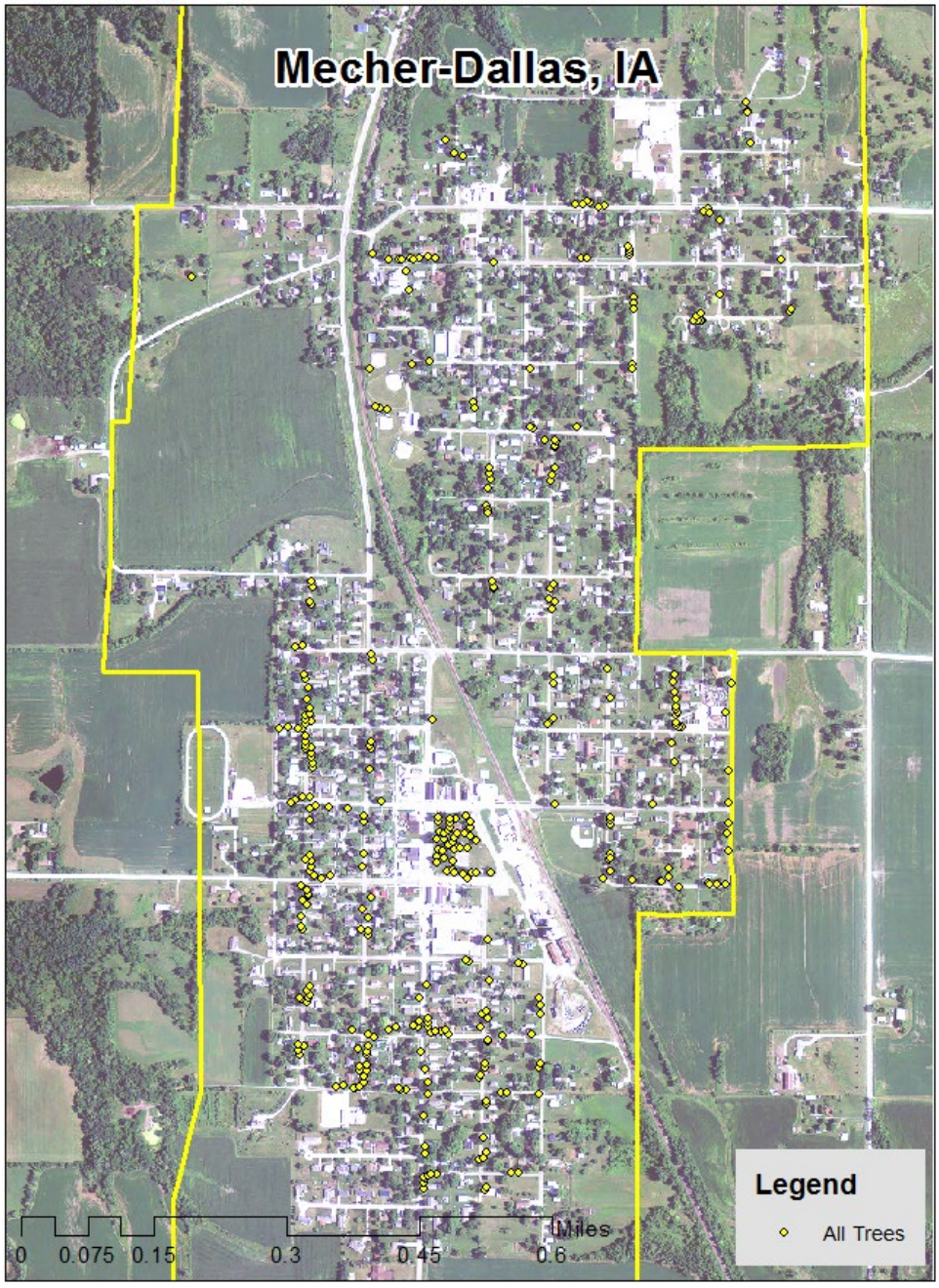
Melcher-Dallas, IA



2015 Urban Forest Plan

Prepared by Jeremy Cochran
Bureau of Forestry, Iowa DNR

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Executive Summary

Overview

This plan was developed to assist the City of Melcher-Dallas 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 maximize 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). Melcher-Dallas will lose 14% of city owned trees (ash) 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 2014, 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 342 trees inventoried.

- Melcher-Dallas's trees provide $76,752 of benefits annually, an average of $224 a tree
- There are over 37 species of trees
- The top three genera are: Maple 37%, Ash 14%, and Elm 12%
- There are 49 ash trees
- 19% of trees are in need of some type of improvement
- 27 other trees are recommended for removal and replacement

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 27 trees needing removal, 14 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, Siberian elm (also called Chinese elm), evergreen, willow or black walnut
- Check ash trees with a visual survey yearly

Introduction

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

Trees are an important component of Melcher-Dallas'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 Melcher-Dallas 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 Melcher-Dallas's urban forestry goals.

Inventory

During August and September 2014, 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 342 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. Melcher-Dallas's trees reduce energy related costs by approximately $19,983 annually (Appendix A, Table 1). These savings are both in Electricity (95.5 MWh) and in Natural Gas (12,992.2 Therms).

Annual Stormwater Benefits

Melcher-Dallas's trees intercept about 1,115,482 gallons of rainfall or snowmelt a year (Appendix A, Table 2). This interception provides $31,314 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 Melcher-Dallas, it is estimated that trees remove 1,303 lbs. of air pollution (ozone (O_3), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $3,701 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Melcher-Dallas, trees sequester about 248,957 lbs. of carbon a year with an associated value of $1,867 (Appendix A, Table 4). In addition, the trees store 5,162,769 lbs. of carbon, with a yearly benefit of $38,721 (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. Melcher-Dallas receives $20,080 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, Melcher-Dallas's trees provide $76,752 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 342 trees in Melcher-Dallas provide approximately $224 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Melcher-Dallas has over 37 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by *species* is as follows:

Species	Percent
Silver maple	28%
Ash	14%
Siberian elm	10%
Northern hackberry	8%
Black walnut	4%
Sugar maple	4%
Catalpa	4%
Norway maple	3%
Apple	2%
Elm	2%
Other species	21%
Total	100.00%

The combined distribution by *genus* is as follows:

Genera	Percent
Maple	37%
Ash	14%
Elm	12%
Hackberry	8%
Walnut	4%
Catalpa	4%
All other genera	21%
Total	100%

Age Class

Most of Melcher-Dallas's trees (48%) are between 12 and 30 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. Melcher-Dallas's size curve indicates typical aged stand, with bell-shaped distribution.

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 Melcher-Dallas indicate that 61% of the trees are in good health and 8% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). 29% of Melcher-Dallas'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 21% of the population.

Management Needs

The following outlines the specific management needs of the street and park trees by number of trees and percent of population (Appendix B, Figure 3).

None	277	81%
Crown Cleaning	32	9%
Tree Removal	27	8%
Crown Raising	5	1%
Tree Staking	1	<1%
Crown Reduction	0	

Canopy Cover

The total canopy with both private and public trees is 24%, 155 acres. The canopy cover included in the Melcher-Dallas inventory includes approximately 12 acres (Appendix A, Figure 4).

Land Use and Location

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

Land Use	
Single family residential	86%
Park/vacant/other	13%
Industrial/Large commercial	<1%
Small commercial	<1%
Multifamily residential	0%

Location	
Planting strip	51%
Front yard	49%
Cutout (surrounded by pavement)	<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

Melcher-Dallas has 12 critical concern trees that need immediate removal, 1 is ash. 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. Please refer to the ten year work plan at the end of this section.

Poor tree species

After the removal of the critical concern trees, 15 trees in poor health should be assessed for removal, 3 are ash (Appendix B, Figure 3 & Appendix B, Figure 4). There are a total of 49 ash trees, and none of those had signs and symptoms that have been associated with EAB at the time of the inventory. *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 10 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 ten 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 Melcher-Dallas.

It is important to plant a diverse mix of species in the urban forest to maintain canopy health, since most insects and diseases target a genus (ash) or species (green ash) of trees. Current

diversity recommendations advise that a *genus* (i.e. maple, oak) not make up more than 20% of the urban forest and a single *species* (i.e. silver maple, sugar maple, white oak, bur oak) not make up more than 10% of the total urban forest. Presently, the forest is heavily planted with maple (37%) (Appendix A, Figure 1). Maples should not be planted until this percentage can be lowered to 20% or less. 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 (Siberian elm), evergreen, willow or black walnut. All trees planted must meet the restrictions in city ordinance.

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.

Ten Year Work Plan

The suggested work plan addresses all 12 critical concern trees, the other 15 trees recommended for removal, and finally, ash tree removal and replacement. Additional funds and effort will be needed to start replacing ash trees when EAB is confirmed in your community. EAB can kill ash trees in less than 4 years.

Year 1

- Removal: 12 critical concern trees
- *Or saving for ash tree treatment
- Planting and Replacement: 14 trees to be planted in open locations
- Visual Survey for signs and symptoms of EAB

Year 2

- Removal: 8 trees with poor health
- *Or saving for ash tree treatment
- Planting and Replacement: 10 trees in open locations
- Routine trimming: Contract to trim 1/3 of the city trees
- Visual Survey for signs and symptoms of EAB

Year 3

- Removal: 7 trees with poor health and removal of any new critical concern trees
- *Or saving for ash tree treatment
- Planting and Replacement: 8 trees to be planted in open locations
- Visual Survey for signs and symptoms of EAB

Year 4

- Removal: 7 trees - removal of ash trees and any new critical concern trees
- *Or saving for ash tree treatment
- Planting and Replacement: 8 trees in open locations
- Routine trimming: Contract to trim 1/3 of the city trees
- Visual Survey for signs and symptoms of EAB

Year 5

Removal: 7 trees - removal of ash trees and any new critical concern trees
*Or saving for ash tree treatment
Planting and Replacement: 8 trees to be planted in open locations
Visual Survey for signs and symptoms of EAB

Year 6

Removal: 7 trees - removal of ash trees and any new critical concern trees
*Or saving for ash tree treatment
Planting and Replacement: 8 trees to be planted in open locations
Routine trimming: Contract to trim 1/3 of the city trees
Visual Survey for signs and symptoms of EAB

Year 7

Removal: 7 trees - removal of ash trees and any new critical concern trees
*Or saving for ash tree treatment
Planting and Replacement: 8 trees to be planted in open locations
Visual Survey for signs and symptoms of EAB

Year 8

Removal: 7 trees - removal of ash trees and any new critical concern trees
*Or saving for ash tree treatment
Planting and Replacement: 8 trees to be planted in open locations
Routine trimming: Contract to trim 1/3 of the city trees
Visual Survey for signs and symptoms of EAB

Year 9

Removal: 7 trees - removal of ash trees and any new critical concern trees
*Or saving for ash tree treatment
Planting and Replacement: 8 trees to be planted in open locations
Visual Survey for signs and symptoms of EAB

Year 10

Removal: 7 trees - removal of FINAL ash trees and any new critical concern trees
*Or saving for ash tree treatment
Planting and Replacement: 8 trees to be planted in open locations
Routine trimming: Contract to trim 1/3 of the city trees
Visual Survey for signs and symptoms of EAB

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 dozens 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. 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.

Budget

Melcher-Dallas Budget Proposal				
	Action Needed	No. trees	Cost	Total
Year 1	removals	12	$700.00	$ 8,400.00
	replacement planting	14	$100.00	$ 1,400.00
	watering & maintenance			$ 500.00
Year 2	removals	8	$700.00	$ 5,600.00
	replacement planting	10	$100.00	$ 1,000.00
	routine trimming			$ 1,700.00
	watering & maintenance			$ 500.00
Year 3	removals	7	$700.00	$ 4,900.00
	replacement planting	8	$100.00	$ 800.00
	watering & maintenance			$ 500.00
Year 4	removals	7	$700.00	$ 4,900.00
	replacement planting	8	$100.00	$ 800.00
	routine trimming			$ 1,700.00
	watering & maintenance			$ 500.00
Year 5	removals	7	$700.00	$ 4,900.00
	replacement planting	8	$100.00	$ 800.00
	watering & maintenance			$ 500.00
Year 6	removals	7	$700.00	$ 4,900.00
	replacement planting	8	$100.00	$ 800.00
	routine trimming			$ 1,700.00
	watering & maintenance			$ 500.00
Year 7	removals	7	$700.00	$ 4,900.00
	replacement planting	8	$100.00	$ 800.00
	watering & maintenance			$ 500.00
Year 8	removals	7	$700.00	$ 4,900.00
	replacement planting	8	$100.00	$ 800.00
	routine trimming			$ 1,700.00
	watering & maintenance			$ 500.00
Year 9	removals	7	$700.00	$ 4,900.00
	replacement planting	8	$100.00	$ 800.00
	watering & maintenance			$ 500.00
Year 10	removals	7	$700.00	$ 4,900.00
	replacement planting	8	$100.00	$ 800.00
	routine trimming			$ 1,700.00
	watering & maintenance			$ 500.00
			Total	$75,500.00

Purposed Budget Increase

EAB could potentially kill all ash trees in Melcher-Dallas within 4 years of its arrival. To remove all 49 ash trees the budget would require $34,300. This does not include the 12 critical concern and 15 other trees with poor health. Additionally, it is recommended that Melcher-Dallas 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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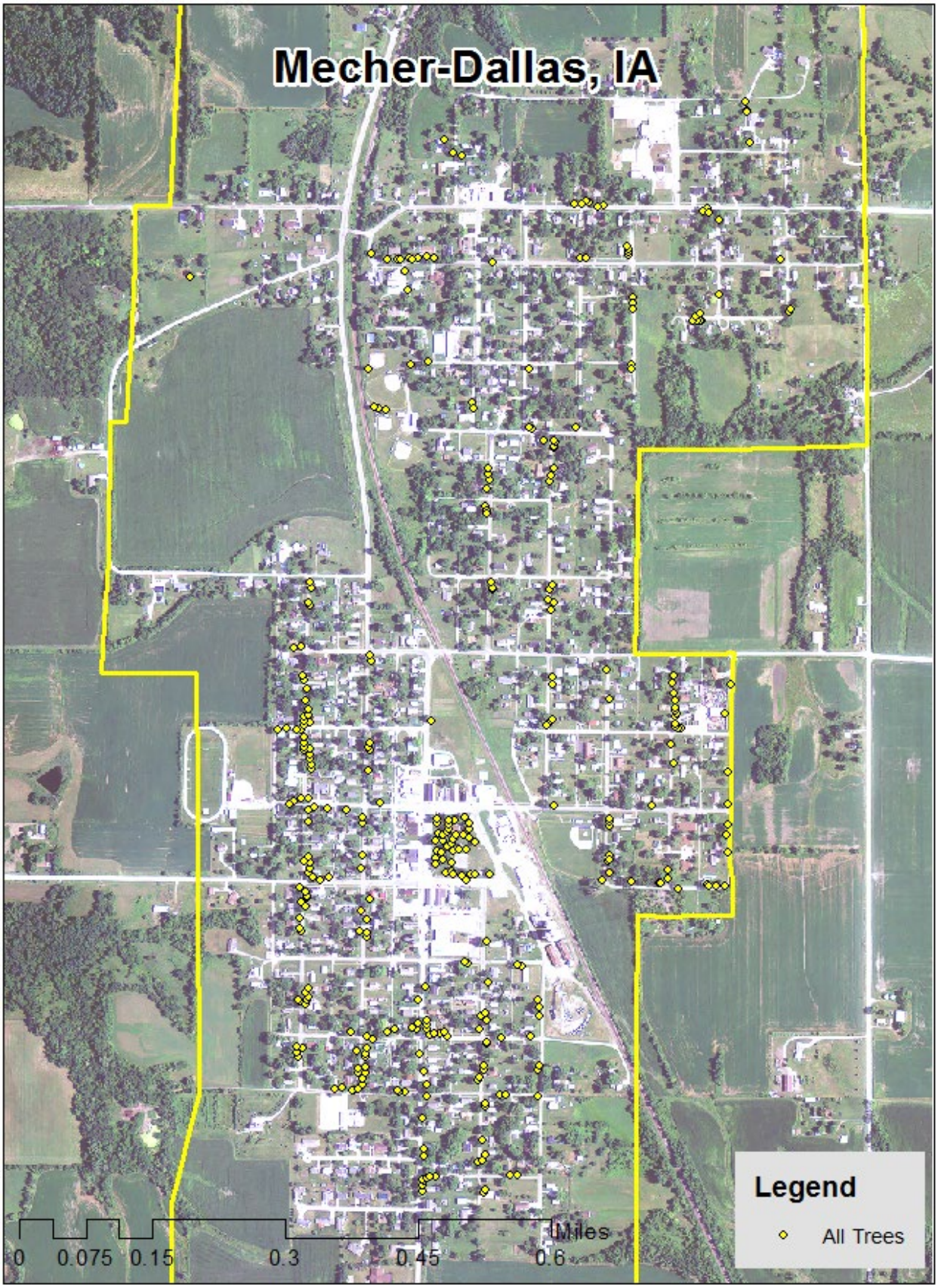
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Legend
All Trees
0 0.075 0.15 0.3 0.45 0.6
Miles

Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Melcher-Dallas

Annual Energy Benefits of Public Trees

12/29/2014

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	31.8	2,416	4,181.3	4,098	6,514	(N/A)	28.4	32.6	67.15
Ash	13.8	1,046	1,995.9	1,956	3,002	(N/A)	14.3	15.0	61.26
Siberian elm	11.4	862	1,514.6	1,484	2,347	(N/A)	9.6	11.7	71.11
Northern hackberry	8.9	676	1,253.9	1,229	1,905	(N/A)	7.9	9.5	70.54
Black walnut	4.5	344	621.8	609	953	(N/A)	4.4	4.8	63.56
Catalpa	4.4	338	593.2	581	919	(N/A)	4.1	4.6	65.64
Sugar maple	3.7	279	481.3	472	750	(N/A)	4.1	3.8	53.60
Norway maple	2.7	205	379.7	372	577	(N/A)	3.2	2.9	52.43
Apple	0.3	21	48.4	47	69	(N/A)	2.3	0.3	8.60
Elm	2.9	221	384.6	377	598	(N/A)	2.3	3.0	74.76
Mulberry	1.3	97	202.6	199	295	(N/A)	2.0	1.5	42.15
Callery pear	0.0	2	4.8	5	7	(N/A)	1.8	0.0	1.10
Eastern red cedar	0.4	33	65.2	64	97	(N/A)	1.5	0.5	19.33
Cottonwood	2.1	161	275.3	270	431	(N/A)	1.5	2.2	86.23
Northern white cedar	0.2	17	38.0	37	54	(N/A)	1.2	0.3	13.58
Blue spruce	0.3	24	45.8	45	69	(N/A)	1.2	0.3	17.23
American basswood	0.9	71	135.2	133	204	(N/A)	1.2	1.0	50.95
Eastern cottonwood	1.9	147	252.4	247	395	(N/A)	1.2	2.0	98.63
Northern pin oak	0.7	52	92.7	91	142	(N/A)	1.2	0.7	35.62
Red maple	0.4	31	51.8	51	81	(N/A)	0.9	0.4	27.13
Boxelder	0.6	49	87.9	86	135	(N/A)	0.6	0.7	67.41
River birch	0.5	36	59.0	58	94	(N/A)	0.6	0.5	46.78
White oak	0.3	20	30.7	30	50	(N/A)	0.6	0.3	25.02
Ginkgo	0.1	5	9.9	10	15	(N/A)	0.3	0.1	14.72
Conifer Evergreen Large	0.1	4	9.5	9	14	(N/A)	0.3	0.1	13.58
American sycamore	0.0	2	3.7	4	6	(N/A)	0.3	0.0	5.82
Amur maple	0.0	2	3.8	4	5	(N/A)	0.3	0.0	5.40
Spruce	0.1	4	9.5	9	14	(N/A)	0.3	0.1	13.58
Southern magnolia	0.0	1	2.8	3	4	(N/A)	0.3	0.0	3.94
Scotch pine	0.1	10	14.6	14	24	(N/A)	0.3	0.1	24.14
Conifer Evergreen Small	0.0	0	0.7	1	1	(N/A)	0.3	0.0	0.93
Eastern white pine	0.1	11	19.7	19	30	(N/A)	0.3	0.2	30.47
Austrian pine	0.1	5	10.2	10	15	(N/A)	0.3	0.1	14.80
Northern red oak	0.2	16	30.6	30	46	(N/A)	0.3	0.2	46.28
Honeylocust	0.3	23	42.3	41	65	(N/A)	0.3	0.3	64.79
Eastern redbud	0.0	0	0.6	1	1	(N/A)	0.3	0.0	0.87
Tulip tree	0.3	20	38.1	37	57	(N/A)	0.3	0.3	57.32
Total	95.5	7,251	12,992.2	12,732	19,983	(N/A)	100.0	100.0	58.43

Table 2: Annual Stormwater Benefits

Melcher-Dallas

Annual Stormwater Benefits of Public Trees

12/29/2014

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	466,162	12,633	(N/A)	28.4	40.3	130.24
Ash	138,446	3,752	(N/A)	14.3	12.0	76.57
Siberian elm	127,710	3,461	(N/A)	9.6	11.1	104.88
Northern hackberry	82,488	2,235	(N/A)	7.9	7.1	82.79
Black walnut	51,738	1,402	(N/A)	4.4	4.5	93.47
Catalpa	57,873	1,568	(N/A)	4.1	5.0	112.03
Sugar maple	45,168	1,224	(N/A)	4.1	3.9	87.43
Norway maple	24,379	661	(N/A)	3.2	2.1	60.06
Apple	941	25	(N/A)	2.3	0.1	3.19
Elm	38,220	1,036	(N/A)	2.3	3.3	129.47
Mulberry	7,309	198	(N/A)	2.0	0.6	28.30
Callery pear	73	2	(N/A)	1.8	0.0	0.33
Eastern red cedar	6,222	169	(N/A)	1.5	0.5	33.72
Cottonwood	30,421	824	(N/A)	1.5	2.6	164.88
Northern white cedar	2,382	65	(N/A)	1.2	0.2	16.14
Blue spruce	3,811	103	(N/A)	1.2	0.3	25.82
American basswood	7,587	206	(N/A)	1.2	0.7	51.40
Eastern cottonwood	28,956	785	(N/A)	1.2	2.5	196.17
Northern pin oak	3,990	108	(N/A)	1.2	0.3	27.03
Red maple	2,366	64	(N/A)	0.9	0.2	21.38
Boxelder	10,165	275	(N/A)	0.6	0.9	137.74
River birch	2,818	76	(N/A)	0.6	0.2	38.19
White oak	1,637	44	(N/A)	0.6	0.1	22.18
Ginkgo	301	8	(N/A)	0.3	0.0	8.17
Conifer Evergreen Large	596	16	(N/A)	0.3	0.1	16.14
American sycamore	172	5	(N/A)	0.3	0.0	4.65
Amur maple	69	2	(N/A)	0.3	0.0	1.86
Spruce	596	16	(N/A)	0.3	0.1	16.14
Southern magnolia	56	2	(N/A)	0.3	0.0	1.53
Scotch pine	1,539	42	(N/A)	0.3	0.1	41.70
Conifer Evergreen Small	24	1	(N/A)	0.3	0.0	0.66
Eastern white pine	2,969	80	(N/A)	0.3	0.3	80.46
Austrian pine	755	20	(N/A)	0.3	0.1	20.47
Northern red oak	2,039	55	(N/A)	0.3	0.2	55.25
Honeylocust	2,905	79	(N/A)	0.3	0.3	78.73
Eastern redbud	7	0	(N/A)	0.3	0.0	0.20
Tulip tree	2,591	70	(N/A)	0.3	0.2	70.21
Citywide total	1,155,482	31,314	(N/A)	100.0	100.0	91.56

Table 3: Annual Air Quality Benefits

Melcher-Dallas

Annual Air Quality Benefits of Public Trees

12/29/2014

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								
Silver maple	86.5	14.7	42.1	3.8	465	150.1	22.0	21.0	144.0	939	-47.2	-177	436.9	1,227	(N/A)	28.4	12.65
Ash	29.5	5.1	14.3	1.3	159	66.9	9.7	9.2	62.5	414	-6.8	-26	191.6	547	(N/A)	14.3	11.17
Siberian elm	22.9	3.9	11.0	1.0	123	53.9	7.9	7.5	51.5	336	0.0	0	159.5	459	(N/A)	9.6	13.92
Northern hackberry	13.5	2.3	6.9	0.6	74	42.9	6.2	5.9	40.4	266	0.0	0	118.7	340	(N/A)	7.9	12.59
Black walnut	6.5	1.0	3.1	0.3	35	21.7	3.2	3.0	20.5	135	0.0	0	59.3	170	(N/A)	4.4	11.30
Catalpa	10.0	1.6	4.5	0.4	53	21.1	3.1	2.9	20.2	132	0.0	0	63.9	184	(N/A)	4.1	13.17
Sugar maple	7.5	1.3	3.6	0.3	40	17.3	2.5	2.4	16.6	108	-5.9	-22	45.8	127	(N/A)	4.1	9.05
Norway maple	4.9	0.9	2.4	0.2	27	13.0	1.9	1.8	12.2	81	-1.2	-4	36.2	103	(N/A)	3.2	9.37
Apple	0.1	0.0	0.1	0.0	1	1.4	0.2	0.2	1.3	9	0.0	0	3.3	9	(N/A)	2.3	1.17
Elm	6.4	1.0	2.9	0.3	34	13.8	2.0	1.9	13.2	86	0.0	0	41.5	120	(N/A)	2.3	14.97
Mulberry	2.6	0.4	1.2	0.1	14	6.3	0.9	0.9	5.8	39	0.0	0	18.2	53	(N/A)	2.0	7.52
Callery pear	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.3	1	(N/A)	1.8	0.14
Eastern red cedar	1.2	0.2	0.9	0.1	8	2.1	0.3	0.3	2.0	13	-3.4	-13	3.7	8	(N/A)	1.5	1.56
Cottonwood	6.0	1.0	2.6	0.3	31	10.0	1.5	1.4	9.6	63	0.0	0	32.4	94	(N/A)	1.5	18.82
Northern white cedar	0.2	0.0	0.2	0.0	1	1.1	0.2	0.2	1.0	7	-0.7	-2	2.3	6	(N/A)	1.2	1.48
Blue spruce	0.4	0.1	0.4	0.0	3	1.5	0.2	0.2	1.4	9	-1.3	-5	3.0	7	(N/A)	1.2	1.87
American basswood	0.8	0.1	0.4	0.0	4	4.6	0.7	0.6	4.3	28	-0.8	-3	10.7	30	(N/A)	1.2	7.45
Eastern cottonwood	6.3	1.0	2.8	0.3	33	9.1	1.3	1.3	8.8	57	0.0	0	30.9	90	(N/A)	1.2	22.55
Northern pin oak	0.5	0.1	0.3	0.0	3	3.3	0.5	0.5	3.1	20	-0.2	-1	8.1	23	(N/A)	1.2	5.69
Red maple	0.4	0.1	0.2	0.0	2	1.9	0.3	0.3	1.8	12	-0.2	-1	4.8	14	(N/A)	0.9	4.50
Boxelder	1.6	0.3	0.7	0.1	8	3.1	0.4	0.4	2.9	19	-0.4	-1	9.1	26	(N/A)	0.6	13.02
River birch	0.4	0.1	0.2	0.0	2	2.2	0.3	0.3	2.1	14	-0.1	0	5.6	16	(N/A)	0.6	7.92
White oak	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)	0.6	4.15
Ginkgo	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.3	2	0.0	0	0.8	2	(N/A)	0.3	2.12
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)	0.3	1.48
American sycamore	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.3	1	(N/A)	0.3	0.87
Amur maple	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.3	1	(N/A)	0.3	0.71
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)	0.3	1.48
Southern magnolia	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	0	0.0	0	0.2	0	(N/A)	0.3	0.47
Scotch pine	0.2	0.0	0.1	0.0	1	0.6	0.1	0.1	0.6	4	-0.5	-2	1.2	3	(N/A)	0.3	2.82
Conifer Evergreen Small	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)	0.3	0.09
Eastern white pine	0.3	0.1	0.3	0.0	2	0.7	0.1	0.1	0.7	4	-1.4	-5	0.9	1	(N/A)	0.3	1.45
Austrian pine	0.1	0.0	0.1	0.0	0	0.3	0.0	0.0	0.3	2	-0.2	-1	0.6	2	(N/A)	0.3	1.53
Northern red oak	0.4	0.1	0.2	0.0	2	1.0	0.1	0.1	1.0	6	-0.6	-2	2.4	7	(N/A)	0.3	6.50
Honeylocust	0.5	0.1	0.3	0.0	3	1.5	0.2	0.2	1.4	9	-0.4	-1	3.8	11	(N/A)	0.3	10.61
Eastern redbud	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)	0.3	0.11
Tulip tree	0.3	0.0	0.1	0.0	1	1.3	0.2	0.2	1.2	8	0.0	0	3.3	9	(N/A)	0.3	9.34
Citywide total	210.6	35.6	102.2	9.6	1,132	455.2	66.3	63.2	432.8	2,837	-71.4	-268	1,303.9	3,701	(N/A)	100.0	10.82

Table 4: Annual Carbon Stored

Melcher-Dallas

Stored CO2 Benefits of Public Trees

12/29/2014

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	2,181,799	16,363	(N/A)	28.4	42.3	168.70
Ash	484,965	3,637	(N/A)	14.3	9.4	74.23
Siberian elm	559,951	4,200	(N/A)	9.6	10.8	127.26
Northern hackberry	206,851	1,551	(N/A)	7.9	4.0	57.46
Black walnut	213,540	1,602	(N/A)	4.4	4.1	106.77
Catalpa	345,132	2,588	(N/A)	4.1	6.7	184.89
Sugar maple	231,263	1,734	(N/A)	4.1	4.5	123.89
Norway maple	81,190	609	(N/A)	3.2	1.6	55.36
Apple	2,883	22	(N/A)	2.3	0.1	2.70
Elm	218,910	1,642	(N/A)	2.3	4.2	205.23
Mulberry	41,364	310	(N/A)	2.0	0.8	44.32
Callery pear	101	1	(N/A)	1.8	0.0	0.13
Eastern red cedar	3,860	29	(N/A)	1.5	0.1	5.79
Cottonwood	210,876	1,582	(N/A)	1.5	4.1	316.31
Northern white cedar	1,027	8	(N/A)	1.2	0.0	1.93
Blue spruce	1,971	15	(N/A)	1.2	0.0	3.70
American basswood	28,249	212	(N/A)	1.2	0.5	52.97
Eastern cottonwood	223,928	1,679	(N/A)	1.2	4.3	419.86
Northern pin oak	9,450	71	(N/A)	1.2	0.2	17.72
Red maple	4,943	37	(N/A)	0.9	0.1	12.36
Boxelder	69,826	524	(N/A)	0.6	1.4	261.85
River birch	7,248	54	(N/A)	0.6	0.1	27.18
White oak	3,857	29	(N/A)	0.6	0.1	14.46
Ginkgo	474	4	(N/A)	0.3	0.0	3.56
Conifer Evergreen La	257	2	(N/A)	0.3	0.0	1.93
American sycamore	185	1	(N/A)	0.3	0.0	1.39
Amur maple	178	1	(N/A)	0.3	0.0	1.33
Spruce	257	2	(N/A)	0.3	0.0	1.93
Southern magnolia	3	0	(N/A)	0.3	0.0	0.02
Scotch pine	1,170	9	(N/A)	0.3	0.0	8.78
Conifer Evergreen Sn	3	0	(N/A)	0.3	0.0	0.02
Eastern white pine	3,343	25	(N/A)	0.3	0.1	25.07
Austrian pine	284	2	(N/A)	0.3	0.0	2.13
Northern red oak	8,218	62	(N/A)	0.3	0.2	61.63
Honeylocust	6,743	51	(N/A)	0.3	0.1	50.57
Eastern redbud	14	0	(N/A)	0.3	0.0	0.10
Tulip tree	8,458	63	(N/A)	0.3	0.2	63.43
Citywide total	5,162,769	38,721	(N/A)	100.0	100.0	113.22

Table 5: Annual Carbon Sequestered

Melcher-Dallas

Annual CO Benefits of Public Trees

12/29/2014

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
Silver maple	146,759	1,101	-10,474	-367	-3	0	0	135,918	1,019 (N/A)	28.4	60.9	10.51
Ash	14,463	108	-2,328	-153	-1	0	0	11,981	90 (N/A)	14.3	5.4	1.83
Siberian elm	21,761	163	-2,688	-123	-1	0	0	18,950	142 (N/A)	9.6	8.5	4.31
Northern hackberry	10,810	81	-993	-83	-1	0	0	9,733	73 (N/A)	7.9	4.4	2.70
Black walnut	10,649	80	-1,025	-47	0	0	0	9,576	72 (N/A)	4.4	4.3	4.79
Catalpa	7,788	58	-1,657	-50	0	0	0	6,081	46 (N/A)	4.1	2.7	3.26
Sugar maple	9,601	72	-1,111	-43	0	0	0	8,447	63 (N/A)	4.1	3.8	4.53
Norway maple	3,699	28	-390	-27	0	0	0	3,282	25 (N/A)	3.2	1.5	2.24
Apple	455	3	-14	-6	0	0	0	436	3 (N/A)	2.3	0.2	0.41
Elm	5,339	40	-1,051	-32	0	0	0	4,257	32 (N/A)	2.3	1.9	3.99
Mulberry	592	4	-199	-21	0	0	0	372	3 (N/A)	2.0	0.2	0.40
Callery pear	33	0	-1	-1	0	0	0	31	0 (N/A)	1.8	0.0	0.04
Eastern red cedar	165	1	-19	-8	0	0	0	139	1 (N/A)	1.5	0.1	0.21
Cottonwood	2,794	21	-1,012	-25	0	0	0	1,757	13 (N/A)	1.5	0.8	2.64
Northern white cedar	211	2	-5	-5	0	0	0	201	2 (N/A)	1.2	0.1	0.38
Blue spruce	207	2	-9	-5	0	0	0	192	1 (N/A)	1.2	0.1	0.36
American basswood	2,108	16	-136	-10	0	0	0	1,962	15 (N/A)	1.2	0.9	3.68
Eastern cottonwood	1,915	14	-1,075	-23	0	0	0	817	6 (N/A)	1.2	0.4	1.53
Northern pin oak	1,220	9	-45	-6	0	0	0	1,168	9 (N/A)	1.2	0.5	2.19
Red maple	687	5	-24	-4	0	0	0	660	5 (N/A)	0.9	0.3	1.65
Boxelder	3,806	29	-335	-10	0	0	0	3,460	26 (N/A)	0.6	1.6	12.98
River birch	772	6	-35	-4	0	0	0	733	5 (N/A)	0.6	0.3	2.75
White oak	520	4	-19	-3	0	0	0	498	4 (N/A)	0.6	0.2	1.87
Ginkgo	58	0	-2	-1	0	0	0	54	0 (N/A)	0.3	0.0	0.41
Conifer Evergreen Large	53	0	-1	-1	0	0	0	50	0 (N/A)	0.3	0.0	0.38
American sycamore	74	1	-1	-1	0	0	0	73	1 (N/A)	0.3	0.0	0.55
Amur maple	38	0	-1	-1	0	0	0	37	0 (N/A)	0.3	0.0	0.27
Spruce	53	0	-1	-1	0	0	0	50	0 (N/A)	0.3	0.0	0.38
Southern magnolia	1	0	0	0	0	0	0	1	0 (N/A)	0.3	0.0	0.01
Scotch pine	116	1	-6	-2	0	0	0	108	1 (N/A)	0.3	0.0	0.81
Conifer Evergreen Small	1	0	0	0	0	0	0	0	0 (N/A)	0.3	0.0	0.00
Eastern white pine	187	1	-16	-3	0	0	0	169	1 (N/A)	0.3	0.1	1.26
Austrian pine	39	0	-1	-1	0	0	0	36	0 (N/A)	0.3	0.0	0.27
Northern red oak	382	3	-39	-3	0	0	0	340	3 (N/A)	0.3	0.2	2.55
Honeylocust	936	7	-32	-3	0	0	0	901	7 (N/A)	0.3	0.4	6.76
Eastern redbud	9	0	0	0	0	0	0	8	0 (N/A)	0.3	0.0	0.06
Tulip tree	660	5	-41	-3	0	0	0	616	5 (N/A)	0.3	0.3	4.62
Citywide total	248,957	1,867	-24,785	-1,076	-8	0	0	223,096	1,673 (N/A)	100.0	100.0	4.89

Table 6: Annual Social and Aesthetic Benefits

Melcher-Dallas

Annual Aesthetic/Other Benefits of Public Trees

12/29/2014

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	10,854	(N/A)	28.4	54.1	111.89
Ash	1,347	(N/A)	14.3	6.7	27.49
Siberian elm	1,484	(N/A)	9.6	7.4	44.98
Northern hackberry	1,477	(N/A)	7.9	7.4	54.69
Black walnut	864	(N/A)	4.4	4.3	57.58
Catalpa	597	(N/A)	4.1	3.0	42.68
Sugar maple	934	(N/A)	4.1	4.7	66.73
Norway maple	351	(N/A)	3.2	1.8	31.95
Apple	25	(N/A)	2.3	0.1	3.14
Elm	398	(N/A)	2.3	2.0	49.76
Mulberry	35	(N/A)	2.0	0.2	5.03
Callery pear	16	(N/A)	1.8	0.1	2.74
Eastern red cedar	70	(N/A)	1.5	0.3	14.01
Cottonwood	190	(N/A)	1.5	0.9	37.98
Northern white cedar	62	(N/A)	1.2	0.3	15.42
Blue spruce	88	(N/A)	1.2	0.4	22.12
American basswood	171	(N/A)	1.2	0.9	42.83
Eastern cottonwood	114	(N/A)	1.2	0.6	28.57
Northern pin oak	131	(N/A)	1.2	0.7	32.69
Red maple	103	(N/A)	0.9	0.5	34.34
Boxelder	190	(N/A)	0.6	0.9	94.82
River birch	78	(N/A)	0.6	0.4	39.16
White oak	61	(N/A)	0.6	0.3	30.29
Ginkgo	7	(N/A)	0.3	0.0	6.77
Conifer Evergreen Large	15	(N/A)	0.3	0.1	15.42
American sycamore	15	(N/A)	0.3	0.1	14.73
Amur maple	2	(N/A)	0.3	0.0	2.06
Spruce	15	(N/A)	0.3	0.1	15.42
Southern magnolia	0	(N/A)	0.3	0.0	0.01
Scotch pine	32	(N/A)	0.3	0.2	32.32
Conifer Evergreen Small	4	(N/A)	0.3	0.0	4.27
Eastern white pine	47	(N/A)	0.3	0.2	47.08
Austrian pine	21	(N/A)	0.3	0.1	21.08
Northern red oak	27	(N/A)	0.3	0.1	27.47
Honeylocust	195	(N/A)	0.3	1.0	194.60
Eastern redbud	0	(N/A)	0.3	0.0	0.03
Tulip tree	58	(N/A)	0.3	0.3	57.69
Citywide total	20,080	(N/A)	100.0	100.0	58.71

Table 7: Summary of Benefits in Dollars

Melcher-Dallas

Total Annual Benefits of Public Trees by Species ($)

12/29/201

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Silver maple	6,514	1,019	1,227	12,633	10,854	32,247	(N/A)	42.0
Ash	3,002	90	547	3,752	1,347	8,738	(N/A)	11.4
Siberian elm	2,347	142	459	3,461	1,484	7,894	(N/A)	10.3
Northern hackberry	1,905	73	340	2,235	1,477	6,030	(N/A)	7.9
Black walnut	953	72	170	1,402	864	3,461	(N/A)	4.5
Catalpa	919	46	184	1,568	597	3,315	(N/A)	4.3
Sugar maple	750	63	127	1,224	934	3,099	(N/A)	4.0
Norway maple	577	25	103	661	351	1,717	(N/A)	2.2
Apple	69	3	9	25	25	132	(N/A)	0.2
Elm	598	32	120	1,036	398	2,184	(N/A)	2.8
Mulberry	295	3	53	198	35	584	(N/A)	0.8
Callery pear	7	0	1	2	16	26	(N/A)	0.0
Eastern red cedar	97	1	8	169	70	344	(N/A)	0.4
Cottonwood	431	13	94	824	190	1,553	(N/A)	2.0
Northern white cedar	54	2	6	65	62	188	(N/A)	0.2
Blue spruce	69	1	7	103	88	270	(N/A)	0.4
American basswood	204	15	30	206	171	625	(N/A)	0.8
Eastern cottonwood	395	6	90	785	114	1,390	(N/A)	1.8
Northern pin oak	142	9	23	108	131	413	(N/A)	0.5
Red maple	81	5	14	64	103	267	(N/A)	0.3
Boxelder	135	26	26	275	190	652	(N/A)	0.8
River birch	94	5	16	76	78	270	(N/A)	0.4
White oak	50	4	8	44	61	167	(N/A)	0.2
Ginkgo	15	0	2	8	7	32	(N/A)	0.0
Conifer Evergreen Large	14	0	1	16	15	47	(N/A)	0.1
American sycamore	6	1	1	5	15	27	(N/A)	0.0
Amur maple	5	0	1	2	2	10	(N/A)	0.0
Spruce	14	0	1	16	15	47	(N/A)	0.1
Southern magnolia	4	0	0	2	0	6	(N/A)	0.0
Scotch pine	24	1	3	42	32	102	(N/A)	0.1
Conifer Evergreen Small	1	0	0	1	4	6	(N/A)	0.0
Eastern white pine	30	1	1	80	47	161	(N/A)	0.2
Austrian pine	15	0	2	20	21	58	(N/A)	0.1
Northern red oak	46	3	7	55	27	138	(N/A)	0.2
Honeylocust	65	7	11	79	195	355	(N/A)	0.5
Eastern redbud	1	0	0	0	0	1	(N/A)	0.0
Tulip tree	57	5	9	70	58	199	(N/A)	0.3
Citywide Total	19,983	1,673	3,701	31,314	20,080	76,752	(N/A)	100.0

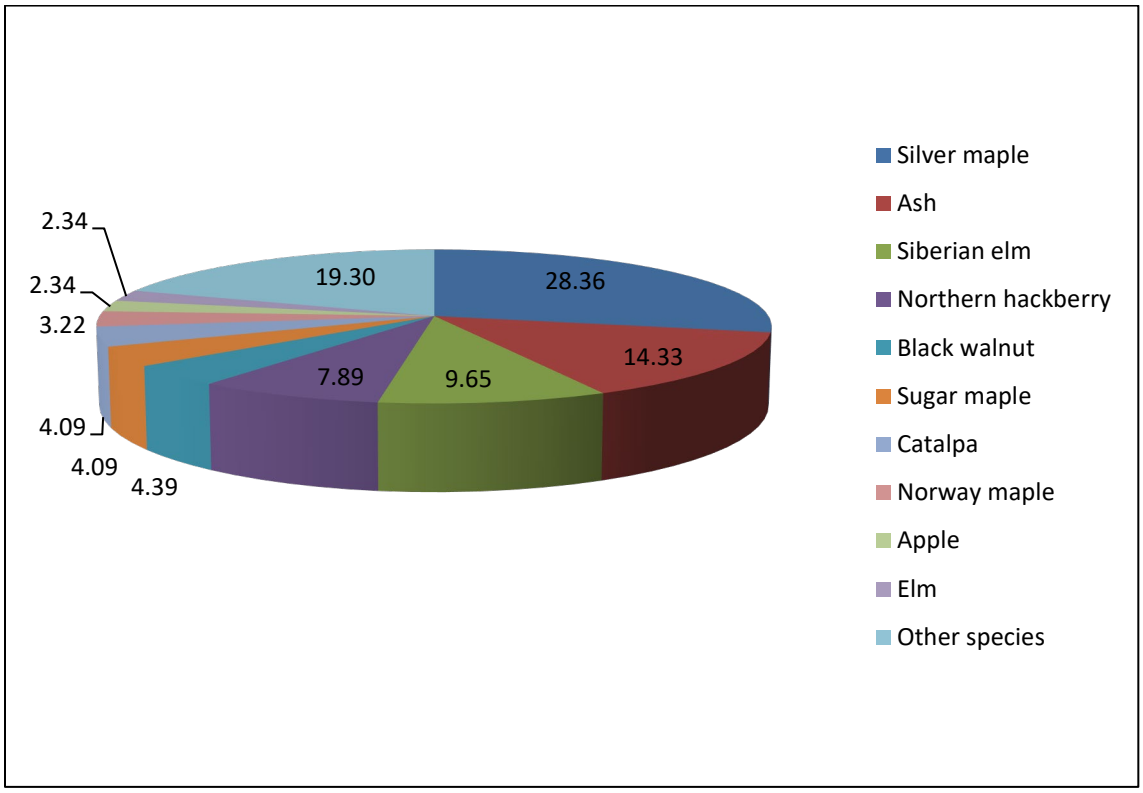

Figure 1: Species Distribution

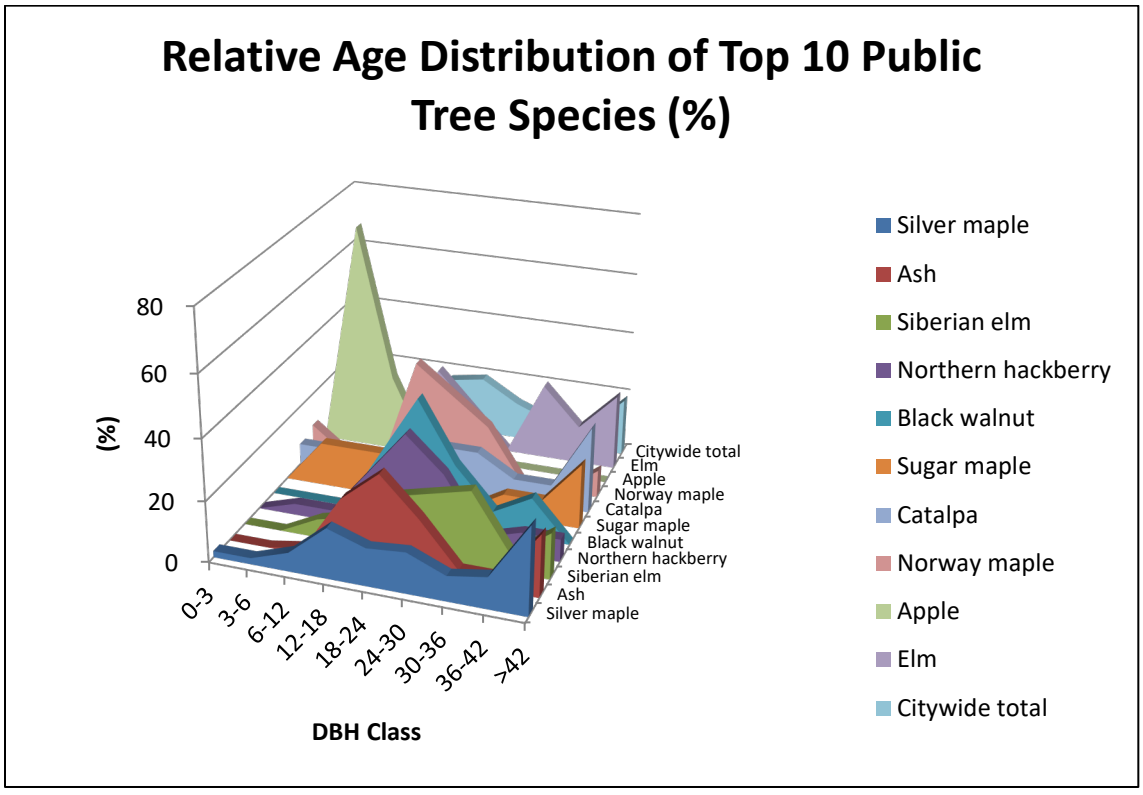

Figure 2: Relative Age Class

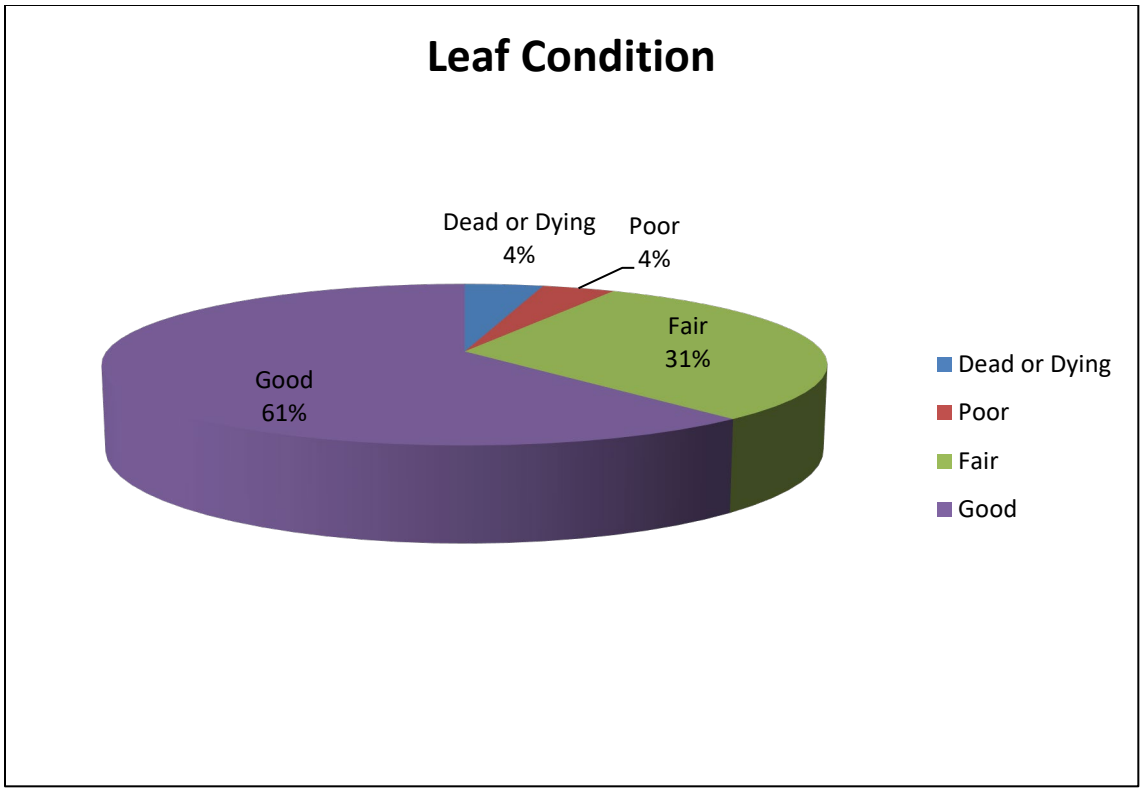

Figure 3: Foliage Condition

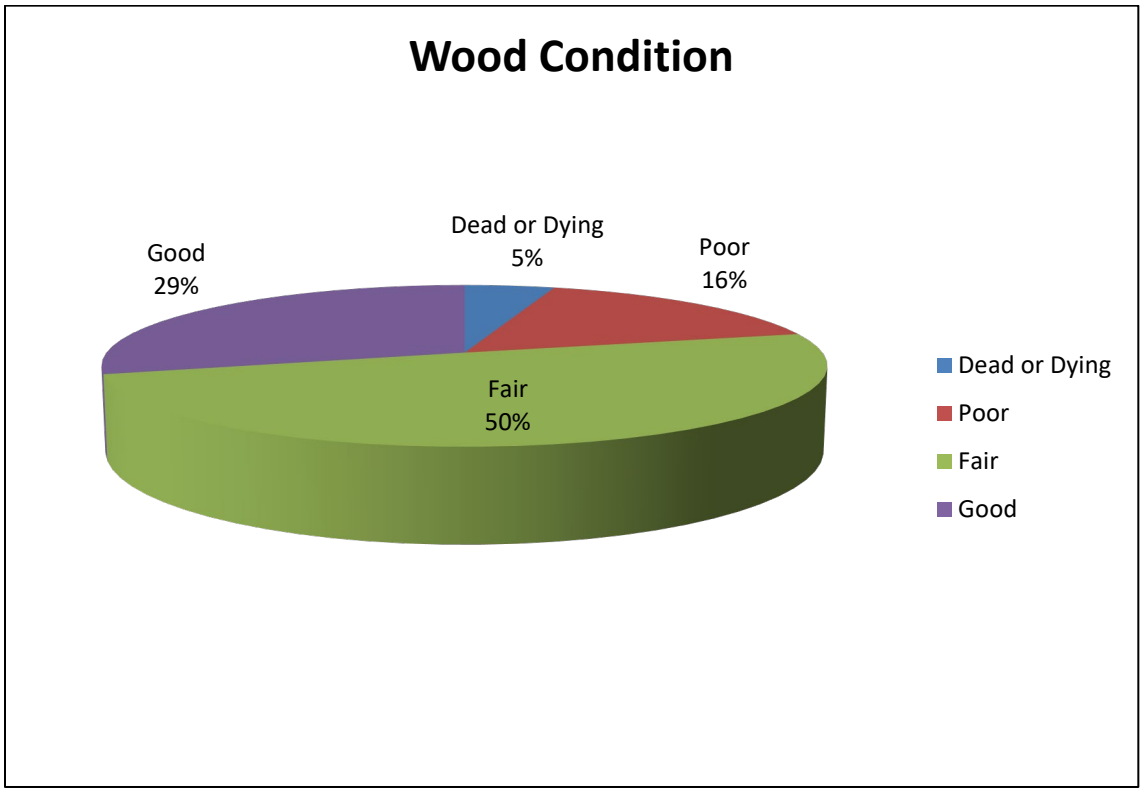

Figure 4: Wood Condition

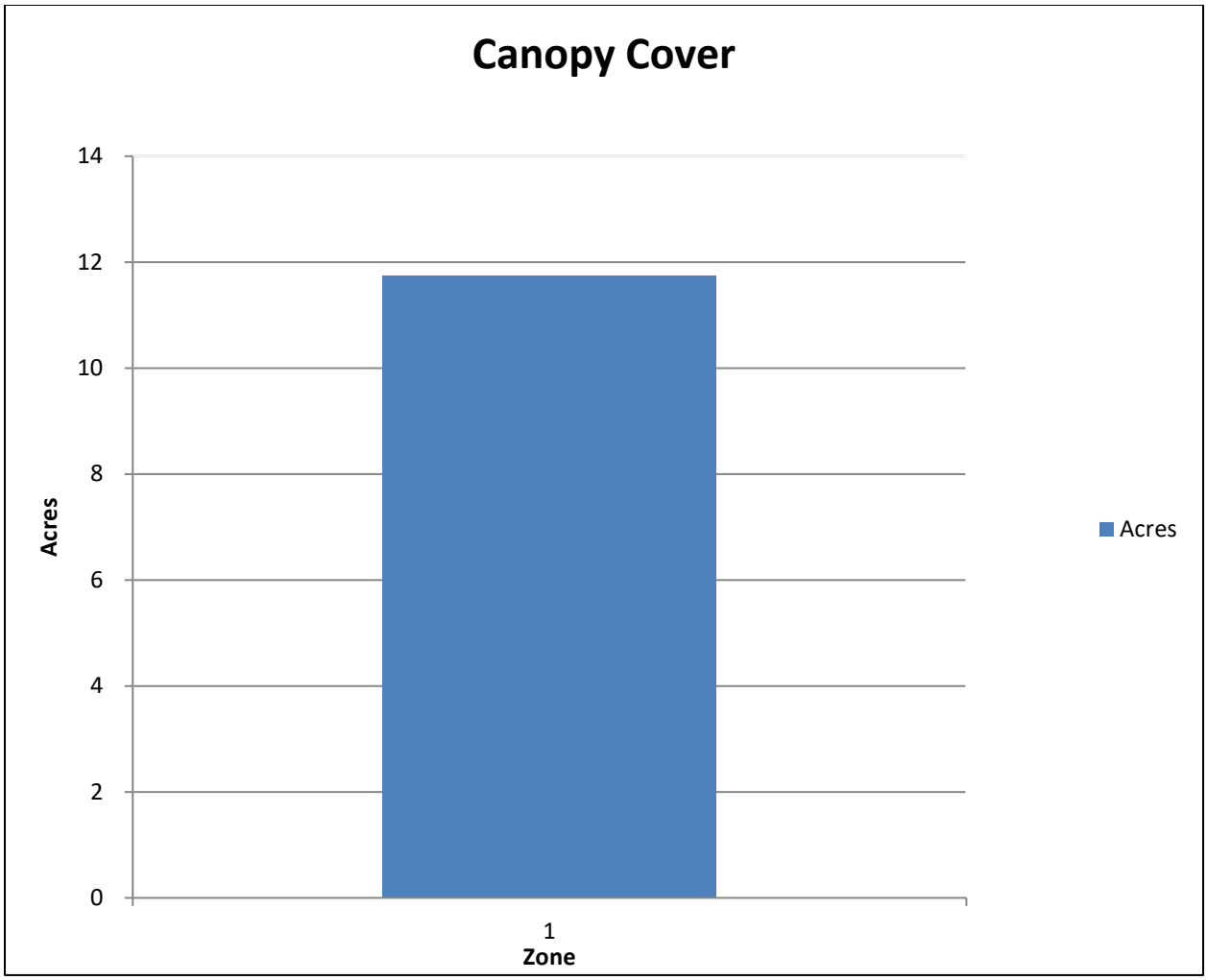

Figure 5: Canopy Cover in Acres

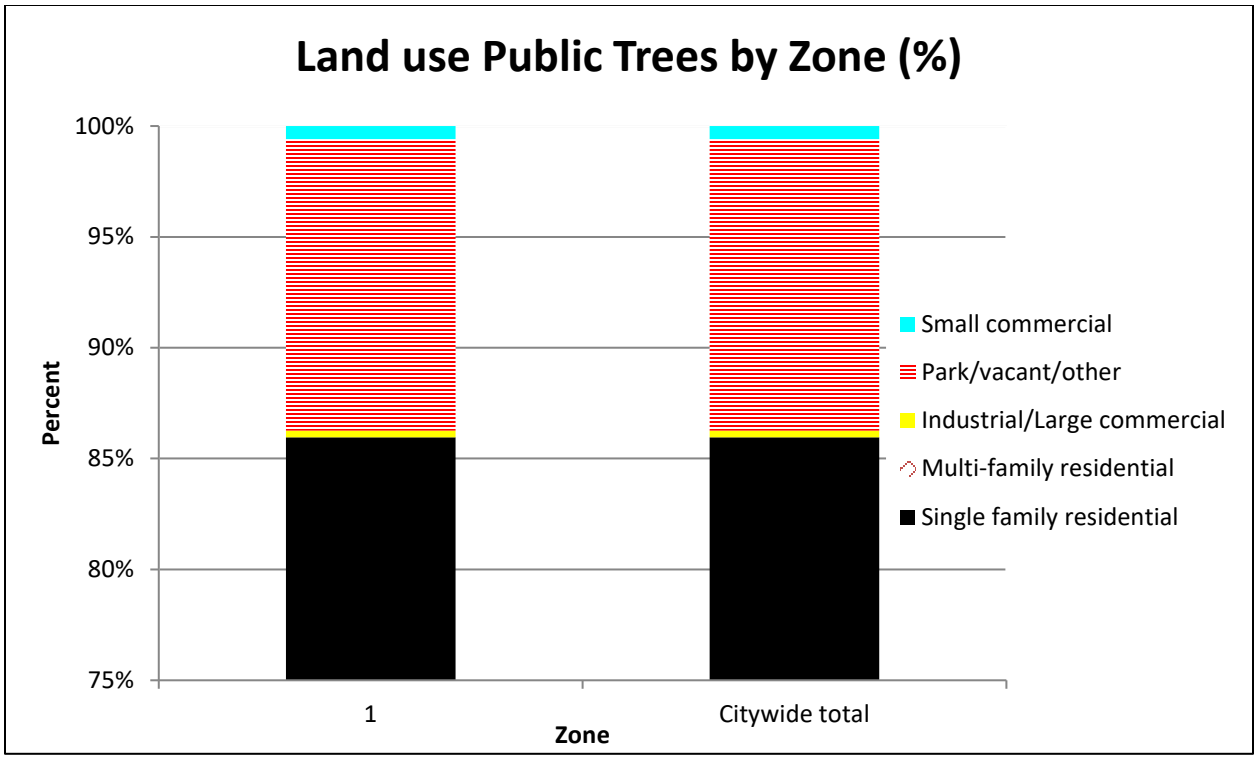

Figure 6: Land Use of city/park trees

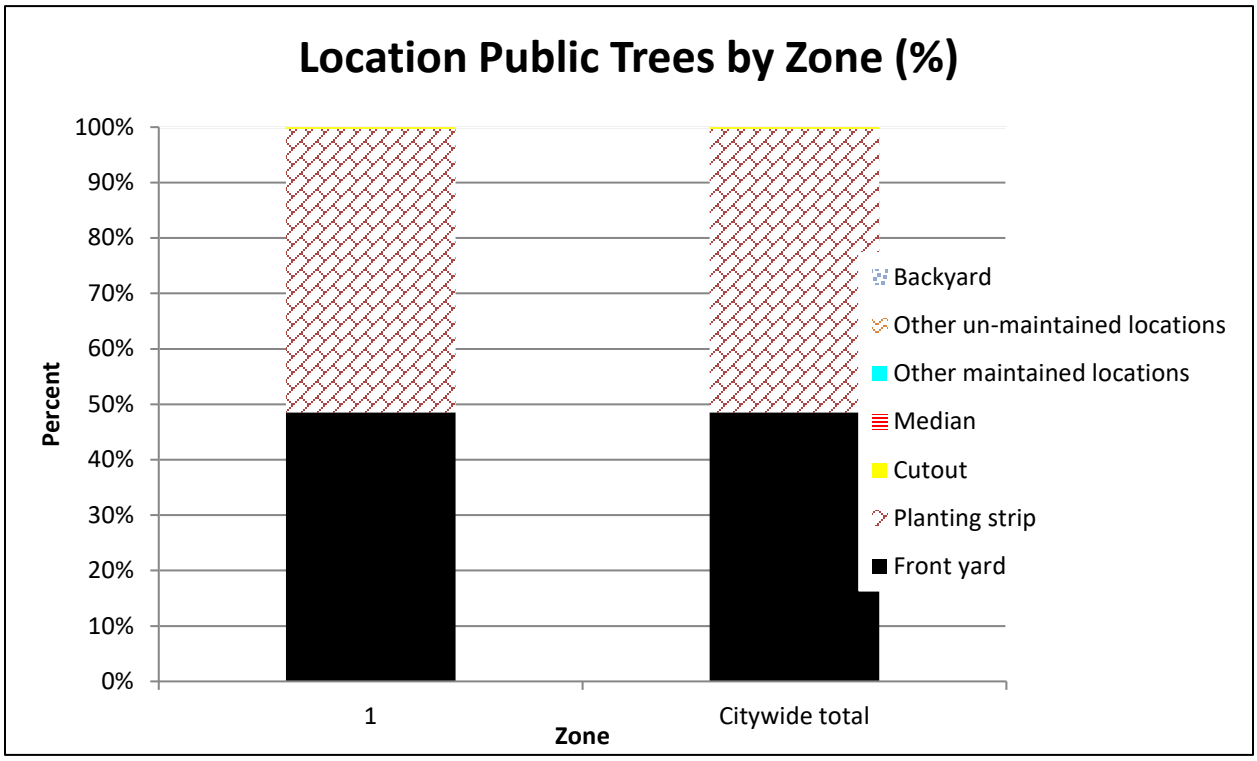

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

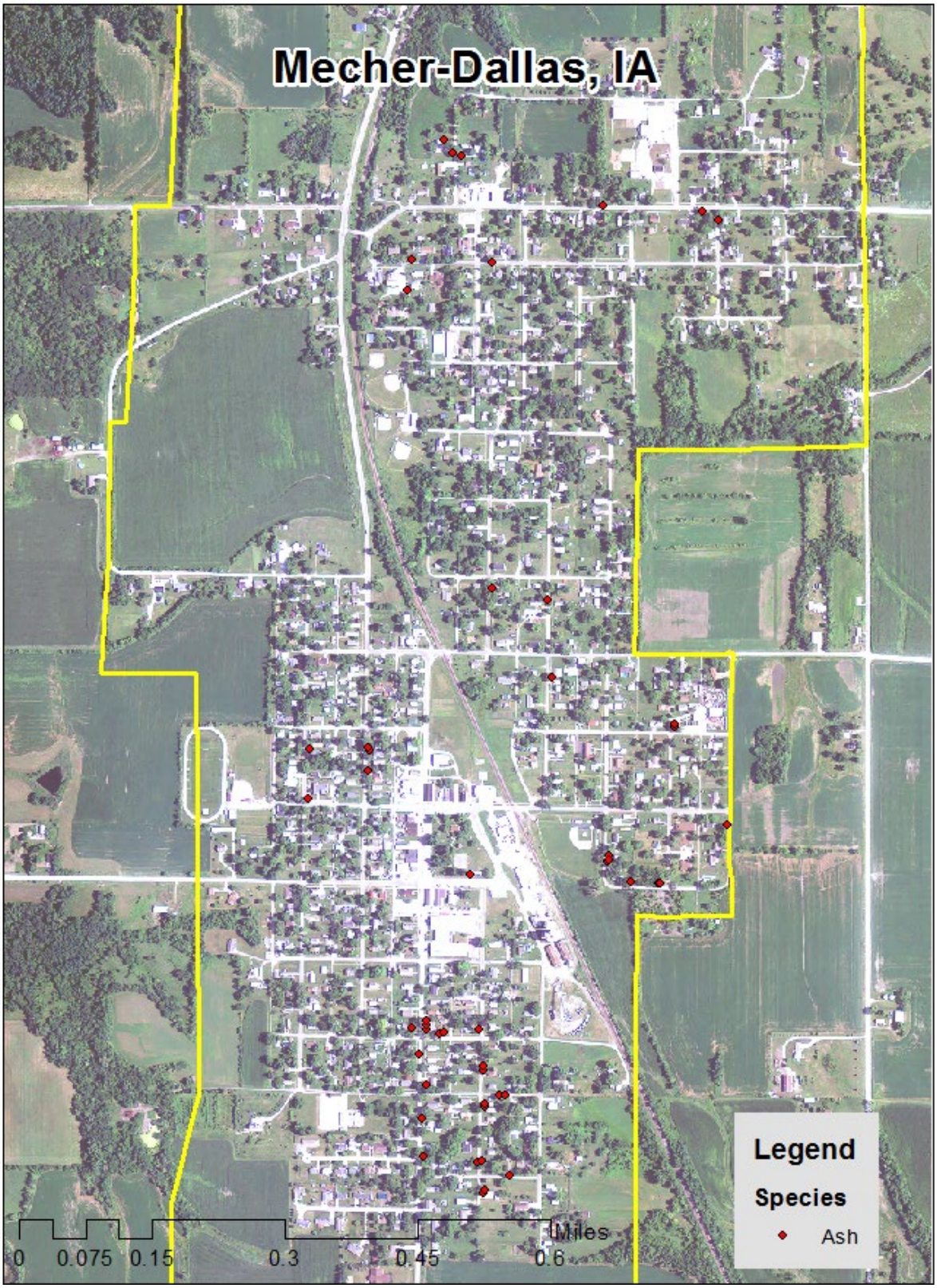

Figure 1: Location of Ash Trees

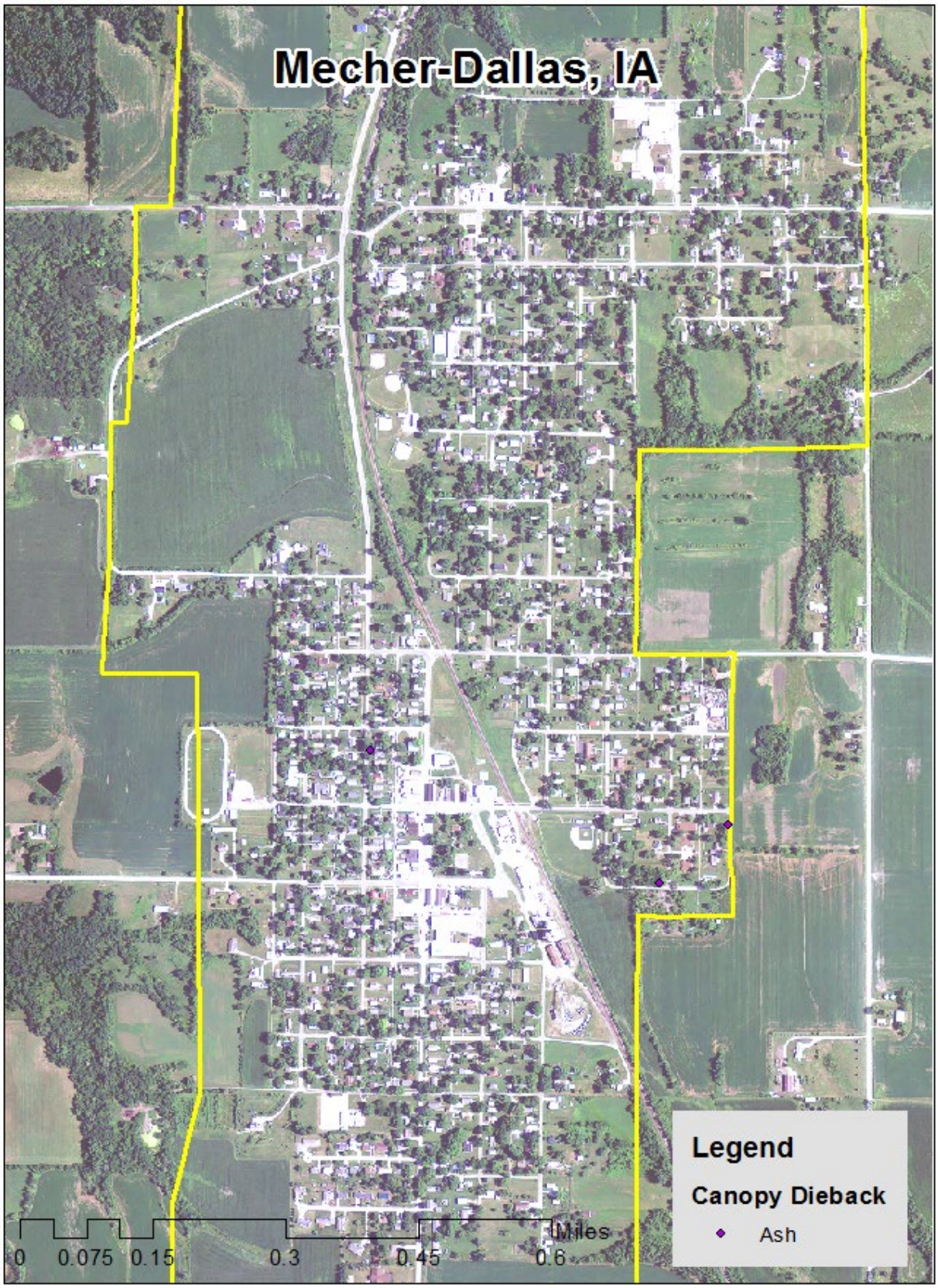

Figure 2: Location of EAB symptoms

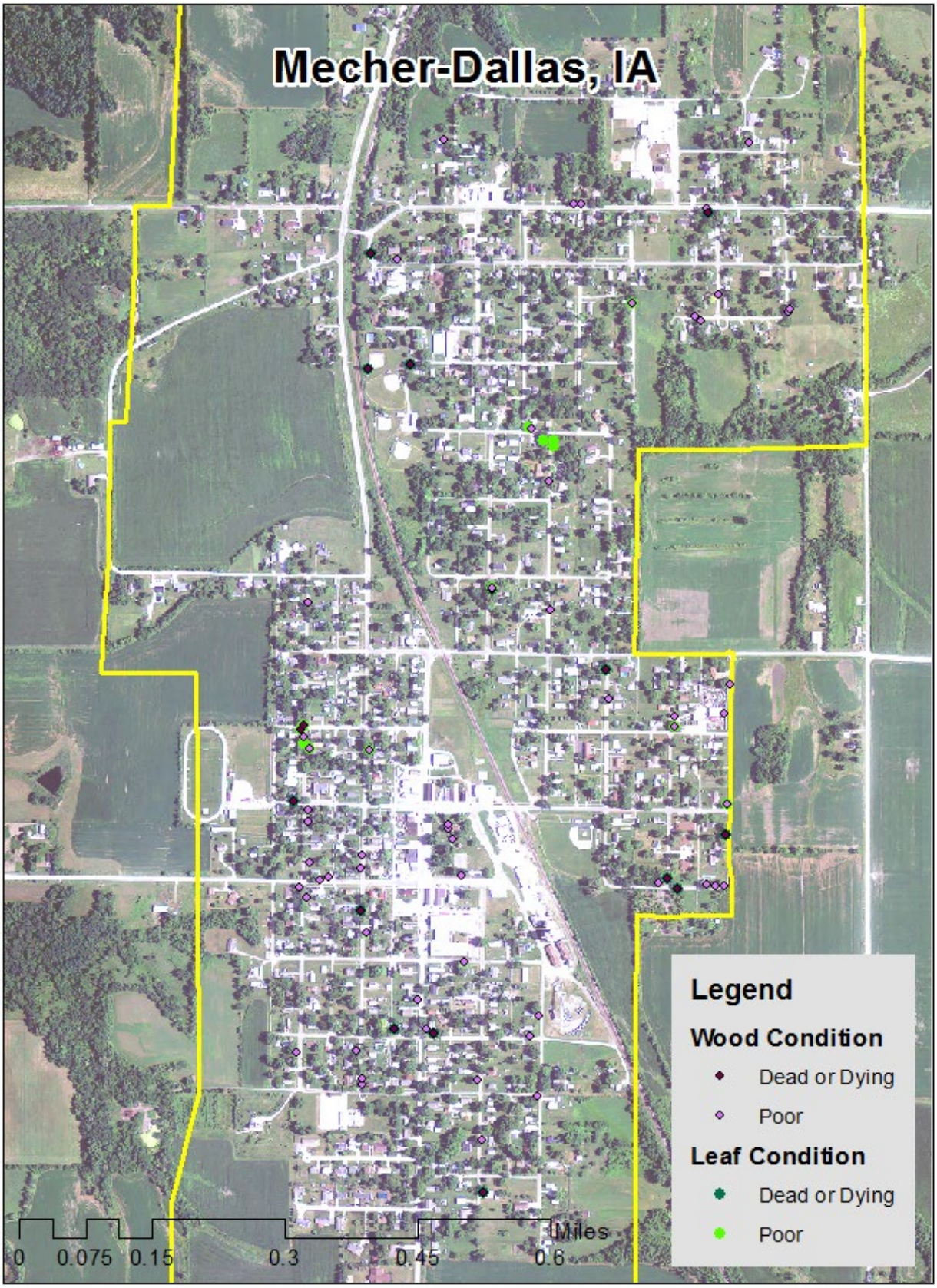

Figure 3: Location of Poor Condition Trees

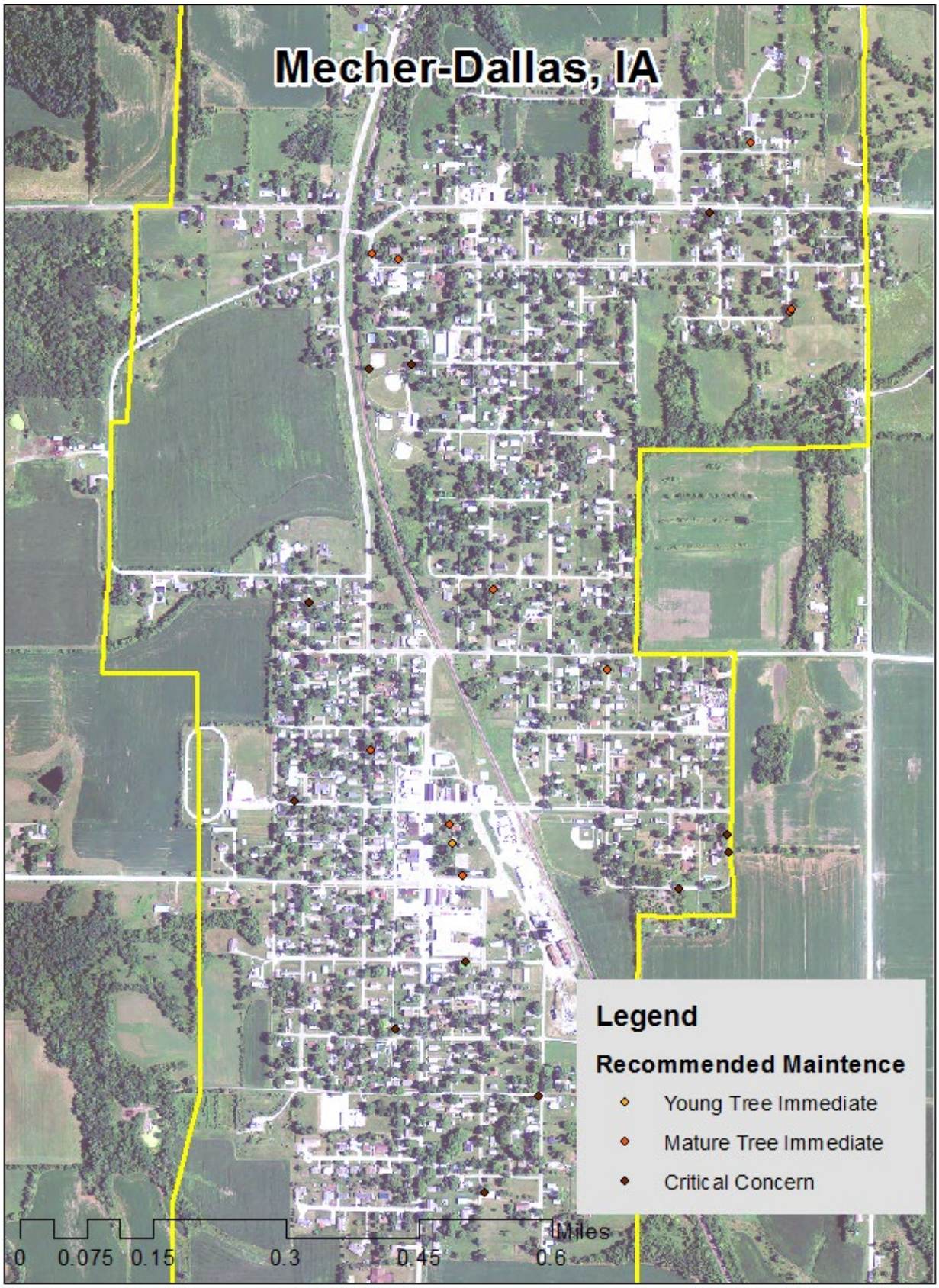

Figure 4: Location of Trees with Recommended Maintenance

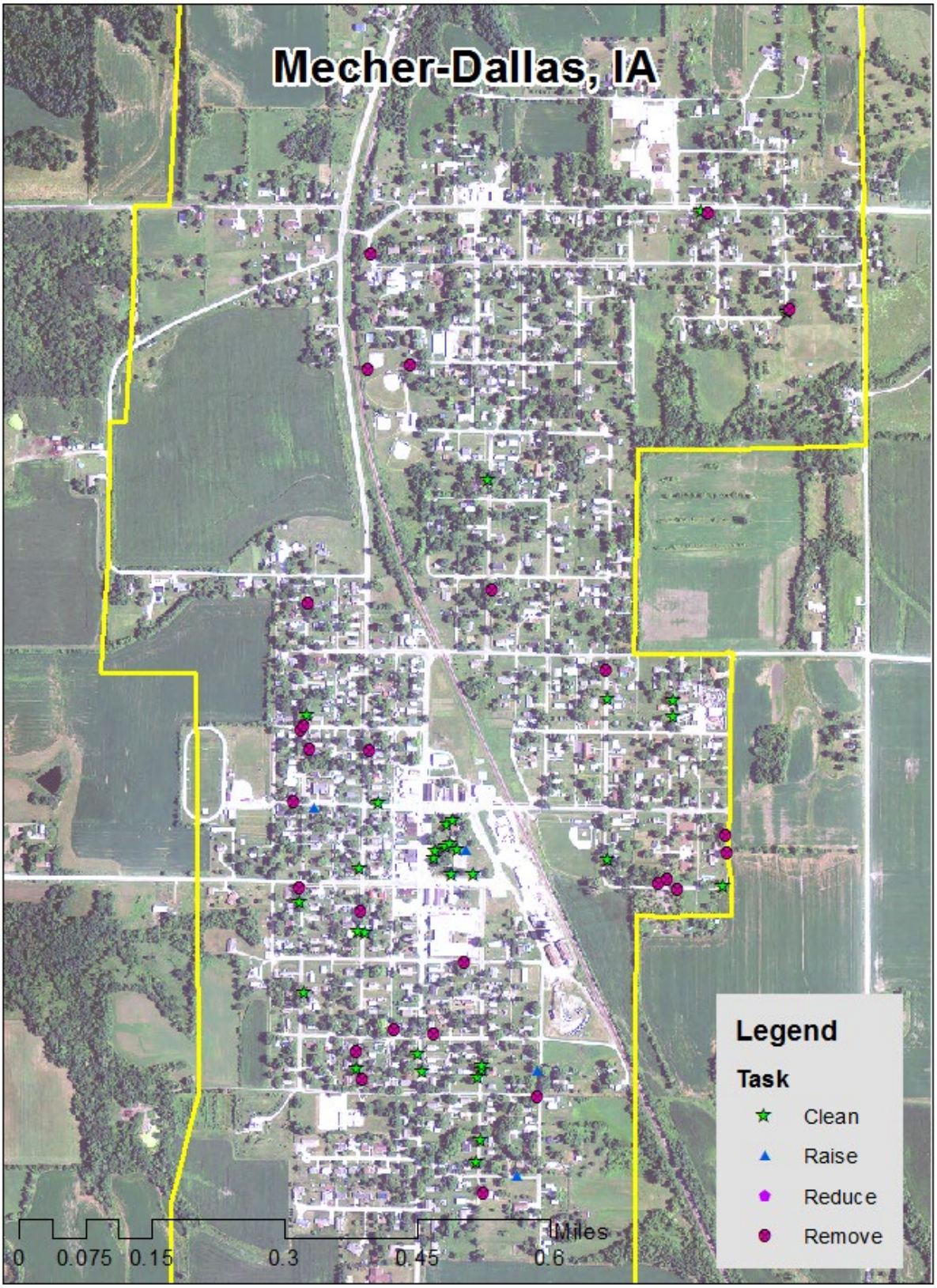

Figure 5: Maintenance Tasks ***City ownership of the trees recommended for removal should be verified prior to any removal***

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