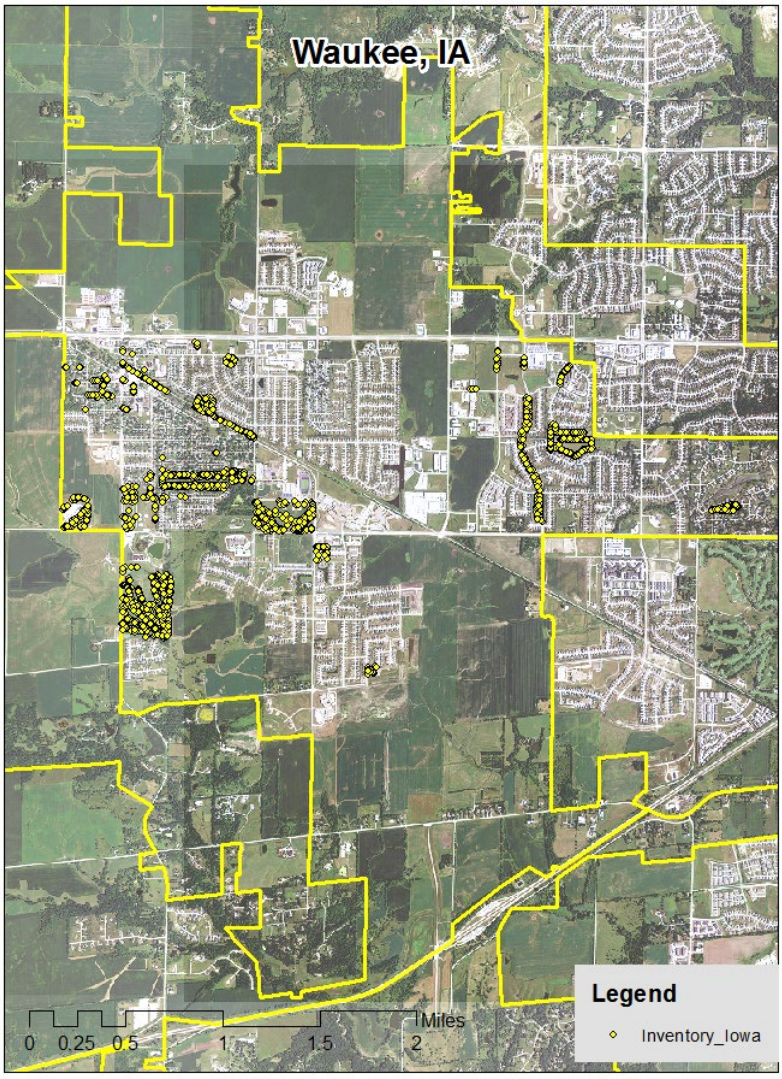
WAUKEE, IA



2014 Urban Forest Management Plan
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Executive Summary

Overview

This plan was developed to assist the City of Waukee 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 over 16% of Waukee'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 2013, a tree inventory was conducted using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street and park trees. Below are some key findings of the 1792 trees inventoried.

- Waukee's trees provide $177,905.20 of benefits annually, an average of $99 a tree
- There are over 51 species of trees
- The top three genera are: ash 17%, maple 11%, and linden 7%
- 4% of trees are in need of some type of management
- 43 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 43 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*
- 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
- With the current budget it could take 24 years to remove ash – Suggestion: request a budget increase to $10,000 annually and apply for grants to plant replacement trees

Introduction

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

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

Inventory

In 2013, a tree inventory was conducted that included 100% of the city owned trees on both streets and parks. The tree data was collected using a handheld Global Positioning System (GPS) receiver. The data collector gives Geographic Information Systems (GIS) coordinates with an accuracy of 3 meters, which can be used in Arc GIS as an active GIS data layer. Because the inventory is a digital document the data can be updated with new information and become a working document.

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

To quantify the urban forest structure and benefits, specific data is collected for each tree. This data includes: location, land use, species, diameter at 4.5 ft, recommended maintenance, priority of that maintenance, leaf health, and wood condition. Additionally, signs and symptoms 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 1792 city trees was entered into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management (STRATUM), part of the i-Tree suite. The following are results from the i-Tree STRATUM analysis.

Annual Benefits

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Waukee's trees reduce energy related costs by approximately $49,646 annually (Appendix A, Table 1). These savings are both in Electricity (234.4 MWh) and in Natural Gas (32,507.4 Therms).

Annual Stormwater Benefits

Waukee's trees intercept about 2,174,212 gallons of rainfall or snowmelt a year (Appendix A, Table 2). This interception provides $58,925 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 Waukee, it is estimated that trees remove 2,869.9lbs 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 $6,980 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Waukee, trees sequester about 462,998lbs of carbon a year with an associated value of $3,472 (Appendix A, Table 5). In addition, the trees store 6,781,047lbs of carbon, with a yearly benefit of $50,858 (Appendix A, Table 4).

Annual Aesthetics Benefits

Social benefits of trees are hard to capture. The analysis does have a calculation for this area that includes: aesthetic value, property values, lowered rates of mental illness and crime, city livability and much more. Waukee receives $55,124 in annual social benefits from trees (Appendix A, Table 6).

Financial Summary of all Benefits

According to the USDA Forest Service i-Tree STRATUM analysis, Waukee's trees provide $177,905.20 of benefits annually. Benefits of individual trees vary based on size, species,

health and location, but on average each of the 1792 trees in Waukee provide approximately $99 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Waukee has over 51 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Green ash	12.17%
Littleleaf linden	7.09%
Apple	6.2%
Eastern white pine	6.2%
Spruce	6.14%
Mulberry	5.81%
Honeylocust	5.75%
Northern hackberry	4.8%
Maple	4.63%
White ash	3.74%
Other Species	37.47%

Age Class

Most of Waukee's trees (38%) are between 6 and 18 inches in diameter at 4.5 ft (Appendix A, Figure 2). For age, it is preferred that the highest amounts of trees are in the smallest size category (a downward slope) to prepare for natural mortality and to maintain canopy cover. Waukee's size curve is on the smaller side, indicating a younger than average stand.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the overall health of the urban forest. The foliage condition results for Waukee indicate that 68% of the trees are in good health, with only 6% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 46% of Waukee'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 19% of the population. This 19% 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).

Tree Removal	43	2%
Crown Cleaning	35	2%

Canopy Cover

The total canopy with both private and public trees is 10% of Waukee. The canopy cover included in the Waukee inventory includes approximately 831.36 acres (Appendix A, Figure 4).

Land Use and Location

The majority of Waukee's city and park trees are in planting strips 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	80%
Single family residential	19%
Industrial/Large commercial	<1%
Multifamily residential	<1%

Recommendations

Risk Management

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

Hazardous trees

Waukee has 1 critical concern tree that needs immediate removal. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). It is recommended to start with the large diameter critical concern trees first. There is 1 tree over 30 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 16 trees with these needs.

Poor tree species

After the removal of the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). There are a total of 296 ash trees, and 11 of those have signs and symptoms that have been associated with EAB. In addition, there are 23 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 1.2 trees for every tree removed, since survival rates will not be 100%. Please refer to the six year maintenance plan at the end of this section. It is not essential that the new trees be planted in the same location of the trees being removed. However, maintaining the same number of trees helps ensure continuation of the benefits of the existing forest in Waukee.

It is important to plant a diverse mix of species in the urban forest to maintain canopy health, since most insects and diseases target a genus (ash) or species (green ash) of trees. Current diversity recommendations advise that a genus (i.e. maple, oak) not make up more than 20% of the urban forest and a single species (i.e. silver maple, sugar maple, white oak, bur oak) not make up more than 10% of the total urban forest. 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, 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

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.

Six Year Maintenance Plan with <u>No Additional Funding</u>

Year 1

- Removal: 8 largest critical concern trees
- Planting and Replacement: 9 trees to be planted in open locations
- Visual Survey for signs and symptoms of EAB

Year 2

- Removal: 2 critical concern trees and 4 additional ash trees with poor health
- *Or saving for ash tree treatment
- Planting and Replacement: 6 trees in open locations from year one removals

Routine trimming: Contract to trim 1/3 of the city trees
Visual Survey for signs and symptoms of EAB

Year 3

Removal: 8 trees - removal of any new critical concern trees and ash in poor health
*Or saving for ash tree treatment
Planting and Replacement: 9 trees to be planted in open locations and locations from previous removals
Visual Survey for signs and symptoms of EAB

Year 4

Removal: 6 trees - removal of any new critical concern trees and ash in poor health
*Or saving for ash tree treatment
Planting and Replacement: 7 trees in open locations from previous removals
Routine trimming: Contract to trim 1/3 of the city trees
Visual Survey for signs and symptoms of EAB

Year 5

Removal: 8 trees - removal of any new critical concern trees and ash in poor health
*Or saving for ash tree treatment
Planting and Replacement: 9 trees to be planted in open locations and locations from previous removals
Visual Survey for signs and symptoms of EAB

Year 6

Removal: 6 trees - removal of any new critical concern trees and ash in poor health
*Or saving for ash tree treatment
Planting and Replacement: 7 trees in open locations from previous removals
Routine trimming: Contract to trim 1/3 of the city trees
Visual Survey for signs and symptoms of EAB

*Reduction of ash over 6 years: Approximately 30 to 38 ash trees removed (approximately 25% of ash). It will take approximately 24 years to remove all ash with the current budget. EAB could potentially kill all ash within 4 years of its arrival.
** To remove all ash trees within 6 years, the budget would need to be increased to $19,500 a year. If the budget were increased to $10,000 a year all ash could be removed in 13 years.

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 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 for your county.

Wood Disposal

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

Canopy Replacement

As budget permits, all removed 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, 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 (trees or shrubs in the City reported or suspected to be infected with or damaged by any disease or insect or disease pests) on private property and that the 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."

Budget

Current Budget
Total $42,000 over 6 years ($7,000/year)

FY 2011 Budget
- Removal: $5,600
- *Or saving for ash tree treatment
- Planting: $900
- Watering & Maintenance: $500

FY 2012 Budget
- Removal: $4,200
- *Or saving for ash tree treatment
- Planting: $600
- Routine trimming: $1,700
- Watering & Maintenance: $500

FY 2013 Budget
- Removal: $5,600
- *Or saving for ash tree treatment
- Planting: $900
- Watering & Maintenance: $500

FY 2014 Budget
- Removal: $4,200
- *Or saving for ash tree treatment
- Planting: $600
- Routine trimming: $1,700
- Watering & Maintenance: $500

FY 2015 Budget
- Removal: $5,600
- *Or saving for ash tree treatment
- Planting: $900
- Watering & Maintenance: $500

FY 2016 Budget
- Removal: $4,200
- *Or saving for ash tree treatment
- Planting: $600
- Routine trimming: $1,700
- Watering & Maintenance: $500

*Reduction of ash over 6 years: approximately 30 to 38 ash trees removed (approximately 25% of ash). **It will take approximately 24 years to remove all ash with the current budget.**

Purposed Budget Increase

EAB could potentially kill all ash trees in Waukee within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to $19,500 a year. If the budget were increased to $10,000 a year all ash could be removed within 13 years. Additionally, it is recommended that Waukee apply for grants to fund replacement trees. Utility Company grants are usually between $500 and $10,000 for community-based, tree-planting projects that include parks, gateways, cemeteries, nature trails, libraries, nursing homes, and schools.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Waukee

Annual Energy Benefits of Public Trees by Species

3/3/2014

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	42.5	3,222	5,899.9	5,782	9,004	(N/A)	12.2	18.1	41.30
Littleleaf linden	6.5	493	948.7	930	1,422	(N/A)	7.1	2.9	11.20
Apple	4.7	360	730.5	716	1,076	(N/A)	6.2	2.2	9.69
Eastern white pine	5.4	411	904.3	886	1,297	(N/A)	6.2	2.6	11.69
Spruce	4.5	341	687.0	673	1,014	(N/A)	6.1	2.0	9.22
Mulberry	17.1	1,301	2,585.3	2,534	3,835	(N/A)	5.8	7.7	36.87
Honeylocust	20.6	1,560	2,741.8	2,687	4,247	(N/A)	5.8	8.6	41.23
Northern hackberry	10.7	815	1,582.3	1,551	2,366	(N/A)	4.8	4.8	27.51
Maple	4.4	330	620.0	608	938	(N/A)	4.6	1.9	11.30
White ash	18.9	1,431	2,331.2	2,285	3,716	(N/A)	3.7	7.5	55.46
Broadleaf Evergreen	4.1	314	599.6	588	902	(N/A)	3.0	1.8	16.70
Black walnut	12.7	966	1,668.5	1,635	2,601	(N/A)	2.9	5.2	51.00
Siberian elm	9.5	720	1,230.0	1,205	1,926	(N/A)	2.4	3.9	44.78
Norway maple	4.4	337	640.5	628	965	(N/A)	2.2	1.9	24.13
Silver maple	10.2	777	1,367.4	1,340	2,117	(N/A)	2.0	4.3	60.47
Eastern red cedar	2.7	206	411.9	404	610	(N/A)	1.9	1.2	17.94
American sycamore	3.1	239	444.5	436	675	(N/A)	1.9	1.4	19.84
Elm	7.2	544	930.0	911	1,455	(N/A)	1.8	2.9	44.10
Northern catalpa	10.4	793	1,431.2	1,403	2,196	(N/A)	1.8	4.4	68.61
Cottonwood	7.2	548	964.8	945	1,494	(N/A)	1.7	3.0	49.79
Willow	3.4	261	499.1	489	750	(N/A)	1.6	1.5	26.80
Sugar maple	2.9	221	390.0	382	603	(N/A)	1.5	1.2	22.33
Northern red oak	0.4	32	66.2	65	97	(N/A)	1.3	0.2	4.22
Scotch pine	2.7	202	317.1	311	512	(N/A)	1.2	1.0	24.40
Broadleaf Evergreen	5.3	400	687.7	674	1,074	(N/A)	1.1	2.2	53.69
Kentucky coffeetree	1.8	136	260.8	256	392	(N/A)	1.1	0.8	20.64
Pear	1.0	75	145.6	143	217	(N/A)	1.0	0.4	12.07
Other street trees	9.9	752	1,421.6	1,393	2,145	(N/A)	7.2	4.3	16.63
Citywide total	234.4	17,789	32,507.4	31,857	49,646	(N/A)	100.0	100.0	27.72

Table 2: Annual Stormwater Benefits

Waukee

Annual Stormwater Benefits of Public Trees by Species

3/3/2014

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	434,772	11,783	(N/A)	12.2	20.0	54.05
Littleleaf linden	65,311	1,770	(N/A)	7.1	3.0	13.94
Apple	21,238	576	(N/A)	6.2	1.0	5.19
Eastern white pine	56,885	1,542	(N/A)	6.2	2.6	13.89
Spruce	61,203	1,659	(N/A)	6.1	2.8	15.08
Mulberry	82,306	2,231	(N/A)	5.8	3.8	21.45
Honeylocust	205,439	5,568	(N/A)	5.8	9.5	54.06
Northern hackberry	61,581	1,669	(N/A)	4.8	2.8	19.41
Maple	27,127	735	(N/A)	4.6	1.3	8.86
White ash	175,751	4,763	(N/A)	3.7	8.1	71.09
Broadleaf Evergreen	31,524	854	(N/A)	3.0	1.5	15.82
Black walnut	115,082	3,119	(N/A)	2.9	5.3	61.16
Siberian elm	80,701	2,187	(N/A)	2.4	3.7	50.86
Norway maple	27,904	756	(N/A)	2.2	1.3	18.91
Silver maple	119,204	3,231	(N/A)	2.0	5.5	92.30
Eastern red cedar	39,015	1,057	(N/A)	1.9	1.8	31.10
American sycamore	39,766	1,078	(N/A)	1.9	1.8	31.70
Elm	58,306	1,580	(N/A)	1.8	2.7	47.88
Northern catalpa	127,303	3,450	(N/A)	1.8	5.9	107.82
Cottonwood	85,540	2,318	(N/A)	1.7	3.9	77.28
Willow	28,789	780	(N/A)	1.6	1.3	27.87
Sugar maple	25,264	685	(N/A)	1.5	1.2	25.36
Northern red oak	1,902	52	(N/A)	1.3	0.1	2.24
Scotch pine	36,349	985	(N/A)	1.2	1.7	46.91
Broadleaf Evergreen	73,699	1,997	(N/A)	1.1	3.4	99.87
Kentucky coffeetree	11,549	313	(N/A)	1.1	0.5	16.47
Pear	3,902	106	(N/A)	1.0	0.2	5.88
Other street trees	76,800	2,081	(N/A)	7.2	3.5	16.14
Citywide total	2,174,212	58,925	(N/A)	100.0	100.0	32.90

Table 3: Annual Air Quality Benefits

Waukee

Annual Air Quality Benefits of Public Trees by Species

3/3/2014

Species	Deposition (lb) O_3	NO_2	PM_{10}	SO_2	Total Depos. ($)	Avoided (lb) NO_2	PM_{10}	VOC	SO_2	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	Standard Error	% of Total Trees	Avg. $/tree
Green ash	48.6	7.8	24.2	2.2	262	203.4	29.6	28.2	192.4	1,265	0.0	0	536.3	1,527	(N/A)	12.2	7.00
Littleleaf linden	11.2	1.9	5.6	0.5	61	31.6	4.6	4.3	29.5	195	-5.3	-20	83.8	236	(N/A)	7.1	1.86
Apple	6.7	1.1	3.1	0.3	36	23.4	3.3	3.2	21.5	144	0.0	0	62.6	179	(N/A)	6.2	1.61
Eastern white pine	4.6	0.9	5.0	0.6	34	27.3	3.9	3.7	24.5	166	-16.0	-60	54.4	140	(N/A)	6.2	1.26
Spruce	5.7	1.1	5.3	0.7	40	22.0	3.2	3.0	20.3	136	-24.1	-90	37.3	85	(N/A)	6.1	0.77
Mulberry	27.8	4.6	12.8	1.3	147	83.9	12.1	11.5	77.7	518	-0.1	-1	231.5	664	(N/A)	5.8	6.39
Honeylocust	38.9	6.4	18.0	1.8	206	97.3	14.2	13.6	93.1	608	-29.6	-111	253.6	703	(N/A)	5.8	6.83
Northern hackberry	5.2	0.9	3.5	0.2	31	52.4	7.6	7.2	48.8	324	0.0	0	125.7	355	(N/A)	4.8	4.12
Maple	4.7	0.8	2.5	0.2	26	21.0	3.0	2.9	19.7	130	-1.7	-7	53.0	149	(N/A)	4.6	1.80
White ash	22.3	3.6	11.0	1.0	120	87.7	12.9	12.4	85.4	552	0.0	0	236.3	672	(N/A)	3.7	10.02
Broadleaf Evergreen	1.1	0.2	2.1	0.1	11	19.9	2.9	2.7	18.6	123	-7.8	-29	40.0	105	(N/A)	3.0	1.94
Black walnut	12.1	1.9	6.2	0.5	66	60.1	8.8	8.4	57.7	376	0.0	0	155.8	442	(N/A)	2.8	8.66
Siberian elm	10.8	1.8	5.6	0.5	59	44.7	6.5	6.3	43.0	280	0.0	0	119.2	339	(N/A)	2.4	7.88
Norway maple	4.0	0.7	2.2	0.2	22	21.6	3.1	3.0	20.2	134	-1.1	-4	53.8	152	(N/A)	2.2	3.79
Silver maple	17.3	2.9	8.9	0.8	94	48.4	7.1	6.8	46.3	303	-9.8	-37	128.7	360	(N/A)	2.0	10.30
Eastern red cedar	7.1	1.4	5.7	0.9	46	13.3	1.9	1.8	12.3	82	-21.3	-80	23.1	48	(N/A)	1.9	1.42
American sycamore	5.3	0.8	2.4	0.2	28	15.2	2.2	2.1	14.3	94	0.0	0	42.5	122	(N/A)	1.9	3.59
Elm	5.4	0.9	2.9	0.2	30	33.8	4.9	4.7	32.5	211	0.0	0	85.4	241	(N/A)	1.8	7.31
Northern catalpa	17.8	2.8	8.2	0.8	94	49.9	7.3	6.9	47.3	311	0.0	0	141.0	405	(N/A)	1.8	12.64
Cottonwood	14.2	2.3	6.5	0.6	75	34.3	5.0	4.8	32.7	214	0.0	0	100.4	289	(N/A)	1.7	9.62
Willow	5.5	0.9	2.8	0.2	30	16.7	2.4	2.3	15.6	103	-1.3	-5	45.2	128	(N/A)	1.6	4.59
Sugar maple	2.9	0.5	1.6	0.1	16	13.8	2.0	1.9	13.2	86	-2.4	-9	33.6	93	(N/A)	1.5	3.46
Northern red oak	0.2	0.0	0.1	0.0	1	2.1	0.3	0.3	1.9	13	-0.3	-1	4.7	13	(N/A)	1.3	0.56
Scotch pine	4.1	0.8	3.5	0.5	27	12.2	1.8	1.7	12.0	77	-14.7	-55	22.0	49	(N/A)	1.2	2.35
Broadleaf Evergreen	10.3	2.0	8.6	1.3	68	24.8	3.6	3.5	23.7	155	-32.8	-123	45.0	100	(N/A)	1.1	5.00
Kentucky coffeetree	0.5	0.1	0.4	0.0	3	8.7	1.3	1.2	8.1	54	0.0	0	20.3	57	(N/A)	1.1	2.99
Pear	1.1	0.2	0.5	0.1	6	4.8	0.7	0.7	4.4	30	0.0	0	12.5	36	(N/A)	1.0	1.98
Other street trees	10.5	1.7	5.4	0.5	57	47.9	6.9	6.6	44.9	297	-1.9	-7	122.4	347	(N/A)	7.2	2.69
Citywide total	305.9	51.3	164.7	16.3	1,694	1,121.9	163.1	155.4	1,061.7	6,980	-170.4	-639	2,869.9	8,035	(N/A)	100.0	4.49

Table 4: Annual Carbon Stored

Waukee

Stored CO2 Benefits of Public Trees by Species

3/3/2014

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	1,584,623	11,885	(N/A)	12.2	23.4	54.52
Littleleaf linden	242,407	1,818	(N/A)	7.1	3.6	14.32
Apple	105,627	792	(N/A)	6.2	1.6	7.14
Eastern white pine	23,983	180	(N/A)	6.2	0.4	1.62
Spruce	49,380	370	(N/A)	6.1	0.7	3.37
Mulberry	430,782	3,231	(N/A)	5.8	6.4	31.07
Honeylocust	498,448	3,738	(N/A)	5.8	7.4	36.29
Northern	70,735	531	(N/A)	4.8	1.0	6.17
Maple	58,261	437	(N/A)	4.6	0.9	5.26
White ash	464,022	3,480	(N/A)	3.7	6.8	51.94
Broadleaf	23,720	178	(N/A)	3.0	0.4	3.29
Black walnut	396,669	2,975	(N/A)	2.9	5.9	58.33
Siberian elm	271,356	2,035	(N/A)	2.4	4.0	47.33
Norway maple	68,945	517	(N/A)	2.2	1.0	12.93
Silver maple	375,444	2,816	(N/A)	2.0	5.5	80.45
Eastern red cedar	23,803	179	(N/A)	1.9	0.4	5.25
American	171,339	1,285	(N/A)	1.9	2.5	37.80
Elm	177,715	1,333	(N/A)	1.8	2.6	40.39
Northern catalpa	585,493	4,391	(N/A)	1.8	8.6	137.22
Cottonwood	494,896	3,712	(N/A)	1.7	7.3	123.72
Willow	92,972	697	(N/A)	1.6	1.4	24.90
Sugar maple	83,622	627	(N/A)	1.5	1.2	23.23
Northern red oak	2,835	21	(N/A)	1.3	0.0	0.92
Scotch pine	33,413	251	(N/A)	1.2	0.5	11.93
Broadleaf	126,169	946	(N/A)	1.1	1.9	47.31
Kentucky	19,656	147	(N/A)	1.1	0.3	7.76
Pear	17,925	134	(N/A)	1.0	0.3	7.47
Other street trees	130,095	2,151	(N/A)	7.2	4.2	16.67
Citywide total	6,781,047	50,858	(N/A)	100.0	100.0	28.40

Table 5: Annual Carbon Sequestered

Waukee

Annual CO_2 Benefits of Public Trees by Species

3/3/2014

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
Green ash	102,646	770	-7,606	-43	-57	71,210	534	166,208	1,247	(N/A)	12.2	20.2	5.72
Littleleaf linden	18,492	139	-1,164	-25	-9	10,886	82	28,190	211	(N/A)	7.1	3.4	1.66
Apple	7,247	54	-507	-22	-4	7,952	60	14,671	110	(N/A)	6.2	1.8	0.99
Eastern white pine	4,963	37	-115	-22	-1	9,082	68	13,908	104	(N/A)	6.2	1.7	0.94
Spruce	4,243	32	-237	-21	-2	7,528	56	11,512	86	(N/A)	6.1	1.4	0.78
Mulberry	23,029	173	-2,068	-20	-16	28,755	216	49,696	373	(N/A)	5.8	6.0	3.58
Honeylocust	44,375	333	-2,393	-20	-18	34,480	259	76,442	573	(N/A)	5.8	9.3	5.57
Northern hackberry	8,223	62	-340	-17	-3	18,022	135	25,888	194	(N/A)	4.8	3.1	2.26
Maple	6,957	52	-280	-16	-2	7,304	55	13,965	105	(N/A)	4.6	1.7	1.26
White ash	44,962	337	-2,227	-13	-17	31,633	237	74,355	558	(N/A)	3.7	9.0	8.32
Broadleaf Evergreen	2,621	20	-114	-11	-1	6,949	52	9,446	71	(N/A)	3.0	1.2	1.31
Black walnut	28,400	213	-1,904	-10	-14	21,344	160	47,830	359	(N/A)	2.9	5.8	7.03
Siberian elm	16,156	121	-1,303	-8	-10	15,920	119	30,765	231	(N/A)	2.4	3.7	5.37
Norway maple	8,449	63	-331	-8	-3	7,458	56	15,569	117	(N/A)	2.2	1.9	2.92
Silver maple	34,915	262	-1,802	-7	-14	17,160	129	50,267	377	(N/A)	2.0	6.1	10.77
Eastern red cedar	928	7	-114	-7	-1	4,563	34	5,370	40	(N/A)	1.9	0.7	1.18
American sycamore	7,770	58	-822	-7	-6	5,281	40	12,222	92	(N/A)	1.9	1.5	2.70
Elm	15,745	118	-853	-6	-6	12,020	90	26,906	202	(N/A)	1.8	3.3	6.12
Northern catalpa	24,046	180	-2,810	-6	-21	17,524	131	38,754	291	(N/A)	1.8	4.7	9.08
Cottonwood	12,341	93	-2,376	-6	-18	12,114	91	22,074	166	(N/A)	1.7	2.7	5.52
Willow	3,973	30	-446	-5	-3	5,772	43	9,294	70	(N/A)	1.6	1.1	2.49
Sugar maple	5,662	42	-401	-5	-3	4,879	37	10,134	76	(N/A)	1.5	1.2	2.81
Northern red oak	548	4	-14	-4	0	710	5	1,240	9	(N/A)	1.3	0.2	0.40
Scotch pine	2,329	17	-160	-4	-1	4,456	33	6,621	50	(N/A)	1.2	0.8	2.36
Broadleaf Evergreen	7,460	56	-606	-4	-5	8,836	66	15,686	118	(N/A)	1.1	1.9	5.88
Kentucky coffeetree	3,967	30	-94	-4	-1	3,016	23	6,885	52	(N/A)	1.1	0.8	2.72
Pear	1,684	13	-86	-4	-1	1,647	12	3,241	24	(N/A)	1.0	0.4	1.35
Other street trees	20,866	156	-1,377	-25	-11	16,624	125	36,087	271	(N/A)	7.2	4.4	2.10
Citywide total	462,998	3,472	-32,549	-349	-247	393,127	2,948	823,226	6,174	(N/A)	100.0	100.0	3.45

Table 6: Annual Social and Aesthetic Benefits

Waukee

Annual Aesthetic/Other Benefits of Public Trees by Species

3/3/2014

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	9,349	(N/A)	12.2	17.0	42.88
Littleleaf linden	2,076	(N/A)	7.1	3.8	16.35
Apple	387	(N/A)	6.2	0.7	3.49
Eastern white pine	1,497	(N/A)	6.2	2.7	13.48
Spruce	1,330	(N/A)	6.1	2.4	12.09
Mulberry	1,354	(N/A)	5.8	2.5	13.02
Honeylocust	10,130	(N/A)	5.8	18.4	98.35
Northern hackberry	2,020	(N/A)	4.8	3.7	23.49
Maple	1,063	(N/A)	4.6	1.9	12.81
White ash	5,303	(N/A)	3.7	9.6	79.15
Broadleaf Evergreen	989	(N/A)	3.0	1.8	18.32
Black walnut	2,583	(N/A)	2.9	4.7	50.65
Siberian elm	1,419	(N/A)	2.4	2.6	33.00
Norway maple	936	(N/A)	2.2	1.7	23.39
Silver maple	3,001	(N/A)	2.0	5.4	85.74
Eastern red cedar	435	(N/A)	1.9	0.8	12.79
American sycamore	713	(N/A)	1.9	1.3	20.96
Elm	1,519	(N/A)	1.8	2.8	46.03
Northern catalpa	1,858	(N/A)	1.8	3.4	58.07
Cottonwood	1,111	(N/A)	1.7	2.0	37.03
Willow	456	(N/A)	1.6	0.8	16.28
Sugar maple	625	(N/A)	1.5	1.1	23.13
Northern red oak	82	(N/A)	1.3	0.2	3.56
Scotch pine	642	(N/A)	1.2	1.2	30.58
Broadleaf Evergreen	1,570	(N/A)	1.1	2.9	78.48
Kentucky coffeetree	543	(N/A)	1.1	1.0	28.56
Pear	94	(N/A)	1.0	0.2	5.24
Other street trees	2,043	(N/A)	7.2	3.7	15.84
Citywide total	55,124	(N/A)	100.0	100.0	30.78

Table 7: Summary of Benefits in Dollars

Average Annual Benefits of Public Trees by Species

Species	Energy	CO2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Green ash	9,004	1,247	1,527	11,783	9,349	$32,909.33	(±0)	18.50
Littleleaf linden	1,422	211	236	1,770	2,076	$5,715.84	(±0)	3.21
Apple	1,076	110	179	576	387	$2,327.45	(±0)	1.31
Eastern white pine	1,297	104	140	1,542	1,497	$4,579.72	(±0)	2.57
Spruce	1,014	86	85	1,659	1,330	$4,173.53	(±0)	2.35
Mulberry	3,835	373	664	2,231	1,354	$8,456.06	(±0)	4.75
Honeylocust	4,247	573	703	5,568	10,130	$21,221.27	(±0)	11.93
Northern hackberry	2,366	194	355	1,669	2,020	$6,603.68	(±0)	3.71
Maple	938	105	149	735	1,063	$2,990.26	(±0)	1.68
White ash	3,716	558	672	4,763	5,303	$15,011.29	(±0)	8.44
Broadleaf Evergreen Medium	902	71	105	854	989	$2,921.26	(±0)	1.64
Black walnut	2,601	359	442	3,119	2,583	$9,103.73	(±0)	5.12
Siberian elm	1,926	231	339	2,187	1,419	$6,101.61	(±0)	3.43
Norway maple	965	117	152	756	936	$2,925.45	(±0)	1.64
Silver maple	2,117	377	360	3,231	3,001	$9,085.46	(±0)	5.11
Eastern red cedar	610	40	48	1,057	435	$2,191.15	(±0)	1.23
American sycamore	675	92	122	1,078	713	$2,678.49	(±0)	1.51
Elm	1,455	202	241	1,580	1,519	$4,997.55	(±0)	2.81
Northern catalpa	2,196	291	405	3,450	1,858	$8,199.22	(±0)	4.61
Cottonwood	1,494	166	289	2,318	1,111	$5,377.16	(±0)	3.02
Willow	750	70	128	780	456	$2,184.48	(±0)	1.23
Sugar maple	603	76	93	685	625	$2,081.52	(±0)	1.17
Northern red oak	97	9	13	52	82	$252.55	(±0)	0.14
Scotch pine	512	50	49	985	642	$2,238.70	(±0)	1.26
Broadleaf Evergreen Large	1,074	118	100	1,997	1,570	$4,858.44	(±0)	2.73
Kentucky coffeetree	392	52	57	313	543	$1,356.18	(±0)	0.76
Pear	217	24	36	106	94	$477.07	(±0)	0.27
Other street trees	2,145	271	347	2,081	2,043	$6,886.78	(±0)	3.87
Citywide total	49,646	6,174	8,035	58,925	55,124	$177,905.20	(±0)	100.00

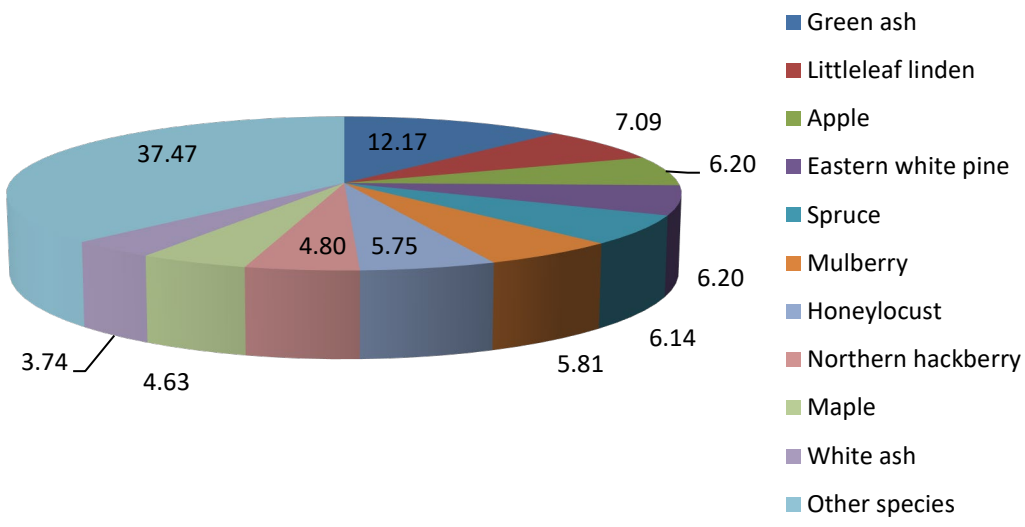

Figure 1: Species Distribution

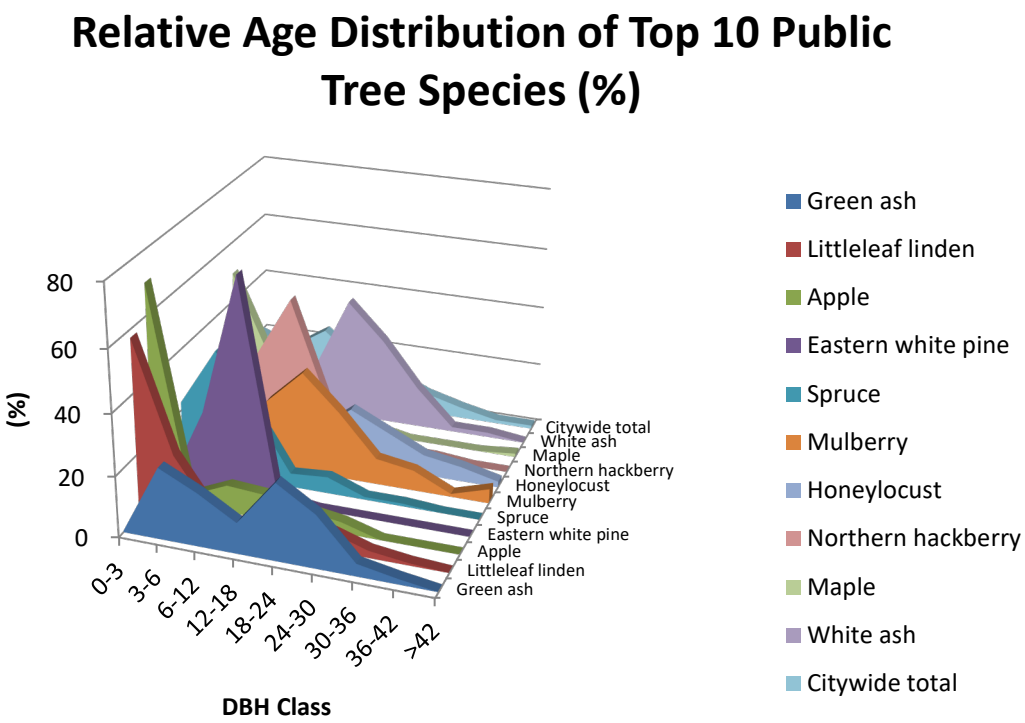

Figure 2: Relative Age Class

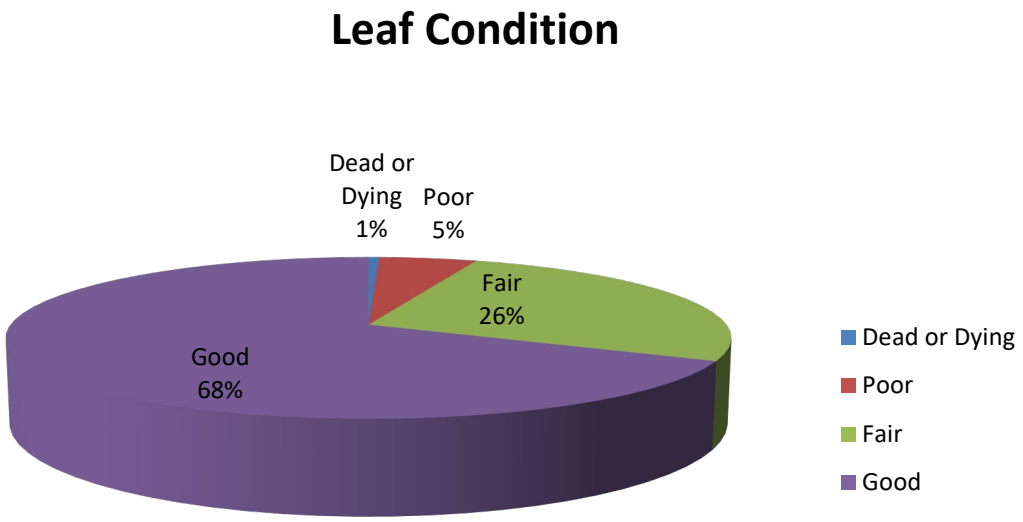

Figure 3: Foliage Condition

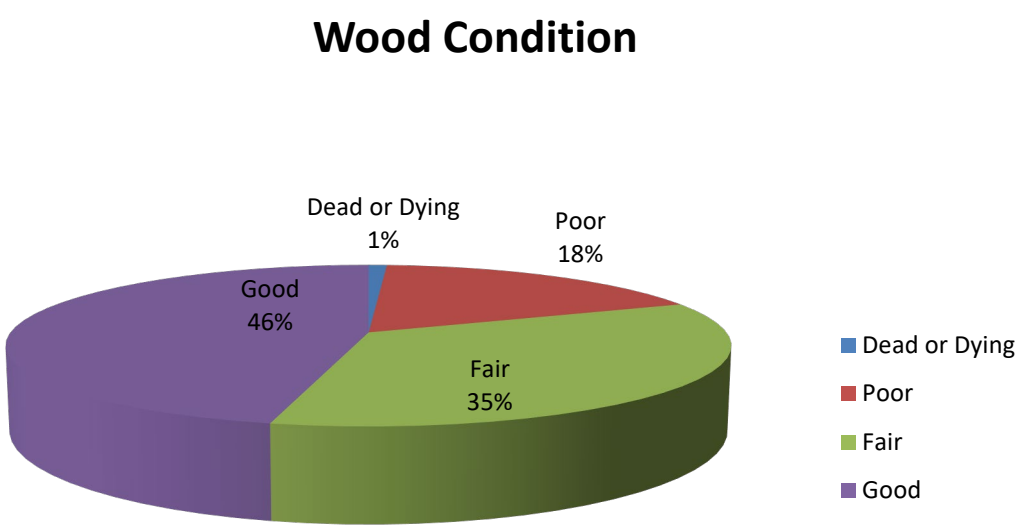

Figure 4: Wood Condition

Figure 5: Canopy Cover in Acres

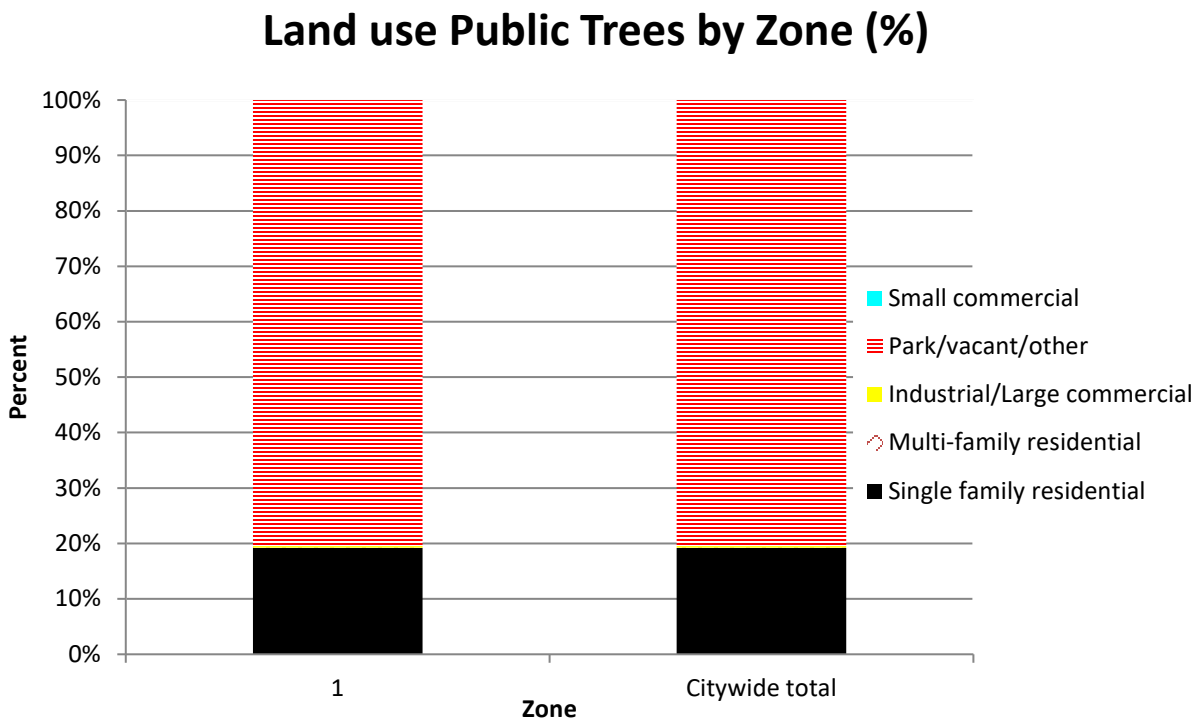

Figure 6: Land Use of city/park trees

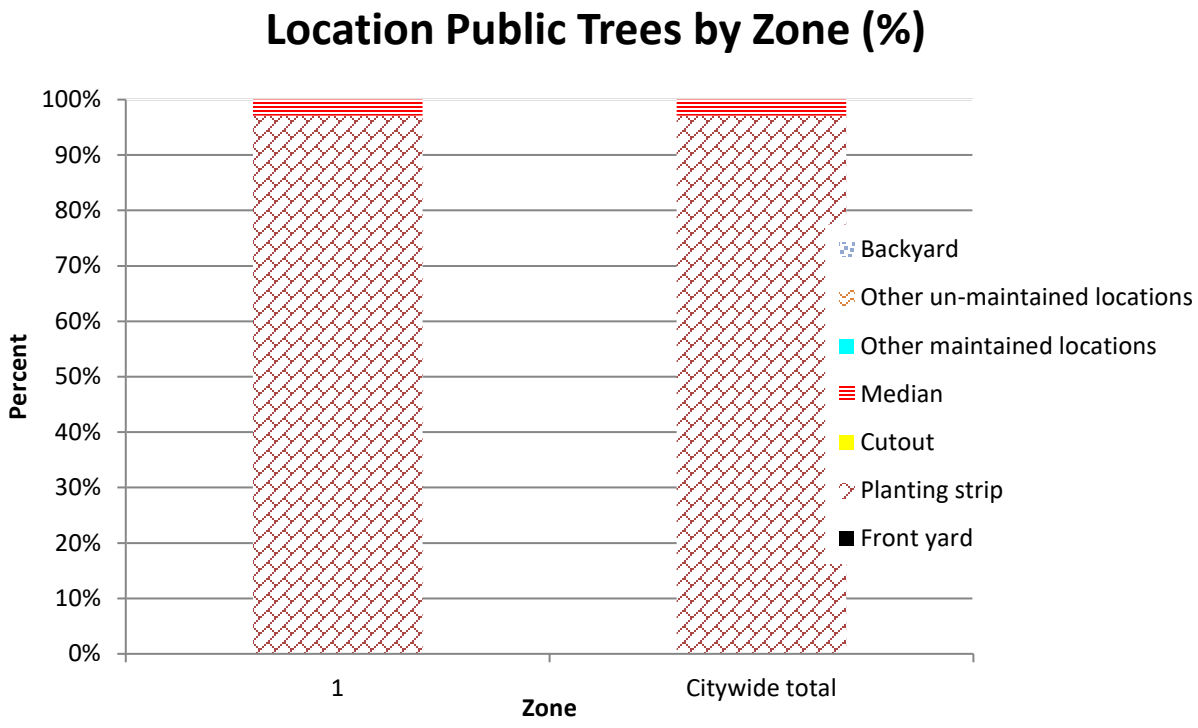

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

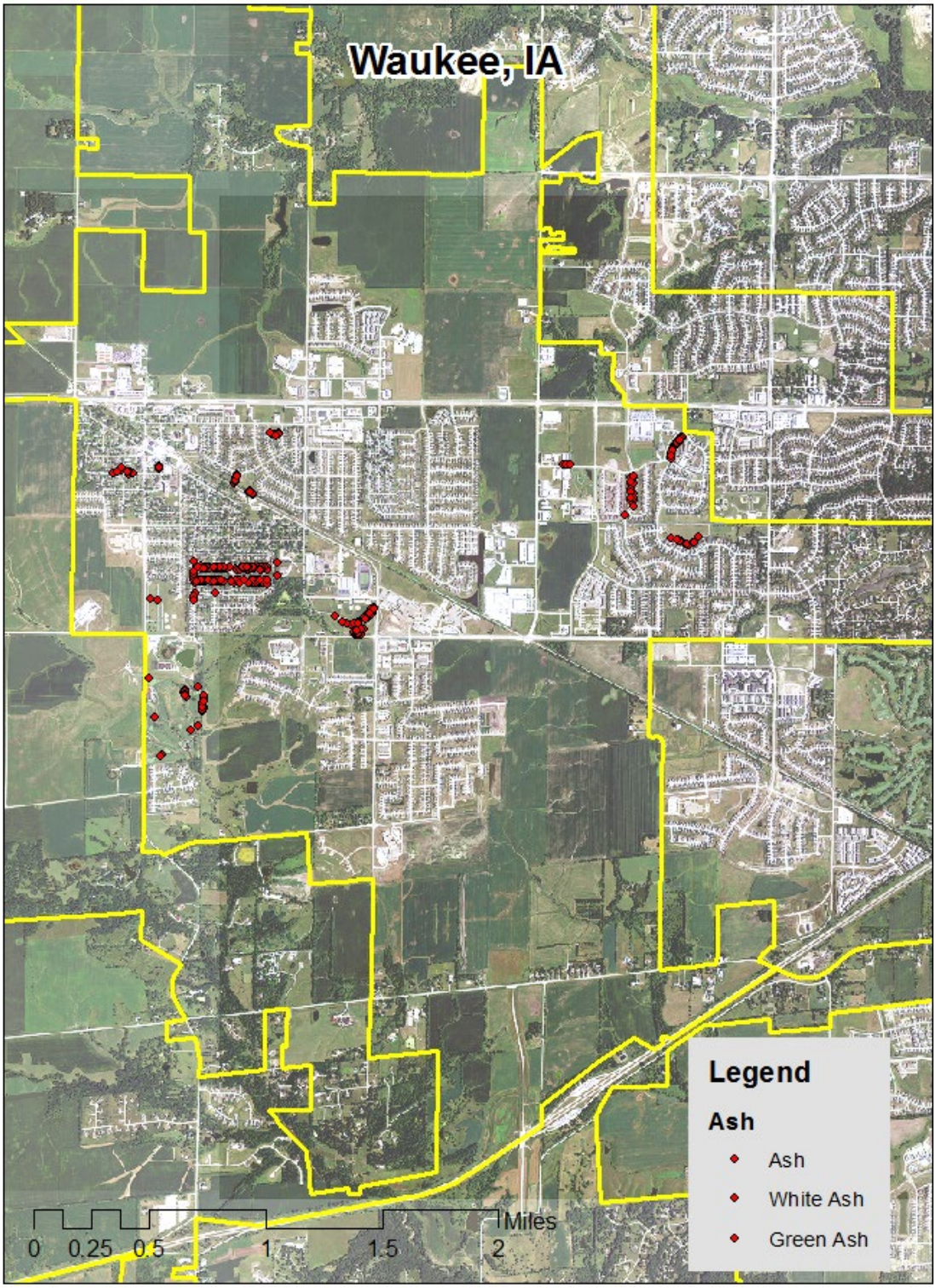

Figure 1: Location of Ash Trees

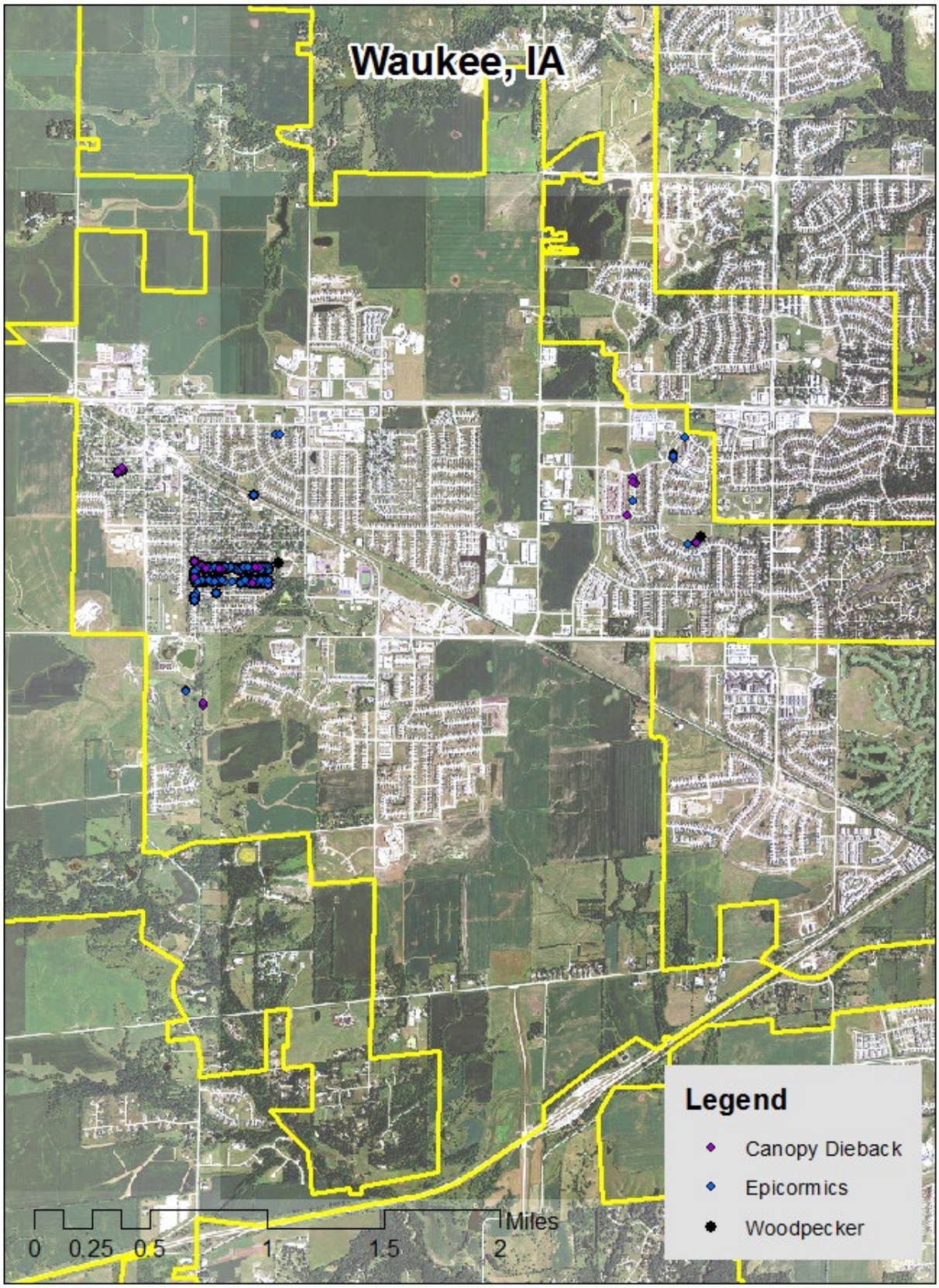

Figure 2: Location of EAB symptoms

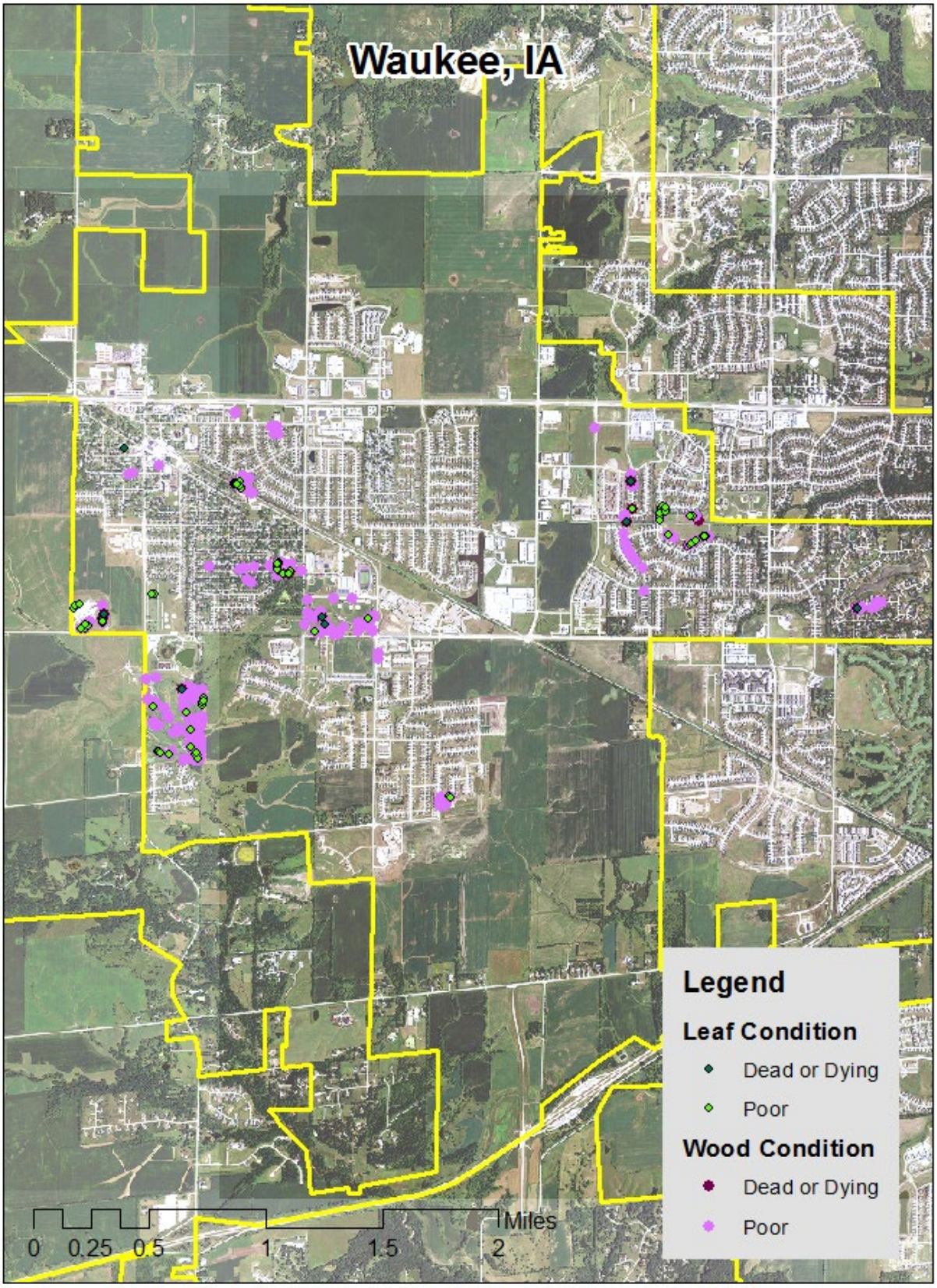

Figure 3: Location of Poor Condition Trees

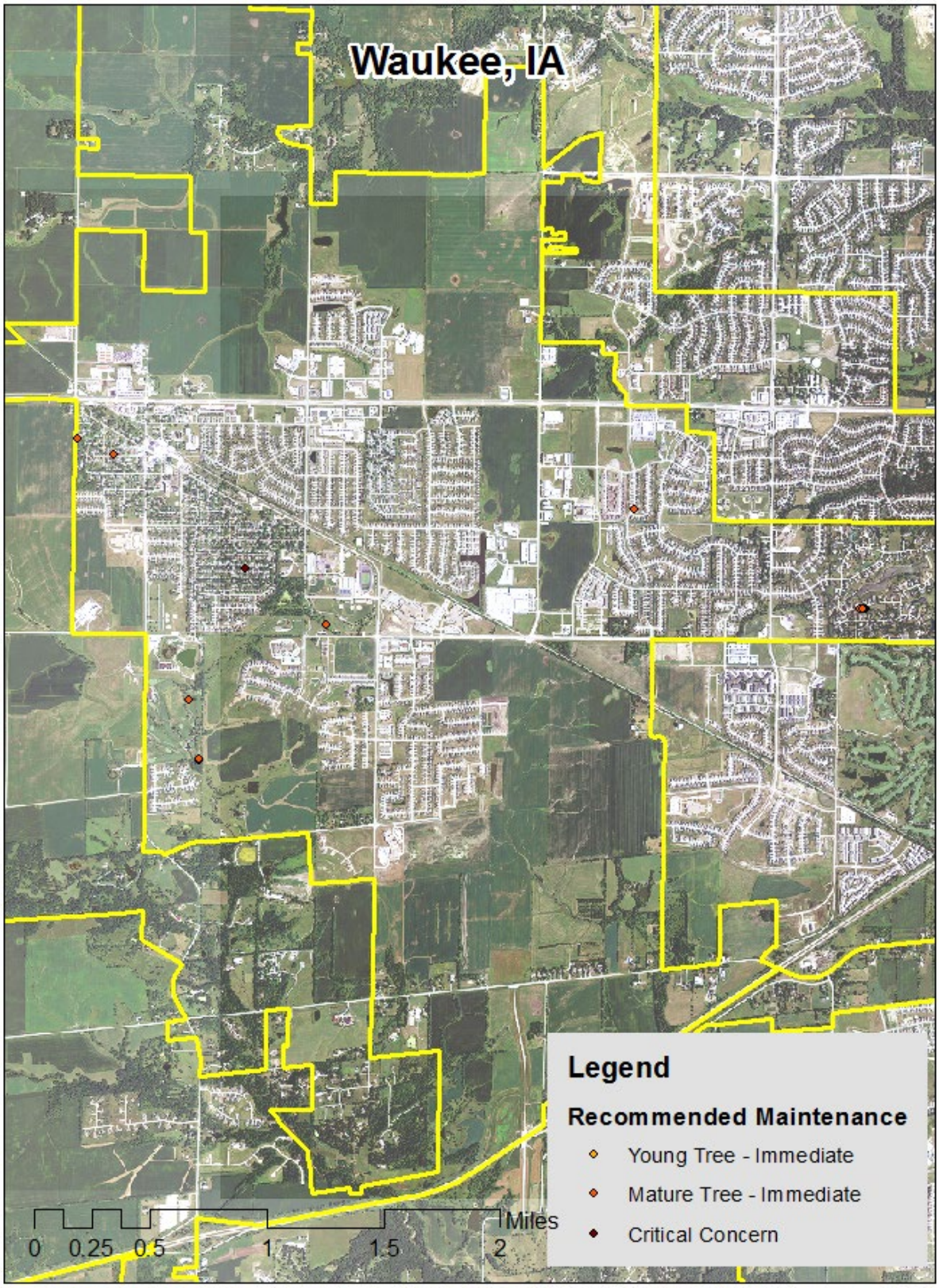

Figure 4: Location of Trees with Recommended Maintenance

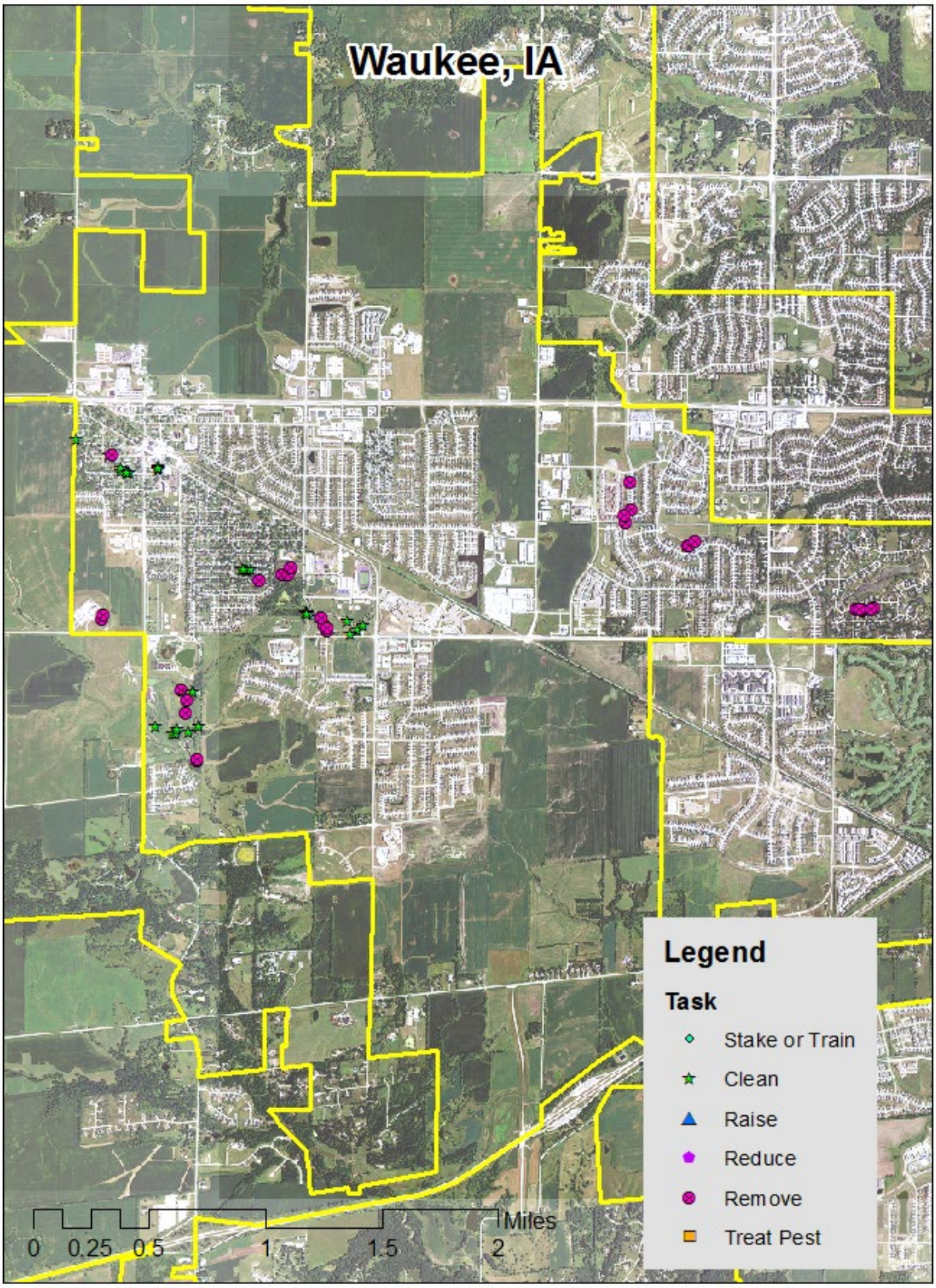

Figure 5: Maintenance Tasks ***City ownership of the trees recommended for removal should be verified prior to any removal***

Appendix C: Waukee Tree Ordinances

CHAPTER 151
TREES AND GRASS

151.01 DEFINITION. For use in this chapter, “boulevard” 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 boulevard or street except in accordance with the following:
1. Alignment. All tress planted in any street shall be planted in the boulevard 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 boulevard 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 eighteen (18) feet above the surface of a street, twenty (20) feet above the surface of a primary highway, 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 infected with or damaged by any disease or insect or disease pests, and such trees and shrubs shall be subject to removal as follows:
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 the 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])

151.07 CUTTING OR MOWING OF GRASS.
1. Duty to Cut and Mow Lawns and Lots. The owner of any property shall cut and mow all lawns and lots so that such growth shall be less than four (4) inches at all times.
2. Cutting and Mowing by City. If a property owner refuses or fails to cut and mow lawns and lots within forty-eight (48) hours after being delivered a notice from the City to perform such action, the Council may require said work to be done and the cost and expenses thereof shall be assessed to the property owner after due notice is given. The amount of such assessment shall be certified to the County Auditor as provided by law and the same shall be collected with and in the same manner as general property taxes.

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 515-281-5918.