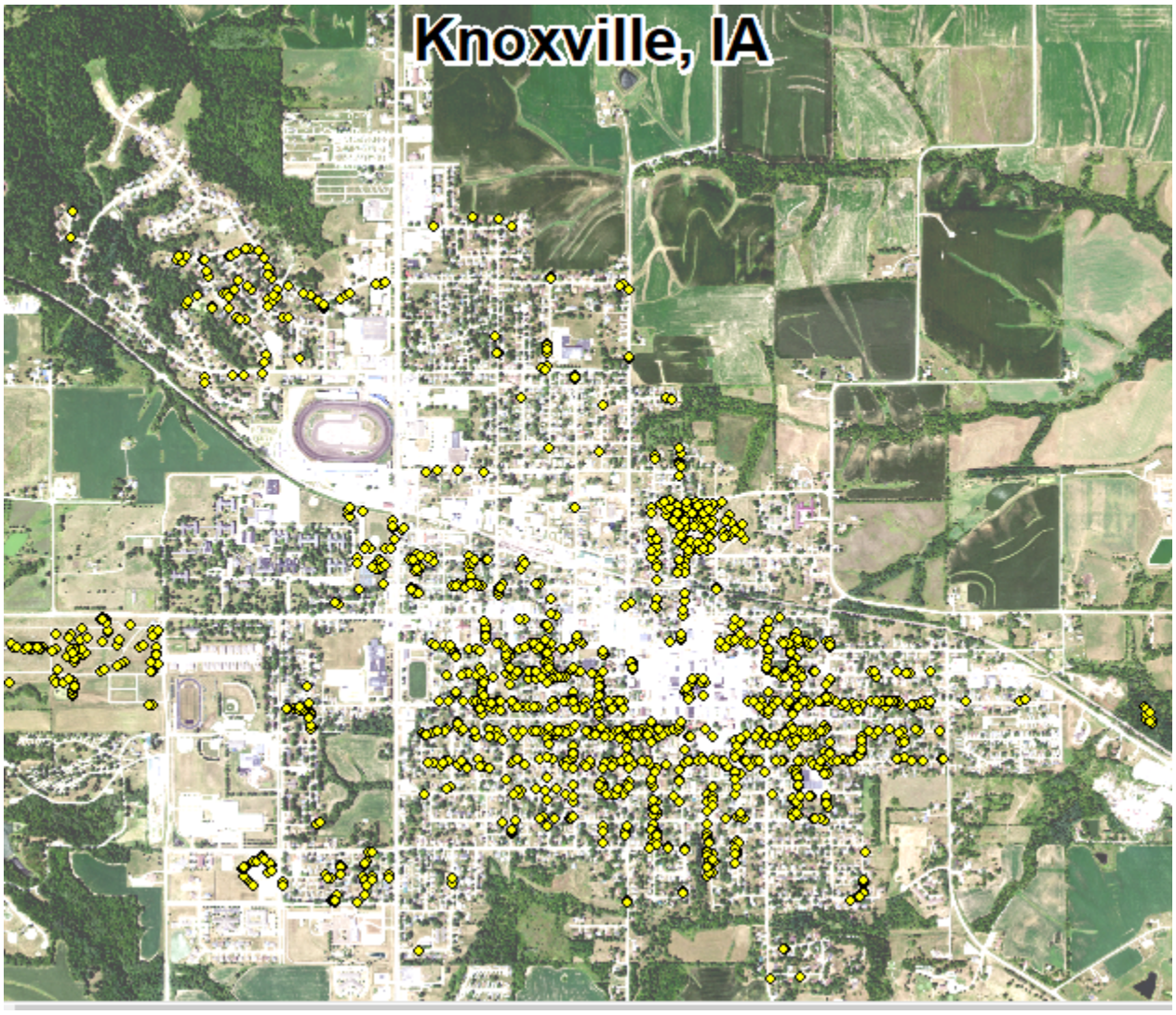
Knoxville, IA



2020 Urban Forest Management Plan

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Table of Contents

Executive Summary

Overview

This plan was developed to assist the City of Knoxville with managing its urban forest, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management allows a community to maximize these benefits. Management is especially important considering the serious threats posed by forest pests such as the emerald ash borer (EAB). EAB is an invasive insect imported from Eastern Asia on wood shipping crates that kills all species of ash trees (this does not include mountain ash). There is a strong possibility that 17% of Knoxville's city owned trees (ash) will die because of EAB 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 2019, 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 1,326 trees inventoried.

- Knoxville's trees provide $258,176 of benefits annually, an average of $195 a tree
- There are over 52 species of trees
- The top four genera are: maple 47%, ash 7%, crabapple 7% and oak 7%
- 29% of trees are in need of some type of management
- 178 trees are recommended for removal and replacement of which 81 are ash

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 178 trees needing removal, 56 are critical concern of various sizes and must be addressed immediately *City ownership of the trees recommended for removal should be verified prior to any removal*
- 80 of the 86 ash trees already have one or more symptoms 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: maple, ash, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut
- Check ash trees with a visual survey yearly
- The proposed budget to implement this plan over six years is $204,300 – Suggestion: request a budget increase and apply for grants to plant replacement trees

Introduction

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

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

Inventory

In 2019, 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. ArcGIS is the most beneficial tool for viewing the spatial data. However, we now have the data online for you to view. The tree numbers in the excel spreadsheet match our free online tree mapping website. That tool can be accessed by going to our urban forestry page www.iowadnr.gov/urbanforestry then scrolling down and clicking on the blue "View my Community's Trees". This allows you to search your town and for specific data such as species or maintenance tasks. This website will allow anyone interested in the data to access a shortened version along with a map.

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 1,326 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. Knoxville's trees reduce energy related costs by approximately $258,176 annually (Appendix A, Table 1). These savings are both in Electricity (319.1 MWh) and in Natural Gas (42,900 Therms).

Annual Stormwater Benefits

Knoxville's trees intercept about 3,628,790 gallons of rainfall or snowmelt a year (Appendix A, Table 2). This interception provides an average $74.16 per tree and total $98,340 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 Knoxville, it is estimated that trees remove 4,059 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 $11,325 and average $8.54 per tree. (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Knoxville, trees sequester about 1,231,463 lbs. of carbon a year with an associated value of $9,236 (Appendix A, Table 5). In addition, the trees store 13,997,328 lbs. of carbon, with a yearly benefit of $104,980 (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. Knoxville receives $73,013 in annual social benefits from trees with an average $55.06 per tree (Appendix A, Table 6).

Financial Summary of all Benefits

According to the USDA Forest Service i-Tree STREETS analysis, Knoxville's trees provide $258,176 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 1,326 trees in Knoxville provide approximately $194.70 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Knoxville has over 52 different tree species along city streets and parks (Appendix A, Figure 1). The species distribution is as follows:

Species	Percent
Sugar maple	15.61
Silver maple	15.54
Crabapple	7.16
Norway maple	6.18
Red maple	4.52
Black maple	4.52
Siberian elm	3.77
Ash	3.24
Green ash	3.17
Honey locust	2.79
Other Species	33.48

Genera Distribution

Pests commonly attack trees within a genus. A good guideline for healthy, diverse urban forests is to have ≤20% of a genus and ≤10% of any one species. Knoxville has over 40 different tree genera along city streets and parks. The distribution of the top genera is as follows:

Genus	Percent
Maple	47%
Ash	7%
Oak	7%
Apple (Crab)	7%
36 Other genera	32%

Age Class

Most of Knoxville's trees (54%) are larger than 18 inches DBH (diameter breast height or 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. Knoxville's size curve is on the larger side, indicating an older than average stand of trees. Trees 6-17" DBH make up 35% while only 11% of trees are less than 6" DBH. This fact shows how important it is to plant new trees to replace dying ash trees and other recommended removals.

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 Knoxville indicate that 89% of the trees are in good and fair health, with 10% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3).

Similarly, 77% of Knoxville'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 22% of the population.

Management Needs

The following outlines the specific management needs of the street and park trees by number of trees and percent of canopy (Appendix B, Figure 3). The total number of trees needing maintenance is 381 (29%). Therefore, 71% of trees do not need maintenance at this time.

Critical concern:			
	Tree Removal	56	4%
Immediate maintenance task:			
	Tree Removal	84	6%
	Crown Cleaning	14	1%
	Crown Reduction	3	<1%
	Crown Raising	0	0%
	Tree Staking	0	0%
Routine maintenance task:			
	Tree Removal	38	3%
	Crown Cleaning	136	10%
	Crown Reduction	18	1%
	Crown Raising	29	2%
	Tree Staking	2	<1%

Recommended maintenance listed above is defined by one of the six following attributes:
None – tree does not need immediate or routine maintenance.
Young tree (routine) – tree is less than 18 ft. tall and in need of maintenance; health or longevity of tree is not compromised by deferring maintenance for up to five years.
Young tree (immediate) – tree is less than 18 ft. tall and in need of maintenance; deferring maintenance beyond one to three years would compromise health or longevity of tree.
Mature tree (routine) – tree is more than 18 ft. tall and in need of maintenance; health or longevity of tree is not compromised by deferring maintenance for up to five years.
Mature tree (immediate) – tree is more than 18 ft. tall and in need of maintenance; deferring maintenance beyond one to three years would compromise health or longevity of tree.
Critical concern (public safety) – tree should be inspected without delay.

Canopy Cover

The total canopy with both private and public trees is 22%, 665 acres. The canopy cover included in the Knoxville inventory (public trees) includes approximately 37 acres, 1.25% (Appendix A, Figure 4). The City's Canopy goal should be to increase canopy by 1% over 30 years. To achieve this goal it is estimated that 72 trees need to be planted annually on public and private lands. A more ambitious goal to increase the canopy 3% over 30 years means 216 trees need to be planted annually.

Land Use and Location

The majority of Knoxville'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	78%
Park/vacant/other	21%
Industrial/Large commercial	2%
Multifamily residential	<1%
Small commercial	0%

Location	
Planting strip	81%
Front yard	19%
Cutout (surrounded by pavement)	<1%

Recommendations

Risk Management

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

Hazardous trees

Knoxville has 56 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) or using the free online tree mapping website. It is recommended to start with the large diameter critical concern trees first. To help prioritize, there are 33 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. After all of the critical concern trees are addressed, there should be follow up on the trees marked as needing maintenance (i.e. removals, cleaning, raise, or reduction). There are a total of 325 trees with these needs.

Poor tree species

After the removal of the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 178 removals, 81 are ash trees. There are a total of 86 ash trees, and 93% 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 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 Knoxville.

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 (maple) or species (silver maple) 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 (47%) (Appendix A, Figure 1). Maples should not be planted for many years 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, black walnut, and others as outlined in Chapter 6 section 7-6-6: PROHIBITED SPECIES of the city ordinance (Appendix C). All new trees planted require city permit and must meet the restrictions in city ordinance Chapter 6 section 7-6-5 Street Tree Categories (Appendix C).

Continual Monitoring

Due to EAB infestation, it is important to continuously check the health of ash trees. It is recommended that ash trees be checked with a visual survey every year for tree decline and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Six Year Maintenance Plan Proposal

Year 1

Removal: 30 largest critical concern trees
Planting and Replacement: 36 trees to be planted in open locations
Young Tree Pruning & Maintenance: 36 trees

Year 2

Removal: 26 critical concern trees, 4 additional trees with poor health (immediate-removals)
Planting and Replacement: 36 trees in open locations from year one removals
Young Tree Pruning & Maintenance: 36
Routine trimming: Contract to trim 1/3 of the city trees
Visual Survey for signs and symptoms of tree pests

Year 3

Removal: 30 trees (immediate-removals) and any new critical concern trees
Planting and Replacement: 36 trees in open locations from previous removals
Young Tree Pruning & Maintenance: 36

Year 4

Removal: 30 trees (immediate-removals) and any new critical concern trees
Planting and Replacement: 36 trees in open locations from previous removals
Routine trimming: Contract to trim 1/3 of the city trees
Visual Survey for signs and symptoms of tree pests
Young Tree Pruning & Maintenance: 36

Year 5

Removal: 20 trees (immediate-removal) plus 10 trees (routine-removal) and any new critical concern trees
Planting and Replacement: 36 trees to be planted in open locations and locations from previous removals
Young Tree Pruning & Maintenance: 36

Year 6

Removal: 28 trees (routine-removal) and any new critical concern trees
Planting and Replacement: 34 trees in open locations from previous removals
Routine trimming: Contract to trim 1/3 of the city trees
Visual Survey for signs and symptoms of tree pests
Young Tree Pruning & Maintenance: 34

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 due to the current EAB infestation. Trees that were already treated for preventative purposes should be monitored and treated every two years or according to the specific insecticide label. For more information on the cost of treatment strategies visit http://extension.entm.purdue.edu/treecomputer/

EAB Quarantines

EAB is an extremely destructive plant pest and it is responsible for the death and decline of millions of ash trees. Ash in both forested and urban settings constitute a significant portion of the canopy cover in the United States. Current tools to detect, control, suppress and eradicate this pest are not as robust as the USDA would desire. In order to stay ahead of this hard to detect beetle, the USDA is attempting to contain the beetle before it spreads beyond its known positions by regulating articles.

A regulated article under the USDA's quarantine includes any of the following items:

- emerald ash borer
- firewood of all hardwood species (for example ash, oak, maple and hickory)
- nursery stock and green lumber of ash
- any other ash material, whether living, dead, cut or fallen, including logs, stumps, roots, branches, as well as composted and not composted chips of the genus ash (Mountain ash is not included)

In addition, any other article, product or means of conveyance not listed above may be designated as a regulated article if a USDA inspector determines that it presents a risk of spreading EAB once a quarantine is in effect for your county.

Wood Disposal

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

Canopy Replacement
As budget permits, all removed trees will be replaced. All trees will meet the restrictions in city ordinance Chapter 6 (Appendix C). The new plantings will be a diverse mix and will not include ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow, black walnut, or others as specified by city ordinance.

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 due to the arrival of EAB if preventative treatments are not being used. City Code should be amended to address privately owned trees using the following sample: "If it is determined with reasonable certainty that any such condition exists (trees or shrubs in the City reported or suspected to be infected with or damaged by any disease or insect or disease pests) on private property and that the danger to other trees or to adjoining property or passing motorists or pedestrians is imminent, the Council shall notify by certified mail the owner, occupant or person in charge of such property to correct such condition by treatment or removal within fourteen (14) days of said notification. If such owner, occupant or person in charge of said property fails to comply within 14 days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property."

Budget

Proposed budget to implement this plan
Total $204,300 over 6 years ($34,050/year)

Average cost assumptions for proposed budget: removals $900 each, tree planting $100 each, young tree watering and maintenance $25 each, routine trimming $75 each.

Year 1 Budget
- Removal: $27,000
- Planting and replacement: $3,600
- Watering & Maintenance: $900

Year 2 Budget
- Removal: $27,000
- Planting and replacement: $3,600

Routine trimming: $5,100
Watering & Maintenance: $900

Year 3 Budget
Removal: $27,000
Planting and replacement: $3,600
Watering & Maintenance: $900

Year 4 Budget
Removal: $27,000
Planting and replacement: $3,600
Routine trimming: $5,100
Watering & Maintenance: $900

Year 5 Budget
Removal: $27,000
Planting and replacement: $3,600
Watering & Maintenance: $900

Tear 6 Budget
Removal: $27,000
Planting and replacement: $3,600
Routine trimming: $5,100
Watering & Maintenance: $900

*Removal of only ash trees: approximately 86 trees removed (100% of ash) is estimated $77,400.

Purposed Budget Increase

EAB is currently killing ash trees in Knoxville and the highest amounts of loss will likely be during the next 1-3 years. To remove all ash trees within the next 3 years the budget would need to be increased $25,800. Additionally, it is recommended that Knoxville 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.

Some communities *without* infestation may be able to treat 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, a 20" DBH tree and at $15 per inch would cost $300 to be treated every two years. 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 because EAB has already infested Knoxville.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Knoxville

Annual Energy Benefits of Public Trees

3/27/2020

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	60.5	4,592	8,004.9	7,845	12,437	(N/A)	15.6	18.8	60.08
Silver maple	63.4	4,813	8,283.8	8,118	12,931	(N/A)	15.5	19.5	62.77
Apple	6.2	472	973.9	954	1,427	(N/A)	7.2	2.2	15.02
Norway maple	17.8	1,351	2,475.2	2,426	3,777	(N/A)	6.2	5.7	46.06
Red maple	12.3	936	1,569.1	1,538	2,474	(N/A)	4.5	3.7	41.23
Black maple	15.9	1,208	2,178.6	2,135	3,343	(N/A)	4.5	5.0	55.72
Siberian elm	17.1	1,300	2,265.9	2,221	3,521	(N/A)	3.8	5.3	70.42
Ash	11.2	852	1,604.3	1,572	2,424	(N/A)	3.2	3.7	56.37
Green ash	11.0	838	1,473.7	1,444	2,282	(N/A)	3.2	3.4	54.33
Honeylocust	11.9	903	1,550.7	1,520	2,423	(N/A)	2.8	3.7	65.48
Pin oak	11.6	884	1,535.3	1,505	2,388	(N/A)	2.6	3.6	70.25
Norway spruce	4.3	330	568.2	557	886	(N/A)	2.3	1.3	28.60
American sycamore	12.0	912	1,629.6	1,597	2,509	(N/A)	2.3	3.8	80.95
Northern hackberry	10.1	763	1,381.0	1,353	2,117	(N/A)	2.2	3.2	72.98
Northern red oak	4.5	340	617.8	605	946	(N/A)	2.0	1.4	35.03
Eastern red cedar	2.6	198	388.0	380	579	(N/A)	2.0	0.9	22.25
Eastern redbud	1.6	125	261.4	256	381	(N/A)	1.6	0.6	18.13
Eastern white pine	2.3	176	279.5	274	450	(N/A)	1.6	0.7	21.44
Northern pin oak	4.2	320	628.2	616	936	(N/A)	1.3	1.4	55.03
American basswood	5.3	402	763.8	748	1,151	(N/A)	1.1	1.7	76.72
Black walnut	4.1	310	556.7	546	856	(N/A)	1.1	1.3	61.14
Spruce	1.7	126	199.2	195	321	(N/A)	1.1	0.5	22.96
Black cherry	1.2	88	167.0	164	252	(N/A)	0.7	0.4	27.99
Hickory	1.6	125	222.6	218	343	(N/A)	0.6	0.5	42.87
Southern magnolia	1.0	75	124.1	122	196	(N/A)	0.6	0.3	24.55
Littleleaf linden	1.3	102	175.8	172	274	(N/A)	0.6	0.4	34.28
Tulip tree	2.5	191	340.3	334	525	(N/A)	0.6	0.8	65.57
Scotch pine	1.1	81	132.3	130	211	(N/A)	0.5	0.3	30.15
Mulberry	0.9	70	138.9	136	206	(N/A)	0.5	0.3	29.40
American elm	2.3	173	285.8	280	453	(N/A)	0.5	0.7	75.46
Broadleaf Deciduous Large	0.5	37	68.9	68	104	(N/A)	0.5	0.2	17.42
Ginkgo	0.9	68	119.7	117	186	(N/A)	0.5	0.3	30.95
Catalpa	1.5	114	206.6	202	316	(N/A)	0.4	0.5	63.22
Willow	0.5	35	73.6	72	107	(N/A)	0.4	0.2	21.38

River birch	0.7	56	113.6	111	167 (N/A)	0.4	0.3	33.48
Bur oak	1.1	87	155.0	152	238 (N/A)	0.4	0.4	47.69
Broadleaf Deciduous Small	0.1	4	9.5	9	13 (N/A)	0.4	0.0	2.68
Cottonwood	0.9	72	130.7	128	200 (N/A)	0.4	0.3	40.03
Japanese tree lilac	0.1	6	14.7	14	21 (N/A)	0.3	0.0	5.20
Conifer Evergreen Large	0.5	38	63.4	62	100 (N/A)	0.3	0.2	25.01
Sweetgum	1.1	86	147.7	145	230 (N/A)	0.3	0.3	57.57
Boxelder	0.7	56	103.3	101	157 (N/A)	0.2	0.2	52.34
Broadleaf Evergreen Large	1.0	74	126.2	124	198 (N/A)	0.2	0.3	65.86
Conifer Evergreen Medium	0.2	12	25.2	25	37 (N/A)	0.2	0.1	12.18
Blue spruce	0.3	24	40.6	40	64 (N/A)	0.2	0.1	21.27
White oak	0.6	43	67.7	66	109 (N/A)	0.2	0.2	36.36
Swamp white oak	0.1	6	13.2	13	19 (N/A)	0.2	0.0	6.36
Lilac	0.0	4	8.2	8	12 (N/A)	0.2	0.0	3.89
Callery pear	0.4	29	52.5	51	80 (N/A)	0.2	0.1	26.74
Eastern cottonwood	0.8	63	112.7	110	173 (N/A)	0.2	0.3	86.52
Maple	0.0	3	6.0	6	9 (N/A)	0.2	0.0	4.44
Red pine	0.1	9	19.0	19	27 (N/A)	0.2	0.0	13.58
Austrian pine	0.3	20	34.7	34	54 (N/A)	0.2	0.1	27.08
Birch	0.4	28	56.4	55	83 (N/A)	0.2	0.1	41.58
Pear	0.3	20	37.5	37	56 (N/A)	0.2	0.1	28.16
Ohio buckeye	0.4	27	53.6	53	80 (N/A)	0.2	0.1	39.91
Elm	1.0	74	126.2	124	197 (N/A)	0.2	0.3	98.63
Broadleaf Deciduous Mediu	0.1	8	16.9	17	24 (N/A)	0.1	0.0	24.47
White ash	0.0	2	4.2	4	7 (N/A)	0.1	0.0	6.65
Black locust	0.3	20	39.6	39	59 (N/A)	0.1	0.1	58.69
Cherry plum	0.0	2	3.8	4	5 (N/A)	0.1	0.0	5.40
Flowering dogwood	0.0	2	3.8	4	5 (N/A)	0.1	0.0	5.40
Quaking aspen	0.1	7	13.7	13	21 (N/A)	0.1	0.0	20.64
Broadleaf Evergreen Mediur	0.0	3	5.6	5	8 (N/A)	0.1	0.0	8.11
Plum	0.0	2	3.8	4	5 (N/A)	0.1	0.0	5.40
Black poplar	0.3	25	46.9	46	71 (N/A)	0.1	0.1	70.91
Total	319.1	24,220	42,899.9	42,042	66,261 (N/A)	100.0	100.0	49.97

Table 2: Annual Stormwater Benefits

Knoxville

Annual Stormwater Benefits of Public Trees

3/27/2020

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	702,770	19,045	(N/A)	15.6	19.4	92.01
Silver maple	884,771	23,977	(N/A)	15.5	24.4	116.39
Apple	23,918	648	(N/A)	7.2	0.7	6.82
Norway maple	144,263	3,910	(N/A)	6.2	4.0	47.68
Red maple	85,460	2,316	(N/A)	4.5	2.4	38.60
Black maple	148,179	4,016	(N/A)	4.5	4.1	66.93
Siberian elm	194,563	5,273	(N/A)	3.8	5.4	105.45
Ash	103,723	2,811	(N/A)	3.2	2.9	65.37
Green ash	122,612	3,323	(N/A)	3.2	3.4	79.11
Honeylocust	129,830	3,518	(N/A)	2.8	3.6	95.09
Pin oak	133,580	3,620	(N/A)	2.6	3.7	106.47
Norway spruce	85,087	2,306	(N/A)	2.3	2.3	74.38
American sycamore	179,894	4,875	(N/A)	2.3	5.0	157.26
Northern hackberry	97,173	2,633	(N/A)	2.2	2.7	90.81
Northern red oak	41,391	1,122	(N/A)	2.0	1.1	41.54
Eastern red cedar	38,121	1,033	(N/A)	2.0	1.1	39.73
Eastern redbud	7,214	196	(N/A)	1.6	0.2	9.31
Eastern white pine	34,770	942	(N/A)	1.6	1.0	44.87
Northern pin oak	46,278	1,254	(N/A)	1.3	1.3	73.77
American basswood	72,283	1,959	(N/A)	1.1	2.0	130.59
Black walnut	45,617	1,236	(N/A)	1.1	1.3	88.30
Spruce	22,133	600	(N/A)	1.1	0.6	42.84
Black cherry	5,098	138	(N/A)	0.7	0.1	15.35
Hickory	14,989	406	(N/A)	0.6	0.4	50.78

Southern magnolia	8,459	229 (N/A)	0.6	0.2	28.65
Littleleaf linden	11,249	305 (N/A)	0.6	0.3	38.11
Tulip tree	36,677	994 (N/A)	0.6	1.0	124.24
Scotch pine	19,968	541 (N/A)	0.5	0.6	77.31
Mulberry	4,218	114 (N/A)	0.5	0.1	16.33
American elm	19,693	534 (N/A)	0.5	0.5	88.95
Broadleaf Deciduous Large	4,930	134 (N/A)	0.5	0.1	22.27
Ginkgo	5,981	162 (N/A)	0.5	0.2	27.01
Catalpa	21,183	574 (N/A)	0.4	0.6	114.81
Willow	2,507	68 (N/A)	0.4	0.1	13.59
River birch	6,143	166 (N/A)	0.4	0.2	33.29
Bur oak	12,115	328 (N/A)	0.4	0.3	65.66
Broadleaf Deciduous Small	160	4 (N/A)	0.4	0.0	0.87
Cottonwood	7,863	213 (N/A)	0.4	0.2	42.62
Japanese tree lilac	287	8 (N/A)	0.3	0.0	1.94
Conifer Evergreen Large	8,277	224 (N/A)	0.3	0.2	56.08
Sweetgum	10,817	293 (N/A)	0.3	0.3	73.29
Boxelder	8,412	228 (N/A)	0.2	0.2	75.99
Broadleaf Evergreen Large	15,878	430 (N/A)	0.2	0.4	143.43
Conifer Evergreen Medium	1,767	48 (N/A)	0.2	0.0	15.96
Blue spruce	3,844	104 (N/A)	0.2	0.1	34.72
White oak	3,539	96 (N/A)	0.2	0.1	31.97
Swamp white oak	338	9 (N/A)	0.2	0.0	3.05
Lilac	145	4 (N/A)	0.2	0.0	1.31
Callery pear	2,158	58 (N/A)	0.2	0.1	19.49
Eastern cottonwood	12,729	345 (N/A)	0.2	0.4	172.48
Maple	149	4 (N/A)	0.2	0.0	2.02
Red pine	1,191	32 (N/A)	0.2	0.0	16.14
Austrian pine	3,857	105 (N/A)	0.2	0.1	52.26
Birch	3,065	83 (N/A)	0.2	0.1	41.53
Pear	931	25 (N/A)	0.2	0.0	12.62
Ohio buckeye	3,927	106 (N/A)	0.2	0.1	53.21
Elm	14,478	392 (N/A)	0.2	0.4	196.17
Broadleaf Deciduous Medium	586	16 (N/A)	0.1	0.0	15.88
White ash	163	4 (N/A)	0.1	0.0	4.43
Black locust	2,479	67 (N/A)	0.1	0.1	67.19
Cherry plum	69	2 (N/A)	0.1	0.0	1.86
Flowering dogwood	69	2 (N/A)	0.1	0.0	1.86
Quaking aspen	608	16 (N/A)	0.1	0.0	16.47
Broadleaf Evergreen Medium	155	4 (N/A)	0.1	0.0	4.21
Plum	69	2 (N/A)	0.1	0.0	1.86
Black poplar	3,943	107 (N/A)	0.1	0.1	106.85
Citywide total	3,628,790	98,340 (N/A)	100.0	100.0	74.16

Table 3: Annual Air Quality Benefits

Knoxville

Annual Air Quality Benefits of Public Trees

3/27/2020

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	98.9	16.8	48.5	4.4	533	286.1	41.8	39.9	274.0	1,788	-77.3	-290	733.2	2,032 (N/A)	15.6	9.82
Silver maple	153.6	26.0	75.5	6.8	828	298.4	43.7	41.8	286.9	1,869	-82.1	-308	850.7	2,389 (N/A)	15.5	11.60
Apple	6.1	1.0	3.0	0.3	33	30.8	4.4	4.2	28.2	189	0.0	0	78.0	222 (N/A)	7.2	2.34
Norway maple	27.3	4.7	13.7	1.2	148	85.5	12.4	11.8	80.8	532	-6.6	-25	230.9	655 (N/A)	6.2	7.99
Red maple	17.8	3.0	8.6	0.8	96	57.8	8.5	8.1	55.9	363	-6.4	-24	154.1	434 (N/A)	4.5	7.24
Black maple	37.3	6.4	17.2	1.7	198	75.9	11.1	10.5	72.1	473	-12.3	-46	219.8	625 (N/A)	4.5	10.42
Siberian elm	35.5	6.0	17.0	1.6	190	81.0	11.8	11.3	77.6	507	0.0	0	241.8	697 (N/A)	3.8	13.93
Ash	21.1	3.6	10.4	0.9	114	54.3	7.9	7.5	50.9	337	-5.0	-19	151.7	432 (N/A)	3.2	10.05
Green ash	16.9	2.7	7.9	0.8	90	52.4	7.6	7.3	50.0	327	0.0	0	145.6	417 (N/A)	3.2	9.92
Honeylocust	25.3	4.2	11.5	1.2	134	56.0	8.2	7.8	53.9	351	-19.6	-73	148.5	411 (N/A)	2.8	11.10
Pin oak	24.2	4.2	12.3	1.1	132	55.0	8.0	7.7	52.7	344	-44.8	-168	120.6	309 (N/A)	2.6	9.07
Norway spruce	10.0	2.0	8.2	1.2	66	20.4	3.0	2.9	19.7	128	-44.9	-168	22.5	26 (N/A)	2.3	0.83
American sycamore	30.1	4.8	13.3	1.3	157	57.3	8.3	8.0	54.5	357	0.0	0	177.6	514 (N/A)	2.3	16.58
Northern hackberry	16.4	2.8	8.3	0.7	89	48.1	7.0	6.7	45.6	300	0.0	0	135.7	389 (N/A)	2.2	13.41
Northern red oak	8.4	1.5	4.2	0.4	46	21.4	3.1	3.0	20.3	133	-12.1	-45	50.2	134 (N/A)	2.0	4.95
Eastern red cedar	7.7	1.5	6.1	1.0	50	12.7	1.8	1.7	11.8	79	-21.0	-79	23.5	50 (N/A)	2.0	1.93
Eastern redbud	2.1	0.3	1.0	0.1	11	8.2	1.2	1.1	7.4	50	0.0	0	21.4	61 (N/A)	1.6	2.91
Eastern white pine	4.0	0.8	3.3	0.5	26	10.7	1.6	1.5	10.5	68	-16.0	-60	16.9	34 (N/A)	1.6	1.62
Northern pin oak	10.2	1.8	4.9	0.5	55	20.6	3.0	2.8	19.1	127	-2.3	-9	60.6	173 (N/A)	1.3	10.21
American basswood	11.0	1.9	5.2	0.5	59	25.7	3.7	3.5	24.0	159	-9.0	-34	66.5	184 (N/A)	1.1	12.27
Black walnut	6.1	1.0	2.9	0.3	33	19.5	2.8	2.7	18.5	122	0.0	0	53.9	154 (N/A)	1.1	11.01
Spruce	2.4	0.5	2.1	0.3	16	7.7	1.1	1.1	7.5	48	-8.4	-32	14.3	33 (N/A)	1.1	2.37
Black cherry	1.7	0.3	0.8	0.1	9	5.6	0.8	0.8	5.3	35	0.0	0	15.3	44 (N/A)	0.7	4.87
Hickory	1.5	0.2	0.8	0.1	8	7.8	1.1	1.1	7.5	49	0.0	0	20.1	57 (N/A)	0.6	7.13
Southern magnolia	0.6	0.1	0.7	0.1	4	4.6	0.7	0.6	4.4	29	-2.3	-9	9.4	24 (N/A)	0.6	3.05
Littleleaf linden	1.8	0.3	0.9	0.1	10	6.4	0.9	0.9	6.1	40	-0.9	-3	16.4	46 (N/A)	0.6	5.75
Tulip tree	6.4	1.0	2.8	0.3	33	12.0	1.7	1.7	11.4	75	0.0	0	37.4	108 (N/A)	0.6	13.53
Scotch pine	2.4	0.5	1.9	0.3	16	5.0	0.7	0.7	4.9	31	-10.8	-40	5.6	7 (N/A)	0.5	0.94
Mulberry	1.4	0.2	0.6	0.1	7	4.5	0.6	0.6	4.2	28	0.0	0	12.2	35 (N/A)	0.5	5.00
American elm	6.0	1.0	2.8	0.3	32	10.6	1.6	1.5	10.3	67	0.0	0	34.0	99 (N/A)	0.5	16.44
Broadleaf Deciduous Large	0.5	0.1	0.3	0.0	3	2.3	0.3	0.3	2.2	15	0.0	0	6.1	17 (N/A)	0.5	2.90
Ginkgo	1.5	0.3	0.8	0.1	8	4.3	0.6	0.6	4.1	27	-0.5	-2	11.7	33 (N/A)	0.5	5.52
Catalpa	3.1	0.5	1.4	0.1	16	7.2	1.0	1.0	6.8	45	0.0	0	21.1	61 (N/A)	0.4	12.15
Willow	0.2	0.0	0.2	0.0	1	2.3	0.3	0.3	2.1	14	-0.1	0	5.4	15 (N/A)	0.4	3.02
River birch	1.1	0.2	0.6	0.0	6	3.6	0.5	0.5	3.4	22	-0.3	-1	9.6	27 (N/A)	0.4	5.48
Bur oak	1.4	0.2	0.7	0.1	8	5.4	0.8	0.8	5.2	34	0.0	0	14.6	42 (N/A)	0.4	8.32
Broadleaf Deciduous Small	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.2	2	0.0	0	0.6	2 (N/A)	0.4	0.35
Cottonwood	0.7	0.1	0.4	0.0	4	4.5	0.7	0.6	4.3	28	0.0	0	11.3	32 (N/A)	0.4	6.42
Japanese tree lilac	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)	0.3	0.72
Conifer Evergreen Large	1.0	0.2	0.8	0.1	6	2.3	0.3	0.3	2.3	15	-4.1	-15	3.2	6 (N/A)	0.3	1.39
Sweetgum	1.2	0.2	0.6	0.1	6	5.3	0.8	0.7	5.1	33	0.0	0	14.0	40 (N/A)	0.3	9.95
Boxelder	1.1	0.2	0.5	0.1	6	3.5	0.5	0.5	3.3	22	-0.5	-2	9.3	26 (N/A)	0.2	8.72
Broadleaf Evergreen Large	2.9	0.6	2.3	0.4	19	4.6	0.7	0.6	4.4	29	-7.4	-28	9.0	20 (N/A)	0.2	6.54
Conifer Evergreen Medium	0.2	0.0	0.2	0.0	1	0.8	0.1	0.1	0.7	5	-0.5	-2	1.5	4 (N/A)	0.2	1.27
Blue spruce	0.5	0.1	0.4	0.1	3	1.5	0.2	0.2	1.4	9	-1.3	-5	3.0	7 (N/A)	0.2	2.44
White oak	0.2	0.0	0.2	0.0	1	2.6	0.4	0.4	2.6	16	0.0	0	6.4	18 (N/A)	0.2	5.95
Swamp white oak	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.4	2	0.0	0	0.9	3 (N/A)	0.2	0.85
Lilac	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.5	2 (N/A)	0.2	0.51
Callery pear	0.3	0.0	0.2	0.0	2	1.8	0.3	0.3	1.7	11	-0.1	0	4.5	13 (N/A)	0.2	4.20
Eastern 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)	0.2	17.37
Maple	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.4	1 (N/A)	0.2	0.62
Red pine	0.1	0.0	0.1	0.0	1	0.6	0.1	0.1	0.5	3	-0.3	-1	1.1	3 (N/A)	0.2	1.48
Austrian pine	0.5	0.1	0.4	0.1	4	1.2	0.2	0.2	1.2	8	-1.4	-5	2.5	6 (N/A)	0.2	2.99
Birch	0.5	0.1	0.3	0.0	3	1.8	0.3	0.2	1.7	11	-0.1	-1	4.8	14 (N/A)	0.2	6.81
Pear	0.3	0.0	0.1	0.0	1	1.3	0.2	0.2	1.2	8	0.0	0	3.2	9 (N/A)	0.2	4.55
Ohio buckeye	0.9	0.2	0.4	0.0	5	1.8	0.3	0.2	1.6	11	-0.2	-1	5.2	15 (N/A)	0.2	7.40
Elm	3.2	0.5	1.4	0.1	16	4.6	0.7	0.6	4.4	29	0.0	0	15.5	45 (N/A)	0.2	22.55
Broadleaf Deciduous Medium	0.1	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	0.0	0	1.2	3 (N/A)	0.1	3.47
White ash	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.1	1	0.0	0	0.4	1 (N/A)	0.1	0.99
Black locust	0.5	0.1	0.2	0.0	3	1.3	0.2	0.2	1.2	8	-0.1	0	3.6	10 (N/A)	0.1	10.16
Cherry plum	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.3	1 (N/A)	0.1	0.71
Flowering dogwood	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.3	1 (N/A)	0.1	0.71
Quaking aspen	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)	0.1	2.99
Broadleaf Evergreen Medium	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.4	1 (N/A)	0.1	1.05
Plum	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.3	1 (N/A)	0.1	0.71
Black poplar	0.5	0.1	0.2	0.0	3	1.6	0.2	0.2	1.5	10	0.0	0	4.4	12 (N/A)	0.1	12.48
Citywide total	618.9	105.5	310.2	30.1	3,362	1,515.3	221.2	211.0	1,445.4	9,458	-398.8	-1,495	4,058.7	11,325 (N/A)	100.0	8.54

Table 4: Annual Carbon Stored

Knoxville

Stored CO2 Benefits of Public Trees

3/27/2020

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	2,890,250	21,677	(N/A)	15.6	20.6	104.72
Silver maple	3,612,331	27,092	(N/A)	15.5	25.8	131.52
Apple	101,447	761	(N/A)	7.2	0.7	8.01
Norway maple	452,507	3,394	(N/A)	6.2	3.2	41.39
Red maple	200,498	1,504	(N/A)	4.5	1.4	25.06
Black maple	399,283	2,995	(N/A)	4.5	2.9	49.91
Siberian elm	865,700	6,493	(N/A)	3.8	6.2	129.85
Ash	347,292	2,605	(N/A)	3.2	2.5	60.57
Green ash	568,249	4,262	(N/A)	3.2	4.1	101.47
Honeylocust	324,726	2,435	(N/A)	2.8	2.3	65.82
Pin oak	645,751	4,843	(N/A)	2.6	4.6	142.44
Norway spruce	112,290	842	(N/A)	2.3	0.8	27.17
American sycamore	1,020,911	7,657	(N/A)	2.3	7.3	246.99
Northern hackberry	258,668	1,940	(N/A)	2.2	1.8	66.90
Northern red oak	179,132	1,343	(N/A)	2.0	1.3	49.76
Eastern red cedar	25,120	188	(N/A)	2.0	0.2	7.25
Eastern redbud	34,168	256	(N/A)	1.6	0.2	12.20
Eastern white pine	37,986	285	(N/A)	1.6	0.3	13.57
Northern pin oak	168,872	1,267	(N/A)	1.3	1.2	74.50
American basswood	416,665	3,125	(N/A)	1.1	3.0	208.33
Black walnut	204,212	1,532	(N/A)	1.1	1.5	109.40
Spruce	18,683	140	(N/A)	1.1	0.1	10.01
Black cherry	25,839	194	(N/A)	0.7	0.2	21.53
Hickory	48,860	366	(N/A)	0.6	0.3	45.81
Southern magnolia	9,215	69	(N/A)	0.6	0.1	8.64
Littleleaf linden	38,036	285	(N/A)	0.6	0.3	35.66
Tulip tree	218,906	1,642	(N/A)	0.6	1.6	205.22
Scotch pine	27,152	204	(N/A)	0.5	0.2	29.09
Mulberry	21,389	160	(N/A)	0.5	0.2	22.92
American elm	117,717	883	(N/A)	0.5	0.8	147.15
Broadleaf Deciduous	17,203	129	(N/A)	0.5	0.1	21.50
Ginkgo	22,069	166	(N/A)	0.5	0.2	27.59
Catalpa	102,933	772	(N/A)	0.4	0.7	154.40
Willow	4,621	35	(N/A)	0.4	0.0	6.93
River birch	18,109	136	(N/A)	0.4	0.1	27.16
Bur oak	47,457	356	(N/A)	0.4	0.3	71.19
Broadleaf Deciduous	397	3	(N/A)	0.4	0.0	0.60
Cottonwood	22,656	170	(N/A)	0.4	0.2	33.98
Japanese tree lilac	949	7	(N/A)	0.3	0.0	1.78
Conifer Evergreen La	10,087	76	(N/A)	0.3	0.1	18.91
Sweetgum	38,889	292	(N/A)	0.3	0.3	72.92
Boxelder	36,506	274	(N/A)	0.2	0.3	91.26
Broadleaf Evergreen l	30,490	229	(N/A)	0.2	0.2	76.23
Conifer Evergreen Mi	611	5	(N/A)	0.2	0.0	1.53
Blue spruce	2,521	19	(N/A)	0.2	0.0	6.30
White oak	8,378	63	(N/A)	0.2	0.1	20.95
Swamp white oak	454	3	(N/A)	0.2	0.0	1.13
Lilac	369	3	(N/A)	0.2	0.0	0.92
Callery pear	4,943	37	(N/A)	0.2	0.0	12.36
Eastern cottonwood	65,202	489	(N/A)	0.2	0.5	244.51
Maple	235	2	(N/A)	0.2	0.0	0.88
Red pine	513	4	(N/A)	0.2	0.0	1.93
Austrian pine	3,779	28	(N/A)	0.2	0.0	14.17
Birch	9,046	68	(N/A)	0.2	0.1	33.92
Pear	3,945	30	(N/A)	0.2	0.0	14.79
Ohio buckeye	14,499	109	(N/A)	0.2	0.1	54.37
Elm	111,964	840	(N/A)	0.2	0.8	419.86
Broadleaf Deciduous	1,101	8	(N/A)	0.1	0.0	8.26
White ash	185	1	(N/A)	0.1	0.0	1.39
Black locust	7,945	60	(N/A)	0.1	0.1	59.59
Cherry plum	178	1	(N/A)	0.1	0.0	1.33
Flowering dogwood	178	1	(N/A)	0.1	0.0	1.33
Quaking aspen	1,035	8	(N/A)	0.1	0.0	7.76
Broadleaf Evergreen l	73	1	(N/A)	0.1	0.0	0.55
Plum	178	1	(N/A)	0.1	0.0	1.33
Black poplar	15,773	118	(N/A)	0.1	0.1	118.30
Citywide total	13,997,328	104,980	(N/A)	100.0	100.0	79.17

Table 5: Annual Carbon Sequestered

Knoxville

Annual CO Benefits of Public Trees

3/27/2020

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	140,673	1,055	-13,875	-655	-109	101,476	761	227,619	1,707	(N/A)	15.6	18.5	8.25
Silver maple	263,898	1,979	-17,346	-698	-135	106,361	798	352,214	2,642	(N/A)	15.5	28.6	12.82
Apple	10,220	77	-488	-92	-4	10,441	78	20,082	151	(N/A)	7.2	1.6	1.59
Norway maple	26,286	197	-2,174	-176	-18	29,861	224	53,797	403	(N/A)	6.2	4.4	4.92
Red maple	24,938	187	-962	-105	-8	20,686	155	44,556	334	(N/A)	4.5	3.6	5.57
Black maple	12,122	91	-1,917	-148	-15	26,700	200	36,757	276	(N/A)	4.5	3.0	4.59
Siberian elm	32,798	246	-4,155	-185	-33	28,733	215	57,190	429	(N/A)	3.8	4.6	8.58
Ash	14,488	109	-1,667	-118	-13	18,825	141	31,528	236	(N/A)	3.2	2.6	5.50
Green ash	23,225	174	-2,728	-117	-21	18,512	139	38,893	292	(N/A)	3.2	3.2	6.95
Honeylocust	30,800	231	-1,559	-92	-12	19,961	150	49,111	368	(N/A)	2.8	4.0	9.95
Pin oak	57,505	431	-3,100	-123	-24	19,531	146	73,813	554	(N/A)	2.6	6.0	16.28
Norway spruce	3,711	28	-539	-85	-5	7,285	55	10,371	78	(N/A)	2.3	0.8	2.51
American sycamore	23,716	178	-4,900	-138	-38	20,165	151	38,842	291	(N/A)	2.3	3.2	9.40
Northern hackberry	12,161	91	-1,242	-94	-10	16,865	126	27,690	208	(N/A)	2.2	2.2	7.16
Northern red oak	3,692	28	-860	-57	-7	7,522	56	10,297	77	(N/A)	2.0	0.8	2.86
Eastern red cedar	433	3	-121	-47	-1	4,383	33	4,648	35	(N/A)	2.0	0.4	1.34
Eastern redbud	3,039	23	-164	-24	-1	2,754	21	5,605	42	(N/A)	1.6	0.5	2.00
Eastern white pine	1,839	14	-182	-40	-2	3,898	29	5,515	41	(N/A)	1.6	0.4	1.97
Northern pin oak	2,239	17	-811	-53	-6	7,072	53	8,447	63	(N/A)	1.3	0.7	3.73
American basswood	22,222	167	-2,000	-65	-15	8,891	67	29,048	218	(N/A)	1.1	2.4	14.52
Black walnut	9,002	68	-980	-43	-8	6,859	51	14,838	111	(N/A)	1.1	1.2	7.95
Spruce	1,601	12	-90	-27	-1	2,790	21	4,274	32	(N/A)	1.1	0.3	2.29
Black cherry	1,604	12	-124	-15	-1	1,952	15	3,417	26	(N/A)	0.7	0.3	2.85
Hickory	3,875	29	-235	-17	-2	2,759	21	6,383	48	(N/A)	0.6	0.5	5.98
Southern magnolia	691	5	-44	-10	0	1,652	12	2,289	17	(N/A)	0.6	0.2	2.15
Littleleaf linden	2,924	22	-183	-16	-1	2,252	17	4,977	37	(N/A)	0.6	0.4	4.67
Tulip tree	4,651	35	-1,051	-29	-8	4,221	32	7,792	58	(N/A)	0.6	0.6	7.31
Scotch pine	1,230	9	-130	-18	-1	1,799	13	2,881	22	(N/A)	0.5	0.2	3.09
Mulberry	772	6	-103	-13	-1	1,540	12	2,196	16	(N/A)	0.5	0.2	2.35
American elm	2,735	21	-566	-22	-4	3,816	29	5,964	45	(N/A)	0.5	0.5	7.46
Broadleaf Deciduous Large	1,219	9	-83	-6	-1	817	6	1,947	15	(N/A)	0.5	0.2	2.43
Ginkgo	1,058	8	-106	-13	-1	1,511	11	2,450	18	(N/A)	0.5	0.2	3.06

Catalpa	3,415	26	-494	-17	-4	2,511	19	5,415	41 (N/A)	0.4	0.4	8.12
Willow	991	7	-23	-5	0	768	6	1,731	13 (N/A)	0.4	0.1	2.60
River birch	1,393	10	-87	-8	-1	1,239	9	2,537	19 (N/A)	0.4	0.2	3.81
Bur oak	2,679	20	-228	-12	-2	1,913	14	4,352	33 (N/A)	0.4	0.4	6.53
Broadleaf Deciduous Smal	102	1	-2	-2	0	91	1	189	1 (N/A)	0.4	0.0	0.28
Cottonwood	2,182	16	-109	-10	-1	1,593	12	3,657	27 (N/A)	0.4	0.3	5.49
Japanese tree lilac	140	1	-5	-2	0	141	1	274	2 (N/A)	0.3	0.0	0.51
Conifer Evergreen Large	540	4	-48	-9	0	838	6	1,321	10 (N/A)	0.3	0.1	2.48
Sweetgum	2,604	20	-187	-11	-1	1,890	14	4,297	32 (N/A)	0.3	0.3	8.06
Boxelder	2,771	21	-175	-10	-1	1,232	9	3,818	29 (N/A)	0.2	0.3	9.54
Broadleaf Evergreen Large	12	0	-146	-9	-1	1,634	12	1,492	11 (N/A)	0.2	0.1	3.73
Conifer Evergreen Medium	89	1	-3	-3	0	261	2	344	3 (N/A)	0.2	0.0	0.86
Blue spruce	220	2	-12	-5	0	532	4	735	6 (N/A)	0.2	0.1	1.84
White oak	1,099	8	-40	-5	0	944	7	1,999	15 (N/A)	0.2	0.2	5.00
Swamp white oak	197	1	-4	-1	0	136	1	328	2 (N/A)	0.2	0.0	0.82
Lilac	85	1	-2	-1	0	80	1	161	1 (N/A)	0.2	0.0	0.40
Callery pear	706	5	-24	-4	0	635	5	1,313	10 (N/A)	0.2	0.1	3.28
Eastern cottonwood	1,872	14	-313	-9	-2	1,384	10	2,934	22 (N/A)	0.2	0.2	11.00
Maple	42	0	-1	-1	0	67	1	107	1 (N/A)	0.2	0.0	0.40
Red pine	105	1	-2	-2	0	189	1	289	2 (N/A)	0.2	0.0	1.08
Austrian pine	238	2	-18	-5	0	445	3	660	5 (N/A)	0.2	0.1	2.48
Birch	694	5	-43	-4	0	616	5	1,262	9 (N/A)	0.2	0.1	4.73
Pear	382	3	-19	-3	0	433	3	792	6 (N/A)	0.2	0.1	2.97
Ohio buckeye	96	1	-70	-5	-1	603	5	624	5 (N/A)	0.2	0.1	2.34
Elm	958	7	-537	-12	-4	1,626	12	2,034	15 (N/A)	0.2	0.2	7.63
Broadleaf Deciduous Medi	224	2	-5	-1	0	176	1	393	3 (N/A)	0.1	0.0	2.95
White ash	65	0	-1	-1	0	55	0	119	1 (N/A)	0.1	0.0	0.89
Black locust	470	4	-38	-3	0	440	3	869	7 (N/A)	0.1	0.1	6.52
Cherry plum	38	0	-1	-1	0	37	0	74	1 (N/A)	0.1	0.0	0.55
Flowering dogwood	38	0	-1	-1	0	37	0	74	1 (N/A)	0.1	0.0	0.55
Quaking aspen	209	2	-5	-1	0	159	1	361	3 (N/A)	0.1	0.0	2.71
Broadleaf Evergreen Medi	16	0	0	-1	0	59	0	74	1 (N/A)	0.1	0.0	0.55
Plum	38	0	-1	-1	0	37	0	74	1 (N/A)	0.1	0.0	0.55
Black poplar	857	6	-76	-4	-1	552	4	1,330	10 (N/A)	0.1	0.1	9.97

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
Citywide total	766,931	5,752	-67,206	-3,509	-530	535,246	4,014	1,231,463	9,236	(N/A)	100.0	100.0	6.97

Table 6: Annual Social and Aesthetic Benefits

Knoxville

Annual Aesthetic/Other Benefits of Public Trees

3/27/2020

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	14,314	(N/A)	15.6	19.6	69.15
Silver maple	20,581	(N/A)	15.5	28.2	99.91
Apple	574	(N/A)	7.2	0.8	6.05
Norway maple	2,616	(N/A)	6.2	3.6	31.90
Red maple	3,401	(N/A)	4.5	4.7	56.68
Black maple	1,572	(N/A)	4.5	2.2	26.19
Siberian elm	2,226	(N/A)	3.8	3.0	44.53
Ash	1,379	(N/A)	3.2	1.9	32.08
Green ash	1,985	(N/A)	3.2	2.7	47.26
Honeylocust	7,455	(N/A)	2.8	10.2	201.49
Pin oak	4,311	(N/A)	2.6	5.9	126.80
Norway spruce	817	(N/A)	2.3	1.1	26.37
American sycamore	1,610	(N/A)	2.3	2.2	51.93
Northern hackberry	1,635	(N/A)	2.2	2.2	56.37
Northern red oak	330	(N/A)	2.0	0.5	12.24
Eastern red cedar	173	(N/A)	2.0	0.2	6.66
Eastern redbud	175	(N/A)	1.6	0.2	8.33
Eastern white pine	486	(N/A)	1.6	0.7	23.14
Northern pin oak	219	(N/A)	1.3	0.3	12.86
American basswood	1,463	(N/A)	1.1	2.0	97.51
Black walnut	746	(N/A)	1.1	1.0	53.30
Spruce	440	(N/A)	1.1	0.6	31.40
Black cherry	93	(N/A)	0.7	0.1	10.32
Hickory	360	(N/A)	0.6	0.5	44.98
Southern magnolia	174	(N/A)	0.6	0.2	21.75
Littleleaf linden	315	(N/A)	0.6	0.4	39.39
Tulip tree	325	(N/A)	0.6	0.4	40.60
Scotch pine	208	(N/A)	0.5	0.3	29.72
Mulberry	44	(N/A)	0.5	0.1	6.26
American elm	354	(N/A)	0.5	0.5	59.06
Broadleaf Deciduous Large	134	(N/A)	0.5	0.2	22.36
Ginkgo	83	(N/A)	0.5	0.1	13.76
Catalpa	255	(N/A)	0.4	0.3	50.94
Willow	118	(N/A)	0.4	0.2	23.55
River birch	141	(N/A)	0.4	0.2	28.26
Bur oak	235	(N/A)	0.4	0.3	47.03
Broadleaf Deciduous Small	4	(N/A)	0.4	0.0	0.84
Cottonwood	218	(N/A)	0.4	0.3	43.67
Japanese tree lilac	7	(N/A)	0.3	0.0	1.63
Conifer Evergreen Large	106	(N/A)	0.3	0.1	26.58
Sweetgum	223	(N/A)	0.3	0.3	55.72
Boxelder	182	(N/A)	0.2	0.2	60.83
Broadleaf Evergreen Large	8	(N/A)	0.2	0.0	2.78
Conifer Evergreen Medium	54	(N/A)	0.2	0.1	18.16
Blue spruce	72	(N/A)	0.2	0.1	23.85
White oak	120	(N/A)	0.2	0.2	40.09
Swamp white oak	29	(N/A)	0.2	0.0	9.50
Lilac	4	(N/A)	0.2	0.0	1.38

Callery pear	78 (N/A)	0.2	0.1	26.09
Eastern cottonwood	125 (N/A)	0.2	0.2	62.47
Maple	7 (N/A)	0.2	0.0	3.66
Red pine	31 (N/A)	0.2	0.0	15.42
Austrian pine	45 (N/A)	0.2	0.1	22.60
Birch	69 (N/A)	0.2	0.1	34.64
Pear	22 (N/A)	0.2	0.0	10.94
Ohio buckeye	13 (N/A)	0.2	0.0	6.44
Elm	57 (N/A)	0.2	0.1	28.57
Broadleaf Deciduous Medium	26 (N/A)	0.1	0.0	26.22
White ash	13 (N/A)	0.1	0.0	12.76
Black locust	43 (N/A)	0.1	0.1	43.05
Cherry plum	2 (N/A)	0.1	0.0	2.06
Flowering dogwood	2 (N/A)	0.1	0.0	2.06
Quaking aspen	29 (N/A)	0.1	0.0	28.56
Broadleaf Evergreen Medium	9 (N/A)	0.1	0.0	9.46
Plum	2 (N/A)	0.1	0.0	2.06
Black poplar	66 (N/A)	0.1	0.1	65.59
Citywide total	73,013 (N/A)	100.0	100.0	55.06

Table 7: Summary of Benefits in Dollars

Knoxville

Total Annual Benefits of Public Trees by Species ($)

3/27/2020

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Sugar maple	12,437	1,707	2,032	19,045	14,314	49,534	(N/A)	19.2
Silver maple	12,931	2,642	2,389	23,977	20,581	62,520	(N/A)	24.2
Apple	1,427	151	222	648	574	3,022	(N/A)	1.2
Norway maple	3,777	403	655	3,910	2,616	11,361	(N/A)	4.4
Red maple	2,474	334	434	2,316	3,401	8,959	(N/A)	3.5
Black maple	3,343	276	625	4,016	1,572	9,831	(N/A)	3.8
Siberian elm	3,521	429	697	5,273	2,226	12,145	(N/A)	4.7
Ash	2,424	236	432	2,811	1,379	7,283	(N/A)	2.8
Green ash	2,282	292	417	3,323	1,985	8,298	(N/A)	3.2
Honeylocust	2,423	368	411	3,518	7,455	14,176	(N/A)	5.5
Pin oak	2,388	554	309	3,620	4,311	11,182	(N/A)	4.3
Norway spruce	886	78	26	2,306	817	4,113	(N/A)	1.6
American sycamore	2,509	291	514	4,875	1,610	9,800	(N/A)	3.8
Northern hackberry	2,117	208	389	2,633	1,635	6,981	(N/A)	2.7
Northern red oak	946	77	134	1,122	330	2,609	(N/A)	1.0
Eastern red cedar	579	35	50	1,033	173	1,870	(N/A)	0.7
Eastern redbud	381	42	61	196	175	854	(N/A)	0.3
Eastern white pine	450	41	34	942	486	1,954	(N/A)	0.8
Northern pin oak	936	63	173	1,254	219	2,645	(N/A)	1.0
American basswood	1,151	218	184	1,959	1,463	4,974	(N/A)	1.9
Black walnut	856	111	154	1,236	746	3,104	(N/A)	1.2
Spruce	321	32	33	600	440	1,426	(N/A)	0.6
Black cherry	252	26	44	138	93	552	(N/A)	0.2
Hickory	343	48	57	406	360	1,214	(N/A)	0.5
Southern magnolia	196	17	24	229	174	641	(N/A)	0.2
Littleleaf linden	274	37	46	305	315	978	(N/A)	0.4
Tulip tree	525	58	108	994	325	2,010	(N/A)	0.8
Scotch pine	211	22	7	541	208	988	(N/A)	0.4
Mulberry	206	16	35	114	44	415	(N/A)	0.2
American elm	453	45	99	534	354	1,484	(N/A)	0.6
Broadleaf Deciduous La	104	15	17	134	134	404	(N/A)	0.2
Ginkgo	186	18	33	162	83	482	(N/A)	0.2
Catalpa	316	41	61	574	255	1,246	(N/A)	0.5
Willow	107	13	15	68	118	321	(N/A)	0.1
River birch	167	19	27	166	141	522	(N/A)	0.2
Bur oak	238	33	42	328	235	876	(N/A)	0.3
Broadleaf Deciduous Sn	13	1	2	4	4	25	(N/A)	0.0
Cottonwood	200	27	32	213	218	691	(N/A)	0.3
Japanese tree lilac	21	2	3	8	7	40	(N/A)	0.0
Conifer Evergreen Large	100	10	6	224	106	446	(N/A)	0.2
Sweetgum	230	32	40	293	223	818	(N/A)	0.3
Boxelder	157	29	26	228	182	622	(N/A)	0.2
Broadleaf Evergreen Lai	198	11	20	430	8	667	(N/A)	0.3
Conifer Evergreen Medi	37	3	4	48	54	145	(N/A)	0.1
Blue spruce	64	6	7	104	72	252	(N/A)	0.1
White oak	109	15	18	96	120	358	(N/A)	0.1
Swamp white oak	19	2	3	9	29	62	(N/A)	0.0
Lilac	12	1	2	4	4	22	(N/A)	0.0
Callery pear	80	10	13	58	78	239	(N/A)	0.1
Eastern cottonwood	173	22	35	345	125	700	(N/A)	0.3
Maple	9	1	1	4	7	22	(N/A)	0.0
Red pine	27	2	3	32	31	95	(N/A)	0.0
Austrian pine	54	5	6	105	45	215	(N/A)	0.1
Birch	83	9	14	83	69	259	(N/A)	0.1
Pear	56	6	9	25	22	118	(N/A)	0.0
Ohio buckeye	80	5	15	106	13	219	(N/A)	0.1
Elm	197	15	45	392	57	707	(N/A)	0.3
Broadleaf Deciduous Mi	24	3	3	16	26	73	(N/A)	0.0
White ash	7	1	1	4	13	26	(N/A)	0.0
Black locust	59	7	10	67	43	186	(N/A)	0.1
Cherry plum	5	1	1	2	2	11	(N/A)	0.0
Flowering dogwood	5	1	1	2	2	11	(N/A)	0.0
Quaking aspen	21	3	3	16	29	71	(N/A)	0.0
Broadleaf Evergreen Ma	8	1	1	4	9	23	(N/A)	0.0
Plum	5	1	1	2	2	11	(N/A)	0.0
Black poplar	71	10	12	107	66	266	(N/A)	0.1
Citywide Total	66,261	9,236	11,325	98,340	73,013	258,176	(N/A)	100.0

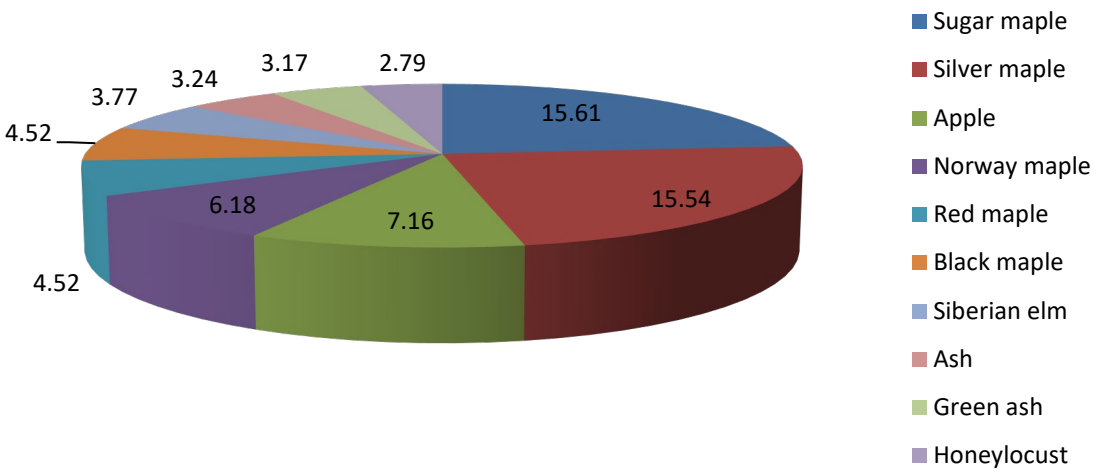

Figure 1: Species Distribution

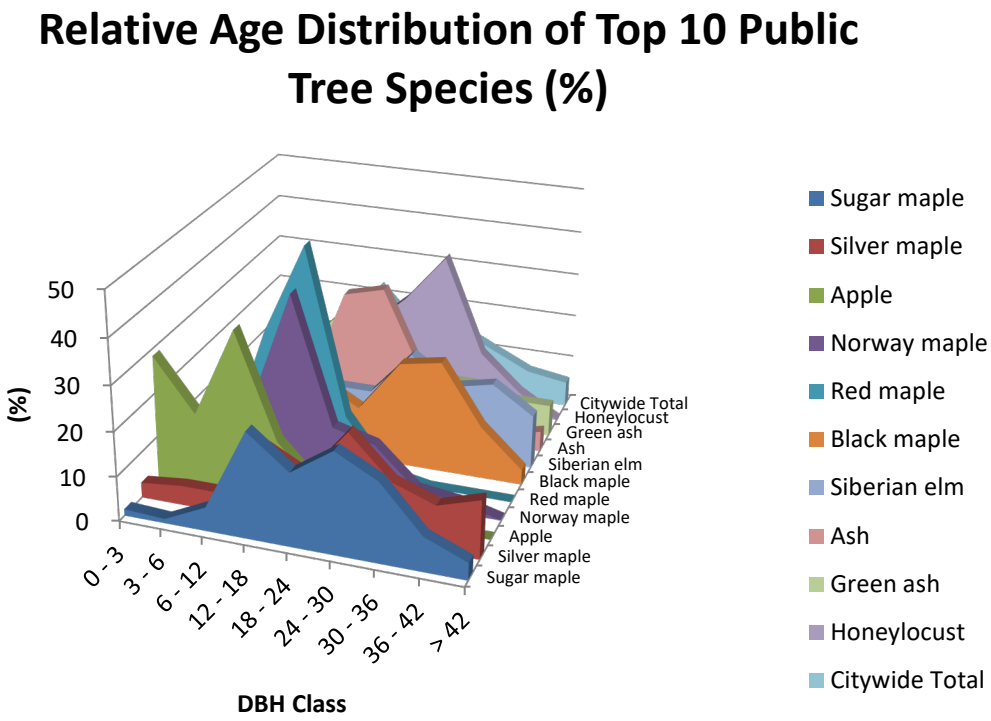

Figure 2: Relative Age Class

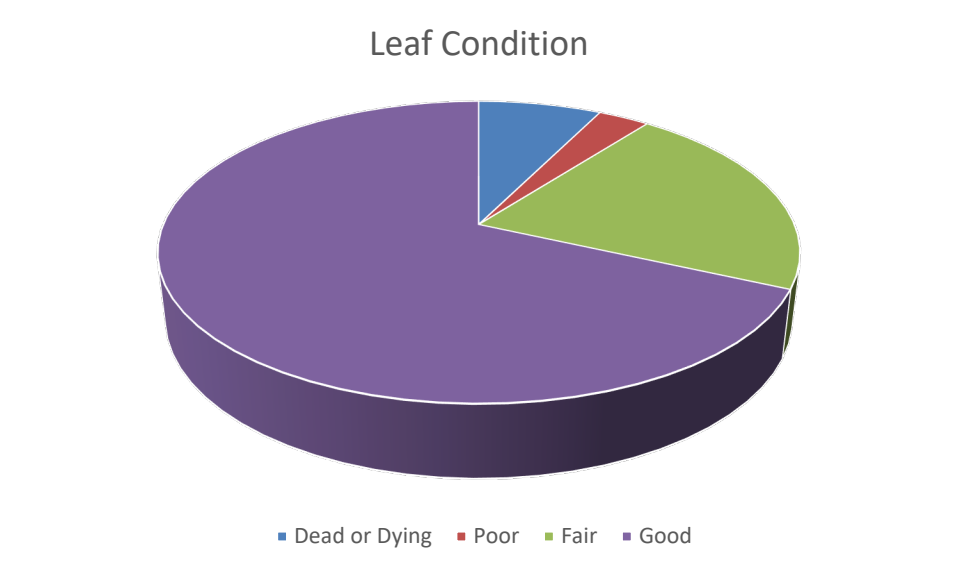

Figure 3: Foliage Condition

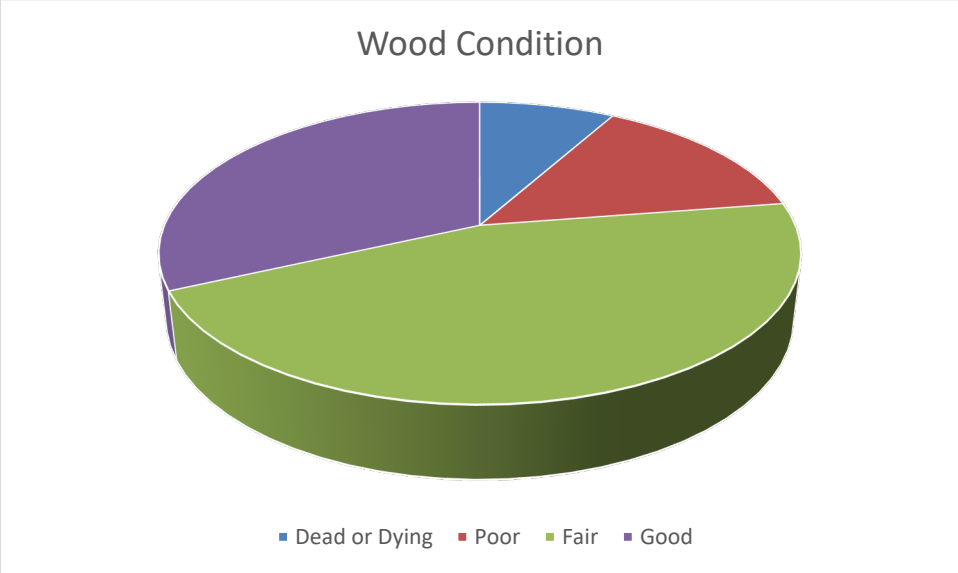

Figure 4: Wood Condition

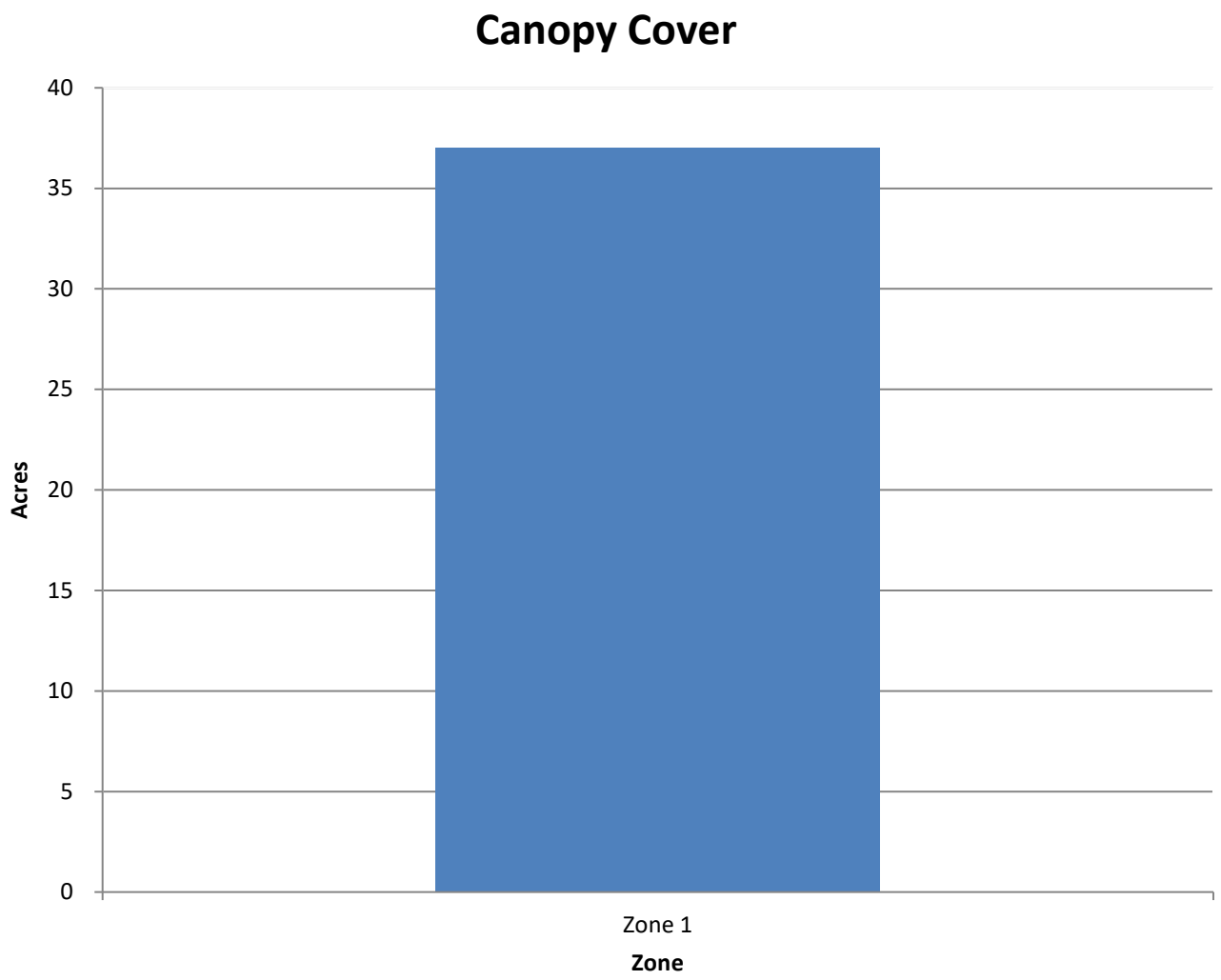

Figure 5: Canopy Cover in Acres

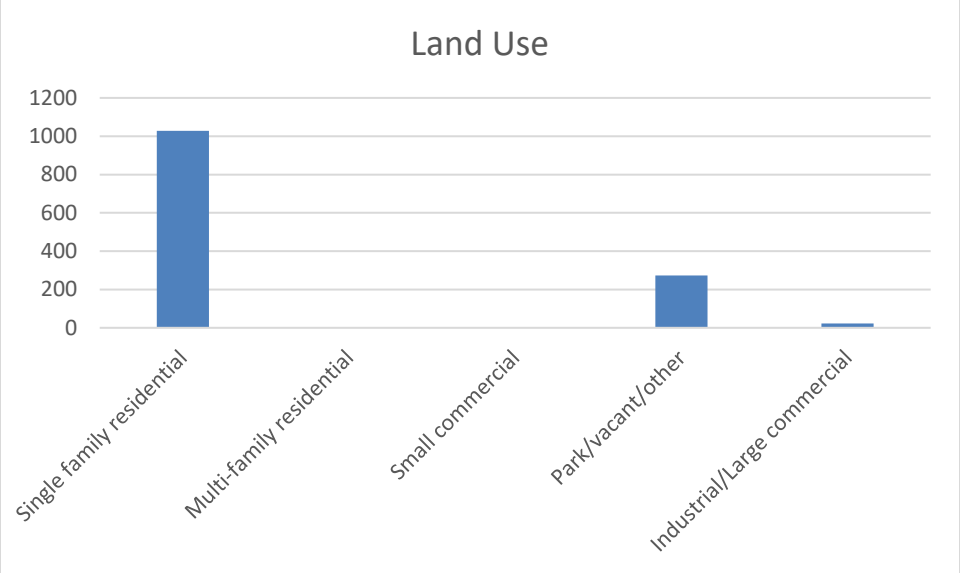

Figure 6: Land Use of city/park trees

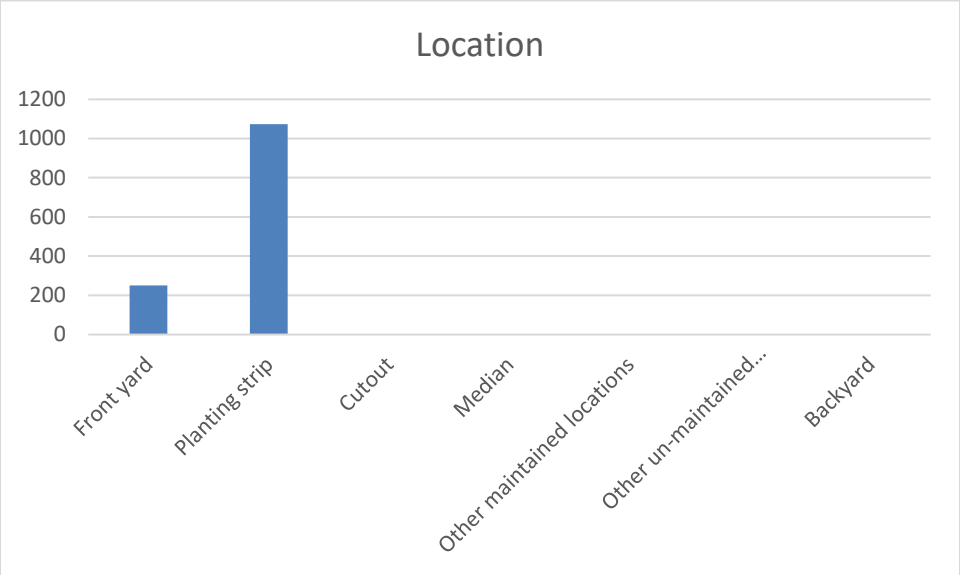

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

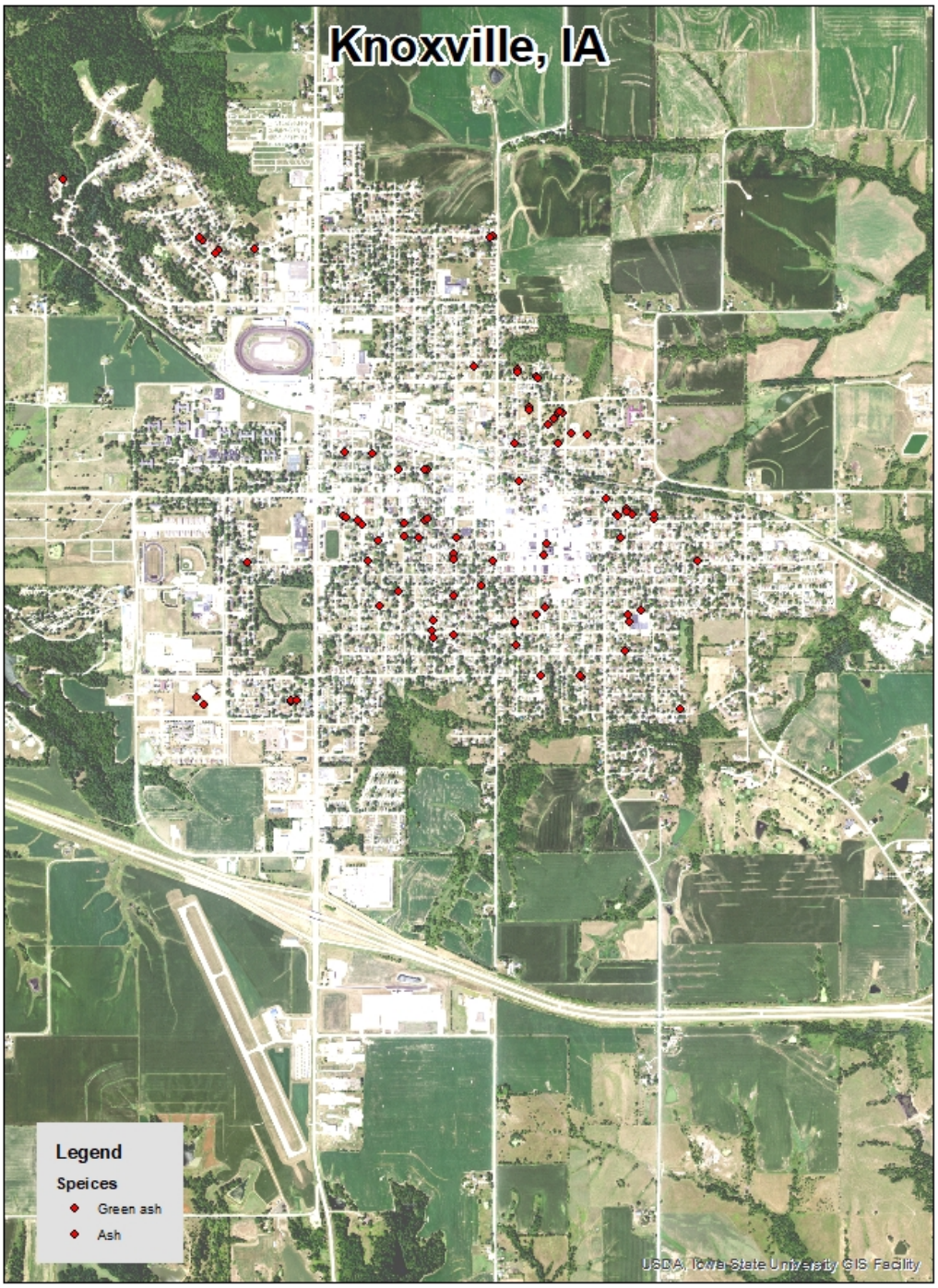

Figure 1: Location of Ash Trees

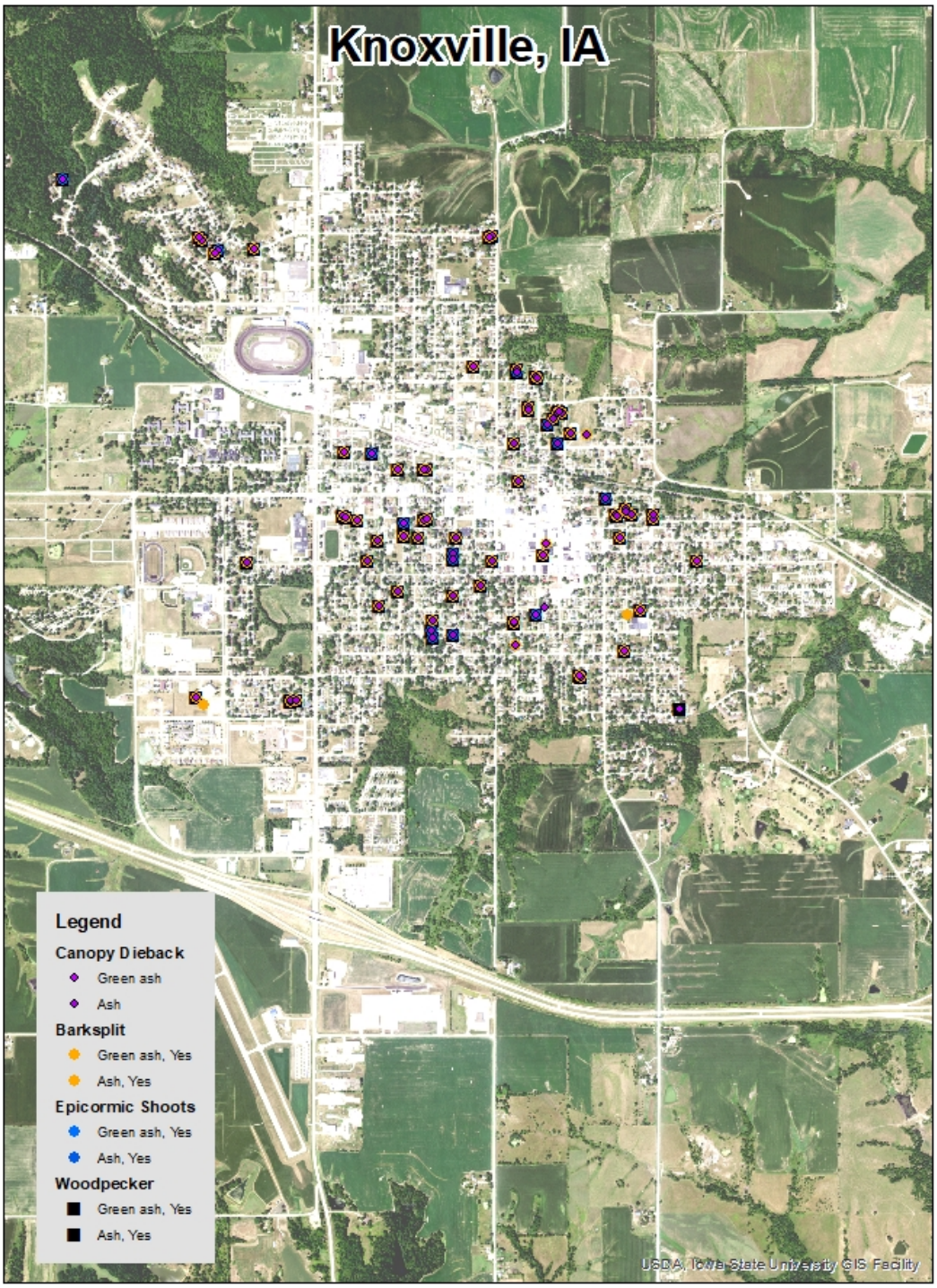

Figure 2: Location of EAB symptoms

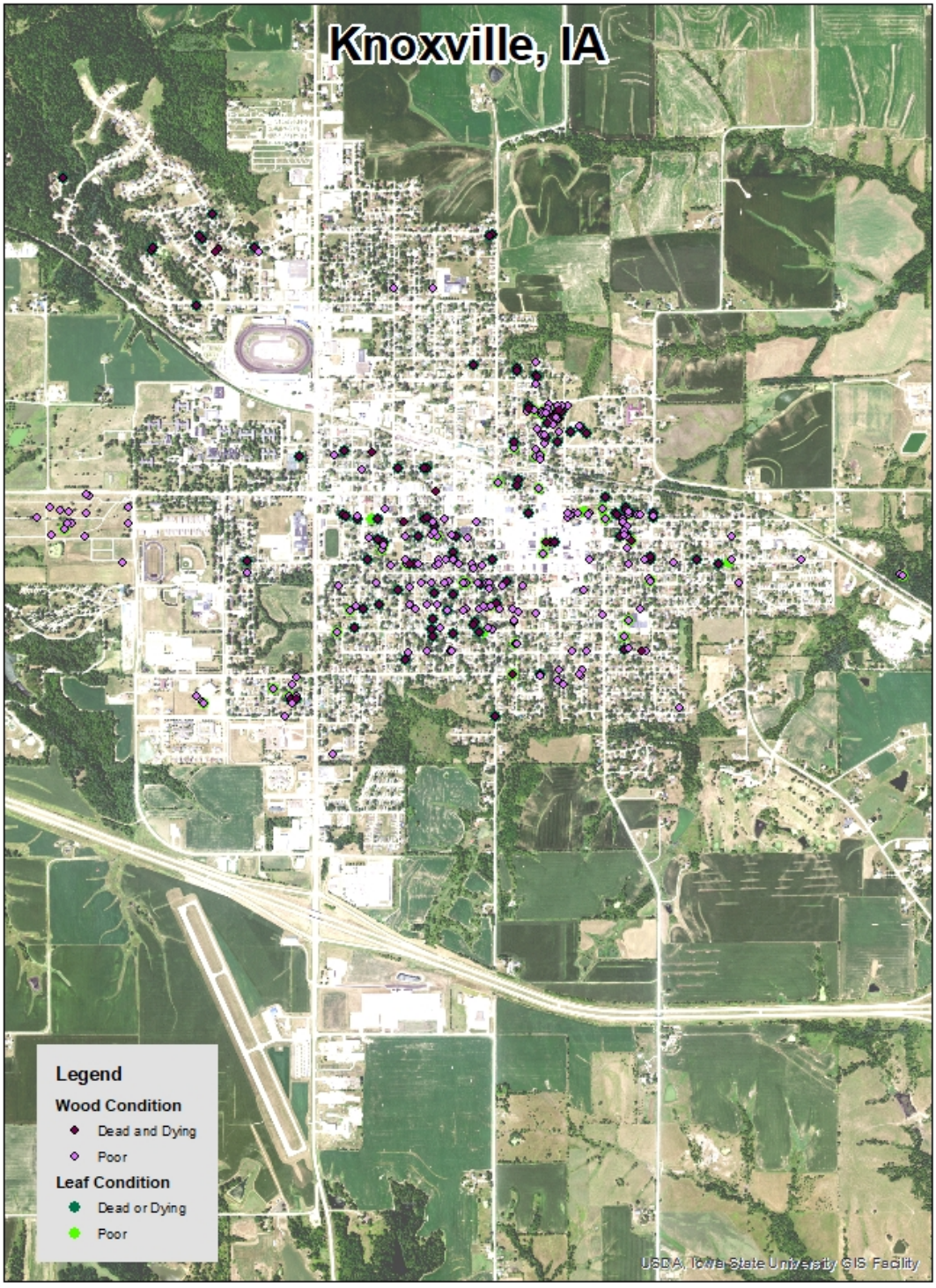

Figure 3: Location of Poor Condition Trees

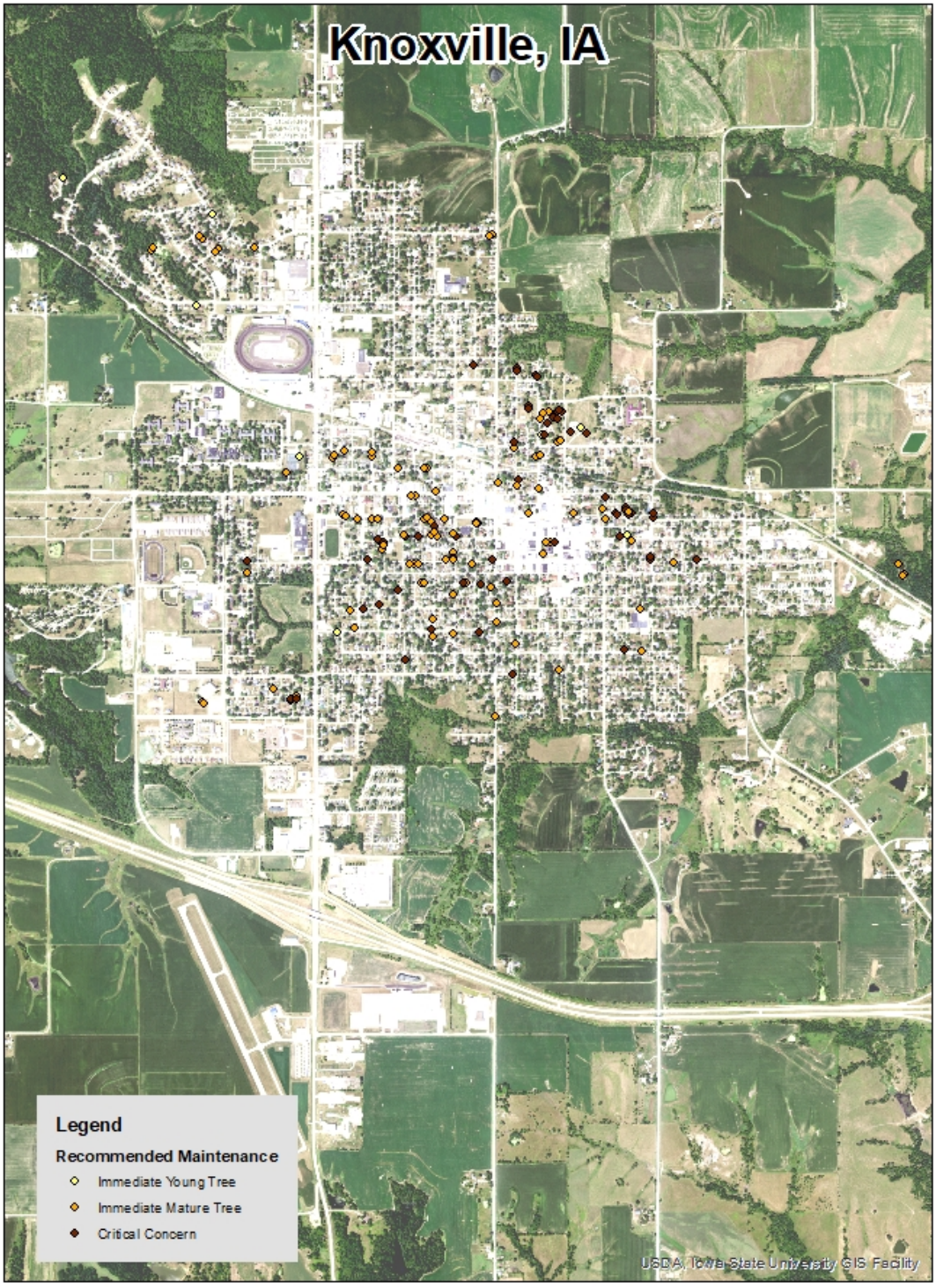

Figure 4: Location of Trees with Recommended Maintenance

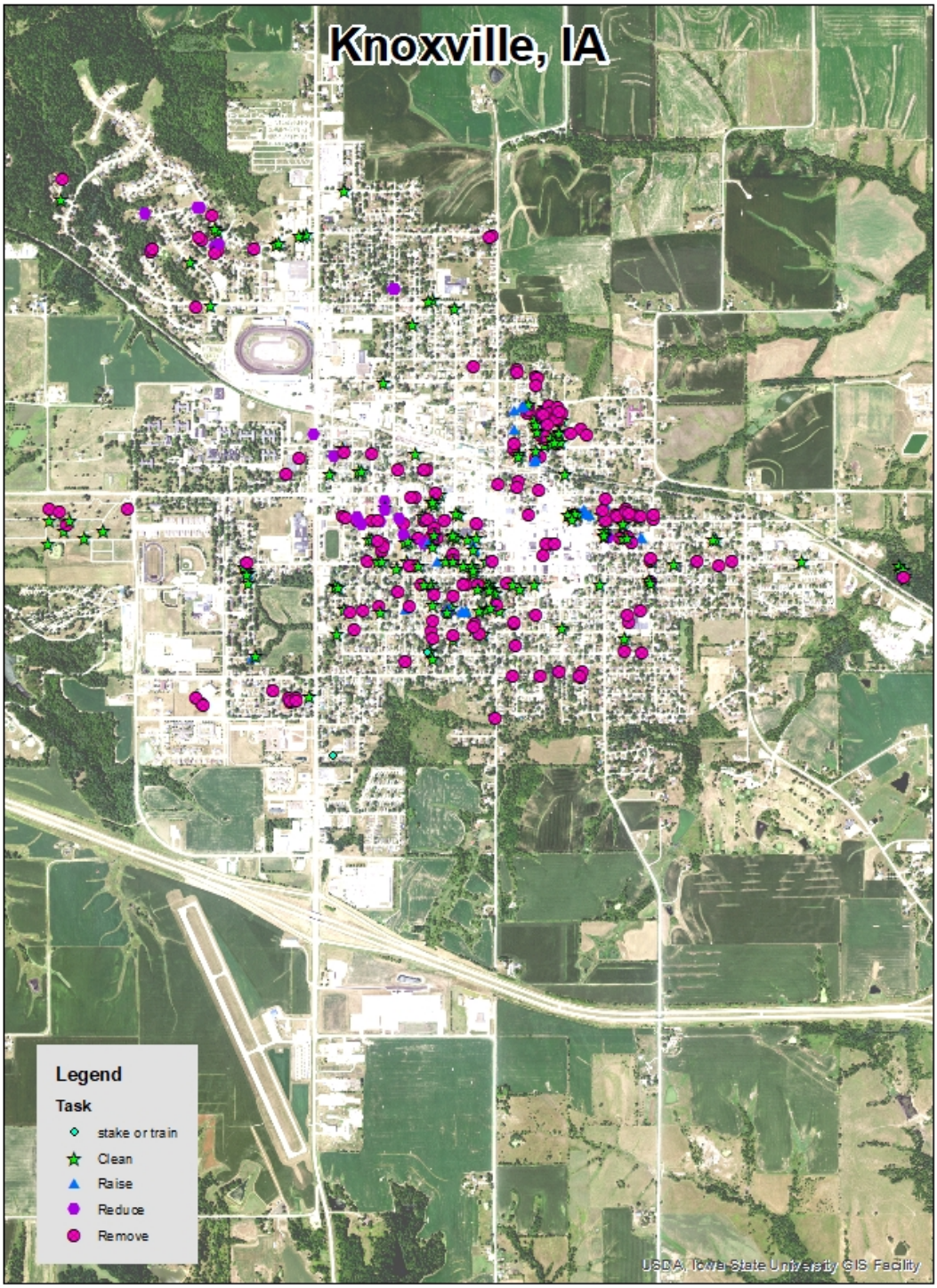

Figure 5: Maintenance Tasks *City ownership of the trees recommended for removal should be verified prior to any removal*

Appendix C: Knoxville Tree Ordinances

Chapter 6 Tree Planting and Trimming

7-6-1: PURPOSE:

The purpose of this chapter is to establish and maintain a healthy urban forest within the city. Rules for planting or removal, care and maintenance of trees are included to ensure proper treatment and to avoid interference with infrastructure on parking areas in Knoxville. (Ord. 08-07, 7-21-2008)

7-6-2: AUTHORITY:

The zoning and building administrator will have the authority to issue permits for planting of trees and other plantings on parking areas. The director of public works will have responsibility for removal of trees and plantings on parking areas. (Ord. 08-07, 7-21-2008)

7-6-3: TREE PLANTING PERMITS:

Before planting trees or shrubs on parking areas, a permit must be received by the zoning and building administrator for review. The applicant shall demonstrate that all plantings will be done in accordance with all the rules and regulations as set out in this chapter. The cost of a tree planting permit shall be one hundred dollars ($100.00) and the revenue collected from this permit fee shall be held in a perpetual care fund for the care and maintenance of the trees in the parking areas. These funds shall not be used to replace trees removed by the city or the property owner. (Ord. 08-07, 7-21-2008)

7-6-4: DEFINITIONS:

For purposes of this chapter the following definitions are adopted:

PARKING AREAS: Those parts of the street right of way not covered by sidewalk and lying between the lot line and the curb line.

STREET TREES: All trees, bushes and shrubs located between the street and the sidewalk. For those lots that do not have a sidewalk, it shall be the area between the lot line and the curb line. (Ord. 15-07, 5-4-2015)

7-6-5: STREET TREE CATEGORIES:

The following is a list of street trees by category which may be planted in street parking areas. Street trees not listed must receive prior planting approval from the public works director:

"A" CATEGORY[1] (PARKING 10 FEET TO 14 FEET)

Common Name	Minimum Spacing (Feet)	Height (Feet)	Spread (Feet)
Amur maple (tree form only)	25	20	20
Eastern redbud	25	25	20
Flowering crabapples:			
Adams	25	20	20
Centurian	25	15	5
Donald Wyman	25	15	15
Indian summer	25	20	20
Pink spire	25	25	15
Prairie fire	25	20	20
Professor Sprenger	25	15	15
Snowdrift	25	20	20
Sparkler	25	15	25
Spring snow (fruitless)	25	20	20
Zumi 'bobwhite'	25	20	15
Zumi 'catocarpa' redbud	25	20	20
Japanese tree lilac	25	15	10
Pagoda dogwood	25	20	15
Washington hawthorn[2]	25	20	15
White fringe tree	25	15	15

Notes:

1.Where utility wires are conflicting, only trees in category "A" may be planted.

2.Washington hawthorn trees should be used with caution. This beautiful tree has wicked thorns, which potentially could harm pedestrians if the tree's canopy is not raised to a proper level.

"B" CATEGORY (PARKING 12 FEET TO 14 FEET)

Common Name	Minimum Spacing (Feet)	Height (Feet)	Spread (Feet)
Columnar sugar maple	35	35	10
Greenspire linden	35	50	35
Littleleaf European linden	35	50	35
Pyramidal American linden	35	50	35
River birch (single stem only)	35	50	35
Shubert chokecherry	35	35	30

"C" CATEGORY (PARKING 14 FEET AND OVER)

Common Name	Minimum Spacing (Feet)	Height (Feet)	Spread (Feet)
Maples:			
Black maple	55	75	50
Fassems black	55	50	40
Red maple	35	60	40
Schwedler maple	55	50	30
Sugar maple	55	75	50
Oaks:			
Bur oak	55	70	50
Red oak	55	75	50
White swamp oak	55	75	50
Others:			
Hackberry	55	50	40
Kentucky coffee tree	55	60	50

Linden	55	50	40
London plane tree	55	60	50
Maidenhair tree (ginkgo, male)	55	50	40
Sycamore	55	75	50
Tulip	55	55	50

The above listed trees are recommended or highly recommended by the Iowa State University's horticulture publication, "Landscape Plants For Iowa". The flowering crabapples are listed as disease free or very disease resistant.

Red maples have several cultivars, which are tall growing trees (60 to 70 feet in height), not the previously listed thirty five feet (35'). Therefore, red maple trees were moved to category "C".

Norway maples (columnar or other) are considered nuisance trees that cast dense shade (little or no grass growth beneath the tree) and have shallow roots that can wreak havoc on concrete sidewalks and driveways.

Elm trees are not recommended because of Dutch elm disease and other infestations. Ash trees are not recommended or not available because of the emerald ash borer, which is approaching Iowa and has afflicted ash trees in states to the east and northeast. (Ord. 08-07, 7-21-2008)

7-6-6: PROHIBITED SPECIES:

It shall be unlawful to plant any of the following described species of street trees upon any street parking areas in the city along with any new species and varieties that are known to be, or which may become a public nuisance. This list includes, but is not limited to, the following:

All species of shrubbery and bushes
Birch
Black locust
Box elder
Carolina poplar
Catalpa
Common fruit trees
Conifers (evergreens)
Cottonwood
Elm (Chinese)
Ginkgo (female only)
Mountain ash
Mulberry, common
Poplar
Russian olive
Soft or silver maple
Sumac

Trees bearing large nuts, i.e., walnut, hickory, butternut
Willow
(Ord. 08-07, 7-21-2008)

7-6-7: TREE PLANTING REGULATIONS IN PARKING AREAS:

A. Spacing:

1. Trees should be spaced so that there will be little or no interference with their full development. The minimum spacing from center of tree to center of tree shall be twenty five feet (25') for category "A", thirty five feet (35') for category "B" and fifty five feet (55') for category "C".
2. Trees shall not be planted closer than one-half ($^1/_2$) of the minimum spacing requirement per category to the neighboring property owner's side or rear lot line extended, i.e., category "A" = 12.5 feet; category "B" = 17.5 feet; category "C" = 27.5 feet.

B. Impervious Materials: No impervious material shall be placed nearer than twenty four inches (24") to the trunk of the tree in categories "A" and "B" and thirty six inches (36") in category "C".

C. Curb, Sidewalk Line: No street tree shall be planted nearer than three feet (3') from the curb or the inside existing or potential sidewalk line and centered in the parking area if possible. Plantings in parking areas over eleven feet (11') in width shall be planted four feet (4') from the edge of the sidewalk.

D. Intersections: At street intersections, trees shall not be located within seventy feet (70') of the intersection of curb lines along arterial streets, within fifty feet (50') along collector streets, or within thirty feet (30') of the intersection of curb lines along local streets. In cases where two (2) different types of streets intersect, the location of the tree shall be determined by the type of street adjacent to the proposed tree.

E. Driveway, Fire Hydrant: No tree shall be planted within ten feet (10') of a driveway or fire hydrant.

F. Standards And Poles: The minimum spacing from a light standard or transmission pole shall be ten feet (10') for category "A"; twenty feet (20') for category "B"; and thirty feet (30') for category "C" measured from center of street tree to standard or pole.

G. Sewer And Water Lines: The city shall not allow the planting of street trees in the city parking area within five (5) horizontal feet of the exterior dimension of any sanitary sewer, storm sewer or water lines; and it may only be the type listed in this chapter under category "A".

H. Under Power Lines: Street trees planted under power lines may only be the type listed in this chapter under category "A".

I. Underground Utilities: The city reserves the right to restrict the planting of trees if there are too many other underground utilities in the parking such as gas, phone, etc.

J. Categories: Category "A" and "B" trees may be used in category "C" plantings as well as category "A" trees may be planted in category "B".

K. Species List: As new tree species are introduced, they will be added to these lists.

L. Enforcement: A variety of street trees planted along city blocks shall be encouraged and enforced by the public works director.

M. Nursery Stock: All street trees shall be of nursery stock unless previously approved by the public works director. (Ord. 08-07, 7-21-2008)

7-6-8: MAINTENANCE OF STREET TREES:

A. Property Owner, Duty To Remove Overhanging Limbs: It shall be the duty of all private property owners having "street trees", as defined herein, located in the "parking areas", as defined herein, or abutting or overhanging any public property, street parkings, public alleyways, public sidewalks and other private property: (Ord. 15-07, 5-4-2015)

1. To keep all trees pruned so that the lower branches are not less than eight feet (8') in height above public sidewalks, sixteen feet (16') above the traveled portion of all public streets, public alleys and primary highways.
2. To remove all damaged and broken limbs; all limbs which are or may become dangerous to travel upon the public way and all limbs that obstruct the natural flow of any meandering public streams within the city limits.
3. To remove or prune all limbs of street trees that are or may become damaging, dangerous, or a potential nuisance to abutting real and personal property.
4. To maintain all street trees in such a manner so as not to interfere with the vision of drivers or vehicles approaching any intersection, street, or alley.
5. To keep all street trees trimmed so as not to unduly obstruct streetlights or traffic signs and signals. (Ord. 08-07, 7-21-2008)

B. Removal Of Trees By City: City crews will remove dead or diseased trees, located in the parking area as defined in this chapter, as determined by the county extension office. (Ord. 15-07, 5-4-2015)

7-6-9: NUISANCE; ABATEMENT:

All street trees which are planted in violation of, or not maintained in strict compliance with, the provisions of this chapter are hereby declared to constitute a public nuisance. The public works director shall cause written notice to be served on the property owner requiring such nuisance to be corrected within a specified period, or the public works director shall cause such nuisance to be abated, and the costs thereof assessed against the owner of the property in the manner as ordinary taxes. (Ord. 08-07, 7-21-2008)

7-6-10: APPEALS TO CITY COUNCIL:

Whenever, because of unusual circumstances, there are practical difficulties involved in carrying out the provisions of this chapter, the city council may grant a specific exemption for individual situations; provided, they shall first find that special and unusual individual circumstances make the strict application of this chapter impractical and that the exemption granted with appropriate safeguards is in conformity with the intent and purposes of this chapter. (Ord. 08-07, 7-21-2008)

7-6-11: TREE TRIMMING SPECIFICATIONS:

A. Purpose: The purpose of this section is to set guidelines for the trimming of trees in the city.

B. Definition: For purposes of this section, "trees" shall include not only trees, but also bushes and other plants to be trimmed.

C. Specifications:
1. Any person trimming trees or causing trees, bushes and other plants to be trimmed under the authority of this section shall:
a. Determine if the property upon which the tree is located is publicly or privately owned; if privately owned, the entity wishing to trim (if not itself the owner) shall cause written notice to be given to the owner, occupant or person in control of the property at least fifteen (15) days prior to any trimming; provided, however, notice shall not be required if trimming is necessary to restore electrical service or relieve a public emergency resulting from storm, accident, similar casualty, or other cause which immediately threatens electrical service or public safety. The notice shall inform the person of the nature of the trimming to be performed, the person's right to trim the tree, bush or other plant, the date when such trimming must be completed if done by owner and whether an assessment or charge will be imposed for trimming the tree, bush or other plant.
b. Trim trees, bushes and plants to the extent necessary to remove obstruction to protect lives and property.
c. Employ persons skilled in tree trimming so that the life and general aesthetic qualities of the tree are preserved.
2. The owner of any tree, shrub or plant protruding into or overhanging a street or sidewalk shall trim the branches thereof to remove any obstruction of the view of any streetlamp, street sign, traffic control device or street intersection. A clear space of eight feet (8') above the surface of a sidewalk and sixteen feet (16') above the street must be maintained. All trimming shall conform to the specifications in subsection C1 of this section.
3. The city manager or his/her designee may order the removal of any tree, shrub or plant or any part thereof which does not conform to the specification of subsection C2 of this section. Notice shall be given to the owner of the property as set forth in subsection C1 of this section. If the owner, occupant or person in control fails to comply with the notice, the city manager or his/her designee shall cause the obstructing branches or foliage to be removed and shall submit the costs incident to the service of notice and removal to the city council, which shall certify the same to the county auditor for collection with and in the same manner as general property taxes. Provided, however, that in the event the city manager or his/her designee determines that a hazardous condition exists which constitutes an immediate danger to public safety because of the extensive nature or location of an obstruction caused by any tree, shrub, plant or any part thereof, the city manager or his/her designee may cause the removal thereof forthwith without notice and in such event, costs may be assessed in the same manner as provided above, after notice to the property owner and opportunity for hearing before the city council is given.
4. Except as provided by subsection C3 of this section, no tree, bush or shrub shall be removed without the written consent of the owner of the property upon which the tree, bush or shrub is located. (Ord. 08-07, 7-21-2008)

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If you need accommodations because of disability to access the services of this Agency, please contact the Director at 515-725-8200.