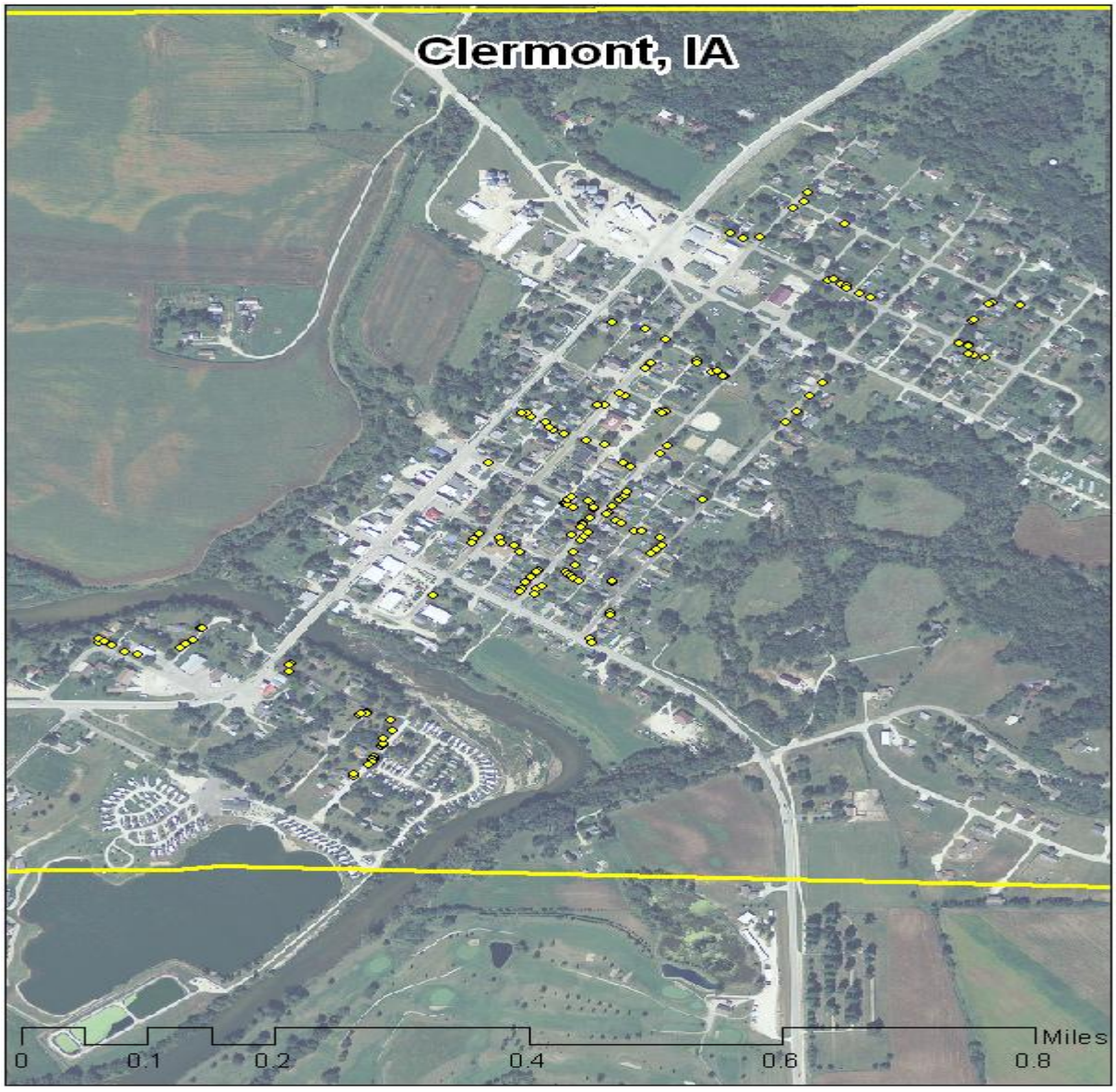
CLERMONT, IA



2011 Management Plan

Prepared by David Asche
IDNR District Forester

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Executive Summary

Overview

This plan was developed to assist the City of Clermont 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 11% of Clermont's city owned trees (ash) will die once EAB becomes established in the community. 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 2010, 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 161 trees inventoried.

- Clermont's trees provide $27,250 of benefits annually, an average of $169 a tree
- There are over 26 species of trees
- The top three species are: Sugar Maple 21%, Silver Maple 15%, and Green Ash 10%
- 51% of trees are in need of some type of management
- 12 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 12 trees needing removal, 2 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*
- None of the ash were displaying signs or symptoms associated with EAB
- All trees should be pruned on a routine schedule
- Plant a diverse mix of trees that do not include: ash, maple, Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven or willow.
- Check ash trees with a visual survey yearly

Introduction

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

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

Inventory

In 2010, a tree inventory was conducted that included 100% of the city owned trees along the streets. 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 of 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 161 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. Clermont's trees reduce energy related costs by approximately $7,378 annually (Appendix A, Table 1). These savings are both in Electricity (35.8 MWh) and in Natural Gas (4,756.4 Therms).

Annual Stormwater Benefits

Clermont's trees intercept about 364,544 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $9880 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 mater (ozone). In Clermont, it is estimated that trees remove 440.5 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 $1,233 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Clermont, trees sequester about 79,022 lbs of carbon a year with an associated value of $593 (Appendix A, Table 5). In addition, the trees store 1,194,922 lbs of carbon, with a yearly benefit of $8962 (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. Clermont receives $7,759 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, Clermont's trees provide $27,250 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 161 trees in Clermont provide approximately $169 annually (Appendix A, Table 7).

Forest Structure

Genus Distribution

Clermont has over 26 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genus is as follows:

Genus	# of Trees	% of Total
Maple	69	42.8
Ash	16	9.9
Siberian Elm	14	8.7
Black Walnut	10	6.2
Apple	6	3.7
Lilac	6	3.7
Hackberry	5	3.1
Red Oak	5	3.1
Other species	30	18.6

Age Class

Most of Clermont's trees are between 12 and 18" in diameter (31%) and between 18 and 24 inches in diameter (20%) at 4.5 ft (Appendix A, Figure 2). For age, a Bell Curve is preferred and shows the highest amount of trees around 16 inches in diameter at 4.5 ft. Clermont's size curve is moving towards the larger side, indicating an aging stand. Only about 13.5% are 1" to 6" in diameter suggesting some new plantings will be needed in the future to replace older trees.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the overall health of the urban forest. The foliage that was present on trees appeared quite healthy (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 74% of Clermont'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 7% of the population. This 7% 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 Raising	57	35%
Tree Removal	12	7%
Crown cleaning	7	4%

Canopy Cover

The canopy cover of Clermont is approximately 4 acres (Appendix A, Figure 4).

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

Clermont has 2 trees over 24 inches in diameter at 4.5 ft that should be addressed immediately for removal. After those trees are addressed, there are 10 trees under 24 inches that should be addressed for removal. After the removals, other trees in town are in need of various work to eliminate possible hazards (Appendix B, Figure 3 & Appendix B, Figure 4).

Ash trees

After the hazardous tree work is complete, ash trees in poor health should be assessed for removal. Of the 12 removals recommended, 2 of these are ash trees. There are a total of 19 ash trees. None of them had 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 6 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 Clermont.

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 (69%) (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: Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven, or willow.

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 death 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*

EAB Quarantines

EAB is an extremely destructive plant pest and it is responsible for the death and decline of over 25 million 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 ash trees will be replaced. All trees will meet the restrictions in the city ordinance. The new plantings will be a diverse mix and will not include ash, maple, Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven, or willow.

Postponed Work

While finances, staffing and equipment are focused on the management of ash, usual services may be delayed. Tree removal requests on genus 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 as trees are infested with Emerald Ash Borer. Trees that are on private property are part of Clermont's urban forest. Private property owners should be given direction to the proper species to plant, spacing, and location.

Six Year Work Plan and Estimated Costs

Year 1:

Remove 4 hazard trees	$2000
Plant 4 trees in open locations	$400
Visual survey of signs and symptoms of Emerald Ash Borer	

Year 2:

Remove 2 hazard trees	$1000
Plant 2 trees in open locations	$400
Maintenance of newly planted trees in city	
Visual survey of signs and symptoms of Emerald Ash Borer	

Year 3:

Remove 2 hazard trees	$1,000
Plant 2 trees in open locations	$200
Maintenance of newly planted trees in city	
Prune 1/4 of city trees	
Visual survey of signs and symptoms of Emerald Ash Borer	

Year 4:

Remove 2 hazard trees	$1,000
Plant 2 trees in open locations	$200
Maintenance of newly planted trees in city	
Prune 1/4 of city trees	
Visual survey of signs and symptoms of Emerald Ash Borer	

Year 5:

Remove 2 hazard trees	$1,000
Plant 2 trees in open locations	$200
Maintenance of newly planted trees in city	
Prune 1/4 of city trees	
Visual survey of signs and symptoms of Emerald Ash Borer	

Year 6:

Remove 2 ash trees	$1,000
Plant 2 trees in open locations	$200
Maintenance of newly planted trees in city	
Prune 1/4 of city trees	
Visual survey of signs and symptoms of Emerald Ash Borer	

** The ash removed in this six year plan is 25% of the total ash in Clermont.

Funding

Clermont can 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

Annual Energy Benefits of Public Trees by Species

12/11/2010

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	9.3	705	1,246.0	1,221	1,927	(N/A)	21.1	26.1	56.66
Silver maple	6.8	517	888.8	871	1,388	(N/A)	15.5	18.8	55.52
Green ash	3.6	274	459.6	450	725	(N/A)	9.9	9.8	45.29
Siberian elm	3.2	240	380.2	373	612	(N/A)	8.7	8.3	43.74
Norway maple	2.6	201	384.2	377	577	(N/A)	6.2	7.8	57.74
Black walnut	2.3	178	323.1	317	494	(N/A)	6.2	6.7	49.44
Apple	0.7	49	91.3	89	139	(N/A)	3.7	1.9	23.14
Lilac	0.1	6	13.3	13	19	(N/A)	3.7	0.3	3.13
Northern hackberry	1.7	127	233.2	228	355	(N/A)	3.1	4.8	71.07
Northern red oak	0.4	30	54.1	53	83	(N/A)	3.1	1.1	16.66
Broadleaf Deciduous	0.1	6	14.1	14	20	(N/A)	1.9	0.3	6.64
White ash	1.0	72	111.2	109	182	(N/A)	1.9	2.5	60.50
Blue spruce	0.4	29	45.6	45	74	(N/A)	1.9	1.0	24.51
Red maple	0.2	17	33.0	32	49	(N/A)	1.2	0.7	24.58
Honeylocust	0.4	27	50.0	49	76	(N/A)	1.2	1.0	38.05
Eastern red cedar	0.2	17	32.9	32	49	(N/A)	1.2	0.7	24.57
Norway spruce	0.2	13	23.7	23	36	(N/A)	1.2	0.5	18.04
Eastern white pine	0.2	15	29.2	29	44	(N/A)	1.2	0.6	22.02
Cottonwood	0.8	63	112.7	110	173	(N/A)	1.2	2.4	86.52
Bur oak	0.9	66	118.0	116	182	(N/A)	1.2	2.5	91.02
Other street trees	0.8	64	112.4	110	174	(N/A)	4.4	2.4	24.84
Citywide total	35.8	2,717	4,756.4	4,661	7,378	(N/A)	100.0	100.0	45.83

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees by Species

12/11/2010

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	96,977	2,628	(N/A)	21.1	26.6	77.30
Silver maple	83,397	2,260	(N/A)	15.5	22.9	90.41
Green ash	28,273	766	(N/A)	9.9	7.8	47.89
Siberian elm	20,594	558	(N/A)	8.7	5.7	39.87
Norway maple	25,898	702	(N/A)	6.2	7.1	70.19
Black walnut	23,156	628	(N/A)	6.2	6.4	62.76
Apple	2,340	63	(N/A)	3.7	0.6	10.57
Lilac	228	6	(N/A)	3.7	0.1	1.03
Northern hackberry	17,139	465	(N/A)	3.1	4.7	92.90
Northern red oak	2,288	62	(N/A)	3.1	0.6	12.40
Broadleaf Deciduous	279	8	(N/A)	1.9	0.1	2.52
White ash	8,624	234	(N/A)	1.9	2.4	77.91
Blue spruce	4,633	126	(N/A)	1.9	1.3	41.85
Red maple	1,251	34	(N/A)	1.2	0.3	16.95
Honeylocust	3,086	84	(N/A)	1.2	0.9	41.81
Eastern red cedar	3,269	89	(N/A)	1.2	0.9	44.30
Norway spruce	3,182	86	(N/A)	1.2	0.9	43.12
Eastern white pine	3,564	97	(N/A)	1.2	1.0	48.30
Cottonwood	12,729	345	(N/A)	1.2	3.5	172.48
Bur oak	14,477	392	(N/A)	1.2	4.0	196.17
Other street trees	9,161	248	(N/A)	4.4	2.5	35.47
Citywide total	364,544	9,880	(N/A)	100.0	100.0	61.37

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees by Species

12/11/2010

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
Sugar maple	12.4	2.1	6.3	0.5	67	44.1	6.4	6.1	42.1	275	-9.8	-37	110.3	306	(N/A)	21.1	9.00
Silver maple	12.6	2.1	6.4	0.6	69	32.1	4.7	4.5	30.8	201	-6.8	-26	87.0	244	(N/A)	15.5	9.76
Green ash	2.6	0.4	1.4	0.1	14	16.9	2.5	2.4	16.4	106	0.0	0	42.7	120	(N/A)	9.9	7.53
Siberian elm	1.9	0.3	1.1	0.1	11	14.6	2.2	2.1	14.3	92	0.0	0	36.6	103	(N/A)	8.7	7.36
Norway maple	5.4	0.9	2.6	0.2	29	12.9	1.9	1.8	12.0	80	-1.3	-5	36.5	104	(N/A)	6.2	10.41
Black walnut	2.5	0.4	1.3	0.1	14	11.2	1.6	1.6	10.6	70	0.0	0	29.3	83	(N/A)	6.2	8.34
Apple	0.7	0.1	0.3	0.0	4	3.1	0.5	0.4	3.0	19	0.0	0	8.1	23	(N/A)	3.7	3.84
Lilac	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.3	2	0.0	0	0.9	2	(N/A)	3.7	0.41
Northern hackberry	2.8	0.5	1.4	0.1	15	8.0	1.2	1.1	7.6	50	0.0	0	22.7	65	(N/A)	3.1	13.05
Northern red oak	0.3	0.1	0.2	0.0	2	1.9	0.3	0.3	1.8	12	-0.5	-2	4.4	12	(N/A)	3.1	2.40
Broadleaf Deciduous	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.4	3	0.0	0	1.0	3	(N/A)	1.9	0.92
White ash	1.1	0.2	0.6	0.1	6	4.4	0.7	0.6	4.3	28	0.0	0	11.9	34	(N/A)	1.9	11.28
Blue spruce	0.6	0.1	0.5	0.1	4	1.8	0.3	0.2	1.7	11	-1.7	-6	3.6	9	(N/A)	1.9	2.89
Red maple	0.2	0.0	0.1	0.0	1	1.1	0.2	0.1	1.0	7	-0.1	0	2.6	7	(N/A)	1.2	3.64
Honeylocust	0.6	0.1	0.3	0.0	3	1.7	0.2	0.2	1.6	11	-0.4	-1	4.4	12	(N/A)	1.2	6.09
Eastern red cedar	0.7	0.1	0.5	0.1	4	1.1	0.2	0.1	1.0	7	-1.8	-7	2.0	4	(N/A)	1.2	2.19
Norway spruce	0.4	0.1	0.3	0.0	2	0.8	0.1	0.1	0.8	5	-1.4	-5	1.1	2	(N/A)	1.2	1.00
Eastern white pine	0.4	0.1	0.3	0.0	3	1.0	0.1	0.1	0.9	6	-1.5	-6	1.5	3	(N/A)	1.2	1.46
Cottonwood	2.0	0.3	0.9	0.1	10	3.9	0.6	0.5	3.7	25	0.0	0	12.0	35	(N/A)	1.2	17.37
Bur oak	2.3	0.4	1.0	0.1	12	4.2	0.6	0.6	4.0	26	0.0	0	13.1	38	(N/A)	1.2	19.04
Other street trees	1.3	0.2	0.9	0.1	8	4.0	0.6	0.6	3.8	25	-2.7	-10	8.8	23	(N/A)	4.3	3.25
Citywide total	50.8	8.6	26.5	2.5	279	169.5	24.8	23.6	162.2	1,059	-27.9	-105	440.5	1,233	(N/A)	100.0	7.66

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees by Species

12/11/2010

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	352,266	2,642	(N/A)	21.1	29.5	77.71
Silver maple	270,087	2,026	(N/A)	15.5	22.6	81.03
Green ash	83,870	629	(N/A)	9.9	7.0	39.31
Siberian elm	51,175	384	(N/A)	8.7	4.3	27.42
Norway maple	89,305	670	(N/A)	6.2	7.5	66.98
Black walnut	81,082	608	(N/A)	6.2	6.8	60.81
Apple	10,211	77	(N/A)	3.7	0.9	12.76
Lilac	575	4	(N/A)	3.7	0.1	0.72
Northern	44,172	331	(N/A)	3.1	3.7	66.26
Northern red oak	5,669	43	(N/A)	3.1	0.5	8.50
Broadleaf	935	7	(N/A)	1.9	0.1	2.34
White ash	23,116	173	(N/A)	1.9	1.9	57.79
Blue spruce	3,355	25	(N/A)	1.9	0.3	8.39
Red maple	2,201	17	(N/A)	1.2	0.2	8.26
Honeylocust	6,921	52	(N/A)	1.2	0.6	25.95
Eastern red cedar	2,204	17	(N/A)	1.2	0.2	8.27
Norway spruce	3,381	25	(N/A)	1.2	0.3	12.68
Eastern white pine	3,599	27	(N/A)	1.2	0.3	13.50
Cottonwood	65,202	489	(N/A)	1.2	5.5	244.51
Bur oak	78,517	589	(N/A)	1.2	6.6	294.44
Other street trees	7,746	128	(N/A)	4.4	1.4	18.30
Citywide total	1,194,922	8,962	(N/A)	100.0	100.0	55.66

Table 5: Annual Carbon Sequestered

Annual CO_2 Benefits of Public Trees by Species

12/11/2010

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
Sugar maple	19,784	148	-1,691	-7	-13	15,589	117	33,676	253	(N/A)	21.1	25.3	7.43
Silver maple	23,790	178	-1,296	-5	-10	11,427	86	33,916	254	(N/A)	15.5	25.4	10.17
Green ash	7,787	58	-403	-3	-3	6,061	45	13,442	101	(N/A)	9.9	10.1	6.30
Siberian elm	4,590	34	-246	-3	-2	5,298	40	9,639	72	(N/A)	8.7	7.2	5.16
Norway maple	3,886	29	-429	-2	-3	4,440	33	7,895	59	(N/A)	6.2	5.9	5.92
Black walnut	5,652	42	-389	-2	-3	3,930	29	9,190	69	(N/A)	6.2	6.9	6.89
Apple	963	7	-49	-1	0	1,092	8	2,006	15	(N/A)	3.7	1.5	2.51
Lilac	140	1	-3	-1	0	128	1	264	2	(N/A)	3.7	0.2	0.33
Northern hackberry	2,103	16	-212	-1	-2	2,803	21	4,693	35	(N/A)	3.1	3.5	7.04
Northern red oak	586	4	-27	-1	0	670	5	1,227	9	(N/A)	3.1	0.9	1.84
Broadleaf Deciduous	131	1	-4	-1	0	135	1	262	2	(N/A)	1.9	0.2	0.65
White ash	2,302	17	-111	-1	-1	1,602	12	3,793	28	(N/A)	1.9	2.9	9.48
Blue spruce	272	2	-16	-1	0	639	5	894	7	(N/A)	1.9	0.7	2.23
Red maple	331	2	-11	0	0	371	3	691	5	(N/A)	1.2	0.5	2.59
Honeylocust	981	7	-33	0	0	600	4	1,547	12	(N/A)	1.2	1.2	5.80
Eastern red cedar	86	1	-11	0	0	374	3	448	3	(N/A)	1.2	0.3	1.68
Norway spruce	205	2	-16	0	0	284	2	473	4	(N/A)	1.2	0.4	1.77
Eastern white pine	240	2	-17	0	0	341	3	563	4	(N/A)	1.2	0.4	2.11
Cottonwood	1,872	14	-313	0	-2	1,384	10	2,943	22	(N/A)	1.2	2.2	11.04
Bur oak	1,824	14	-377	0	-3	1,469	11	2,916	22	(N/A)	1.2	2.2	10.93
Other street trees	1,497	11	-82	-1	-1	1,407	11	2,821	21	(N/A)	4.4	2.1	3.02
Citywide total	79,022	593	-5,736	-31	-43	60,045	450	133,299	1,000	(N/A)	100.0	100.0	6.21

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees by Species

12/11/2010

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	2,093	(N/A)	21.1	27.0	61.56
Silver maple	2,023	(N/A)	15.5	26.1	80.92
Green ash	752	(N/A)	9.9	9.7	47.02
Siberian elm	450	(N/A)	8.7	5.8	32.15
Norway maple	360	(N/A)	6.2	4.6	35.95
Black walnut	495	(N/A)	6.2	6.4	49.54
Apple	55	(N/A)	3.7	0.7	9.16
Lilac	6	(N/A)	3.7	0.1	1.05
Northern hackberry	278	(N/A)	3.1	3.6	55.69
Northern red oak	60	(N/A)	3.1	0.8	11.93
Broadleaf Deciduous	6	(N/A)	1.9	0.1	2.16
White ash	254	(N/A)	1.9	3.3	84.61
Blue spruce	76	(N/A)	1.9	1.0	25.23
Red maple	60	(N/A)	1.2	0.8	29.84
Honeylocust	202	(N/A)	1.2	2.6	101.11
Eastern red cedar	27	(N/A)	1.2	0.4	13.68
Norway spruce	54	(N/A)	1.2	0.7	26.96
Eastern white pine	63	(N/A)	1.2	0.8	31.25
Cottonwood	125	(N/A)	1.2	1.6	62.47
Bur oak	117	(N/A)	1.2	1.5	58.34
Other street trees	204	(N/A)	4.4	2.6	29.10
Citywide total	7,759	(N/A)	100.0	100.0	48.19

Table 7: Summary of Benefits in Dollars

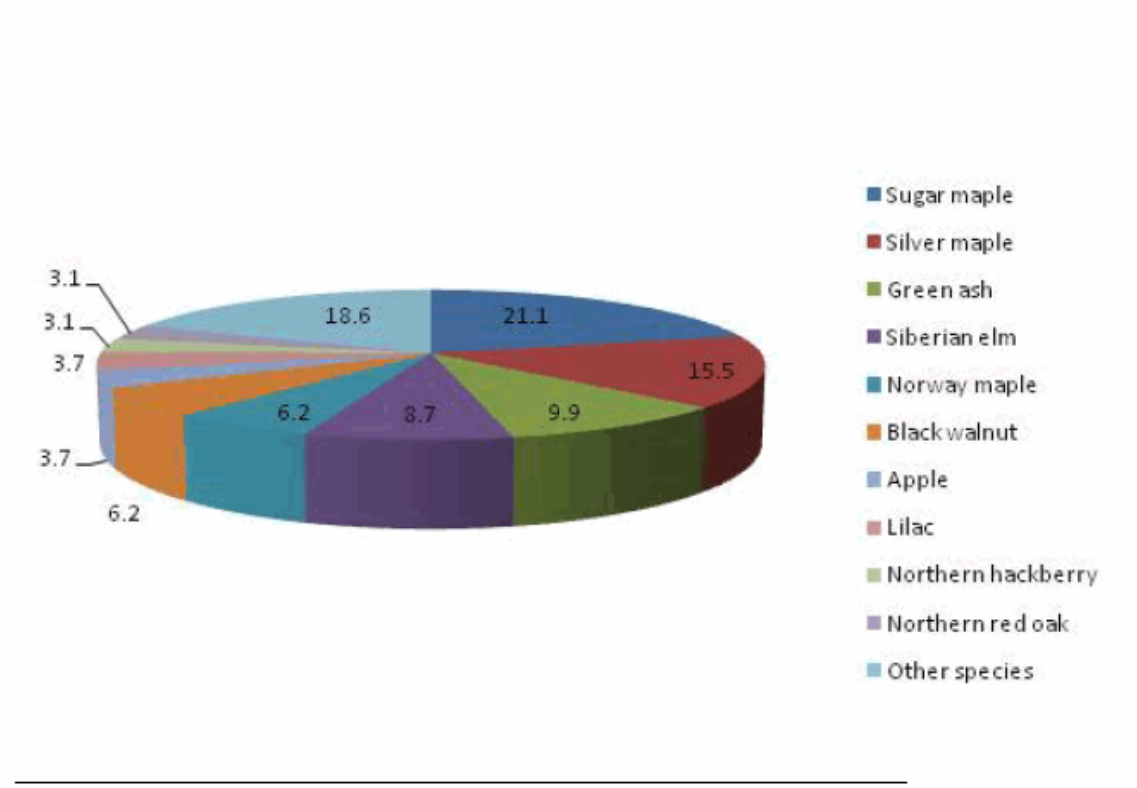
Total Annual Benefits of Public Trees by Species ($)

12/11/20

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Sugar maple	1,927	253	306	2,628	2,093	7,206	(±0)	26.4
Silver maple	1,388	254	244	2,260	2,023	6,170	(±0)	22.6
Green ash	725	101	120	766	752	2,465	(±0)	9.0
Siberian elm	612	72	103	558	450	1,796	(±0)	6.6
Norway maple	577	59	104	702	360	1,802	(±0)	6.6
Black walnut	494	69	83	628	495	1,770	(±0)	6.5
Apple	139	15	23	63	55	295	(±0)	1.1
Lilac	19	2	2	6	6	36	(±0)	0.1
Northern hackberry	355	35	65	465	278	1,199	(±0)	4.4
Northern red oak	83	9	12	62	60	226	(±0)	0.8
Broadleaf Deciduous	20	2	3	8	6	39	(±0)	0.1
White ash	182	28	34	234	254	731	(±0)	2.7
Blue spruce	74	7	9	126	76	290	(±0)	1.1
Red maple	49	5	7	34	60	155	(±0)	0.6
Honeylocust	76	12	12	84	202	386	(±0)	1.4
Eastern red cedar	49	3	4	89	27	173	(±0)	0.6
Norway spruce	36	4	2	86	54	182	(±0)	0.7
Eastern white pine	44	4	3	97	63	210	(±0)	0.8
Cottonwood	173	22	35	345	125	700	(±0)	2.6
Bur oak	182	22	38	392	117	751	(±0)	2.8
Other street trees	174	21	23	248	204	670	(±0)	2.5
Citywide Total	7,378	1,000	1,233	9,880	7,759	27,250	(±0)	100.0

Species Distribution of Public Trees (%)

12/11/2010

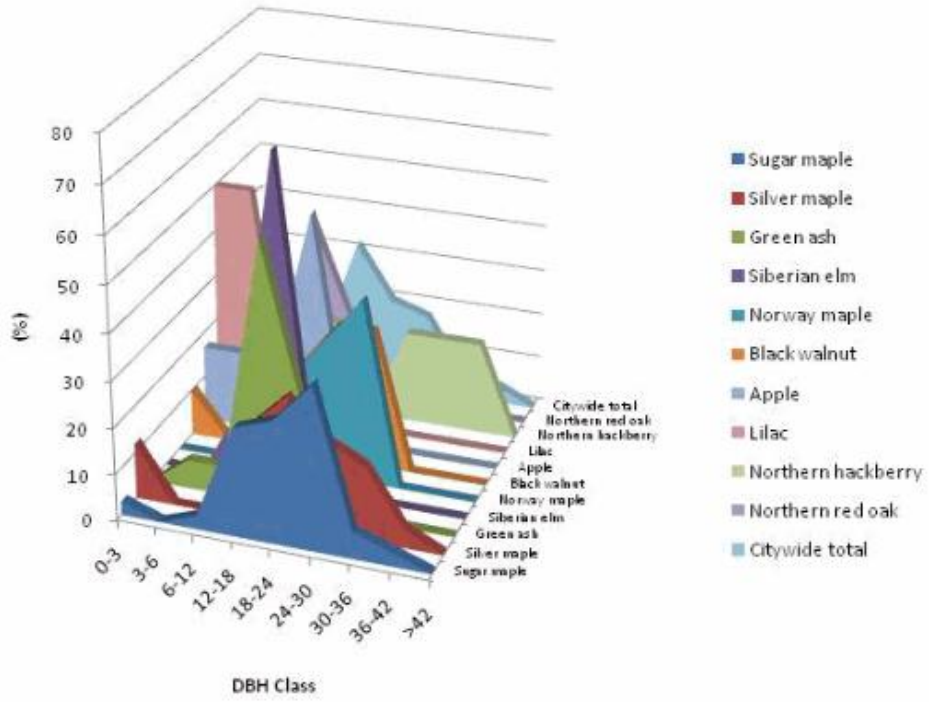


Species	Percent
Sugar maple	21.1
Silver maple	15.5
Green ash	9.9
Siberian elm	8.7
Norway maple	6.2
Black walnut	6.2
Apple	3.7
Lilac	3.7
Northern hackberry	3.1
Northern red oak	3.1
Other species	18.6
Total	100.0

Figure 1: Species Distribution

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

12/11/2010



	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Sugar maple	2.9	0.0	2.9	23.5	26.5	35.3	5.9	2.9	0.0
Silver maple	12.0	0.0	0.0	20.0	28.0	20.0	16.0	4.0	0.0
Green ash	0.0	6.3	6.3	56.3	25.0	6.3	0.0	0.0	0.0
Siberian elm	0.0	0.0	14.3	71.4	7.1	7.1	0.0	0.0	0.0
Norway maple	0.0	0.0	10.0	20.0	30.0	40.0	0.0	0.0	0.0
Black walnut	10.0	0.0	10.0	20.0	30.0	30.0	0.0	0.0	0.0
Apple	16.7	16.7	16.7	50.0	0.0	0.0	0.0	0.0	0.0
Lilac	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Northern hackberry	0.0	0.0	20.0	20.0	0.0	20.0	20.0	20.0	0.0
Northern red oak	40.0	0.0	40.0	20.0	0.0	0.0	0.0	0.0	0.0
Citywide total	8.7	5.0	8.7	31.7	19.9	17.4	5.0	3.7	0.0

Figure 2: Relative Age Class

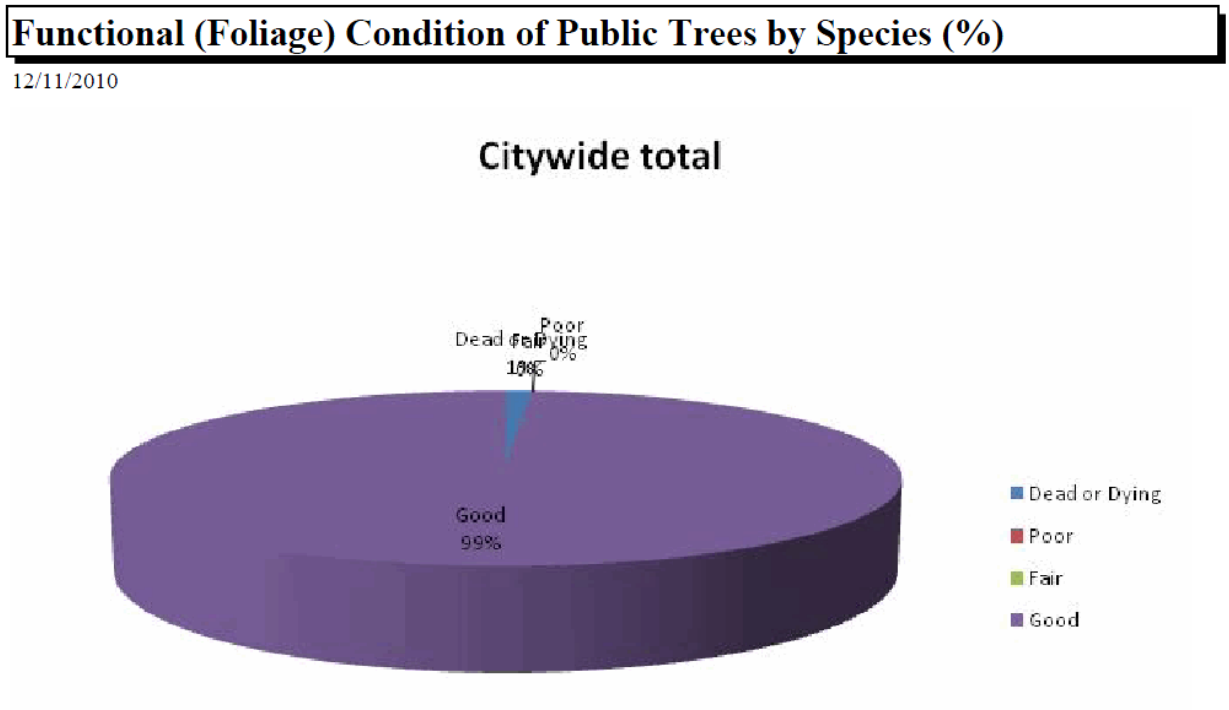


Figure 3: Foliage Condition

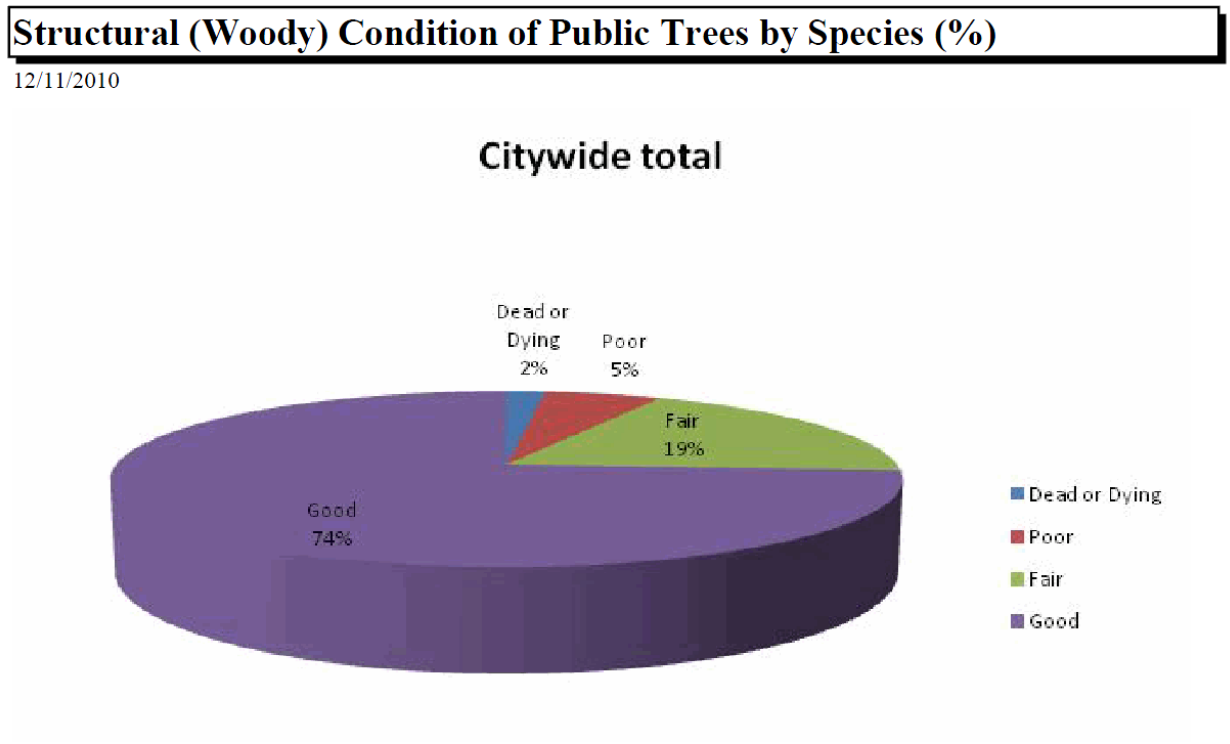
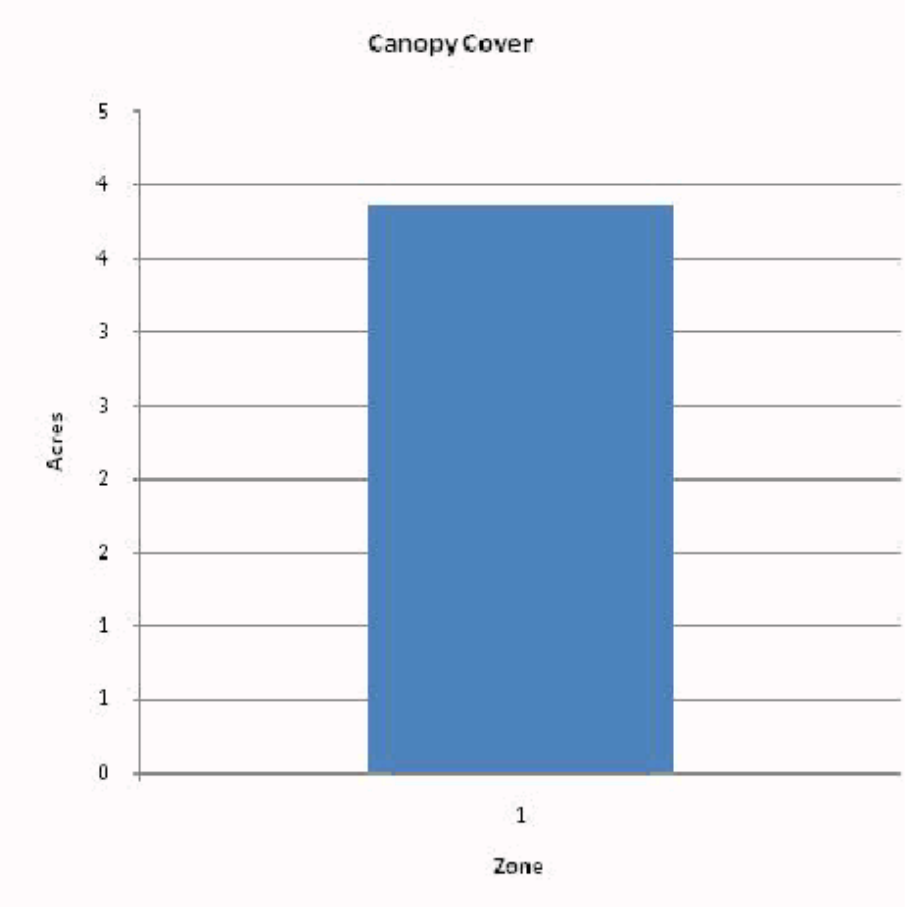


Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

12/11/2010



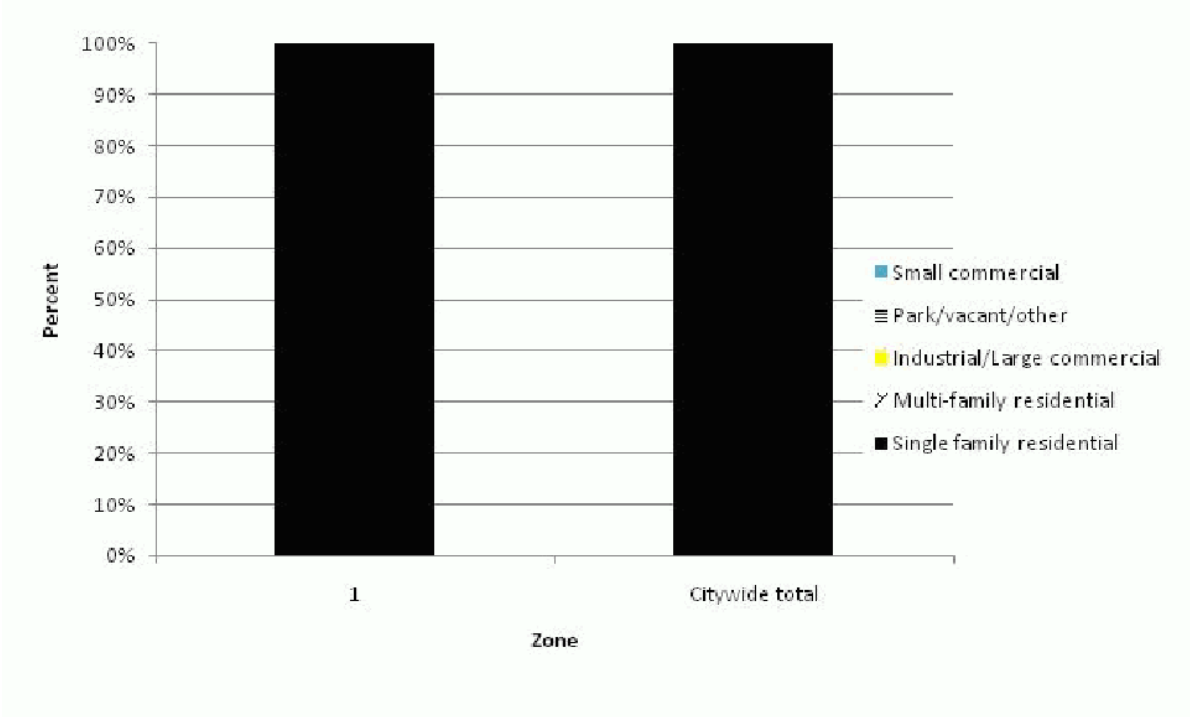
Zone	Acres	% of Total Canopy Cover
1	4	100.0
Citywide total	4	100.0

	Total Land Area	Total Street and Sidewalk Area	Total Canopy Cover	Canopy Cover as % of Total Land Area	Canopy Cover as % of Total Streets and Sidewalks
Citywide	0	0	4		

Figure 5: Canopy Cover in Acres

Land Use of Public Trees by Zone (%)

12/11/2010

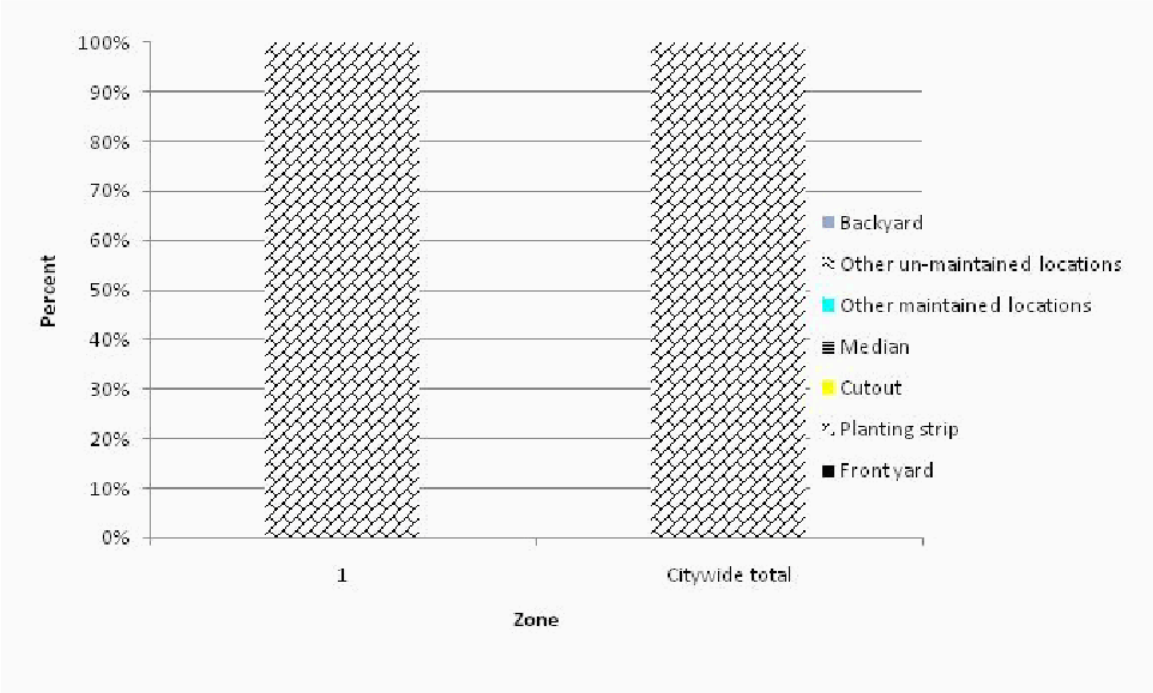


Zone	Single family residential	Multi-family residential	Industrial/ Large commercial	Park/vacant/ other	Small commercial
1	100.0	0.0	0.0	0.0	0.0
Citywide total	100.0	0.0	0.0	0.0	0.0

Figure 6: Land Use of city/park trees

Location of Public Trees by Zone (%)

12/11/2010



Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
1	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Citywide total	0.0	100.0	0.0	0.0	0.0	0.0	0.0

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

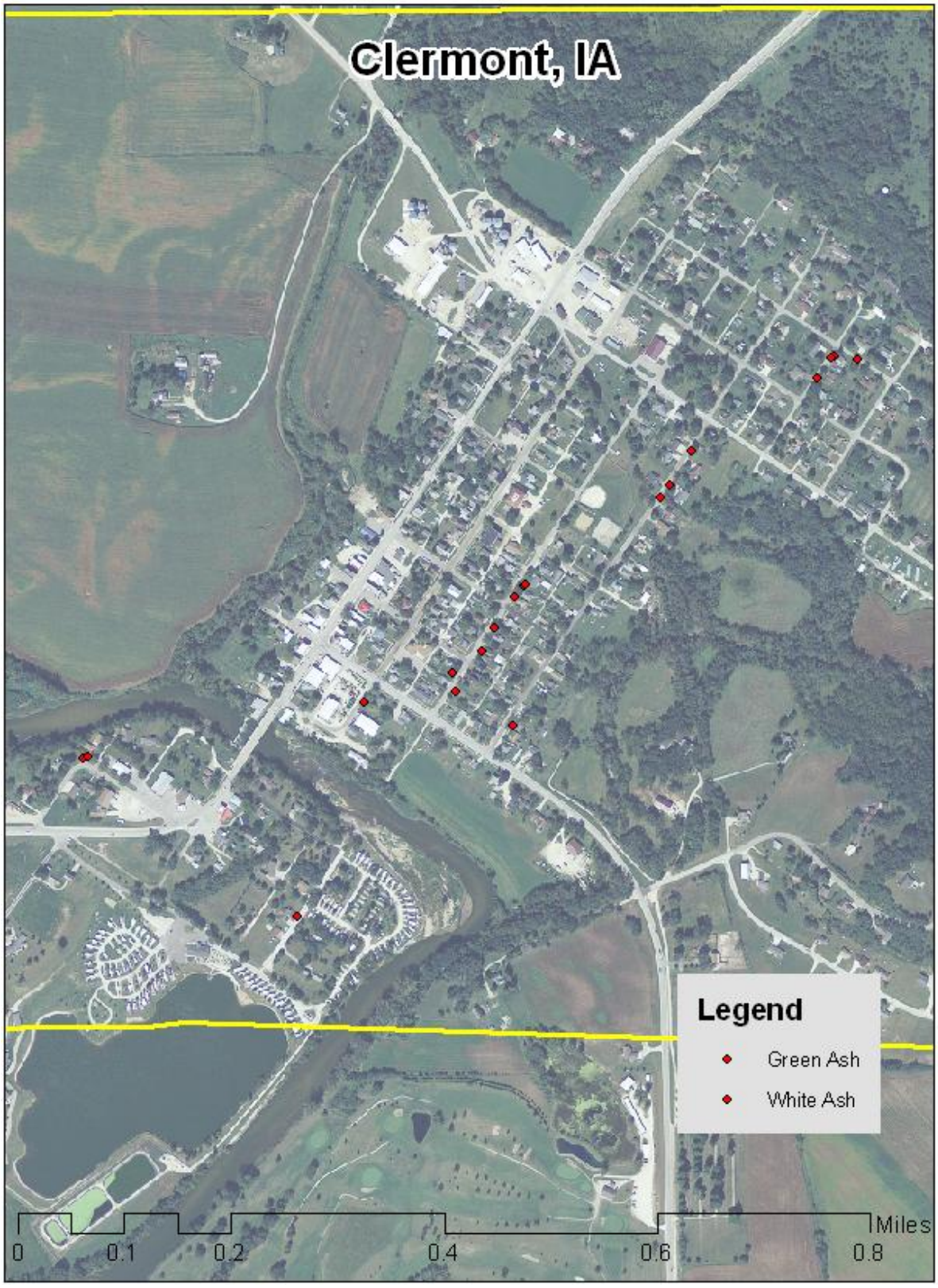


Figure 1: Location of Ash Trees

Figure 2: Location of EAB symptoms

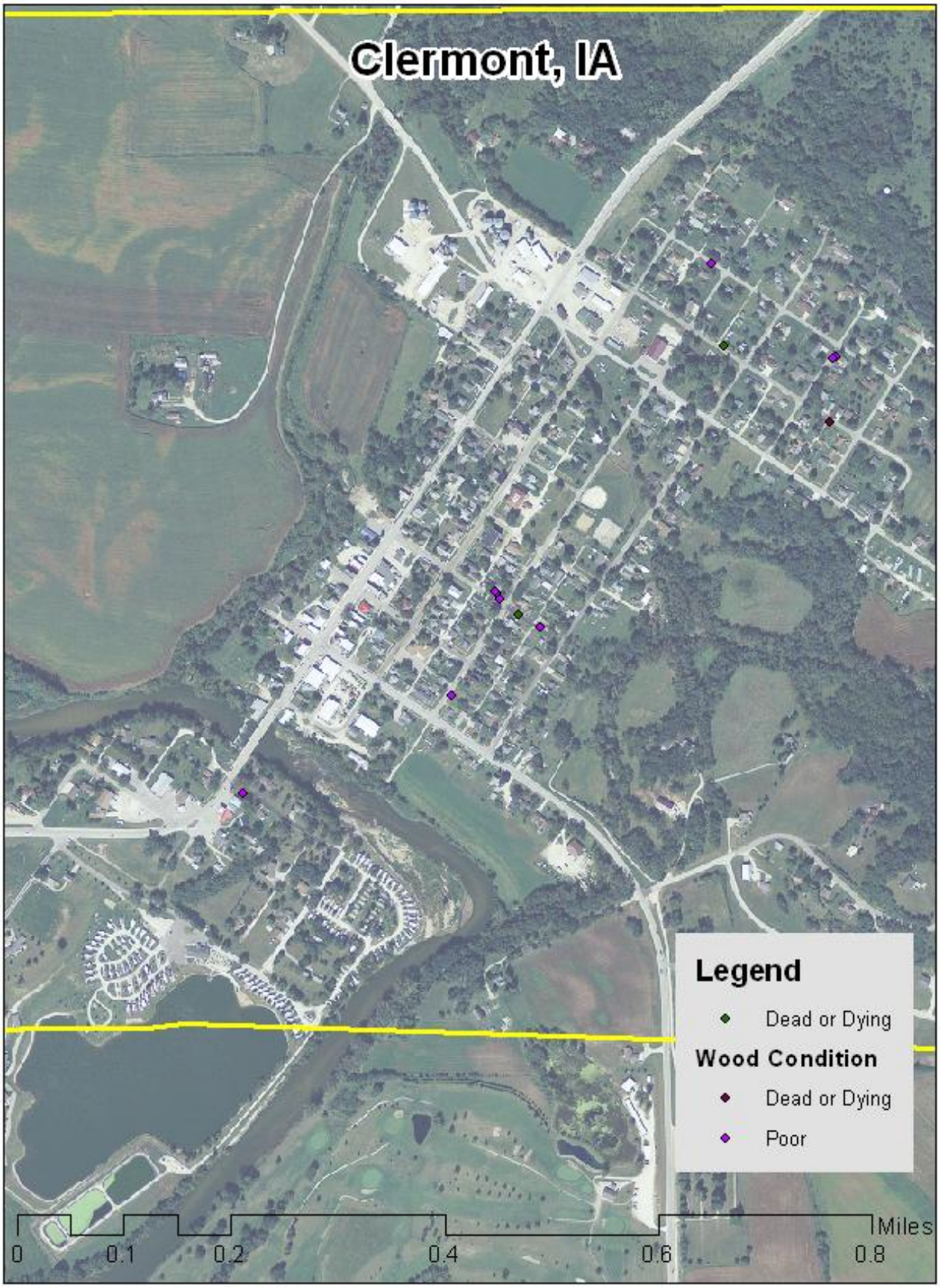


Figure 3: Location of Poor Condition Trees

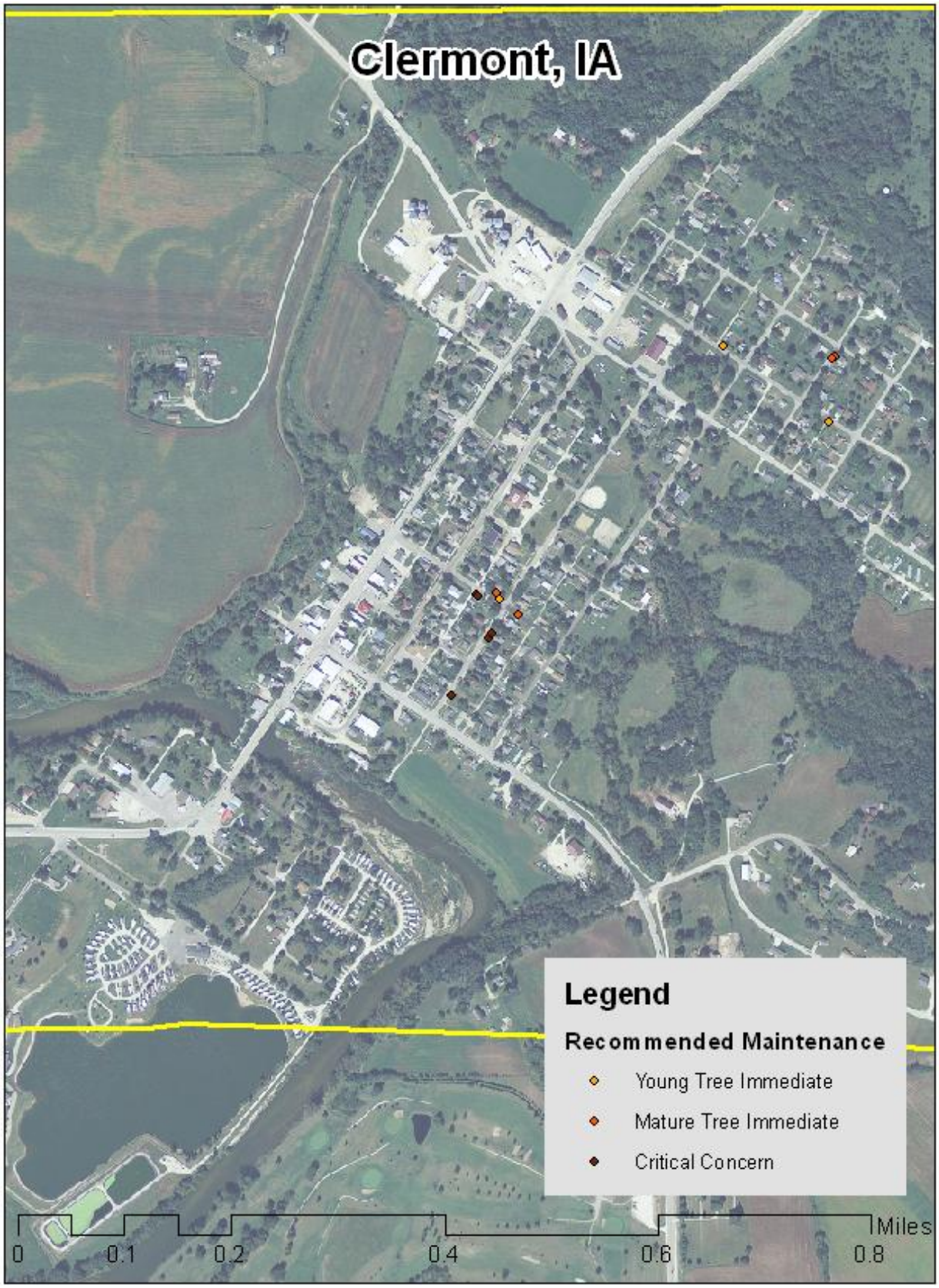


Figure 4: Location of Trees with Recommended Maintenance

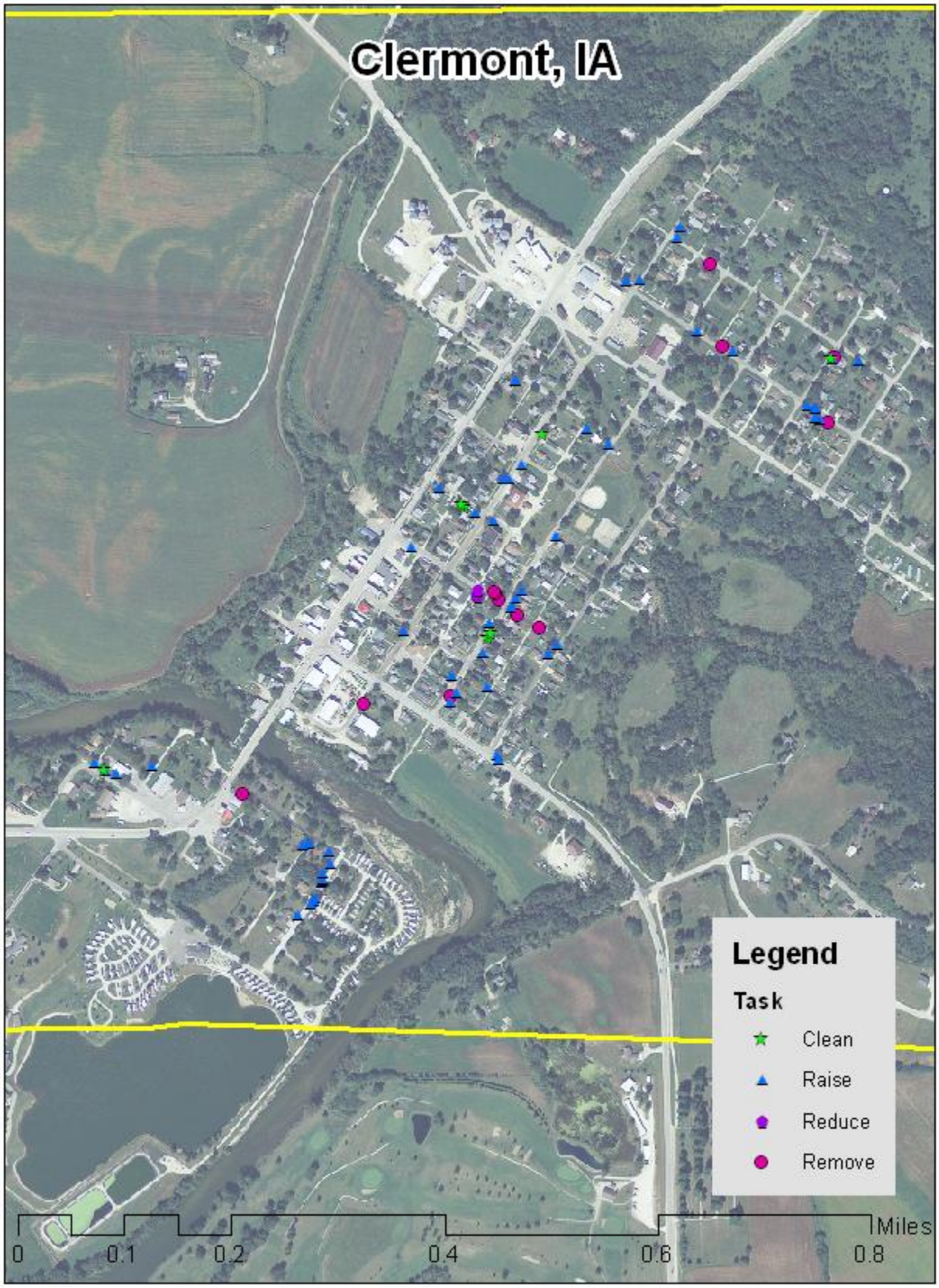


Figure 5: Maintenance Tasks *City ownership of the trees recommended for removal should be verified prior to any removal*