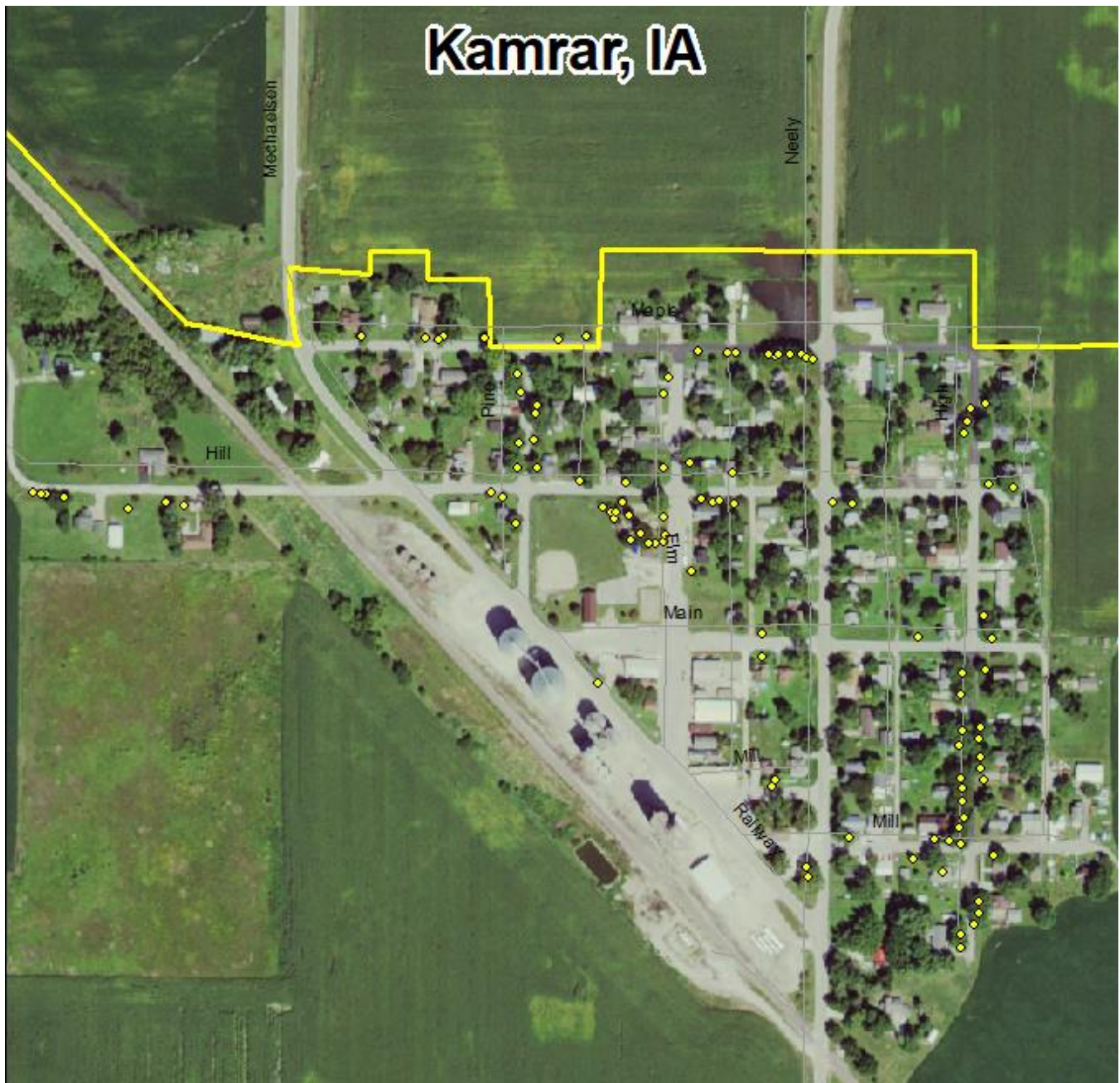


Kamrar, IA



2018 Urban Forest Management Plan
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Executive Summary

Overview

This plan was developed to assist the City of Kamrar 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 17% of Kamrar's city owned trees (ash) will die once EAB becomes established in the community, unless preventative treatment is used. With proper planning and management, the costs of removing dead and dying trees can be extended over years, mitigating public safety issues.

Inventory and Results

In 2018, a tree inventory was conducted using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street and park trees. Below are some key findings of the 105 trees inventoried.

- Kamrar's trees provide \$20,748 of benefits annually, an average of \$197 per tree
- There are over 15 species of trees
- The top three genera are: Maple 33%, Apple 25%, and Ash 17%
- 21% of trees are in immediate or greater need of some type of management
- 8 trees are recommended for removal

Recommendations

The core recommendations are detailed in the Recommendations Section. The Emerald Ash Borer Plan includes management recommendations as well. Below are some key recommendations.

- Of the 8 trees needing removal, 3 trees are over 30 inches in diameter at 4.5 ft and must be addressed immediately [*City ownership of the trees recommended for removal should be verified prior to any removal*](#)
- 3 of the 18 ash trees should be removed as soon as possible.
- 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 a budget of \$2,000 per year it would take more than 7 years to remove all ash trees.

Introduction

This plan was developed to assist Kamrar with the management, budgeting and future planning of their urban forest. Across the state, forestry budgets continue to decrease with more and more of that money spent on tree removal. With the anticipated arrival of Emerald Ash Borer (EAB), an invasive pest that kills native ash trees, it is time to prepare for the increased costs of tree removal or treatment and replacement planting. With proper planning and management of the current canopy in Kamrar, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

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

Inventory

In 2018, a tree inventory was conducted that included 100% of the city-owned street and park trees. The tree data was collected using a handheld Global Positioning System (GPS) receiver. The data collector gives Geographic Information Systems (GIS) coordinates with an accuracy of 3 meters, which can be used in Arc GIS as an active GIS data layer. Because the inventory is a digital document the data can be updated with new information and become a working document.

The programming used to collect tree information on the data collectors was written to be compatible with a state-of-the-art software suite called i-Tree. i-Tree was developed by the USDA Forest Service to quantify the structure of community trees and the environmental services that trees provide. The i-Tree suite is a public domain which can be accessed for free.

To quantify the urban forest structure and benefits, specific data is collected for each tree. This data includes: location, land use, species, diameter at 4.5 ft, recommended maintenance, priority of that maintenance, leaf health, and wood condition. Additionally, signs and symptoms associated with EAB were noted for all ash trees. The signs and symptoms noted were canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Inventory Results

The data collected for the 105 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. Kamrar's trees reduce energy related costs by approximately \$5,380 annually (Appendix A, Table 1). These savings are both in Electricity (25.7 MWh) and in Natural Gas (3,497.2 Therms).

Annual Stormwater Benefits

Kamrar's trees intercept about 290,637 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides \$7,876 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 Kamrar, it is estimated that trees remove 344.5 lbs. of air pollution (ozone (O₃), particulate matter less than 10 microns (PM₁₀), carbon monoxide (CO), nitrogen dioxide (NO₂), and sulfur dioxide (SO₂)) per year with a net value of \$975 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Kamrar, trees sequester about 67,543 lbs. of carbon a year with an associated value of \$507 (Appendix A, Table 5). In addition, the trees store 1,243,403 lbs. of carbon, with a yearly benefit of \$9,326 (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. Kamrar receives \$5,734 in annual social benefits from trees (Appendix A, Table 6).

Financial Summary of all Benefits

According to the USDA Forest Service i-Tree STREETS analysis, Kamrar's trees provide \$20,748 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 105 trees in Kamrar provide approximately \$197 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Kamrar has over 15 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Maple	35	33%
Apple	26	25%
Ash	18	17%
Black Walnut	6	6%
Honeylocust	5	5%
Eastern Redcedar	3	3%
Mulberry	2	2%
American Sycamore	1	<1%
Flowering Dogwood	1	<1%
Littleleaf Linden	1	<1%
Northern Catalpa	1	<1%
Northern Hackberry	1	<1%
Northern White Cedar	1	<1%
Pear	1	<1%
Red Oak	1	<1%
Spruce	1	<1%
Broadleaf Decid Med	1	<1%

Age Class

Most of Kamrar's trees (60%) are between 6 and 24 inches in diameter at 4.5 ft (Appendix A, Figure 2). For age, it is preferred that the highest amounts of trees are in the smallest size category (a downward slope) to prepare for natural mortality and to maintain canopy cover. Kamrar's size curve is on the smaller-to-medium side, indicating a younger than average stand.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the overall health of the urban forest. The foliage condition results for Kamrar indicate that 92% 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, 90% of Kamrar's trees are in fair or 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 10% 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).

Crown Cleaning	50	48%
Crown Raising	27	26%
Crown Reduction	9	9%
Tree Removal	8	8%
Staking/Training	1	<1%

Canopy Cover

The total canopy cover of public trees is 3.05 acres; this represents less than 1% of total land area for the city of Kamrar (Appendix A, Figure 4).

Land Use and Location

The majority of Kamrar's city and park trees are in front yards in single family residential neighborhoods (Appendix A, Figure 6 & Appendix A, Figure 7). The following describes the land use and locations for the street and park trees.

Land Use

Single family residential	76%
Industrial/Large Commercial	18%
Park/Vacant/Other	4%
Multifamily residential	2%

Location

Front Yard	67%
Planting Strip	32%
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

Kamrar has 2 trees that should be removed as soon as possible. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). It is recommended to start with the large diameter critical concern trees first. There is one tree over 42 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 and immediate trees are addressed, there should be follow up on the trees marked as needing maintenance. There are a total of 74 trees with these needs.

Poor tree species

After the removal of the critical concern and immediate need trees, ash trees in poor health should be assessed for removal (Appendix B, Figures 3 and 4). Of the 8 removals, 3 are ash trees. Of the 18 total ash trees, 3 are in poor health for wood condition and should therefore be monitored closely. [*City ownership of the trees recommended for removal should be verified prior to any removal*](#)

Pruning Cycle

Proper pruning can extend the life and good health of trees, as well as reduce public safety issues. In the Management Needs section of the Findings there are four main maintenance issues to be addressed: routine pruning, crown cleaning, crown raising, and crown reduction. Crown cleaning removes dead, diseased, and damaged limbs. Crown raising is the removal of lower branches that are 2 inches in diameter or larger in the case of providing clearance for pedestrians or vehicles. Crown reduction is removing individual limbs from structures or utility wires. It is recommended that all trees be pruned on a routine schedule every five to seven years. Please refer to the six year maintenance plan for further information.

Planting

Most of the planting over the next 5 years will replace the trees that are removed. It is recommended to plant 1.2 trees for every tree removed, since survival rates will not be 100%. Please refer to the six year maintenance plan at the end of this section. It is not essential that the new trees be planted in the same location of the trees being removed. However, maintaining the same number of trees helps ensure continuation of the benefits of the existing forest in Kamrar.

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 (33%) (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 and black walnut.

Continual Monitoring

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

Six Year Maintenance Plan

Year 1

Removal: 2 largest critical concern trees
Planting and Replacement: 3 trees to be planted in open locations
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 2

Removal: 2 ash trees marked for removal
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 2 trees in open locations from year one removals
Young Tree Pruning & Maintenance:
Routine trimming: Contract to trim 1/3 of the city trees
Visual Survey for signs and symptoms of EAB

Year 3

Removal: 1 ash tree marked for removal and 1 additional tree in need of removal
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 3 trees to be planted in open locations and locations from previous removals
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 4

Removal: 2 trees, including any new critical concern trees and/or ash in poor health
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 2 trees in open locations from previous removals
Routine trimming: Contract to trim 1/3 of the city trees
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 5

Removal: 2 trees, including any new critical concern trees and/or ash in poor health
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 3 trees to be planted in open locations and locations from previous removals
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 6

Removal: 2 trees, including any new critical concern trees and/or ash in poor health
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 2 trees in open locations from previous removals
Routine trimming: Contract to trim 1/3 of the city trees
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

*Reduction of ash over 6 years: Approximately 3-6 ash trees removed (approximately 16-33% if ash). It will take approximately 8 years to remove all ash with a yearly budget of \$2,000. EAB could potentially kill all ash within 4 to 15 years of its arrival.

**To remove all ash trees within 6 years, the budget would need to be increased to \$2,500 per year. If the budget were increased to \$3,000 a year all ash could be removed in 5 years.

Emerald Ash Borer Plan

Ash Tree Removal

Tree removal will be prioritized with dead, dying, hazardous trees to be removed first (Appendix B, Figure 4). Next will be all ash in poor condition and displaying signs and symptoms of EAB (Appendix B, Figure 2 & Appendix B, Figure 3). **City ownership of the tree recommended for removal should be verified prior to any removal**

Treatment of Ash Trees

Chemical treatment can be effective tool for communities to spread removal costs out over several years while allowing trees to continue to provide benefits. However, treatment is not recommended if EAB is more than 15 miles away from the community. For more information on the cost of treatment strategies visit <http://extension.entm.purdue.edu/treecomputer/>

EAB Quarantines

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

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

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

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

Wood Disposal

A very important aspect of planning is determining how wood infested with EAB will be handled, keeping in mind that quarantines will restrict its movement. Consider who will cut and haul the dead and dying trees? Is there an accessible, secured site big enough to store and sort the hundreds of trees and the associated brush and chips? How will wood be disposed of or utilized? Do you have equipment capable of handling the amount and size of ash trees your tree inventory has identified? Once your

county is under quarantine for EAB, contact USDA-APHIS-PPQ at 515-251-4083 or visit the website http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/regulatory.shtml. Wood waste can be disposed of as you normally would if your county is not part of a quarantine.

Canopy Replacement

As budget permits, all removed trees will be replaced with trees that conform to city code.

Postponed Work

While finances, staffing and equipment are focused on the management of ash, usual services may be delayed. Tree removal requests on genera other than ash will be prioritized by hazardous or emergency situations only.

Monitoring

It is recommended that ash trees be checked with a visual survey every year for tree death and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Private Ash Trees

It is strongly recommended that private property owners start removing ash trees on their property upon arrival of EAB if preventative treatments are not being used.

Budget

Current Budget

Total \$12,000 over 6 years (\$2,000/year)

FY 2018 Budget

Removal: \$1,500

*Or saving for ash tree treatment and/or future ash removal

Planting: \$300

Watering & Maintenance: \$100

FY 2019 Budget

Removal: \$1,500

*Or saving for ash tree treatment and/or future ash removal

Planting: \$200

Routine trimming: \$200

Watering & Maintenance: \$100

FY 2020 Budget

Removal: \$1,500

*Or saving for ash tree treatment and/or future ash removal

Planting: \$300

Watering & Maintenance: \$100

FY 2021 Budget

Removal: \$1,500

*Or saving for ash tree treatment and/or future ash removal

Planting: \$200

Routine trimming: \$200

Watering & Maintenance: \$100

FY 2022 Budget

Removal: \$1,500

*Or saving for ash tree treatment and/or future ash removal

Planting: \$300

Watering & Maintenance: \$100

FY 2023 Budget

Removal: \$1,500

*Or saving for ash tree treatment and/or future ash removal

Planting: \$200

Routine trimming: \$200

Watering & Maintenance: \$100

*Reduction of ash over 6 years: approximately 3 – 6 ash trees removed (approximately 16-33% of ash).

It will take approximately 8 years to remove all ash with a budget of \$2,000 per year.

Proposed Budget Increase

EAB could potentially kill all ash trees in Kamrar within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to \$2,500 per year. If the budget were \$3,000 per year all ash could be removed within 5 years. Additionally, it is recommended that Kamrar apply for grants to fund replacement trees. Utility Company grants are usually between \$500 and \$10,000 for community-based, tree-planting projects that include parks, gateways, cemeteries, nature trails, libraries, nursing homes, and schools.

Another option being considered by many communities is treating a number of selected trees, either to maintain those trees in the landscape or to delay their removal – to spread out the costs and number of trees needing removed all at once. Trunk injection is administered every two years for the life of the tree. If treatment is discontinued, the tree dies. For instance, in this treatment scenario, the average ash diameter is 26 inches and at \$15 per inch, about 2 trees could be treated per year (every other year treatment). This would be 6 trees selected for treatment, and Kamrar would still need to find at least \$9,000 in total for removal. Alternatively, if there are only 3 treatable trees, it would cost approximately \$390 per year for treatment, which would leave approximately \$1,500 for removal (not including replanting, maintenance and care). These are alternatives to straight removal of ash trees. However, whether or not the treatment option is selected, there will be an increased cost of dealing with ash trees if EAB is found in Kamrar. It is suggested to consider increasing the budget to plan for this.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Kamrar

Annual Energy Benefits of Public Trees

3/25/2018

Species	Total Electricity (MWh)	Electricity (\$)	Total Natural Gas (Therms)	Natural Gas (\$)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Apple	3.6	270	516.0	506	775	(N/A)	24.8	14.4	29.82
Green ash	5.3	404	709.7	696	1,099	(N/A)	17.1	20.4	61.08
Silver maple	6.9	521	905.1	887	1,408	(N/A)	17.1	26.2	78.23
Norway maple	2.3	174	339.0	332	506	(N/A)	8.6	9.4	56.26
Maple	1.3	97	163.1	160	257	(N/A)	5.7	4.8	42.78
Black walnut	1.6	123	226.3	222	344	(N/A)	5.7	6.4	57.40
Honeylocust	1.8	135	232.0	227	362	(N/A)	4.8	6.7	72.38
Eastern red cedar	0.3	21	40.8	40	61	(N/A)	2.9	1.1	20.20
Black maple	0.5	39	60.1	59	98	(N/A)	1.9	1.8	48.95
Mulberry	0.1	6	13.5	13	19	(N/A)	1.9	0.4	9.53
Northern hackberry	0.5	40	69.7	68	108	(N/A)	1.0	2.0	108.50
Spruce	0.1	4	9.5	9	14	(N/A)	1.0	0.3	13.58
UNKNOWN	0.0	0	0.0	0	0	(N/A)	1.0	0.0	0.00
Northern white cedar	0.1	11	19.7	19	30	(N/A)	1.0	0.6	30.47
American sycamore	0.5	37	63.1	62	99	(N/A)	1.0	1.8	98.63
Pear	0.2	15	31.6	31	46	(N/A)	1.0	0.9	46.14
Catalpa	0.3	25	46.9	46	71	(N/A)	1.0	1.3	70.91
Flowering dogwood	0.0	2	3.8	4	5	(N/A)	1.0	0.1	5.40
Littleleaf linden	0.2	15	23.9	23	39	(N/A)	1.0	0.7	38.70
Northern red oak	0.2	15	23.3	23	38	(N/A)	1.0	0.7	37.72
Total	25.7	1,953	3,497.2	3,427	5,380	(N/A)	100.0	100.0	51.24

**Table 2: Annual Stormwater Benefits
Kamrar**

Annual Stormwater Benefits of Public Trees						
3/25/2018						
Species	Total rainfall interception (Gal)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Apple	13,727	372	(N/A)	24.8	4.7	14.31
Green ash	66,506	1,802	(N/A)	17.1	22.9	100.13
Silver maple	109,796	2,975	(N/A)	17.1	37.8	165.30
Norway maple	21,920	594	(N/A)	8.6	7.5	66.00
Maple	8,929	242	(N/A)	5.7	3.1	40.33
Black walnut	15,771	427	(N/A)	5.7	5.4	71.23
Honeylocust	21,644	587	(N/A)	4.8	7.4	117.31
Eastern red cedar	3,928	106	(N/A)	2.9	1.4	35.49
Black maple	3,208	87	(N/A)	1.9	1.1	43.46
Mulberry	272	7	(N/A)	1.9	0.1	3.68
Northern hackberry	6,493	176	(N/A)	1.0	2.2	175.96
Spruce	596	16	(N/A)	1.0	0.2	16.14
UNKNOWN	0	0	(N/A)	1.0	0.0	0.00
Northern white cedar	2,969	80	(N/A)	1.0	1.0	80.46
American sycamore	7,239	196	(N/A)	1.0	2.5	196.17
Pear	1,174	32	(N/A)	1.0	0.4	31.82
Catalpa	3,943	107	(N/A)	1.0	1.4	106.85
Flowering dogwood	69	2	(N/A)	1.0	0.0	1.86
Littleleaf linden	1,260	34	(N/A)	1.0	0.4	34.14
Northern red oak	1,193	32	(N/A)	1.0	0.4	32.34
Citywide total	290,637	7,876	(N/A)	100.0	100.0	75.01

Table 3: Annual Air Quality Benefits

Kamrar

Annual Air Quality Benefits of Public Trees

3/25/2018

Species	Deposition (lb)				Total Depos. (\$)	Avoided (lb)				Total Avoided (\$)	BVOC Emissions (lb)	BVOC Emissions (\$)	Total (lb)	Total (\$)	Standard Error	% of Total Trees	Avg. \$/tree
	O ₃	NO ₂	PM ₁₀	SO ₂		NO ₂	PM ₁₀	VOC	SO ₂								
Apple	4.0	0.7	1.9	0.2	21	17.2	2.5	2.4	16.1	107	0.0	0	45.0	128 (N/A)	24.8	4.93	
Green ash	10.1	1.6	4.6	0.5	53	25.2	3.7	3.5	24.1	158	0.0	0	73.3	211 (N/A)	17.1	11.71	
Silver maple	20.9	3.5	10.0	0.9	112	32.4	4.7	4.5	31.0	203	-10.9	-41	97.1	274 (N/A)	17.1	15.20	
Norway maple	4.5	0.8	2.2	0.2	24	11.2	1.6	1.5	10.4	69	-1.0	-4	31.3	89 (N/A)	8.6	9.93	
Maple	1.9	0.3	0.9	0.1	10	6.0	0.9	0.8	5.8	38	-0.7	-3	16.0	45 (N/A)	5.7	7.51	
Black walnut	1.7	0.3	0.8	0.1	9	7.8	1.1	1.1	7.3	48	0.0	0	20.1	57 (N/A)	5.7	9.54	
Honeylocust	4.3	0.7	1.9	0.2	23	8.3	1.2	1.2	8.0	52	-3.4	-13	22.5	62 (N/A)	4.8	12.42	
Eastern red cedar	0.7	0.1	0.6	0.1	5	1.3	0.2	0.2	1.2	8	-2.2	-8	2.4	5 (N/A)	2.9	1.66	
Black maple	0.6	0.1	0.3	0.0	3	2.4	0.4	0.3	2.3	15	-0.2	-1	6.2	18 (N/A)	1.9	8.75	
Mulberry	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)	1.9	1.33	
Northern hackberry	1.7	0.3	0.8	0.1	9	2.5	0.4	0.3	2.4	16	0.0	0	8.4	25 (N/A)	1.0	24.53	
Spruce	0.1	0.0	0.1	0.0	0	0.3	0.0	0.0	0.3	2	-0.2	-1	0.6	1 (N/A)	1.0	1.48	
UNKNOWN	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0 (N/A)	1.0	0.00	
Northern white cedar	0.3	0.1	0.3	0.0	2	0.7	0.1	0.1	0.7	4	-1.4	-5	0.9	1 (N/A)	1.0	1.45	
American sycamore	1.6	0.3	0.7	0.1	8	2.3	0.3	0.3	2.2	14	0.0	0	7.7	23 (N/A)	1.0	22.55	
Pear	0.4	0.1	0.2	0.0	2	1.0	0.1	0.1	0.9	6	0.0	0	2.9	8 (N/A)	1.0	8.35	
Catalpa	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)	1.0	12.48	
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)	1.0	0.71	
Littleleaf linden	0.2	0.0	0.1	0.0	1	0.9	0.1	0.1	0.9	6	-0.1	0	2.3	6 (N/A)	1.0	6.42	
Northern red oak	0.2	0.0	0.1	0.0	1	0.9	0.1	0.1	0.9	6	-0.3	-1	2.1	6 (N/A)	1.0	5.79	
Citywide total	53.6	9.0	25.8	2.5	288	122.5	17.9	17.0	116.5	764	-20.4	-76	344.5	975 (N/A)	100.0	9.29	

Table 4: Annual Carbon Stored

Kamrar

Stored CO2 Benefits of Public Trees

3/25/2018

Species	Total Stored CO2 (lbs)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Apple	62,225	467	(N/A)	24.8	5.0	17.95
Green ash	340,006	2,550	(N/A)	17.1	27.3	141.67
Silver maple	509,096	3,818	(N/A)	17.1	40.9	212.12
Norway maple	73,012	548	(N/A)	8.6	5.9	60.84
Maple	21,019	158	(N/A)	5.7	1.7	26.27
Black walnut	53,275	400	(N/A)	5.7	4.3	66.59
Honeylocust	55,722	418	(N/A)	4.8	4.5	83.58
Eastern red cedar	2,481	19	(N/A)	2.9	0.2	6.20
Black maple	7,248	54	(N/A)	1.9	0.6	27.18
Mulberry	922	7	(N/A)	1.9	0.1	3.46
Northern hackberry	28,932	217	(N/A)	1.0	2.3	216.99
Spruce	257	2	(N/A)	1.0	0.0	1.93
UNKNOWN	0	0	(N/A)	1.0	0.0	0.00
Northern white cedar	3,343	25	(N/A)	1.0	0.3	25.07
American sycamore	55,982	420	(N/A)	1.0	4.5	419.86
Pear	6,743	51	(N/A)	1.0	0.5	50.57
Catalpa	15,773	118	(N/A)	1.0	1.3	118.30
Flowering dogwood	178	1	(N/A)	1.0	0.0	1.33
Littleleaf linden	3,595	27	(N/A)	1.0	0.3	26.96
Northern red oak	3,595	27	(N/A)	1.0	0.3	26.96
Citywide total	1,243,403	9,326	(N/A)	100.0	100.0	88.81

Table 5: Annual Carbon Sequestered

Kamrar

Annual CO₂ Benefits of Public Trees

3/25/2018

Species	Sequestered (lb)	Sequestered (\$)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released (\$)	Avoided (lb)	Avoided (\$)	Net Total (lb)	Total Standard (\$)	% of Total Trees	% of Total \$	Avg. \$/tree
Apple	5,613	42	-299	-43	-3	5,959	45	11,230	84 (N/A)	24.8	10.8	3.24
Green ash	10,958	82	-1,632	-58	-13	8,926	67	18,194	136 (N/A)	17.1	17.4	7.58
Silver maple	33,401	251	-2,444	-81	-19	11,515	86	42,392	318 (N/A)	17.1	40.6	17.66
Norway maple	3,700	28	-350	-24	-3	3,848	29	7,173	54 (N/A)	8.6	6.9	5.98
Maple	2,703	20	-101	-11	-1	2,141	16	4,732	35 (N/A)	5.7	4.5	5.92
Black walnut	3,941	30	-256	-16	-2	2,711	20	6,380	48 (N/A)	5.7	6.1	7.97
Honeylocust	2,422	18	-267	-14	-2	2,974	22	5,115	38 (N/A)	4.8	4.9	7.67
Eastern red cedar	83	1	-12	-5	0	456	3	521	4 (N/A)	2.9	0.5	1.30
Black maple	966	7	-35	-4	0	862	6	1,789	13 (N/A)	1.9	1.7	6.71
Mulberry	123	1	-4	-1	0	130	1	246	2 (N/A)	1.9	0.2	0.92
Northern hackberry	745	6	-139	-6	-1	887	7	1,488	11 (N/A)	1.0	1.4	11.16
Spruce	53	0	-1	-1	0	94	1	145	1 (N/A)	1.0	0.1	1.08
UNKNOWN	0	0	0	0	0	0	0	0	0 (N/A)	1.0	0.0	0.00
Northern white cedar	187	1	-16	-3	0	246	2	415	3 (N/A)	1.0	0.4	3.11
American sycamore	479	4	-269	-6	-2	813	6	1,017	8 (N/A)	1.0	1.0	7.63
Pear	478	4	-32	-3	0	335	3	778	6 (N/A)	1.0	0.7	5.84
Catalpa	857	6	-76	-4	-1	552	4	1,330	10 (N/A)	1.0	1.3	9.97
Flowering dogwood	38	0	-1	-1	0	37	0	74	1 (N/A)	1.0	0.1	0.55
Littleleaf linden	514	4	-17	-2	0	337	3	832	6 (N/A)	1.0	0.8	6.24
Northern red oak	281	2	-17	-2	0	329	2	591	4 (N/A)	1.0	0.6	4.43
Citywide total	67,543	507	-5,968	-283	-47	43,152	324	104,443	783 (N/A)	100.0	100.0	7.46

**Table 6: Annual Social and Aesthetic Benefits
Kamrar**

Annual Aesthetic/Other Benefits of Public Trees

3/25/2018

Species	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Apple	325	(N/A)	24.8	5.7	12.50
Green ash	860	(N/A)	17.1	15.0	47.78
Silver maple	2,392	(N/A)	17.1	41.7	132.89
Norway maple	344	(N/A)	8.6	6.0	38.17
Maple	366	(N/A)	5.7	6.4	61.07
Black walnut	342	(N/A)	5.7	6.0	57.03
Honeylocust	584	(N/A)	4.8	10.2	116.70
Eastern red cedar	35	(N/A)	2.9	0.6	11.68
Black maple	132	(N/A)	1.9	2.3	65.89
Mulberry	6	(N/A)	1.9	0.1	3.22
Northern hackberry	81	(N/A)	1.0	1.4	81.25
Spruce	15	(N/A)	1.0	0.3	15.42
UNKNOWN	0	(N/A)	1.0	0.0	0.00
Northern white cedar	47	(N/A)	1.0	0.8	47.08
American sycamore	29	(N/A)	1.0	0.5	28.57
Pear	29	(N/A)	1.0	0.5	28.80
Catalpa	66	(N/A)	1.0	1.1	65.59
Flowering dogwood	2	(N/A)	1.0	0.0	2.06
Littleleaf linden	55	(N/A)	1.0	1.0	55.09
Northern red oak	24	(N/A)	1.0	0.4	24.08
Citywide total	5,734	(N/A)	100.0	100.0	54.61

Table 7: Summary of Benefits in Dollars

Kamrar

Total Annual Benefits of Public Trees by Species (\$)

3/25/2018

Species	Energy	CO ₂	Air Quality	Stormwater	Aesthetic/Other	Total (\$)	Standard Error	% of Total \$
Apple	775	84	128	372	325	1,685	(N/A)	8.1
Green ash	1,099	136	211	1,802	860	4,109	(N/A)	19.8
Silver maple	1,408	318	274	2,975	2,392	7,367	(N/A)	35.5
Norway maple	506	54	89	594	344	1,587	(N/A)	7.6
Maple	257	35	45	242	366	946	(N/A)	4.6
Black walnut	344	48	57	427	342	1,219	(N/A)	5.9
Honeylocust	362	38	62	587	584	1,632	(N/A)	7.9
Eastern red cedar	61	4	5	106	35	211	(N/A)	1.0
Black maple	98	13	18	87	132	348	(N/A)	1.7
Mulberry	19	2	3	7	6	37	(N/A)	0.2
Northern hackberry	108	11	25	176	81	401	(N/A)	1.9
Spruce	14	1	1	16	15	48	(N/A)	0.2
UNKNOWN	0	0	0	0	0	0	(N/A)	0.0
Northern white cedar	30	3	1	80	47	163	(N/A)	0.8
American sycamore	99	8	23	196	29	354	(N/A)	1.7
Pear	46	6	8	32	29	121	(N/A)	0.6
Catalpa	71	10	12	107	66	266	(N/A)	1.3
Flowering dogwood	5	1	1	2	2	11	(N/A)	0.1
Littleleaf linden	39	6	6	34	55	141	(N/A)	0.7
Northern red oak	38	4	6	32	24	104	(N/A)	0.5
Citywide Total	5,380	783	975	7,876	5,734	20,748	(N/A)	100.0

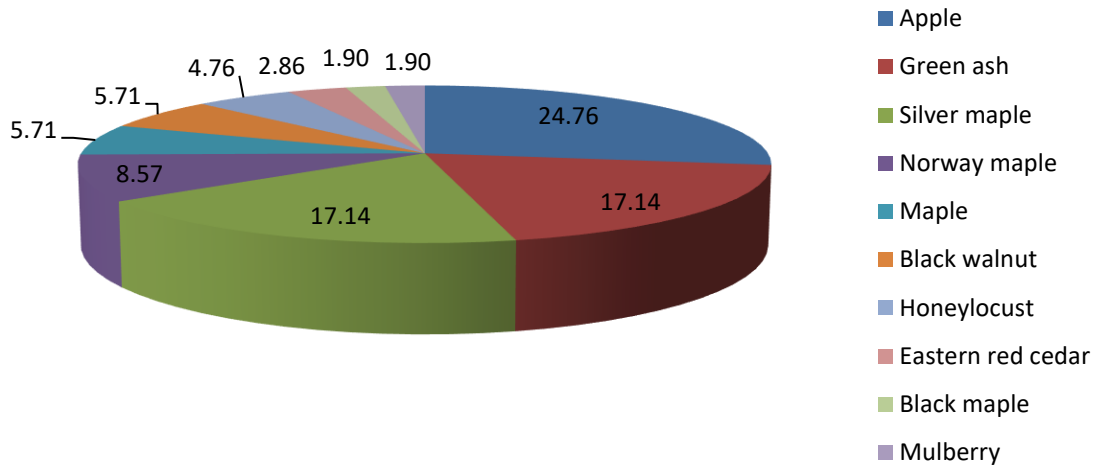


Figure 1: Species Distribution

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

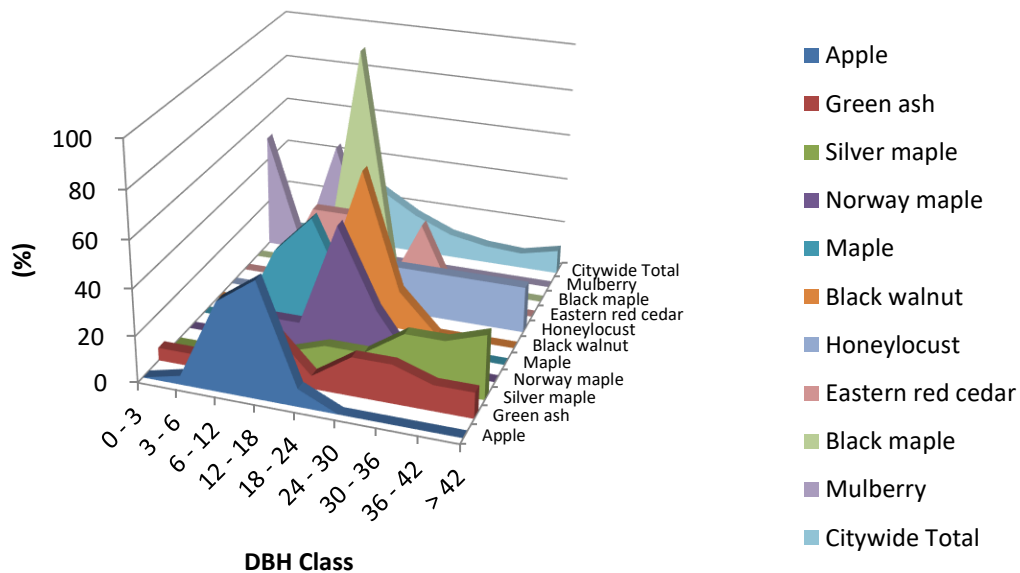


Figure 2: Relative Age Class

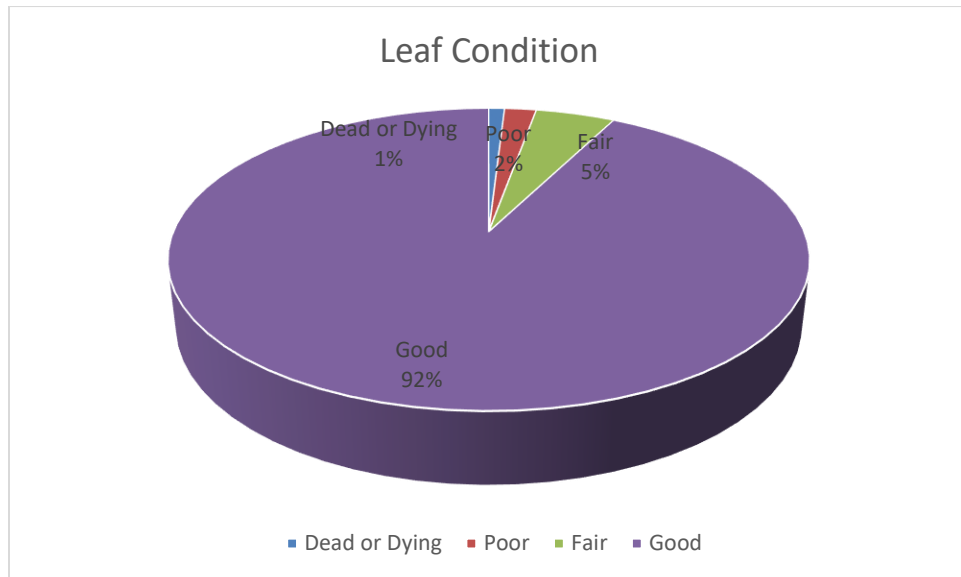


Figure 3: Foliage Condition

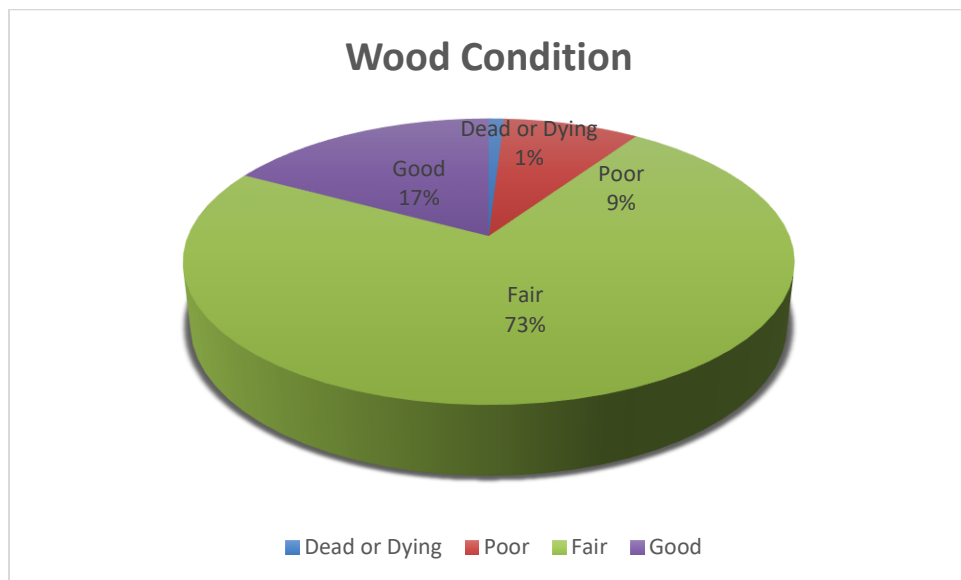


Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

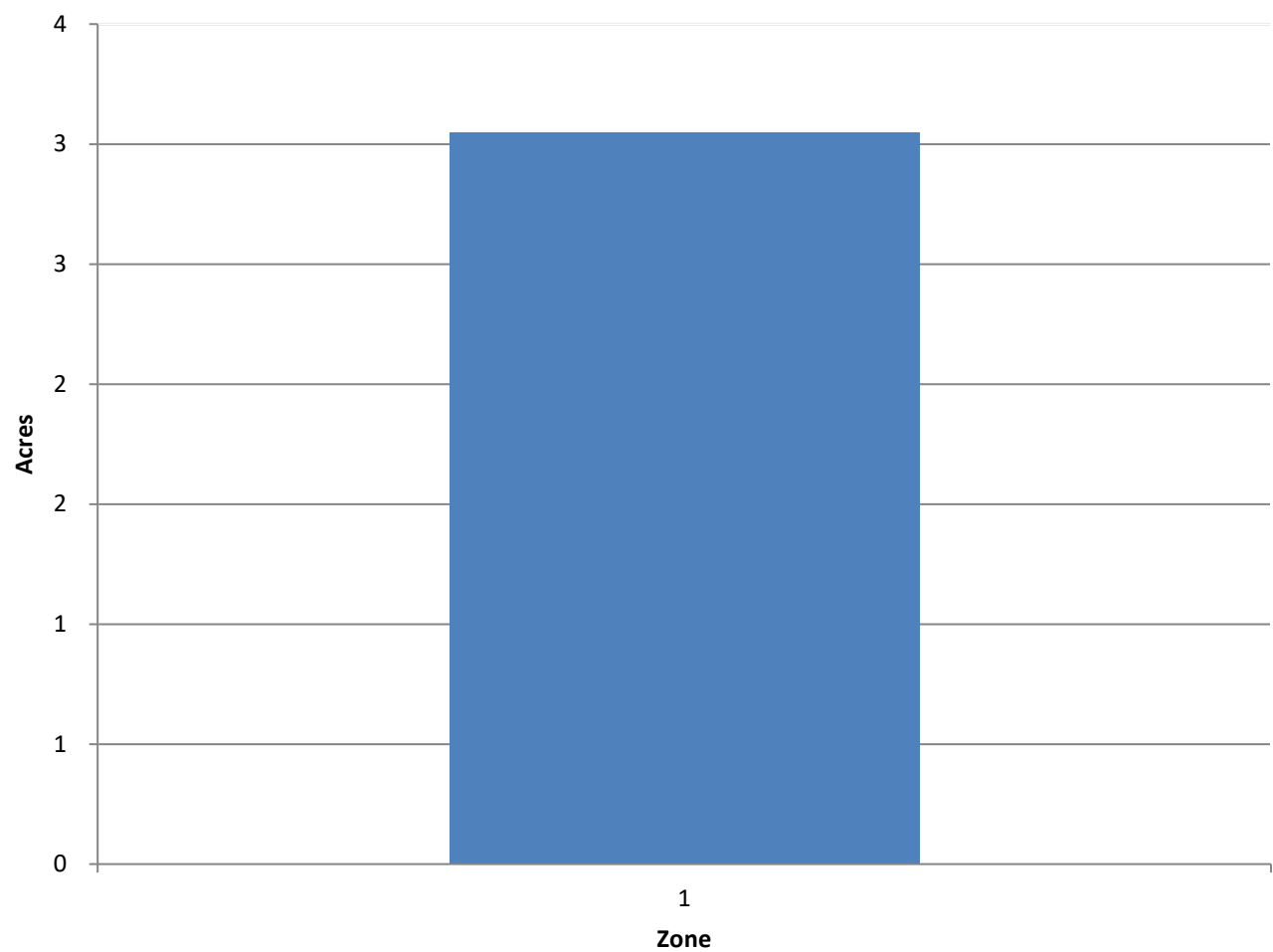


Figure 5: Canopy Cover in Acres

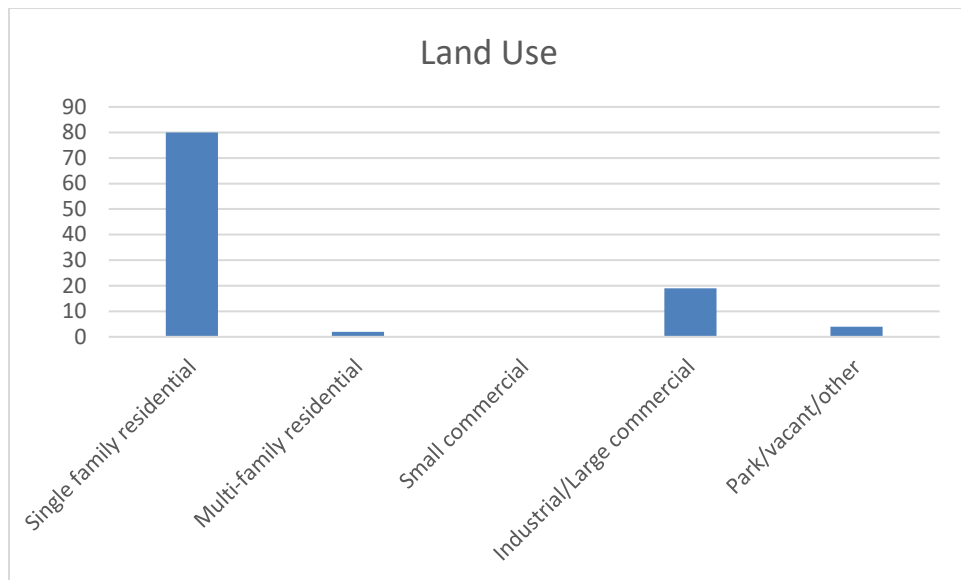


Figure 6: Land Use of city/park trees

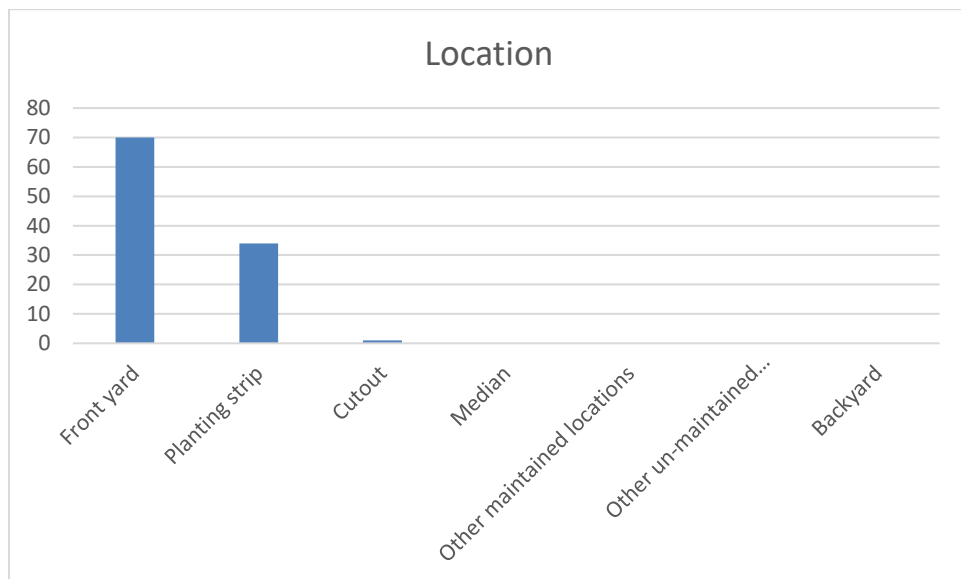


Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping



Figure 1: Location of Ash Trees



Figure 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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