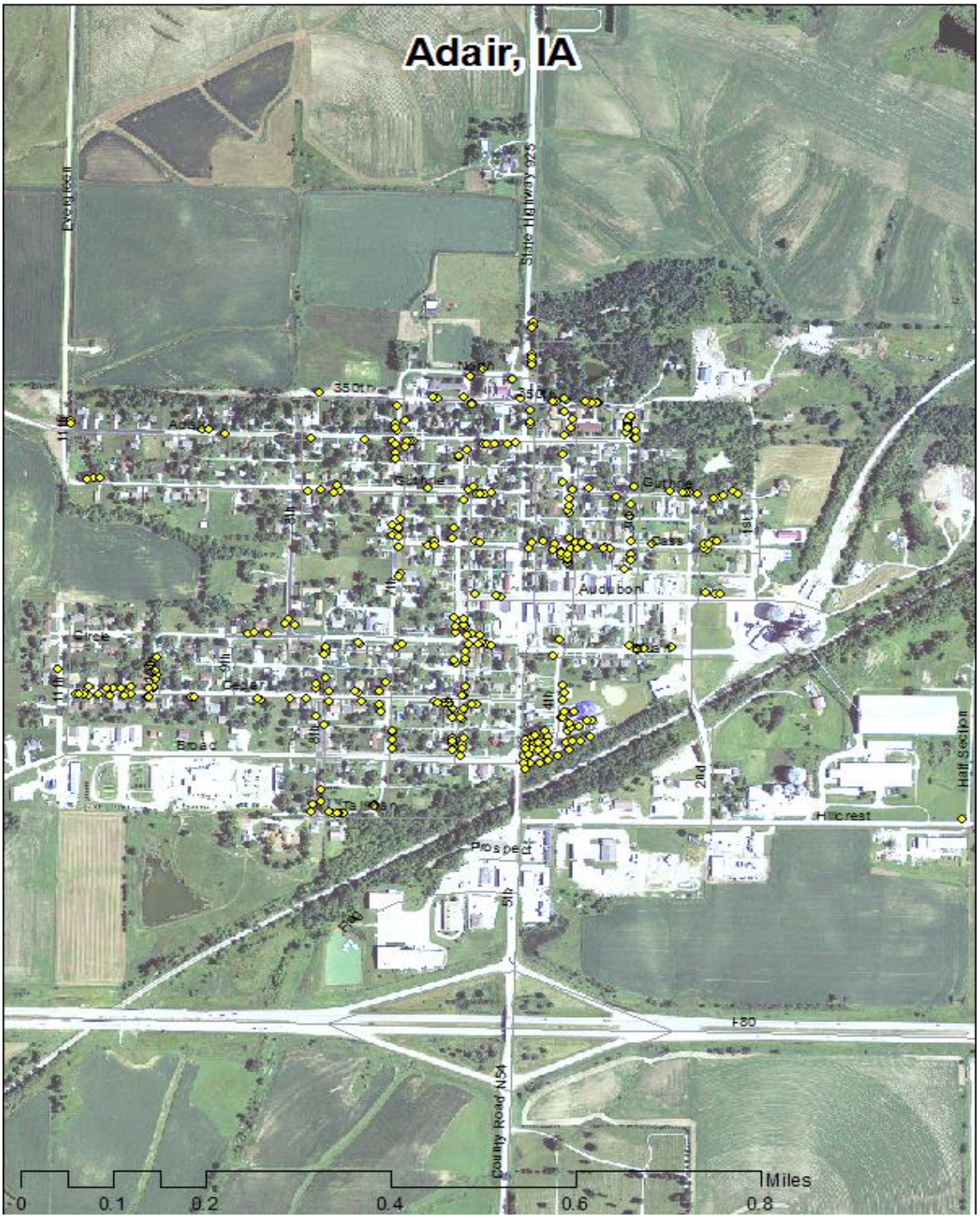

2013 Management Plan
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Executive Summary

Overview

This plan was developed to assist the City of Adair 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 16% of Adair'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 2013, a tree inventory was conducted using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street and park trees. Below are some key findings of the 342 trees inventoried.

- Adair's trees provide $102,961 of benefits annually, an average of $301 a tree
- There are over 23 species of trees
- The top three genus are: Maple 38%%, Ash 16%, and Spruce 6%
- 35% of trees (120) are in need of some type of maintenance (See Fig. 5, Append. B)
- 45 trees are recommended for evaluation for removal/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 45 trees recommended for removal, 14 are "critical concern" trees and should be removed immediately (See Fig. 4, Append. B, and attached listing and map). *City ownership of the trees recommended for removal should be verified prior to any removal*
- 19 of the 53 ash trees are in need of follow up because they are displaying signs and symptoms associated with EAB (Fig. 2, Append. B) All ash trees (Fig. 1, Append. B)
- 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 an estimated removal cost of $ 900 per tree (contracted), it could take $47,700 or more to remove the 53 ash trees if EAB damage occurs. Suggestion: begin by requesting a budget increase to $10,000 annually for tree removal and apply for grants to help plant replacement trees, or treat ash like any other tree and remove when tree health declines or infestations occur and replace trees as needed.

Introduction

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

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

Inventory

In 2013, a tree inventory was conducted that included 100% of the city owned trees, mostly on 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 342 city owned 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. Adair's trees reduce energy related costs by approximately $18,084 annually (Appendix A, Table 1). These savings are both in Electricity (86 MWh) and in Natural Gas (11795 Therms).

Annual Stormwater Benefits

Adair's trees intercept about 1,038,207 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $28,137 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 Adair, it is estimated that trees remove 1,119 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 $3,139 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Adair, trees sequester about 363,395 lbs of carbon a year with an associated value of $2,725 (Appendix A, Table 5). In addition, the trees store 4,165,524 lbs of carbon, with a yearly benefit of $31,241 (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. Adair receives $19,635 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, Adair's trees provide $102,961 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 342 trees in Greenfield provide approximately $301 annually in benefits.

Forest Structure

Species Distribution

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

Maple	138	40.3%
Ash	53	15.4%
Spruce	32	9.3%
Black Walnut	16	4.6%
Apple	16	4.6%
Linden/Basswood	13	3.8%
Lilac	11	3.2%
Other Species	63	18.8%

Other species include: birch, pines, Eastern redcedar, mulberry, honeylocust, hackberry, catalpa, Siberian elm, American elm, Northern red oak, Northern pin oak, and bur oak.

Age Class

Twenty one percent of Adair's trees are between 12 and 18 inches in diameter at 4.5 ft (Appendix A, Figure 2). Approximately 43% of the trees are in the 24" and over diameter class. For age, it is preferred that smaller size classes have the highest amount of trees to prepare for natural mortality and to maintain canopy cover. Adair's size curve is above average for age 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 Adair indicate that 90% of the trees are in good health, with only 3% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 67% of Adair'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 12% of the tree population. This 12% is an estimate of trees that need management follow up for possible removal.

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, Figures 4 & 5).

Crown Cleaning	73	21%
Tree Staking	2	.6%
Tree Removal	45	13%

Canopy Cover

The city owned canopy cover of Adair is approximately 10.23 acres (Appendix A, Figure 5). According to the 2010 census, Adair occupies 1,402.8 acres. Thus the canopy cover on city land is just under 1%.

Land Use and Location

The majority of Adair'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	92%
Park/vacant/other	4%
Industrial/Large commercial	<1%
Small commercial	0%
Multifamily residential	4%

Location	
Planting strip	100%
Other maintained locations	0%
Cutout (surrounded by pavement)	0%
Front yard	0%

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

Adair has 14 "critical concern" trees that need immediate removal. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4) and in a detailed listing provided with this plan. It is recommended to start with the large diameter critical concern trees first. After the removal of the critical concern trees, there are 31 trees that are recommended for removal/evaluation for removal within the next 3-5 years (locations listed on the map, Append. B, Figure 5).

Poor tree species

After the removal of the 14 critical concern trees (4 are ash), 31 other trees in poor health should be assessed for removal (Appendix B, Figures 3, 4, & 5). Six of these "other trees" are

ash. After that, ash trees in poor health should be assessed for removal. Adair has a total of 53 city owned ash trees, and 19 of those have signs and symptoms that have been associated with EAB. Ash trees should be inspected on a yearly basis for decline. *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. There are approximately 73 trees in Adair in need of some kind of pruning, mostly foliage cleaning.

Planting

Most of the planting should be done annually to 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%. 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 Greenfield.

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 (40.3%) (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 or any tree species restricted by 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 death and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage (bark flecking).

Six Year Maintenance Plan – Proposed

Remove all "critical concern" trees first (14 total, there are 4 ash in this group). Then, concentrate on the other poor condition trees recommended for removal evaluation/removal and remove them before they become critical concern trees (there are 6 ash in this group of 31). Treat ash like any other tree species, removing the trees in poor health first. Replanting should be done yearly and ash trees should be inspected yearly for signs and symptoms of EAB.

Year 1
- Removal: 6 critical concern trees (take the ash first)
- Planting and Replacement: none
- Visual Survey for signs and symptoms of EAB

Year 2
- Removal: 8 remaining critical concern trees and the 6 additional ash trees recommended for removal
- Planting and Replacement: 6 trees in open locations from year one removals
- Routine trimming: trim 24 of the city trees needing pruning of some type
- Visual Survey for signs and symptoms of EAB

Year 3
- Removal: 6 trees in poor health/removal recommended
- Planting and Replacement: 20 trees to be planted in open locations and locations from previous removals
- Visual Survey for signs and symptoms of EAB

Year 4
- Removal: 6 trees in poor health/removal recommended
- Planting and Replacement: 6 trees in open locations from previous removals
- Routine trimming: trim 24 of the city trees needing pruning of some type
- Visual Survey for signs and symptoms of EAB

Year 5
- Removal: 6 trees in poor health/removal recommended
- Planting and Replacement: 6 trees to be planted in open locations and locations from previous removals
- Visual Survey for signs and symptoms of EAB

Year 6
- Removal: 7 trees in poor health/removal recommended
- Planting and Replacement: 6 trees in open locations from previous removals
- Routine trimming: trim 25 of the city trees needing pruning of some type
- Visual Survey for signs and symptoms of EAB

*Reduction of ash over 6 years will probably be minimal. EAB could potentially kill all ash within 4 years of infestation. After the 6 year recommended period to remove and trim everything with designated needs, concentrate on removing ash trees if needed, those in poor condition

first. Any new critical concern trees and trees evaluated as needing removal are always top candidates for priority management.

Emerald Ash Borer Plan

Ash Tree Removal

Tree removal should 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, spreading 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/ For information about available treatments, visit http://extension.iastate.edu/Publications/PM2084.pdf

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 should be replaced with a suitable diversity of non-ash tree species. All trees must meet the species restrictions in any existing city ordinance. In lieu of ordinance restrictions, it is recommended that new plantings should be a diverse mix and should 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 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. If you suspect that you may have EAB damage, the first step is to contact the ISU Plant and Insect Diagnostic Clinic at 515-294-0581.

Private Ash Trees

It is strongly recommended that private property owners start removing ash trees on their property upon arrival of EAB in accordance with any existing city tree ordinance or city rules.

Budget

Assuming that the budget for tree maintenance will remain minimal, the following are some estimated costs associated with the recommended maintenance work.

If a budget increase may be possible, a recommendation would be to increase the $2 per capita, which is a requirement for becoming a Tree City USA.

Tree removal costs average around $500-$900 per tree, depending on the size and numbers of trees. The estimated range would be $350-$1,500.

Trimming (including cleaning, raising, reducing) averages $75 per tree and can range from $70 to $200 per tree.

New planting averages about $150 per tree (5' trees in 10 gallon containers are about $75-$100 plus the cost of watering).

Purposed Budget Increase

EAB could potentially kill all ash trees in Adair within 4 years of its arrival. Realistically, it may take $8,000 of additional funding per year for 6 years to remove all of the ash trees in the city.

It is recommended that Adair apply for grants to fund replacement trees and/or to work with organizations like Trees Forever. 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. For more information about grants please contact Emma Hanigan, DNR State Urban Forester, at 515-281-5600 or by e-mail at Emma.Hanigan@dnr.iowa.gov

Works Cited

Census Bureau. 2010. http://censtats.census.gov/data/IA/1601964290.pdf (April, 2013)

USDA Forest Service, et al. 2006. i-Tree Software Suite v1.0 User's Manual. Pp. 27-40.

McPherson EG, Simpson JR, Peper PJ, Gardner SL, Vargas KE, Ho J, Maco S, Xiao Q. 2005b. City of Charleston, South Carolina, municipal forest resource analysis. Internal Tech Rep. Davis, CA: U.S. Department of Agriculture, Center for Urban Forest Research. p. 57

Nowak, D.J. and J.F. Dwyer. 2007. Understanding the benefits and costs of urban forest ecosystems. In: Kuser, J. (ed.) Urban and Community Forestry in the Northeast. New York: Springer. Pp. 25-46.

Peper, Paula J.; McPherson, E. Gregory; Simpson, James R.; Vargas, Kelaine E.; Xiao, Qingfu 2009. Lower Midwest community tree guide: benefits, costs, and strategic planting. Gen. Tech. Rep. PSW-GTR-219. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. p.115

Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Adair

Annual Energy Benefits of Public Trees by Species

11/26/2013

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	26.0	1,972	3,433.1	3,364	5,336	(N/A)	21.1	29.5	74.11
Green ash	15.4	1,171	2,141.4	2,099	3,270	(N/A)	15.5	18.1	61.69
Norway maple	6.6	505	950.6	932	1,436	(N/A)	7.9	7.9	53.19
Blue spruce	2.4	183	320.8	314	497	(N/A)	6.4	2.8	22.59
Sugar maple	5.4	409	726.7	712	1,121	(N/A)	4.7	6.2	70.07
Black walnut	4.0	303	556.1	545	848	(N/A)	4.7	4.7	53.00
Apple	2.9	220	410.7	402	622	(N/A)	4.7	3.4	38.89
Maple	1.1	87	161.2	158	245	(N/A)	4.1	1.4	17.47
Lilac	2.1	163	327.0	320	484	(N/A)	3.2	2.7	43.96
American basswood	3.3	248	469.8	460	708	(N/A)	2.6	3.9	78.69
Amur maple	1.1	84	163.5	160	244	(N/A)	2.3	1.4	30.49
Broadleaf Deciduous	1.4	107	205.5	201	309	(N/A)	2.3	1.7	38.60
Conifer Evergreen	0.8	58	102.9	101	159	(N/A)	1.8	0.9	26.43
Norway spruce	0.8	63	97.8	96	159	(N/A)	1.8	0.9	26.48
Mulberry	0.7	54	106.6	104	159	(N/A)	1.5	0.9	31.76
Broadleaf Deciduous	0.4	27	57.9	57	83	(N/A)	1.2	0.5	20.85
Catalpa	1.2	94	156.9	154	247	(N/A)	1.2	1.4	61.83
Honeylocust	1.4	107	184.5	181	288	(N/A)	1.2	1.6	71.91
Spruce	0.6	46	78.7	77	123	(N/A)	1.2	0.7	30.81
Littleleaf linden	0.6	45	82.2	81	125	(N/A)	1.2	0.7	31.36
Siberian elm	1.2	89	152.0	149	238	(N/A)	1.2	1.3	59.48
Other street trees	6.5	492	909.5	891	1,383	(N/A)	8.5	7.7	47.70
Citywide total	86.0	6,524	11,795.5	11,560	18,084	(N/A)	100.0	100.0	52.88

Table 2: Annual Stormwater Benefits

Adair

Annual Stormwater Benefits of Public Trees by Species

11/26/2013

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	397,168	10,764	(N/A)	21.1	38.3	149.50
Green ash	180,533	4,893	(N/A)	15.5	17.4	92.32
Norway maple	59,832	1,622	(N/A)	7.9	5.8	60.06
Blue spruce	32,291	875	(N/A)	6.4	3.1	39.78
Sugar maple	70,104	1,900	(N/A)	4.7	6.8	118.75
Black walnut	42,475	1,151	(N/A)	4.7	4.1	71.95
Apple	12,292	333	(N/A)	4.7	1.2	20.82
Maple	6,190	168	(N/A)	4.1	0.6	11.98
Lilac	11,391	309	(N/A)	3.2	1.1	28.07
American basswood	44,952	1,218	(N/A)	2.6	4.3	135.36
Amur maple	4,884	132	(N/A)	2.3	0.5	16.54
Broadleaf Deciduous	10,120	274	(N/A)	2.3	1.0	34.28
Conifer Evergreen	11,393	309	(N/A)	1.8	1.1	51.46
Norway spruce	12,297	333	(N/A)	1.8	1.2	55.54
Mulberry	3,036	82	(N/A)	1.5	0.3	16.46
Broadleaf Deciduous	1,710	46	(N/A)	1.2	0.2	11.59
Catalpa	16,114	437	(N/A)	1.2	1.6	109.18
Honeylocust	16,958	460	(N/A)	1.2	1.6	114.90
Spruce	12,081	327	(N/A)	1.2	1.2	81.85
Littleleaf linden	5,557	151	(N/A)	1.2	0.5	37.65
Siberian elm	12,461	338	(N/A)	1.2	1.2	84.43
Other street trees	74,368	2,016	(N/A)	8.5	7.2	69.50
Citywide total	1,038,207	28,137	(N/A)	100.0	100.0	82.27

Table 3: Annual Air Quality Benefits

Adair

Annual Air Quality Benefits of Public Trees by Species

11/26/2013

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
Silver maple	72.6	12.3	35.2	3.2	390	122.6	17.9	17.1	117.5	767	-37.7	-141	360.7	1,015	(N/A)	21.1	14.10
Green ash	23.4	3.7	11.0	1.0	124	73.9	10.7	10.2	69.9	460	0.0	0	204.1	584	(N/A)	15.5	11.02
Norway maple	12.0	2.1	5.9	0.5	65	32.2	4.7	4.4	30.2	199	-2.8	-11	89.0	253	(N/A)	7.9	9.39
Blue spruce	4.2	0.8	3.5	0.5	28	11.4	1.7	1.6	10.9	71	-11.6	-44	22.9	55	(N/A)	6.4	2.51
Sugar maple	10.3	1.8	5.0	0.5	55	25.6	3.7	3.6	24.4	160	-8.0	-30	66.8	185	(N/A)	4.7	11.57
Black walnut	4.9	0.8	2.4	0.2	26	19.1	2.8	2.6	18.1	119	0.0	0	51.0	146	(N/A)	4.7	9.09
Apple	4.1	0.7	1.9	0.2	22	14.0	2.0	1.9	13.1	87	0.0	0	37.8	108	(N/A)	4.7	6.75
Maple	0.8	0.1	0.5	0.0	5	5.5	0.8	0.8	5.2	34	-0.3	-1	13.3	37	(N/A)	4.1	2.67
Lilac	4.1	0.7	1.9	0.2	22	10.5	1.5	1.4	9.7	65	0.0	0	30.0	86	(N/A)	3.2	7.86
American basswood	6.9	1.2	3.2	0.3	37	15.8	2.3	2.2	14.8	98	-5.6	-21	41.0	114	(N/A)	2.6	12.62
Amur maple	1.6	0.3	0.7	0.1	8	5.4	0.8	0.7	5.0	33	0.0	0	14.5	42	(N/A)	2.3	5.19
Broadleaf Deciduous	1.6	0.3	0.9	0.1	9	6.9	1.0	0.9	6.4	43	-0.4	-2	17.7	50	(N/A)	2.3	6.25
Conifer Evergreen	1.7	0.3	1.4	0.2	11	3.6	0.5	0.5	3.4	23	-4.3	-16	7.4	18	(N/A)	1.8	2.94
Norway spruce	1.4	0.3	1.2	0.2	9	3.8	0.6	0.5	3.8	24	-5.6	-21	6.1	13	(N/A)	1.8	2.09
Mulberry	0.9	0.2	0.4	0.0	5	3.5	0.5	0.5	3.2	22	0.0	0	9.3	27	(N/A)	1.5	5.31
Broadleaf Deciduous	0.5	0.1	0.2	0.0	3	1.8	0.3	0.2	1.6	11	0.0	0	4.7	14	(N/A)	1.2	3.39
Catalpa	3.3	0.5	1.4	0.1	17	5.8	0.8	0.8	5.6	36	0.0	0	18.4	53	(N/A)	1.2	13.35
Honeylocust	3.4	0.6	1.5	0.2	18	6.6	1.0	0.9	6.4	41	-2.7	-10	17.8	49	(N/A)	1.2	12.31
Spruce	1.4	0.3	1.2	0.2	9	2.9	0.4	0.4	2.8	18	-6.2	-23	3.3	4	(N/A)	1.2	1.03
Littleleaf linden	0.9	0.2	0.5	0.0	5	2.8	0.4	0.4	2.7	18	-0.4	-2	7.5	21	(N/A)	1.2	5.24
Siberian elm	2.2	0.4	1.0	0.1	12	5.5	0.8	0.8	5.3	35	0.0	0	16.1	46	(N/A)	1.2	11.55
Other street trees	12.0	2.1	6.4	0.7	67	31.1	4.5	4.3	29.4	194	-11.0	-41	79.5	219	(N/A)	8.5	7.55
Citywide total	174.2	29.5	87.4	8.6	946	410.3	59.7	56.9	389.3	2,555	-96.7	-363	1,119.2	3,139	(N/A)	100.0	9.18

Table 4: Annual Stored Carbon

Adair

Stored CO2 Benefits of Public Trees by Species

11/26/2013

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	1,707,438	12,806	(N/A)	21.1	41.0	177.86
Green ash	766,211	5,747	(N/A)	15.5	18.4	108.43
Norway maple	196,345	1,473	(N/A)	7.9	4.7	54.54
Blue spruce	26,478	199	(N/A)	6.4	0.6	9.03
Sugar maple	302,262	2,267	(N/A)	4.7	7.3	141.69
Black walnut	160,290	1,202	(N/A)	4.7	3.9	75.14
Apple	61,287	460	(N/A)	4.7	1.5	28.73
Maple	11,556	87	(N/A)	4.1	0.3	6.19
Lilac	63,053	473	(N/A)	3.2	1.5	42.99
American	258,983	1,942	(N/A)	2.6	6.2	215.82
Amur maple	24,426	183	(N/A)	2.3	0.6	22.90
Broadleaf	27,542	207	(N/A)	2.3	0.7	25.82
Conifer Evergreen	12,737	96	(N/A)	1.8	0.3	15.92
Norway spruce	13,341	100	(N/A)	1.8	0.3	16.68
Mulberry	14,633	110	(N/A)	1.5	0.4	21.95
Broadleaf	8,572	64	(N/A)	1.2	0.2	16.07
Catalpa	115,821	869	(N/A)	1.2	2.8	217.16
Honeylocust	43,477	326	(N/A)	1.2	1.0	81.52
Spruce	15,346	115	(N/A)	1.2	0.4	28.77
Littleleaf linden	20,045	150	(N/A)	1.2	0.5	37.58
Siberian elm	53,026	398	(N/A)	1.2	1.3	99.42
Other street trees	119,138	1,970	(N/A)	8.5	6.3	67.93
Citywide total	4,165,524	31,241	(N/A)	100.0	100.0	91.35

Table 5: Annual Carbon Sequestered

Adair

Annual CO_2 Benefits of Public Trees by Species

11/26/2013

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	118,236	887	-8,196	-14	-62	43,571	327	153,597	1,152	(N/A)	21.1	42.3	16.00
Green ash	36,613	275	-3,678	-10	-28	25,883	194	58,807	441	(N/A)	15.5	16.2	8.32
Norway maple	9,720	73	-942	-5	-7	11,151	84	19,923	149	(N/A)	7.9	5.5	5.53
Blue spruce	1,913	14	-127	-4	-1	4,035	30	5,816	44	(N/A)	6.4	1.6	1.98
Sugar maple	13,785	103	-1,451	-3	-11	9,036	68	21,367	160	(N/A)	4.7	5.9	10.02
Black walnut	9,711	73	-769	-3	-6	6,695	50	15,634	117	(N/A)	4.7	4.3	7.33
Apple	4,015	30	-294	-3	-2	4,857	36	8,574	64	(N/A)	4.7	2.4	4.02
Maple	1,710	13	-55	-3	0	1,913	14	3,565	27	(N/A)	4.1	1.0	1.91
Lilac	3,674	28	-303	-2	-2	3,604	27	6,973	52	(N/A)	3.2	1.9	4.75
American basswood	13,762	103	-1,243	-2	-9	5,476	41	17,993	135	(N/A)	2.6	5.0	14.99
Amur maple	1,996	15	-117	-2	-1	1,849	14	3,726	28	(N/A)	2.3	1.0	3.49
Broadleaf Deciduous	2,608	20	-132	-2	-1	2,373	18	4,847	36	(N/A)	2.3	1.3	4.54
Conifer Evergreen	514	4	-61	-1	0	1,277	10	1,729	13	(N/A)	1.8	0.5	2.16
Norway spruce	834	6	-64	-1	0	1,393	10	2,162	16	(N/A)	1.8	0.6	2.70
Mulberry	1,241	9	-70	-1	-1	1,200	9	2,370	18	(N/A)	1.5	0.7	3.56
Broadleaf Deciduous	715	5	-41	-1	0	589	4	1,262	9	(N/A)	1.2	0.4	2.37
Catalpa	1,477	11	-556	-1	-4	2,067	16	2,988	22	(N/A)	1.2	0.8	5.60
Honeylocust	936	7	-209	-1	-2	2,360	18	3,086	23	(N/A)	1.2	0.9	5.79
Spruce	746	6	-74	-1	-1	1,020	8	1,692	13	(N/A)	1.2	0.5	3.17
Littleleaf linden	1,915	14	-96	-1	-1	992	7	2,810	21	(N/A)	1.2	0.8	5.27
Siberian elm	2,183	16	-255	-1	-2	1,966	15	3,894	29	(N/A)	1.2	1.1	7.30
Other street trees	10,970	82	-1,261	-6	-9	10,875	82	20,578	154	(N/A)	8.5	5.7	5.32
Citywide total	239,274	1,795	-19,995	-67	-150	144,181	1,081	363,395	2,725	(N/A)	100.0	100.0	7.97

Table 6: Annual Social and Aesthetic Benefits

Adair

Annual Aesthetic/Other Benefits of Public Trees by Species

11/26/2013

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	8,750	(N/A)	21.1	44.6	121.52
Green ash	2,947	(N/A)	15.5	15.0	55.60
Norway maple	925	(N/A)	7.9	4.7	34.25
Blue spruce	500	(N/A)	6.4	2.6	22.71
Sugar maple	1,352	(N/A)	4.7	6.9	84.48
Black walnut	832	(N/A)	4.7	4.2	52.02
Apple	234	(N/A)	4.7	1.2	14.64
Maple	289	(N/A)	4.1	1.5	20.62
Lilac	219	(N/A)	3.2	1.1	19.93
American basswood	908	(N/A)	2.6	4.6	100.89
Amur maple	117	(N/A)	2.3	0.6	14.61
Broadleaf Deciduous	269	(N/A)	2.3	1.4	33.66
Conifer Evergreen	111	(N/A)	1.8	0.6	18.58
Norway spruce	188	(N/A)	1.8	1.0	31.31
Mulberry	73	(N/A)	1.5	0.4	14.51
Broadleaf Deciduous	42	(N/A)	1.2	0.2	10.41
Catalpa	118	(N/A)	1.2	0.6	29.43
Honeylocust	195	(N/A)	1.2	1.0	48.65
Spruce	153	(N/A)	1.2	0.8	38.18
Littleleaf linden	203	(N/A)	1.2	1.0	50.71
Siberian elm	158	(N/A)	1.2	0.8	39.56
Other street trees	1,054	(N/A)	8.5	5.4	36.34
Citywide total	19,635	(N/A)	100.0	100.0	57.41

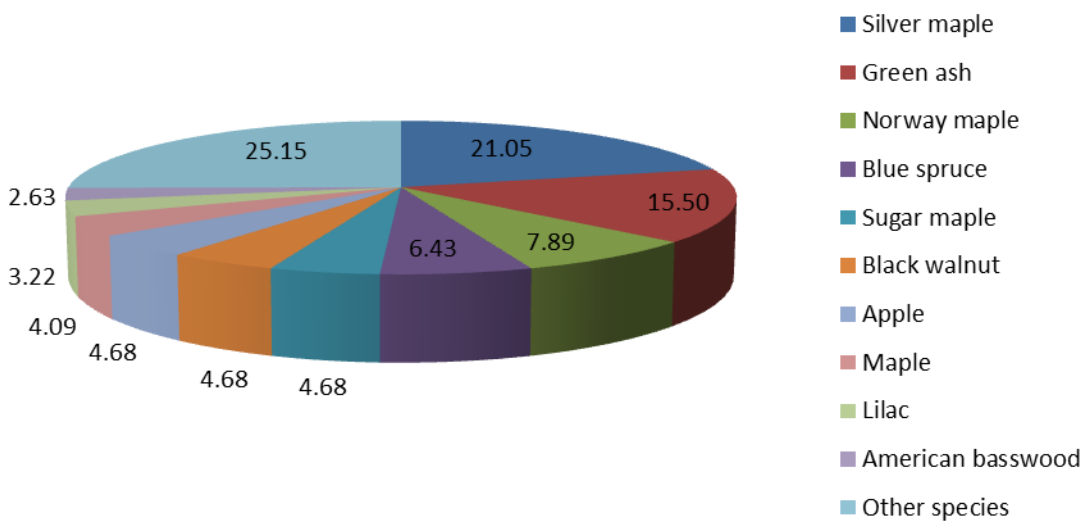

Figure 1: Species Distribution

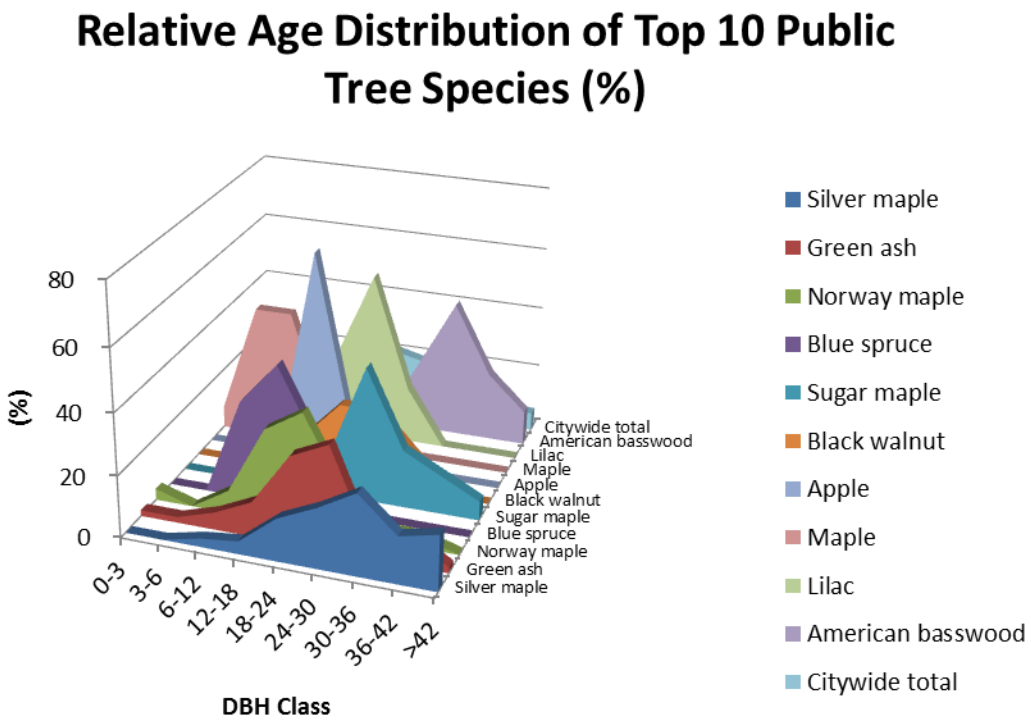

Figure 2: Relative Age Class

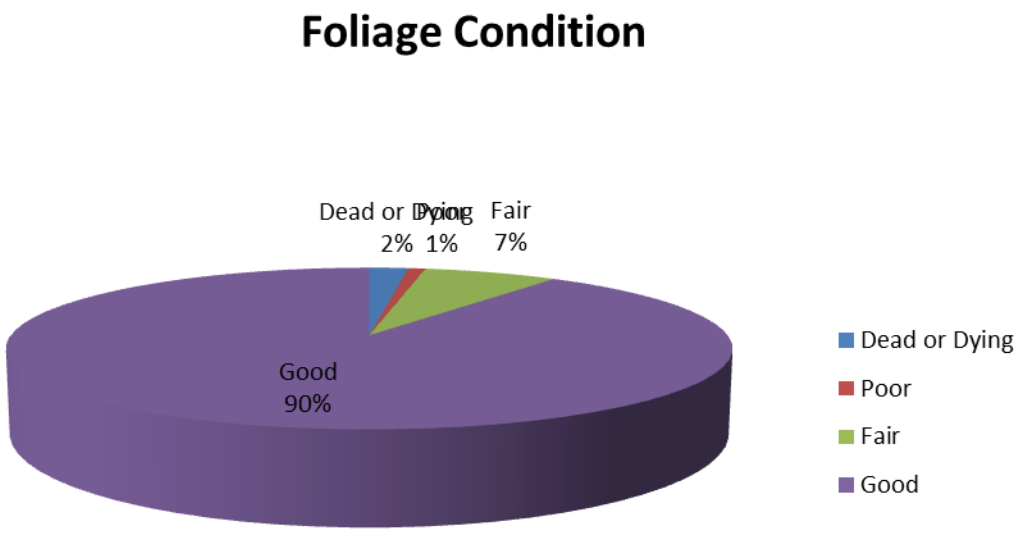

Figure 3: Foliage Condition

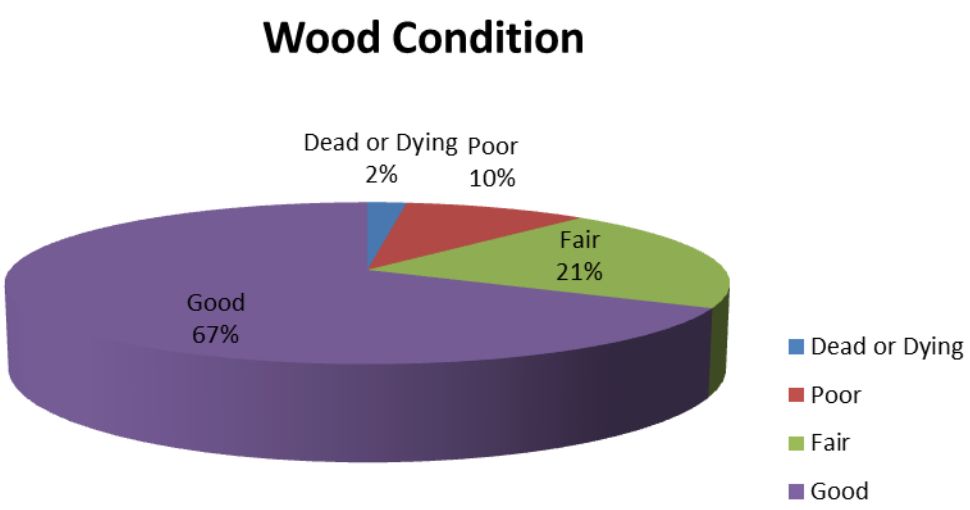

Figure 4: Wood Condition

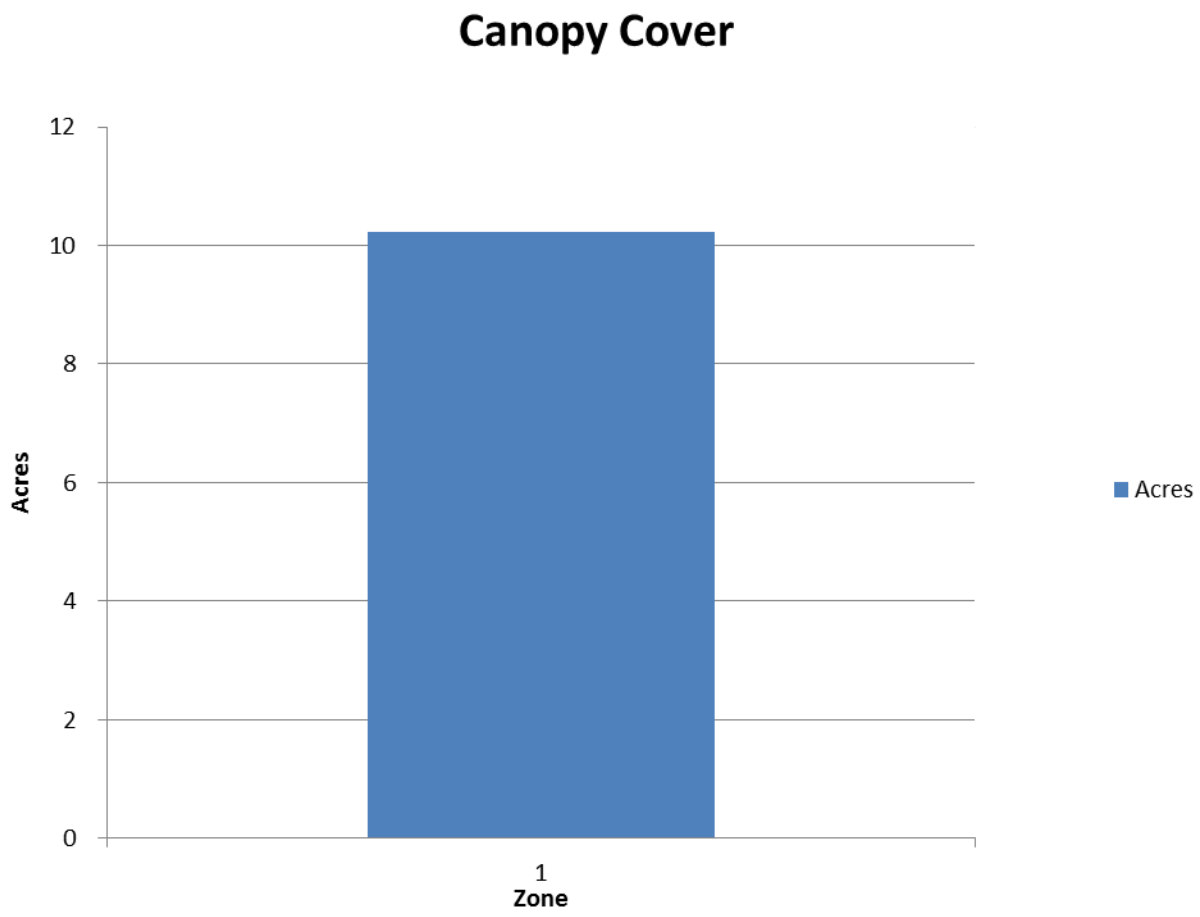

Figure 5: Canopy Cover in Acres

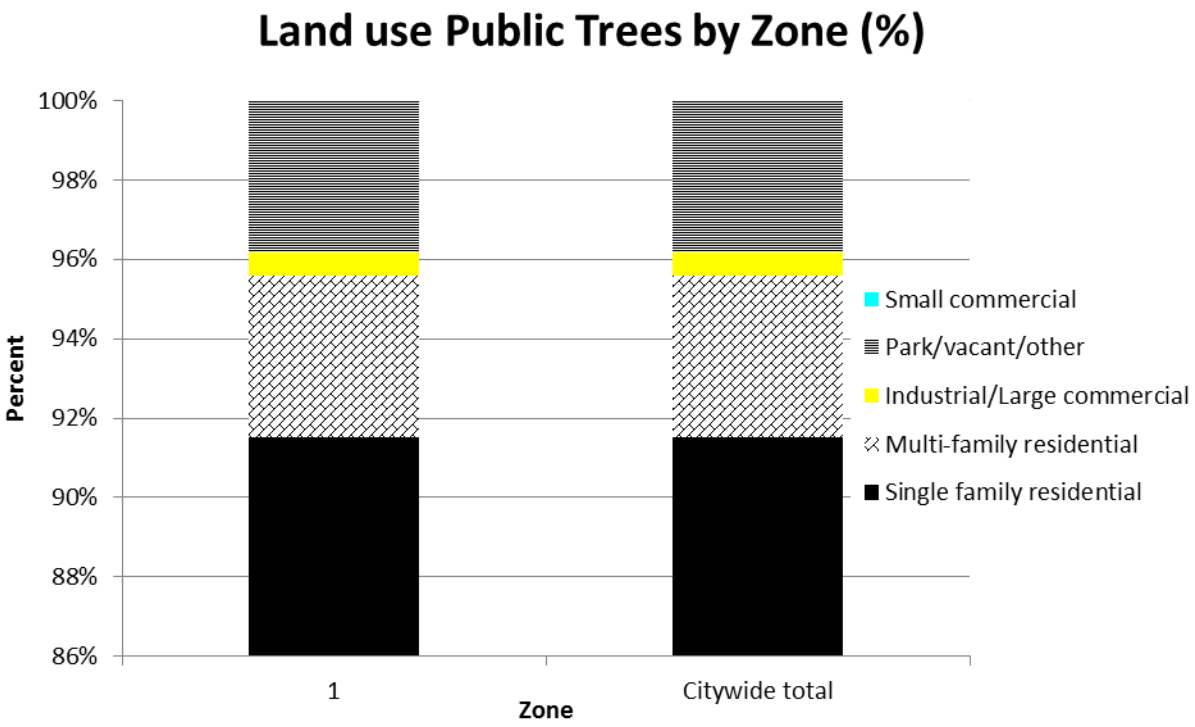

Figure 6: Land Use of city/park trees

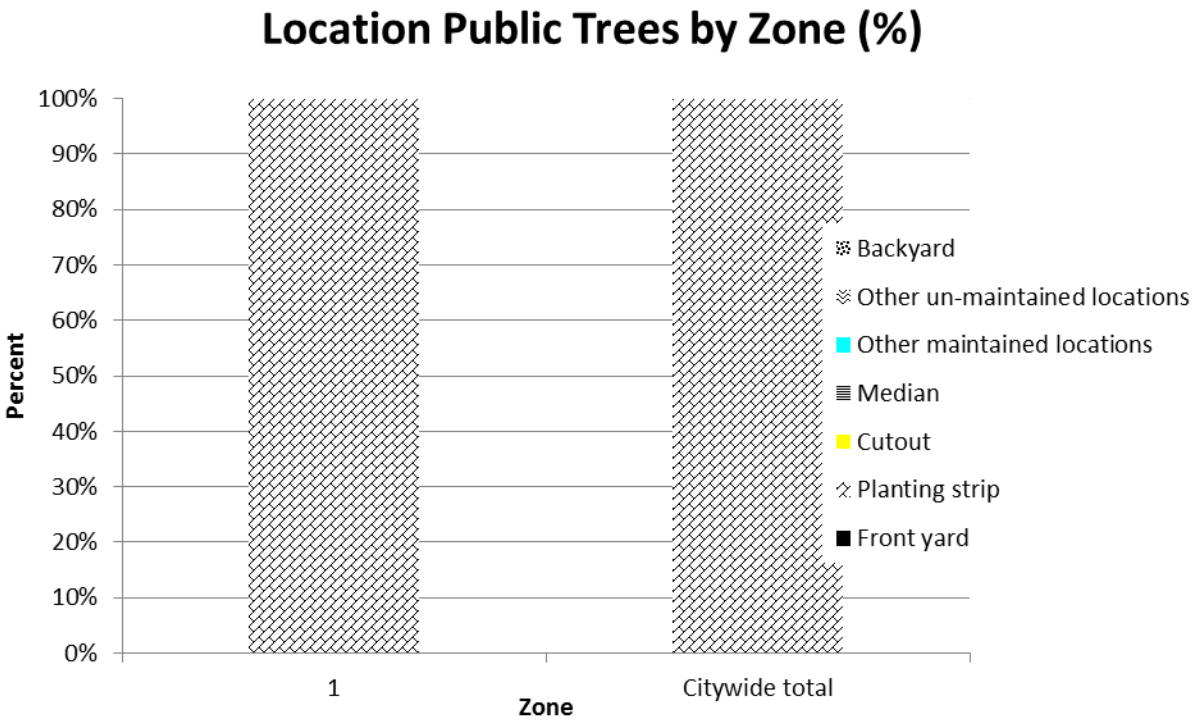

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

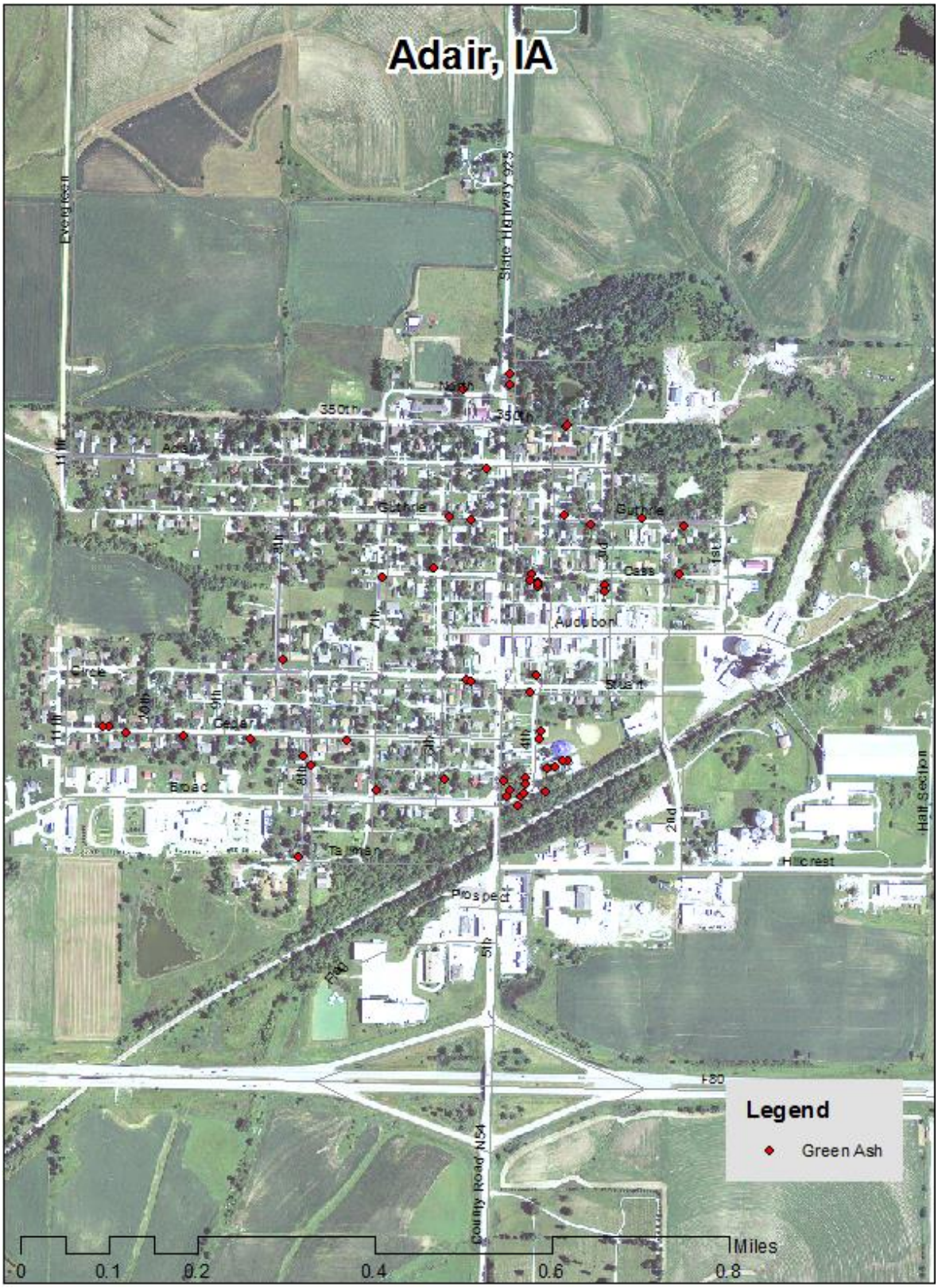

Figure 1: Location of Ash Trees

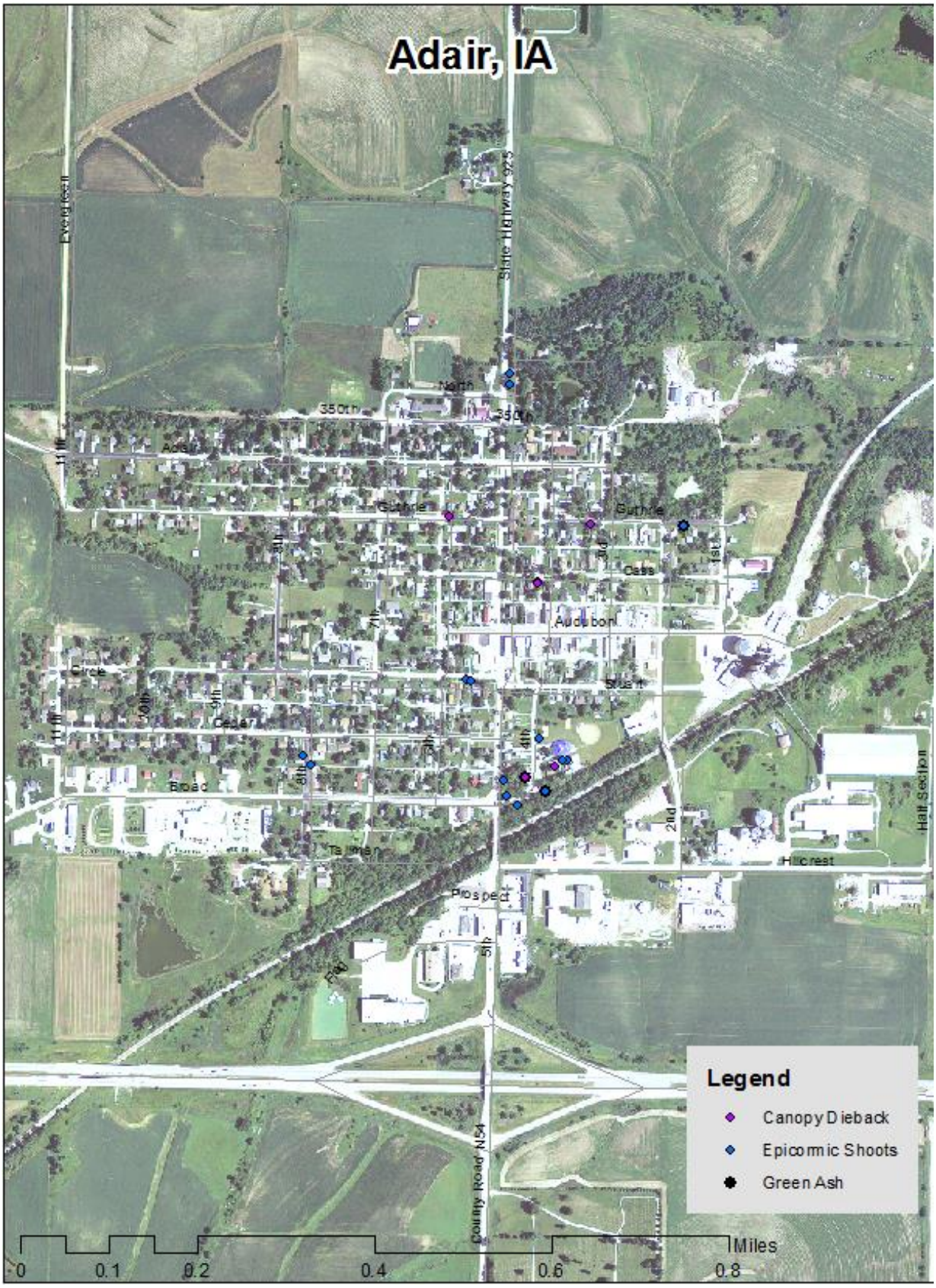

Figure 2: Location of EAB symptoms

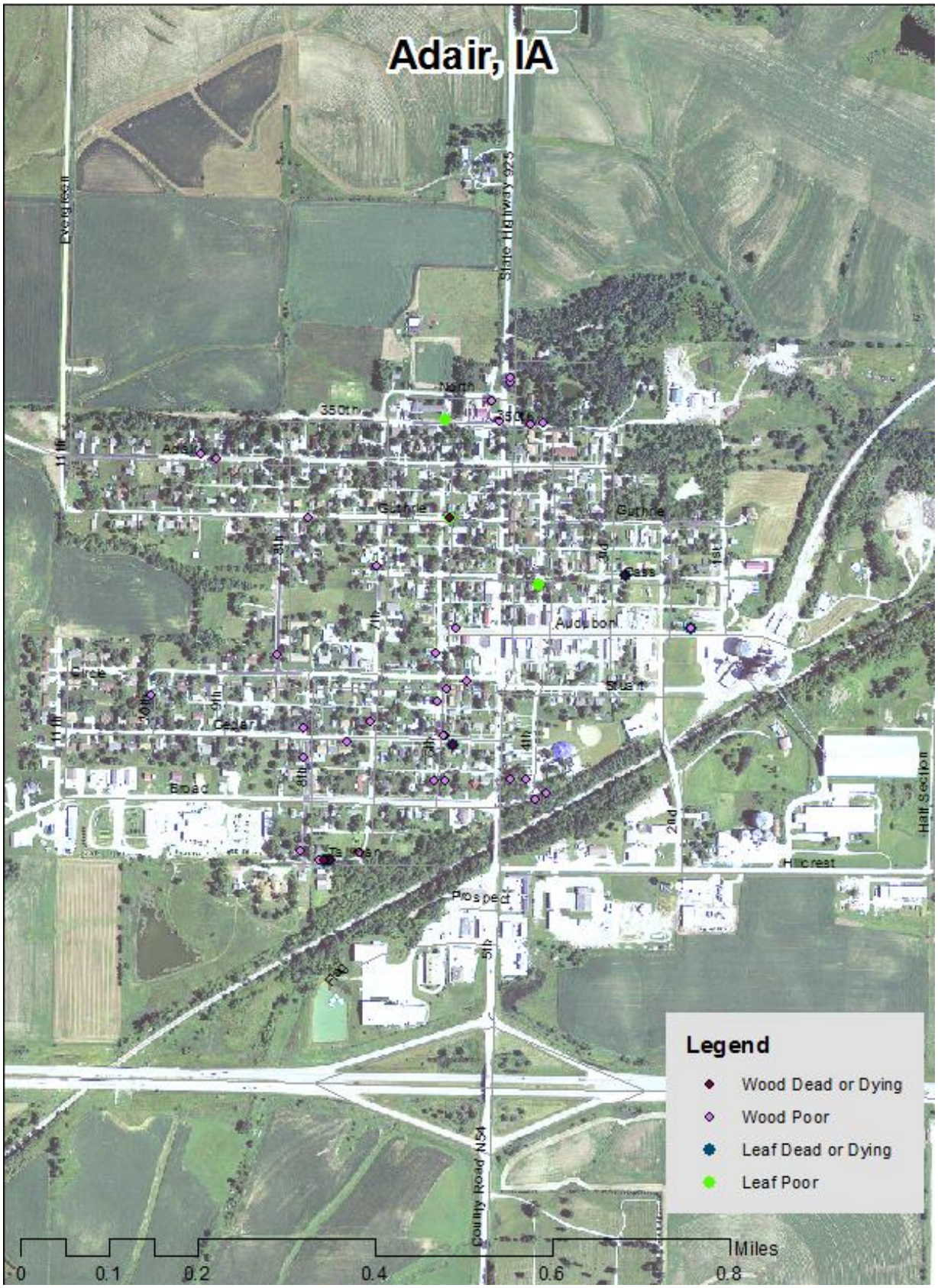

Figure 3: Location of Poor Condition Trees

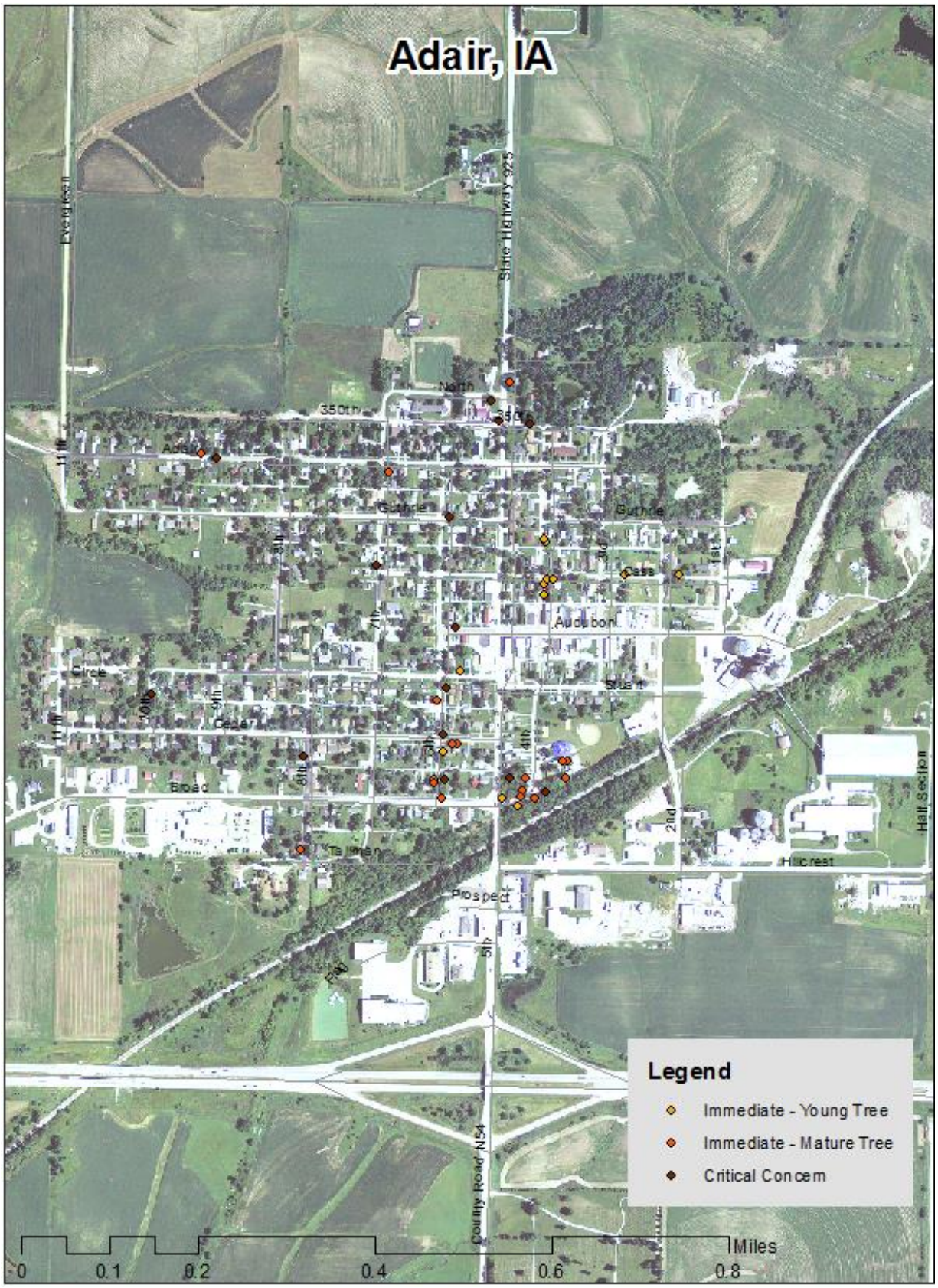

Figure 4: Location of Trees with Recommended Maintenance

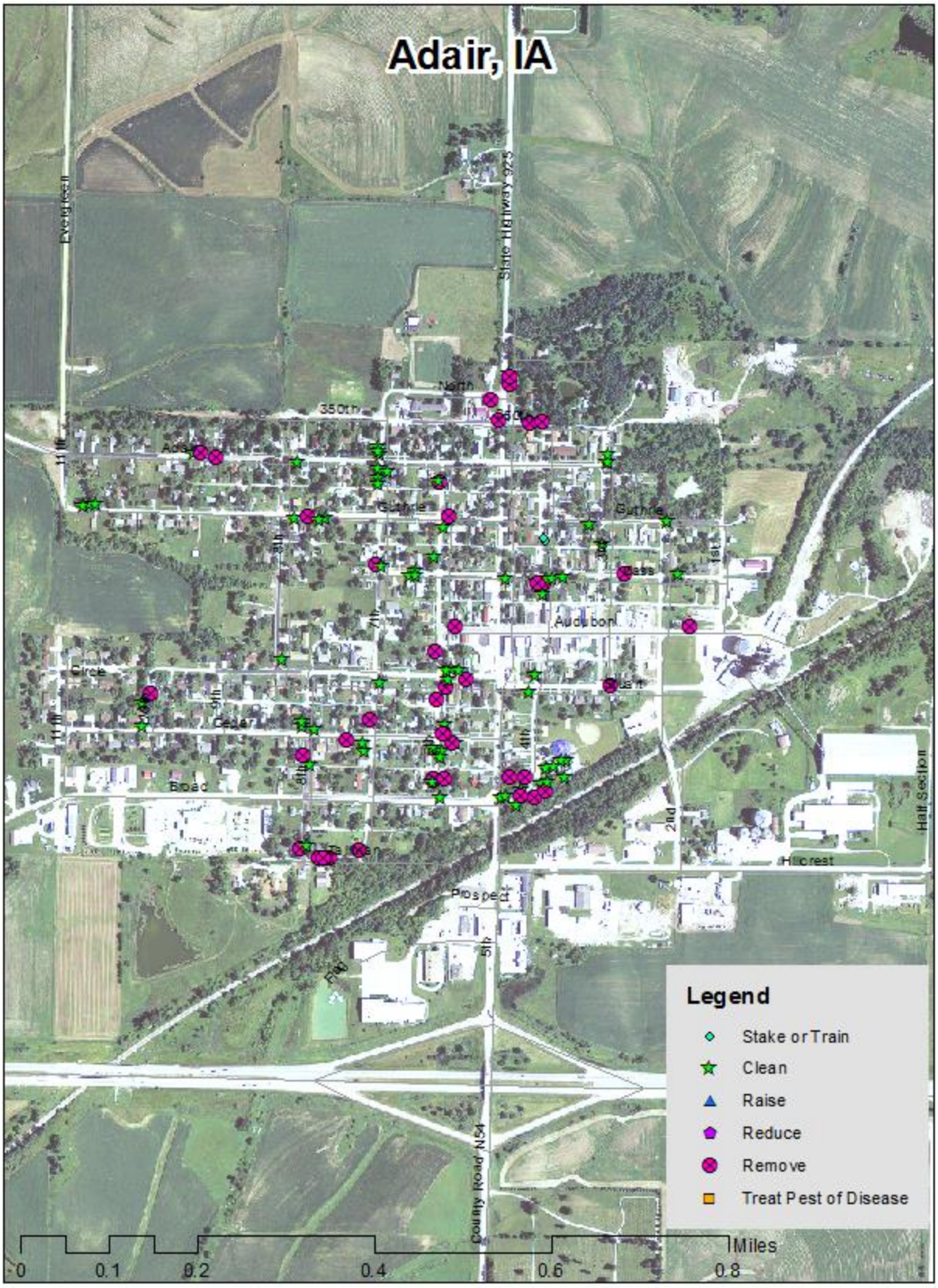

Figure 5: Maintenance Tasks *City ownership of the trees recommended for removal should be verified prior to any removal*

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