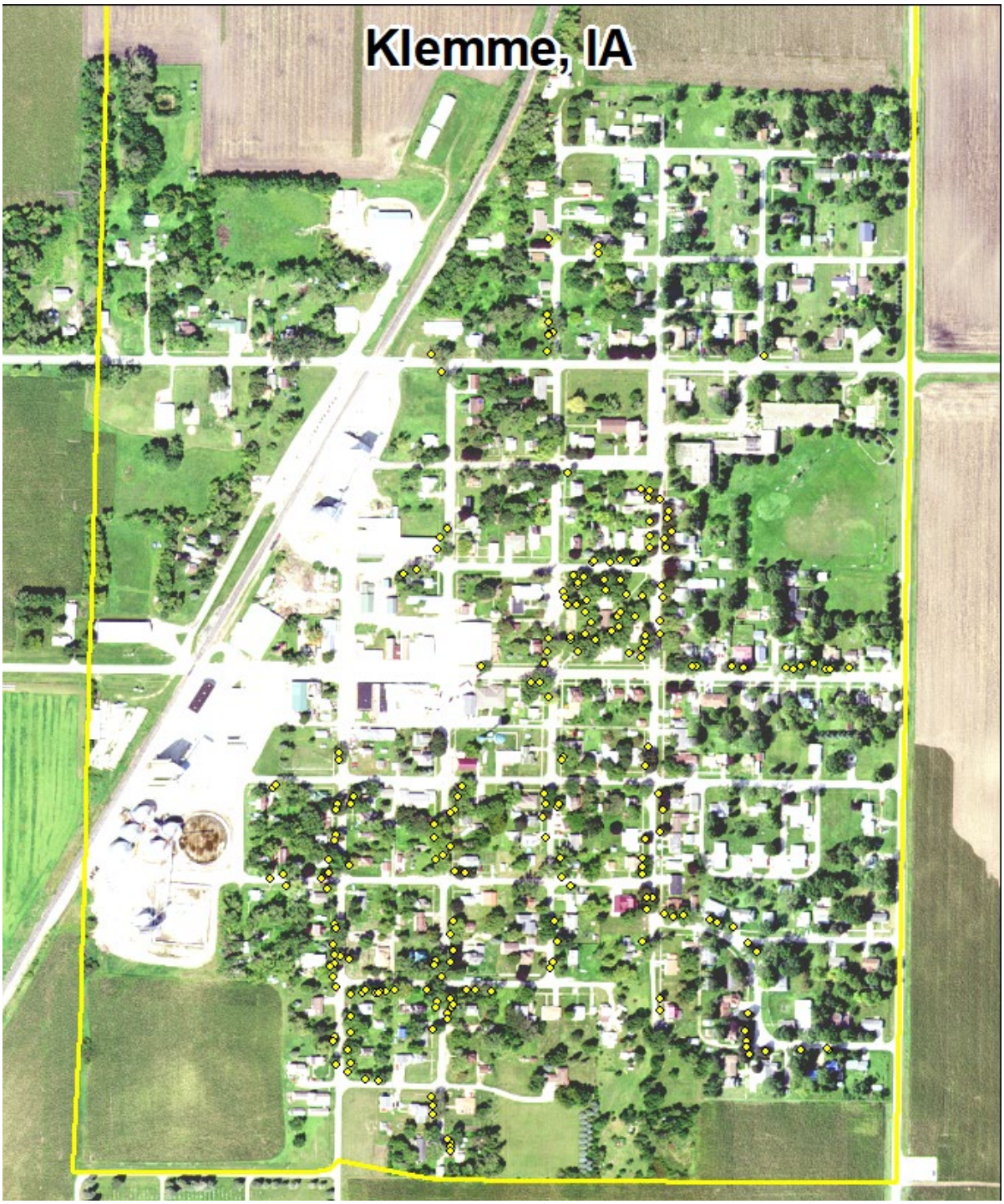
Klemme, IA



2019 Urban Forest Management Plan
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Executive Summary

Overview

This plan was developed to assist the City of Klemme 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 38% of Klemme'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 2018, 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 221 trees inventoried.

- Klemme's trees provide $49,016 of benefits annually, an average of $221 a tree
- There are over 23 species of trees
- The top three genera are: Maple 38%, Ash 38%, and Oak 4%
- 66% of trees are in need of some type of management
- 15 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 15 trees needing removal, 10 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*
- 15 of the 85 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
- With the current budget it could take 41 years to remove ash – Suggestion: request a budget increase to $5,700 annually and apply for grants to plant replacement trees
- Create a community tree ordinance

Introduction

This plan was developed to assist Klemme 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 or treatment and replacement planting. With proper planning and management of the current canopy in Klemme, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

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

Inventory

In 2018, 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 221 city trees was entered into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management as 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. Klemme's trees reduce energy related costs by approximately $13,536 annually (Appendix A, Table 1). These savings are both in Electricity (63.6 MWh) and in Natural Gas (8,889.5 Therms).

Annual Stormwater Benefits

Klemme's trees intercept about 740,650 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $20,072 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 Klemme, it is estimated that trees remove 852.9 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 $2,424 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Klemme, trees sequester about 133,645 lbs of carbon a year with an associated value of $1,002 (Appendix A, Table 5). In addition, the trees store 2,973,462 lbs of carbon, with a yearly benefit of $22,301 (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. Klemme receives $11,295 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, Klemme's trees provide $49,016 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 221 trees in Klemme provide approximately $221 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Klemme has over 23 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Maple	86	38%
Ash	85	38%
Oak	10	4%
Linden/Basswood	9	4%
Apple (Crab)	7	3%
Hackberry	5	2%
Walnut	4	1%
Spruce	3	1%
Locust	2	<1%
Other Medium Deciduous	2	<1%
Buckeye	1	<1%
Catalpa	1	<1%
Willow	1	<1%
Cedar	1	<1%
Cottonwood	1	<1%
Other Large Evergreen	3	1%

Age Class

Most of Klemme's trees (21%) 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. Klemme'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 Klemme indicate that 81% of the trees are in good health, with only 4% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 85% of Klemme'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 4% of the population. This 4% 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	87	39%
Tree Removal	15	6%
Crown Raising	3	1%
Crown Reduction	3	1%
Treat Pest/Disease	1	<1%

Canopy Cover

The total canopy with both private and public trees is 14%, 44 acres. The canopy cover included in the Klemme inventory includes approximately 7 acres (Appendix A, Figure 4). The City's Canopy goal is to increase canopy by 3%, in 30 years. To achieve this goal it is estimated that 24 trees need to be planted annually on public and private lands.

Land Use and Location

The majority of Klemme'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	85%
Park/vacant/other	14%

Location	
Planting strip	59%
Front Yard	39%
Median	<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

Klemme has 8 immediate concern trees that need immediate pruning and removal. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). It is recommended to start with the large diameter critical concern trees first. There are 8 trees over 18 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.

Poor tree species

After the removal of the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 15 removals, 4 are ash trees. There are a total of 85 ash trees, and 15 of those have signs and symptoms that have been associated with EAB. *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 Klemme.

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 (38%) (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

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.

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.

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 if preventative treatments are not being used.

PROPOSED WORK SCHEDULE AND ESTIMATED COSTS

YEAR 1	**ESTIMATED COSTS**
Remove 1 immediate recommended trees	$700
Trim 7 immediate need tree	$210
Plant 12 trees in open locations	$1,200
Water and Maintenance	$600
Proposed: Remove (or treat) 14 ash trees*	$9,800
Inspect ash trees for signs of Emerald Ash Borer	

YEAR 2	
Proposed: Remove (or treat) 14 ash trees*	$9,800
Plant 12 trees in open locations	$1,200
Water & Maintenance	$600
Prune 1/3 of city owned trees	$2,210
Inspect ash trees for signs of Emerald Ash Borer	

YEAR 3	
Proposed: Remove (or treat) 14 ash trees*	$9,800
Plant 12 trees in open locations	$1,200
Water & Maintenance	$600
Inspect ash trees for signs of EAB	

YEAR 4	
Proposed: Remove (or treat) 14 ash trees*	$9,800
Plant 12 trees in open locations	$1,200

Water & Maintenance	$600
Prune 1/3 of city owned trees	$2,210
Inspect ash trees for signs of Emerald Ash Borer	

YEAR 5

Proposed: Remove (or treat) 14 ash trees*	$9,800
Plant 12 trees in open locations	$1,200
Water & Maintenance	$600
Inspect ash trees for signs of EAB	

YEAR 6

Proposed: Remove (or treat) 14 ash trees*	$9,800
Plant 12 trees in open locations	$1,200
Water & Maintenance	$600
Prune 1/3 of city owned trees	$2,210
Inspect ash trees for signs of Emerald Ash Borer	

*The removal or treatment of ash trees is discussed in more detail below. This proposed budget illustrates what it would be like if you removed all 85 of the city's ash trees within the 6 year maintenance cycle.
Estimated costs based on average costs of $700/tree for removal, $100/tree for planting, $50/tree for water and maintenance, and $30/tree for pruning.

Purposed Budget Increase

EAB could potentially kill all ash trees in Klemme within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to $5,700 a year (this would only include the budget needed to remove ash trees, this does not include budgeting for routine pruning and maintenance). If the budget were increased to $3,440 a year all ash could be removed within 10 years. Additionally, it is recommended that Klemme 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 instance, in this treatment scenario, the average ash diameter is 27 inches and at $15 per inch, say 10 trees could be treated per year (every other year treatment), this would cost $4,050 annually. This would be 20 trees selected for treatment, and Klemme would still need to find $7,580 annually for removal. Alternatively, if there are 40 treatable trees, it would cost approximately $8,100 a year for treatment and leave $4,666 for removal. 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 Klemme. It is suggested to consider increasing the budget to plan for this.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Klemme

Annual Energy Benefits of Public Trees

1/11/2019

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	26.4	2,007	3,635.7	3,563	5,570	(N/A)	38.5	41.2	65.53
Norway maple	16.1	1,226	2,385.0	2,337	3,563	(N/A)	24.4	26.3	65.98
Silver maple	5.6	426	735.2	721	1,146	(N/A)	7.2	8.5	71.63
American basswood	2.4	183	338.0	331	514	(N/A)	4.1	3.8	57.15
Sugar maple	2.2	165	296.0	290	455	(N/A)	3.6	3.4	56.90
Apple	0.6	49	102.4	100	150	(N/A)	3.2	1.1	21.38
Northern red oak	0.7	50	90.8	89	139	(N/A)	3.2	1.0	19.81
Northern hackberry	2.0	153	286.5	281	434	(N/A)	2.3	3.2	86.76
Red maple	1.0	76	141.4	139	214	(N/A)	2.3	1.6	42.90
Black walnut	1.4	107	194.9	191	298	(N/A)	1.8	2.2	74.44
Bur oak	0.8	60	114.3	112	172	(N/A)	1.4	1.3	57.32
Blue spruce	0.3	25	44.9	44	69	(N/A)	1.4	0.5	22.99
Broadleaf Evergreen Large	1.0	78	133.0	130	208	(N/A)	1.4	1.5	69.47
Amur maple	0.1	7	16.6	16	24	(N/A)	0.9	0.2	11.80
Broadleaf Deciduous Mediu	0.5	38	69.1	68	105	(N/A)	0.9	0.8	52.73
Boxelder	0.3	22	40.7	40	62	(N/A)	0.5	0.5	62.01
Honeylocust	0.4	28	47.4	46	74	(N/A)	0.5	0.5	74.28
Black locust	0.2	18	29.5	29	47	(N/A)	0.5	0.3	46.78
Ohio buckeye	0.2	18	29.5	29	47	(N/A)	0.5	0.3	46.78
Northern catalpa	0.4	29	53.7	53	82	(N/A)	0.5	0.6	82.02
Willow	0.2	18	29.5	29	47	(N/A)	0.5	0.3	46.78
Eastern red cedar	0.1	8	16.4	16	25	(N/A)	0.5	0.2	24.57
Eastern cottonwood	0.4	33	59.0	58	91	(N/A)	0.5	0.7	91.02
Total	63.6	4,824	8,889.5	8,712	13,536	(N/A)	100.0	100.0	61.25

Table 2: Annual Stormwater Benefits

Klemme

Annual Stormwater Benefits of Public Trees

1/11/2019

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	315,072	8,538	(N/A)	38.5	42.5	100.45
Norway maple	179,357	4,861	(N/A)	24.4	24.2	90.01
Silver maple	82,825	2,245	(N/A)	7.2	11.2	140.28
American basswood	24,291	658	(N/A)	4.1	3.3	73.14
Sugar maple	23,768	644	(N/A)	3.6	3.2	80.52
Apple	2,771	75	(N/A)	3.2	0.4	10.73
Northern red oak	3,643	99	(N/A)	3.2	0.5	14.10
Northern hackberry	22,513	610	(N/A)	2.3	3.0	122.02
Red maple	9,363	254	(N/A)	2.3	1.3	50.75
Black walnut	17,716	480	(N/A)	1.8	2.4	120.02
Bur oak	7,772	211	(N/A)	1.4	1.0	70.21
Blue spruce	4,612	125	(N/A)	1.4	0.6	41.66
Broadleaf Evergreen Large	15,425	418	(N/A)	1.4	2.1	139.34
Amur maple	333	9	(N/A)	0.9	0.0	4.51
Broadleaf Deciduous Medium	3,888	105	(N/A)	0.9	0.5	52.69
Boxelder	4,024	109	(N/A)	0.5	0.5	109.04
Honeylocust	4,685	127	(N/A)	0.5	0.6	126.96
Black locust	1,409	38	(N/A)	0.5	0.2	38.19
Ohio buckeye	1,409	38	(N/A)	0.5	0.2	38.19
Northern catalpa	5,491	149	(N/A)	0.5	0.7	148.79
Willow	1,409	38	(N/A)	0.5	0.2	38.19
Eastern red cedar	1,635	44	(N/A)	0.5	0.2	44.30
Eastern cottonwood	7,239	196	(N/A)	0.5	1.0	196.17
Citywide total	740,650	20,072	(N/A)	100.0	100.0	90.82

Table 3: Annual Air Quality Benefits

Klemme

Annual Air Quality Benefits of Public Trees

1/11/2019

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								
Green ash	41.3	6.6	19.4	1.9	219	126.4	18.4	17.5	119.9	787	0.0	0	351.4	1,006	(N/A)	38.5	11.84
Norway maple	40.0	6.9	19.2	1.8	215	78.8	11.4	10.8	73.2	487	-9.1	-34	233.0	668	(N/A)	24.4	12.36
Silver maple	15.3	2.6	7.4	0.7	82	26.4	3.9	3.7	25.4	165	-8.1	-30	77.2	217	(N/A)	7.2	13.57
American basswood	3.2	0.5	1.6	0.1	17	11.6	1.7	1.6	11.0	72	-2.8	-10	28.5	79	(N/A)	4.1	8.78
Sugar maple	3.1	0.5	1.6	0.1	17	10.4	1.5	1.4	9.9	65	-2.4	-9	26.0	72	(N/A)	3.6	9.03
Apple	0.8	0.1	0.4	0.0	4	3.2	0.5	0.4	2.9	20	0.0	0	8.4	24	(N/A)	3.2	3.42
Northern red oak	0.5	0.1	0.3	0.0	3	3.1	0.5	0.4	3.0	19	-0.7	-3	7.2	20	(N/A)	3.2	2.81
Northern hackberry	3.8	0.7	1.9	0.2	21	9.7	1.4	1.3	9.1	60	0.0	0	28.2	81	(N/A)	2.3	16.22
Red maple	2.3	0.4	1.1	0.1	12	4.8	0.7	0.7	4.5	30	-0.8	-3	13.8	39	(N/A)	2.3	7.88
Black walnut	2.8	0.5	1.3	0.1	15	6.7	1.0	0.9	6.4	42	0.0	0	19.7	57	(N/A)	1.8	14.21
Bur oak	0.8	0.1	0.4	0.0	4	3.8	0.6	0.5	3.6	24	0.0	0	9.9	28	(N/A)	1.4	9.34
Blue spruce	0.6	0.1	0.5	0.1	4	1.6	0.2	0.2	1.5	10	-1.7	-6	3.1	8	(N/A)	1.4	2.51
Broadleaf Evergreen Large	2.3	0.5	1.9	0.3	15	4.8	0.7	0.7	4.6	30	-7.0	-26	8.7	19	(N/A)	1.4	6.34
Amur maple	0.0	0.0	0.0	0.0	0	0.5	0.1	0.1	0.4	3	0.0	0	1.1	3	(N/A)	0.9	1.63
Broadleaf Deciduous Medium	0.7	0.1	0.4	0.0	4	2.4	0.3	0.3	2.3	15	-0.2	-1	6.4	18	(N/A)	0.9	9.04
Boxelder	0.6	0.1	0.3	0.0	3	1.4	0.2	0.2	1.3	9	-0.2	-1	3.9	11	(N/A)	0.5	11.20
Honeylocust	0.9	0.2	0.4	0.0	5	1.7	0.3	0.2	1.7	11	-0.8	-3	4.7	13	(N/A)	0.5	12.87
Black locust	0.2	0.0	0.1	0.0	1	1.1	0.2	0.2	1.1	7	-0.1	0	2.8	8	(N/A)	0.5	7.92
Ohio buckeye	0.2	0.0	0.1	0.0	1	1.1	0.2	0.2	1.1	7	-0.1	0	2.8	8	(N/A)	0.5	7.92
Northern catalpa	0.8	0.1	0.4	0.0	4	1.9	0.3	0.3	1.8	12	0.0	0	5.5	16	(N/A)	0.5	15.71
Willow	0.2	0.0	0.1	0.0	1	1.1	0.2	0.2	1.1	7	-0.1	0	2.8	8	(N/A)	0.5	7.92
Eastern red cedar	0.3	0.1	0.3	0.0	2	0.5	0.1	0.1	0.5	3	-0.9	-3	1.0	2	(N/A)	0.5	2.19
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)	0.5	19.04
Citywide total	122.2	20.5	59.5	5.7	657	305.2	44.3	42.2	288.1	1,897	-34.8	-130	852.9	2,424	(N/A)	100.0	10.97

Table 4: Annual Carbon Stored

Klemme

Stored CO2 Benefits of Public Trees

1/11/2019

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	1,352,443	10,143	(N/A)	38.5	45.5	119.33
Norway maple	660,108	4,951	(N/A)	24.4	22.2	91.68
Silver maple	369,922	2,774	(N/A)	7.2	12.4	173.40
American basswood	119,383	895	(N/A)	4.1	4.0	99.49
Sugar maple	88,452	663	(N/A)	3.6	3.0	82.92
Apple	12,859	96	(N/A)	3.2	0.4	13.78
Northern red oak	8,067	61	(N/A)	3.2	0.3	8.64
Northern hackberry	59,717	448	(N/A)	2.3	2.0	89.57
Red maple	25,155	189	(N/A)	2.3	0.8	37.73
Black walnut	95,985	720	(N/A)	1.8	3.2	179.97
Bur oak	25,373	190	(N/A)	1.4	0.9	63.43
Blue spruce	4,064	30	(N/A)	1.4	0.1	10.16
Broadleaf Evergreen l	27,052	203	(N/A)	1.4	0.9	67.63
Amur maple	1,086	8	(N/A)	0.9	0.0	4.07
Broadleaf Deciduous	11,569	87	(N/A)	0.9	0.4	43.39
Boxelder	22,806	171	(N/A)	0.5	0.8	171.04
Honeylocust	12,245	92	(N/A)	0.5	0.4	91.84
Black locust	3,624	27	(N/A)	0.5	0.1	27.18
Ohio buckeye	3,624	27	(N/A)	0.5	0.1	27.18
Northern catalpa	25,943	195	(N/A)	0.5	0.9	194.57
Willow	3,624	27	(N/A)	0.5	0.1	27.18
Eastern red cedar	1,102	8	(N/A)	0.5	0.0	8.27
Eastern cottonwood	39,259	294	(N/A)	0.5	1.3	294.44
Citywide total	2,973,462	22,301	(N/A)	100.0	100.0	100.91

Table 5: Annual Carbon Sequestered

Klemme

Annual CO Benefits of Public Trees

1/11/2019

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	62,875	472	-6,492	-280	-51	44,364	333	100,468	754	(N/A)	38.5	44.6	8.86
Norway maple	13,320	100	-3,169	-190	-25	27,085	203	37,047	278	(N/A)	24.4	16.4	5.15
Silver maple	25,358	190	-1,776	-64	-14	9,404	71	32,922	247	(N/A)	7.2	14.6	15.43
American basswood	7,162	54	-573	-27	-4	4,048	30	10,611	80	(N/A)	4.1	4.7	8.84
Sugar maple	4,782	36	-425	-23	-3	3,649	27	7,983	60	(N/A)	3.6	3.5	7.48
Apple	1,164	9	-62	-9	-1	1,090	8	2,183	16	(N/A)	3.2	1.0	2.34
Northern red oak	981	7	-39	-8	0	1,097	8	2,032	15	(N/A)	3.2	0.9	2.18
Northern hackberry	2,796	21	-287	-20	-2	3,382	25	5,871	44	(N/A)	2.3	2.6	8.81
Red maple	2,051	15	-121	-10	-1	1,677	13	3,597	27	(N/A)	2.3	1.6	5.40
Black walnut	2,852	21	-461	-16	-4	2,359	18	4,735	36	(N/A)	1.8	2.1	8.88
Bur oak	1,979	15	-122	-8	-1	1,324	10	3,173	24	(N/A)	1.4	1.4	7.93
Blue spruce	276	2	-20	-6	0	552	4	803	6	(N/A)	1.4	0.4	2.01
Broadleaf Evergreen Large	1,072	8	-130	-9	-1	1,726	13	2,660	20	(N/A)	1.4	1.2	6.65
Amur maple	152	1	-5	-2	0	161	1	306	2	(N/A)	0.9	0.1	1.15
Broadleaf Deciduous Medi	856	6	-56	-5	0	835	6	1,631	12	(N/A)	0.9	0.7	6.12
Boxelder	1,454	11	-109	-4	-1	490	4	1,830	14	(N/A)	0.5	0.8	13.73
Honeylocust	1,486	11	-59	-3	0	615	5	2,039	15	(N/A)	0.5	0.9	15.29
Black locust	386	3	-17	-2	0	395	3	762	6	(N/A)	0.5	0.3	5.71
Ohio buckeye	386	3	-17	-2	0	395	3	762	6	(N/A)	0.5	0.3	5.71
Northern catalpa	960	7	-125	-4	-1	650	5	1,481	11	(N/A)	0.5	0.7	11.11
Willow	386	3	-17	-2	0	395	3	762	6	(N/A)	0.5	0.3	5.71
Eastern red cedar	0	0	-5	-2	0	187	1	180	1	(N/A)	0.5	0.1	1.35
Eastern cottonwood	912	7	-188	-5	-1	734	6	1,453	11	(N/A)	0.5	0.6	10.90
Citywide total	133,645	1,002	-14,273	-700	-112	106,616	800	225,288	1,690	(N/A)	100.0	100.0	7.65

Table 6: Annual Social and Aesthetic Benefits

Klemme

Annual Aesthetic/Other Benefits of Public Trees

1/11/2019

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	4,952	(N/A)	38.5	43.8	58.26
Norway maple	1,191	(N/A)	24.4	10.5	22.05
Silver maple	1,883	(N/A)	7.2	16.7	117.70
American basswood	521	(N/A)	4.1	4.6	57.93
Sugar maple	507	(N/A)	3.6	4.5	63.39
Apple	68	(N/A)	3.2	0.6	9.66
Northern red oak	103	(N/A)	3.2	0.9	14.78
Northern hackberry	340	(N/A)	2.3	3.0	67.91
Red maple	255	(N/A)	2.3	2.3	51.05
Black walnut	217	(N/A)	1.8	1.9	54.36
Bur oak	173	(N/A)	1.4	1.5	57.69
Blue spruce	66	(N/A)	1.4	0.6	22.09
Broadleaf Evergreen Large	218	(N/A)	1.4	1.9	72.57
Amur maple	8	(N/A)	0.9	0.1	4.23
Broadleaf Deciduous Medium	82	(N/A)	0.9	0.7	41.11
Boxelder	79	(N/A)	0.5	0.7	78.52
Honeylocust	389	(N/A)	0.5	3.4	388.90
Black locust	39	(N/A)	0.5	0.3	39.16
Ohio buckeye	39	(N/A)	0.5	0.3	39.16
Northern catalpa	67	(N/A)	0.5	0.6	66.60
Willow	39	(N/A)	0.5	0.3	39.16
Eastern red cedar	0	(N/A)	0.5	0.0	0.00
Eastern cottonwood	58	(N/A)	0.5	0.5	58.34
Citywide total	11,295	(N/A)	100.0	100.0	51.11

Table 7: Summary of Benefits in Dollars

Klemme

Total Annual Benefits of Public Trees by Species ($)

1/11/2019

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Green ash	5,570	754	1,006	8,538	4,952	20,820	(N/A)	42.5
Norway maple	3,563	278	668	4,861	1,191	10,559	(N/A)	21.5
Silver maple	1,146	247	217	2,245	1,883	5,738	(N/A)	11.7
American basswood	514	80	79	658	521	1,853	(N/A)	3.8
Sugar maple	455	60	72	644	507	1,739	(N/A)	3.5
Apple	150	16	24	75	68	333	(N/A)	0.7
Northern red oak	139	15	20	99	103	376	(N/A)	0.8
Northern hackberry	434	44	81	610	340	1,509	(N/A)	3.1
Red maple	214	27	39	254	255	790	(N/A)	1.6
Black walnut	298	36	57	480	217	1,088	(N/A)	2.2
Bur oak	172	24	28	211	173	607	(N/A)	1.2
Blue spruce	69	6	8	125	66	274	(N/A)	0.6
Broadleaf Evergreen La	208	20	19	418	218	883	(N/A)	1.8
Amur maple	24	2	3	9	8	47	(N/A)	0.1
Broadleaf Deciduous M	105	12	18	105	82	323	(N/A)	0.7
Boxelder	62	14	11	109	79	274	(N/A)	0.6
Honeylocust	74	15	13	127	389	618	(N/A)	1.3
Black locust	47	6	8	38	39	138	(N/A)	0.3
Ohio buckeye	47	6	8	38	39	138	(N/A)	0.3
Northern catalpa	82	11	16	149	67	324	(N/A)	0.7
Willow	47	6	8	38	39	138	(N/A)	0.3
Eastern red cedar	25	1	2	44	0	72	(N/A)	0.1
Eastern cottonwood	91	11	19	196	58	375	(N/A)	0.8
Citywide Total	13,536	1,690	2,424	20,072	11,295	49,016	(N/A)	100.0

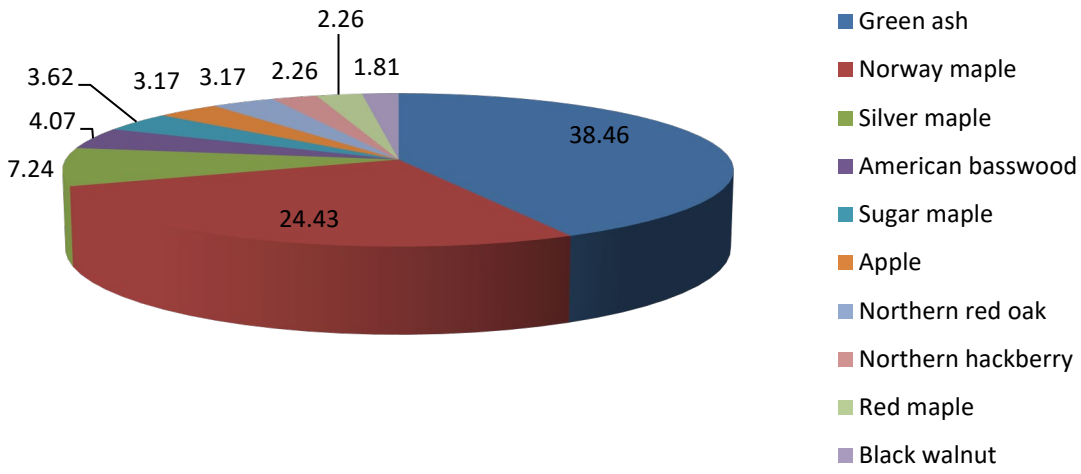

Figure 1: Species Distribution

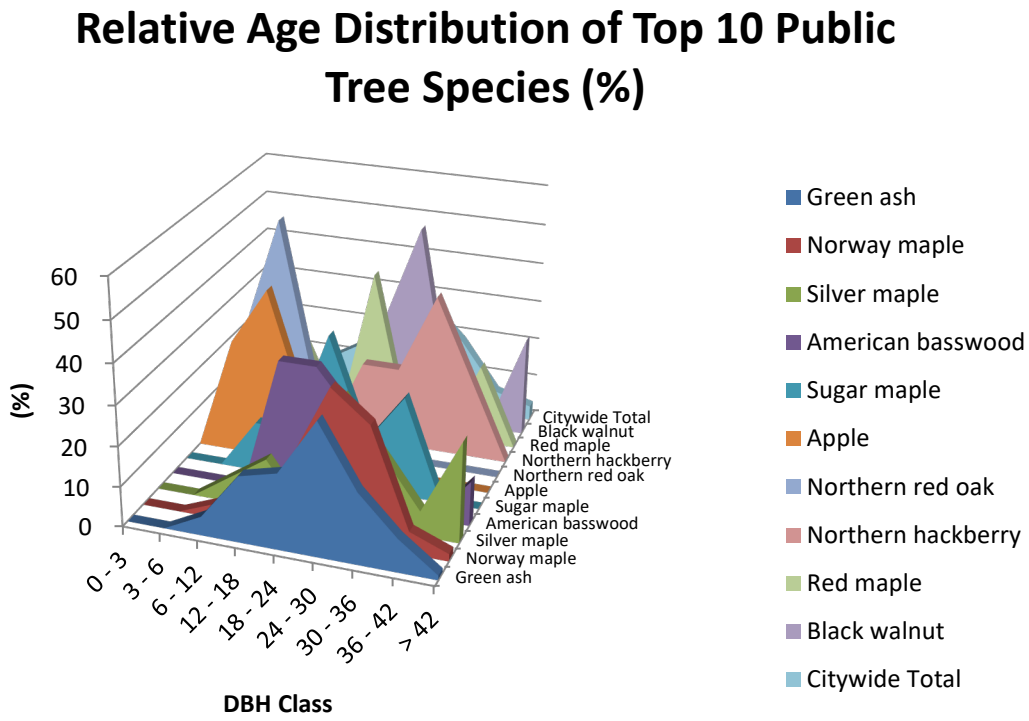

Figure 2: Relative Age Class

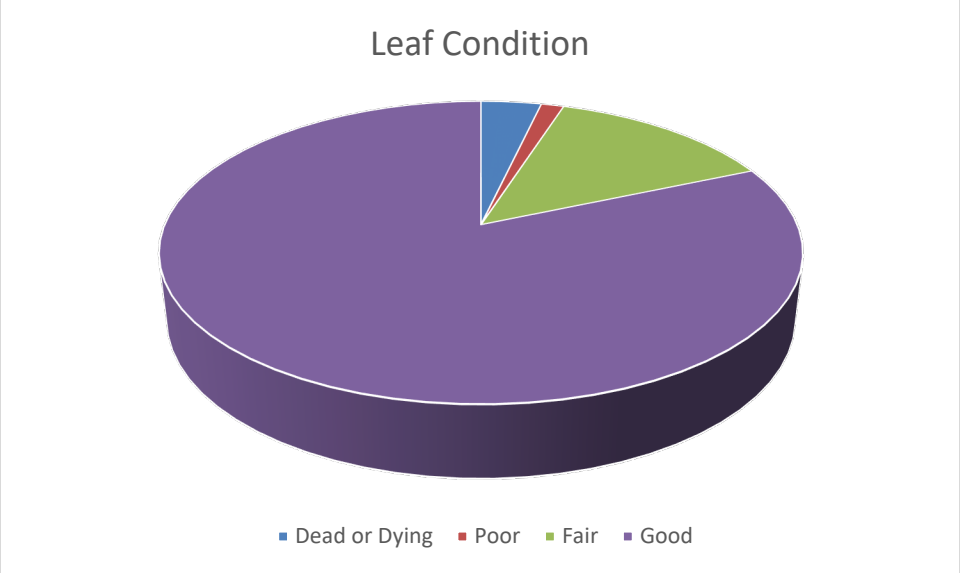

Figure 3: Foliage Condition

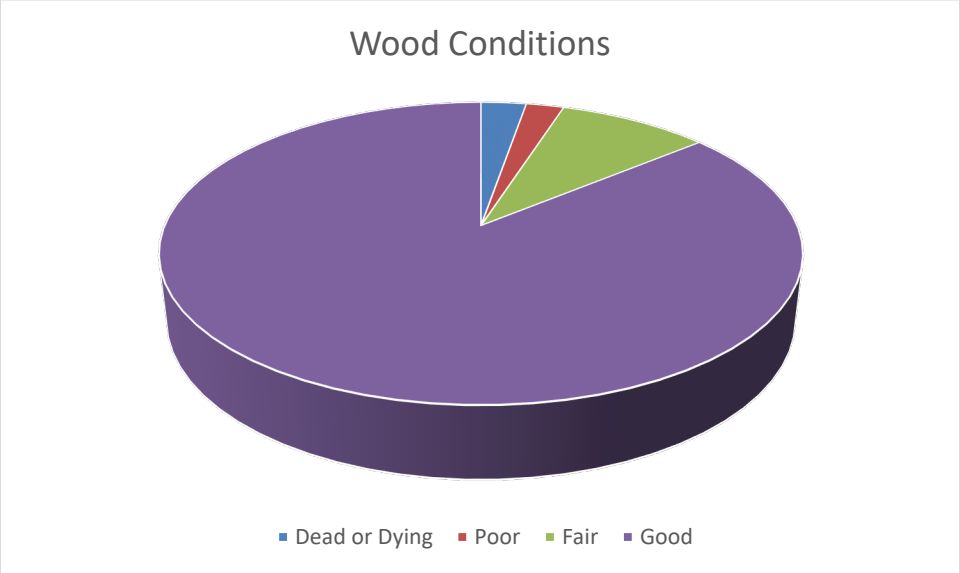

Figure 4: Wood Condition

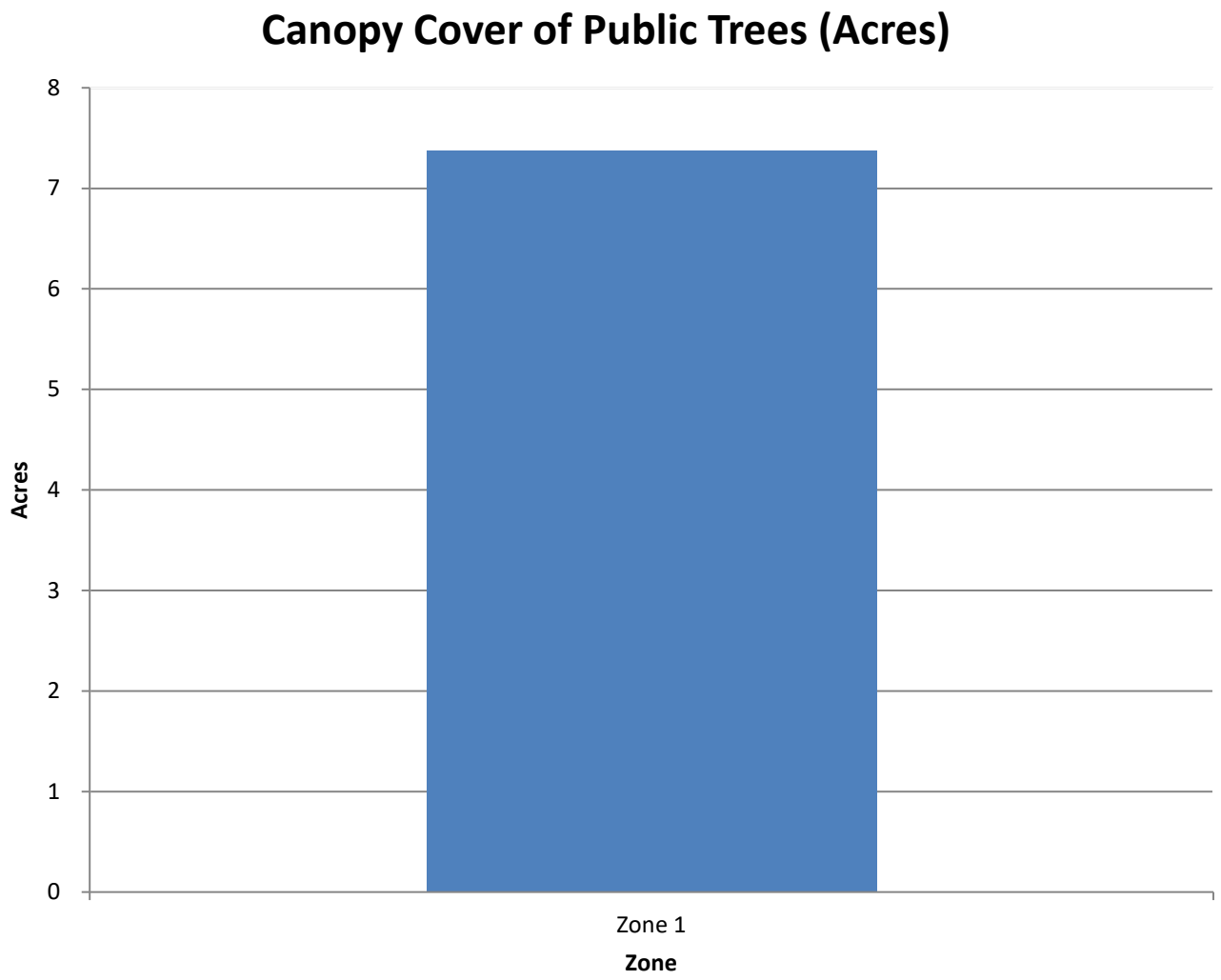

Figure 5: Canopy Cover in Acres

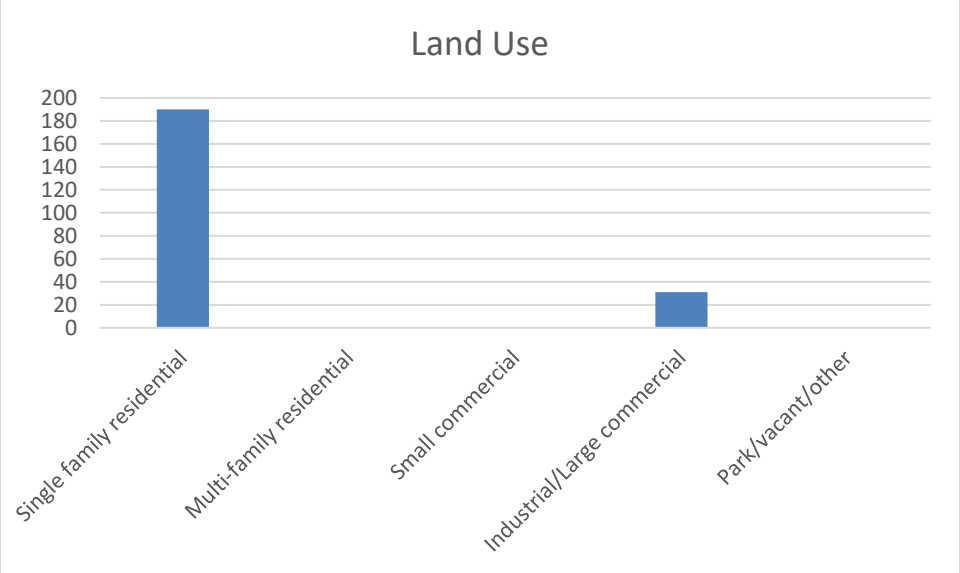

Figure 6: Land Use of city/park trees

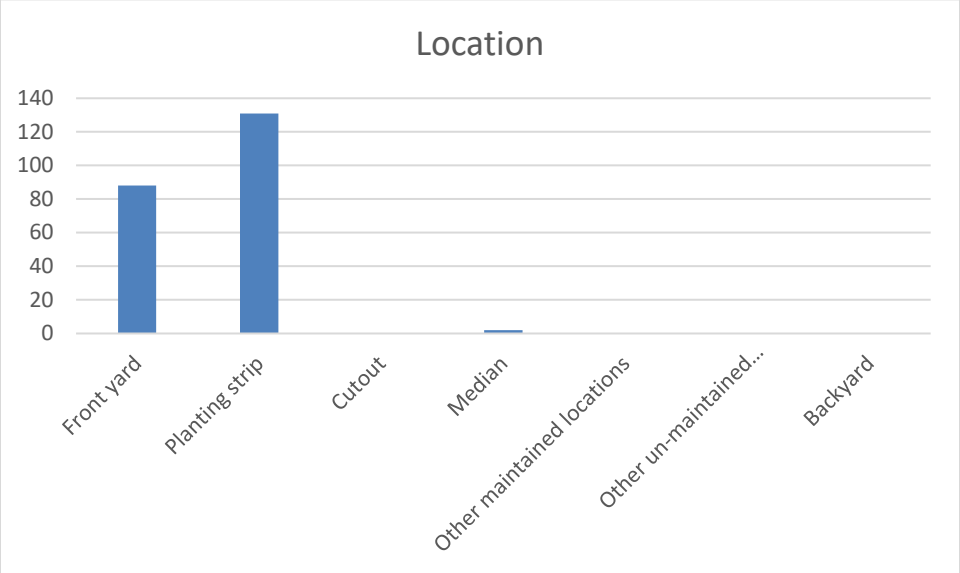

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

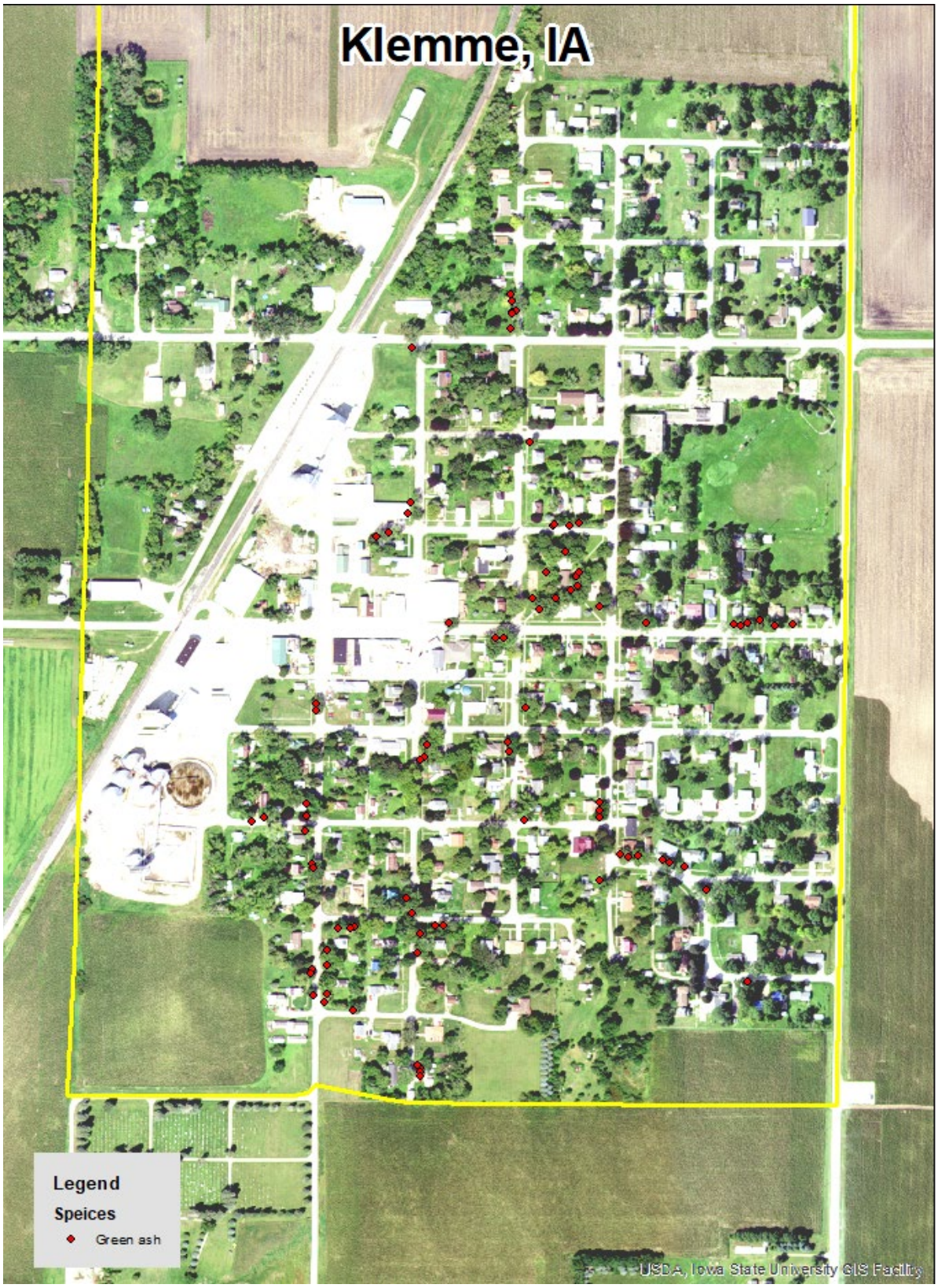

Figure 1: Location of Ash Trees

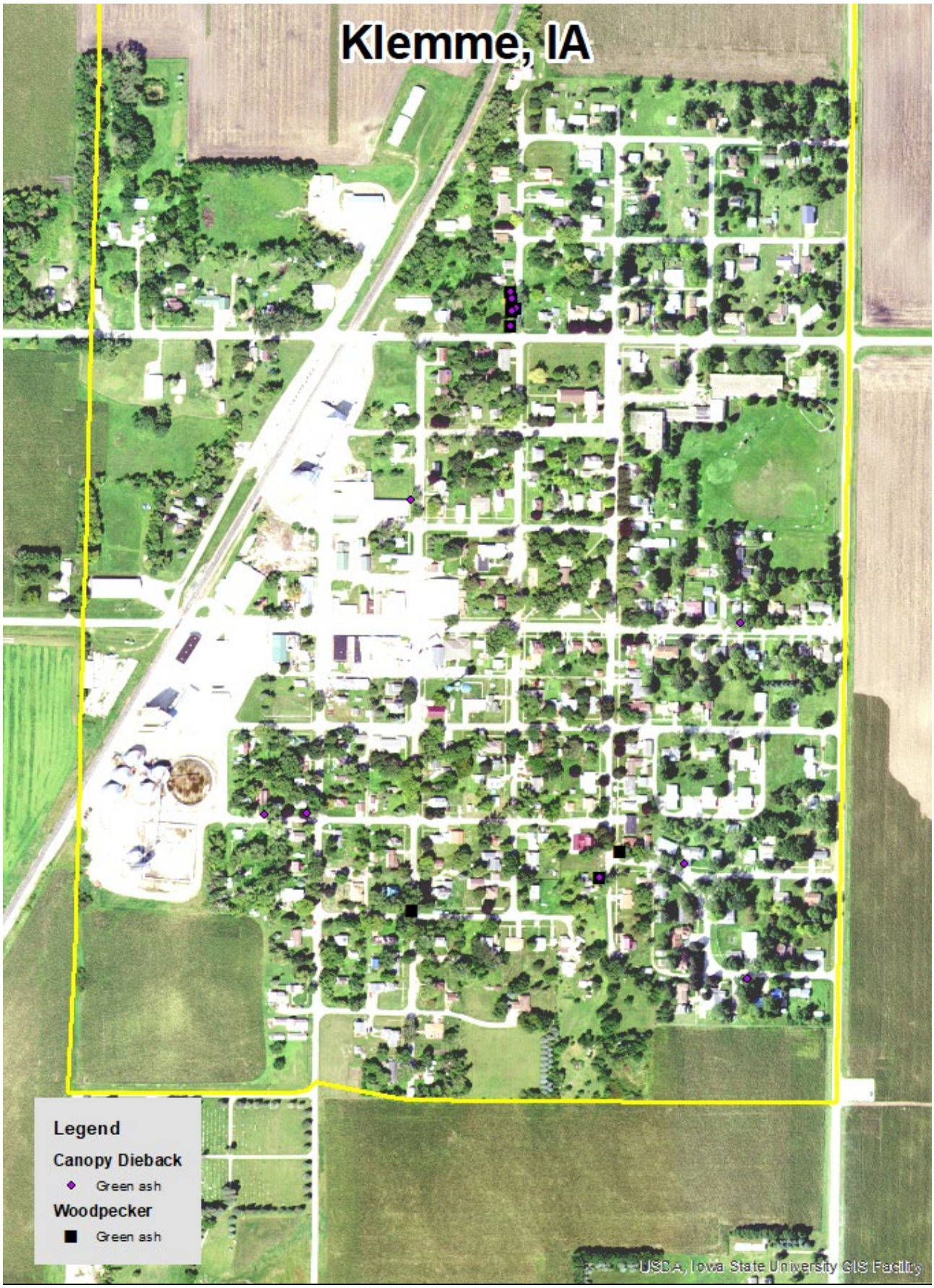

Figure 2: Location of EAB symptoms

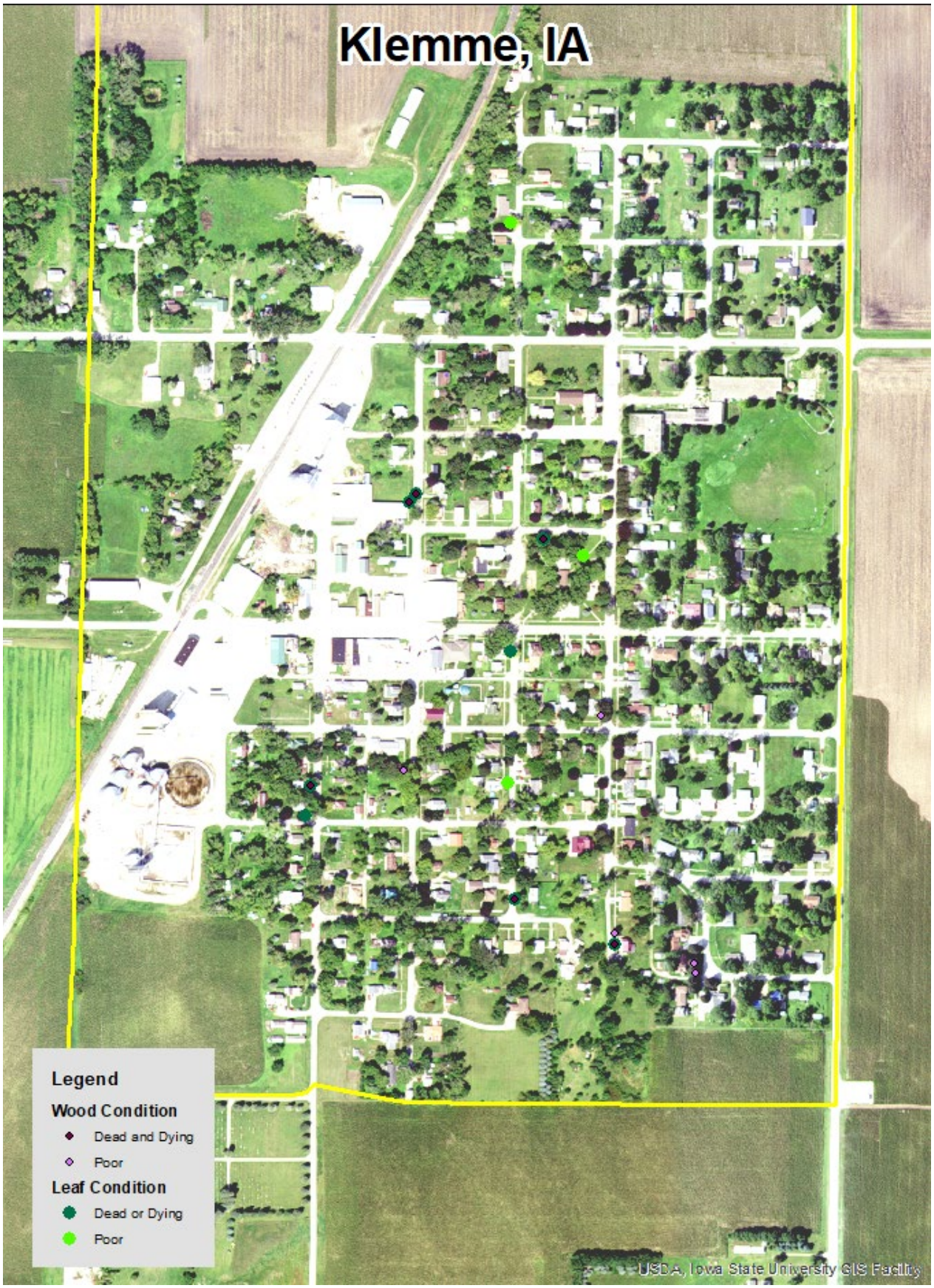

Figure 3: Location of Poor Condition Trees

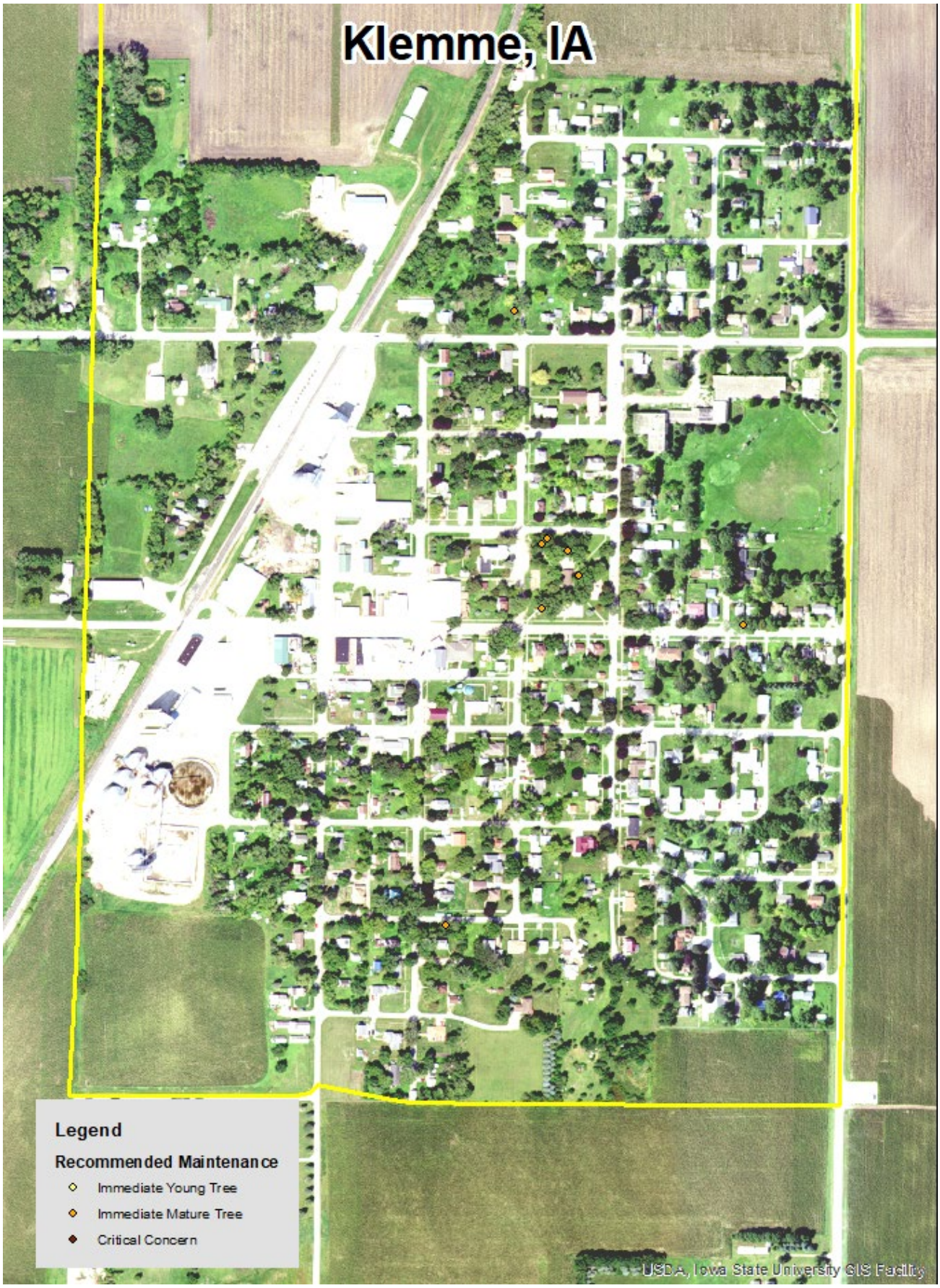

Figure 4: Location of Trees with Recommended Maintenance

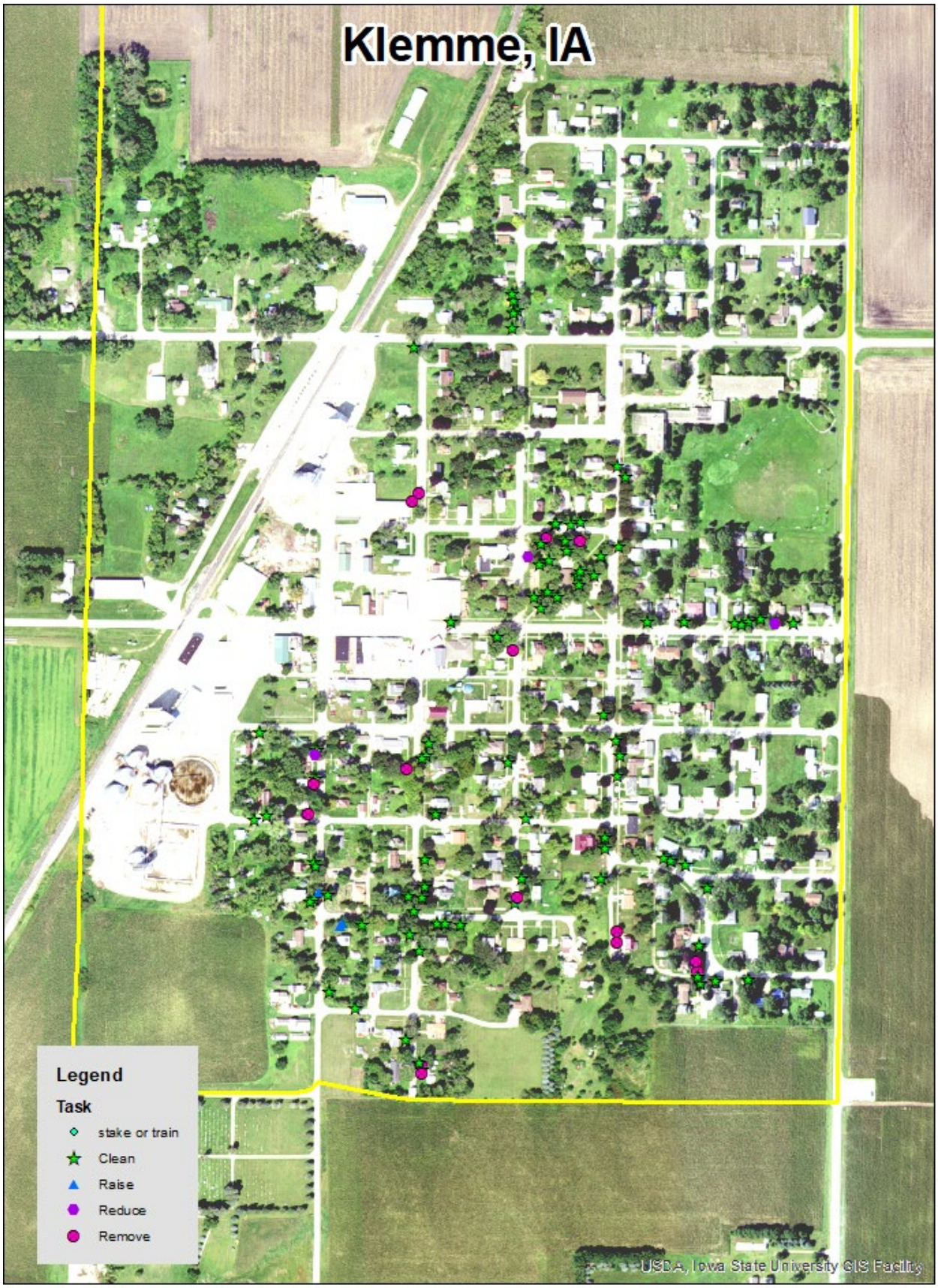

Figure 5: Maintenance Tasks ***City ownership of the trees recommended for removal should be verified prior to any removal***

Appendix C: Klemme Tree Ordinances

None.

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.