

Birmingham, IA



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



Table of Contents

Executive Summary	3
Overview	3
Inventory and Results.....	3
Recommendations	3
Introduction	4
Inventory ____	4
Inventory_ Results.....	5
<i>Annual Benefits.....</i>	<i>5</i>
Annual Energy Benefits	5
Annual Stormwater Benefits	5
Annual Air Quality Benefits	5
Annual Carbon Benefits	5
Annual Aesthetics Benefits	5
Financial Summary of all Benefits	5
<i>Forest Structure.....</i>	<i>6</i>
Species Distribution	6
Age Class.....	6
Condition: Wood and Foliage	6
Management Needs.....	7
Canopy Cover	7
Land Use and Location	7
Recommendations	7
Risk Management.....	7
Pruning Cycle	8
Planting	8
Continual Monitoring For EAB	8
Emerald Ash Borer	11
Ash Tree Removal	11
EAB Quarantines.....	11
Wood Disposal.....	11
Canopy Replacement	12
Postponed Work	12
Monitoring.....	12
Private Ash Trees.....	12
Six Year Maintenance Plan and Cost Estimates	13
Works Cited	15
Appendix A: i-Tree Data	16
Appendix B: ArcGIS Mapping	29

Executive Summary

Overview

This plan was developed to assist the City of Birmingham 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 8% of Birmingham'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 132 trees inventoried.

- Birmingham's trees provide \$25,402 of benefits annually, an average of \$192 a tree
- There are over 30 species of trees
- The top three genera are: Maple 45%, Ash 8%, and Oak 8%
- 19% of trees are in need of some type of management
- 9 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 9 trees needing removal, 5 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*](#)
- 4 of the 11 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, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut
- Check ash trees with a visual survey yearly
- Budget impacts from ash removal – Suggestion: request a budget increase to at least \$800-\$1,650 a year and apply for grants to plant replacement trees

Introduction

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

Trees are an important component of Birmingham'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 Birmingham 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 Birmingham'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 132 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. Birmingham's trees reduce energy related costs by approximately \$6,262 annually (Appendix A, Table 1). These savings are both in Electricity (30.1 MWh) and in Natural Gas (4,062.5 Therms).

Annual Stormwater Benefits

Birmingham's trees intercept about 345,015 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides \$9,350 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 Birmingham, it is estimated that trees remove 386.9 lbs of air pollution (ozone (O₃), particulate matter less than 10 microns (PM₁₀), carbon monoxide (CO), nitrogen dioxide (NO₂), and sulfur dioxide (SO₂)) per year with a net value of \$1,087 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Birmingham, trees sequester about 89,594 lbs of carbon a year with an associated value of \$672 (Appendix A, Table 4). In addition, the trees store 1,239,212 lbs of carbon, with a yearly benefit of \$9,294 (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. Birmingham receives \$7,699 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, Birmingham's trees provide \$25,402 of benefits annually. Benefits of individual trees vary based on size, species, health and

location, but on average each of the 132 trees in Birmingham provides approximately \$192 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Birmingham has over 30 different tree species along city streets and parks (Appendix A, Figure 1).

The distribution of trees by genera is as follows:

Maple	60	45%
Ash	11	8%
Oak	11	8%
Eastern Redbud	8	6%
Spruce	7	5%
Mulberry	6	5%
Elm	5	4%
Catalpa	3	2%
Black Walnut	3	2%
Pine	3	2%
Hackberry	2	2%
Honeylocust	2	2%
Apple/Crabapple	2	2%
Eastern Red Cedar	1	1%
Aspen/Cottonwood	1	1%
Pear	1	1%
Other Small Deciduous	4	3%
Other Large Deciduous	1	1%
Other Large Evergreen	1	1%

Age Class

Almost half of Birmingham's trees (45%) 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. Birmingham will have an aging tree population as this 45% matures, and should consider new plantings (currently only 7% 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 Birmingham indicate that 62% of the trees are in good health, with only 2% of the foliage in poor health, dead or dying (Appendix A, Figure 3 &

Appendix B, Figure 3). Additionally, 56% of Birmingham'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 14% of the population. This 14% 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	16	12%
Tree Removal	9	7%

Canopy Cover

The total canopy with both private and public trees is 10% (66 acres). The canopy cover included in the Birmingham inventory includes approximately 4 acres (Appendix A, Figure 4).

Land Use and Location

The majority of Birmingham's city and park trees are in yard settings in single family residential neighborhoods (Appendix A, Figure 6 & Appendix A, Figure 7). The following describes the land use and locations for the street and park trees.

Land Use

Single family residential	52%
Park/vacant/other	47%
Small commercial	2%

Location

Front yard	71%
Planting strip	29%

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

Birmingham has 1 critical concern tree which needs immediate removal. This tree can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). Please

refer to the six year maintenance plan at the end of this section. After the critical concern tree is addressed, there should be follow up on the trees marked as needing maintenance. There are a total of 25 trees with these needs.

Poor tree species

After the removal of the critical concern tree, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 9 removals, 0 are ash trees. There are a total of 11 ash trees, and 4 of those have signs and symptoms that have been associated with EAB. In addition, there are 0 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

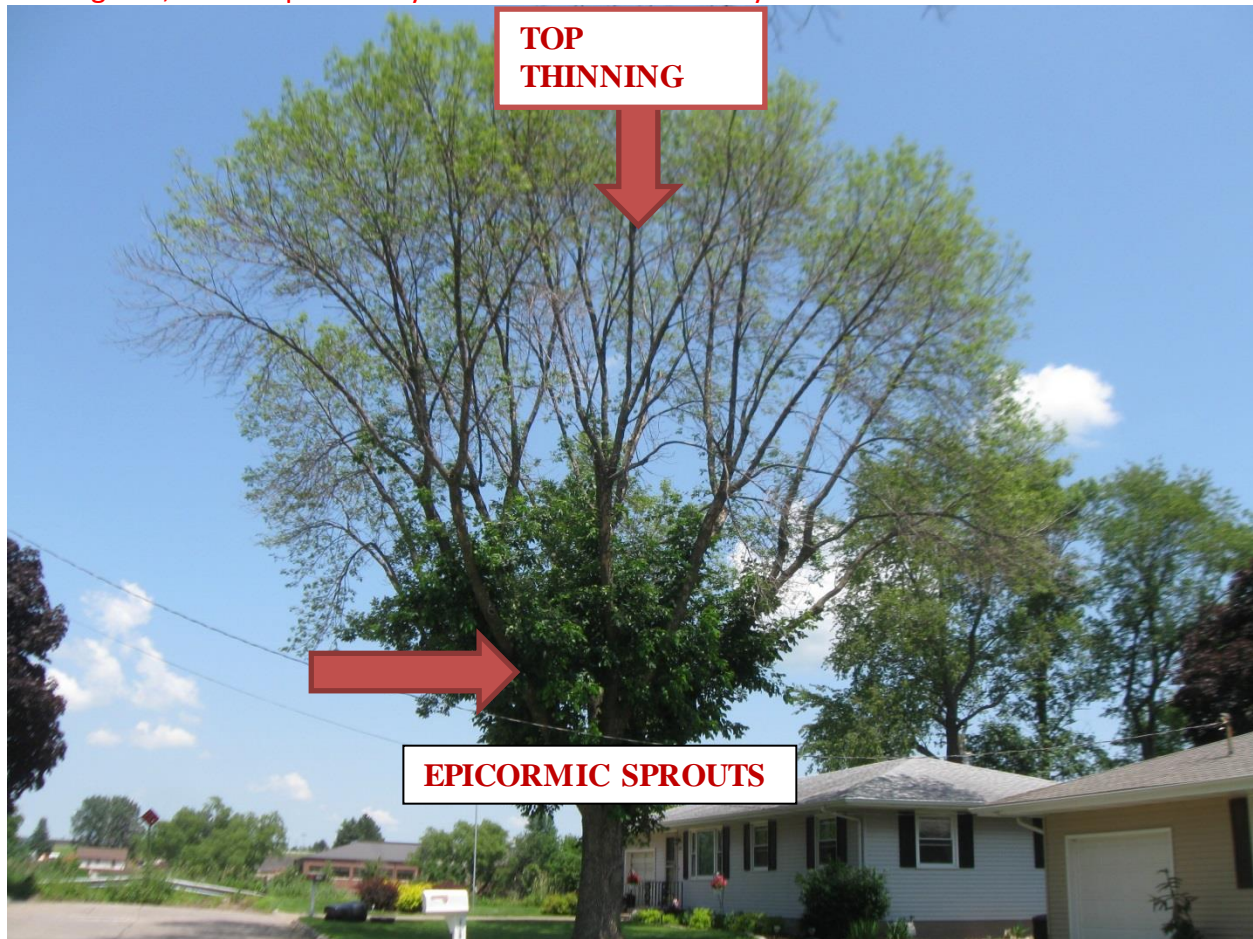
Most of the planting over the next 5 years will replace the trees that are removed. It is recommended to plant at least 1.2 trees for every tree removed, since survival rates will not be 100%. Please refer to the six year maintenance plan at the end of this section. It is not essential that the new trees 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 Birmingham.

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 (45%) (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: cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

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 Birmingham, it could potentially kill all ash within 4 to 10 years of its arrival.



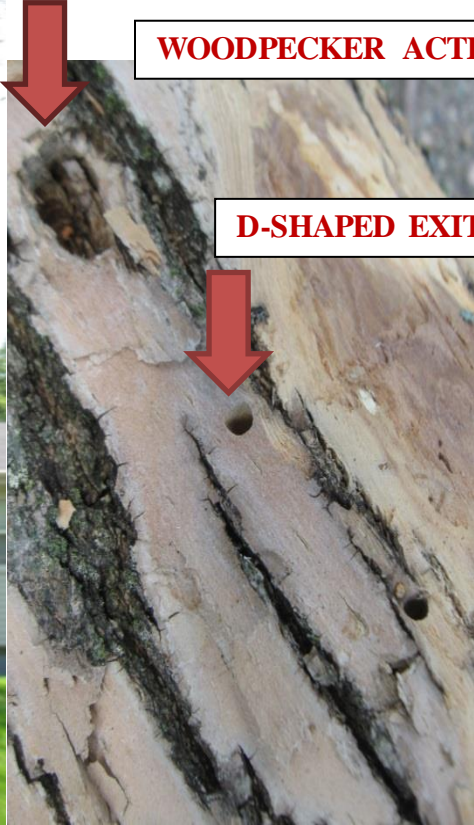
EAB infested tree in Muscatine with top thinning and many new green epicormic sprouts

WOODPECKER ACTIVITY



EPICORMIC SPROUTS

WOODPECKER ACTIVITY



D-SHAPED EXIT HOLE

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. The new plantings will be a diverse mix and will not include ash, maple, 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.

Six Year Maintenance Plan and Cost Estimates

Year 1 (FY 2016)

Remove 1 critical concern tree that needs immediate attention	\$900
Remove 4 trees (marked for removal)	\$3,600
Plant and Maintain 10 trees in open locations (pursue grants)	\$1,000
Ash tree treatment (if elected), 8 trees in good condition, average 12–18” -\$15 per inch, treated every two years, see note *Or saving for future ash removal	avg. \$225/tree
Visual Survey for signs and symptoms of EAB	

Year 2 (FY 2017)

Remove 4 trees (marked for removal)	\$3,600
Plant and Maintain 10 trees in open locations (pursue grants)	\$1,000
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 20 trees in open locations (pursue grants)	\$2,000
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 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 5 (FY 2020)

Remove any new critical concern trees and ash in poor health	\$900/tree
Plant and Maintain 20 trees in open locations (pursue grants)	\$2,000
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 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	

*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 \$1,650 a year to remove all ash trees within 6 years.

***Suggest a future (post ash removal and replacement) budget of at least \$2 per capita (population 448). Currently, this amount would cover about 55% 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 Birmingham within 4-15 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to \$1,650 a year. If the budget were increased to \$800 a year all ash could be removed within 13 years. Additionally, it is recommended that Birmingham 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 Birmingham 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 Birmingham. 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

1/15/2016

Species	Total Electricity (MWh)	Electricity (\$)	Total Natural Gas (Therms)	Natural Gas (\$)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Silver maple	14.1	1,067	1,832.3	1,796	2,862	(N/A)	31.8	45.7	68.15
Green ash	2.6	195	343.5	337	532	(N/A)	8.3	8.5	48.36
Eastern redbud	0.9	67	136.1	133	201	(N/A)	6.1	3.2	25.07
Swamp white oak	0.7	51	108.1	106	157	(N/A)	6.1	2.5	19.62
Spruce	0.5	41	76.7	75	116	(N/A)	5.3	1.9	16.60
Mulberry	0.8	60	119.5	117	177	(N/A)	4.5	2.8	29.50
Sugar maple	1.0	79	133.5	131	210	(N/A)	3.8	3.4	41.98
Norway maple	1.0	78	135.9	133	211	(N/A)	3.0	3.4	52.79
Broadleaf Deciduous Small	0.0	2	5.7	6	8	(N/A)	3.0	0.1	2.00
Elm	1.3	97	174.4	171	268	(N/A)	3.0	4.3	67.02
Black walnut	0.7	52	98.7	97	149	(N/A)	2.3	2.4	49.62
Catalpa	1.0	79	147.4	144	224	(N/A)	2.3	3.6	74.61
Apple	0.2	14	25.3	25	39	(N/A)	1.5	0.6	19.50
Maple	0.4	28	46.6	46	74	(N/A)	1.5	1.2	36.76
Boxelder	0.5	36	67.1	66	102	(N/A)	1.5	1.6	50.95
Pin oak	0.7	51	92.0	90	141	(N/A)	1.5	2.3	70.52
Eastern white pine	0.3	21	34.3	34	55	(N/A)	1.5	0.9	27.30
Red maple	0.4	30	56.4	55	85	(N/A)	1.5	1.4	42.63
Honeylocust	0.7	56	94.8	93	149	(N/A)	1.5	2.4	74.28
Amur maple	0.4	28	49.3	48	76	(N/A)	1.5	1.2	38.13
Northern hackberry	0.5	37	73.0	72	109	(N/A)	1.5	1.7	54.41
Scotch pine	0.1	4	9.5	9	14	(N/A)	0.8	0.2	13.58
Eastern red cedar	0.0	0	0.7	1	1	(N/A)	0.8	0.0	0.93
Eastern cottonwood	0.4	33	59.0	58	91	(N/A)	0.8	1.5	91.02
Siberian elm	0.3	25	46.6	46	71	(N/A)	0.8	1.1	71.03
Japanese maple	0.1	6	12.8	13	18	(N/A)	0.8	0.3	18.19
Broadleaf Deciduous Large	0.3	25	46.9	46	71	(N/A)	0.8	1.1	70.91
Northern red oak	0.1	7	14.2	14	21	(N/A)	0.8	0.3	21.11
Conifer Evergreen Large	0.1	4	9.5	9	14	(N/A)	0.8	0.2	13.58
Pear	0.1	6	12.8	13	18	(N/A)	0.8	0.3	18.19
Total	30.1	2,281	4,062.5	3,981	6,262	(N/A)	100.0	100.0	47.44

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees

1/15/2016

Species	Total rainfall interception (Gal)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Silver maple	197,839	5,361	(N/A)	31.8	57.3	127.65
Green ash	22,736	616	(N/A)	8.3	6.6	56.01
Eastern redbud	3,634	98	(N/A)	6.1	1.1	12.31
Swamp white oak	3,691	100	(N/A)	6.1	1.1	12.50
Spruce	6,055	164	(N/A)	5.3	1.8	23.44
Mulberry	3,301	89	(N/A)	4.5	1.0	14.91
Sugar maple	9,157	248	(N/A)	3.8	2.7	49.63
Norway maple	7,992	217	(N/A)	3.0	2.3	54.14
Broadleaf Deciduous Small	91	2	(N/A)	3.0	0.0	0.62
Elm	14,842	402	(N/A)	3.0	4.3	100.55
Black walnut	7,141	194	(N/A)	2.3	2.1	64.51
Catalpa	13,376	363	(N/A)	2.3	3.9	120.83
Apple	674	18	(N/A)	1.5	0.2	9.13
Maple	2,229	60	(N/A)	1.5	0.6	30.21
Boxelder	5,323	144	(N/A)	1.5	1.5	72.12
Pin oak	7,181	195	(N/A)	1.5	2.1	97.30
Eastern white pine	4,508	122	(N/A)	1.5	1.3	61.08
Red maple	3,492	95	(N/A)	1.5	1.0	47.32
Honeylocust	9,370	254	(N/A)	1.5	2.7	126.96
Amur maple	1,333	36	(N/A)	1.5	0.4	18.06
Northern hackberry	4,237	115	(N/A)	1.5	1.2	57.41
Scotch pine	596	16	(N/A)	0.8	0.2	16.14
Eastern red cedar	24	1	(N/A)	0.8	0.0	0.66
Eastern cottonwood	7,239	196	(N/A)	0.8	2.1	196.17
Siberian elm	3,359	91	(N/A)	0.8	1.0	91.03
Japanese maple	264	7	(N/A)	0.8	0.1	7.17
Broadleaf Deciduous Large	3,943	107	(N/A)	0.8	1.1	106.85
Northern red oak	529	14	(N/A)	0.8	0.2	14.33
Conifer Evergreen Large	596	16	(N/A)	0.8	0.2	16.14
Pear	264	7	(N/A)	0.8	0.1	7.17
Citywide total	345,015	9,350	(N/A)	100.0	100.0	70.83

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees

1/15/2016

Species	Deposition (lb)				Total Depos. (\$)	Avoided (lb)				Total Avoided (\$)	BVOC Emissions (lb)	BVOC Emissions (\$)	Total (lb)	Total (\$) Error	% of Total Trees	Avg. \$/tree
	O ₃	NO ₂	PM ₁₀	SO ₂		NO ₂	PM ₁₀	VOC	SO ₂							
Silver maple	33.7	5.7	16.6	1.5	182	66.1	9.7	9.3	63.6	414	-17.3	-65	188.9	531 (N/A)	31.8	12.65
Green ash	2.3	0.4	1.2	0.1	12	12.2	1.8	1.7	11.7	76	0.0	0	31.3	89 (N/A)	8.3	8.06
Eastern redbud	1.0	0.2	0.5	0.0	6	4.4	0.6	0.6	4.0	27	0.0	0	11.3	32 (N/A)	6.1	4.04
Swamp white oak	0.3	0.1	0.2	0.0	2	3.4	0.5	0.5	3.0	21	-0.1	0	7.9	22 (N/A)	6.1	2.77
Spruce	0.6	0.1	0.6	0.1	4	2.6	0.4	0.4	2.4	16	-1.9	-7	5.2	13 (N/A)	5.3	1.86
Mulberry	1.0	0.2	0.5	0.0	5	3.9	0.6	0.5	3.6	24	0.0	0	10.2	29 (N/A)	4.5	4.85
Sugar maple	1.1	0.2	0.6	0.0	6	4.9	0.7	0.7	4.7	31	-0.9	-3	12.0	33 (N/A)	3.8	6.67
Norway maple	1.5	0.3	0.8	0.1	8	4.9	0.7	0.7	4.7	30	-0.4	-1	13.2	37 (N/A)	3.0	9.33
Broadleaf Deciduous Small	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.1	1	0.0	0	0.4	1 (N/A)	3.0	0.26
Elm	1.9	0.3	0.9	0.1	10	6.1	0.9	0.8	5.8	38	0.0	0	16.8	48 (N/A)	3.0	12.02
Black walnut	0.8	0.1	0.4	0.0	4	3.3	0.5	0.5	3.1	21	0.0	0	8.7	25 (N/A)	2.3	8.27
Catalpa	1.8	0.3	0.8	0.1	9	5.0	0.7	0.7	4.7	31	0.0	0	14.2	41 (N/A)	2.3	13.55
Apple	0.2	0.0	0.1	0.0	1	0.9	0.1	0.1	0.8	6	0.0	0	2.3	7 (N/A)	1.5	3.33
Maple	0.4	0.1	0.2	0.0	2	1.7	0.3	0.2	1.7	11	-0.2	-1	4.4	12 (N/A)	1.5	6.20
Boxelder	0.7	0.1	0.3	0.0	4	2.3	0.3	0.3	2.2	14	-0.3	-1	6.0	17 (N/A)	1.5	8.42
Pin oak	1.2	0.2	0.6	0.1	7	3.2	0.5	0.4	3.0	20	-2.3	-8	7.0	18 (N/A)	1.5	9.04
Eastern white pine	0.5	0.1	0.4	0.1	3	1.3	0.2	0.2	1.2	8	-1.9	-7	2.1	4 (N/A)	1.5	2.13
Red maple	0.8	0.1	0.4	0.0	4	1.9	0.3	0.3	1.8	12	-0.3	-1	5.3	15 (N/A)	1.5	7.59
Honeylocust	1.9	0.3	0.8	0.1	10	3.4	0.5	0.5	3.3	22	-1.5	-6	9.3	26 (N/A)	1.5	12.87
Amur maple	0.4	0.1	0.2	0.0	2	1.7	0.3	0.2	1.7	11	0.0	0	4.6	13 (N/A)	1.5	6.56
Northern hackberry	0.6	0.1	0.3	0.0	3	2.4	0.3	0.3	2.2	15	0.0	0	6.3	18 (N/A)	1.5	9.03
Scotch pine	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)	0.8	1.48
Eastern red cedar	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)	0.8	0.09
Eastern cottonwood	1.2	0.2	0.5	0.1	6	2.1	0.3	0.3	2.0	13	0.0	0	6.6	19 (N/A)	0.8	19.04
Siberian elm	0.5	0.1	0.3	0.0	3	1.6	0.2	0.2	1.5	10	0.0	0	4.4	13 (N/A)	0.8	12.72
Japanese maple	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.3	2	0.0	0	0.9	3 (N/A)	0.8	2.55
Broadleaf Deciduous Large	0.5	0.1	0.2	0.0	3	1.6	0.2	0.2	1.5	10	0.0	0	4.4	12 (N/A)	0.8	12.48
Northern red oak	0.1	0.0	0.0	0.0	0	0.5	0.1	0.1	0.4	3	-0.1	0	1.1	3 (N/A)	0.8	2.89
Conifer Evergreen Large	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)	0.8	1.48
Pear	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.3	2	0.0	0	0.9	3 (N/A)	0.8	2.55
Citywide total	55.2	9.3	27.6	2.6	299	142.8	20.8	19.9	136.1	891	-27.4	-103	386.9	1,087 (N/A)	100.0	8.24

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees

1/15/2016

Species	Total Stored CO2 (lbs)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Silver maple	737,657	5,532	(N/A)	31.8	59.5	131.72
Green ash	73,675	553	(N/A)	8.3	5.9	50.23
Eastern redbud	16,626	125	(N/A)	6.1	1.3	15.59
Swamp white oak	6,839	51	(N/A)	6.1	0.6	6.41
Spruce	3,624	27	(N/A)	5.3	0.3	3.88
Mulberry	15,541	117	(N/A)	4.5	1.3	19.43
Sugar maple	32,255	242	(N/A)	3.8	2.6	48.38
Norway maple	25,153	189	(N/A)	3.0	2.0	47.16
Broadleaf Deciduous	219	2	(N/A)	3.0	0.0	0.41
Elm	61,161	459	(N/A)	3.0	4.9	114.68
Black walnut	25,265	189	(N/A)	2.3	2.0	63.16
Catalpa	57,489	431	(N/A)	2.3	4.6	143.72
Apple	3,051	23	(N/A)	1.5	0.2	11.44
Maple	4,725	35	(N/A)	1.5	0.4	17.72
Boxelder	22,225	167	(N/A)	1.5	1.8	83.35
Pin oak	30,478	229	(N/A)	1.5	2.5	114.29
Eastern white pine	4,513	34	(N/A)	1.5	0.4	16.92
Red maple	9,046	68	(N/A)	1.5	0.7	33.92
Honeylocust	24,490	184	(N/A)	1.5	2.0	91.84
Amur maple	6,074	46	(N/A)	1.5	0.5	22.78
Northern hackberry	8,473	64	(N/A)	1.5	0.7	31.77
Scotch pine	257	2	(N/A)	0.8	0.0	1.93
Eastern red cedar	3	0	(N/A)	0.8	0.0	0.02
Eastern cottonwood	39,259	294	(N/A)	0.8	3.2	294.44
Siberian elm	12,245	92	(N/A)	0.8	1.0	91.84
Japanese maple	908	7	(N/A)	0.8	0.1	6.81
Broadleaf Deciduous	15,773	118	(N/A)	0.8	1.3	118.30
Northern red oak	1,025	8	(N/A)	0.8	0.1	7.68
Conifer Evergreen La	257	2	(N/A)	0.8	0.0	1.93
Pear	908	7	(N/A)	0.8	0.1	6.81
Citywide total	1,239,212	9,294	(N/A)	100.0	100.0	70.41

Table 5: Annual Carbon Sequestered

Annual CO₂ Benefits of Public Trees

1/15/2016

Species	Sequestered (lb)	Sequestered (\$)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released (\$)	Avoided (lb)	Avoided (\$)	Net Total (lb)	Total Standard (\$)	% of Total Trees	% of Total \$	Avg. \$/tree
Silver maple	56,743	426	-3,541	-152	-28	23,573	177	76,623	575 (N/A)	31.8	57.3	13.68
Green ash	5,892	44	-354	-25	-3	4,318	32	9,830	74 (N/A)	8.3	7.4	6.70
Eastern redbud	1,507	11	-80	-12	-1	1,486	11	2,901	22 (N/A)	6.1	2.2	2.72
Swamp white oak	1,445	11	-34	-8	0	1,127	8	2,530	19 (N/A)	6.1	1.9	2.37
Spruce	494	4	-17	-10	0	905	7	1,372	10 (N/A)	5.3	1.0	1.47
Mulberry	877	7	-75	-11	-1	1,324	10	2,116	16 (N/A)	4.5	1.6	2.64
Sugar maple	1,931	14	-155	-11	-1	1,747	13	3,512	26 (N/A)	3.8	2.6	5.27
Norway maple	1,528	11	-121	-9	-1	1,724	13	3,121	23 (N/A)	3.0	2.3	5.85
Broadleaf Deciduous Small	64	0	-1	-1	0	54	0	116	1 (N/A)	3.0	0.1	0.22
Elm	3,119	23	-294	-13	-2	2,147	16	4,959	37 (N/A)	3.0	3.7	9.30
Black walnut	1,725	13	-121	-7	-1	1,152	9	2,749	21 (N/A)	2.3	2.1	6.87
Catalpa	2,673	20	-276	-11	-2	1,755	13	4,141	31 (N/A)	2.3	3.1	10.35
Apple	276	2	-15	-2	0	314	2	574	4 (N/A)	1.5	0.4	2.15
Maple	648	5	-23	-3	0	616	5	1,239	9 (N/A)	1.5	0.9	4.65
Boxelder	1,733	13	-107	-6	-1	799	6	2,419	18 (N/A)	1.5	1.8	9.07
Pin oak	2,982	22	-146	-7	-1	1,123	8	3,953	30 (N/A)	1.5	3.0	14.82
Eastern white pine	303	2	-22	-5	0	463	3	739	6 (N/A)	1.5	0.6	2.77
Red maple	165	1	-43	-4	0	663	5	780	6 (N/A)	1.5	0.6	2.93
Honeylocust	1,486	11	-118	-5	-1	1,230	9	2,592	19 (N/A)	1.5	1.9	9.72
Amur maple	535	4	-29	-4	0	617	5	1,119	8 (N/A)	1.5	0.8	4.20
Northern hackberry	578	4	-41	-5	0	823	6	1,356	10 (N/A)	1.5	1.0	5.08
Scotch pine	53	0	-1	-1	0	94	1	145	1 (N/A)	0.8	0.1	1.08
Eastern red cedar	1	0	0	0	0	6	0	6	0 (N/A)	0.8	0.0	0.05
Eastern cottonwood	912	7	-188	-5	-1	734	6	1,453	11 (N/A)	0.8	1.1	10.90
Siberian elm	640	5	-59	-4	0	561	4	1,139	9 (N/A)	0.8	0.9	8.54
Japanese maple	114	1	-4	-1	0	124	1	232	2 (N/A)	0.8	0.2	1.74
Broadleaf Deciduous Large	857	6	-76	-4	-1	552	4	1,330	10 (N/A)	0.8	1.0	9.97
Northern red oak	147	1	-5	-1	0	160	1	301	2 (N/A)	0.8	0.2	2.26
Conifer Evergreen Large	53	0	-1	-1	0	94	1	145	1 (N/A)	0.8	0.1	1.08
Pear	114	1	-4	-1	0	124	1	232	2 (N/A)	0.8	0.2	1.74
Citywide total	89,594	672	-5,949	-330	-47	50,410	378	133,725	1,003 (N/A)	100.0	100.0	7.60

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees					
1/15/2016					
Species	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Silver maple	4,427	(N/A)	31.8	57.5	105.40
Green ash	545	(N/A)	8.3	7.1	49.53
Eastern redbud	87	(N/A)	6.1	1.1	10.93
Swamp white oak	173	(N/A)	6.1	2.2	21.62
Spruce	142	(N/A)	5.3	1.8	20.25
Mulberry	50	(N/A)	4.5	0.7	8.36
Sugar maple	219	(N/A)	3.8	2.8	43.75
Norway maple	149	(N/A)	3.0	1.9	37.23
Broadleaf Deciduous Small	2	(N/A)	3.0	0.0	0.54
Elm	244	(N/A)	3.0	3.2	60.91
Black walnut	152	(N/A)	2.3	2.0	50.61
Catalpa	198	(N/A)	2.3	2.6	65.93
Apple	16	(N/A)	1.5	0.2	7.76
Maple	96	(N/A)	1.5	1.2	47.86
Boxelder	117	(N/A)	1.5	1.5	58.53
Pin oak	233	(N/A)	1.5	3.0	116.38
Eastern white pine	79	(N/A)	1.5	1.0	39.70
Red maple	30	(N/A)	1.5	0.4	14.92
Honeylocust	389	(N/A)	1.5	5.1	194.45
Amur maple	31	(N/A)	1.5	0.4	15.48
Northern hackberry	88	(N/A)	1.5	1.1	43.91
Scotch pine	15	(N/A)	0.8	0.2	15.42
Eastern red cedar	4	(N/A)	0.8	0.1	4.27
Eastern cottonwood	58	(N/A)	0.8	0.8	58.34
Siberian elm	46	(N/A)	0.8	0.6	46.00
Japanese maple	6	(N/A)	0.8	0.1	6.40
Broadleaf Deciduous Large	66	(N/A)	0.8	0.9	65.59
Northern red oak	16	(N/A)	0.8	0.2	16.24
Conifer Evergreen Large	15	(N/A)	0.8	0.2	15.42
Pear	6	(N/A)	0.8	0.1	6.40
Citywide total	7,699	(N/A)	100.0	100.0	58.33

Table 7: Summary of Benefits in Dollars

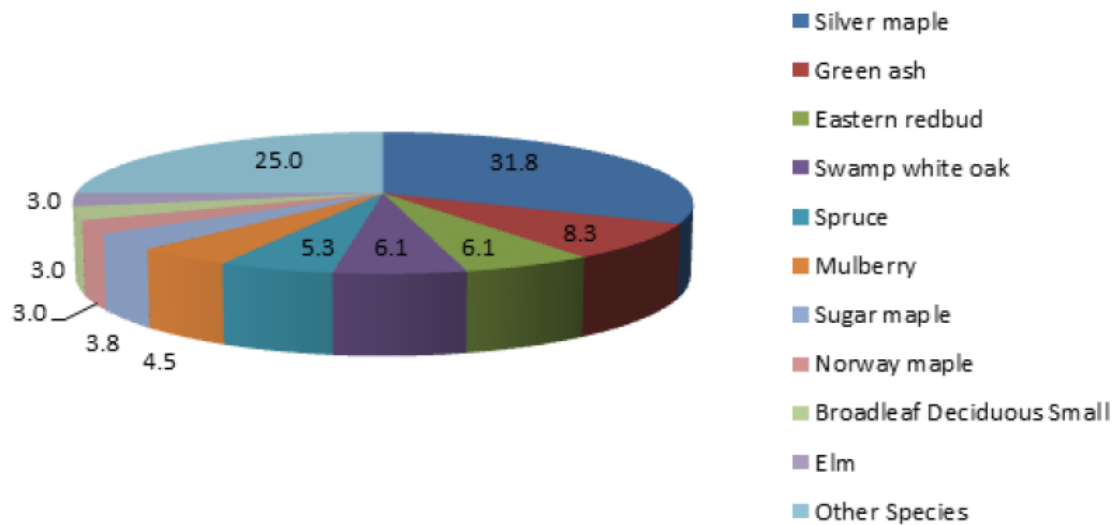
Total Annual Benefits of Public Trees by Species (\$)

1/15/2016

Species	Energy	CO ₂	Air Quality	Stormwater	Aesthetic/Other	Total (\$)	Standard Error	% of Total \$
Silver maple	2,862	575	531	5,361	4,427	13,757	(N/A)	54.2
Green ash	532	74	89	616	545	1,855	(N/A)	7.3
Eastern redbud	201	22	32	98	87	441	(N/A)	1.7
Swamp white oak	157	19	22	100	173	471	(N/A)	1.9
Spruce	116	10	13	164	142	445	(N/A)	1.8
Mulberry	177	16	29	89	50	362	(N/A)	1.4
Sugar maple	210	26	33	248	219	736	(N/A)	2.9
Norway maple	211	23	37	217	149	637	(N/A)	2.5
Broadleaf Deciduous Sn	8	1	1	2	2	15	(N/A)	0.1
Elm	268	37	48	402	244	999	(N/A)	3.9
Black walnut	149	21	25	194	152	540	(N/A)	2.1
Catalpa	224	31	41	363	198	856	(N/A)	3.4
Apple	39	4	7	18	16	84	(N/A)	0.3
Maple	74	9	12	60	96	251	(N/A)	1.0
Boxelder	102	18	17	144	117	398	(N/A)	1.6
Pin oak	141	30	18	195	233	616	(N/A)	2.4
Eastern white pine	55	6	4	122	79	266	(N/A)	1.0
Red maple	85	6	15	95	30	231	(N/A)	0.9
Honeylocust	149	19	26	254	389	837	(N/A)	3.3
Amur maple	76	8	13	36	31	165	(N/A)	0.6
Northern hackberry	109	10	18	115	88	340	(N/A)	1.3
Scotch pine	14	1	1	16	15	48	(N/A)	0.2
Eastern red cedar	1	0	0	1	4	6	(N/A)	0.0
Eastern cottonwood	91	11	19	196	58	375	(N/A)	1.5
Siberian elm	71	9	13	91	46	229	(N/A)	0.9
Japanese maple	18	2	3	7	6	36	(N/A)	0.1
Broadleaf Deciduous La	71	10	12	107	66	266	(N/A)	1.0
Northern red oak	21	2	3	14	16	57	(N/A)	0.2
Conifer Evergreen Large	14	1	1	16	15	48	(N/A)	0.2
Pear	18	2	3	7	6	36	(N/A)	0.1
Citywide Total	6,262	1,003	1,087	9,350	7,699	25,402	(N/A)	100.0

Species Distribution of Public Trees

1/15/2016

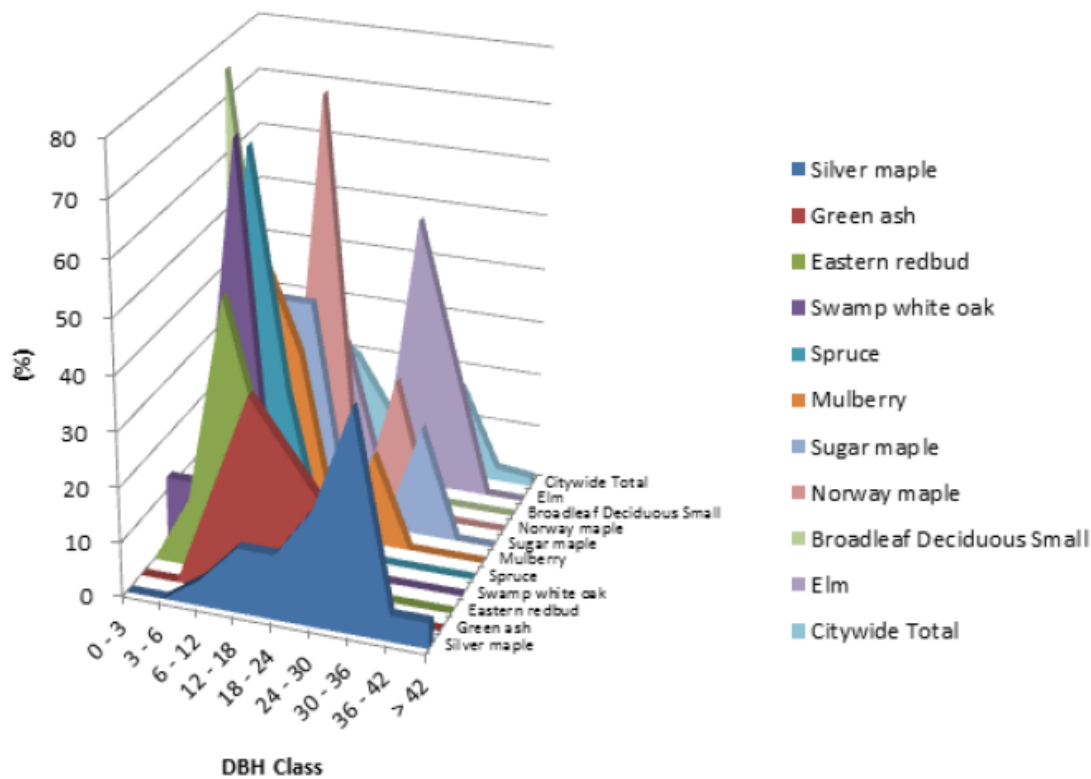


Species	Percent
Silver maple	31.8
Green ash	8.3
Eastern redbud	6.1
Swamp white oak	6.1
Spruce	5.3
Mulberry	4.5
Sugar maple	3.8
Norway maple	3.0
Broadleaf Deciduous Small	3.0
Elm	3.0
Other Species	25.0
Total	100.0

Figure 1: Species Distribution

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

1/15/2016



Species	DBH class (in)								
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42
Silver maple	0.00	0.00	4.76	11.90	11.90	21.43	40.48	4.76	4.76
Green ash	0.00	0.00	18.18	36.36	27.27	18.18	0.00	0.00	0.00
Eastern redbud	0.00	12.50	50.00	25.00	12.50	0.00	0.00	0.00	0.00
Swamp white oak	12.50	12.50	75.00	0.00	0.00	0.00	0.00	0.00	0.00
Spruce	0.00	0.00	71.43	28.57	0.00	0.00	0.00	0.00	0.00
Mulberry	0.00	0.00	50.00	33.33	0.00	16.67	0.00	0.00	0.00
Sugar maple	0.00	0.00	40.00	40.00	0.00	0.00	20.00	0.00	0.00
Norway maple	0.00	0.00	0.00	75.00	0.00	25.00	0.00	0.00	0.00
Broadleaf Deciduous Sm	75.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elm	0.00	0.00	0.00	25.00	0.00	50.00	25.00	0.00	0.00
Citywide Total	4.55	2.27	25.00	19.70	9.09	18.94	16.67	2.27	1.52

Figure 2: Relative Age Class

Leaf Condition

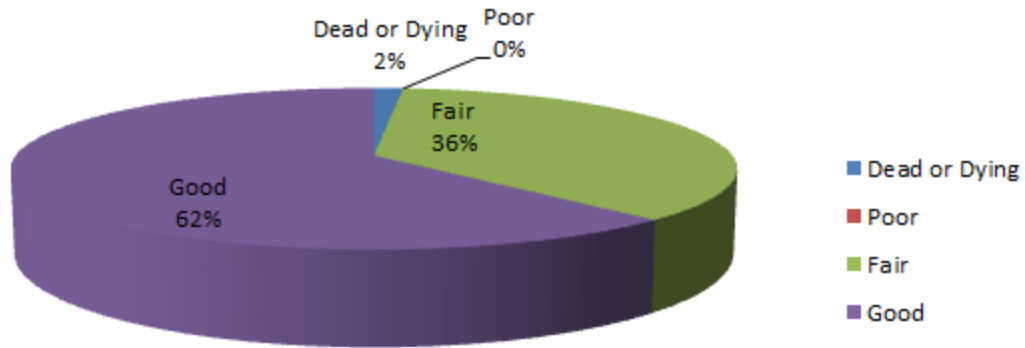


Figure 3: Foliage Condition

Wood Condition

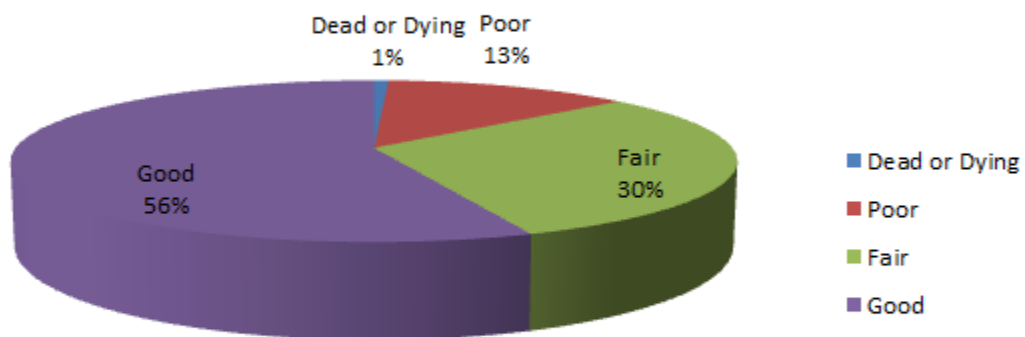
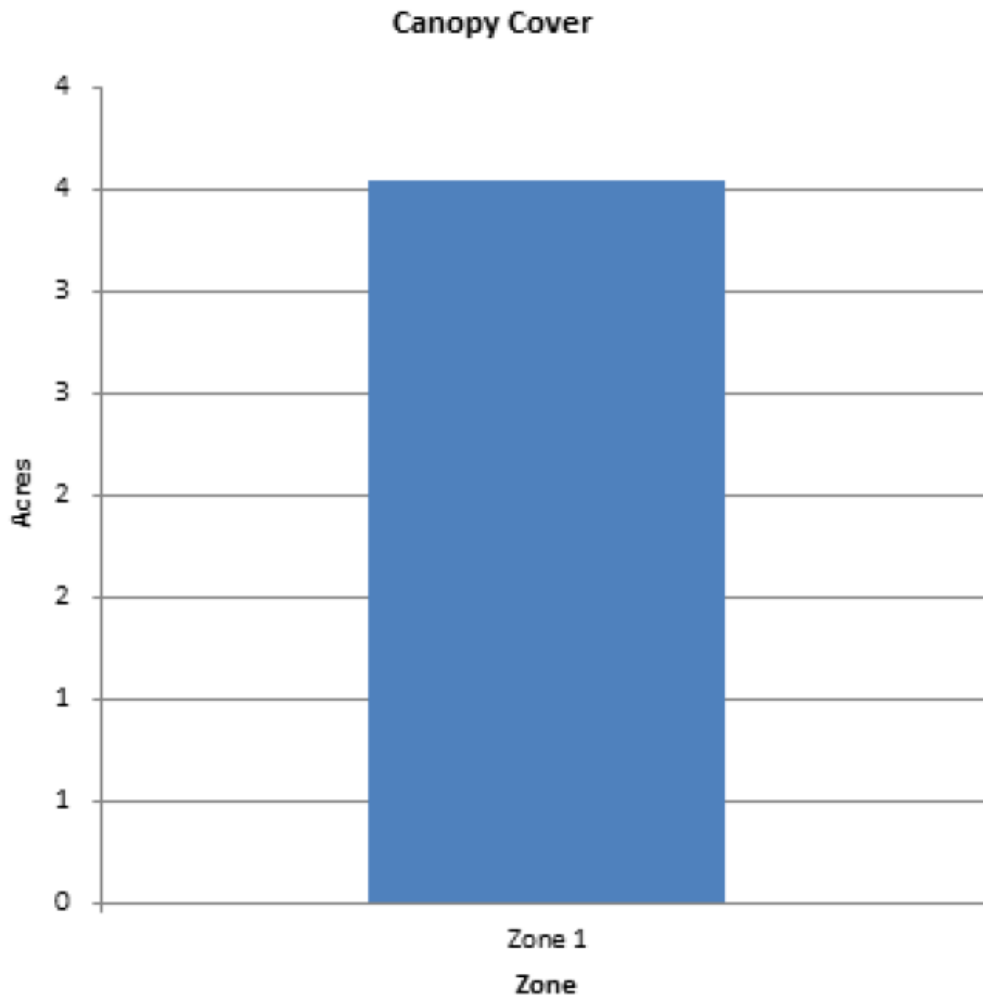


Figure 4: Wood Condition

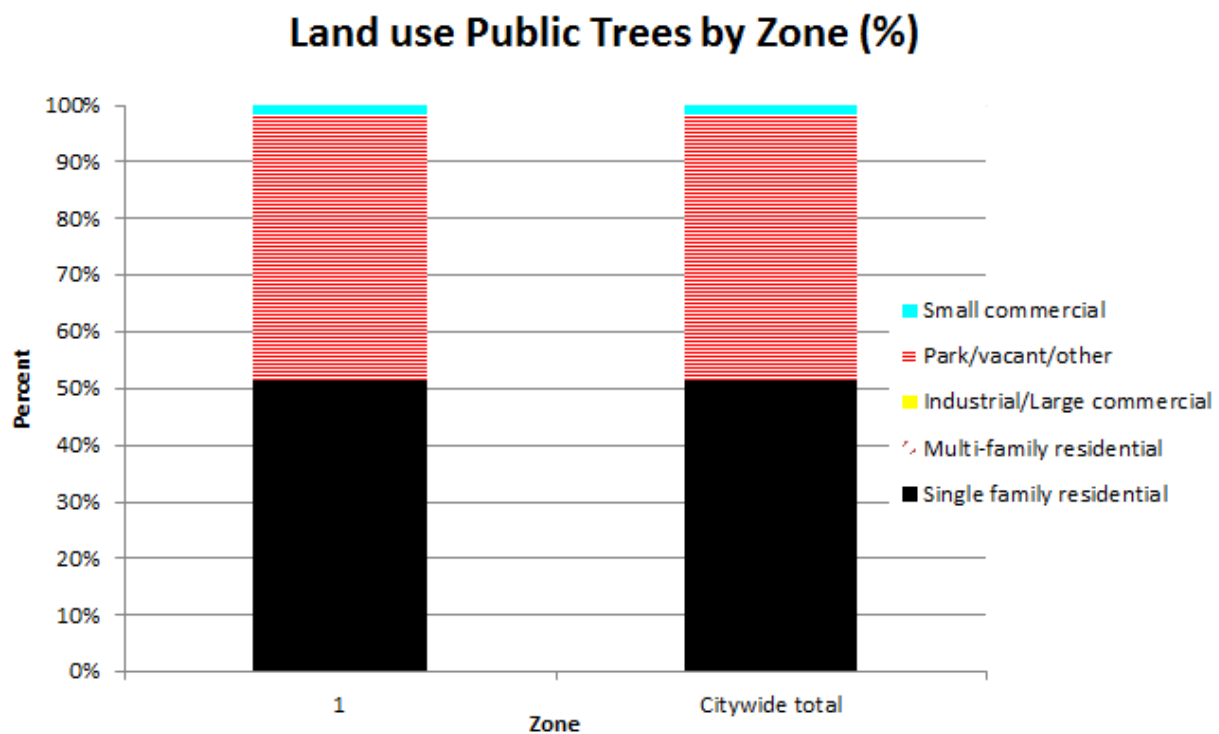
Canopy Cover of Public Trees (Acres)

1/15/2016



Zone	Acres	% of Total Canopy Cover
Zone 1	4	100.0
Citywide total	4	100.0

Figure 5: Canopy Cover in Acres



Zone	Single family residential	Multi-family residential	Industrial/Large commercial	Park/vacant /other	Small commercial
1	51.52	0.00	0.00	46.97	1.52
Citywide total	51.52	0.00	0.00	46.97	1.52

Figure 6: Land Use of city/park trees

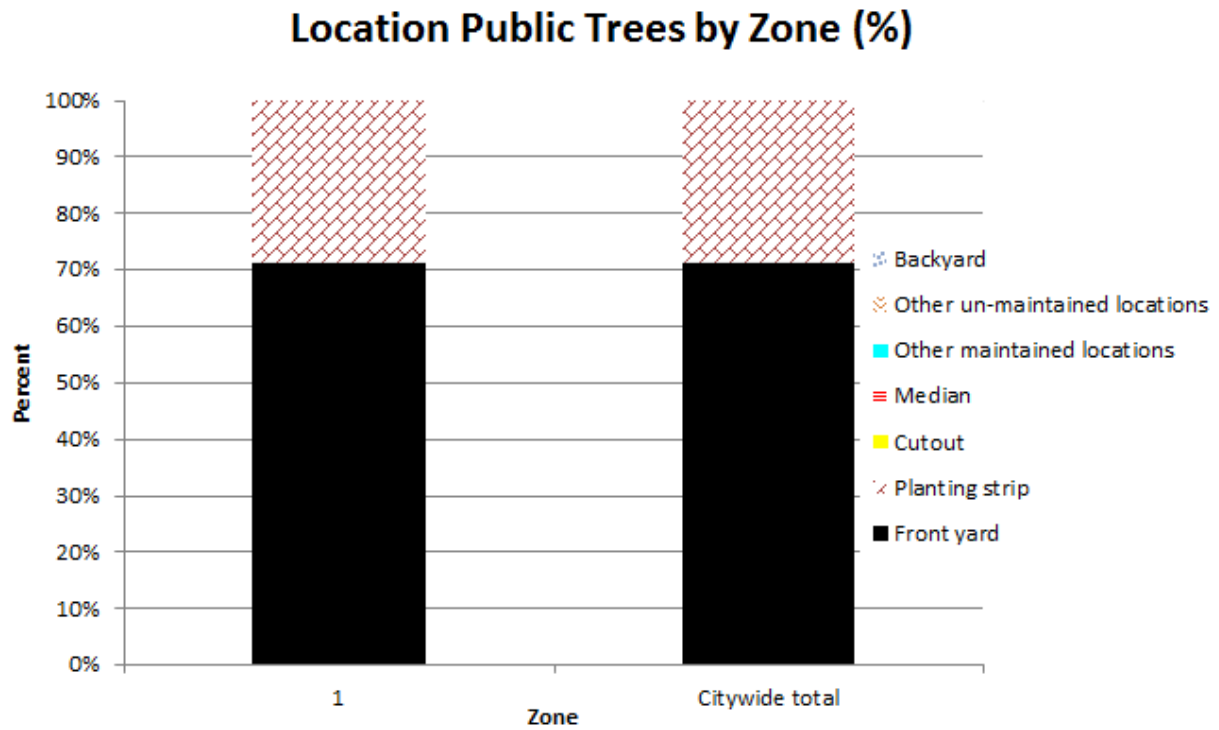


Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

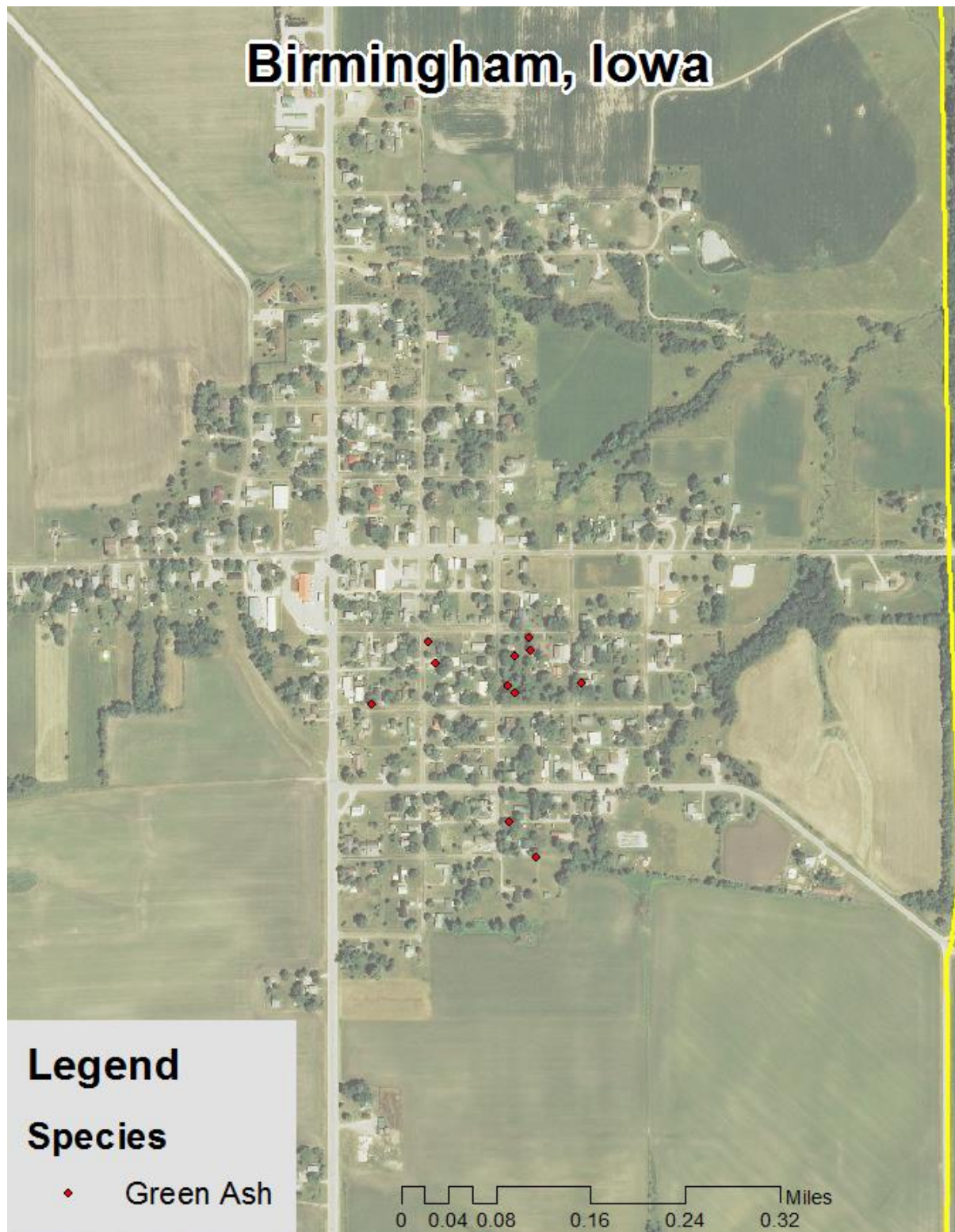


Figure 1: Location of Ash Trees

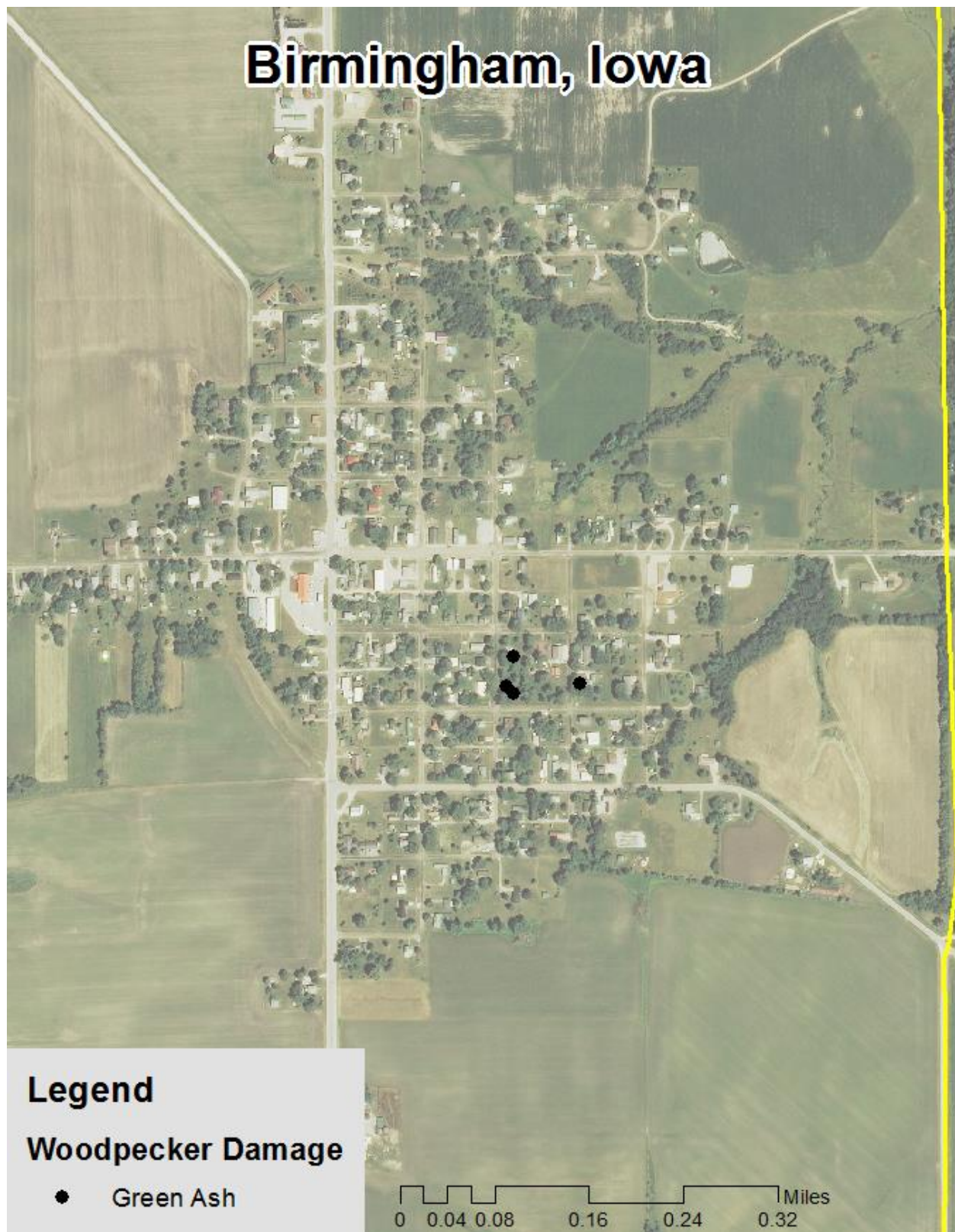


Figure 2: Location of EAB symptoms



Figure 3: Location of Poor Condition Trees

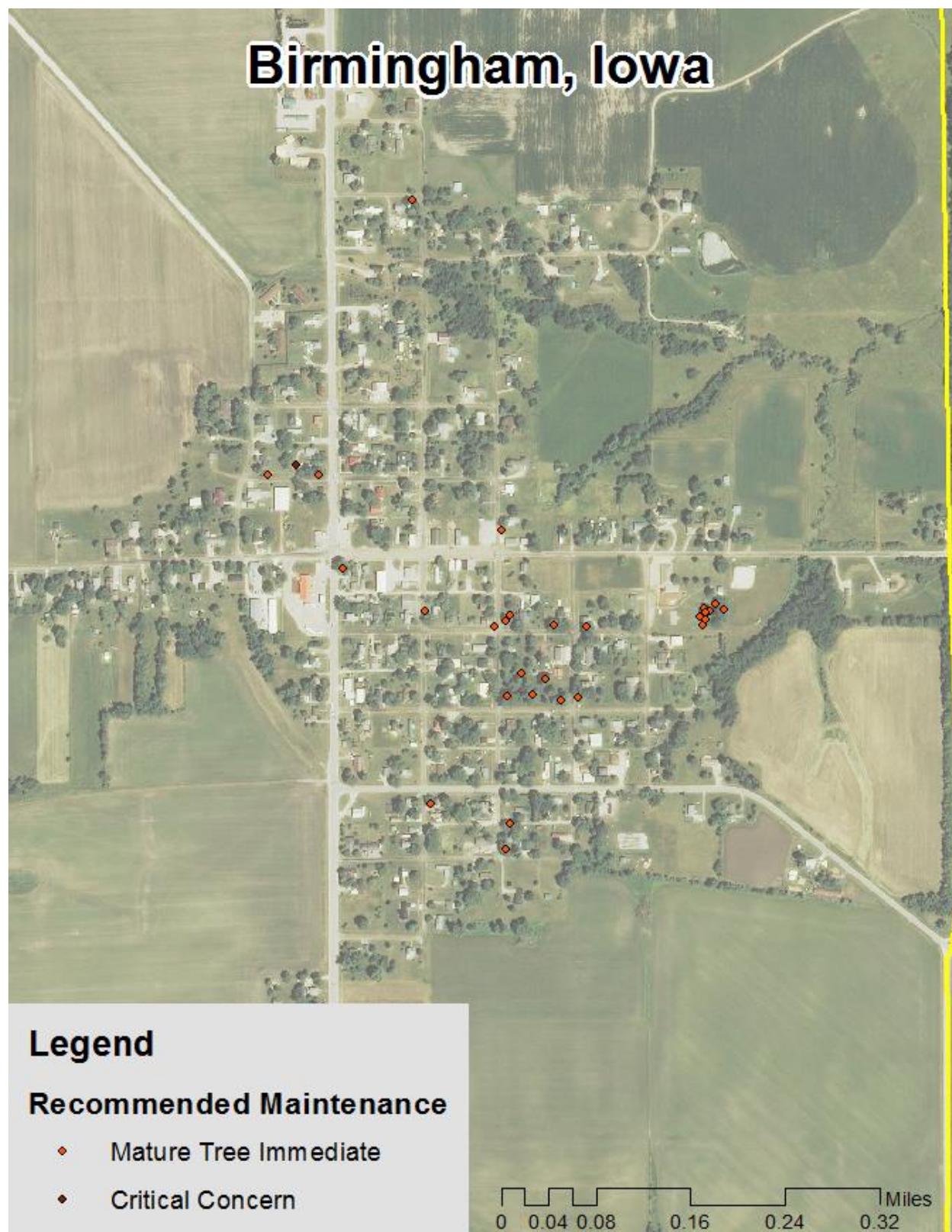


Figure 4: Location of Trees with Recommended Maintenance

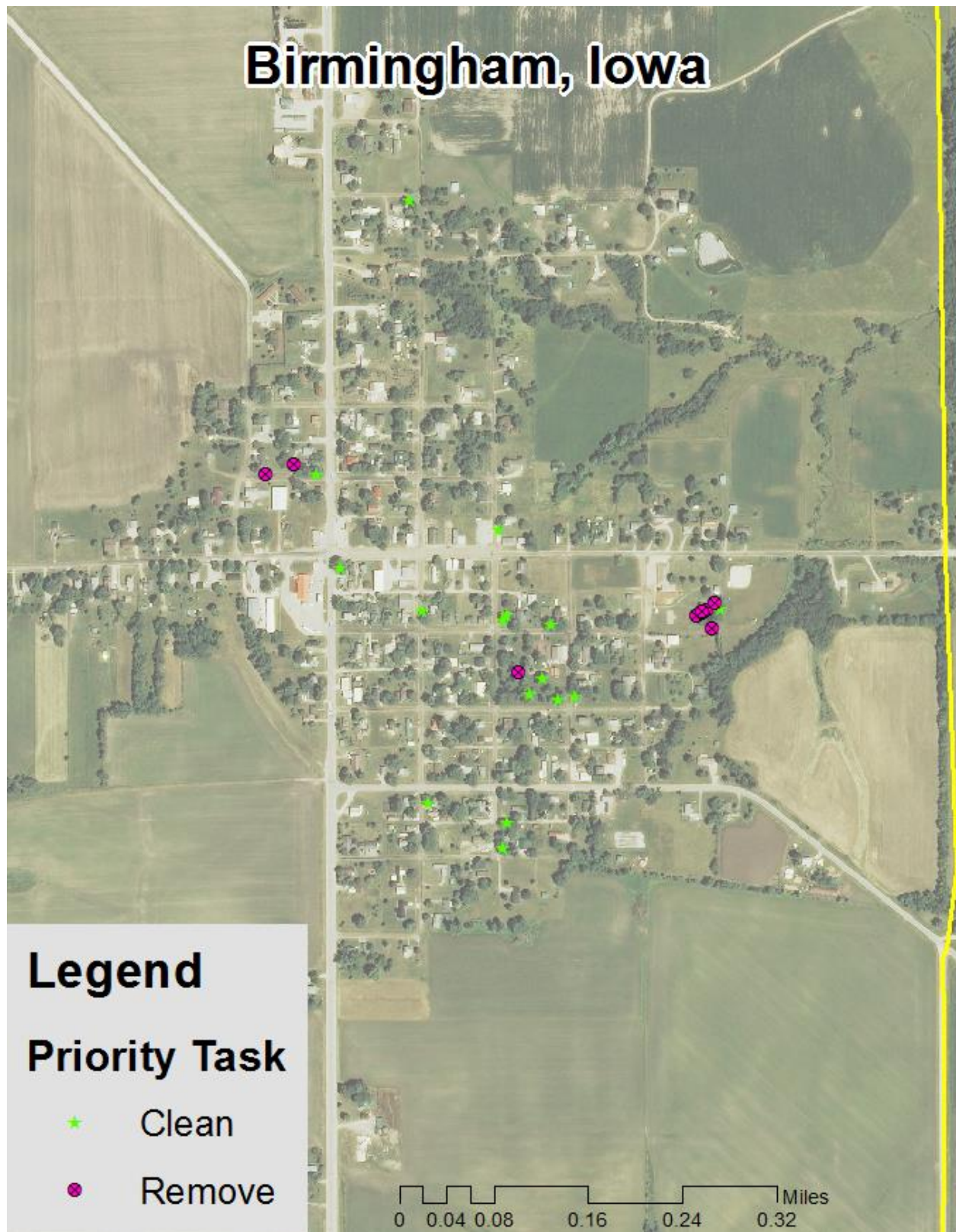


Figure 5: Maintenance Tasks *City ownership of the trees recommended for removal should be verified prior to any removal*

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.