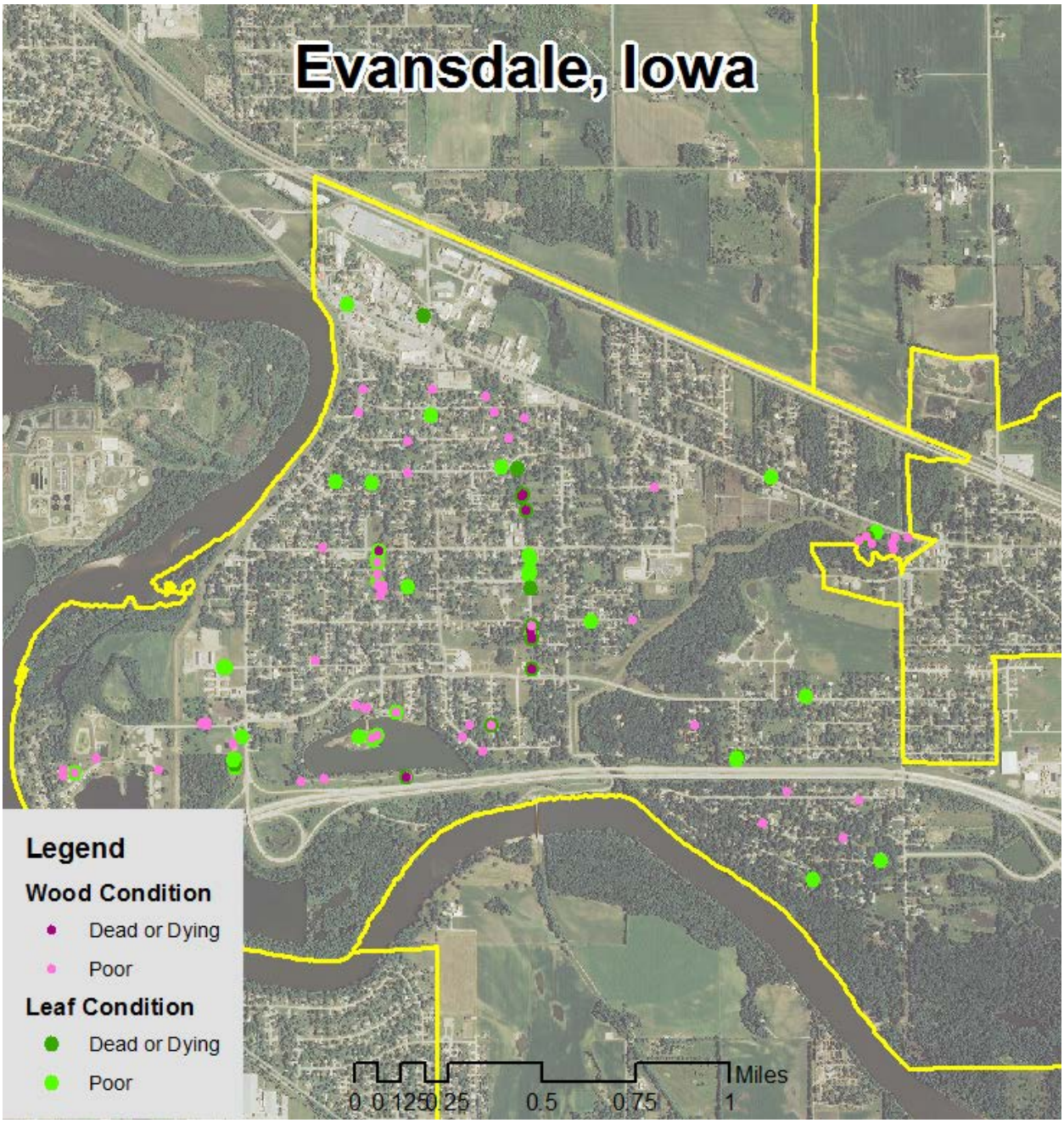


Figure 3: Location of Poor Condition Trees

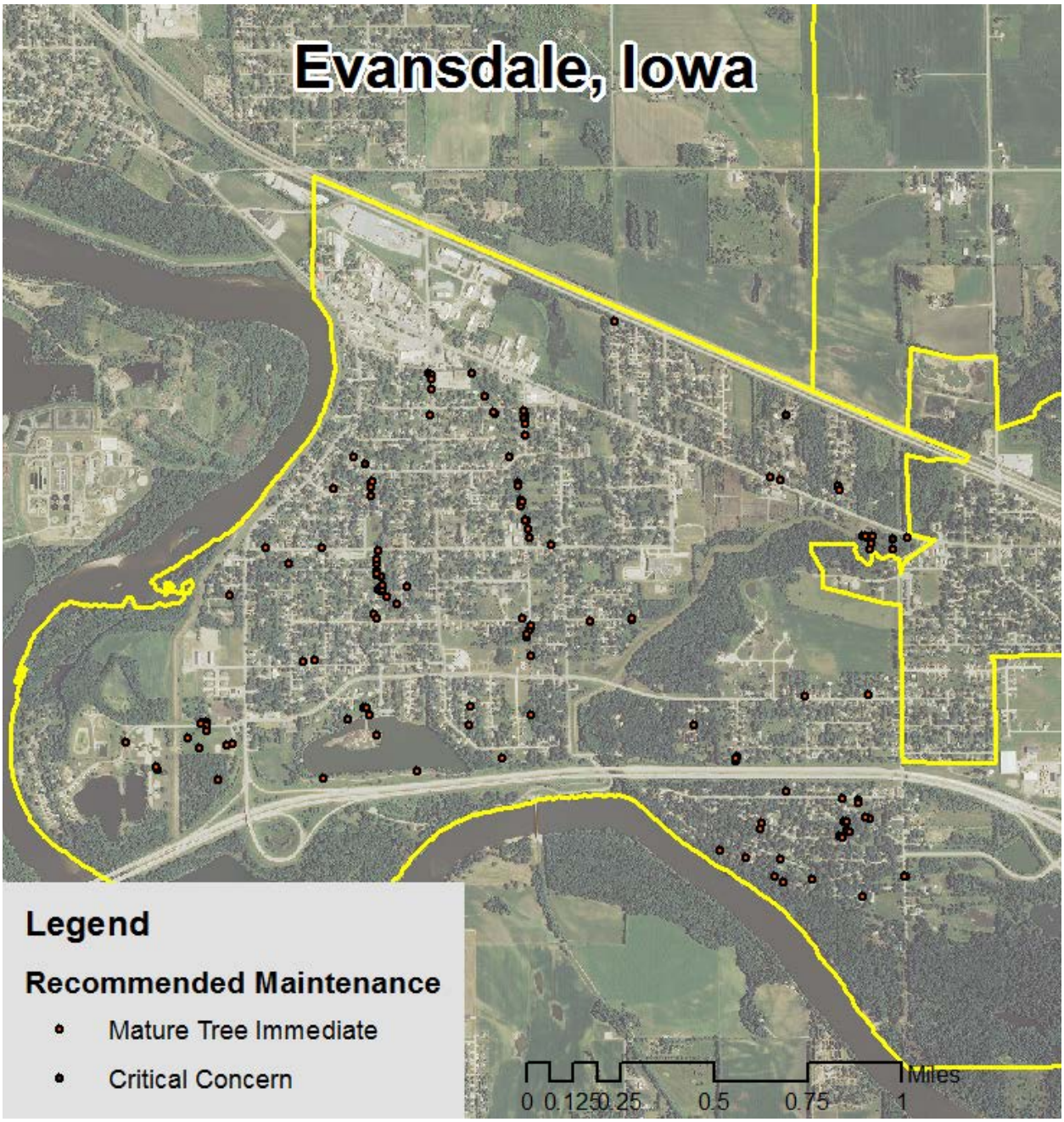


Figure 4: Location of Trees with Recommended Maintenance

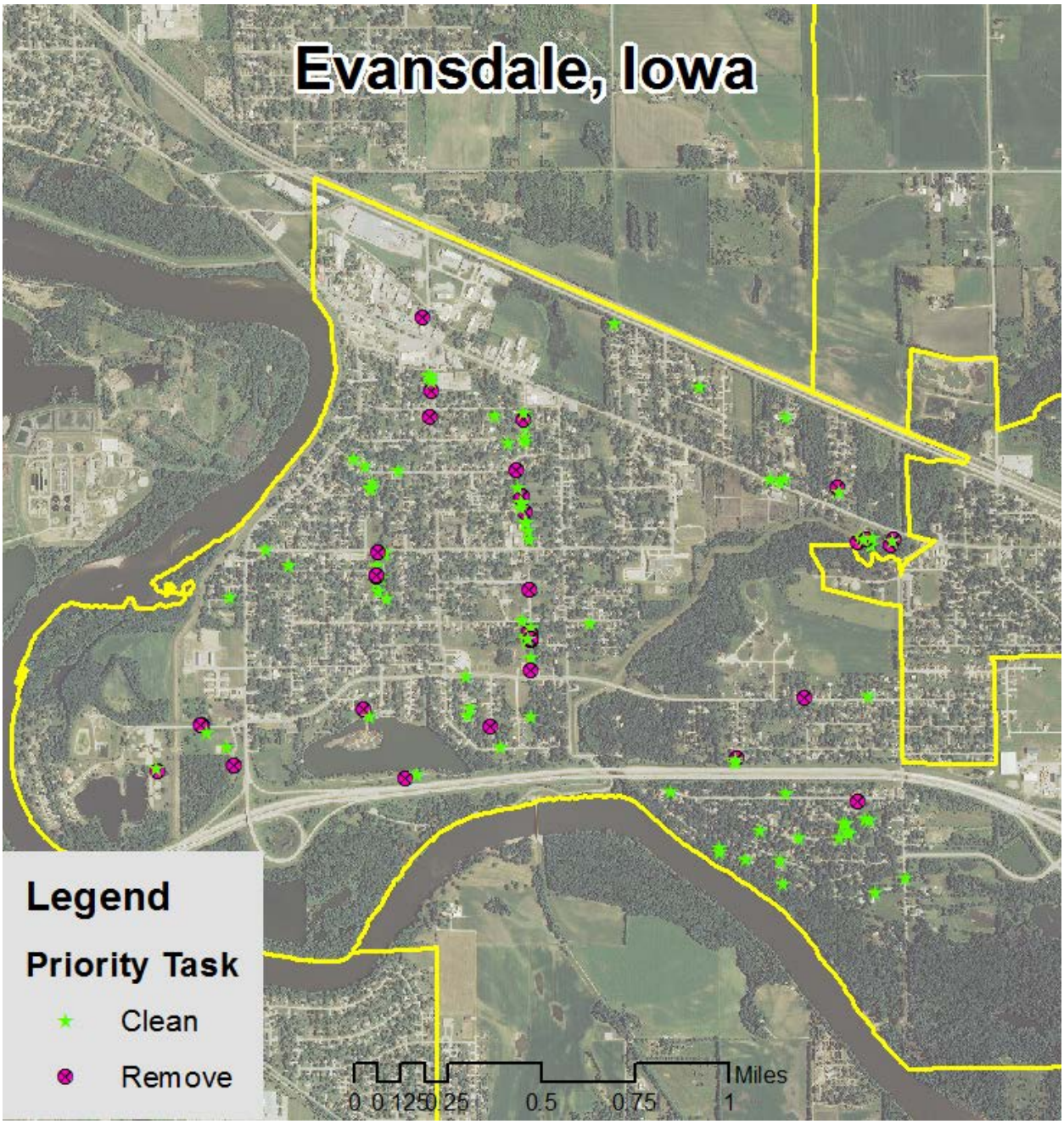


Figure 5: Maintenance Tasks ***City ownership of the trees recommended for removal should be verified prior to any removal***

Appendix C: Evansdale Tree Ordinances

CHAPTER 151

TREES

151.01 DEFINITION. For use in this chapter, "parking" means that part of the street, avenue, or highway in the City not covered by sidewalk and lying between the lot line and the curb line or, on unpaved streets, that part of the street, avenue, or highway lying between the lot line and that portion of the street usually traveled by vehicular traffic.

151.02 PLANTING RESTRICTIONS. No tree shall be planted in any parking or street except in accordance with the following:

1. Alignment. All trees planted in any street shall be planted in the parking midway between the outer line of the sidewalk and the curb. In the event a curb line is not established, trees shall be planted on a line ten (10) feet from the property line.

2. Spacing. Trees shall not be planted on any parking which is less than nine (9) feet in width, or contains less than eighty-one (81) square feet of exposed soil surface per tree. Trees shall not be planted closer than twenty (20) feet from street intersections (property lines extended) and ten (10) feet from driveways. If it is at all possible trees should be planted inside the property lines and not between the sidewalk and the curb.

3. Prohibited Trees. No person shall plant in any street any fruit-bearing tree or any tree of the kinds commonly known as cottonwood, poplar, box elder, Chinese elm, evergreen, willow, or black walnut.

151.03 DUTY TO TRIM TREES. The owner or agent of the abutting property shall keep the trees on, or overhanging the street, trimmed so that all branches will be at least fifteen (15) feet above the surface of the street and eight (8) feet above the sidewalks. If the abutting property owner fails to trim the trees, the City may serve notice on the abutting property owner requiring that such action be taken within five (5) days. If such action is not taken within that time, the City may perform the required action and assess the costs against the abutting property for collection in the same manner as a property tax.

(Code of Iowa, Sec. 364.12[2c, d & e])

151.04 TRIMMING TREES TO BE SUPERVISED. Except as allowed in Section 151.03, it is unlawful for any person to trim or cut any tree in a street or public place unless the work is done under the supervision of the City.

151.05 DISEASE CONTROL. Any dead, diseased, or damaged tree or shrub which may harbor serious insect or disease pests or disease injurious to other trees is hereby declared to be a nuisance.

151.06 INSPECTION AND REMOVAL. The Council shall inspect or cause to be inspected any trees or shrubs in the City reported or suspected to be dead, diseased or damaged, and such trees and shrubs shall be subject to the following:

1. City Property. If it is determined that any such condition exists on any public property, including the strip between the curb and the lot line of private property, the Council may cause such condition to be corrected by treatment or removal. The Council may also order the removal of any trees on the streets of the City which interfere with the making of improvements or with travel thereon.

2. Private Property. If it is determined with reasonable certainty that any such condition exists on private property and that danger to other trees or to adjoining property or passing motorists or pedestrians is imminent, the Council shall notify by certified mail the owner, occupant or person in charge of such property to correct such condition by treatment or removal within fourteen (14) days of said notification. If such owner, occupant, or person in charge of said property fails to comply within 14 days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property.

(Code of Iowa, Sec. 364.12[3b & h])

CHAPTER 126

LICENSING OF TREE TRIMMERS

126.01 LICENSE REQUIRED. No person shall engage in the business of removing, cutting, or trimming of trees in the City without first obtaining a license therefor.

126.02 WRITTEN TEST. Each applicant for the license shall first take a written test, which test will determine the applicant's understanding of the basic principles of proper tree removal, cutting, and trimming. The test shall be prepared by the City Building Inspector, in question and answer form, and given by and marked by the Clerk. Anyone holding a valid license from the City of Waterloo, Iowa, shall be eligible for a license under this chapter without the necessity of first taking a written test.

126.03 ISSUANCE OF LICENSE; FEE. If the applicant for the license correctly answers over seventy percent (70%) of the questions on the test, said applicant shall be granted a license as a tree trimmer upon payment of an annual license fee in an amount set by resolution of the Council, payable on October 1 of each year.

126.04 SCOPE OF LICENSE. The license required in this chapter shall allow the removing, cutting and trimming of shade trees over thirty (30) feet in height standing in any street, alley, parkway, boulevard or other public or private place in the City.

126.05 EXEMPTIONS. Sections 126.01 through 126.04 do not apply to:

1. The United State of America, the State, any county, municipality or political subdivision of the State, any department, bureau or agency of the foregoing or any official representative of any of the foregoing in the pursuit of official duties;

2. Any person with reference to trees on said person's own premises;

3. Any individual performing labor or services on or in connection with trees at the direction and under the personal supervision of a licensed tree trimmer, while in the performance of such functions;

4. Any public utility, including its authorized employees and agents, when engaged in tree trimming or tree removal for the purpose of line clearance, and in order to ensure the continuity of utility service to the public.

126.06 BOND REQUIRED. Any person, before engaging in the business or occupation of removing, cutting or trimming trees in the City, shall deposit with the Clerk good and sufficient bond in the sum of five thousand dollars ($5,000.00) conditioned that such person shall faithfully comply with the provisions of this chapter, and further conditioned to indemnify, save, and keep harmless the City and its officers from any and all claims, damages, losses, and actions by reason of any acts or things done under or by authority or permission granted pursuant to this chapter.

126.07 PERMIT REQUIRED FOR REMOVAL OF SPECIFIC TREES. In addition to any other requirements of this chapter, a person must obtain a permit before removing any trees in the City.

126.08 REMOVAL OF TRIMMINGS. Any person having a permit as provided in this chapter shall immediately and at said person's own expense remove all tree trunks, limbs, branches, twigs or brush, and dispose of them in a way so designated by the City Building Inspector, or at such other place provided for the disposal of the same.

126.09 WORKER'S COMPENSATION POLICY. Any person, before engaging in the business or occupation of removing, cutting or trimming trees in the City, shall furnish satisfactory evidence to the Clerk that the workers employed by said person are covered by a suitable worker's compensation policy according to the laws of the State or of the state of the domicile of such person.

The State of Iowa is an Equal Opportunity Employer and provider of ADA services.

Federal law prohibits employment discrimination on the basis of race, color, age, religion, national origin, sex or disability. State law prohibits employment discrimination on the basis of race, color, creed, age, sex, sexual orientation, gender identity, national origin, religion, pregnancy, or disability. State law also prohibits public accommodation (such as access to services or physical facilities) discrimination on the basis of race, color, creed, religion, sex, sexual orientation, gender identity, religion, national origin, or disability. If you believe you have been discriminated against in any program, activity or facility as described above, or if you desire further information, please contact the Iowa Civil Rights Commission, 1-800-457-4416, or write to the Iowa Department of Natural Resources, Wallace State Office Bldg., 502 E. 9th St., Des Moines, IA 50319.

If you need accommodations because of disability to access the services of this Agency, please contact the Director at 515-725-8200.